Chapter -11

Electric Current

SYNOPSIS

According to Drude and Lorentz, metals contain a large number of free electrons while the positive ions are fixed in their locations. When the conductor is in open the net charge moving along a conductor through any cross section is Zero. When the ends of the conductor are connected to the battery through a bulb the bulb glows.

If 'Q' is the charge crossing through any cross section of the conductor in a time interval 't', then electric current $I = \frac{Q}{t}$. A conductor with cross section is 'A' and V_d is the drift speed of the electron, n is the number of electrons then electric current $I = nqAv_d$, where q is the charge of an electron.

Potential is the work done by the electric force on unit positive charge to move it through a certain distance. The S.I unit of potential is "Volt".

1volt = 1 joule/coulomb.

Ohm's law is an empirical law which connects voltage and current. It states that "at constant temperature the current through the conductor (I) is directly proportional to voltage difference between the ends of conductor". i.e. $V \alpha I$ or $V = IR$, where 'R' is the resistance. When resistors are connected in series them the effective resistance.

$$R_{eq} = R_1 + R_2 + R_3 + \ldots\ldots$$

When resistors are connected in parallel then the effective resistance is-

$$\frac{1}{Req} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4} \ldots\ldots$$

To DC circuits there are two Kirchhoff's laws. 1) Junction law, 2) Loop law. Electric power can be calculate by the formula

$$p = I^2 R = {v^2}/{R}.$$

2 Mark Questions

1. Are the headlights of a car connected in series or parallel? Why? [AS2]

A. The headlights of car are connected in parallel due to following reasons.

1) Same potential (Voltage) will be maintained in two head lights.
2) If one of the lights be damaged, the other light will work without any disturbance.

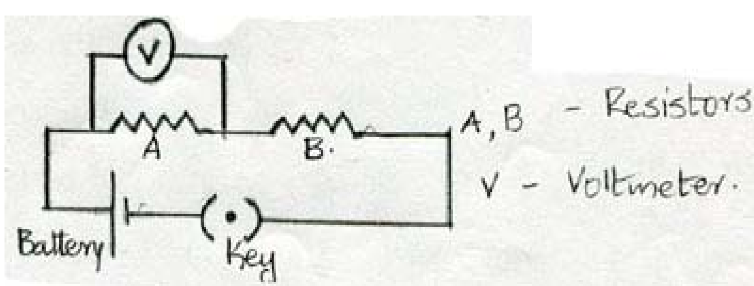
2. Why should we connect electric appliances in parallel in household circuit? What happens if they are connected in series? [AS2]

A. The household appliances are connected in parallel in a household circuit.

Reason: If they are connected in series, if any appliance switched off, other appliances get off. So to avoid this we use parallel connection.

3. Draw a circuit diagram for a circuit in which two resistors A and B are connected to measure the potential difference across the resistor A [AS5]

A.



A, B – Resistors

V – Voltmeter

1 Mark Questions

1. What is a value of 1KWh in joules [AS1]

A. Given

1KWh $= 1000\text{ w} \times 1\text{ hour}$

$= 1000 \times 3600\text{ sec}$ (1w= 1Joule/ sec)

$= 36 \times 10^5$ Joules

$= 3.6 \times 10^6$ Joules.

2. Silver is a better conductor of electricity than copper. Why do we use copper wire for conduction for electricity? [AS1]

A. Silver is a better conductor of electricity than copper. But silver is a costly metal than copper. Hence copper is widely used for conduction for electricity.

3. Why don't we use series arrangement of electrical appliances like bulb, television, fan and others in domestic circuits? [AS1]

A. In series combination same current passes through all resistors in circuit. So, this series combination is not suggestible for household appliances like T.V, bulb, fan.

4. Why do we consider tungsten as suitable material for making the filament of a bulb? [AS2]

A. The filament of an electric bulb is usually made of tungsten, because of its higher resistivity value ($5.56 \times 10^{-8}\ \Omega m$) and its high melting point (3422^0c).

5. a) Take a battery and measure the potential difference make a circuit and measure the potential difference when the battery is connected in a circuit. Is there any difference in potential difference in battery? [AS4]

A. No. We don't find any change in potential difference in either case.

b) Measure the resistance of a bulb (filament) in open circuit with a millimeter. Make a circuit with elements such as bulb, battery of 12v and key in series. Close the key. Then again measure the resistance of same bulb for every 30 seconds. Record the observations in a proper table. What can you conclude from above results? [AS4]

A. When the bulb is connected in a circuit and key is closed the resistance increase for every 30 seconds.

Conclusion:

1. The potential difference never changes in open circuit and closed circuit. The resistance of conductor increases when temperature of conductor increases.

4 Mark Questions

1. Explain how electron flow causes electric current with Lorentz – Drude theory of electrons. [AS1]

A. 1. Drude and Lorentz, scientists of 19th century, proposed that conductors like metals contain large number of free electrons while the positive ions are fixed in their locations. The arrangement of positive ions is called lattice.

2. When the conductor is in an open circuit, the electrons move randomly in lattice space as shown in below figure (1)

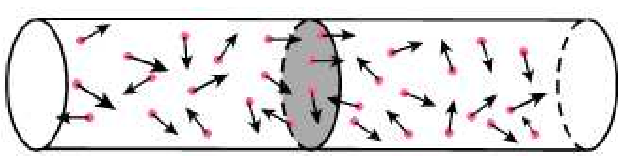


fig-1: Random motion of electrons (in open circuit)

3. If we imagine any cross section as shown above the number of electrons, crossing the cross section from left to right in one second is equal to that of electors passing the cross section form right to left in one second. Hence net charge moving along a conductor through any cross section is zero.

4. When the ends of the conductor are connected to battery through a bulb, the bulb glows because of energy flows takes place from battery to bulb.

5. This happens only due to orderly motion of electron.

6. When the electrons are in ordered motion there will be a net charge crossing through any cross section of the conductor as shown in figure(2).

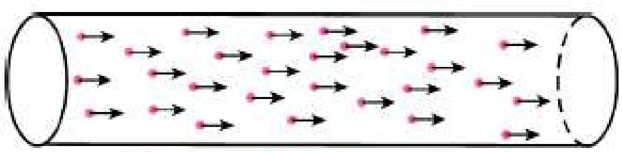


fig-2: Ordered motion of electrons

7. The ordered motion of electrons is called electric current.

2. How does a battery work? Explain [AS1]

A. 1. A battery consists of two metal plates and a chemical [electrolyte]

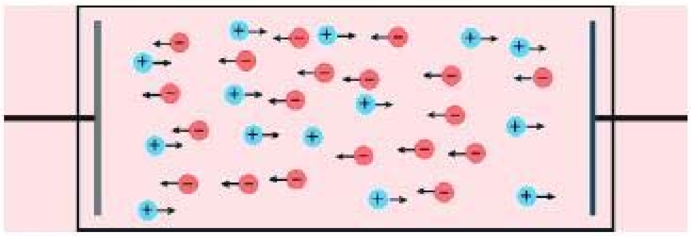
2. The electrolyte consist positive and negative ions which move in opposite directions.

3. This electrolyte exerts a force called chemical force (F_c) to make ions move in a specified direction.

4. Positive ion move towards one plate and accumulate on that, as a result this plate becomes positively charged (Anode).

5. Negative ions move to another plate and accumulate on that. As a result this plate becomes negatively charged.

6. This accumulation continues till both plates are sufficiently charged.



Ordered motion of electrons

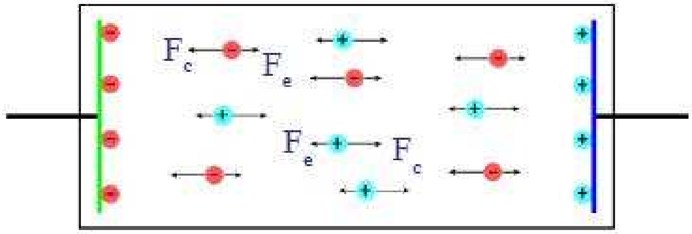
7. But the ions experience another force called electric force (F_e), when sufficiently number of charges accumulated on the plates.

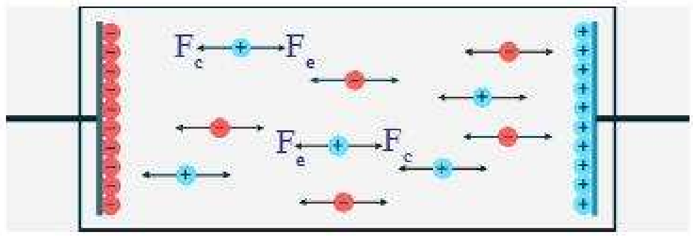
8. The direction of F_e is opposite to F_c and magnitude depends on the amount of charges accumulated on plates

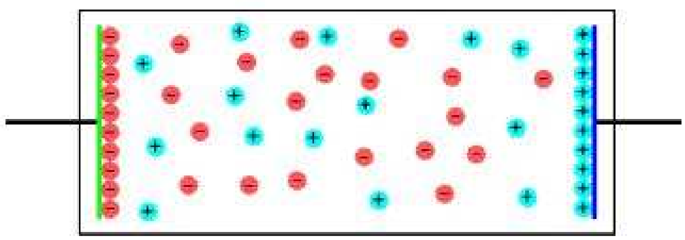
9. The accumulation of charges on plates is continuous till F_e becomes equal to F_c. Now there will not be any motion due to balance of F_e and F_c.

10. The new battery that we buy from the shop is under the influence of balanced forces. This is the reason for constant potential difference between the terminals of battery.

11. When a conducting wire is connected to terminals of the battery, a potential difference is created between the ends of the conductor which sets up an electric filed throughout the conductor.







12. The large number of electron in the conductor near the positive terminal of battery is attracted by it and start to move towards positive terminal. As a result the amount of positive change on this plate decreases. So F_e becomes weaker than F_c and F_c pulls negative ions from anode towards cathode.

13. The negative terminal pushes one electron into the conductor because of stronger repulsion between negative terminal and negative ion.

14. Hence, total number of electrons in a conductor remains constant during current flow.

3. Write the differences between potential difference and EMF? [AS1]

A.

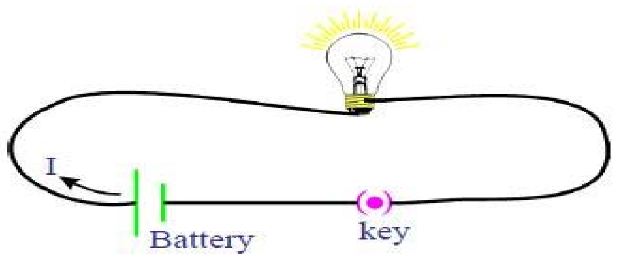
Potential Difference	Electro Motive Force (EMF)
1. Work done by electric force (F_e) on unit positive charge to move it through a distance 'l' in the direction of electric field is called potential difference	1. EMF is defined as work done by the chemical force (F_c) to move unit positive charge from negative to positive terminal of battery.
2. Potential difference = $v = \frac{w}{q} = \frac{F_e l}{q}$.	2. EMF= $\varepsilon = \frac{W}{q} = \frac{F_c d}{q} = \frac{F_e d}{q}$ d= distance between terminals
3. S.I unit of potential difference is volt	3. S.I unit of EMF is volt
4. Potential difference is effect	4. EMF is cause
5. It depends upon resistance of circuit	5. It doesn't depend upon resistance of circuit
6. Potential difference is always less than EMF	6. EMF is always greater than potential difference
7. It doesn't remain constant	7. It remains constant.
8. Potential difference takes place between two points	8. EMF creates potential difference in entire circuit

4. How can you verify that resistance of conductor is temperature dependent? [AS1]

A. 1. Measure the resistance of the bulb when it is in open circuit, using a multimeter.

2. Note the reading in your book.

3. Connect the circuit as shown in figure



4. Switch on the circuit after a few minutes switch off the circuit and measure the resistance of bulb using multimeter.

5. Note this reading in your note book.

6. The value of resistance in second instance is more than the resistance bulb in open circuit.

7. When bulb is connected in a circuit and current is passed through it, the bulb gets heated. This is responsible for increase in the resistance of bulb.

8. Hence the value of resistance of conductor depends on temperature for constant potential difference between the ends of conductor.

5. What do you mean by electric shock? Explain how it takes place. [AS1]

A. An electrical shock can be experienced when there a potential difference exists between one part of body and another part.

1. When current flows through human body, it chooses the path which offers low resistance.

2. The resistance of body is not uniform throughout it.

3. As long as current flow continues inside the body the current and resistance of human body goes on changing inversely.

4. Hence, the electric shock is a combined effect of potential difference, electric current and resistance of human body.

6. Derive $R = \frac{\rho l}{A}$ [AS1]

A. 1. Resistance of conductor (R) is directly proportional to its length for a constant potential difference.

$$R \alpha l \longrightarrow (i)$$

2. Resistance of a conductor is inversely proportional to cross section area.

$$R \alpha \frac{1}{A} \longrightarrow (ii)$$

3. From (i) and (ii) we get

$$R \alpha \frac{l}{A} \quad \text{[At constant temperature]}$$

$$R = \frac{\rho l}{A}$$

Where $'\rho'$ is proportionality constant and it is called as specific resistance or resistivity

4. S.I unit of resistivity is $\Omega - m$

7. How do you verify that resistance of a conductor is proportional to the length of the conductor for constant cross section area and temperature? [AS1]

A. Following is the procedure-

1. We shall collect iron spokes of different lengths with the same cross sectional area

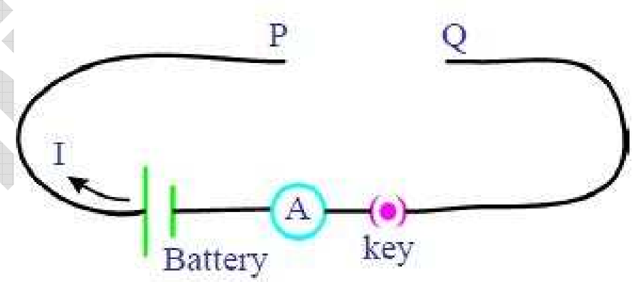
2. Make the circuit or shown in figure.

3. Then connect one of the iron spokes between P and Q

4. Measure the value of current using the ammeter connected to circuit and note it in your note book.

5. Repeat this for other lengths of iron spokes. Note the corresponding values of currents in your note book as shown below

Length of spoke	**Current**



6. We observe that current decreases as the length of spoke increases.

7. We know that resistance increases as current decreases

8. Hence we resistance of iron spoke increases as its length increases.

9. Hence we conclude that

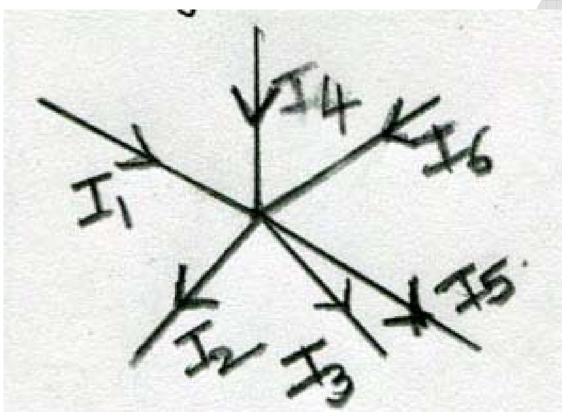
Resistance of conductor is directly proportional to length

$R \alpha l$

8. Explain Kirchhoff's laws with examples. [AS1]

A. 1. Kirchhoff's first law or Junction law:

At any junction point in a circuit where the current can divide. The sum of current INTO the junction is EQUAL to the sum of currents LEAVING the junction.



From the figure, we have

$I_1 + I_4 + I_6 = I_2 + I_3 + I_5$

This is based on conservation of energy

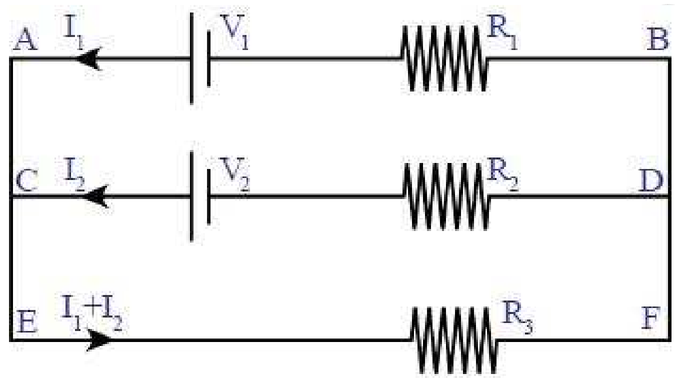
2. Kirchhoff's second law or loop's law:

1. The algebraic sum of the potential difference across the various components and EMFs in a closed circuit loop is Zero.

2. This law is based on conservation of energy

Example:

Let us imagine that in a circuit loop the potential difference between two points at beginning of loop has certain value. As we move around the circuit loop and measure the potential difference across each component in the loop, the potential difference across each component in the loop, the potential difference may decrease or increase depending upon the nature of the element likes a resistor or a battery. But when we have completely transverse the circuit loop and arrive back to our starting point, the net change in the potential difference must be zero.



Applying loop law

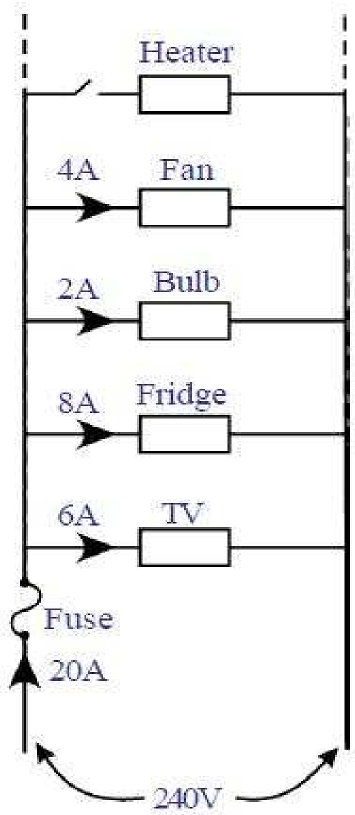
For the loop ACDBA $- V_2 + I_2R_2 - I_1R_1 + V_1 = 0$

For the loop EFDCE $- (I_1 + I_2) R_3 - I_2R_2 + V_2 = 0$

For the loop EFBAE $- (I_1 + I_2) R_3 - I_1R_1 + V_1 = 0.$

9. Explain overloading of household circuit. [AS1]

A. 1.Electricity enters our homes through two wires called lines. These lines have low resistance and potential difference between the wires is usually about 240v.



2. All electric devices are connected in parallel in our home. Hence, the potential drop across each device is 240V.

3. Based on the resistance of each electric device. It draws some current from supply. Total current drawn from the main is equal to sum of currents passing through each device.

4. If we add more devices to the household circuit the current drawn from the mains also increases.

5. This leads to overheating and may cause fire. This is called overloading.

10. Why do we use fuses in household circuits? [AS1]

A. 1. The fuse consists of a thin wire; the entire current from mains must pass through the fuse.

2.To prevent damages due to overloading we connect an electric fuse to the household circuit.

3.Generally the fuse consists of thin wire of low melting point.

4.When the current in the fuse overloaded, the wire gets heated and melted.

5.Now the circuit becomes open and prevents the flow of current.

6.So, all electrical devices are saved from damage that could be coursed by overload.

11. Deduce the expression for equivalent resistance of three resistors connected in series? [AS1]

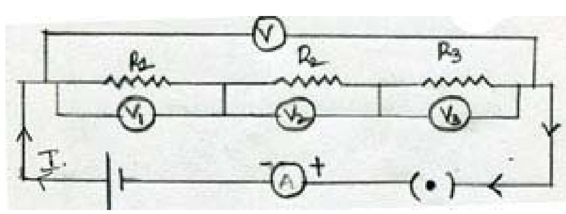
A. Two or more resistors are said to be connected in series. If the current flowing through one resistors, also flows through the others,

In same combination we know that-

a) Same current passes through the resistors

b) The potential difference across combination of resistor is equal to sum of voltage across the individual resistors. Connect the circuit as shown in figure.

The cell connected across the series combination of 3 resistors maintains a potential difference (V) across the combination. Current flowing through combination is I.

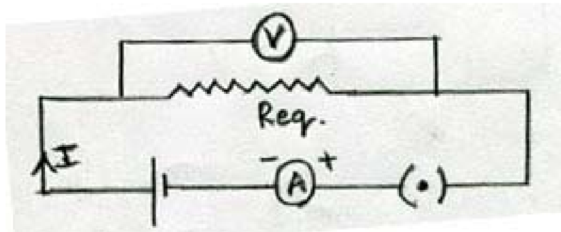


Let us replace the combination of resistors of 3 resistors by a single resistor R_{eq}, such that current doesn't change

R_{eq} is given by

$$Req = \frac{V}{I}$$

$V = I\ R_{eq}$



The potential differences V_1, V_2, V_3 across the resistors R_1, R_2, R_3 respectively are given by Ohm's law

$V_1 = IR_1$; $V_2 = IR_2$; $V_3 = IR_3$

Since resistors connected in series

$V = V_1 + V_2 + V_3$

$= IR_1 + IR_2 + IR_3$

$= I\ (R_1 + R_2 + R_3)$

`

$IR_{eq} = I\ (R_1 + R_2 + R_3)$

$R_{eq} = R_1 + R_2 + R_3$

Similarly, for n resistors connected in series.

$R_{eq} = R_1 + R_2 + R_3 + \text{-----}\ R_n$.

12. **Deduce the expression for equivalent resistance for three resistors connected in parallel? [AS1]**

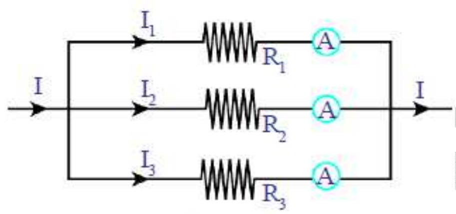
A. If resistances are connected in such a way that the same potential difference gets applied across each of them, they are said to be connected in parallel.

For parallel combination, we know that

1. The total current flowing into the combination is equal to the sum of currents passing through the individual resistors.

2. The potential difference is same in all resistors connect the circuit as shown.

3. The cell connected across three resistors maintains the same potential difference across each resistor.



4. The current (I) divided into I_1, I_2, I_3 which flows through resistors R_1, R_2, R_3 Respectively.

5. Let replace the all resistors with equivalent resistance R_{eq}.

Equivalent resistance $\mathrm{Re}q = \frac{V}{I}$

$$I = \frac{V}{\mathrm{Re}q}$$

Similarly $I_1 = \frac{V}{\mathrm{R}_1}; I_2 = \frac{V}{R_2}; I_3 = \frac{V}{R_3}$

Since Resistance in parallel

$$I = I_1 + I_2 + I_3$$

$$\frac{V}{\mathrm{Re}q} = \frac{V}{\mathrm{R}_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\frac{V}{\mathrm{Re}q} = V\left[\frac{1}{\mathrm{R}_1} + \frac{1}{R_2} + \frac{1}{R_3}\right]$$

$$\frac{1}{\mathrm{Re}q} = \frac{1}{\mathrm{R}_1} + \frac{1}{R_2} + \frac{1}{R_3}.$$

13. State Ohm's law? Suggest an experiment to verity it and explain the procedure? [AS3]

A. Ohm's law:

At constant temperature, the potential difference between the ends of a conductor is directly proportional to electric current passing through it.

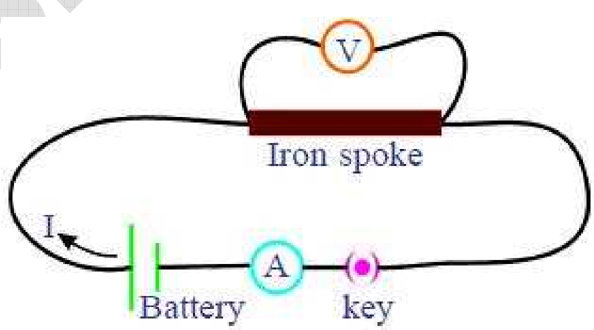
Verification:

Aim: To verity Ohm's law. (or) To show that the ratio $\frac{V}{I}$ is a constant for a conductor.

Materials required: 5 dry cells, of 1.5v each, conducting wires, an ammeter thin iron spoke, a voltmeter, LED and key.

Procedure:

1. Connect a circuit as shown in figure.



2. Solder the connecting wires to the ends of iron spoke.

3. Close the key.

4. Note the readings of current from ammeter and voltmeter reading in following table.

S.No.	Potential diff(v)	Current I	(V/I)

5. Now connect two cells instead of one cell in circuit. Note the values of ammeter and voltmeter and record then in above table.

6. Repeat the same for three cells, four cells and five cells respectively.

7. Record the values of V and I respectively to each case in the table.

8. Find $\frac{V}{I}$ for each set of values

9. We notice the $\frac{V}{I}$ is constant

$$V \alpha I$$

$$\Rightarrow \frac{V}{I} = \text{constant.}$$

This constant is known as resistance

$$\frac{V}{I} = R$$

$$V = IR.$$

14. How can you appreciate the role of a small fuse in house wiring circuit in preventing damage to various electrical appliances connected in a circuit? [AS7]

A. 1. The fuse consists of a thin wire; the entire current from mains must pass through the fuse.

2. To prevent damages due to overloading we connect an electric fuse to household circuit.

3. Generally the fuse consists of thin wire of low melting point.

4. When the current in the fuse overloaded, the wire get heated and melted.

5. Now the circuit becomes open and prevents the flow of current. So, all electrical appliances are saved from damage that could be caused by overload.

Problems

1. Two bulbs have ratings 100W, 220V, and 60W, 220V which one has greater resistance? [AS1]

Sol: Resistance of first bulb $R_1 = \frac{v^2}{p}$

$$= \frac{220 \times 220}{100}$$

$$= 484\Omega$$

Resistance of second bulb $R_2 = \frac{v^2}{p}$

$$= \frac{220 \times 220}{60}$$

$$= 806.6\Omega$$

The bulb rated 60W, 220V has higher resistance.

2. A wire of length 1m and 0.1mm radius has a resistance of 100Ω. Find resistivity of material. [AS1]

Sol: Given

Resistance R = 100Ω

Length l = 1m = 1000 mm

Radius r = 0.1mm

Area of cross section A = πr^2

$$= \frac{22}{7} \times 0.1 \times 0.1$$

$$= \frac{22}{7} \times 0.01$$

= 3.14 × 0.01

= 0.0314 mm^2

Resistivity $\rho = \frac{RA}{L} = \frac{100 \times 0.0314}{1000}$

Resistivity ρ = 0.00314Ω mm.

3. Suppose that you have three resistors each of value 30Ω. How many resistors can you obtain by various combinations of these three resistors? Draw diagrams in support your predictions. [AS2]

Sol: Let $R_1 = R_2 = R_3 = 30$.

We get three combinations

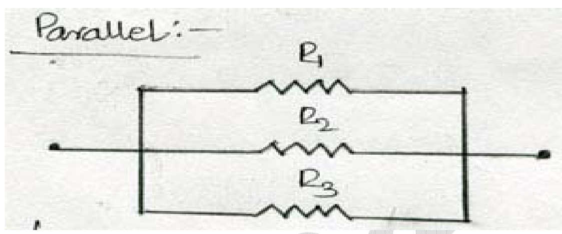
1. Series:

$$R_{eq} = R_1 + R_2 + R_3$$

$= 30 + 30 + 30 = 90\ \Omega$

$R_{eq} = 90\ \Omega$

2. Parallel:



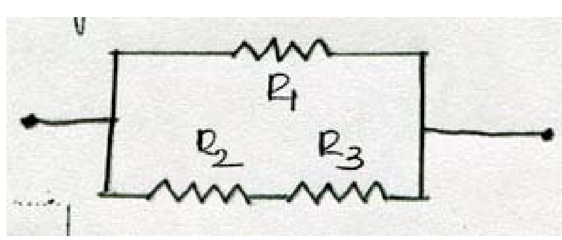
$$\frac{1}{R_{eq}} \neq \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$= \frac{1}{30} + \frac{1}{30} + \frac{1}{30}$$

$$= \frac{3}{30} = \frac{1}{10}$$

$R_{eq} = 10\Omega$

3. Using both parallel and series:



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2 + R_3}$$

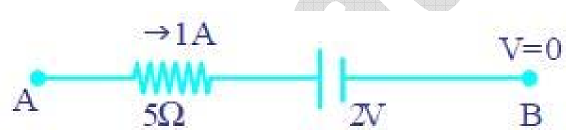
$$= \frac{1}{30} + \frac{1}{30+30}$$

$$= \frac{3}{30} + \frac{1}{60}$$

$$\frac{1}{R_{eq}} = \frac{1}{20}$$

$$R_{eq} = 20$$

4. In the following figure, the potential at A is ___ when the potential at B is zero [AS5].



Sol: Potential difference between A and B.

$$V_{AB} = V_A - V_B$$

$$= V_A - 0$$

$$V_{AB} = V_A = 5 \times 1 - 2v$$

$$= 5\text{-}2$$

$$= 3v$$

Potential at A = 3V

5. **Observe the circuit and answer the questions given below.**

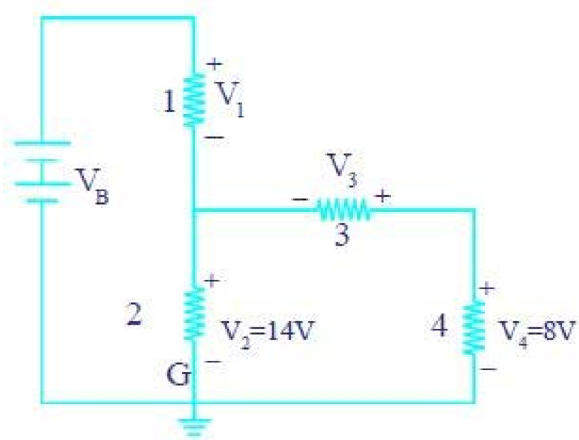
i) Are resistors 3 and 4 in series?

ii) Are resistors 1 and 2 in series?

iii) Is the battery in series with any resistor?

iv) What is the potential drop across the resistor 3?

v) What is the total EMF in the circuit if the potential drop across resistor is 6v? [AS5]



i. No, resistors 3 and 4 are not in series.

ii. Yes, resistors 1 and 2 are in series.

iii. No, battery is not in series with any resistor.

iv. As 3 and 4 resistors are in parallel, same potential difference will be allowed through them

$V_4 = V_3 = 8v$

v. Total EMF = $v_1 + v_2 + v_3$

$= 6 + 14 + 8$ $[\because V_1 = 6v]$

$= 28v.$

6. If the resistance of your body is 100000Ω, what would be the current that flows in your body when you touch the terminals of 12v battery?

Sol: Resistance of the body (R) = 100000 Ω

Potential difference of battery (v) = 12V

Current that flows in body I = i (say)

According to ohm's law

$V = iR$

$i = \frac{v}{R}$

$= \frac{12}{1,00,000}$

$i = 0.00012A.$

Current flows in body = 0.00012A.

7. A uniform wire of resistance 100Ω is melted and recast into wire of length doubles that of the original. What would be the resistance of new wire formed? [AS7]

Sol: Before recasting

Resistance $R_1 = 100\ \Omega$

Length $(l_1) = l$

After casting

Resistance R_2 =?

Length (l_2) = 2l

we know that

Resistance α length i.e., R α l

$$\frac{R_1}{R_2} = \frac{l_1}{l_2}$$

$$\frac{100}{R_2} = \frac{l}{2l}$$

$$\frac{100}{R_2} = \frac{1}{2}$$

$R_2 = 200\ \mathbf{\Omega}$

Resistance of new wire formed = 200 **Ω**

8. A house has three tube lights, two fans and a television. Each tube light draws 40W. The fan draws 80W and the television draws 60W. On the average, all the tube lights are kept on for four hours, two fans for 12 hours and the television for five hours a day. Find the cost of electric energy used in 30 days at the rate of Rs. 3.00 per KWh. [AS7]

Sol: Given

Device	Rated power	Time utilized
Tube light	40W	5 hours
Fan	80W	12 hours

Television	60W	5 hours

Power consumed by tube lights in a day = 40W × 3 × 5H

= 600 watt hour

= 0.6 KWh.

Power consumed by fans in a day = 80W × 2 × 12H

= 1920 watt hour

= 1.920 KWh.

Power consumed by television in a day = 60W × 1 × 5H

= 380 watt hour

= 0.380 KWh.

Total power consumed in 1 day = 0.6 + 1.920+0.38

= 2.820 KWh

Power consumed in 30 days = 2.820 × 30

= 84.6 KWh.

Rate of 1kmh = Rs 300/-

Rate of 84.6kwh = 84.6 × 3

= Rs. 253.8/-

Cost of electric energy used = Rs. 253.8.

Fill in the Blanks

1. The kilowatt hour is that unit of __________.
2. A thick wire has a ______ resistance than a thin wire.
3. An unknown circuit draws a current of 2A and 12V battery its equivalent resistance is ________.
4. S.I. unit of potential difference is __________.
5. S.I. unit of current is _________.
6. Three resistors of values 2Ω, 4Ω, 6Ω are connected in series. The equivalent resistance of combination of resistors__________.
7. Three resistors of 2Ω, 4Ω, 6Ω are connected in parallel. The equivalent resistance of combination of resistors__________.
8. The power delivered by a battery of EMF10v is l0W then the current delivered by battery is _________.
9. __________ is used to measure current.
10. _______ is used to measure voltage (potential difference).
11. S.I. unit of power ______________.
12. S.I unit of electric energy ___________.
13. Filament of electric bulb is made of ________________.
14. The ordered motion of electron is ________.
15. Symbol of rheostat ____________.

Key.

1. Electrical energy, **2.** Less, **3.** 6Ω, **4.** Volt,

5. Ampere, **6.** 12 ohm, **7.** $\frac{11}{12}ohm$, **8.** 1 ampere,

9. Ammeter, **10.** E voltmeter, **11.** Watt,

12. Kilo Watt Hour (KWh), **13.** Tungsten **14.** Electric current

15. 

Objective Type Questions

1. A uniform wire of resistance 50Ω is cut into five equal parts. These parts are now connected in parallel, then the equivalent resistance of combinations is? [ ]

A. 2 Ω B. 12 Ω C. 250 Ω D. 6250 Ω

2. A change is moved from a point A to a point B. The work done to move unit charge during this process is called- [ ]

A. Potential at A B. Potential at B

C. Potential difference between A and B D. Current from A to B

3. Joule/coulomb is the same as? [ ]

A. 1 watt B. 1volt C.1 ampere D. 1 ohm

4. **The current in wire depends?** [ ]

A. Only on the potential difference applied

B. Only on the resistance of wire

C. On both of them

D. None of them

5. **Consider following statements-**

A: In series connection, the same current flows through each element

B: In parallel connection, the same potential difference gets applied across each element [ ]

A) Both A and B are correct B) A is correct but B is wrong

C) A is wrong but B is correct D) Both A and B are wrong

6. **Electricity conducts freely in?** [ ]

A) Conductor B) Insulator

C) Semiconductor D) None of these

7. **Kilowatt hour is the unit of?** [ ]

A) Potential difference B) Energy

c) Electrical energy D) Electrical resistance

8. **The obstruction of the flow of electrons is called?** [ ]

A) Current B) Potential difference

c) Resistance D) Voltage

9. If two or more resistors are connected in series, then ______ flows through them is same. [ ]

A) Potential difference B) Current

C) Resistance D) Heat

10. If two or more resistors connected in parallel, then ____ is same in them. [ ]

A) Potential difference B) Current

C) Resistance D) Heat

Key:

1. A, 2. C, 3. B, 4. C, 5. A, 6. A, 7. C, 8. C, 9. B, 10. A,

Match the Following

1.

Group-I Variable		Group-II S.I.Units
1. Resistance	[ ]	A) Watt
2. Current	[ ]	B) Volt
3. Electrical energy	[ ]	C) Kilowatt hour
4. Electrical power	[ ]	D) Ohm
5. Electro Motive Force (EMF)	[ ]	E) Ampere

Key:

1. D, 2. E, 3. C, 4. A, 5. B

2.	**Group-I** **<u>Measuring device</u>**		**Group-II** **<u>Variable</u>**
1.	Ammeter	[ ]	A) Current, voltage and resistance
2.	Volt meter	[ ]	B) Power
3.	Energy - meter	[ ]	C) Voltage and EMF
4.	Watt- meter	[ ]	D) Current
5.	Multimeter	[ ]	E) Electric energy

Key:

1. D, 2. C, 3. E, 4. B, 5. A

3. Group-I **Group-II**

	Group-I		Group-II
1.	All resistors are in series	[ ]	A) $\frac{R_3R_1 + R_2R_1}{R_1 + R_3 + R_2}$
2.	All resistors are in parallel	[ ]	B) $\frac{R_1R_3 + R_2R_3}{R_1 + R_2 + R_3}$
3.	R_1, R_2 are in series and R_3 is parallel to both of them	[ ]	C) $R_1 + R_2 + R_3$
4.	R_1, R_2 are in parallel and R_3 is in series with them	[ ]	D) $\frac{R_1R_2R_3}{R_1R_2 + R_2R_3 + R_3R_1}$
5.	R_3 in series with R_2 and R_1 in parallel to both of them	[ ]	E) $\frac{R_1R_2 + R_1R_3 + R_2R_3}{R_1 + R_2}$

R_1, R_2, R_3 are three resistors

Key:

1. C, 2. D, 3. B, 4. E, 5. A

Chapter -12

Electromagnetism

SYNOPSIS

Hans Christian Orsted was the father of electromagnetism. His famous experiments refueled the connection between electricity and magnetism.

The number of magnetic lines passing through the Area 'A' is known as flux (ϕ). If B is magnetic flux density then-

$$B = \frac{\phi}{A}$$

or $\phi = BA$.

When the reference plane makes an angle with the field, then

$\phi = BA\cos\theta$.

If q use the change moving with velocity v in magnetic field of indentation B then the force acting on the change is-

$F = q\,v\,B\sin\theta$.

The direction of force can be measured by the light hand rule.

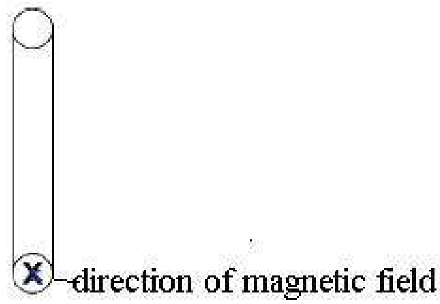
Electric motor is a device which can be converted electric energy into mechanical energy.

Faraday's experiments tell about the link between change of magnetic flux and a current generation in the coil.

2 Mark Questions

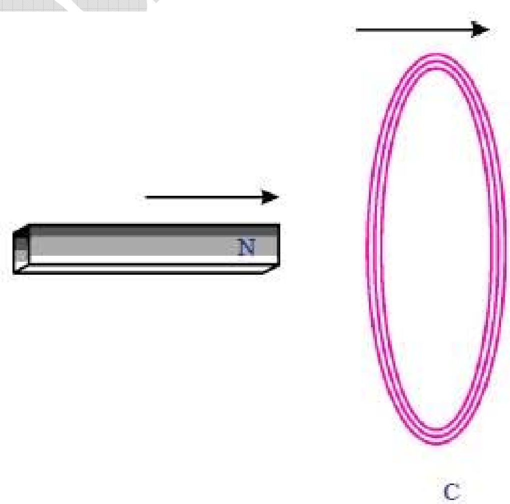
1.A coil is kept perpendicular to the page. At P, current flows into the page and at Q it comes out of the page as shown in figure. What is the direction of magnetic field due to the coil? (AS1)

A. To known the direction of magnetic field, we use right hand rule i.e., when you curt your right hand fingers in the direction of current, thumb gives the direction of magnetic field.



2. As shown in the figure, both coil and bar magnet moves in the same direction. Your friend is arguing that there is no change in flux. Do you agree with his statement? If not, what doubts do you have? Frame questions about the doubts you have regarding change in flux. (AS2)

A. Agree:



1) Yes, I will agree

2) The induced EMF will not produce when the coil and magnet are moving in the same direction with same velocity.

Disagree:

1) If both move in same direction, is any linkage of then with in coil.

3. Give a few applications of Faraday's law of induction in daily life? [AS7]

A. Some of the daily life applications of Faraday's law of induction are-

1) Generation of electricity

2) The tape recorder

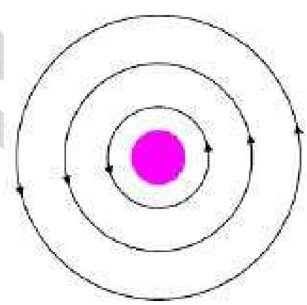
3) Induction stoves

4) Motors

5) Transformers etc.

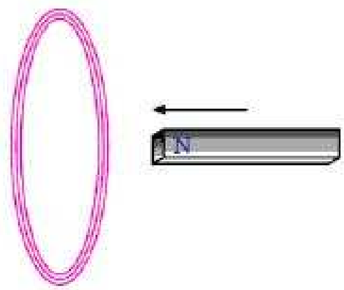
1 Mark Questions

1. See magnetic lines are shown. What is the direction of the current flowing through the wire? (AS1)



A. The magnetic lines are antilock wise using Right hand thumb rule, current flow upwards.

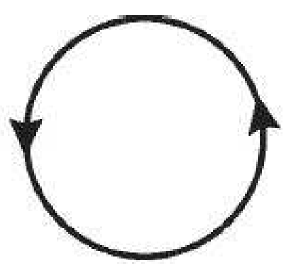
2. A bar magnet with North Pole facing towards a coil moves as shown in figure. Then what happens to the magnetic flux passing through the coil? (AS1



A. The magnetic flux passing through the coil induces current in coil. This current is also induced EMF.

3. The direction of current flowing in a coil is shown in fig.Q-5. What type of magnetic pole is formed at the face that has flow of current shown in figure? (AS1)

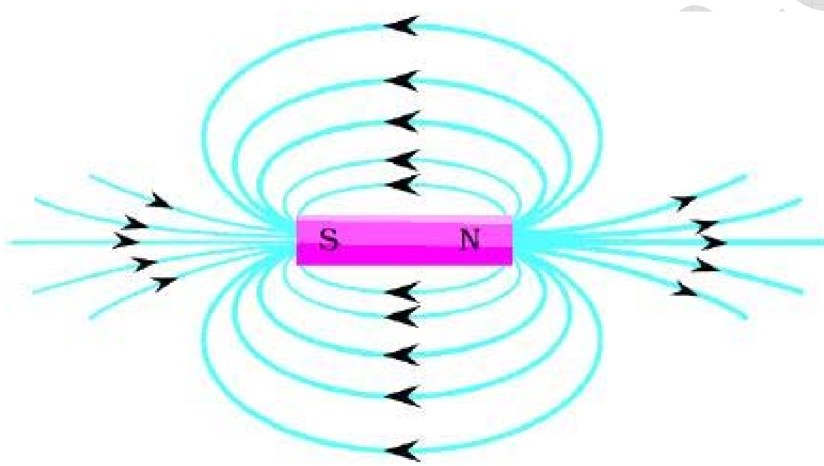
A. North. Here current flowing in anticlockwise, north pole formed at face we are viewing.



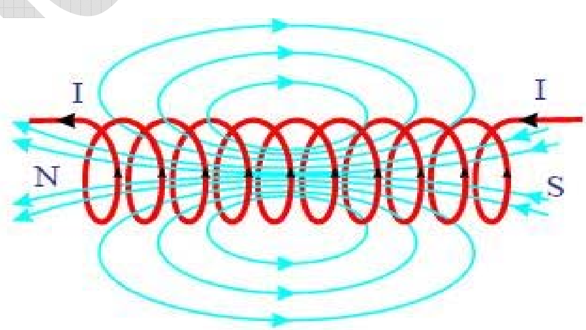
4 Mark Questions

1. Are the magnetic field lines closed? Explain.

A. The magnetic field lines produced by magnet field appear to be closed, but we can't conclude whether they are closed or open loops by just looking at the picture of the filed lines, because the alignment of lines that are passing the bar magnet should also be considered. If we observe the field lines by a solenoid, they are continuous with those inside. Outside of the solenoid, the direction of the field lines is from north to south while inside the direction is opposite (i.e. south to north). Thus, the magnetic field lines are closed loops.



Magnetic field lines

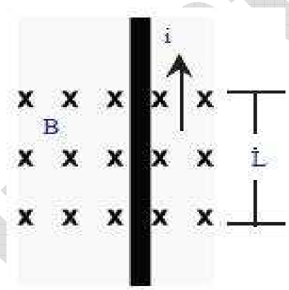


Magnetic field lines Magnetic field lines are closed loops

2. Why does a picture appear distorted when a bar magnet is brought close to the screen on television? Explain. (AS1)

A. Picture on a television screen is due to motion of the electrons reaching the screen. These electrons are affected by magnetic field of bar magnet. This must be due to the fact that magnetic field exerts a force on moving charges. This force is called magnetic force. Due to this magnetic force, the picture is distorted when you remove the bar magnet away from the screen, the motion of electron is not affected by the magnetic force and the picture will be normal.

3. Symbol 'X' indicates the direction of a magnetic field into the page. A straight long wire carrying current along its length is kept perpendicular to the magnetic field. What is the magnitude of force experienced by the wire? In what direction does it act? (AS1)



A. From the given figure, a straight wire caning current which is kept perpendicular to a uniform magnetic field 'B'. This 'B' is directed into the page. Let the field be confined to the length 'L' we know that the electric current means charges in motion. Hence they move with a certain velocity called drift velocity 'V'.

Let total charge inside the magnetic field be 'Q'. So magnetic force on the current carrying wire is given by

$$F = BQV \rightarrow (1)$$

Time taken by the charge (Q) to cross the field be

$$t = \frac{L}{v}$$

$$t = \frac{L}{v} \longrightarrow (2)$$

Substituting (2) in (1) we get

$$F = BQ.\frac{L}{t}$$

$$= BL.\frac{Q}{t}$$

We know that $\frac{Q}{t} = I$

F = BL.I

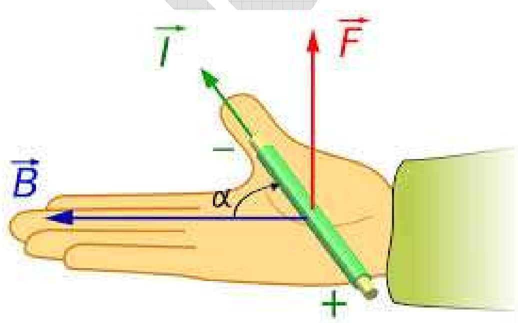
Direction of force:

The direction of force can be finding out by using Right Hand Rule

1) Fore finger points towards the velocity of current

2) Middle finger points to the direction of magnetic field (B).

3) Thumb gives the direction of force (F).



4. Explain the working of electric motor with a neat diagram? (AS1)

A. 1) Consider a rectangular coil kept in uniform magnetic field as shown in below figure

Switch on the circuit, so that the current flows through the coil. The direction of current is shown in figure.

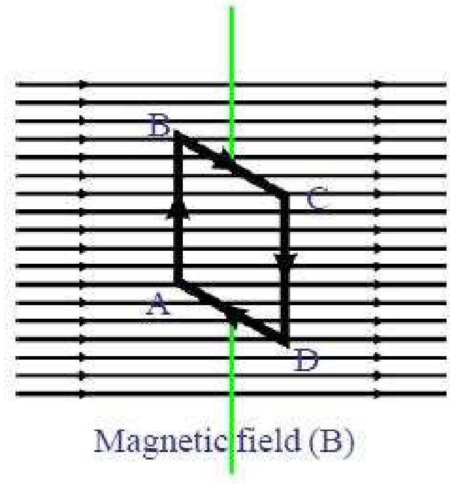
2) The sides AB and CD of the coil is always at right angles to the magnetic field.

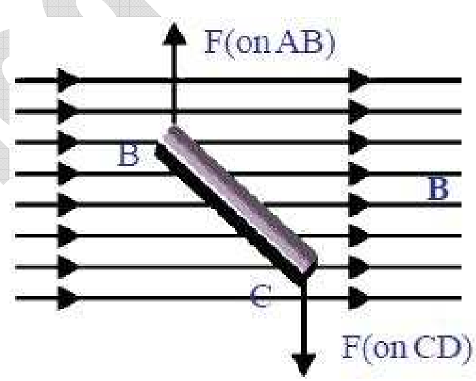
3) According to Right Hand Rule, at AB the magnetic force acts inwards perpendicular to the field of magnet and on CD, it acts outward.

4) The top view of coil I shown in figure.

5) The force on the sides BC and DA varies because they make different angles at different positions of coil in the field. At BC, Magnetic force pulls the coil up and at DA magnetic force pulls it down.

6) The net force acting on AB and on CD is zero because they carry equal currents in the opposite directions. Similarly the sum of the forces on sides BC and DA is also zero. So, net force on coil is zero.





7) But the rectangular coil comes into rotation in clockwise direction because equal and opposite direction because equal and opposite pair of forces acting on the two sides of coil.

8) If the direction of current in the coil is unchanged, it rotates, up to half rotation in one direction and the next half in the direction opposite to previous like to and fro motion.

9) If the direction of current of coil is changed the coil will rotate continuously in one and same direction.

10) To achieve these brushes B_1 and B_2 were used.

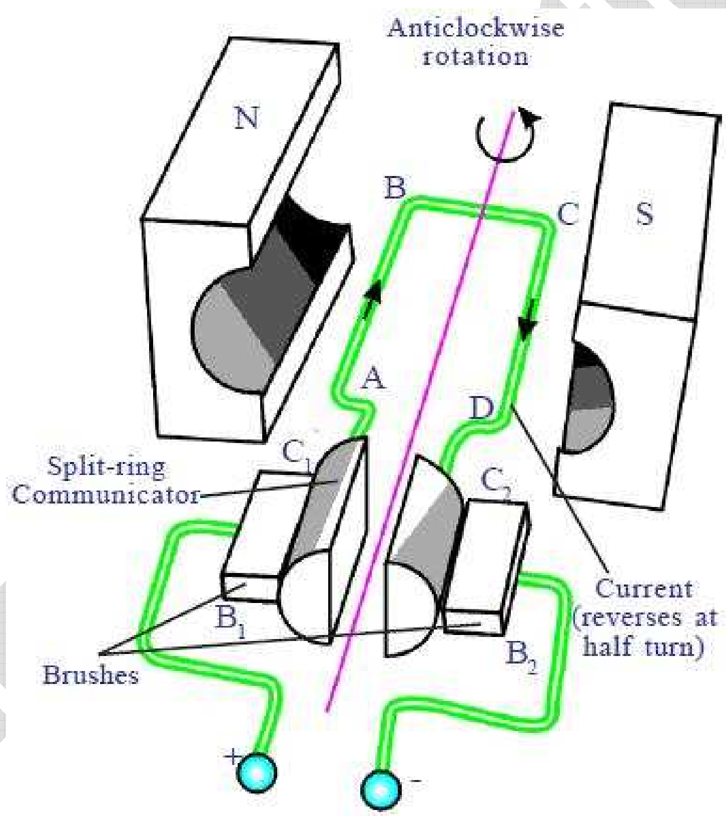
11) These brushes are connected to the battery. The ends of coils are connected to slip rings C_1 and C_2 which rotate along with coil.

12) Initially C_1 is in contact with B_1 and C_2 is in contact with B^2.

13) After half rotation, the brushes come into contact with other rings in such a way that the direction of current through the coil is reversed this happens every half rotation.

14) Thus the direction of rotation of coil remains the same. This is the principle used in electric motor.

15) In electric motor electrical energy is converted into mechanical energy.



5. Derive Faraday's law of induction from law of conservation of energy. (AS1)

A. 1) Let arrange an apparatus shown in the figure.

2) It consists of a pair of parallel bare conductors which are spaced one meter apart in uniform magnetic field 'B'.

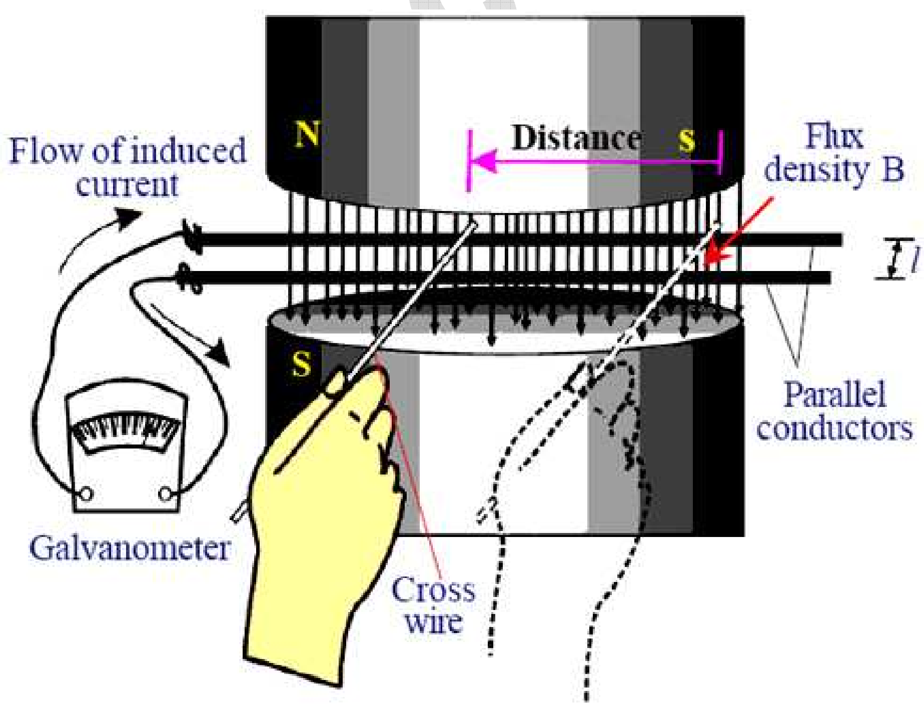
3) We can hold another bare conductor in such a way that it is in contact with the two parallel wires.

4) A galvanometer is connected to the ends of parallel conductors to complete an electric circuit.

5) Now if the cross conductor placed across parallel conductors to move to left, galvanometer needle will defect in one direction.

6) If the cross conductor is moved to the right its needle deflect in a direction opposite to previous deflection.

7) A current will set up in the circuit where there is an EMF (Electro motive force) in the circuit. Let this EMF be ε.



8) According to the principle of conservation of energy this electric energy must come from the works that we have done in moving cross wire.

9) If we ignore friction, the work done by this applied force = F.S. (Where 'S' is the distance moved by cross conductor)

10) Force applied on cross wire by filed B is

F = BIL.

11) Work done = F.S

= BIL.S $\rightarrow$ (1)

12) Now we move the cross wire to the left, the area of loop decreases and the flux through the loop also decreases.

The decrease in flux = $\Delta\phi$ = BL.S $\rightarrow$ (2)

From (1)

W = BILS

= (BLS) I

From (2)

W = $(\Delta\phi)$I

Let divide both sides by Δt

$$\frac{W}{\Delta t} = I.\left(\frac{\Delta\phi}{\Delta t}\right)$$

We known that electric power is the product of current and EMF

$$\varepsilon = \frac{\Delta\phi}{\Delta t}$$

Electric power = I.E $\rightarrow$ (3)

Electric power $p = I.\frac{\Delta\phi}{\Delta t}$ $\left[\because \frac{W}{\Delta t} = power\ p\right]$

13) Thus the electrical power generated in the circuit is equal to product in induced EMF and the current. Thus the mechanical energy utilized to move the cross wire in one second is converted into electric power $\left(\frac{\Delta\phi}{\Delta t}\right).I$ I

[Conservation of energy]

Divide (2) by Δt

$$\frac{w}{\Delta t} = \frac{Fs}{\Delta t} = \frac{BILS}{\Delta t}$$

Where $\frac{s}{\Delta t}$ is the speed of cross wire, let it be (v)

Electric power $P = \frac{Fs}{\Delta t} = FV$

$= \text{BILV} \rightarrow (4)$

Equating (3) and (4) we get

E.I = B.I. L.V

ε = B.L.V.

Induced EMF = BLV.

6. Explain with the help of two activities that current carrying wire produces magnetic field? (AS1)

A. Activity I:

1) Take a thermocol sheet and fix two thin wooden sticks of height 1cm which have small slit at the top of their ends.

2) Arrange of copper wire of 24 gauge so that it passes thought these slits and make a circuit.

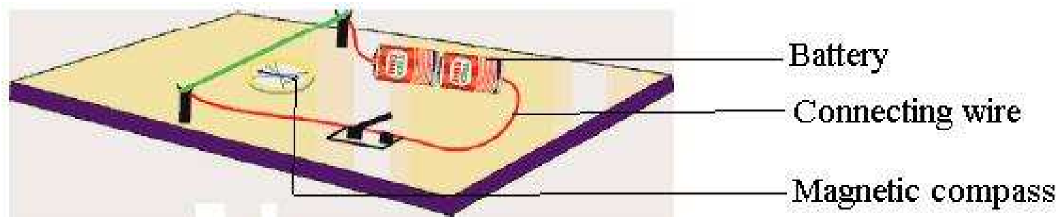
3) The circuit of 3 or 9v battery, key and copper wire which is connected in series as shown in figure.

4) Now, keep a magnetic compass below the wire and bring a bar magnet close the compass.

5) The needle in the compass deflects. This deflection is due to magnetic filed produced by bar magnet.

6) Take the bar magnet far away from the circuit and switch on the circuit. Observe the changes in compass.

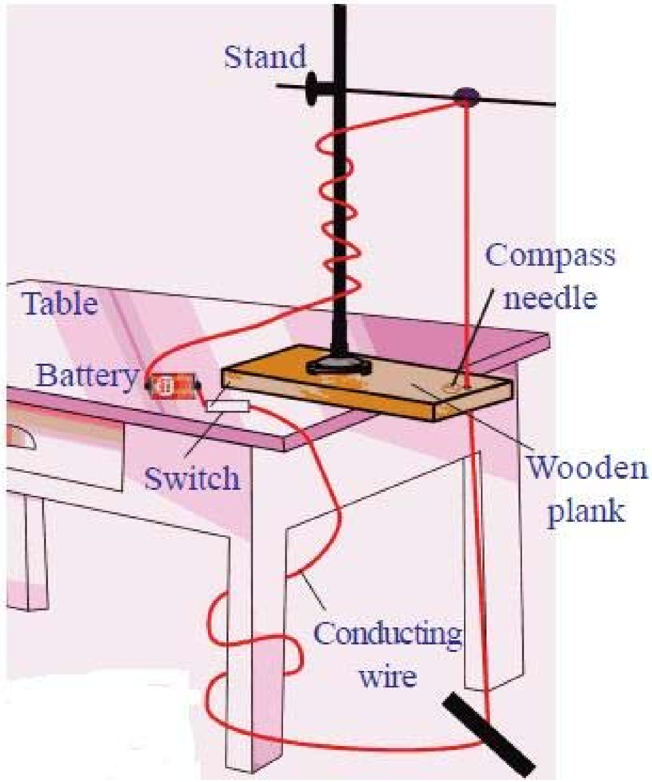
7) The compass needle deflects.



8) This deflection is due to magnetic field produced by current carrying conductor. (Wire)

Activity II:

1) Take a wooden plank and make a hole as shown in figure.
2) Place this plank on a table. Now place a retort stand on the plank.
3) Pass a 24 guage copper wire through a hole of the plank and rubber knob of the retort stand in such a way that the wire be arranged in a vertical position and doesn't touch the stand.
4) Connect the two ends of wire to a battery via switch.
5) Place 6 to 10 compass needles in a circular path around the hole so that its centre coincides with the hole. Use 3 o r9 volts battery in a circuit.
6) Now switch on current flows through wire.
7) The compass needle deflects in a particular direction.
8) The deflection is due to magnetic field produced by current carrying wire.



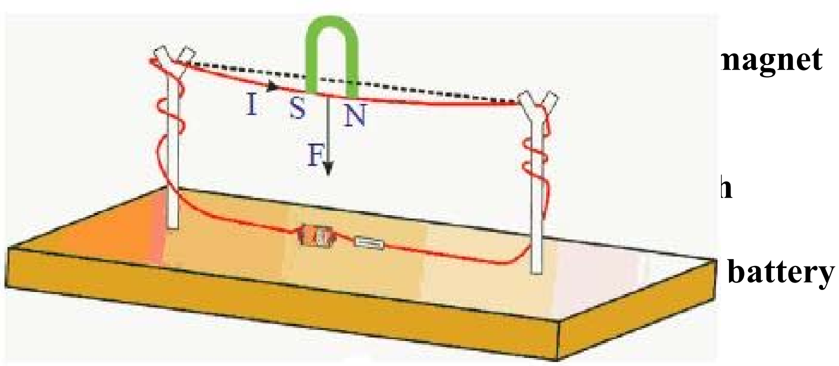
7. How do you verify experimentally that the current carrying conductor experiences a force when it is kept in magnetic field? (AS1)

A. 1. A copper wire is passed through splits of wooden stick.

2. Connect the wire to 3 volts battery.

3. Close the switch to make the circuit current passes through the wire.

4. Bring the horse shoe magnet near the wire.



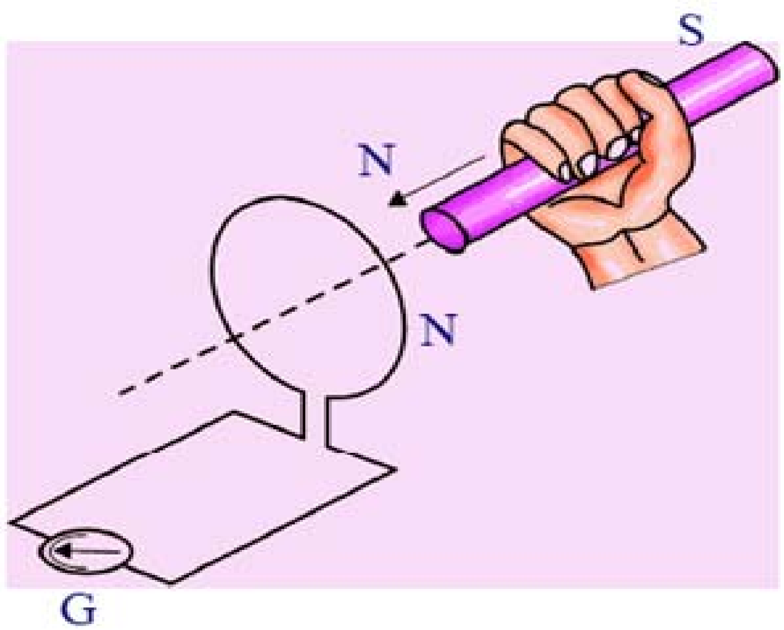
5. Then a force experienced on wire.

6. Reverse the polarities of magnet, then the direction of force is also reversed.

7. The right hand rule helps the direction of flow of current.

8. Explain Faraday's law of induction with the help of activity. (AS1)

A. 1. Connect the terminals of a coil to a sensitive galvanometer as shown in figure.



2. Normally, we would not expect any defection of needle in the galvanometer because there is no EMF in the circuit.

3. Now, if we push a bar magnet towards the coil, with its north pole facing the coil, the needle in the galvanometer deflects, showing that a current has been setup in the coil; the galvanometer doesn't deflect if the magnet is at rest.

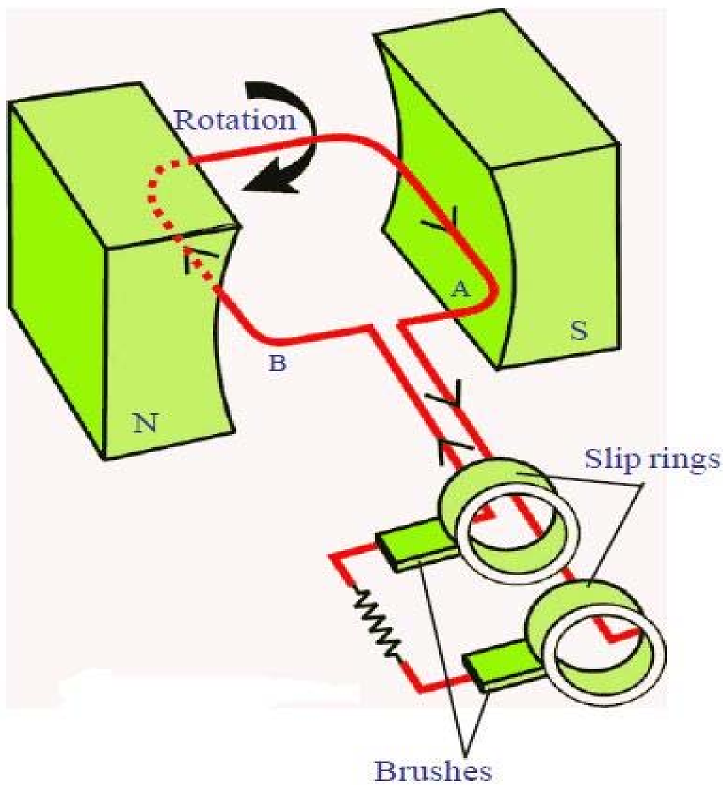
4. If the magnet is moved away from the coil, the needle in the galvanometer again deflects, but in opposite direction, which means that a current is set up in coil in opposite direction.

5. If we use the end of South Pole of magnet instead of North Pole, the results i.e., the deflection in galvanometer are exactly opposite to previous one.

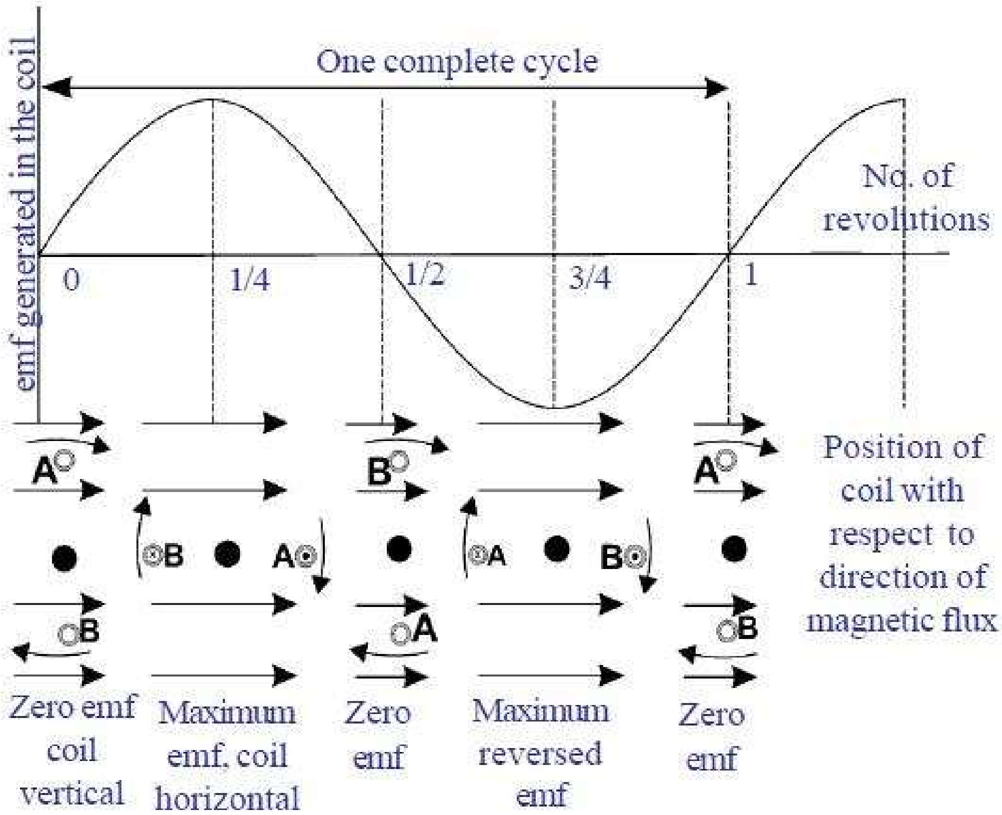
6. Form this, we conclude that change in magnetic than liked with closed coil, produces current.

9. Explain the working of AC electric generator with a neat diagram. (AS1)

A.



1. Generators convert mechanical energy into electrical energy.
2. Consider a rectangular coil. Let it be held between the poles of curve- shaped permanent magnet as shown in figure.
3. As the coil rotates the magnetic flux passing through the coil changes.
4. According to the law of electromagnetic induction an induced current is generated in coil.
5. **Direction of Current:**
   i. Initially the coil positioned in such a way that magnetic field passes through it. When the coil is at rest in vertical position, with side [A] of coil at top position and side [B] at bottom position no. current is induced in it. In this position current is zero.



ii. When a coil is rotated in clock wise direction, current will be induced in it flows from A to B, during the first quarter of rotation, the current increases from zero to a maximum position when the coil is in horizontal position.

iii. If we continue the rotation of coil, current decreases during second quarter of the rotation and once again become zero. When coil comes to vertical position with side B at top and side A at bottom. During second part of rotation, current generated follows the same pattern as that in the first half; expect that the direction of current is reversed.

6. Usage of induced current produced:

i. The ends of the coil are connected to two slip rings and two carbon brushes are arranged in such a way that they press the slip rings to obtain current form the coil

ii. When these brushes are connected to external devices like T.V. etc we can make them work with the current supplied from ends of carbon brushes

iii. This current is known as alternating current [AC]

10. Explain the working of D.C. generator with a neat diagram. (AS1)

A. 1. Generator works on the principle of electromagnetic induction.

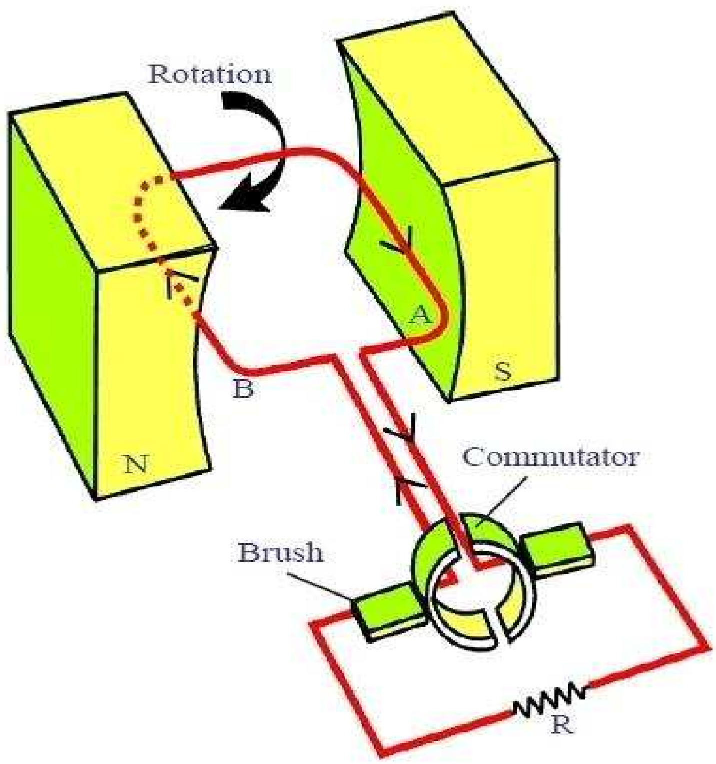
2. It converts mechanical energy into electrical energy.

3. Consider a rectangular coil. Let it be held between the poles of cure shaped permanent magnet as shown in figure.

4. As the coil rotates the magnetic this passing through the coil changes.

5. According to the law of electromagnetic induction an induced current is generated in coil.

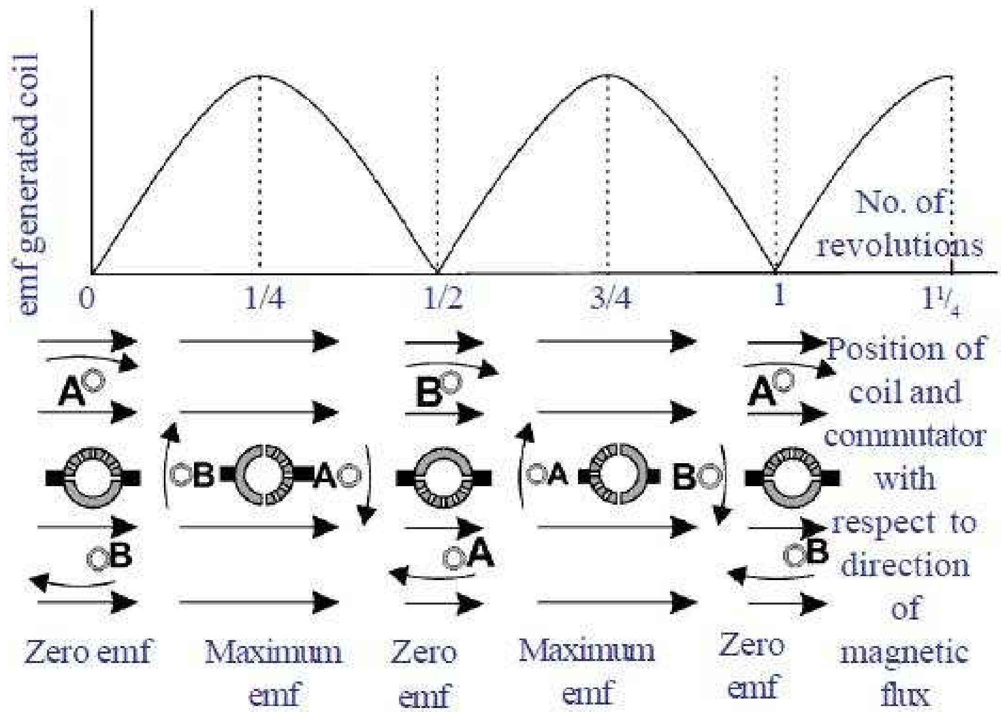
6. If two half slip rings are connected to ends of coil as shown in below, this generator works as DC generator to produce DC current.



Working:

1. When the coil is in vertical position the induced current generated during the first half rotation, rises from zero to maximum and falls to zero again.
2. As the coil moves further from this position, the ends of the coil go to other slip rings.

3. Hence, during the second half rotation, the current is reversed in the coil itself, the current is generated in the second half rotation of the coil is identical with that during the first half of the direct current for one revolution.



11. Rajkumar said to you that the magnetic field lines are open and they start at North Pole of bar magnet and end at South Pole. What questions do you ask Rajkumar to correct him by saying "field lines are closed"? [AS2]

A. 1. If the magnetic field lines start at North Pole and end at South Pole, where do the lines go from South Pole?

2. What happening with in bar magnet?

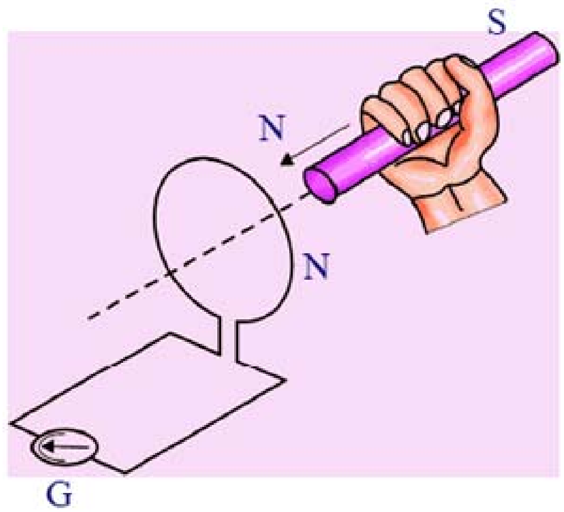
3. If the magnetic lines are open then is it possible to obey conservation of energy?

12. What experiment do you suggest to understand Faraday's law? What items are required? What suggestions do you give to get good results of the experiment? Give precautions also? [As3]

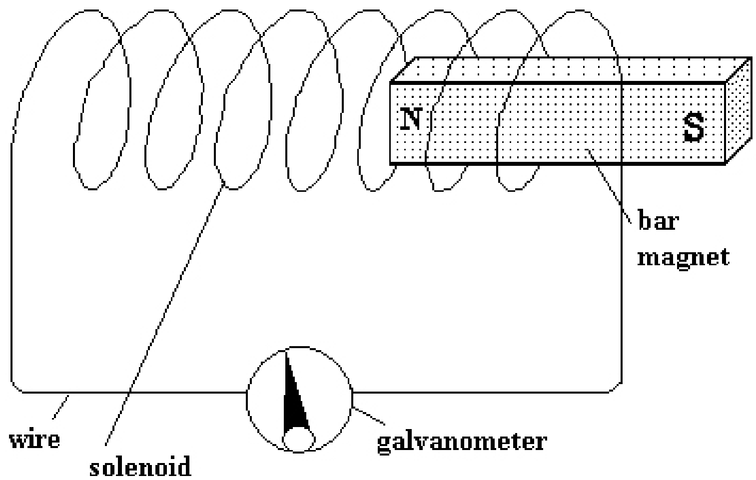
A. **Aim:** To understand Faraday's law of induction-

Materials required:

1) A coil of copper wire
2) A bar magnet
3) Galvanometer etc



Faraday's laws



Procedure:

1) Connect the terminal of a coil to a sensitive galvanomally as shown in figure.
2) Normally we wouldn't expect any deflections of in the galvanometer because there is to be no EMF in this circuit.
3) Now if we push a bar magnet towards the coil with its north pole facing the coil, we observe the needle in the galvanometer deflect, Showing that a current is set up in the coil.
4) The galvanometer doesn't deflect if the magnet is at rest.

5) If the magnet is moved away from the coil, the needle in the galvanometer again deflects, but in the opposite direction, which means that a current is setup in the coil, in the opposite direction.
6) If we use end of South Pole of magnet instead of North Pole in the above activity, the deflections are partly reversed.
7) This experiment proves "Whenever there is a continents change of magnetic flux linked with closed coil, a current is generated in coil".

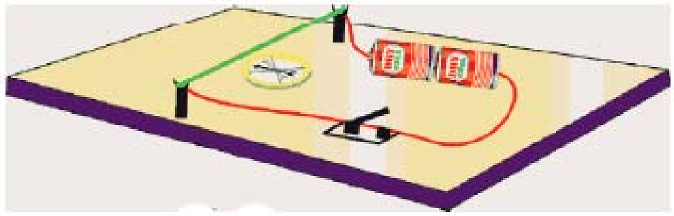
Precautions:

1. The coil should be kept on an insulating surface
2. Bar magnet should be of good magnetic moment
3. The centre of galvanometer scale must be zero.

13. How can you verify that a current carrying wire produces a magnetic field with the help of an experiment? (AS3)

A. Experiment:

1. Take a thermocol sheet and fix two thin wooden sticks of height 1cm which have small slit at the top of their ends.
2. Arrange a copper wire of 24 gauge so that it passes through these slits and make a circuit.
3. The circuit consists of 3 or 9 v battery, key and copper wire which are connected in series.
4. Now keep a magnetic compass below the wire bring a bar magnet, close to the compass.
5. The needle in the compass deflects. This deflection is due to magnetic field produced by bar magnet.
6. Take the bar magnet far away from the circuit and switch on the circuit.
7. The compass needle deflects.
8. The deflection is due to magnetic field produced by current carrying wire.



14. Collect information about generation of current by using Faraday's law. [AS4]

A. Faraday's law is used to generation of current-

1. Change in magnetic flux induces EMF in the coil.

2. Electromagnetic induction proposed by Faraday is the base for generator, which produces electric current.

3. Transformer also works on principle of electromagnetic induction, which used to transmit the current.

15. Collect information about material required and procedure of making a simple electron from internet and make a simple motor on your own. [AS4]

A. **Aim:** Preparation of electric motor-

Materials required:

1. A wire nearly 15cm
2. 1.5 v battery
3. Iron nail
4. Strong magnet
5. Paper clip

Procedure:

1. Attach the magnet to the head of iron nail
2. Attach a paper clip to the open end of magnet
3. Now attach the other end of the nail to positive terminal of battery
4. Now connect the negative terminal of the battery and the head of the iron nail through a wire
5. We observe that paper clip rotates

16. Collect information of experiments done by Faraday? [AS4]

A. 1. Connect the terminals of a coil to a sensitive galvanometer as shown in figure.

2. Normally, we wouldn't expect any deflection of needle in the galvanometer because there is no EMF in the circuit.

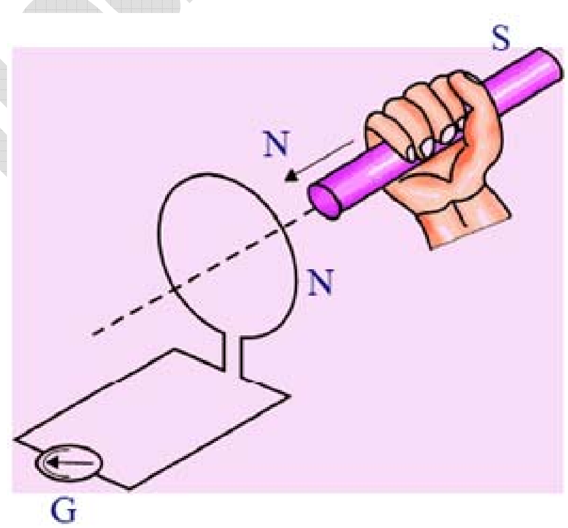
3. Now, if we push a bar magnet towards the coil, with its north pole facing the coil, the needle in the galvanometer deflects, showing that a current has been set up in the coil, the galvanometer doesn't deflect if the magnet is at rest.

4. If the magnet is moved away from the coil, the needle in the galvanometer again deflects, but in the opposite direction, which means that a current is set up in the coil in the opposite direction.

5. If we use the end of the South Pole instead of North Pole, the results i.e., the deflection sin galvanometer are exactly opposite to each other.

6. The activity proves that the change in magnetic flux linked with a closed coil, produces current.

7. From this Faraday's law of induction can be stated as whenever there is a continuous change of magnetic flux linked with a closed coil. A current is generated in coil this induced EMF is equal to the rate of change of magnetic flux passing through it.



17. How do you appreciate Faraday's law, which is the consequence of conservation of energy? [AS6]

A. Law of Conservation of Energy:

1. Energy neither be created nor be destroyed, but can be converted from on form to another.

2. Faraday's law says whenever there is a change in magnetic flux linked with closed coil; a current is generated in the coil.

3. The induced EMF is equal to the rate of change of magnetic flux passing through it.

4. The work input: we have to more the magnet through the coil.

5. The energy is converted into electrical energy.

18. How do you appreciate the relation between magnetic field and electricity that changed the life style of mankind?

A. 1. Changes in the life style of mankind are a result of several scientific many inventions.

2. All appliances like generators, tans, mixers, motors make our life easy and comfortable.

3. By using Faraday's law, electricity is produced from varying magnetic flux.

19. Which of the various methods of current generation protects nature well? Give examples to support your answer. (AS7)

A. Nowadays, current is generated in many ways like hydel power, thermal power, wind power, nuclear power and power from solar radiation, among others.

Hydel Power:

1. It uses a lot of water stored at very high places.
2. Water is a non renewable source.

Thermal Power:

1. By heating the cool, water converts to steam runs the turbine and produces electricity.
2. Coal is non renewable source.

Fill in the Blanks

1. The SI unit of magnetic field induction is _________.
2. Magnetic flux is the product of magnetic field induction and________.
3. The charge is moving along the direction of magnetic field. Then force acting on it is ___________.
4. A current carrying wire of length L is placed perpendicular to a uniform magnetic field B. Then the force acting on the wire with current I is ____________.
5. Faraday's law of induction is the consequence of ____________.
6. The magnetic field inside a ________ is uniform.
7. S.I unit of magnetic field strength is ________.
8. The direction of magnetic field lines along a current carrying conductor is given by _____________.
9. Dynamos work on the principle of _________.
10. Motor works on the principle of _________.
11. A DC generator is based on principle of ____________.
12. S.I unit of magnetic flux is ____________.
13. The magnetic field intensity at centre of magnetic is ______.

Key:

1) Tesla; 2) Area; 3) Zero;
4) F = B.I.L; 5) Consignation of energy; 6) Magnet;
7) Tesla; 8) Maxwell's right hand rule; 9)Faraday's law;
10) Ampere's force law; 11) Faraday's law; 12) Weber;
13) Zero;

Objective Type Questions

1. Which of the following converts electrical energy into mechanical energy? [ ]

   a) Motor b) Battery c) Generator d) Switch

2. Which of the following converts mechanical energy into electrical energy? [ ]

   a) Motor b) Battery c) Generator d) Switch

3. The magnetic force on a current carrying wire placed in uniform magnetic field if the wire is oriented perpendicular to magnetic field, is______.

   [ ]

   a) 0 b) ILB c) 2ILB d) ILB/2

4. _______ law gives direction of induced current. [ ]

   a) Faraday's law b) Kirchhoff's law c) Lenz's law d) Lorentz law

5. Magnetic field is a ________ quantity. [ ]

   a) Vector b) Scalar c) Dimension less d) unit law

6. The relation between Weber and teals is _________. [ ]

   a) Weber.m^2 = Tesla b) wb = Tesla × m^2

   c) $\frac{m^2}{wb}$ d) wb = Tesla

7. The magnetic field inside a ________ is uniform. [ ]

   a) Current carrying conductor b) Solenoid c) Coil d) Magnet

8. Relation between flux linked with the coil (ε) and no of turns (N) is ______ [ ] where is magnetic flux.

   a) $\varepsilon = N.\frac{d\phi}{dt}$ b) $\varepsilon = \frac{1}{N}.\frac{d\phi}{dt}$ c) $\varepsilon = N.\frac{dt}{d\phi}$ d) $N = \varepsilon\frac{d\phi}{dt}$

9. Magnetic field lines are ____________. [ ]

a) Closed loops b) Open loops c) Parallel d) None of these

10. Electric power p =_________ [ ]

a) $p = I.\frac{d\phi}{dt}$ b) $p = \frac{1}{I}.\frac{d\phi}{dt}$ c) $I = \frac{pdt}{d\phi}$ d) $d\phi = \frac{PI}{dt}$

Key:

1.a; 2. c; 3. b; 4. c; 5. a; 6. b; 7. d 8. a; 9. a; 10. a.

Problems

1. The value of magnetic field induction which is uniform is 2T. What is the flux passing through a surface of area 1.5m^2 perpendiculars to field?

Sol: Magnetic field induction B = 2T

Area (A) = 1.5m^2

Magnetic flux = B.A

= 2 × 1.5

= 3 wb.

2. An 8N force on a rectangular conductor 20cm long placed perpendicular to a magnetic field. Determine the magnetic field induction if the current in conductor is 40A.

Sol: Force acting F = 8N

Length of conductor l = 20cm = 0.2cm

Current I = 40 A

Magnetic field induction B =?

We know that F = BIL

$$B = \frac{F}{IL}$$

$$= \frac{8}{40 \times 0.2} = 1 Tesla$$

Magnetic field induction B = 1 Tesla.

Match the following

	Group – I		Group – II
1.	Motor	[ ]	A) Magnitude of induced EMF
2.	Generator	[ ]	B) Direction of induced EMF
3.	Lenz's law	[ ]	C) Converts electrical energy to mechanical energy
4.	Faraday's law	[ ]	D) Converts mechanical to electrical energy
5.	Right hand thumb rule	[ ]	E) Direction of flied by current wire

Key:

1.C; 2. E; 3. B; 4. A; 5. D;

II.

	Group - I Physical Quantities		Group - II Units
1.	Magnetic flux	[ ]	A) Volts
2.	Magnetic flux density	[ ]	B) Weber (wb)
3.	Induced EMF	[ ]	C) N-m
4.	Induced current	[ ]	D) Tesla (T)
5.	Torque	[ ]	E) Ampere

Key:

1.B; 2. D; 3. A; 4. E; 5. C;

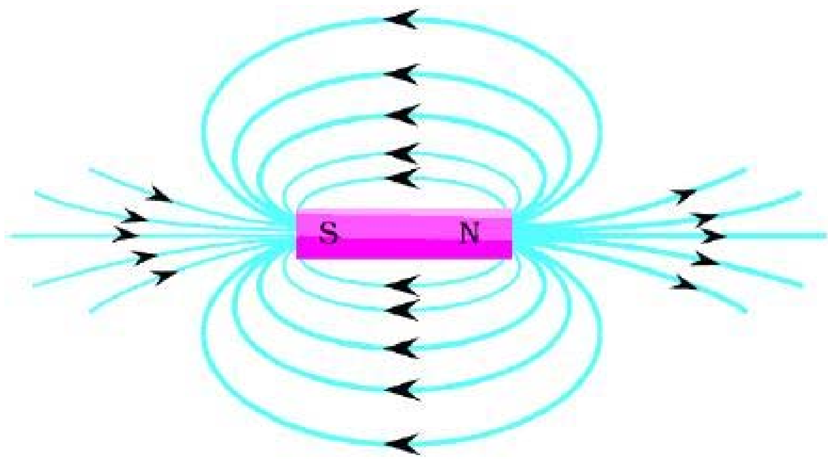
III

	Group – I		Group – II
1.	Force acting on '(F)' current currying wire	[ ]	A) BILS
2.	Magnetic flux 'ϕ'	[ ]	B) $\frac{\Delta\phi}{\Delta t}$
3.	Induced EMF 'ε'	[ ]	C) BIL or BQV
4.	Work done on cross wire w	[ ]	D) $I\frac{\Delta\phi}{\Delta t}$
5.	Power produced by induced EMF	[ ]	E) $\vec{B}.\vec{A}$

Key: 1.C; 2. E; 3. B; 4. A; 5. D;

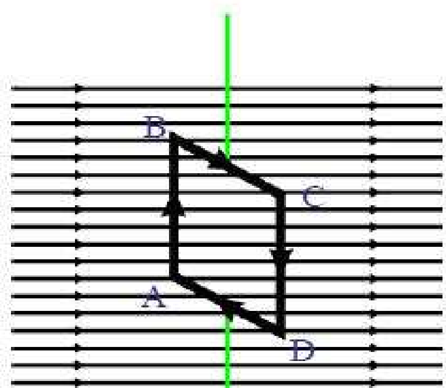
5 Mark Questions

1. Description of magnetic field lines in a magnet.



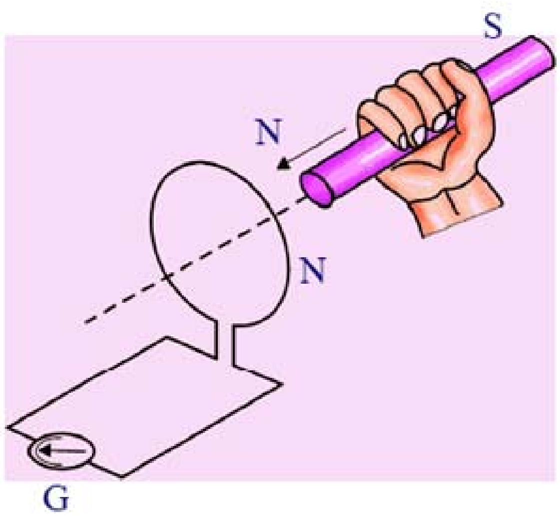
Magnetic field lines

2. Behavior of current carrying coil in a magnetic field.



Magnetic field (B)

3. Faraday's experimental analysis:



Chapter -7

Human Eye and Colourful World

SYNOPSIS

The human eye functions on the principle of sensation of vision. We see objects because of the light scattered from them falls on the eye. The eye has a lens in its structure. This eye lens forms a real and inverted image of an object on the retina. The distance between the lens and retina is about 2.5 cm i.e., for any position of object in front of the eye the image distance is fixed and about 2.5cm. The maximum and minimum focal lengths of eye lenses are 2.5 cm and 2.27 cm respectively.

Some times the eye may gradually lose its ability for accommodation. In such conditions the person cannot see an object clearly and comfortably. The vision becomes blurred due to defects of the eye lens. There are mainly three common defects of vision. They are i) Myopia ii) Hypermetropia iii) Presbyopia

Myopia is also called near sightedness. A person suffering myopia cannot see objects at long distance but can see nearby objects clearly. To correct one's myopia by bi-concave lens.

Hypermetropia is also known as "far sightedness". A person with hypermetropia can see distant object clearly but cannot see objects at near distance. Biconvex lens is used to correct the defect of hypermetropia.

Presbyopia is vision defect. This happens due to gradual weakening of ciliary muscles. To correct we need bi-focal lenses which are formed using both concave and convex lenses.

The refractive index of the material of the prism can be calculated by the formula

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\frac{A}{2}}$$

The splitting of white light into different colors (VIBGYOR) is called dispersion. Rainbow formation is the example of dispersion of light.

Sun appears red in colour during sunrise and sunset due to scattering of light. The blue colour of sky is also due to scattering of light.

2 Mark Questions

1.Light wave length (λ_1) enters a medium with refractive index n_2 from medium with refractive index n_1. Then what is the wave length of light to second medium? (AS_1)

Sol. Wave length in first medium $=\lambda_1$

Wave length in second medium $=\lambda_2$

Refractive index of first medium $=n_1$

Refractive index of second medium$=n_2$

Light enters from first medium to second medium

$$\frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} = \frac{n_2}{n_1}$$

2.Assertion: The refractive index of a prism depends only on the kind of glass of which it is made of and the color of light.

Reason: The refractive index of a prism depends on the refracting angle of the prism and on the angle of minimum direction (AS_2)

Sol: Both A and R are true and R is not the correct explanation of A

Refractive index (n) depends on nature of material and colour of light and also it is measured in terms of apex angle and deviation angle as follows

$$n = \frac{\sin\left(A+D\right)}{\sin\left(\frac{A}{2}\right)}$$

3. Assertion: Blue colour of sky appears due to scattering of light.

Reason: Blue color has shortest wavelength among all colors of white light. (AS_2)

A. Here A is true and R is false.

Sky appears blue due to scattering of light.

Among all colours, violet colour has shortest wave length, but blue is sensible to eyes in white light, so, sky appears as blue in colour.

4. Why does the sky sometimes appear white? (AS_7)

A. 1. When the atmosphere contains lot of dust particles that are larger than nitrogen and oxygen molecules, light of lower frequencies is also scattered strongly.

2. Due to this, sky sometimes wears whitish appearance.

3. After a heavy rain during which most of the dust particles are washed down, the sky takes back its blue colour.

5. Glass is known to be a transparent material. But ground glass is opaque and white in colour. Why? (AS_7)

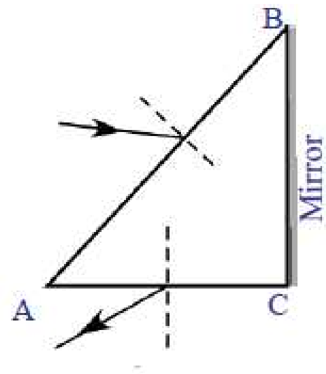
A. 1. Glass is general a transparent material because it transmits most of the light incident on it.

2. When glass is ground, its surface becomes rough due to microscopic unevenness.

3. When light is incident on such a rough surface, it is reflected in many different directions.

4. This type of reflection is known as diffuse reflection due to this ground glass opaque and white in color.

6. Incident ray in one of the face (AB) of a prism and emergent ray from the face are given in figure. Complete the ray diagram. (AS_5)



A. Here AB, AC are refracting surface and BC is reflecting surface. Incident ray enters into prism (denser medium) from air (rarer medium) so it bends towards normal.

Emergent ray comes into (rarer medium) air from prism (denser medium)

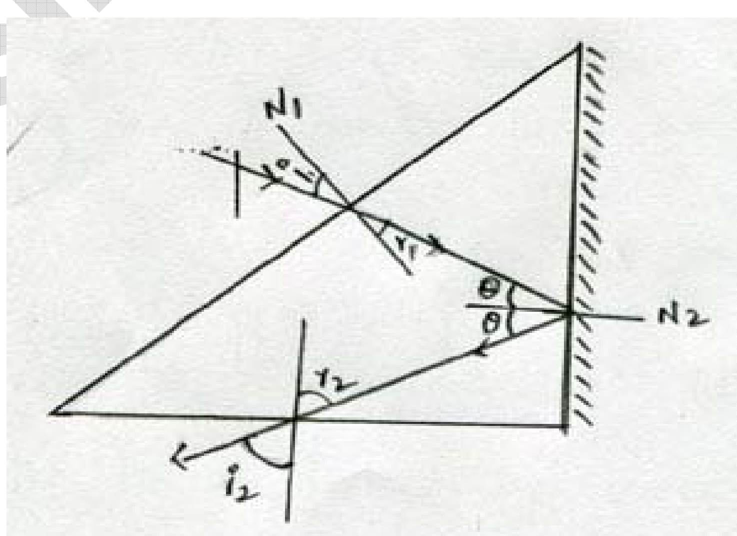
So, it bends away from normal

For mirror: angle of incidence= angle of reflection

N_1, N_2, N_3 are normal's — i_1- angle of incidence

i_2- angle of emergence — r_1, r_2- angle of refraction

-angle of incidence, reflection for the mirror



7. Eye is the only organ to visualize the colourful world around as this is possible due to accommodation of eye lens. Prepare a six line stanza explaining your wonderful feelings. (AS_6)

A. Oh! wonderful eyes

You help us to see behind skies

You show us the world bright

The depth of oceans

And the mountains height

Thank you nature for gifting me sight

8.How do you appreciate the working of ciliary muscle in the eye? (AS_6)

A. Ciliary muscle is a ring shaped smooth muscle in the middle layer of eye that control shape of the lens for viewing objects at varying distances.

1. It also regulates the flow of aqueous humor.

2. When they contracts, it pull itself forward and moves the central region towards the axis of the eye.

3. This causes the lens of eyes to become more spherical adapting to short range forces.

4. On other hand, relaxation of ciliary muscles causes flattering of lens increasing long range forces

9. A person is viewing an extended object. If a converging lens is placed in front of his eye, will he feel that the size of the object has increased? Why? (AS_7)

A. The image formed by convex lens depends on the position of object

i.e., 1.is the person feels that the size of objects has increased

2. He used the converging lens i.e., the convex lens and the image is an extended object.

3. The image is formed when the object is in between foci (f) and lens centre (p) of the lens.

4. Hence the size of image seems to be increased.

1 Mark Questions

1. If a write sheet of paper is strained with oil, the paper turns transparent. Why?

A. As paper is a white solid material and absorbent, it will absorb oil, so it becomes transparent until it dries. Until it dries, it can transmit the light which incident on it.

2. What is accommodation of eye lens?

A. The ability of eye lens to change its focal length with respective to ciliary muscles is known as accommodation of eye lens.

3. State the range of focal length of human eye lens for an adult.

A. 2.27cm-2.5cm

4. Define dispersion?

A. splitting of white light into colors, this phenomenon is known as dispersion.

5. in all colours in white light, white colour has minimum divination?

A. Red colour has minimum deviation

6. Can you guess the reason, why sun does not appear red during noon hours?

A. During noon hours, sun light travels less distance through the atmosphere then the morning and evening times. Therefore all the colors reaches without much scattering, thus the sun appear white at noon.

7. State function of optical nerve?

A. The optical nerve transmits visual information from retina to the brain.

8. Define scattering.

A. The process of absorption of light of certain frequency and re-emission in all possible directions with altered frequency by the atoms (molecules) of a substance is known as scattering.

9. State different types of defects of vision.

A. Mainly defects of vision are 3 types-

1. Myopia
2. Hypermetropia
3. Presbyopia

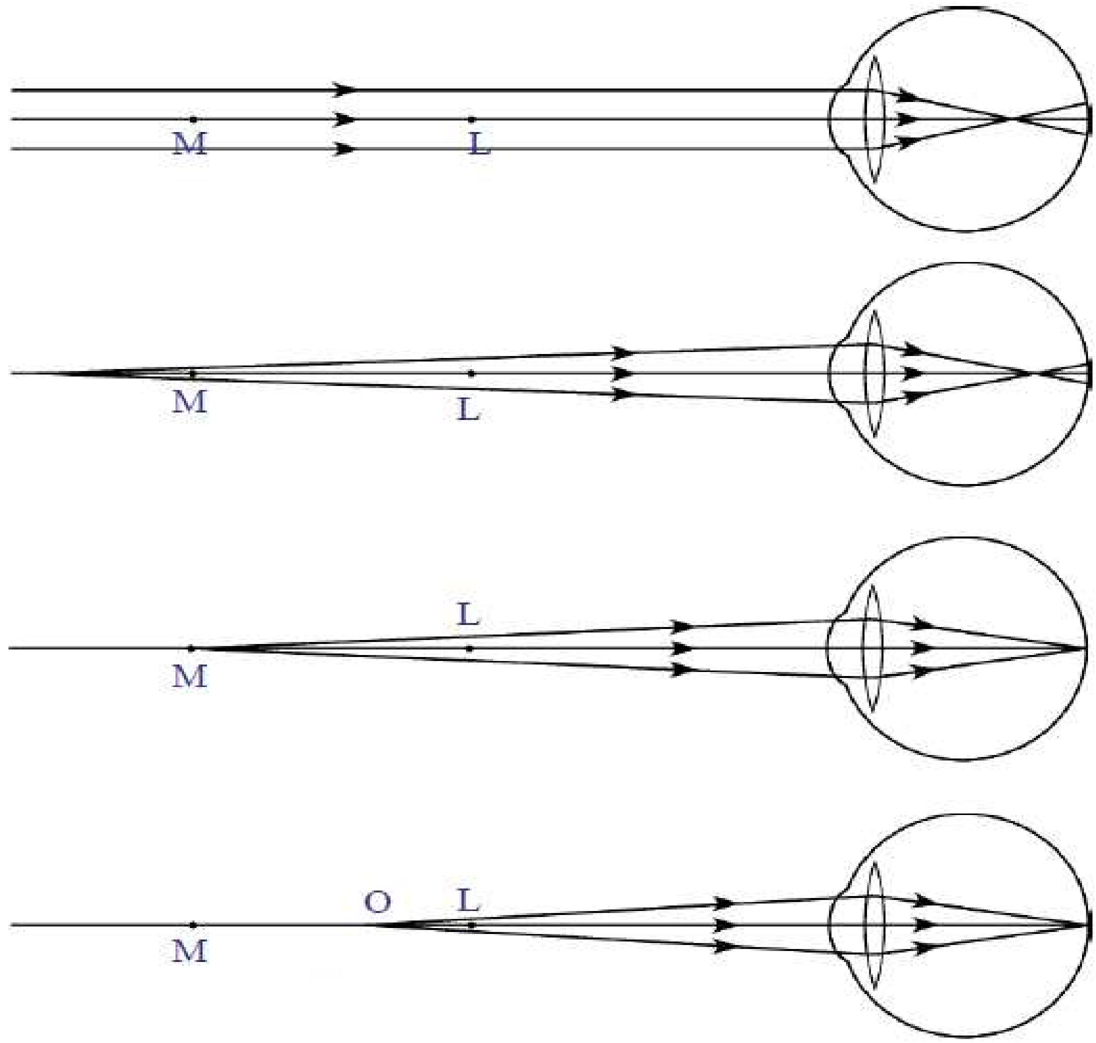
4 Mark Questions

1. How do you correct the eye defects myopia? (AS_1)

A. 1. The point of maximum distance at which the eye lens can form an image in the retina is called as far point.

2. The defeat in which people can't see objects beyond the far point is myopia (or) near sightedness.

3. The eye lens can form clear image on the retina when an object is placed between far point and point of least distance of distinct vision.



4. If we are able to bring the image of the object kept beyond far point, between far point and the point of least distance of distinct vision using a lens, this image acts as an object for the eye lens

5. This can be possible only when a concave lens is used.

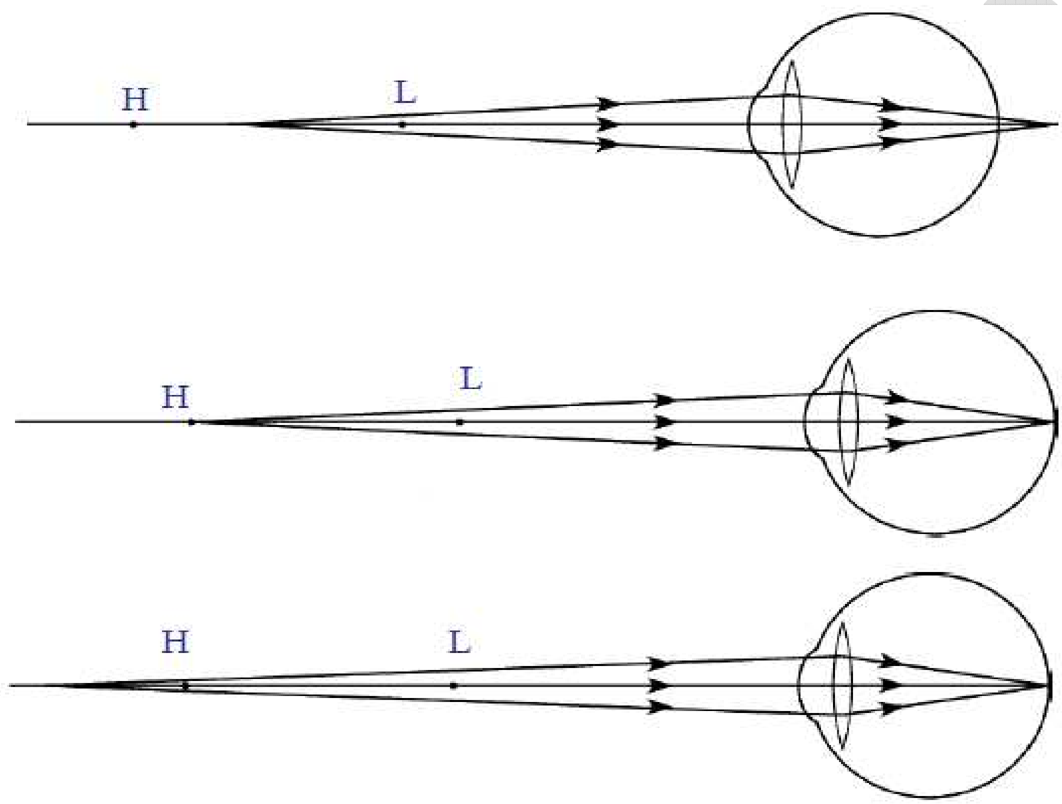
6. To correct one's myopia, we need to select a lens which forms an image at the far point for an object at infinity.

7. We need to select biconcave lens to correct this, with a focal length (f=-D)

D-distance of far point (in cm)

2. Explain the correction of the eye defect hypermetropia?

A. 1. In the case of hypermetropia, the rays coming from a nearly object after refraction from the lens, form an image beyond retina.



2. Let the point of minimum distance at which the eye lens forms clear image on retina be known as near point.

3. The people with defect of hypermetropia cannot see objects placed between near point (H) and point of least distance of distinct vision (L)

4. Eye lens can form a clear image on the retina when any object is placed beyond near point.

5. To correct hypermetropia, we need to use an lens which forms an image beyond near point when the object is placed between near point (H) and least distance of

clear vision (L), so we need a double convex lens of focal length $f = \frac{25d}{d-25} cm$ where 'd' is distance of near point.

3. How do you find experimentally the refractive index of a prism? (AS_1)

A. **Aim:** Finding the refractive index of a prism

Materials required: Prism, piece of white chart of size 20X20cm, pencil, protractor, pins and scale.

Procedure:

1. Let us take a prism and place it on the white chart in such a way that the triangular base of the prism is on the chart.

2. Let us draw a line around the prism using a pencil having vertices P, Q and R and remove the prism.

3. Measure the angle between PQ and QR which gives the angle of prism (A).

4. Let us consider a light ray 'AB' incident on at M. Draw a normal at M.

5. Let us mark M on PQ and draw a perpendicular to PQ at M.

6. Let us mark an angle 30^0 and draw a line AB at 'M'.

7. Fix 2 pins vertically on the line AB.

8. Now let us look for the images of 2 pins through the prism on other side and fix another 2 pins say C and D.

9. Remove the prism and draw a line to PR which passes through C and D points. This line gives emergent ray.

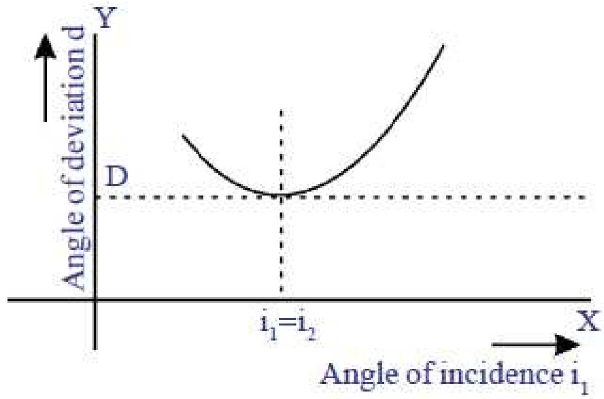
10. Draw a normal to 'PR' and measure the angle of emergence (i_2).

11. Now extend the both incident and emergent ray till they meet a point O.

12. Measure the angle between the extended 2 rays which give angle of deviation ($\angle d$) plot graph between i and d.

13. As the angle of incidence charges angle of deviation also charges

14. As the angle of incidence increases, angle of deviation decreases and attains a minimum value (Angle of minimum deviation) and further it increases with increasing in angle of incidence.



15. Now tabulate the reading of angle of incidence (i_1), angle of emergence (i_2) and angle of deviation (d)

Angle of incidence (i_1),	**Angle of emergence (i_2)**	**Angle of deviation (d)**

16. Angle of prism is A.

Angle of minimum deviation is D

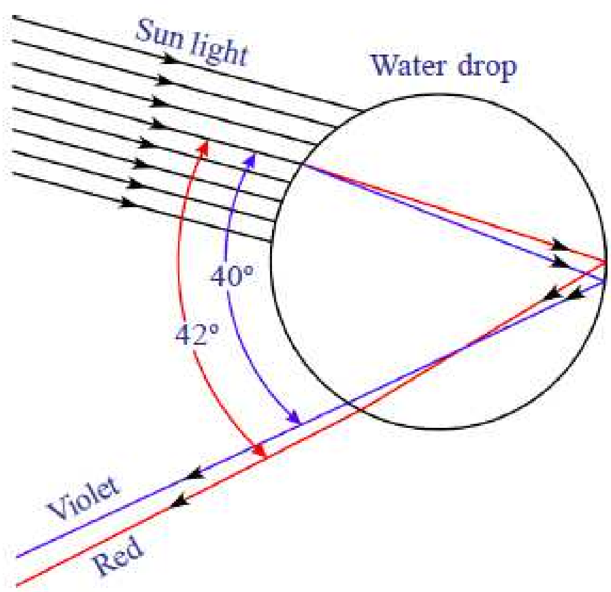
i.e., $\mu = \frac{\sin i}{\sin r} \Rightarrow \mu = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$

4. Explain the formation of rainbow. (AS_1)

A. 1. The beautiful colours of the rainbow are due to dispersion of the sunlight by millions of tiny water droplets. Let us consider the case of an individual water droplet.

2. Observe the figure the rays of sunlight enters the drop near its top surface at this first refraction, the white light is dispersed into its spectrum of colors, violet being deviated the most and red the least.

3. Reaching the opposite side of the drop each colour is reflected back into the drop because of total internal reflection.



4. Arriving at the surface of the drop each colour is again refracted into air

5. At the second refraction, the angle between red and violet rays further increases when compared to the angle between those at first refraction.

6. We observe bright rainbow when the angle incoming and outgoing rays are near the maximum angle is 42^0.

5. Explain briefly the reason for the blue of the sky? (AS_1)

A. 1. Sky appears blue due to a phenomenon known as scattering of light, which may be defined as re emission of light by atoms or molecule in all directions with different frequency when compared to incident frequency

2. An atom will respond to incoming light only when the wave length is comparable to size of the atom. Majority of earth's atmosphere is composed of nitrogen and oxygen molecules

3. The atomic size of these molecules matches with wave length of violet and blue colour light so, these colours are scattered more giving a beautiful sight.

4. Even though violet colour undergoes maximum scattering, we see the sky to be blue because human eye is more sensitive to blue to be blue because human eye is more sensitive to blue colour than violet colour light

6. Explain 2 activities for the formation of artificial rainbow. (AS_1)

A. Activity 1:

1. Take a metal tray and fill it with water.

2. Place a mirror in the water such that it makes an angle to the water surface.

3. Now focus, white lights on the mirror though the water as shown in the figure.

4. Try to obtain colours on a white cardboard sheet kept above the water surface.

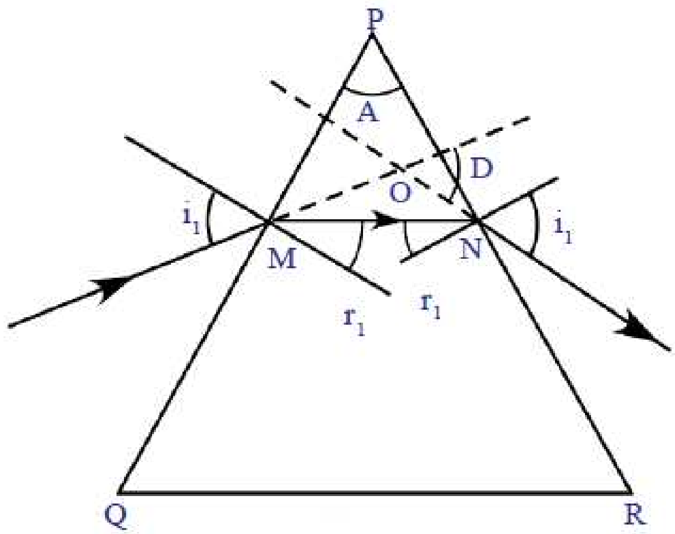
5. We can observe the seven colors of VIBGYOR on the cardboard sheet.

Activity 2:

1. Take a CD. Wipe it to make sure it is not dusty, so it will look better
2. Place it on a float surface, level side down under a light or in front of a window
3. Look at the CD, and the rainbow will be visible.
4. Hold the CD in between your fingers an move to see how the colours move

7. Derive an expression for the refractive index of the material of a prism (AS$_1$)

Description:



PQR –Glass triangular shaped prism

PQ, PR- refracting surfaces of prism

QR- Base of prism

A- Angle of prism (or) apex angle

M^{1}M – incident ray

N^{1}N- emergent ray

MN- refracted ray

d- Angle of deviation

Derivation

From triangle OMN

$$d = i_1 - r_1 + i_2 - r_2$$

$$(i_1 + i_2)(r_1 - r_2) \longrightarrow (1)$$

From Δ^{le} PMN

$A+90-r_1+90-r_2$________(2)

From (1) and (2) we have

$d=i_1+i_2-A$

$d + A = i_1 + i_2 \longrightarrow (3)$

This is the relation between angle of incidence, angle of emergence, angle of prism, angle of deviation.

From Snell's law, we known that $n_1 \sin i = n_2 \sin r$

Here n is the refractive index of the prism.

Using Snell's law at M

$1. \sin i_1 = n \sin r_1$________(4) ($\because n_1$ (air)=1)

Similarly at N

$n. \sin r_2 = 1 \sin i_2$________(5)

We known that at the angle of minimum deviation (D) the angle of incidence is equal to angle to angle of emergence is i.e., $i_1=i_2$

Observe the figure, you can notice that MN is parallels to base of prism (QR)

When $i_1 \neq i_2 = i$ angle of deviation (d) becomes angle of deviation (D)

Then (3) comes

$D+A=2i \Rightarrow i = \frac{D+A}{2}$

If $i_1=i_2 \Rightarrow r_1=r_2$

r_1+r_2__________ from(2)

$2r = A$

$r = \frac{A}{2}$

So, substituting r and i in (4)

$$\sin\left(\frac{D+A}{2}\right) = n\sin\left(\frac{A}{2}\right)$$

Formula for refractive index of the prism

$$n = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin\left(\frac{A}{2}\right)}$$

For small angles $\sin\theta \approx \theta$

$$n = \frac{\left(\frac{D+A}{2}\right)}{\frac{A}{2}} = n = \frac{D+A}{A}$$

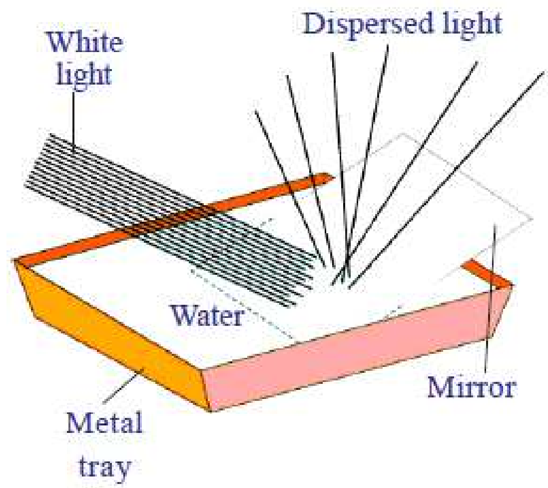
8. Suggest an experiment to produce a rainbow in your classroom and explain the procedure. (AS_3)

A. Aim. To produce rainbow-

Apparatus: tray, water, mirror

Procedure:

1. Take a metal tray and fill it with water.
2. Place a mirror in the water such that it makes an angle to the water surface.
3. Now focus the white light on the mirror.
4. Try to obtain colour on a white cardboard sheet kept above the water surface.
5. Note the names of the colors you could see in note book.
6. We know that the white light is splitting into certain different colour as rainbow.



9. Prism used in binoculars. Collects information why prisms are used in binoculars (AS_4)

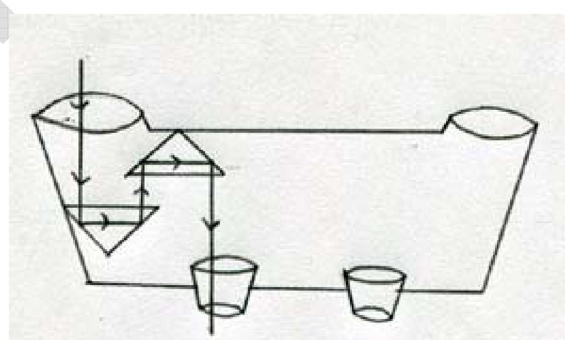
A. 1. If 2 telescopes are mounted parallel to each other so that an object can be seen by both the eyes simultaneously the arrangement is called binocular.

2. The length of each tube is reduced by using a set of totally reflecting prisms.

3. They provide intense, erect image free from lateral inversion.

f_0-focal length of objective

f_e- focal length eyepiece



4. Through a binocular we get 2 images of the same object from different angles at same time.

5. Their super position gives the perception of depth also with length and breadth.

6. Binocular vision gives proper 3D image.

7. By using total reflecting prisms there is no loss of intensity.

10. How do you appreciate the role of molecules in the atmosphere for the blue colour of sky? (AS_6)

A. 1.Blue colour of the sky is because of scattering of sunlight by molecules of air

2. Out of all the visible frequencies violet is scattered most followed by blue, green, yellow, orange and red.

3. A though violet is scattered more than blue we see the sky to be blue in colour because human eye is more sensitive to blue colour than violet.

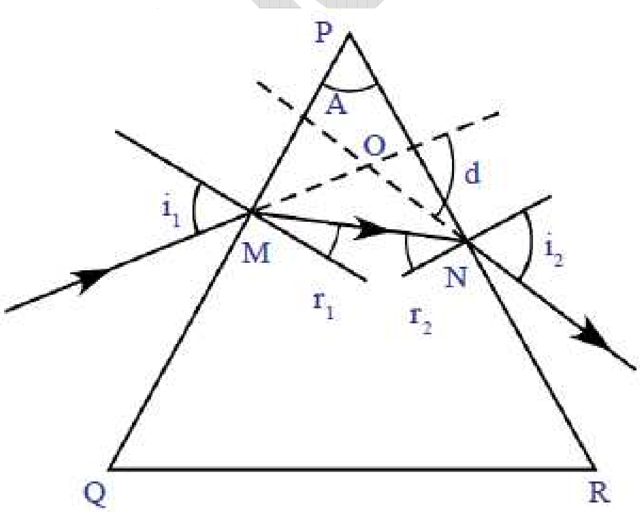
4. Nitrogen and oxygen molecules make up large part of the atmosphere.

5. When sunlight falls on them they absorb certain frequencies and re-emit the light in all directions with different frequencies.

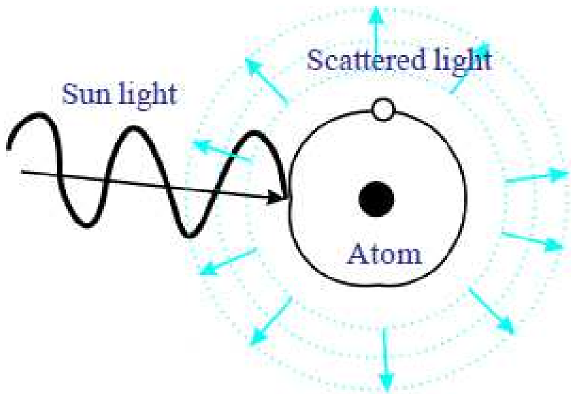
6. The amount of scattering is proportional to frequency of light.

5 Mark Questions

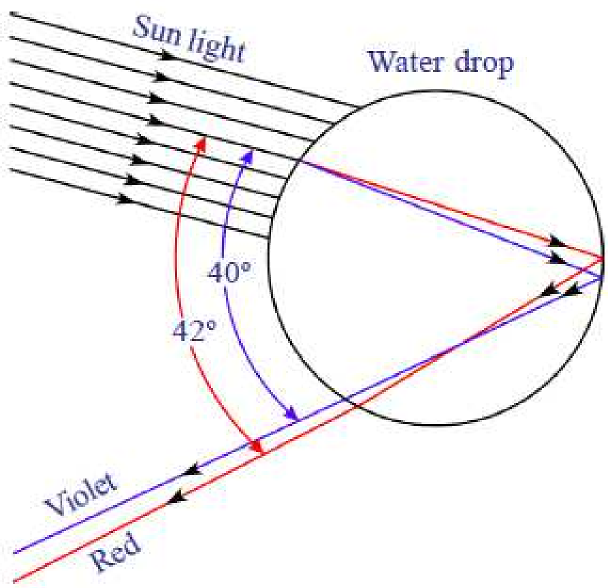
1. **Refraction of light in prism**



2. Scattering of sunlight by an atom



3. Dispersion of light in a water drop



Problems

1. Light ray falls on one of the faces of a prism at an angle 40^0 so that it suffers angle of minimum deviation of 30^0. Find the angle of prism and angle of refraction at a given surface. (AS_1)

A. Angle of incidence $i=40^0$

Angle of minimum deviation $D=30^0$

Let angle of prism =A

At angle of minimum deviation

$A + D=2i$

$A + 30= 2(40)$

$A=80-30$

$=50^0$

Angle of prism $=50^0$

Refractive index of prism n= $n=\dfrac{\sin\frac{A+D}{2}}{Sin\frac{A}{2}}$

$$=\frac{\sin\frac{50+30}{2}}{Sin\frac{40}{25}}$$

$$\frac{\sin 40}{\sin 25}$$

n=1.5209

Using Snell's law

$$\frac{\sin i}{\sin r} = n$$

$$\frac{\sin 40}{sinr} = n$$

$$sinr = \frac{\sin 40}{n} = \frac{\sin 40}{1.5209}$$

$$r = \sin^{-1}\left[\frac{\sin 40}{1.5209}\right]$$

$r = 25.001^{o}$

Angle of refraction $r = 25^{o}$

2. The focal length of a lens suggested to person with hypermetropia is 100 cm. Find the distance of near point and power of lens.

A. Focal length of lens =100cm

Power of lens p= $\frac{100}{f} = \frac{100}{100}$

1D

Power of lens p= 1 diptre

The focal length of lens f=$\frac{25d}{d-25}$

Where d is the nearest point

$$100 = \frac{25d}{d-25}$$

4d-100=d

3d=100

$$d = \frac{100}{3}$$

d= 33.3cm

Distance of near point =33.33cm

Fill in Blanks

1. The value of least distance of distant vision is about _________.
2. The distance between eye lens and retina is _____.
3. The minimum focal length of eye lens is about________.
4. The eye lens can change its focal length due to working if ___muscles.
5. The power of lens is one di ptre (ID) then focal length is ______.
6. Myopia is corrected by using ____lens.
7. Hypermetropia can be corrected by using _____lens.
8. In minimum deviation position of prism the angle of incidence is equal to angle of _________.
9. The splitting of white light into different colors (VIBGYOR) is called___.
10. During refraction of light, the character of light doesn't change is
11. Blue colour of sky is a result of ________.
12. ______are the receptors which identify colour.
13. ______ are the receptors which identify intensity of light.
14. A person suffering from hypermetropia cannot see the objects at__.
15. A person suffering from myopia cannot see the objects at _________.
16. When $i_1=i_2$ (angle of incidence =angle of emergence) then the angle of deviation becomes____.
17. Power of lens p=_________.
18. Limit of power is ________.
19. Refractive index of a medium depends on _______of light.
20. Refractive index of prism n=.

Key

1) 25cm 2) 2.5 cm 3) 2.5 cm 4) Ciliary muscles

5) 100cm 6) Biconcave 7) Biconvex 8) Emergence

9) Dispersion 10) Frequency 11) Dispersion 12) Rods

13. Cones 14) Near distance 15) Longer distance

16) Minimum (angle of minimum deviation) 17) $\frac{100}{(f)\, in\, cm}$

18) Dioptre 19. Wave length 20.) $\frac{\sin\frac{(A+D)}{2}}{\sin\left(\frac{A}{2}\right)}$

Multiple Choice Questions

1. The size of an object is perceived by an eye depends primarily on? **[b]**

(a) Actual size of object (b) Distance of the object from the eye

(c) Aperture of pupil (d) Size of image formed on retina

2. When objects at different distances are seen by eye, which of the following remain constant? **[d]**

(a) Focal length of lens (b) Object distance from eye lens

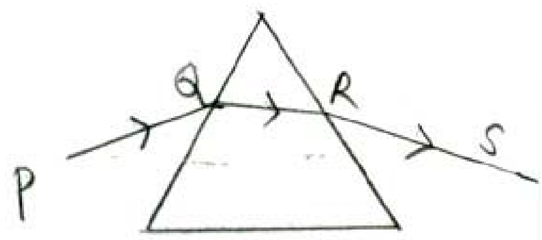
(c) The radii of curvature (d) Image distance of eye lens

3. During refraction, _______will not change. **[b]**

(a) Wave length (b) Frequency

(c) Speed of light (d) All the above

4.A ray of light falls on one of the lateral surface of an equilateral glass prism placed on a horizontal surface of a table as shown in figure for minimum deviation of ray, which of the following is true [b]



(a) PQ is horizontal (b) QR is horizontal

(c) RS is horizontal (d) Either PQ or RS horizontal

5. **Far point of person is 5m in order that he has normal vision what kind of spectacles should he use. [a]**

(a) Concave lens with focal length 5m (b) Concave lens with focal length 10m

(c) Concave lens with focal length 5m (d) Concave lens with focal length 2.5m

6. **The process of remission of absorbed light in all directions with different intensities by an atom or molecule is called? [a]**

(a) Scattering of light (b) Dispersion of light

(c) Reflection of light (d) Refraction of light

7. **A camera employs a ________lens to form ________ images. [b]**

(a) Divergent, real (b) Convergent, real

(c) Divergent, virtual (d) Convergent, virtual

8. The muscles of it control the __________. **(b)**

(a) Focal length of eye lens (b) Opening of pupil

(c) Shape of crystalline lens (d) Optic nerve

9. Rainbow is censed due to _____. **[c]**

(a) Reflection of sunlight from air

(b) Dispersion of light

(c) Refraction of light

(d) Scattering of light

10. The number of surfaces bounding a prism______. **[c]**

(a) 3 (b) 4 (c) 5 (d) 6

11. The sky looks blue and clear on sunny day because____. **[b]**

(a) Dispersion of light (b) scattering of light

(c) Reflection light (d) refraction of light

12. The power of accommodation of normal eye is? **[a]**

(a) 4D (b) 40D c) 44D (d) 400D

13. Natural example of dispersion of light is? **[c]**

(a) Scattering (b) blue colour of sky

(c) Rainbow (d) none of these

14. When the focal length of lens is 50cm, then power of lenses is _____. **[d]**

(a) 1D (b) 2D (c) 0.25D (d)0.5D

15. The wave lengths corresponding to violet, yellow, red lights - **[b]**

a) $\lambda_v > \lambda_y > \lambda_r$ (b) $\lambda_v < \lambda_y < \lambda_r$

(c) $\lambda_y < \lambda_v < \lambda_r$ (d) $\lambda_y < \lambda_r < \lambda_v$

Match the following

I. Group1 **Group 2**

Group1		Group 2
1. Myopia	[B]	A. Far sightedness
2. Retina	[D]	B. Near sightedness
3. Cornea	[C]	C. Thin membrane
4. Presbyopia	[E]	D. Light sensitive screen
5. Hypermetropia	[A]	E. Gradual weakening of ciliary muscles

II. Group1 **Group 2**

Group1		Group 2
1. Power	[E]	A. $n = \dfrac{\sin\dfrac{(A+D)}{2}}{\sin\dfrac{A}{2}}$
2. Refractive index prism	[A]	B. V= $\upsilon\lambda$
3. Snells law	[D]	C. $i_1 = i_2$
4. Condition of minimum Deviation	[C]	D. $n = \dfrac{\sin i}{\sin r}$
5. Velocity of light	[B]	E. $\dfrac{1}{(f)inm} or \dfrac{100}{f.incm}$

Chapter -6

Refraction of Light at Curved Surfaces

SYNOPSIS

A lens is formed when a transparent material is bounded by two surfaces of which one or both surfaces are spherical. Lenses can be of various types. Biconvex lens, Biconcave lens, Plano convex lens, Plano concaves lens and concave – convex lens.

In lenses, light undergoes the phenomena of refraction. If u,v and f are the object distance, Image distance and focal length then the lens formula is $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$.

If R_1, R_2 are the radius of curvatures of the lens, 'n' is the absolute refractive index then

$\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$ known as the Lens-Maker's formula.

In concave lens, only virtual image is formed. In convex lens both virtual and real images are formed. The position of image changed in convex lens by changing the position of object.

2 Mark Questions

1. A man wants to get a picture of a zebra. He photographed a white donkey after fitting a glass, with black stripes, on to the lens of his camera. What photo will he get? Explain? [AS1]

A. 1. He will get a photograph which consists of Black and White strips.

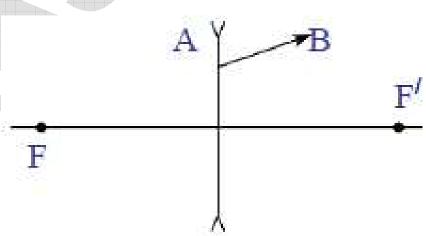
2. Black strips opera with more intensity and white strips appear with less intensity because the reflected rays from white donkey entered into camera through the lens having black stripes, these black stripes don't allow the rays inside. So photograph of white donkey will obtained with reduced brightness.

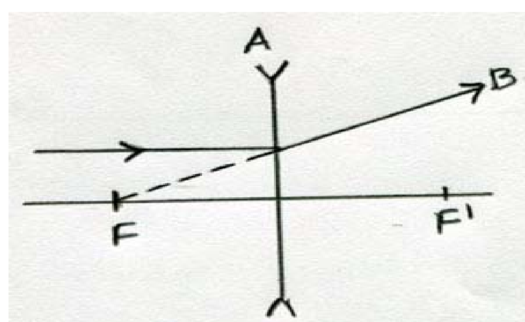
2. A convex lens is made up of three different materials as shown in figure. How many of images does it form? [AS2]

A. The lens has been made up of three different materials. These three different materials will have three different refractive indices. Hence three different images will be formed.

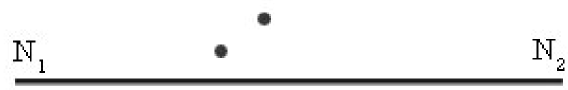
3. Figure shows ray AB that has passed through a divergent lens. Construct the path of the ray up to the lens if the position of focal is known?

A. A light passing parallel to principal axis, after refraction appears to be diverging from the focus of lens.





4. Figure shows a point light source and its image produced by a lens with an optical axis N_1N_2. Find the position of the lens and its focal using a ray diagram?



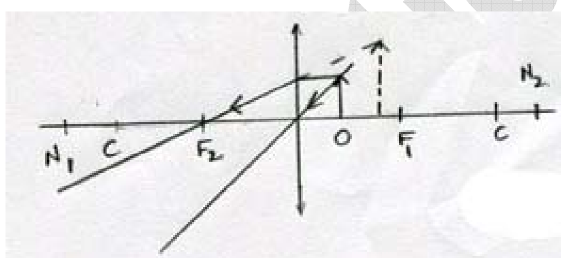
A. 1. The object is in between focus and optic centre

2. Lens used us is convex lens

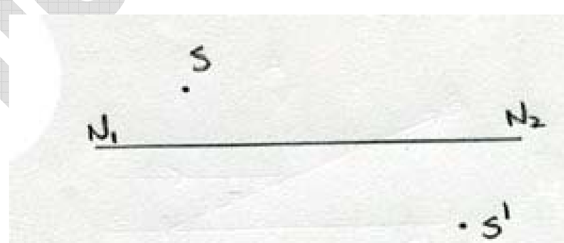
3. Image is virtual, Erect, Magnified.

4. Object is at 'O'; image is at I, ll_1 is the lens.

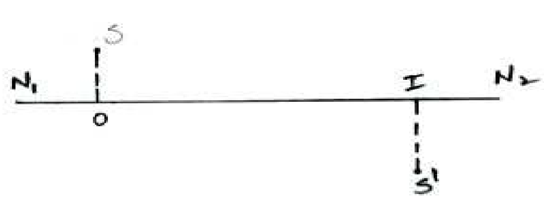
5. F is the focal point



5. Find the focus by drawing a ray diagram using the position of source 'S' and image 'S^1' given in figure?

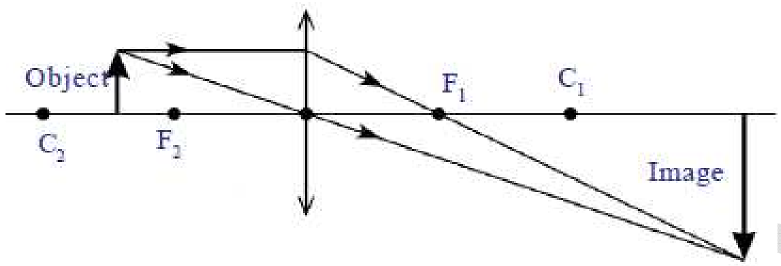


A. 1. Here the image should be inverted, and magnified because 'SO' < 'S^{1}I'.



2. The object is placed between curvature (C) and focal point F. The image formed beyond centre of curvature (C_2).

3. Image produced is Inverted, Real, Magnified.



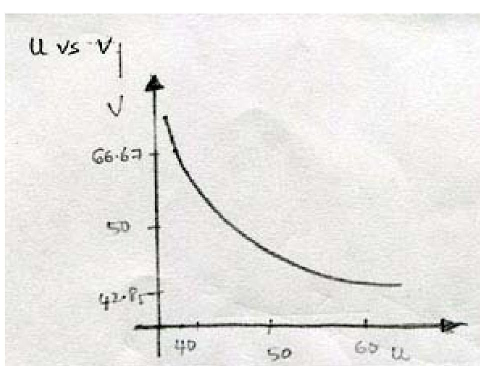
6. Use the data obtained by activity 2 in table 1 of this lesson and draw the graphs of u vs. v and $\frac{1}{u} vs \frac{1}{v}$

A. Graph of u – v using data obtained by activity 2 take focal length of lens be f(say) = 25 cm.

$$\frac{1}{f} = \frac{1}{u} - \frac{1}{v}$$

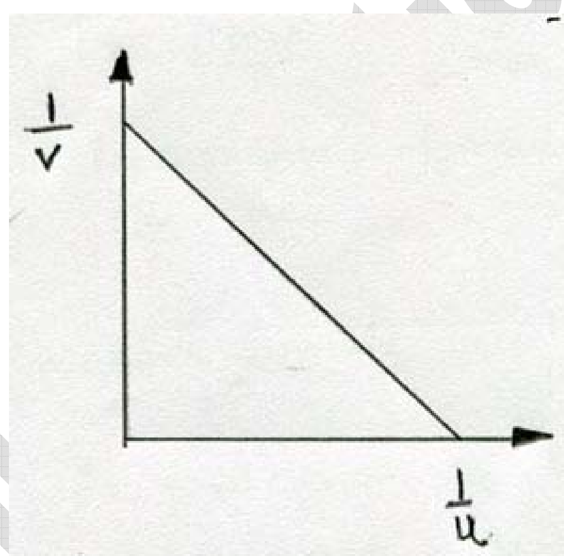
Object distance (u)	Image distance (v)	Focal length (f)
60cm	42.85cm	25cm
50cm	50cm	25cm
40cm	66.67cm	25cm

Graph: u vs. v



Graph $\frac{1}{u} vs \frac{1}{v}$

S.No.	u(cm)	V(cm)	$\frac{1}{u}\left(cm^{-1}\right)$	$\frac{1}{v}\left(cm^{-1}\right)$
1	60	42.85	$\frac{1}{60} = 0.01667$	$\frac{1}{42.85} = 0.0233$
2	50	50	$\frac{1}{50} = 0.02$	$\frac{1}{50} = 0.02$
3	40	66.67	$\frac{1}{40} = 0.025$	$\frac{1}{66.67} = 0.015$



1 Mark Questions

1. Write the lens makers formula and explain the terms in it? [AS1]

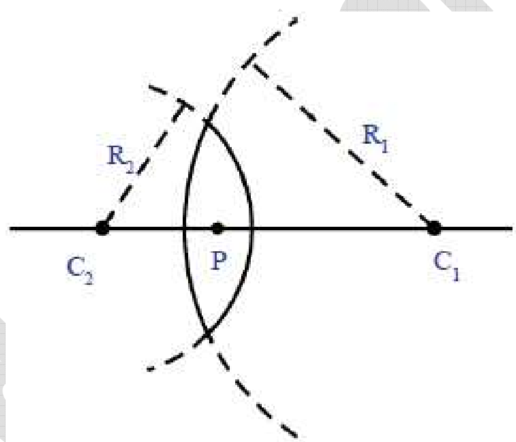
A. Lens maker's formula is $\frac{1}{f}=(n-1)\left[\frac{1}{R_1}-\frac{1}{R_2}\right]$

f = focal length of lens

n = refractive index of lens

R_1 = Radius of curvature of first surface on lens

R_2 = Radius of curvature of second surface on lens.



2. Assertion [A]: A person standing on the land appears taller than actual height to a fish inside a pond.

Reason [R]: Light bends away from the normal as it enters air from water.

Which of the following are correct? Explain?

a) **Both A and R are true and R is the correct explanation of A.**

b) **Both A and R are true and R is not correct explanation of A.**

c) **A is the true but R is false**

d) **Both A and R are false**

e) A is false but R is true.

A. Option (c) is correct.

Assertion is correct because the person in air the light ray (from fish) travels from denser to rarer medium. So, the person appears taller than his actual height.

Reason is wrong because as the light ray travels from air to water light ray bends towards the normal.

3. Can a virtual image be photographed by camera? (AS2)

A. Yes. Virtual image can be photographed by camera.

4. Suppose you are inside the water in a swimming pool near an edge. A friend is standing on an edge. Do you find your friend taller or shorter than his usual height? Why? [AS7]

A. My friend appears to be taller than usual height because the light travelling from denser to rarer medium the rays bends away from the normal. So it is actually Virtual image of my friend appears to be larger and taller than actual height due to refraction.

4 Mark Questions

1. Two convergent lenses are to be placed in the path of parallel rays so that the rays remain parallel after passing through both lenses. How should the lenses be arranged? Explain with neat diagram. [AS1]

A. 1. Let the lenses are l_1 and l_2

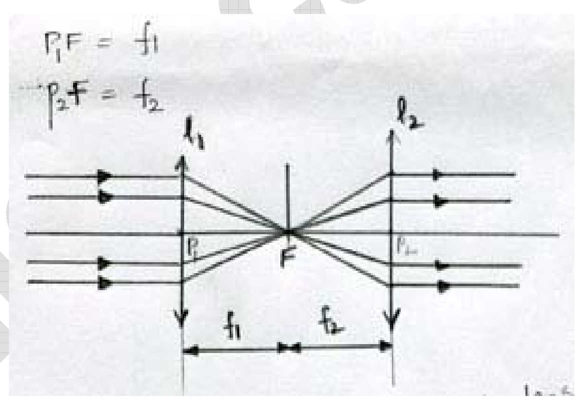
2. P_1, P_2 are the optic centers of lenses l_1 and l_2

3. Assume focal lengths of two lenses are to be f_1 and f_2

4. F is the focus of both lenses

$P_1F = f_1$

$P_2F = f_2$



From above figure, two convergent lenses are to be placed in a path of parallel rays, so that the rays remain parallel after passing through both lenses by separating the lenses at a distance of $f_1 + f_2$ units apart.

2. How do you verity experimentally that the focal length of a convex lens is increased when it is kept in water? [AS1]

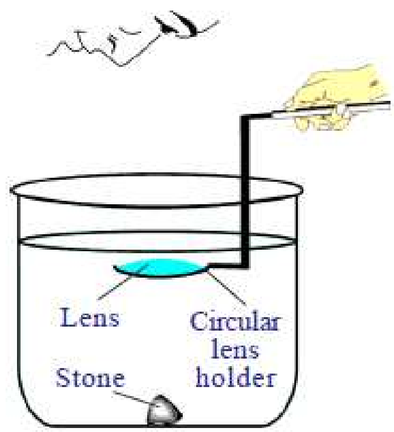
A. 1.Take a convex lens whose focal lengths is known

2.Take a glass tumbler, whose height is known and nearly four times of focal length of lens

3.Keep a black stone inside the vessel

4.Now pour water into the vessel up to a height such that the height of water level from the top of surface of stone is greater than focal length of lens.

5.Now dip the lens horizontally using a circular lens holder.



6.Set the distance between stone and lens that is equal to or less than focal length of lens.

7.Now look at the stone through lens.

8.We can see the image of the stone if the distance between lens and stone is less than the focal length of lens.

9.Now increase the distance between lens and stone until you can't see the image of stone.

10.We have dipped the lens to a certain height which is greater than the focal length of lens in air but we can see the image. This shows that focal length of lens has increased in water.

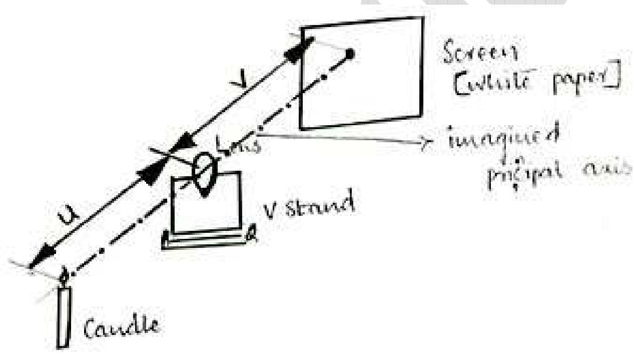
3. How do you find the focal length of a lens experimentally? [AS1]

A. 1.Take a ‘v’ stand and place it on a long table at the middle

2.Place a convex lens on ‘v’ stand. Imagine the principal axis of lens.

3.Light a candle and ask your friend to take the candle far away from the lens along the principal axis.

4.Adjust a screen (a sheet of white paper placed perpendicular to axis) which is on other side of lens until you get an image on it.



5.Measure the distance of image from the v stand of lens (image distance ‘v’) and also measure the distance between candle and stand of lens (object distance ‘u’). Record the values in table.

S.No	Object distance(u)	Image distance (v)	Focal length ‘f’

6.Now place the candle at a distance of 60cm from the lens, try to get an image of candle flame on other side on screen. Adjust the screen till you get a clear image.

7.Now measure 'V' (image distance) and object distance 'U' and values are tabulated.

8.Repeat the experiment for various object distances like 50cm, 40cm, 30cm etc. Measure the distances of images and tabulate the values.

9.Using formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$, find f in all cases we will observe the value 'f'is equal in all cases.

10.The value 'f' is the focal length of lens.

4. Harsha tells Siddhu that the double convex lens behaves like a convergent lens. But Siddhu knows that Harsha's assertion is wrong and corrected Harsha by asking some questions. What are the questions asked by Siddhu? [AS2]

A. 1.If the refractive index of medium is greater than the refractive index of lens, then double convex lens behaves unlike to convergent lens.

2.What happens to the rays when the object is kept in between the pole and focal point.

3.How do the air bubbles in water behave?

5. You have a lens. Suggest an experiment to find out the focal length of lens? [AS3]

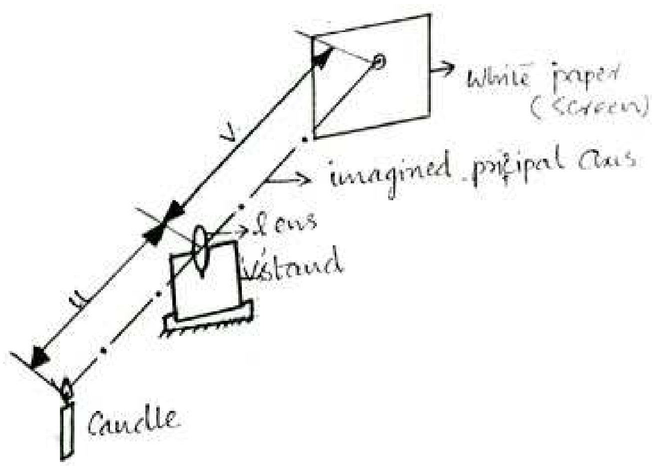
A. 1.Take a v stand and place it on a long table at the middle.

2. Place a convex lens on v stand Imagine the principal axis of lens.

3. Light a candle and ask your friend to take the candle far away from the lens along the principal axis.

4. Adjust a screen (a sheet of paper perpendicular to axis) which is on other side of lens until you get an image on it.

5. Measure the distance of image of V-stand of lens (image distance v) and object distance [u], tabulate the values.



6.Now place the candle at a distance of 60cm from lens, try to get an image of candle flame on the other side on screen. Adjust the screen till you get a clear image.

7.Measure the image distance 'v' and object distance 'u' and record the values in table.

S.No	Object distance (u)	Image distance (v)	Focal length(f)

8.Repeat the experiment for various object distances like 50cm, 40cm, 30cm etc. Measure the image distances in all class and tabulate them.

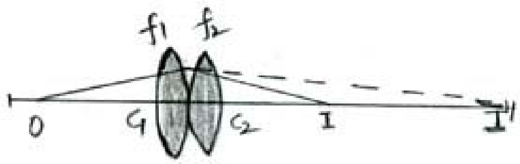
9.Using the formula $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$. Find f in all cases. The value of 'f' is the focal lengths of lens.

6. Let us assume a system that consists of two lenses with focal length f_1 and f_2 respectively. How do you find the focal length of system respectively, when-

i.Two lenses are touching each other.

ii.They are separated by distance 'd' common principal axis [AS3]

A. i.When two lenses are in contact with each other.



1.Focal lengths of two lenses l_1, l_2 is f_1, f_2 (say) respectively.

2.Lenses are made of same material with refractive index 'n'

3.$u = OC_1$

$v_1 = I_1C_1$

(I_1 = image of object 'o' produced by lens of focal length f_1)

$+ v_2 = -I_1C_1$ ($\because$ the image of object 'o' acts as a object to second lens of focal length f_2)

$\approx -I_2C_1$

$V_2 = C_2I$ (I is the image formed by I^1)

$$\therefore \frac{1}{u_1} + \frac{1}{v_1} = \frac{1}{f_1}; \frac{1}{u_2} + \frac{1}{v_2} = \frac{1}{f_2}$$

$$\frac{1}{OC_1} + \frac{1}{I_1C_1} = \frac{1}{f_1} \quad \text{——(1)}; \quad \frac{1}{-C_1I_1} + \frac{1}{IC_1} = \frac{1}{f_2} \quad \text{—(2)}$$

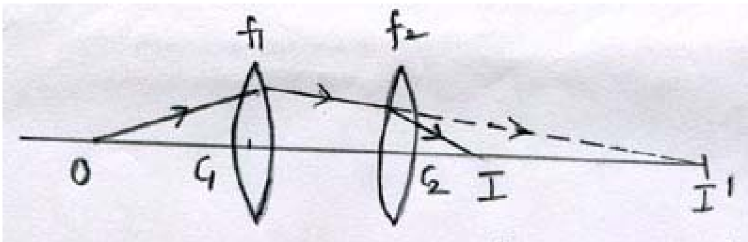
Adding (1) and (2) we get

$$\frac{1}{OC_1} + \frac{1}{C_1I} = \frac{1}{f_1} + \frac{1}{f_2}$$

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2}$$

Effective focal length $F = \frac{f_1 f_2}{f_1 + f_2}$

ii. Combined focal length of two thin lenses separated by a distance d



Let the lens be l_1, l_2 and focal lengths of lens are f_1 and f_2 respectively

Let the object be o

I^1 be the image formed by object o by lens l_1

I be the image formed by image I^1 by lens l_2

So object distance for first lens $(l_1) = u_1 = OC_1$

Image distance for lens $l_1 = v_1 = I^1 C_1$

Object distance for second lens $= I^1 C_2 = u_2$

Images distance for second lens $= I C_2 = v_2$

$I_1 C_1 = I_1 C_2 + d$

So $\frac{1}{f_1} = \frac{1}{u} + \frac{1}{v_1}$

$$\frac{1}{f_1} = \frac{1}{OC_1} + \frac{1}{I_1 C_1} \longrightarrow (1)$$

Similarly

$$\frac{1}{f_2} = \frac{1}{u_2} + \frac{1}{v_2}$$

$$= \frac{1}{-I_1 C_2} + \frac{1}{IC_2}$$

$$= \frac{1}{-\left(I_1C_1 - d\right)} + \frac{1}{IC_2} \longrightarrow (2)$$

And $\frac{1}{OC_1} + \frac{1}{IC_2} = \frac{1}{F}$ ____(3)

Solving (1) and (2) and substituting (3) we get

$$\frac{1}{f_1} + \frac{1}{f_2} = \frac{1}{F} + \frac{d}{f_1 f_2}$$

$$\frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2} = \frac{1}{F}$$

$$\frac{1}{F} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{d}{f_1 f_2}$$

7. Collect the information about the lenses available in a optical shop. Find out how the focal length of lens may be determined by given 'power' in lens. [AS4]

A. Lenses available in an optical shop are-

1) Plano convex lens
2) Double convex lens
3) Plano concave lens
4) Double concave lens
5) Cylindrical lens
6) Achromatic lens
7) Aspheric lens
8) IR lens
9) UV lens
10) Atoric lens

To know focal length:

If given power is 'p', then focal length

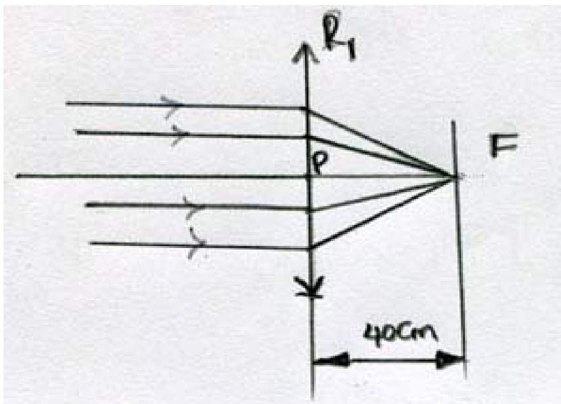
$$f = \frac{100}{p} cm$$

'p' is positive, lens in Biconvex

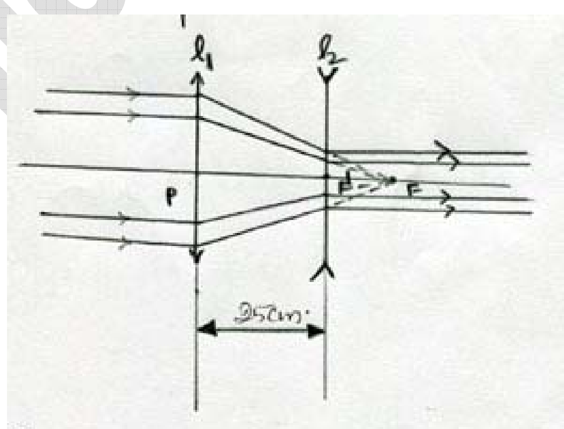
'p' is negative, lens is Biconcave

8. A parallel beam of rays is incident on a convergent lens with a focal length of 40 cm. where should a divergent lens with a focal length of 15cm be placed for the beam of rays to remain parallel after passing through two lenses? Draw a ray diagram? (AS5)

A. A parallel beam of rays when incident on a convergent lens, after refraction they meet at focus of lens.



Divergent lens of focal length 15cm should be placed after convergent lens at a distance of (40-15) cm from convergent lens. So the rays remain parallel.



(Or)

Let focal length of convergent lens = f_1 = 40cm

Focal length of divergent lens = f_2 = –15 cm

Let the 'd' is the distance between two lens

Then $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}-\frac{d}{f_1 f_2}$

$$\frac{1}{\infty}=\frac{1}{40}+\frac{1}{-25}-\frac{d}{40\times(-15)}\ (\mathit{for\ emergent\ parallel\ beam}\ F=\infty)$$

$$0=\frac{1}{40}-\frac{1}{25}+\frac{d}{40(15)}$$

$$\frac{1}{15}=\frac{1}{40}+\frac{d}{40(15)}$$

$$d=40(15)\left[\frac{1}{15}-\frac{1}{40}\right]$$

$$d=\frac{40-15}{40\times 15}\ (40\times 15)$$

d = 25cm.

Distance between two lens = 25cm

9. Draw ray diagrams for the following positions and explain the nature and position of image. [AS6]

i) Object placed at c_2

ii) Object placed between F_2 and centre p.

A. i. object is placed at c_2

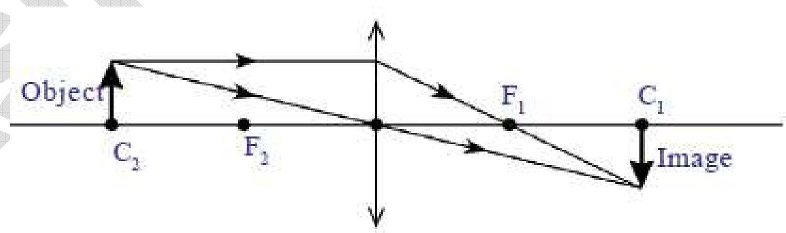


Image:

i. Real , inverted same size of object

ii. Formed at c_1.

Object placed between $F_2$and centre p:

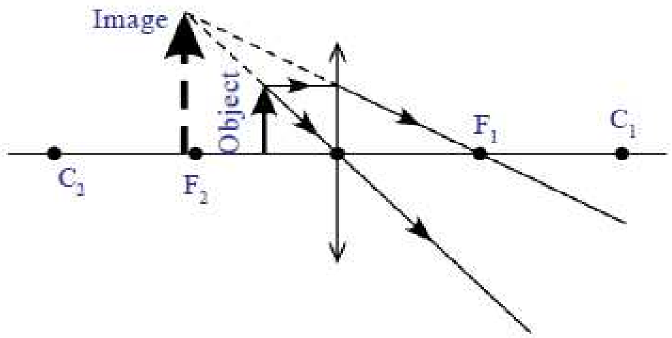


Image:

i) Virtual, magnified, erect image

ii) Image formed between C_2 and F_2

10. How do you appreciate the coincidence of the experimental facts with the results obtained by a ray diagram in terms of behavior of images formed by lenses? [AS7]

A. 1. The behavior of images formed by lenses i.e., image in real/virtual; inverted/erect; magnified/diminished when the object is kept at different places from lens.

2. The ray diagrams are based on the fact that the light travels in a straight line and takes the shortest way for its travel [Fermat's principal]

Problem

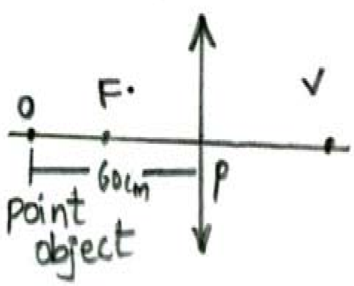
1. The focal length of a converging lens is 20cm. An object is 60cm from the lens. Where the image will be formed and what kind of image it is? [AS1]

A. Given

Focal length of converging lens (f) = 20 cm

Object distance, u = 60cm

Image distance, v = v (say)



Lens formula

$$\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$$

u = –60 w.r.t sign convention

$$\frac{1}{v}-\frac{1}{-60}=\frac{1}{20}$$

$$\frac{1}{v}+\frac{1}{60}=\frac{1}{20}$$

$$\frac{1}{v}=\frac{1}{20}-\frac{1}{60}$$

$$\frac{1}{v}=\frac{1}{30}$$

v = 30 cm

The image is Real, Diminished and Inverted.

2. A double convex lens has two surfaces of equal radii 'R', and refractive index n = 1.5. Find the focal length 'f'? (AS1)

Sol: Radii of curvature of both surfaces are equal-

$R_1 = R_2 = R$

Refractive index of material n = 1.5

Focal length of lens, f =?

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

For double convex lens w.r.t. sign convention

R_1 is +ve; R_2 is – ve

$$\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{-R_2}\right)$$

$$= (n-1)\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$$

$$= (n-1)\left[\frac{1}{R} + \frac{1}{R}\right] \qquad [\because R_1 = R_2 = R]$$

$$= (n-1)\left(\frac{2}{R}\right) \qquad [\because Given\, n = 1.5]$$

$$= (1.5-1)\left(\frac{2}{R}\right)$$

$$= \frac{(0.5)(2)}{R}$$

$$\frac{1}{f} = \frac{1}{R}$$

f = R.

Focal length of double convex lens is R.

3. Find the refractive index of the glass which has symmetrically convergent lens if its focal length is equal to radius of curvature of its surface? [AS7]

A. Given

Lens is symmetrical converging lens-

$$R_1 = R_2 = R$$

Focal length of lens, f = R

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

According sign convention-

$R_1 = R$ and $R_2 = -R_2$

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{-(R_2)}\right]$$

$$= (n-1)\left[\frac{1}{R_1} + \frac{1}{R_2}\right]$$

$$= (n-1)\left[\frac{1}{R} + \frac{1}{R}\right] \qquad [\because R_1 = R_2 = R]$$

$$= (n-1)\left(\frac{2}{R}\right)$$

$$\frac{1}{f} = \frac{(n-1)2}{R}$$

$$f = \frac{R}{2(n-1)}$$

$$\cancel{R} = \frac{\cancel{R}}{2(n-1)}$$

$$2(n-1) = 1$$

$$(n-1) = \frac{1}{2}$$

$$n = 1 + \frac{1}{2}$$

$$n = 1.5$$

Refractive index of glass n = 1.5

4. Find the radii of curvature of convexo concave. Convergent lens made of glass with refractive index 1.5 having focal length of 24cm. One of the radii of curvature is double the other. [AS7]

Sol: Refractive index of material = n = 1.5

Given

"Convexo –concave convergent lens"

Focal length of f=24cm

Given one of the radius of curvature is double to other so

$R_2 = 2R_1$

According to sign convention R_1 is positive

R_2 is positive

Using lens maker's formula

$$\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$$

$$= (n-1)\left(\frac{1}{R_1} - \frac{1}{2R_1}\right)$$

$$= (n-1)\left[\frac{1}{2R_1}\right]$$

$$\frac{1}{24} = (1.5-1)\left[\frac{1}{2}.R_1\right]$$

$$\frac{1}{24} = (0.5)(0.5)\left[\frac{1}{R_1}\right]$$

R_1= 24 (0.5) (0.5)

= 6

R_1= 6cm

Given R_2= $2R_1$

= 2 × 6

= 12cm

Ans: R_1= 6cm

R_2= 12cm

5. When the distance between two point sources of light is 24cm, where should a convergent lens with focal length of f=9cm be placed between them to obtain the images of both sources at same point? [AS7]

Sol. Distance between the two point sources d = 24 cm

Focal length of lens f = 9 cm

Lens is separated from first object at a distance = x (say)

From first point source

$$\frac{1}{f}=\frac{1}{u_1}+\frac{1}{v_1}$$

$$\frac{1}{9}=\frac{1}{x}+\frac{1}{v}\longrightarrow(i)$$

Similarly from second point source $\frac{1}{f}=\frac{1}{u_2}+\frac{1}{v_2}$

Here v_2 is negative w.r.t sign conversion

$$\frac{1}{9}=\frac{1}{24-x}-\frac{1}{v}\longrightarrow(ii)$$

$[\because u_1+u_2=d=24]$

$[x+u_2=24]$

$[u_2=24-x]$

(i) + (ii)

$$\Rightarrow\frac{1}{9}+\frac{1}{9}=\frac{1}{x}+\frac{1}{v}+\frac{1}{24-x}-\frac{1}{v}$$

$$\frac{2}{9}=\frac{1}{x}+\frac{1}{24-x}$$

$$\frac{2}{9}=\frac{24-x+x}{(24-x)x}$$

$$\frac{2}{9}=\frac{24}{(24-x)x}$$

$24x-x^2=12\times9$

$x^2-24x=-108$

$x^2-24x+108=0$

$x^2-18x-6x+108=0$

$(x-6)(x-18)=0$

$x = 6, 18$

Lens should be placed at 6cm or 18 cm.

Fill in the Blanks

1. The rays from the distant object, falling on the convex lens pass through ________.
2. The ray passing through the _____ of the lens is deviated.
3. Lens formula is given by _______.
4. The focal length of the Plano convex lens is 2R where R is the radius of curvature of the surface. Then the refractive index of the material of the lens is ________.
5. The lens which can form real and virtual images is _______.
6. If the focal length is positive then the lens is ______.
7. If the focal length is negative then the lens is ______.
8. _______ image cannot be seen by eyes.
9. _______ image captured on screen.
10. _______ lens is called converging lens.

Key: 1. Focal point, 2. Pole, 3. $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$,

4. 3/2, 5. Convex 6. Convex,

7. Concave 8. Virtual 9. Real

10.convex.

Objective type Questions

1. **Which of the following material cannot be used to make a lens? [ ]**

   A) Water B) Glass C) Plastic D) Clay

2. **Which of the following is true? [ ]**

   A) The distance of virtual image is always greater than the object distance for convex lens

   B) The distance of virtual image is not greater than the object distance for convex lens

   C) Convex lens always forms a virtual image

   D) Convex lens always forms a real image

3. **Focal length of the Plano convex lens is ______ when radius of curvature R and n is refractive index of lens. [ ]**

   A) f = R B) $f = \frac{R}{2}$ C) $f = \frac{R}{n-1}$ D) $f = \frac{n-1}{R}$

4. **The value of focal length of lens is equal to the value of image distance when the rays are- [ ]**

   A) Passing through the optic centre

   B) Parallel to principal axis

   C) Passing through focus

   D) In all cases

5. **Which of the following is the Lens-Maker's formula? [ ]**

   A) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ B) $\frac{1}{f} = (n+1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

   C) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$ D) $\frac{1}{f} = (n+1)\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$

Key:

1. D, 2. B, 3. C, 4.D, 5.C

Match the Following

I. Group-I **Group-II**

Object position for convex lens **image position**

1.	Beyond centre of curvature	[ ]	a) Real, inverted, magnified
2.	At center of curvature	[ ]	b) Real, inverted, same size
3.	Between centre of curvature and focus	[ ]	c) Real, inverted, diminished
4.	Between focus/ optic centre	[ ]	d) Converged to focus
5.	Parallel beam	[ ]	e) Virtual, erect, magnified

Key:

1. c, 2. b, 3. a, 4. e, 5. d

II. Group-I **Group-II**

1.	Lens-Maker's Formula	[ ]	a) $n = \frac{\sin i}{\sin r}$
2.	Lens Formula	[ ]	b) $F = \frac{f_1 f_2}{f_1 + f_2}$
3.	Optical power	[ ]	c) $\frac{1}{f} = (n-1)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

4. Snell's Law [ ] d) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

5. When two lens are touching

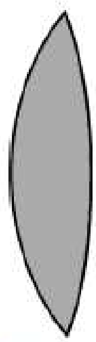
each other then focal length [ ] e) $p=\frac{1}{f(m)}$

Key:

1. c, 2. d, 3. e, 4. a, 5. b

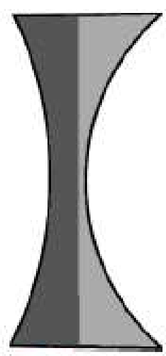
Important Images

1. Biconvex lens



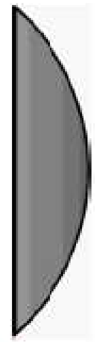
Biconvex

2. Biconcave lens



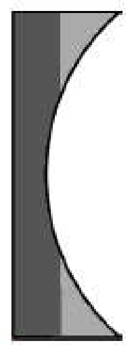
Biconcave

3. Plano convex



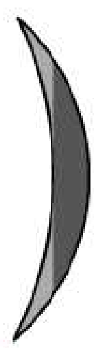
Plano-convex

4. Plano concave



Plano-concave

5. Concavo - convex



Concavo-convex

Chapter -5

Refraction of Light at Plane Surfaces

SYNOPSIS

Light travels different speeds in different media depend upon the densities of the substances.

When light rays travel from rare medium to denser medium it bends towards the normal. If the light rays travels from denser to rarer medium it bends away from the normal.

Speed of light is maximum in vacuum. It travels with a speed of 3×10^8 m/s. When it propagates in any medium its velocity is less than 3×10^8 m/s. The ratio of these two velocities is constant. The constant is called "refraction index" (n).

Snell's law is relation between incident angle (i) to the refracted angle (r)

i.e. $n_1 \sin i = n_2 \sin r$.

When light travels from denser medium to rare medium, at a particular incident angle i.e. angle more than the critical angle the total interval reflection takes places. To internal reflection is a phenomenon behind mirage and shining of diamond.

2 Mark Questions

1. Write the laws of refraction?

A. There are two laws of refraction.

1) The incident ray, the refracted ray and the normal to interface of two transparent media at the point of incidence all lie in the same place.

2) During the refraction light follows Snell's law constant.

$$n_1 \sin i = n_2 \sin r$$

$$\frac{\sin i}{\sin r} = \text{constant}$$

.

2. Define Total internal reflection? Given two examples?

A. **Total internal Reflection:** When the angle of incidence is greater than critical angle, the light ray gets reflected into the denser medium at the interface i.e. light never enter the rarer medium. This phenomenon is called internal reflection.

Ex: 1) Formation of mirages.

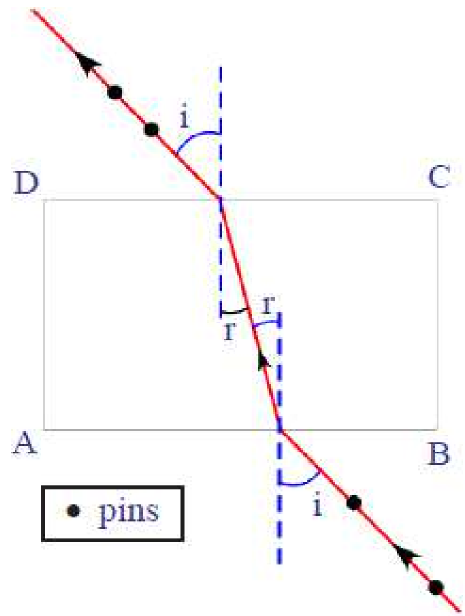
2) Brilliance of diamonds.

3. What is the reason behind the shimming of diamond and how do you appreciate it?

A. Total internal reflection is the main cause for brilliance of diamonds. The critical angle of diamonds is very low (24.4^0). Diamond sparkles due to repeated internal reflections. But cutting diamond in such a way that incident angle greater than critical angle (c) so that total internal reflection takes place again and again.

4. What is the angle of deviation produced by a glass slab? Explain with ray diagram (AS_7)?

A. **Angle of Deviation:** The angle between incident ray and emergent ray is known as angle of deviation (δ).



A glass slab is having two parallel sides. At first surface DC the light ray is travelling from rarer to denser. Hence the light ray bends towards normal i.e., i > r

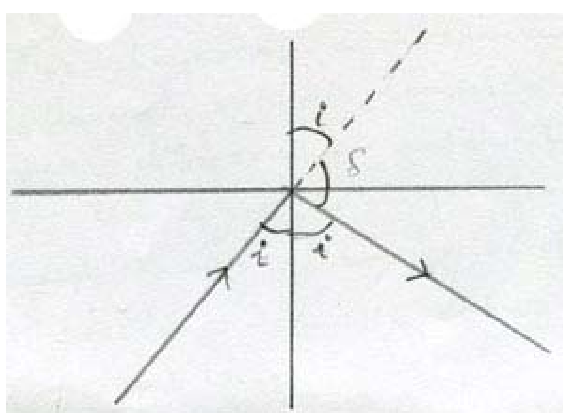
$\therefore$ Deviation angle $(\delta_1) = (i_1 - r_1)$

When light ray travels from denser to rarer it moves away from the normal i.e. r > i

$\therefore$ Deviation angle $(\delta_2) = (r_2 - i_2)$

5. A ray of light travels from an optically denser to rarer medium. The critical angle of two media is 'c'. What is the maximum possible deviation of the ray? (AS_7)

A.



If the light incident at an angle $i > c$ as shown in the figure the angle of deviation is given by $\delta = \pi - 2i$

The maximum value of δ occurs when $i = c$ and is equal to $\delta_{max} = \pi - 2c$.

6. When we sit at a camp fire, objects beyond the five is seen swaying. Give the reason for it (AS7).

A. From the campfire, heat is carried into surrounding air by the process of convection. During this process the density of surrounding air changes continuously, thus changes its refraction index slightly.

This continuous change in refraction index gives rise to continuous change in angle of refraction which results in the objects seeming to be swaying.

7. Why do stars appear twinkling?

A. Stars appear twinkling due to atmospheric refraction. The layers of atmosphere on the earth have different optical densities due to which they offer different refractive index values to the light coming from stars. So, the light bends many times giving different apparent positions of the star which we see as twinkling.

1 Mark Questions

1. What is refraction of light?

A. **Refraction of light:** The process of changing speed at an interface when light travels from medium to another resulting in a changes in direction is called refraction of light.

2. How light ray moves when it enters from rarer medium to denser medium?

A. If light ray enters from rarer medium to denser medium then refracted ray moves towards the normal.

3. What is the speed of light in vacuum?

A. Speed of light in vacuum c = 3×10^8 m/s.

4. Define refractive index (n)?

A. Refractive index (n): The ratio of the speed of light in vacuum to the speed of light in that medium is defined as refraction index (n). It is also called absolute refractive index

$$\text{Absolute refractive index} = \frac{\text{Speed of light in vaccum}}{\text{Speed of light in medium}}$$

$$n = \frac{c}{v}$$

5. Which factor decides the speed of light in the medium?

A. Refraction index (n)

6. On what factors does the refractive index of a medium depend?

A. Refractive index of the material depends on the following factors.

1) Nature of the material.

2) Wavelength of light used.

7. What is mirage?

A. **Mirage:** mirage is an optical illusion where it appears that water has collected on the road at a distant place but when we get there we don't find any water.

8. What is the critical angle of a diamond?

A. Critical angle of a diamond is 24.4^0.

9. How do you appreciate the sole of Fermat principle in drawing ray diagrams?

A. Fermat's principle says that light selects a shortest path to travel. This is the basic reason for the straight line propagation of light using this principle, we can draw ray diagram to trace the image formed by mirrors to understand reflection and refraction.

10. Define rarer medium?

A. A medium in which the speed of light is more is known as optically rarer medium.

11. Define denser medium?

A. A medium in which the speed of light is less is known as optically denser medium.

12. What is the use of refractive index of a light?

A. Refractive index gives the idea of how fast the light travels in a medium.

13. For which medium refractive index is minimum and maximum?

A. Refractive index is minimum for vacuum (n = 1). Refractive index is maximum for diamond (n = 2.42).

4 Mark Questions

1. Why is it difficult to shoot fish swimming in water?

A. When light ray enters from one medium to another it deviates from its actual path. This phenomenon is called as refraction.

Due to refraction the depth of pond, well appears to rise upwards. Hence we cannot estimate the actual depth of the object in the water.

When we shoot the fish in water, we cannot judge the actual position of fish, because it appears to be raised due to refraction.

2. Explain the formation of mirage? (AS1)

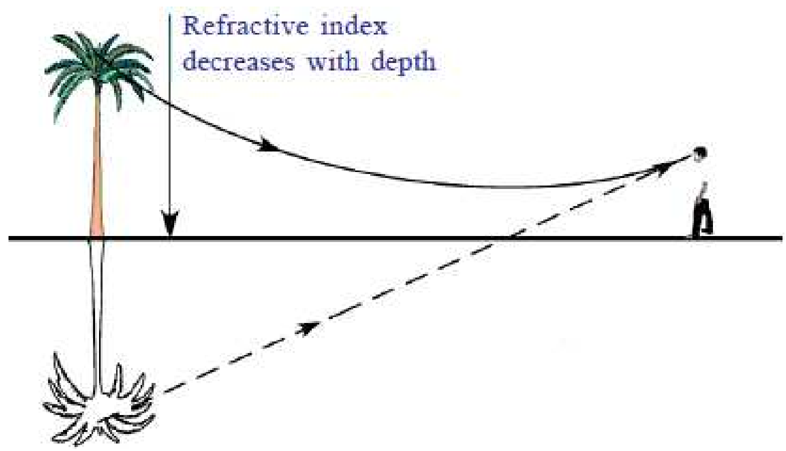
A. Mirage is an optical illusion where it appears that water has collected on the road at a distant place but when we get there, we don't find any water.

Explanation: During the hot summer day, due to temperature differences at different altitudes the refractive indices of air are different.

The cooler air at the top has greater refraction index than hotter air just above the road.

When the light from a tall object such as tree or from the sky passes through a medium just above the road, whose refractive index decreases towards ground, it suffers refraction and takes a curved path because of total internal reflection as shown in the figure.

This refraction light reaches the observer in a direction shown in figure this appears to the observer as if the ray is reflected from the ground. Hence we feel the illusion of water being present on road. This is the virtual image of the sky and inverted image of tree on the road.



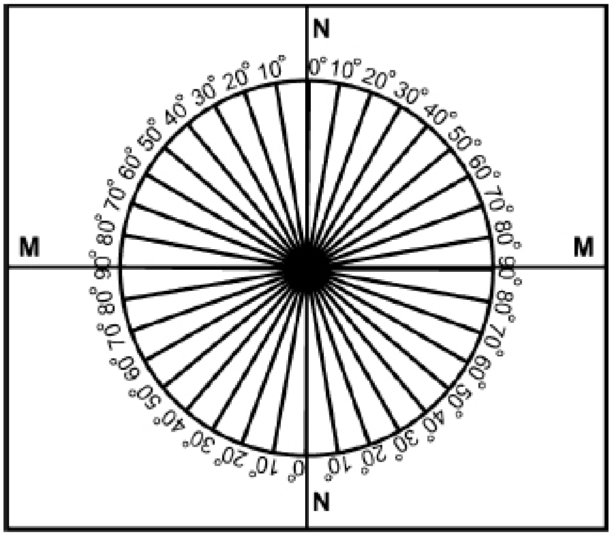
3. How do you verify experimentally that $\frac{\sin i}{\sin r}$ is a constant?

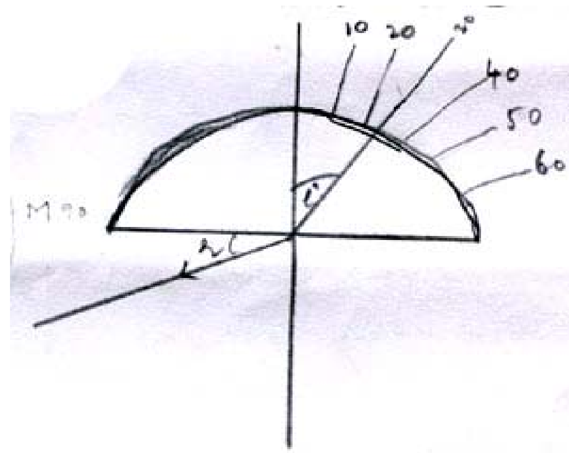
A. **Aim:** Obtaining a relation between angle of incidence and angle of refraction.

Materials required: A plank, white chart, protractor, scale, small black painted plank, a semi circular glass disc of thickness nearly 2cm, pencil and laser light.

Procedure: Take a wooden plank which is covered with white chart. Draw two perpendicular lines, passing through the middle of the paper as shown in the figure. Let the point of intersection be o. Mark one line as NN which is normal to another line marked as MM. Here MM represents the line drawn along the interface of two media and NN represents the normal drawn to this line at 'o'.

Take a protractor and place it along NN in such way that it centre coincides with 'o' as shown in figure. Then mark the angles from 0^0 to 90^0 on both sides of the line NN as shown in the figure. Repeat the same on the other side of line NN. The angles should be indicated on the curved line.





Now place a semi-circular glass disc so that its diameter coincides with the inter face line (MM) and its centre coincides with the point 'o'.

Send laser light along a line which makes 15^0 with NN. Measure its corresponding angle of refraction. Repeat the experiment for 20^0, 30^0, 40^0, 50^0 and 60^0 and noted the corresponding angles of refraction.

S.No	i	r	Sin$i$	Sin$r$	$\frac{\sin i}{\sin r} =$

If we calculate sin$i$, sin$r$ ratio we will get the ratio as a constant.

4. Explain the phenomenon of total internal reflection with one or two activities? (AS1)

Activity1: Place the semi circle glass disc in such a way that its diameter coincides with interface and its centre coincides with centre point of the interface.

Now send light from the curved side of the semicircular glass disc. Start with angle of incidence (i) equal to 0^0, i.e. along the normal.

Send laser light along angles of incidence 5^0, 10^0, 15^0 etc., and measure the angle of refraction we will observe that at a certain incident angle of incidence the refracted ray does not come out but grazes the interface of incidence separating air and glen is known as critical angle.

When the angle of the incidence is greater than critical angle, the light ray of get reflected into denser medium at the interface. This phenomenon is called internal reflection.

5. How do you verify experimentally that the angle of refraction is more than angle of incidence when light ray travel from the denser to rarer medium?

A. When light ray travel from the denser to rarer the angle of refraction is more than the angle of incidence. This can be verified by the below experiment.

Procedure: Take a metal disc and mark angles using protractor. Arrange two straws at the centre of disk. Adjust one of the straws to make an angle 10^0. Immerse the half of disc in transparent vessel containing water vertically. The straw should be at an angle 10^0 inside the water. Adjust the other straw which is outside the water until both the straws appears to be in straight line. Take the disc out of the water, we will find that the straws are not in straight line. Measure the angle between the normal and second straw. Do the same for various angles of incidence (i) and note down corresponding angles of refraction (r) in the given table.

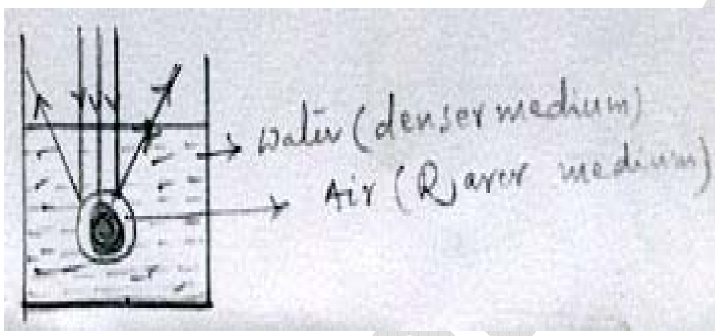
S.No	Angle of incidence (i)	Angle of refraction (r)

Observation: We will find the angle of refraction is more than angle of incidence.

Conclusion: When light travels from douser (water) to rarer (air) it bends away from the normal.

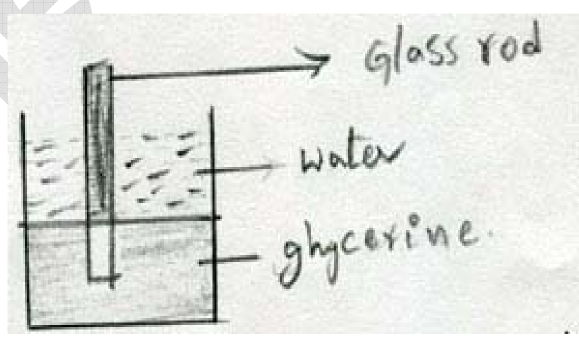
6. **Take a bright metal ball and make it black with soot in a candle flame immerses it in water. How does it appear and why? (Make hypothesis and do the above experiment) As2**

Sol: Take a metal ball coated with soot of candle flame. Now in water beaker it appears shining. When immersed in water a thin air film is formed in between water and shoot. Light passes from denser medium (water) to rarer medium (air) total internal reflection takes place. This is cause for shining.



7. **Take a bright glass vessel and pour some glycerin into it and then pour water up to the brim. Take a Quartz glass rod. Keep it in the vessel. Observe glass rod from the sides of the glass vessel. What change of you notice? What could be the reasons for these changes? (AS2)**

A.



As shown in the figure, the vessel contains glycerin (n = 1.47) and water (n = 1.33) when glass rod immersed into the liquid the part in the glycerin disappear. This is due to the fact that both glass rod (n = 1.5) and glycerin (1.47) have same refractive index. When refractive Indies are same the light speed is same in both media. So no bending is takes place and hence no refraction takes place.

The part of the glass rod in water appears as larger than the original size of the rod. This is due to refraction.

8. Collect the values of refractive index of following media?

1) Water, 2) Coconut oil, 3) Flint glass, 4) Crown glass,

5) Diamond, 6) Benzene, 7) Hydrogen gas.

Sol: water = 1.33

Coconut oil = 1.445

Flint glass: 1.62

Crown glass: 1.52

Diamond: 2.42

Benzene: 1.50

Hydrogen gas: 1.000132

9. Collect information on working of optical fibres. Prepare a report about various uses of optical fibres in our daily life?

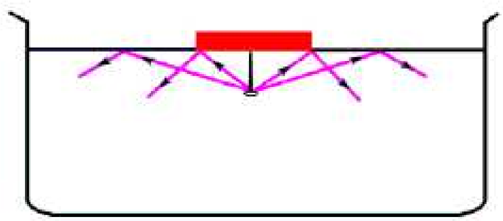
A. Optical fibres are working on the principle of Total Internal Reflection. It is very thin fibre made of glass or plastic having radius about a micro meter (10^{-6}m). Each fibre consists of a core (n_1) and cladding (n_2). Here $n_1 > n_2$. A bunch of thin fibres forms a light pipe.

Working: The light going into pipe make a nearly glancing incidence on the wall. The angle of incidence is greater than the critical angle and hence total internal reflection takes place. In this way Light is transmitted.

Uses: 1.Optical fibres are used in medical equipments such as laparoscope and endoscope to observe unreachable parts in human body.

2.Optical fibres are used as sensors in industry to measure temperature and pressure.

10. **Take thin thermocol sheet. Cut it in circular discs of different radii like 2cm, 3cm, 4cm, 4.5cm, 5cm etc and mark centers with nearly 6 cm. pin a needle to each disc at its centre vertically. Take water in a large opaque tray and place the disc with 2 cm radius in such a way that the needle is inside the water as shown in fig-**



Now try to view the tree end (head) of the needle from surface of water.

a) Are you able to see the head of the needle?

Now do the same with other discs of different radii. Try to see the head of the needle, each time.

Note: The position of your eye and the position of the disc on water surface should not be changed while repeating the activity with other discs.

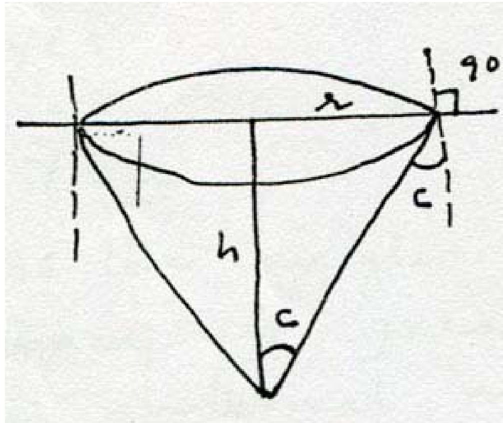
b) At what maximum radius of disc, were you not able to see the free end of the needle?

c) Why were you not able to view the head of the hail for certain radii of the discs?

d) Does this activity help you to find the critical angle of the medium (water)?

e) Draw a diagram to show the passage of light ray from the head of the nail in different situations.

A) First we have to calculate the maximum radius of disc for which we can able to see the free end of the needle.



Here c**:** critical angle of water – air interface

r = radius of circular disc

h = height of the needle

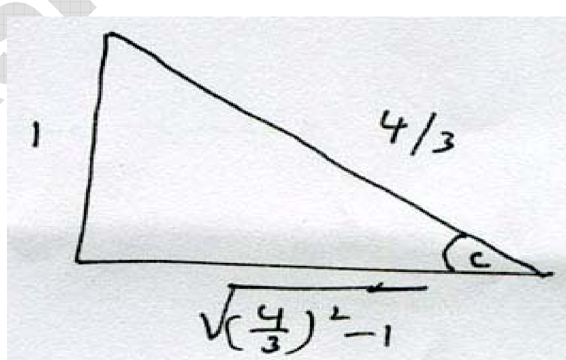
Apply Snell's law to water – air interface

$h_{water} \times \sin c = h_{air} \times \sin r$

$h_{water} \times \sin c = h_{air} \times \sin 90^0$

$h_{water} \times \sin c = 1 \times 1$

$$sinc = \frac{1}{h_{water}} = \frac{1}{4/3}\ (\because h_w = \frac{4}{3})$$



From right angle triangle-

$$\tan c = \frac{r}{h} = \frac{1}{\sqrt{\left(\frac{4}{3}\right)^2 - 1}}$$

$$r = \frac{h}{\sqrt{\left(\frac{4}{3}\right)^2 - 1}}$$

$$r = \frac{6}{\sqrt{\frac{16-9}{9}}} = \frac{6\times 3}{\sqrt{16-9}} = \frac{18}{\sqrt{7}}$$

$$r = \frac{18}{2.645} = 6.8 \approx 7$$

a) Yes

b) 7cm

c) As the angle of incidence on water surface is greater than critical angle total internal reflection takes place no light ray incident on eye. Hence needle head cannot be seen.

d)Yes, applying Snell's law to water – air interface.

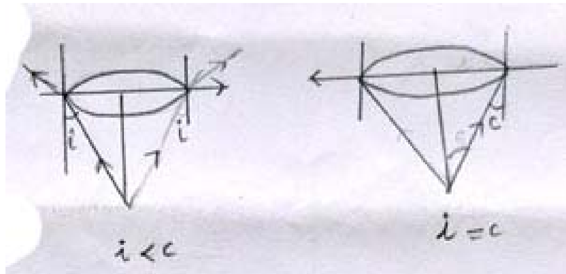
$$\sin c = \frac{1}{h_{water}}$$

$$\sin c = \frac{1}{\frac{4}{3}} = \frac{3}{4}$$

$$c = \sin^{-1}\left(\frac{3}{4}\right)$$

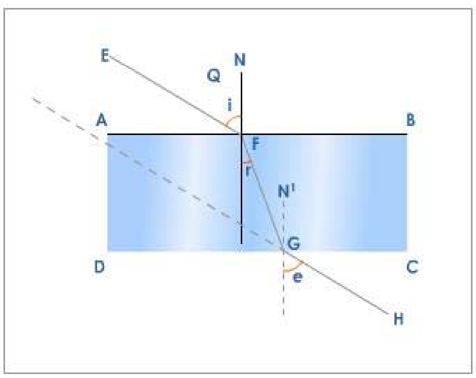
$$c = 49°$$

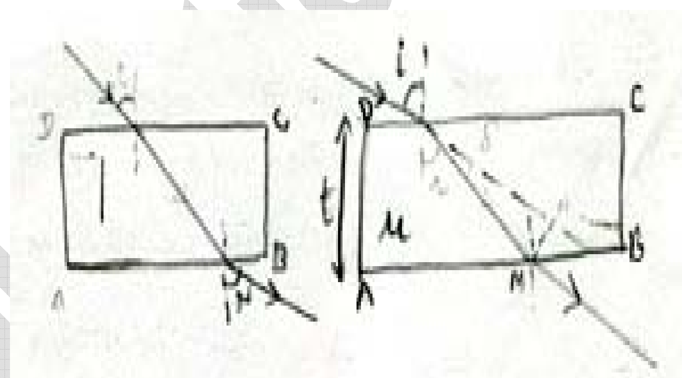
e) In all the cases.



11. Explain the refraction of light through a glass slab with a neat ray diagram.

A. The refracting surfaces of glass slab are parallel to each other. When light ray passes through a glass slab, it is refracted twice at the two parallel faces and finally emerges out parallel to its incident direction.





Here

i = Angle of incidence

r = angle of refraction

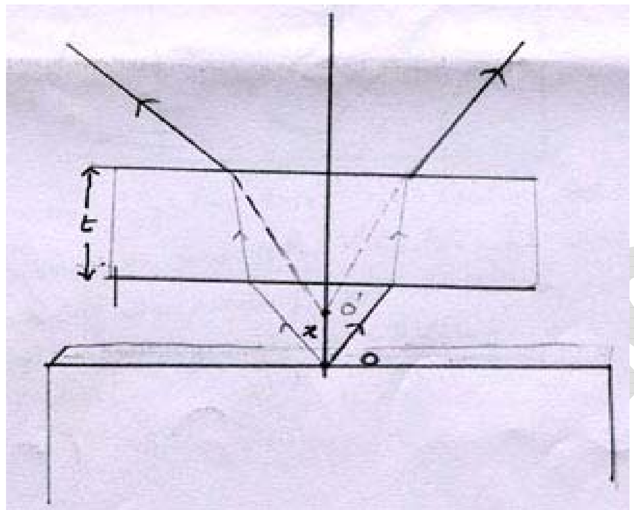
δ = angle of deviation

ABCD: Rectangular glass slab

MN: Lateral shift perpendicular distance between incident and the emergent ray.

12. Place an object on the table. Look at the object through the transparent glass slab. You will observe that it will appear closer to you. Draw a ray diagram to show the passage of light in this situation.

A.

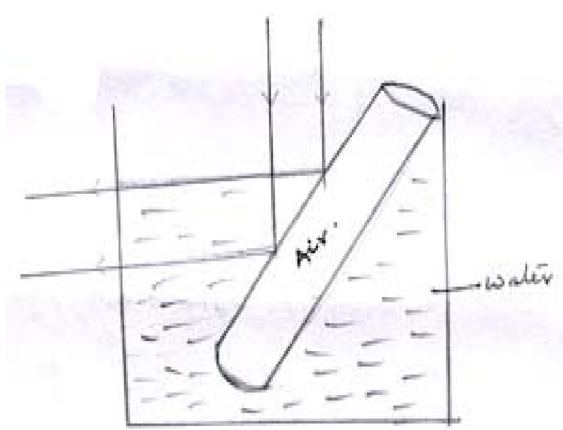


If a glass slab is placed in the path of a converging or diverging beam of light them point of convergence or point of divergence appears to be shifted as shown in the figure.

13. Explain why a test tube immersed at a certain angle in a tumbler of water appears to have a mirror surface for a certain viewing position. (AS7)

A. When a test tube is immersed at a certain angle in a tumbler of water appears to have a mirror surface for a certain viewing position.

Explanation:



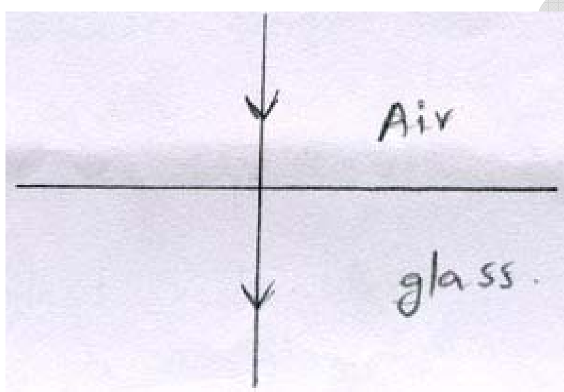
As light tries to enter air in the test tube it under goes total internal reflection bouncing back into water from the surface of the test tube giving it a shiny mirror like surface.

14. In what cases do a light ray does not deviate at the interface of two media?

A. A light ray does not deviate at the interface of two media in two cases-

Case (i):

When the incident ray strikes normally at the point of incidence it does not deviates from its path.



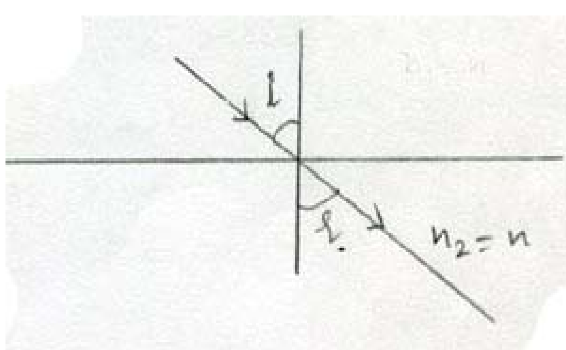
Li = 0

$\angle r = 0$

$\delta = 0$

Case (2): If the refractive indices of two media are equal

$n_1 = n_2 = n$



From Snell's law

$$n \sin i = n \sin r$$

$$\sin i = \sin r$$

$$\angle i = \angle r$$

Hence the ray passes without any deviation at the boundary.

15. Why does a diamond shine more than glass piece cut to the same shape?

A. Refractive index of diamond is 2.42. The critical angle of diamond – air interface is

$$\sin c = \frac{1}{n_d} = \frac{1}{2.42}$$

$$c = \sin^{-1}\left(\frac{1}{2.42}\right) = 24^\circ$$

So critical angle of diamond is very less. Hence the rays whose angle of incidence greater than 24°enter into the diamond and due to total internal reflection it shines more.

For glass refractive index is $\frac{4}{3} = 1.33$ critical angle of glass – air interface is-

$$\sin c = \frac{1}{n_g} = \frac{1}{1.33}$$

$$c = \sin^{-1}\left(\frac{100}{133}\right) = 42^\circ$$

For the glass critical angle value is more than diamond. Hence most of the incident ray refracts and less number of rays gets total internal reflection due to which less shines than diamond.

Problems

1. Find the speed of light in glass whose refractive index is $\frac{3}{2}$.

A. Given n = $\frac{3}{2}$, speed of light (v) = x

Refractive index (n) = $\dfrac{\text{speed of light in vaccum}}{\text{speed of light in glass}}$

$$n = \frac{c}{v}$$

$$\frac{3}{2} = \frac{3\times10^8}{x}$$

$$x = \cancel{3}\times10^8\times\frac{2}{\cancel{3}}$$

$$x = 2\times10^8 \text{ ms}^{-1}$$

Speed of light in glass = 2×10^8 ms^{-1}

2. The speed of light in a diamond is 1, 24,000 km/s. Find the refractive index of diamond if the speed of light in air is 3,00,000km/s. (AS1)

A. Give

Speed of light in air (c) = 3,00,000km/s

Speed of light in diamond (v) = 1,24,000 km/s

Refractive index of the diamond $n = \frac{c}{v}$

$$n = \frac{3{,}00{,}000}{1{,}24{,}000}$$

$$n = \frac{300}{124} = 2.419$$

Refraction index of diamond (n) = 2.419.

3. Refractive index of glass relative to water is 9/8. Then what is the refraction index of water relative to glass? (AS1)

Sol: Relative refractive index (n_{21}) = $\frac{R.I.of\ second\ medium\ (2)}{R.I.of\ first\ medium\ (1)}$

$$n_{21}=\frac{n_2}{n_1}$$

Refractive index of glass relative to water

$$n_{gw}=\frac{R.I.of\ glass}{R.I.of\ water}=\frac{9}{8}$$

Refractive index of water relative to glass

$$n_{wg}=\frac{R.I.of\ water}{R.I.of\ glass}=\frac{8}{9}$$

4. The absolute refraction index of water is $\frac{4}{3}$ what is the critical angle? (AS1)

Sol: Given-

Absolute refractive index of water $n=\frac{4}{3}$

Critical angle (c) =?

We know that

$$n=\frac{1}{sinc}$$

$$sinc=\frac{1}{n}$$

$$\sin c=\frac{1}{\frac{4}{3}}=\frac{3}{4}=0.75$$

$C = \sin^{-1}(0.75)$

$\therefore$ Critical angle (c) = 48.59^0

5. Determine the refractive index of benzene if the critical angle is 42^0. (AS1)

Sol: Critical angle of the Benzene (c) =

$$\text{Sin c} = \sin 42 = 0.6691$$

Refractive index (n) = ?

We know that

Refractive index $n = \frac{1}{sinc}$

$$n = \frac{1}{sin42}$$

$$n = \frac{1}{0.6691} = 1.5$$

Refractive index n = 1.5

Important Table

Table:1 Refractive indices of some material media.

Material medium	Refractive index	Material medium	Refractive index
Air	1.0003	Canada balsam	1.53
Ice	1.31	Rock salt	1.54
Water	1.33	Carbon Diasulphide	1.63
Kerosene	1.44	Dense flint glass	1.65
Fused quartz	1.46	Ruby	1.71
Turpentine oil	1.47	Sapphire	1.77
Crown glass	1.52	Diamond	2.42
Benzene	1.50		

Matching

1. **Group-A** / **Group-B**

	Group-A		Group-B
1.	Snell's law	**[e]**	a) Used in communication
2.	Mirage	**[d]**	b) $\frac{c}{v}$
3.	Refractive index	**[b]**	c) $\sin c = \frac{1}{n}$
4.	Critical angle	**[c]**	d) Total internal reflection
5.	Optical fibres	**[a]**	e) $n_1 \sin i = n_2 \sin r$

Fill in the Blanks

1. At critical angle of incidence, the angle of refraction is ___________. **(90°)**

2. $n_1 \sin i = n_2 \sin r$, is called ______. **(Snell's law)**

3. Speed of light in vacuum is ________. **(3×10^8 ms^{-1} constant)**

4. Total internal reflection takes place when a light ray propagates from ______ to _______ medium. (Denser, rarer)

5. The refractive index of a transparent material is 3/2. The speed of the light in that medium is __________. (2×10^8 ms^{-1})

6. Mirage is an example of ________. (Total internal reflection)

7. The process of changing speed when light travels from one medium to another is called __________ of light. (Refraction)

8. ________ is the basic principle for of optical fibre. (Total internal reflection)

9. Absolute refractive index = $\frac{?}{Speed\ of\ light\ in\ midium}$. (**Speed of light in vacuum**)

10. Refractive index value of ruby is _______. (**1.71**)

11. Refraction depends upon the ________ of the light in the medium. (speed)

12. Mirages form because of the _______. (**Total internal reflection**)

13. ______ is the main cause for brilliance of diamonds. (Total internal reflection)

14. The critical angle of diamond is _______. (**24.4°**)

15. An angel of incidence for which the angle of refraction is 90^0 for a given pair of media is called _________. (**Critical angle**)

16. Light travels in vacuum with a speed to _______ m/s. (**3×10^8**)

17. A light ray travelling obliquely from a denser medium to a rarer medium bends_______ the normal. (**Away from**)

18. The speed of light in a medium depends upon ______ of the medium. (optical density)

19. A light ray bends __________ the normal when it travels obliquely from rarer to a denser medium. (**Towards**)

20. The ratio of speed of light in vacuum to the speed of light in that medium is defined as __________. (**Refractive index**)

Multiple Choice Questions

1. **In medium water to air, rays of light-** [A]

A) Bend away from the normal

B) Travels in a straight line in the same direction

C) Travels in a straight line in the opposite direction

D) None of the above

2. **The basic cause of refraction is?** **[C]**

A) When light is incident on a boundary

B) When the refractive indices of two media are equal

C) The change in the speed of light in going from one medium to another

D) None

3. **A ray of light travels from a medium of refractive index 'n_1', to medium of refractive index n_2. If angle of incidence is 'i' and the angle of refraction is 'r'? Then $\frac{\sin i}{\sin r}$ is equal to?** **[D]**

A) n_1 B) n_2 c) n_{12} D) n_{21}

4. **Which of the following is Snell's law?** **[B]**

A) $n_1 \sin i = \sin r/n_2$ B) $n_1/n_2 = \sin r/\sin i$

C) $n_2/n_1 = \sin r/\sin I$ D) $n_2 \sin i = \text{constant}$

5. **A plane glass slab is placed over different colored letters. The color that appears to be raised by least amount is?** **[C]**

A) Violet B) Yellow C) red D) Green

6. **A ray of light passes from vacuum into a medium of refraction index if the angle of incidence is twice the angle of refraction, then angle of incidence is?**

[C]

A) $\cos^{-1}\left[\frac{n}{2}\right]$ B) $\sin^{-1}\left[\frac{n}{2}\right]$ C) $2\cos^{-1}\left[\frac{n}{2}\right]$ D) $2\sin^{-1}\left[\frac{n}{2}\right]$

7. **Light of wavelength 6000 A^0 enters glass from air. Its wave length in glass will be $\left[ng = \frac{3}{2}\right]$. Find the answer?** **[C]**

A) 6000 A^0 B) 9000 A^0 C) 2000 A^0 D) 4000 A^0

8. **The refractive index of glass with respect to air is 2. Then the critical angle of glass- air interface is ______.** **[C]**

A) 0^0 B) 45^0 C) 30^0 D) 60^0

9. **Which one of the following is not an application of total internal reflection?**

[A]

A) Sparkling diamond B) Optical fibre

C) Blue color of sky D) Mirage

10. **The angle of deviation produced by the glass slab is ______.** **[A]**

A) 0^0 B) 20^0 C) 90^0 D) 40^0

11. **Total internal reflection takes place when the light ray travels from _____.**

[D]

A) Rarer to denser medium B) Rarer to rarer medium

C) Denser to denser medium D) Denser to rarer medium

12. **When a pencil kept in a glass tumbler filled with water seen from the side of the glass it seems to bend. Due to** **[C]**

A) Reflection B) Dispersion C) Refraction D) Slattering

13. **The net deviation produced by a rectangular glass slab is?** **[C]**

A) Equal to angle of incidence B) Greater than angle of incidence

C) Less than angle of incidence D) Zero, always

14. **Which of the following absolute refractive index values is not possible?** **[D]**

A) $\sqrt{2}$ B) $\sqrt{3}$ C) $\sqrt{2}+1$ D) $\sqrt{2}-2$

15. **Twinkling of stars is due to?** **[D]**

A) Total internal reflection B) scattering

C) Dispersion D) atmosphere refraction

16. **The refractive index of medium 1 relative to medium 2 is $\frac{4}{3}$. Then the refractive index of medium 2 relative to medium 1 is?** **[A]**

A) $\frac{0.8}{9}$ B) $\frac{4}{3}$ C) $\frac{3}{4}$ D) $\frac{9}{16}$

17. **Which one of the following characteristics of light is not altered by refraction?** **[B]**

A) Speed B) frequency C) wave length D) intensity

18. **A coin is placed at a depth of 4cm in water. When seen from air it appears to be at a depth of** $\left[n_w = \frac{4}{3}\right]$**. Find the answer.** **[D]**

A) 4cm B) 3cm C) $\frac{9}{16}cm$ D) $\frac{16}{9}cm$

19. **If speed of light were same in all the media, which of these processes are (is) not possible?** **[B & C]**

A) Reflection B) refraction

C) Dispersion D) all the above

20. **The absolute refractive index of water and glass respectively are** $\frac{4}{3}$ **and** $\frac{3}{2}$**. Then the relative refractive index of glass with respect of water is?**

[A]

A) $\frac{8}{9}$ B) $\frac{17}{6}$ C) 2 D) $\frac{9}{8}$

21. **A ray of light is incident on a plane surface of refractive index** $\sqrt{3}$ **at certain angle. It is found that the reflected and refracted rays are perpendicular to each other. Then the angle of incidence is?** **[C]**

A) 30^0 B) 45^0 C) 60^0 D) 15^0

Chapter –1 Heat

S.NO	Name of the Physical Quantity	Units	
		C.G.S	S.I
1.	Temperature	$0^{o}C$ (Degree configurable)	Kelvin (k)
2.	Heat (Q)	Calorie (cal)	Joule (J)
3.	Specific Heat $S = \frac{Heat\ energy(Q)}{Mass\ (m) \times temperature\ difference}$	Cal/g - ^{o}C	J/kg – k
4.	Latent Heat $L = \frac{Heat\ energy(Q)}{mass}$	Cal/g	J /kg

Summary

Heat is a form of energy which transfers from high temperature body to low temperature body. The temperature of a body determines whether or not the body is in thermal equilibrium with the neighbouring systems. Thermometer is the instrument to measure the temperature. When heat is supplied to the body the internal energy increases.

The average kinetic energy of molecules of the body is directly proportional to the absolute temperature. The amount of heat energy absorbed by substances depends on the Mass of the body, temperature of the body and specific heat of the substances.

The specific heat of a substance gives us an idea of the degree of reluctance of a substance to change its temperature. The specific heat of a body determines with the principle of "Method of Mixtures".

When a liquid is exposed to air, the molecules at the surface keep on escaping the surface till the entire liquid disappears in air. This process is called evaporation. The reverse process of evaporation is condensation.

The amount of water vapour present in air is called humidity. In the winter when temperature goes down, the water vapour condensed on the grass and flowers. The water droplets condense on such surfaces is known as dew. If the temperature falls further, the water molecules condense on the dust particles in air forms fog.

The liquid state matter converts into gases state at a temperature. This temperature is known as boiling temperature and the processed is called boiling. The temperature is kept at constant during this process. The heat energy required to convert the liquid state matter into gases state at constant temperature is called "Latent heat of vaporization".

The process in which the solid phase changes to liquid phase at a constant temperature is called melting. This constant temperature is called melting point. The heat energy required to convert "1gram" of solid completely into liquid at a constant temperature is called Latent heat of fusion.

Freezing is the process to convert liquid to solid. In this process internal energy of the system decreases.

Problems

Formulae

1. Temperature in Kelvin = 273 + [Temperature in degree Celsius]

   $$K = 273 + t^{o}c$$

2. Heat energy $Q = ms\Delta T = ms\,(T_2 - T_1)$
3. Principle of method of mixtures

   Net Heat lost (Q_1) = Net Heat gained (Q_2)

4. Specific Heat of solid

   $$s_l = \frac{\left[m_1 s_c + (m_2 - m_1)s_w\right](T_3 - T_1)}{(m_3 - m_2)(T_2 - T_3)}$$

5. Latent Heat $L = \frac{Q}{m}$.

1. What would be the final temperature of a mixture of 50g of water at 20^0c temperature and 50g of water at 40^0c temperature (As$_1$)?

Sol:

Mass of hot water (m_1) = 50g

Temperature of hot water (t_2) = 40^0c

Specific heat of water (s) = 1 cal/g -^{0}c

Final temperature of hot water (T_1) = T (say)

Heat lost by hot water (Q_1) = $m_1 s\,(T_2 - T_1)$

$$Q_1 = 50 \times 1 \times (40 - T)$$

Mass of cold water (m_2) = 50g

Temperature of cold water (T_1) = 20^0c

Final temperature of cold water (T_2) = T

Heat gained by cold water $Q_2 = m_2 s(T_2 - T_1)$

$$Q_2 = 50 \times 1 \times (T - 20)$$

According to principle of method of mixture $Q_2 = Q_1$

$50 \times 1 \times (40 - T) = 50 \times 1 \times (T - 20)$

$40 - T = T - 20$

$40 + 20 = 2T$

$2T = 60$

$T = \frac{60}{2} = 30^0$

$1T = 30^0c$

Final temperature of mixture = 30^0c

2. Answer these (AS_1)

(a) How much energy is transferred when 1gm of boiling water at 100^0c condenses to water at 100^0c?

Sol: We know that latent heat of vaporization of water (L) = 540 cal/g

Mass of water (m) = 1g

Energy transfer (Q) = mL

$= 1\times 540$

$= 540$ cal.

Hence heat energy required to transferred 1gm boiling water at 100^0c condenses to water at 100^0c is 540 cal

(b) How much energy is transferred when 1 gm of boiling water at 100^0c cools to water at 0^0c?

Sol: Mass of the water (m) = 1g

Initial temperature (T_1) = 0^0c

Final temperature (T_2) = 100^0c

Specific Heat of water (s) = 1 cal /g - ^oc

Heat energy transferred Q = ms ($T_2 - T_1$)

$Q = 1 \times 1 \times (100 - 0)$

$Q = 100$ cal

(c) How much energy is released or absorbed when 1 gm of water at 0^0c freezes to ice at 0^0c.

Sol: Latent heat of ice = 80 cal

Mass of ice = 1 g

Heat energy Released Q = mL

$Q = 1 \times 80$

$Q = 80$ cal.

(d) How much energy released or absorbed when 1 gm of steam at 100^0c turns to ice at 0^0c.

Sol: we know that

Latent Heat of steam (L_s) = 540 cal / g

Latent Heat of ice (L_i) = 80 cal / g

Specific Heat of water (s_w) = 1 cal / g- ^oc

Mass of steam (m) = 1g

There are three stages for formation of ice.

1) 100^0c steam to 100^0c water

Heat released $Q_1 = m\,L_s$

$= 1 \times 540 = 540$ cal

2) 100^0c water to 0^0c of water

Heat energy released $Q_2 = ms(T_2 - T_1)$

$= 1 \times 1 \times (100 - 0)$

$= 100$

3) 0^0c of water to 0^0c of ice

Heat released $Q_3 = m\,L_i$

$= 1 \times 80$

$= 80$

Total heat energy released

$Q = Q_1 + Q_2 + Q_3$

$Q = 540 + 100 + 80$

$Q = 720$ cal

3. Convert 20^0c into Kelvin scale? (AS_1)

Kelvin scale = 273 + centigrade scale

$K = 273 + 20$

$K = 293$

$\therefore 20^0\mathbf{c} = 293$ k

4. Suppose that 1l of water is heated for a certain time to rise and its temperature by 2^0c. If 2l of water is heated for same time, by how much will its temperature rise? (AS_7)

Sol: Given volume of the water = 1 lt

Mass of the 1lt water (m) = 100g (llt = 1000g)

Specific heat of water (s_w) = 1 cal/g- ^{o}c

Temperature difference $\left(\Delta \bar{F}\right) = 2°c$

Heat energy required $Q = ms_w\Delta T$

$Q = 100 \times 1 \times 2 \ = 2000$ cal

Volume of the water = 2lt

Mass of the water (m_2) = $2 \times 1000 = 2000$g

Specific heat of water (s_w) = 1 cal / g – ^{0}c

Temperature difference $(\Delta T) = ?$

Heat energy supplied in same time is same for two cases

$\therefore$ Heat energy (Q_2) = 2000 cal

$\therefore 2000 = 2000 \times 1 \times \Delta T$

$\Delta T = 1^0$c.

1 Mark Questions

1. **Define temperature?**

A. **Temperature:** The degree of hotness or coldness.

2. **What is thermal equilibrium?**

A. The state of a thermal equilibrium denotes a state of body where it neither receives nor gives out heat energy.

3. **What is "Heat"?**

A. **Heat:** It is a form of energy in transit that flows from a body at higher temperature to a body at lower temperature.

4. **Define "Calorie"?**

A. **Calorie:** The amount of heat required to raise the temperature of 1 gram of water by 1^0c is called calorie. It is the C.G.S. unit of "Heat".

5. **Write the definition of "Specific Heat" (S).**

A. **Specific Heat(S):** The specific heat of a substance is the amount of heat required to raise the temperature of unit mass of the substance by one unit.

6. **How much heat energy is required to raise the temperature of 1g mass of water to 14.5^0c to 15.5^0c?**

A. One calorie

7. **What is evaporation?**

A. "The process of escaping of molecules from the surface of a liquid at any temperature is called evaporation"

8. What is "dew"?

A. **Dew:** The water droplets condensed on window panes, flower, grass etc during the winter nights is dew.

9. What is "Fog"?

A. **Fog:** During the low temperature, the water molecules presents in vapour condense on the dust particles in air and form small droplets of water. These droplets keep floating in the air and form a thick mist. This thick mist is called fog.

10.Define Boiling?

A. "Boiling is a process in which the liquid phase changes to gaseous phase at a constant temperature at a given pressure."

11.What is Latent Heat of Fusion?

A. "Heat energy required to converted 1g of solid completely into liquid at a constant temperature is called Latent Heat of fusion"

12.What happens to the water when wet clothes dry? (AS_3)

A. Water present in the clothes changes to vapour state.

2 Mark Questions

1. Write the principle of Mixture?

A. "When two or more bodies at different temperature are brought into thermal contact, then Net heat lost by the hot bodies is equal to Net heat gained by the cold bodies until they attain thermal equilibrium".

Net heat lost = Net heat gain

2. Differentiate between evaporation and Boiling? (As_1)

Evaporation	Boiling
1.It takes place at any temperature	1. Boiling occurs at a definite temperature called Boiling point
2.The temperature of liquid falls during evaporation	2.The temperature remains constant until all of the liquid has boiled away

3. Explain why dogs pant during hot summer days using the concept of evaporation? (AS_1)

A. Evaporation is the cooling phenomenon when dogs pant, the water molecules present on the tongue and in the mouth evaporate. This helps to cool the interior parts of the body.

4. Why do we get dew on the surface of a cold soft drink bottle kept in open air?

A. Cold soft drink bottle is almost at below $0^{o}c$ temperature. When it is kept in open air, the water vapour in air condenses and forms water droplets on it.

5. Equal amounts of water are kept in a cap and a dish. Which will evaporate faster? Why?

A. The state of evaporation of a liquid depends on its surface area, temperature and amount of vapour already present in the air.

The surface area of the liquid in cap is less than the surface area of the liquid in dish.

Hence the liquid in dish evaporates quickly.

6. If you are chilly outside the shower state, why do you feel warm after the bath if you stay in the bathroom?(AS_7)

A. We feel warm after finish our bath under the shower. In the bathroom, the number of vapor molecules per unit volume is greater than the number of vapour molecules per unit volume outside the bathroom. When we try to dry ourselves with a towel, the vapour molecules surrounding us condense on our skin. This condensation makes us feel warm.

7. How do you appreciate the role of the higher specific heat of water in stabilizing atmospheric temperature during winter and summer seasons?

A. Earth receives huge amount of heat energy from the Sun every day. With this heat, the Earth must have been heated beyond the level that it can withstand. But this is not actually happen because of the water bodies such oceans, seas and rivers. Oceans act as store houses of heat energy from the Sun.

During the winter and summer the water acts as balancing factor for controlling the temperature with its high specific heat.

8. What role does specific heat play in keeping a watermelon cool for a long time after removing it from a fridge on a hot day? [AS7]

A. Water has greater specific heat (1cal/g-^{o}c or 4180 J/kg – k). Greater the specific heat, the rate of rise or fall in temperature is low.

Watermelon contains large percentage of water. When it is in fridge the temperature of watermelon becomes very low. If it is taken out temperature (low), it will be remain low for a longtime.

4 Mark Questions

1. The surrounding air becomes warm or cool when vapour phase of H_2o condenses. Explain?

A. Place a glass tumbler on the table and pour cold water up to half its height. After 2 or 3 minutes water droplets form on the glass tumbler.

Air surrounding us contains water vapour. It is of high temperature than the water in the tumbler.

During their motion, the water molecules of air strike the surface of the glass tumbler which is at low temperature (cool) and they lose their kinetic energy which lowers their temperature and they get converted into droplets. The kinetic energy lost by the water molecules in air is gained by water molecules in glass through tumbler. Hence the temperature of water in glass increases. This process is called condensation. It is a warming process.

Hence the surrounding air becomes warm.

2. Explain the procedure of finding specific heat of solid experimentally. (AS_1)

A. Aim: To find the specific heat of given solid.

Material Required: Calorimeter, thermometer, stirrer water, steam heater, wooden box and lead shots.

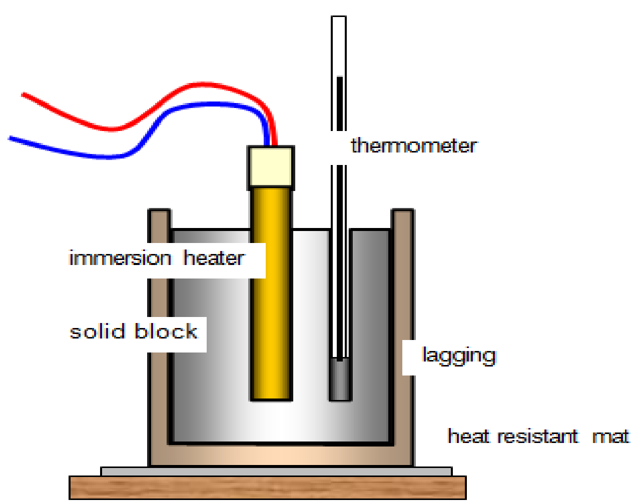


Figure 1

Procedure: Measure the mass of the calorimeter along with stirrer (m_1). Now fill one third of the volume of calorimeter with water as (m_2). Its temperature is T_1.

Take a few lead shots and place them in hot water or steam heater. Heat them up to a temperature 100^0c. Let this temperature be T_2.

Transfer the hot lead shots quickly into the calorimeter. Measure the temperature of water and lead shots. Note the resultant temperature as T_3. Now measure the mass of calorimeter along with content as m_3.

Mass of the water = $m_2 - m_1$

Mass of the lead shots = $m_3 - m_2$

Specific heat of calorimeter = S_c

Specific heat of water = S_w

Specific Heat of lead shots= s_l

Initial temperature of water = T_1

Temperature of Lead shots = T_2

Final temperature of the system = T_3.

According to the method of mixtures we know that

Heat lost by the solid = Heat gain by the calorimeter + Heat gained by the water

$(m_3 - m_2)s_l (T_2 - T_3) = m_1 s_c (T_3 - T_1) + (m_2 - m_1) s_w (T_3 - T_1)$

$$s_l = \frac{\left[m_1 s_c + (m_2 - m_1) s_w\right](T_3 - T_1)}{(m_3 - m_2)(T_2 - T_3)}$$

By the above formula one can calculate the specific heat of the lead shots (solid)

3. Your friend is asked to differentiate between evaporation and boiling. What Questions could you ask to make him to know the differences between evaporation and boiling? (As_2)

A. i. Does evaporation take place at all temperatures?

ii. Does boiling take place at all temperatures?

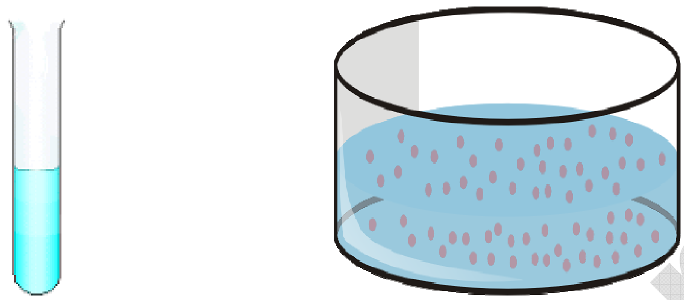
iii. Is boiling surface phenomena?

iv. Is evaporation a surface phenomena?

v. Is evaporation a cooling process or warming process?

4. Suggest an experiment to prove that the rate of evaporation of a liquid depends on its surface are and vapour already present in surroundings?

A. 1. **Rate of evaporation depends on surface Area:**



Take 10 ml of volatile liquid in a cap and another 10 ml of volatile liquid in dish. The surface area of liquid in a dish is more than the area of liquid in a cap.

After some time, the liquid disappears in dish whereas in cap liquid remains. This is only due to difference in area of liquid.

2. **Rate of evaporation depends on vapour already present in it**

Take a few drops of spirit in two Petri dishes separately. Keep one of the dishes containing spirit under a ceiling fan and switch on the fan. Keep another dish with its lid closed. Observe the quantity of spirit in both dishes after 5 minutes.

We will notice that spirit in the dish that is kept under the ceiling fan disappears, where as we find some spirit left in the dish that is kept in hidden dish.

This produced that evaporation faster at no vapour present in surrounding air.

5. Place a Pyrex funnel with its mouth down in a sauce pan full of water in such a way that the stem tube of the funnel is above the water or pointing upward into air. Rest the edge of the bottom portion of the funnel on a nail or on a coin so that water can get under it. Place the pan on a stove and heat it till it begins to boil. Where do the bubbles form first? Why? Can you explain how a geyser works using this experience?

A. i) The boiling point of water increases with increase in pressure.

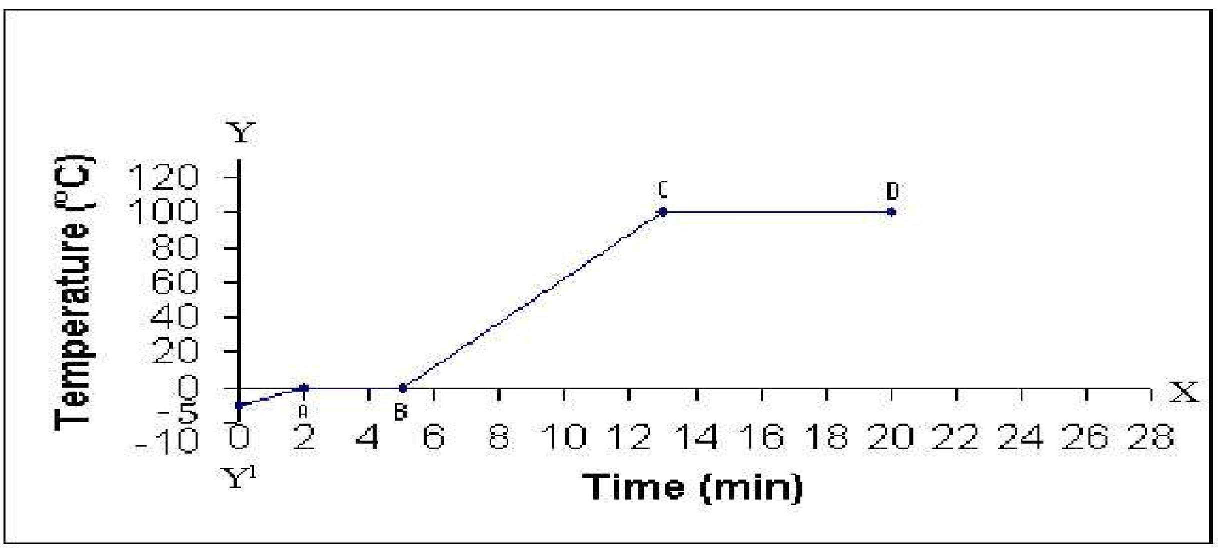
ii) So the bubbles start from the bottom at the sauce pan where the nail or coin arranged.

iii) In geyser, boiling begins near the bottom and the bubbles that are raising above push the water out starting the eruption.

iv) This is the laboratory demonstration of working of natural geyser.

6. Assume that heat is being supplied continuously of 2kg of ice at -5^{0}c. You know that ice melts at 0^{0}c and boils at 100^{0}c. Continue the heating till it starts boiling. Note the temperature every minute. Draw the graph between the temperature and time using the values you get. What do you understand from the graph? Write the conclusions (AS$_5$).

A.



1) OA region tells the temperature of ice increases from – 5^0c to 0^0c.
2) In AB region, the supplied heat energy is utilized for conversion of ice to water.
3) In BC region, water temperature increases from 0^0c to 100^0c.
4) Between C and D, water converts to steam at constant 100^0c.

Important Table

Substance	Specific heat	
	In cal/g-°C	In J/kg-K
Lead	0.031	130
Mercury	0.033	139
Brass	0.092	380
Zinc	0.093	391
Copper	0.095	399
Iron	0.115	483
Glass(flint)	0.12	504
Aluminum	0.21	882
Kerosene oil	0.50	2100
Ice	0.50	2100
Water	1	4180
Sea water	0.95	3900

Fill in the Blanks

1. Heat is a form of ____________. (**Energy**)
2. Hot and cold are __________ terms. (**Relative**)
3. When heat energy enters, our body we get a feeling of ______. (**Hotness**)
4. Heat energy transferred from the _______ body to the ______ body.
   (**Hotter, Colder**)
5. ________ is a measure of thermal equilibrium. (**^{0}c**)
6. The S.I. unit of heat is ____________. (**Joule, J**)
7. C.G.S. unit of heat is ________. (**Calorie(cal)**)
8. 1 calorie = ______ joules. (**4.186**)
9. Temperature measured on Kelvin scale is called __________ temperature.
   (**Absolute**)
10. The average kinetic energy of molecules of a hotter body is ____than that of colder body. (**Greater**)
11. S.I unit of specific heat is _______. (**J/kg - k**)
12. 1cal/g-^{0}c = _________ J/kg – k. (**4.2 ×10^3**)
13. _______ gives us of a substance to change its temperature. (**specific heat**)
14. The total energy of the system is called _________ of the system.
    (**Internal energy**)
15. Evaporation is a _________ phenomenon. (**Surface**)
16. ________________ is a cooling process. (**Evaporation**)
17. ____________ is a warming process. (**Condensation**)
18. The amount of water vapour in air is called _______. (**Humidity**)
19. When water is heated, the solubility of gases contains ______(**reduces**)
20. Heat energy utilized to change the state of liquid to vapour ___________.
    (**latent heat of vaporization**)
21. _________ is the S.I. unit of vaporization. (**J/kg**)
22. Latent heat of vaporization of water is __________. (**540 Cal/g**)
23. Ice melting point ____________. (**0^{0}c or 273 k**)

24. Freezing of water takes place at ________ temperature and normal pressure. **(0^oc)**

25. On freezing volume of the water _______. **(increases)**

26. Temperature of a body is directly proportional to _________ **(average kinetic energy)**

27. According to the principle of method of mixture, the net heat lost by the hot bodies is equal to _______ by the cold bodies. **(Heat gained)**

28. The sultriness in summer days is due to _______. **(Humidity)**

29. ________ is used as coolant. **(water)**

30. Ice floats on water becomes ________. **(lesser density)**

Multiple Choices

1. **If K_B: is the average kinetic energy of the molecules and "T" is the absolute temperature. Then** **(b)**

   a) $K_B = T$ b) $k_B \alpha T$ c) $k_B \alpha \frac{1}{T}$ d) $k_B \alpha \sqrt{T}$

2. **Of the following which determines the direction of heat flow.** **(b)**

   a) Thermometer b) Temperature
   c) Specific heat d) Latent Heat

3. **'Q' is heat energy, 'S' is specific Heat 'ΔT' is the temperature difference, 'm' is the Mass of the substance than Q =** **(a)**

   a) $ms\Delta T$ b) $\frac{m}{S\Delta T}$ c) $\frac{ms}{\Delta T}$ d) $\frac{1}{ms\Delta T}$

4. **C.G.S. unit of specific heat is -** **(c)**

   a) J/kg – k b) J/g – k c) cal/g – ^{o}c d) Cal/kg – ^{o}c

5. The specific heat(s) of a substance depends on its- **(c)**

a) Temperature b) Mass c) Nature d) All the above

6. Of the following which has more specific heat? **(d)**

a) Kerosene oil b) Iron c) Copper d) Water

7. "Store Houses" for the earth are- **(d)**

a) Animals b) Forests c) Hills d) Oceans

8. What happens to the temperature during evaporation? **(a)**

a) Falls b) Rise c) Constant d) Not linear

9. Rate of evaporation of a liquid depends on its- **(d)**

a) Surface area b) Temperature

c) Amount of water vapour d) All the above

10. C.G.S. unit of latent heat of vaporization- **(c)**

a) J/kg b) J – kg c) Cal/g d) Cal – kg

11. Boiling point of water at 1 atm- **(d)**

a) 100k b) 273^0c c) 3073k d) 373 k

12. Of the following, which parameter increases when heat energy supplied to the ice? **(a)**

a) Temperature b) Volume

c) Internal energy d) All the above

13. The process of converting solid into a liquid is- **(a)**

a) Melting b) Boiling c) Freezing d) None of the above

14. The value of Latent heat of fusion of ice- **(a)**

a) 80 cal/gm b) 80j – k/gm c) 80 j/kg d) 100 cal /gm

15. During the process conversion from liquid to solid, the internal energy of water- **(c)**

a) Remains constant b) Increases

c) Decreases d) None of the above

16. Which of the following is a warm process- **(b)**

a) Evaporation b) Condensation

c) Cooling d) All the above

17. Melting is a process in which solid phase changes to- **(b)**

a) Liquid phase b) Liquid phase at constant temperature

c) Gaseous phase d) Any phase

18. Three bodies A, B and C are in thermal equilibrium. The temperature of B is 45^{o}c then the temperature of c is ___ **(a)**

a) 45^{0}c b) 50^{0}c c) 40^{0}c d) Any temperature

19. The temperature of a steel rod is 330k. Its temperature in ^{0}c is ________ **(b)**

a) 55^{0}c b) 57^{0}c c) 59^{0}c d) 53^{0}c

20. When ice melts, it temperature- **(a)**

a) Remains constant b) Increases

c) Decreases d) Cannot say

3. Reflection of Light by Different Surfaces

Mirror is an optically opaque material which forms images by the phenomenon of reflection. When light ray incident on the mirror it comes back in to the same medium this is known as reflection.

Mirrors are generally classified in to three types. They are 1.Plane mirror 2.Concave mirror 3.Convex mirror.

In the plane mirror, the image is virtual, appears lateral inversion. The concave mirror is also called convergent mirror. It forms virtual and real images. It also forms erected and inverted images. The convex mirror diverges the light rays. It forms virtual, diminished images.

In mirrors, the angle of incidence is equal to angle of reflection. According to Fermat's principle, light selects the path which takes the least time to travel. This was the principle behind why angle of incidence is equal to angle of reflection.

Concave mirror are used in making solar cookers. They are used in medical diagnosis by ENT specialists.

Formulae

1. Mirror formula-

   $\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$

2. Magnification (m) = $-\frac{v}{u}$

   m = $\frac{h_i}{h_0}$

Problems

1) **An object 4 cm in size is placed at 25 cm in front of a concave mirror of focal length 15cm. At what distance from the mirror would a screen be placed in order to obtain a sharp image? Find the nature and size of the image?**

Sol: According to sign convention

Focal length (f) = -15cm

Object distance (u) = - 25cm

Object height (h_0) = +4cm

Image distance (v) =?

Image height h_i =?

Substitute the above values in the equation

$$\frac{1}{f}=\frac{1}{u}+\frac{1}{v}$$

$$\frac{1}{-15}=\frac{1}{-25}+\frac{1}{v}$$

$$\frac{1}{25}-\frac{1}{15}=\frac{1}{v}$$

$$\frac{15-25}{25\times15}=\frac{1}{v}$$

$$\frac{-15}{375}=\frac{1}{v}$$

V=–37.5cm

Magnification (m) = $\frac{h_i}{h_0}=-\frac{v}{u}$

$$\frac{h_i}{4} = -\frac{37.5}{25}$$

$$h_i = -4 \times \frac{37.5}{25}$$

$$h_i = -\frac{150}{25}$$

$$h_i = -6cm$$

So, the image is inverted and enlarged.

2) Find the distance of the image when an object is placed on the principal axis at a distance of 10cm in front of a concave mirror whose radius of curvature is 8 cm?

Sol. Given

Radius of curvature of the concave mirror R = 8cm

Focal length of the concave mirror f = $\frac{R}{2} = \frac{8}{2}$ = 4cm

Object distance (u) = 10cm

Image distance (v) =?

We know that

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{4} = \frac{1}{10} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{1}{4} - \frac{1}{10}$$

$$\frac{1}{v} = \frac{10-4}{40} = \frac{6}{40}$$

$v = \frac{40}{6}$ = 6.67

∴ The image distance (v) = 6.67 cm

3) A convex mirror with a radius of curvature of 3m is used as rear view in an automobile. If a bus is located at 5m from the mirror find the position, nature and size of the image. (AS_1)

Sol: Radius of curvature R = 3m

Focal length $f = \frac{R}{2} = \frac{3}{2} = 1.5m$

Object distance (u) = 5m

Image distance (v) =?

We know that

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

$$\frac{1}{f} = \frac{1}{-5} + \frac{1}{v}$$

$$\frac{1}{1.5} = \frac{1}{-5} + \frac{1}{v}$$

$$\frac{1}{v} = \frac{5 + 1.5}{1.5 \times 5} = \frac{6.5}{7.5}$$

$$v = \frac{7.5}{6.5} = \frac{75}{65} = \frac{15}{13} = 1.15$$

The image formed behind 1.15 cm of mirror image is virtual, erect and diminished.

4) An object is placed at a distance of 10cm from a convex mirror of focal length 15cm find the position and nature of the image. (As_9)

Sol: Given

Object distance (u) =10cm

Focal length (f) =15cm

Image distance (v) =?

We know that

$$\Rightarrow \frac{1}{f}=\frac{1}{u}+\frac{1}{v}$$

$$\frac{1}{15}=\frac{1}{-10}+\frac{1}{v}$$

$$\frac{1}{v}=\frac{1}{15}+\frac{1}{10}$$

$$\Rightarrow \frac{10+15}{15\times 10}=\frac{25}{150}=\frac{5}{30}$$

$$\frac{1}{v}=\frac{5}{30}$$

$$v=\frac{30}{5}=6cm$$

The image is virtual and seen in the mirror.

Magnification m= $-\frac{v}{u}=-\frac{6}{-10}=0.6$

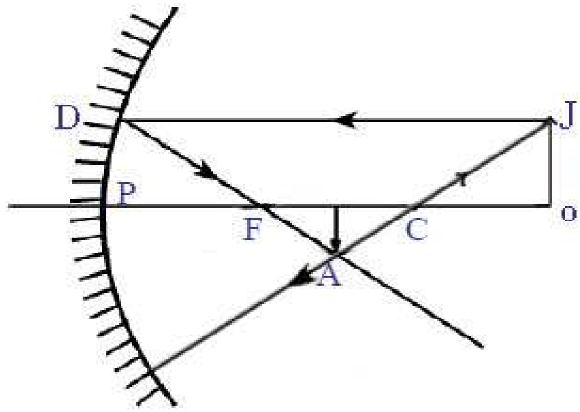
So the image is erect and diminished.

1 Mark Questions

1. What do you know about the terms given below related to spherical mirrors?

a. Pole **b.** Centre of curvature **c.** Focus **d.** Radius of curvature **e.** Focal length

f. Principal axis **g.** Object distance **h.** Image distance **i.** Magnification



a. Pole (p): The geometrical centre of the mirror is called pole of the mirror.

b. Centre of curvature (C): the centre of curvature of a spherical mirror is centre of sphere of which the mirror is a part.

c. Focus (F): It is a point on its principal axis to which all the incident rays which are parallel and close to axis converge.

d. Radius of curvature (R): The distance between pole and centre of curvature is called radius of curvature of the mirror.

e. Focal length (f): The distance between the pole and image of the mirror is called focal length of the mirror.

f. Principal axis: The horizontal line which passes through the centre of curvature and pole is called central axis or principal axis.

g. Object distance (U): The distance between the pole of the mirror and object is known as object distance.

h. Image distance (V): The distance between the pole of the mirror and image is known as image distance.

i. Magnification: The ratio of height of image to the height of the object is known as linear magnification.

Magnification m=$\frac{h_i}{h_o}$

2. When does a concave mirror form virtual image?

A) A concave mirror forms virtual image when the object is placed between pole and focal point.

3. What are the values of radius of curvature and focal length of a plane mirror?

A) Both the radius of curvature and focal length of a plane mirror are infinity.

4. What is the relation between radius of curvature and focal length of a concave mirror?

A) The focal point is the midpoint of centre of curvature and pole. So, focal length is half of radius of curvature.

5. How do you find magnification produced by a spherical mirror?

A) There are two ways of finding the magnification

a) The ratio of size of the image to object distance [m=$\frac{h_i}{h_o}$]

b) The ratio of image distance to object distance [$m = \frac{v}{u}$]

6. What does the sign of magnification indicates?

A) +Ve magnification: The image is erect, virtual.

- Ve Magnification: The image is inverted real.

7. What happens to image when an object is moved towards a concave mirror from infinity?

A) The image moves away from mirror staring from focal point to infinity.

8. Can a convex mirror burn a paper? If not? Why?

A) We cannot burn a paper by using a convex mirror, because the rays coming parallel to principal axis after reflection diverge from the mirror.

9. Which mirror has wider field view?

A) A convex mirror has wider file view.

10. Why does our image appear thin or bulged?

A) Due to converging or diverging of height rays from the mirror.

11. Can we focus sunlight at a point using a mirror instead of magnifying glass?

A) Yes, by using concave mirror we can focus sun light at a point.

12. Why is angle of incidence is equal to angle of reflection when a light ray reflected from a surface?

A) Because light selects the path that takes least time to cover a distance.

13. Are angle of reflection and angle of incidence equal for curved surface?

A) Yes, it is equal for curved surfaces like spherical mirrors.

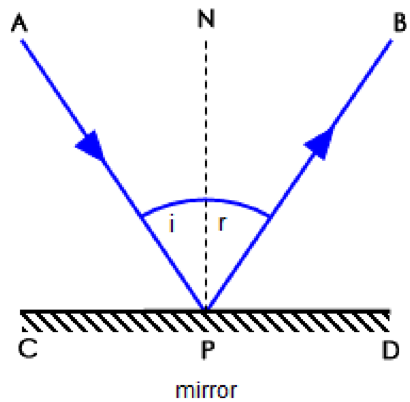
2 Marks Questions

1. State the laws of reflection of light? (AS_1)

A) Laws of reflection:

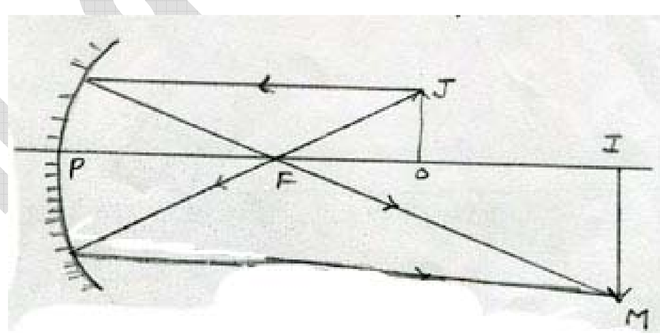
1. **First law:** the angle of incidence is equal to the angle of reflection.

2. Second law: The incident ray, the normal and the reflected ray lie in the same plane.



2. Where will the image form when we place an object, on the principal axis of a concave mirror at a point between focus and centre of curvature (As_1)

A)



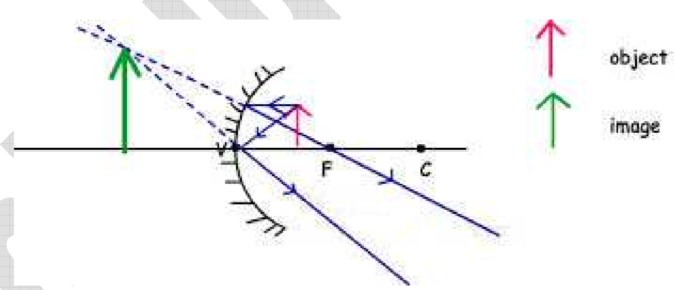
When an object is placed between focus and centre of curvature on the principal axis of a concave mirror, a real inverted image is formed beyond the centre of curvature.

3. State the differences between convex and concave mirrors. (As_1)

Convex Mirror	Concave Mirror
1. If outer side of a spherical mirror is reflecting, it is convex.	**1.** If inner side of spherical mirror is reflecting it is concave.
2. It always forms virtual erect and diminished image irrespective of position of object.	2. It forms real inverted images except when the object is between pole and focus.
3. It is used as rear view mirror in auto mobiles and optical instruments.	3.It is used in search lights, automobile head lights, reflecting telescopes etc.

4. How do you get a virtual image using a concave mirror?

A) When an object is kept between pole and focus of a concave mirror virtual image is formed behind the mirror.



5. Write the rules of sign convention?

A) 1. All distances should be measured from the pole.

2. The distances measured in the direction or incident light, to be taken positive and those measured in the direction opposite to incident light to be taken negative.

3. Height of object (H_0) and height of image (H_i) are positive if measured upwards from the axis and negative if measured downwards.

6. The magnification produce by the plane mirror is +1.what does this mean?

1. Magnification = $\frac{Height\ of\ the\ image\ (H_i)}{Height\ of\ the\ object(\ H_o)}$

Given $\frac{H_i}{H_o} = 1$

2. If the magnification of the image is +1, it indicates that the size of the image is equal to the size of the object.

3. The +ve sign of the magnification of the plane mirror indicates that the image is erect.

7. Imagine that spherical mirrors were not known to human beings. Guess the consequences? (AS$_2$)

A) If spherical mirrors were not known, the below said developments may not be possible

1. Safe driving in automobile will not be possible.

2. Automobile head lights, torch light, search lights cannot give bright lighting.

3. Constructions of reflecting telescopes would not be possible.

4. Dentists may not have proper diagnosis of teeth.

8. By observing steel vessels and different images in them, Surya a third class student asked some questions his elder sister Vidya. What may be those questions?

A) After observing the images, formed on steel vessels, surya may ask the following questions to his elder sister Vidya, they may be-

1) Why the image is not clearly visible?

2) Why the image is blurred?

3) Why the image is not as clear as in mirror?

4) Why the image seems to be small sometimes?

9) How will our image be in concave and convex mirror?

Concave mirror:

1) In concave mirrors our image is thin and enlarged.

2) As we move away from the mirror, the image will be diminished and become pointed at the-

Convex mirror:

1) In convex mirror, our image is bulged and size of image is diminished.

2) As we move away from the mirror, the image is further diminished.

10) How do you appreciate the use of reflection of light by a concave mirror in making of antenna dishes?

A) I appreciate the working process of TV antenna dishes. It contains the concave surface to receive the signals from the distinct communication satellites. The concave (parabolic) shape of a dish antenna helps to reflect the signal to the focal point of the dish. A device known as feed horn is mounted at the focal point which gathers the signals and sends them to processing unit.

11) Have you ever observed the image of the sky in rain water pools on earth? Explain the reflection of light in this context?

A) The surface of rain water pool acts as a plane mirror. When light rays incident on the surface of water pool, we can observe a virtual image of the sky. The incident ray undergoes irregular reflections from the surfaces. Hence we cannot see the image of the sky.

12) Why do we prefer a convex mirror as a rear-view mirror in the vehicle?

We use convex mirror as a rear view mirror in the vehicles because

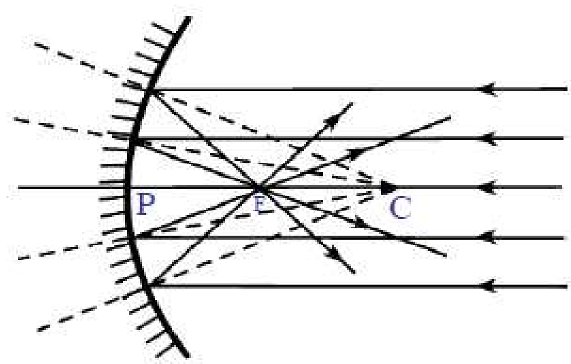
1) Convex mirror always forms virtual, erect and diminished images irrespective of distance of the object.

2) A convex mirror enables a driver to view large area of the traffic behind him.

3) Convex mirror forms very small image than the object. Due to this reason convex mirrors are used as rear view mirrors in the vehicles.

4 Mark Questions

1) How do you find the focal length of a concave mirror?



A) Hold a concave mirror such that sunlight falls on it. Take a small paper and slowly move it in front of the mirror and find out the point where you get the smallest and brightest spot, which will be the image of the sun.

The rays coming from the sun parallel to the principal axis of the concave mirror converge to a point. This point is called focus or focal point (F) of the concave mirror. Measure the distance of this spot from the pole of the mirror. This distance (PF) is the focal length (f) of the mirror. The Radius of curvature (R) will be twice this distance (R=2f).

2 Distinguish between real and virtual images? (AS_1)

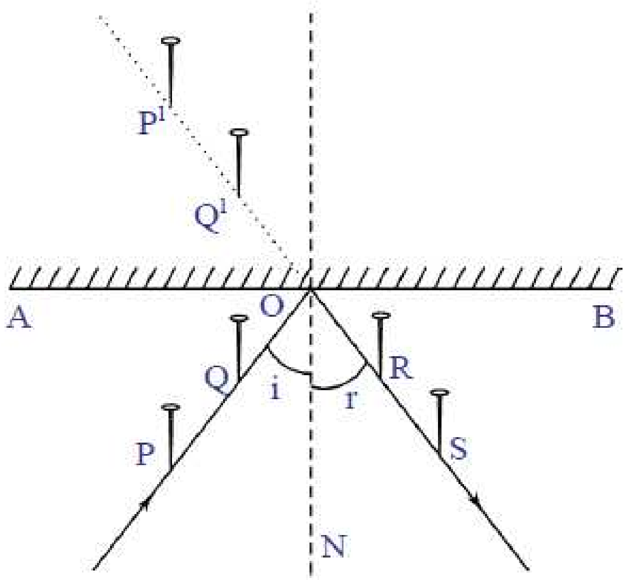
Real image	Virtual image
1. Real image is formed due to actual intersection of the reflected ray. 2 Inverted images are formed 3. Image can be obtained on the screen. 4. Real images can be diminished magnified or same size of the object	1. Virtual image is formed by the extending the diverging light rays backwards. 2. Erect images are formed. 3. Image cannot be obtained on the screen. 4. Virtual images are always diminished

depending on the object distance.	irrespective of position of the object.
5. Real images can be seen directly on the screen without looking into the mirror.	5. Virtual images are visible only in the mirror.

3. How do you verify the 1st law of reflection of light with an experiment?

A. Aim: verification of 1st law of reflection.

Required material: Mirror strip, drawing board, plane mirror, pins, clamps, scale and pencil.



Procedure: Take a drawing board and fix a white paper on it with the help of clamps. Draw a straight line AB at the centre of the paper and also a normal (on) to AB at the point ‘O’. Draw a straight line PQ making certain angle (i) with on as shown in figure. Fix two pins at the point P and Q on the paper vertically observe the image P’ of the pin P and Q’ of the pin Q in the mirror kept along the line AB. Fix two more pins R and S such that they are in the same line as that of P’ and Q’ . Join R, S and O as shown in figure.

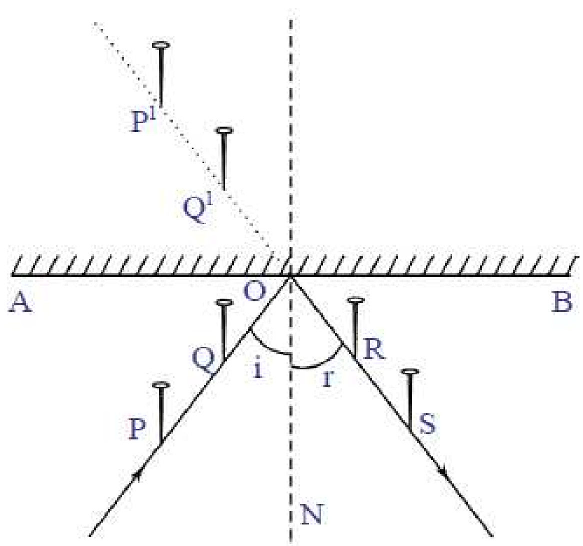
Observations: The angle between RS and ON is almost same as that of PQ and ON i.e., the angle of incidence= angle of reflection repeats the experiment with different angles of incidences and measures the corresponding angles of reflection.

Conclusion: In all observations the angle of incidence is equal to the angle of reflection.

4. How do you verify the 2nd Law of reflection of light with an experiment?

A. Aim: Verification of 2nd law of reflection.

Required material: mirror strip, drawing board, plane mirror, pins, clamps, scale and pencil.



Procedure:

1. Take a drawing board and fix the plane mirror on it with the help of clamps.

2. Draw straight line AB along the mirror and also a normal (ON) to AB at the point 'O'.

3. Draw a straight line PQ making certain angle (i) with on as shown.

The incident ray is the ray which is passing through the points 'P' and 'Q' touching the paper. The reflected ray is the ray which is passing through the points 'R' and 'S' touch the same paper and 'ON' is the normal to the mirror point 'O' .

Observation: The incident ray and reflected ray are in the plane parallel to the plane of the paper. Repeat the experiment with different angles of incidence.

Conclusion: In all observations incident ray and reflected ray are present in the same plane hence 2^{nd} law of reflections is proved.

5. What do you infer from the experiment which you did with concave mirrors and measure the distance of object and distance of image?

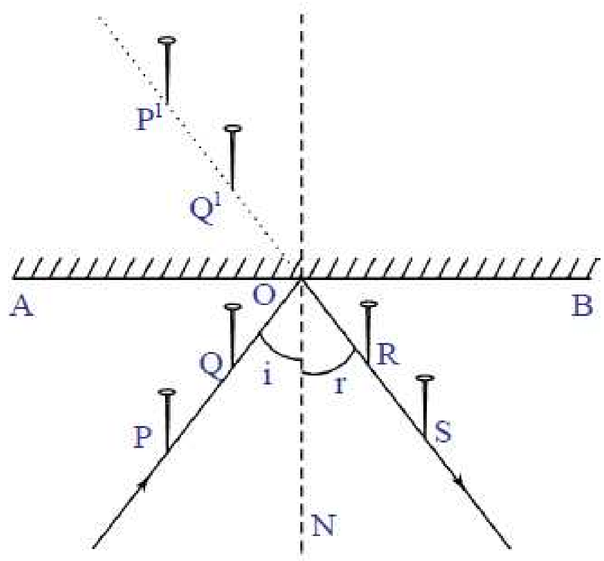
A. The observations from the experiments are

1. When an object is infinity distance the image is formed at the focus.

2. When an object is placed beyond the centre of curvature, the image is formed between the focus and centre of curvature.

6. Find the plane of the reflection experimentally for the incident ray which passes through the heads of the pins pierced in front of the mirror? (As_3)

A. The plane in which the incident ray, reflected ray and normal will lie is the plane of reflection.



1. Take a drawing board and fix a white paper on it with the help of clamps.

2. Draw a straight line AB at the centre of the paper and also a normal (ON) to AB at the point 'O'.

3. Draw a straight line PQ making certain angle with ON.

4. Fix two pins at the points P and Q on the paper vertically.

5. Observe the image p' of the pin P and Q' of the pin Q, in the mirror kept along the line AB.

6. Fix two more pins R and S such that they are in the same line as that of P' and Q'.

7. Join R, S and O.

8. Assume that the heads of all pins pierced at points P, Q, R and S are in the same height.

9. If the incident ray is the ray which is passing through the heads of pins those are localized at P and Q and reflected rays is the ray which is passing through the heads of pins those are located at points R and S, then the normal lies along the plane of PQRS.

10. Then the plane along PQRS is known as plane of reflection.

7. Think about the objects which act as concave or convex mirrors in your surroundings. Make a table and display in your class room?

Convex mirror	Concave mirror
1. Vehicle mirrors.	1. Head light of motorcycle.
2. Globe.	2. Inner surface of glasses
3. Calling Bell	3. Sink inwards
4. Surface of the steel flask.	4. Spoon bulged inwards.
5. Surface the pens.	5.Inner surface of cooking vessel
6. Spoon bulged out wards.	

8. Collect information about the history of spherical mirrors in human civilization. Display it in your class room?

A. The idea of mirror came into existence long back when people saw their images in water on polluted surfaces etc.

The earliest manufactured mirrors were pieces of polished stone such as obsidian a naturally occurring volcanic glass.

The Romans also developed a technique for creating crude mirrors by coating blown glass with molten lead.

The first modern silver-glass mirror was created by Justus von Liebig, a German chemist in 1835.

The invention of glass blowing method during the 14th century led to the discovery of spherical mirrors, which increased the popularity of glass mirrors. By the end of 18th century, decorative mirrors were widely used.

New cheaper techniques of mirror production in the 19th century led to a great proliferation of their use.

9) Draw and explain the process of formation of image with a pin hole camera.

A) Process of formation of image with a pin hole camera.

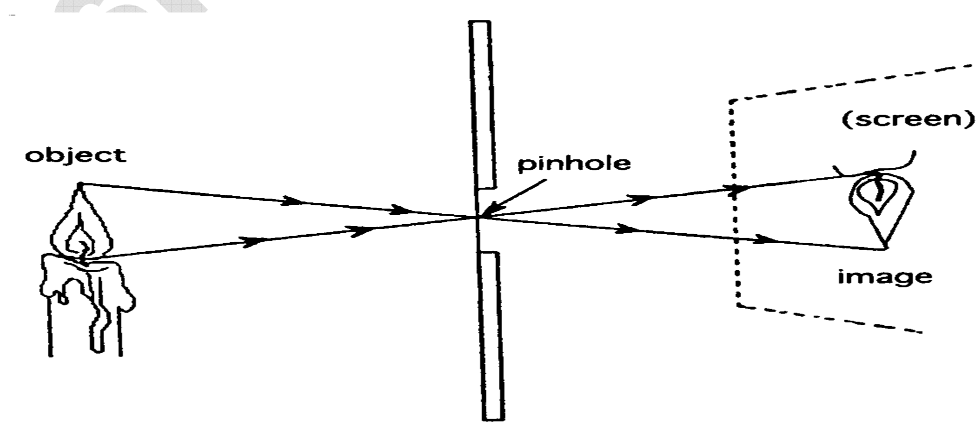
1) The light from candle travels straight in all directions from each point of the flame of the candle.

2) But only the light coming in some particular directions can enter into the camera through its pin hole.

3) Light which comes from the point at the top of the flame goes straight towards the bottom of the screen and light which comes from the [point at the bottom of the flame goes straight towards the top of the screen as shown in the figure.

4) The other rays are blocked by the black sheet.

5) This leads to the formation of an inverted image.



10. Make a solar header / cooker and explain in process of making?

A. Principle: A concave mirror focuses parallel sun ray at the focal point of the mirror and produces heat energy at that point.

Process: Make a wooden /iron frame in the shape of TV dish. Cut acrylic mirror sheets into 8 or 12 pieces in the shape of isosceles triangles with a height equal to the radius of your dish antenna. The bases of the 8 or 12 triangles together make the circumference of the dish. Stick the triangle mirrors to the dish.

Arrange it so that concave part faces sun. Find its focal point and place a vessel at that point. It will get heated. One can even cook rice in that vessel.

11. To form the image on the object itself, how should we plane the object in front of a concave mirror? Explain with a ray diagram?

A. To form the image on the object itself, the object should be kept at centre of curvature a concave mirror.

Explanation: 1. AB has been placed at the centre of curvature C on the concave mirror.

2. A ray of light AD which is parallel to the principal axis passes through the focus F after reflection.

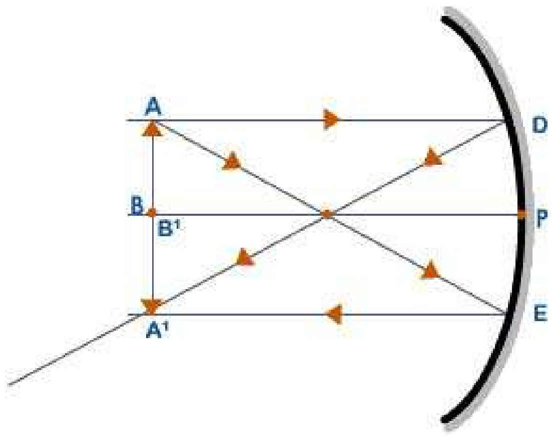
3. The second ray of light that we usually use is the one passing through the 'C' but in this case the object itself placed at the centre of curvature.

4. A ray of light passing through the focus of the concave mirror becomes parallel to the principal axis ray AE passing through the focus F.

5. It strikes the mirror at the point E and gets reflected in the direction of EA. Parallel to the principal axis.

6. the reflected ray DA' and EA' meet at a point A of A'. So the real image formed at point A of the object. To get the complete image, we draw A' B' perpendicular to the principal axis.

8. This A' B' is the real image of the object AB.



12. How do you appreciate the role of spherical mirrors in our daily life? (As_6)

A. Spherical mirrors (concave and convex mirrors) are very useful to our life. They are-

1. Concave mirrors are used by dentists to see the large images of the teeth of patient.

2. Spherical mirrors are used in telescopes.

3. Concave mirrors are used as reflectors in torches and vehicle head lights.

4. Concave mirrors are used in solar furnaces.

5. Convex mirrors are used as rear view mirrors in vehicles.

13. Discuss the merits and demerits of using mirrors in building elevation?

A. Merits:

1. Mirrors can be cut into different shapes or sizes.

2. Mirrors do not rust.

3. Mirrors do not let water passing through them.

Demerits:

Elevation of buildings with mirrors is not suggested able because these are.

1. These mirrors reflect sun rays at day time and reflect lighting from nearby electrical bulbs at light time, which causes confusion and people who are running on the nearby roads lead to accidents.

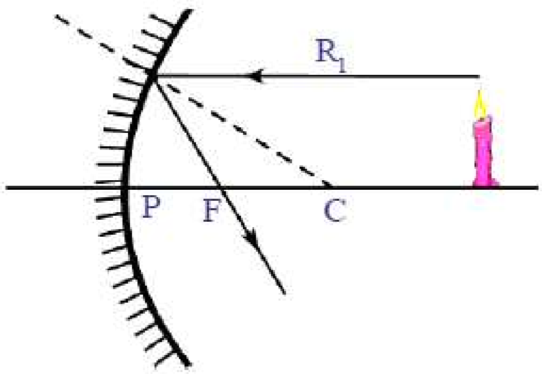
2. Birds like sparrows; crow will get confusion while flying on roads.

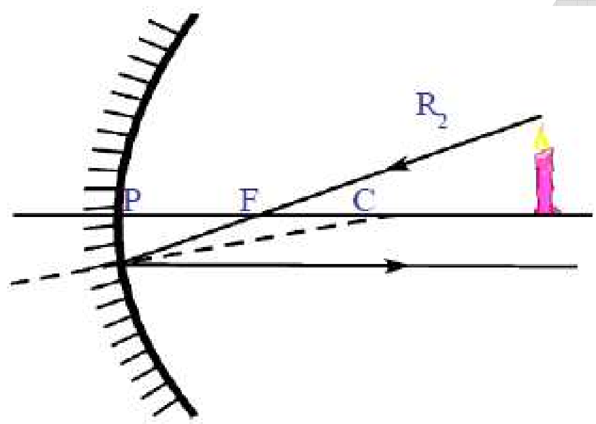
3. They are also not safe enough to the buildings, which causes easy access thieves.

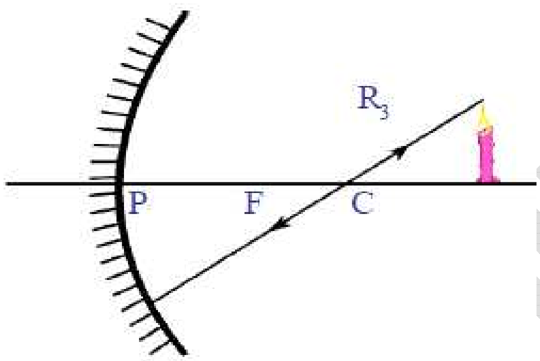
4. Glass elevation is not environmental friendly, becomes natural air does not enter into the building.

5 Marks Diagrams

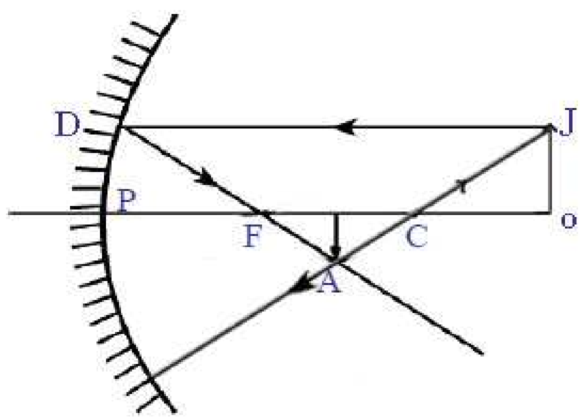
1. **Draw suitable rays by which we can guess the position of the image formed by a concave mirror.**







2. Show the formation of image with a ray diagram when an object is placed on the principal axis of a concave mirror away from the centre of curvature.



Fill in the Blanks (Half Mark)

1. Light travels in a ---------------- line.

A. Straight

2. The centre of sphere to which a spherical mirror belongs, is called ----------------.

A. Centre of curvature

3. The geometric centre of the mirror is -------**.**

A. Pole

4. The rays which are parallel to the principal axis of a concave mirror on reflection, meet at-

A. Focus

5. The line which passes through the centre of curvature and pole is -------.

A. Principal axis

6. The distance between pole and center of curvature-----------.

A. Radius of curvature

7. The distance between pole and focus ----------------.

A. Focal length

8. The relation between focal length and radius of curvature is given by-----------.

A. f=2r or r= $\frac{f}{2}$

9. Light selects the least time path to travel between two points. This principle was stated by-

A. Pierre de Fermat

10. The equation of the mirror is --------.

A. $\frac{1}{F}=\frac{1}{u}+\frac{1}{v}$

11. The relation between the angle of incidence and angle of reflection is given by ---------.

A. i=r

12. In the pin hole camera if hole is big we get------image.

A. Blurred

13. Concave mirror focuses parallel sun rays at the -----------of the mirror.

A. Focal point

14. The image that can be formed on the screen is called ------.

A. Real image

15. ------------ Cannot be form on screen.

A. Virtual images

16. --------- Image is formed in pin whole camera.

A. Real and inverted

17. Shaving mirrors are ------------.

A. Concave mirrors

18. Dish antenna is ------ shape to observe the signals.

A. Concave

19. In shops security system -----------mirrors are used.

A. Convex

20. -------------- is called converging mirror.

A. Concave mirror

21. ----------is called diverging mirror.

A. Convex mirror

Multiple Choice Questions

1. If an object is placed at 'c' on the principle axis in front of a concave mirror, the position of the image is _________. **[c]**

A) At infinity **B)** between F and C **C)** At C **D)** beyond C

2. We get a diminished image with a concave mirror when the object is placed ___. [d]

A) At F **B)** between the pole and F **C)** At c **D) beyond C**

3. We get a virtual image in a concave mirror when the object is placed______. **[b]**

A) At F **B)** between the pole and F **C)** At C **D)** beyond C

4. Magnification m=_______. **[a and d]**

A) $\frac{v}{u}$ **B)** $\frac{u}{v}$ **C)** $\frac{h_0}{h_i}$ **D)** $\frac{h_i}{h_o}$

5. A ray which seems to be travelling through the focus of a convex mirror passes_____ after reflection. **[a]**

A) parallel to the axis **B)** along with the same path in opposite direction

C) Through F **D)** through C

6. The angle of reflection is equal to the angle of incidence **[a]**

A) Always **B)** Sometimes **C)** Under special condition **D)** Never

7. _____ Mirrors are used in solar cookers. **[c]**

A) Convex **B)** Double Convex

C) Parabolic **D)** Spherical

8. The angle of incidence between the plane of a mirror and light ray is 45^0. The angle of reflection is _________. **[b]**

A) 30^0 **B)** 45^0

C) 60^0 **D)** 90^0

9. The mirror which can form a magnified image of an object is ______. **[c]**

A) Convex mirror **B)** Plane mirror

C) Concave **D)** Both convex and concave mirrors

10. Magnification produced by a convex mirror is always ____. **[c]**

A) More than 1 **B)** Less than 1

C) Equal to 1 **D)** All of the above

11. The focal length of a spherical mirror of radius of curvature 30cm is ______. **[b]**

A) 10cm **B)** 15cm

C) 20cm **D)** 30cm

12. The image of an object formed by a plane mirror is ____. **[a]**

A) Virtual **B)** Real **C)** Diminished **D)** Upside-down

13. The mirror used by ENT specialists is _. [b]

A) Plane **B)** Concave

C) Convex **D)** None of these

14. The scientist who burned ships using mirrors is __. [a]

A) Archimedes **B)** Pierced de format

C) Snell **D)** Faun hoofer

15. The centre of mirror is called _____ [b]

A) Centre of curvature **B)** Vertex

C) Radius of curvature **D)** Focus

Matching

1. Group A

1. Concave mirror [**d**] a. Virtual image.

2. Convex mirror [**a**] b. Divergent mirror

3. Plane mirror [**e**] c. Convergent mirror

4. Security mirror [**b**] d. Real image

5. Head light reflections [**c**] e. laterally inverted

f. Focal length

2. Group B

1. Rare view mirror used in vehicles [**d**] a. >1

2. Mirror used by dentists [**c**] b. <1

3. Mirror used at homes [**f**] c. Concave mirror

4. The magnification of convex Mirrors always [**b**] d. convex mirror

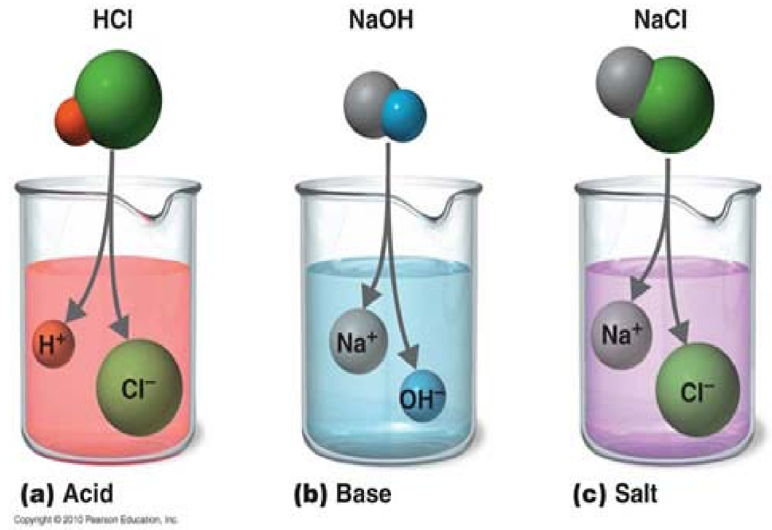
5. Magnification [**e**] e. $\frac{v}{u}$

f. plane mirror

3. Group C

1. Plane	[**d**]	a. rear view in automobiles
2. Convex	[**a**]	b. barber shop
3. Concave	[**b**]	c. solar cooker
4. Parabolic	[**c**]	d. households as toilet mirror
5. Centre of the spherical Mirror	[**f**]	f. pole

Acids, Bases and Salts



Synopsis

Substances are classified into acids, bases and salts depending on their chemical behavior and properties. Acids are of sour taste and turn blue litmus to red. Bases are soapy to touch and turn red litmus to blue. According to Lewis, electron pair acceptor is an acid and electron pair donor is a base.

The strength of acid or base depends on the concentration of H_3O^+ ions or OH^- produced in the solution. If an acid consists more H_3O^+ ions, then it is a strong acid, if the H_3O^+ ions are fewer then it is a weak acid.

A scale for measuring hydrogen ion concentration in a solution is called 'pH' scale. The pH scale ranges from 0 to 14. Acid pH value varies from 0 to 7. Neutral substances have pH value 7. pH value is 7 to 14 for Base.

When acid reacts with base, it forms salt and water. Sodium chloride is the most common salt. Sodium hydroxide, Bleaching powder, baking soda, washing soda are some of the salts obtained from common salt. Plaster of Paris is obtained from gypsum.

4 Mark Questions

1. **Five solutions A, B, C, D and E when tested with universal indicator showed pH as 4, 1, 11, 7 and 9 respectively, Which solution is**

   a) neutral b) strongly alkaline c) strongly acidic d) weakly acidic

   e) Weakly alkaline. Arrange the PH in increasing order of hydrogen ion concentration (AS_1).

Ans: **Solution** **pH value**

Solution		pH value
A	________	4
B	________	1
C	_______	11
D	_______	7
E	_______	9

a) Solution 'D' is neutral

b) Solution 'C' is strongly alkali metals

c) Solution 'B' is strongly acidic

d) Solution 'A' is weakly acid

e) Solution 'E' is weakly alkali metals

$pH = -\log [H^+]$

A) $4 = -\log [H^+]; [H^+] = 10^{-4}$

B) $1 = -\log [H^+]; [H^+] = 10^{-1}$

C) $11 = -\log [H^+]; [H^+] = 10^{-11}$

D) $7 = -\log [H^+]; [H^+] = 10^{-7}$

E) $9 = -\log [H^+]; [H^+] = 10^{-9}$

Increasing order of hydrogen ion concentration i.e. 10^{-11}, 10^{-9}, 10^{-7}, 10^{-4}, 10^{-1}

C', E', D', A', B'

2. Compounds such as alcohols and glucose contain hydrogen but are not categorized as acids. Describe an activity to prove it?

Ans: Prepare solutions of glucose and alcohol. Fix two iron nails on a rubber cork and place the cork in a beaker as shown in the figure.

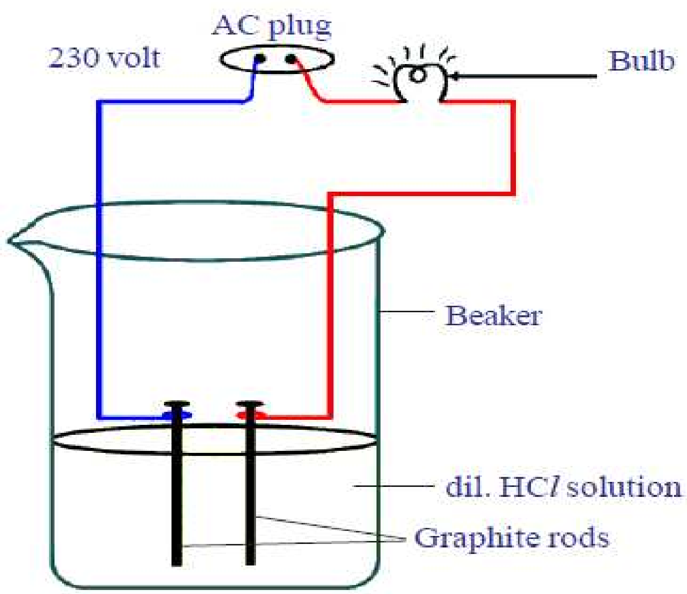


fig-3: Acid solution in water conducts electricity

Connect the nails to the two terminals of a battery through a switch and a bulb. Now pour glucose solution ($C_6H_{12}O_6$) and switch on the current. The bulb does not glow. This shows that glucose solution does not conduct electricity.

Repeat this experiment with alcohol solution in the beaker. The bulb does not glow again, that means alcohol solution does not conduct electricity.

Due to the absence of ions in glucose and alcohol solutions they do not conduct electricity. Glucose and alcohol do not dissociate in water to produce H^+ ions even though they contain hydrogen. Thus glucose and alcohols are not categorized as acids because they do not produce H^+ ions in water.

3. What is meant by "Water of Crystallization" of a substance?

- Describe an activity to show the water of crystallization?

Ans. **<u>Water of Crystallization:</u>** water of crystallizations is the fixed number of water molecules present in one formula unit of salt.

Ex: $Cuso_4.5H_2O$

In means that five water molecules are present in one formula unit of copper sulphate.

Activity:

1) Take a few crystals of copper sulphate in dry test tube and heat the test tube.
2) We observe water droplets on the walls of the test tube and salt turn white.
3) Add 2 – 3 drops of water on the sample of copper sulphate obtained after heating.
4) We observe the blue color of copper sulphate crystals is restored.

Reason: In the above activity, copper sulphate crystals which seem to be dry contain the water of crystallization, when these crystals are heated, water present in crystals is evaporated and the salt turns White. When the crystals are moistured with water, the blue color reappears.

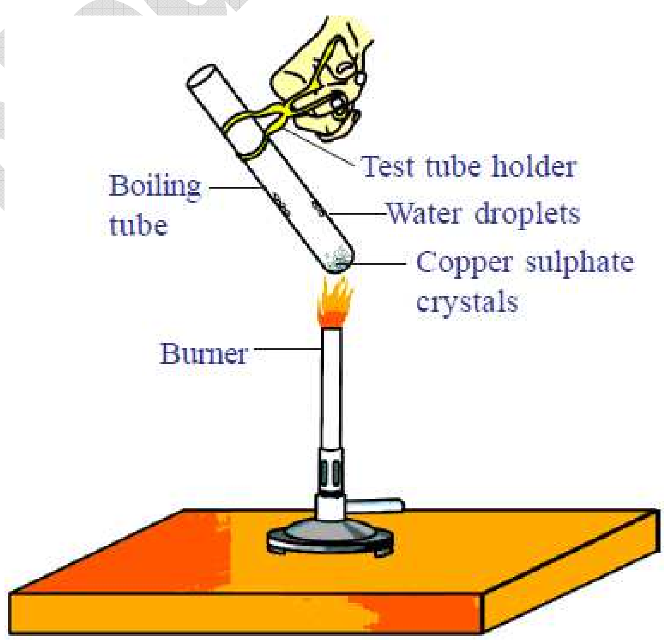


fig-10: Removing water of crystallisation

2 Mark Questions

1. What is neutralization reaction? Give two examples? (AS_1)

A. The reaction of an acid with a base to give a salt and water is known as neutralization. In general, neutralization reaction can be writer as-

$$Base + Acid \longrightarrow salt + Water$$

$$Ex: \quad NaoH + Hcl \longrightarrow Nacl + H_2o$$

2. What happens when an acid or base is mixed with water? (AS_7)

A. Mixing of an acid or base with water results in decrease in the concentration of ions per unit volume. Such a process is called dilution and the acid or the base is said to be diluted.

3. Why does tooth decay start when the pH of mouth is lower than 5.5 (As_1)?

A. The pH value of saliva is 6.4 to 6.9. It is almost neutral in nature. When sugar and food particles degraded by the bacteria in mouth produce free acid. Due to this the pH of the mouth falls. Tooth enamel, made of calcium phosphate. It is the hardest substance in the body. It does not the dissolve in water, but is corroded when the pH in mouth is below 5.5. Tooth decay starts when the pH of the mouth is lower than 5.5.

4. Why does not distilled water conduct electricity?

A. Liquids conduct electricity only due to ions. In distilled water, the concentration of both H_3o^+ and OH^- is same. Hence they do not form ions. As there is no formation of ions in electrolysis, distilled water do not conduct electricity.

5. Dry hydrogen chloride gas does not turn blue litmus to red. Whereas hydrochloric acid does. Why?

A. Dry hydrogen chloride gas do not dissociate in the absence of water. Hence it does not turn blue litmus to red. So dry hydrogen chloride gas is not acidic. The Hcl

(Hydrochloric acid) dissociates in the presence of water. Hence it turns blue litmus to red. So, Hcl is acidic.

The dissociation will be as follows.

$$Hcl + H_2o \longrightarrow H_3o^+ + cl^-$$

6. A milkman adds a very small amount of baking soda to fresh milk.

a) Why does he shift pH of the fresh milk from 6 to slightly alkaline?

b) Why does this milk take a long time to set as curd?

A. a) The chemical name of the compound is sodium hydrogen carbonate (Na HCO_3) and its pH value is 8.1. When milk man adds a little baking soda to fresh milk to make it slightly alkaline so that it can be preserved for longer time.

b) Lactic acid which was formed initially reduces the basic nature of the baking soda. Then more lactic acid is needed to convert milk into curd. That is why it takes time to produce more lactic acid and hence the milk takes a long time to become curd.

7. Plaster of Paris should be stored in moisture-proof container. Explain. (As_2).

A. Plaster of Paris chemical name is calcium sulphate hemihydrates ($caso_4$. ½ H_20).

It is a white powder and on mixing with water, it sets into hard solid mass due to the formation of gypsum.

$$CaSo_4.\frac{1}{2}H_2o + 1\frac{1}{2} \longrightarrow Caso_4.2H_2o$$

Because of the above reason plaster of Paris should be stored in moisture proof container.

8. Why acetic acid does not turn blue litmus to red.

A. Acetic acid is a weak acid, changing the color of litmus paper depend on the strength of the acid. Being a weak acid, acetic acid does not turn the blue litmus to red.

9. Fresh milk has a pH of 6. Explain why the pH changes as it turns into curd? (AS_3).

A. Fresh milk has a pH of 6. Lacto bacillus bacteria turns milk to curd by releasing 'Lactic acid'. That means curd contains more acid than milk. Hence, the pH value decreases than 6.

10. Equal lengths of magnesium ribbons are taken in test tubes A and B. Hydrochloric acid is added to tube A, while acetic acid is added to test tube B. Amount and concentration of the both the acids is same. In which test tube the fizzing occurs more vigorously and why?

A. Magnesium is a metal strong acid vigorously reacts with metals and releases Hydrogen gas. Hydrochloric acid is strong acid than acetic acid. So in test tube A, the reaction occurs vigorously as it contains strong acid.

11. How do you prepare your own indicator using beetroot? Explain (AS_5)

A. Take two beetroots and prepare juices. Dip a filter paper into the beetroot juices. The paper changes into "Red color". Now add a few drops of vinegar on the piece of beetroot paper. Observe whether the color is changed or not. There is no change in color.

Now add a few drops of soap solution on the piece of beetroot paper. Observe whether the color is changed or not. It turns yellow. From this, we conclude that beetroot paper act as an indicator and this is a natural indicator.

12. How does the flow of acid rain into a river make the survival of aquatic life in a river difficult? (As_7)

A. When the pH of rain water is less than 5.6 it is called acid rain. When acid rain water flows in river, it lowers the pH value after river water to such an extent that the survival of aquatic animal becomes difficult. The high acidity of river water can even kill the aquatic animals like fish.

13. What is backing powder? How does it make the cake soft and spongy?

A. Baking powder is a mixture of baking soda and a mild edible acid such as tartaric acid. When baking powder is heated or mixed in water, the following reaction takes place.

$$NaHco_3 + H^+ \longrightarrow Co_2 + H_2O + \text{sodium salt of acid}$$

Carbon dioxide produced during the reaction causes bread or cake to rise making them soft and spongy.

14. Give two important uses of washing soda and baking soda.

A. Uses of washing soda: 1) Sodium carbonate (washing soda) is used in glass, soap and paper industries.

2) It is used in the manufacture of sodium compound such as borax.

3) Sodium carbonate can be used as a cleaning agent for domestic purpose.

Uses of baking soda: 1) Baking soda is sometimes added for faster cooking.

2) Baking soda (sodium hydrogen carbonate) is also an ingredient in antacids.

3) It acts as mild antiseptic.

1 Mark Questions

1. What are antacids?

A. Antacids are mild alkalis. These are used for getting relief from acidity and indigestion.

Ex: Milk of magnesia.

2. What are olfactory indicators?

A. There are some substances whose odour changes in acidic or basic media. These are called olfactory indicator.

3. What is neutralization reaction?

A. The reaction of an acid with a base to give a salt and water is known as a neutralization reaction.

Base + Acid $\longrightarrow$ Salt + Water

4. What is bleaching powder? Write its formula?

A. Beaching powder is produced by the action of chlorine on dry slaked lime.

$$ca(OH)_2 + cl_2 \longrightarrow caocl_2 + H_2o$$

Formula of bleaching powder is $caocl_2$.

5. What is the range of pH scale?

A. The range of PH scale is from 0 to 14.

6. What are alkalis?

A. Bases which are soluble in water are called alkalis.

7. What is water of crystallization?

A. Water of crystallization is the fixed number of water molecules present in one formula unit of salt.

8. Write the reaction of copper oxide with hydrochloric acid?

A. $Cuo_{(s)} + 2Hcl_{(aq)} \longrightarrow Cucl_{2(aq)} + H_2O_{(l)}$

9. What are the salts obtained from common salt?

A. The various salts obtained from common salt are sodium hydroxide, baking soda, washing soda, bleaching powder and many more.

10. Where acid is added to water, what type of reaction is it?

A. When acid is added to water, it is an exothermic reaction.

11.How do you decide the strength of acid or base?

A. The strength of acid or base can be decided on the basis of no of H_3O^+ ions or OH^- ions produced in solution.

12.What is a pH scale?

A. A scale for measuring hydrogen ion concentration in a solution is called pH scale.

Fill in the Blanks

1. i. ____________ taste is a characteristic property of all acids in igneous solution. **[Sour]**

ii. Acids react with some metals to produce ________ gas. **[Hydrogen]**

iii. Because igneous acid solutions conduct electricity, they are identified Gas _____________. **[Conductors]**

iv. Acids react with bases to produce a _______ and water. **[Salt]**

v. Acids turn __________ different colors. **[Indicators]**

2. i. Bases tend to taste ______ and feel ____. **[Bitter, Soapy]**

ii. Like acids, aqueous basic solutions conduct ___________, and are identified as ____________. **[Electricity, conductor]**

iii. Bases react with __________ to produce a salt and _______. **[Acid, water]**

iv. Bases turn ________ different colors. **[Indicators]**

3. The strength of the base is measured by the number of _________ ions it produces in a solution. **[OH^-]**

4. An aqueous solution of sodium chloride is _________. **[brine]**

5. The irritation and pain due to indigestion can be reduced by using substances called ______. **[Antacids]**

6. The chemical name of Plaster of Paris is ________. **[Calcium sulphate hemihydrate]**

7. When the blue color of copper sulphate crystals are heated the salt turns ________. **[white]**

8. Baking powder is a mixture of baking soda and a _________. **[mild edible acid]**

9. Bleaching powder is represented by formula _______. **[$caocl_2$]**

10.__________ used as a reagent in the preparation of chloroform. **[bleaching powder]**

11. Magnesium hydroxide is an _________ that neutralizes the excess acid in stomach. **[antacid]**

12. Substances whose odour changes in acidic or basic are called ___________. **[Olfactory indicators]**

13. $2NaoH + zn \longrightarrow Na_2zno_2 +$ ______ **[H_2]**

(Sodium Zincates)

14. $Metal\ carbonate + Acid + \longrightarrow salt +$ ______ $+ water$ **[carbon dioxide]**

15. To know the strength of acid or base ____________ indicator can be used. **[Universal]**

16. In pH, p stands for _________. **[potent]**

17. The pH value of neutral solution is __________. **[7]**

18. When pH of rain water is ___________ it is called acid rain. **[less than 5.6]**

19. Tooth decay starts when the pH of the mouth is lower than _______. **[5.5]**

20.________ is the hardest substance in the body. **[calcium phosphate]**

21. Tooth pastes which are generally _________. **[basic]**

22. Magnesium hydroxide [$Mg(OH)_2$].which is used antacid is ________. **[mild base]**

23. Stinging hair of leaves of nettle plant injects ________ causing burning pain. **[Methanoic acid]**

24. 24. 2Nacl $_{(aq)}$ + $2H_2O_{(l)} \longrightarrow$ 2NaOH + _______ + $H_{2\,(g)}$ **[cl$_2$]**

25. _________ used for disinfecting drinking water to make it free of germs.

[Bleaching powder]

26.________ used for removing permanent hardness of water. **[Sodium carbonate]**

Multiple Choice Questions

1. The color of methyl orange indicator in acidic medium is _______. **[d]**

   a) Yellow b) Green c) Orange d) red

2. The color of phenolphthalein indicator in basic solution is ______. **[c]**

   a) Yellow b) Green c) Pink d) red

3. Color of methyl orange in alkali condition_______. **[b]**

   a) Orange b) Yellow c) red d) Blue

4. A solution turn red litmus into blue, its pH is likely to be? **[d]**

   a) 1 b) 4 c) 5 d) 10

5. A solution reacts with crushed egg – shells to give a gas that turns lime water milky the solution contains________. **[b]**

   a) Nacl b) Hcl c) Licl d) Kcl

6. If a base dissolved in water by what name is it better known? **[d]**

   a) Neutralization b) basic c) acid d) alkali

7. Which of the following substances when mixed together will produce table salt? **[d]**

   a) Sodium thiosulphate and sulphur dioxide

   b) Hydrochloric acid and Sodium hydroxide

   c) Chlorine and oxygen

   d) Nitric acid and sodium hydrogen carbonate

8. What color would hydrochloric acid (PH_{31}) turn universal indicator? **[d]**

a) Neutralization b) basic c) acid d) alkali

9. Which one of the following types of medicine is used for treating indigestion?

[c]

a) Antibiotic b) analgesic c) Antacid d) Antiseptic

10. What gas is produced when magnesium is made to react with hydrochloric acid?

[a]

a) Hydrogen b) Oxygen

c) Carbon dioxide d) No gas is produced

11. Which of the following is the most accurate way of showing neutralizations? **[b]**

a) $Acid + Base \longrightarrow acid - base\, solution$

b) $Acid + Base \longrightarrow salt + water$

c) $Acid + Base \longrightarrow sodium\, chloride + hydrogen$

d) $Acid + Base \longrightarrow Neutral\, solution$

12. Which of the following indicators is not an acid – base indicator? **[b]**

a) Phenolphthalein b) Vanilla c) Litmus d) Methyl orange

13. The acid formed in stomach which help in digestion is ________. **[a]**

a) Hcl b) H_2So_4 c) CH_3COOH d) citric acid

Match the Following

Group - A		Group – B
a) Plaster of Paris	[4]	1) $Caocl_2$
b) Gypsum	[5]	2) $NaHCo_3$
c) Beaching Powder	[1]	3) Na_2co_3
d) Baking soda	[2]	4) $CaSo_4$ 1/2 H_2o
e) Washing soda	[3]	5) $CaSo_4.2H_2o$

Group - A		Group – B
1) Plaster of Paris	[b]	a) enhance the taste of food
2) Washingsoda (sodium carbonate)	[c]	b) Making toys
3) Baking soda	[d]	c) Glass industry
4) Bleaching Powder	[e]	d) Mild non – corrosive base
5) Common salt	[a]	e) Oxidizing agent

Group - A		Group – B
1) Hcl	[b]	a) Strong Base
2) NaOH	[a]	b) Strong Acid
3) CH_3cooH	[d]	c) Weak Base
4) NH_4oH	[c]	d) Weak Acid

Important Images

1. Draw a neat diagram showing acid solution in water conducts electricity.

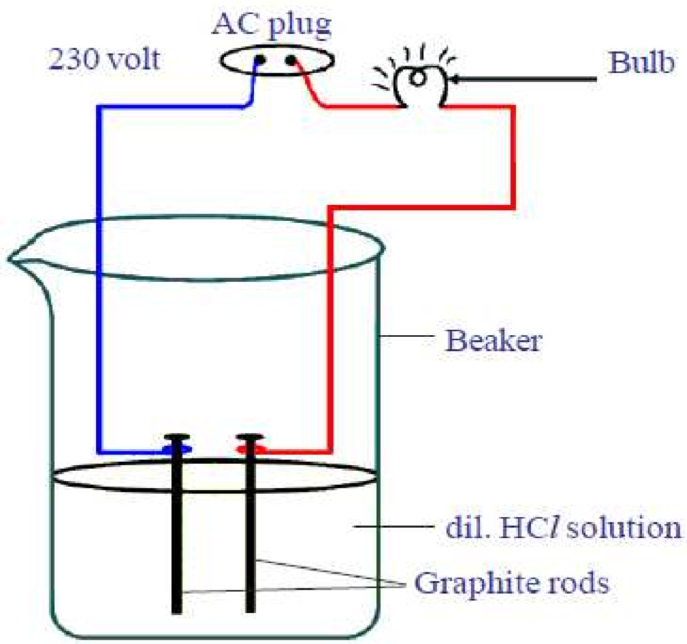


fig-3: Acid solution in water conducts electricity

2. HCL and testing hydrogen gas by a burning match stick

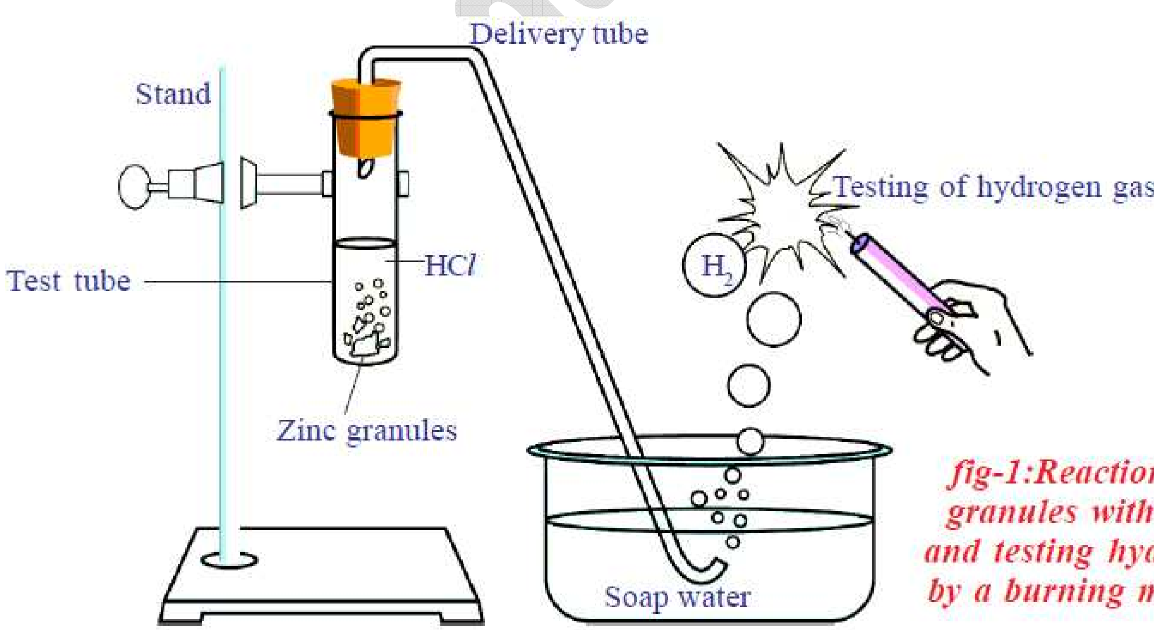


fig-1:Reaction of zinc granules with dil. HCl and testing hydrogen gas by a burning match stick

2. Passing CO_2 gas through $Ca(OH)_2$

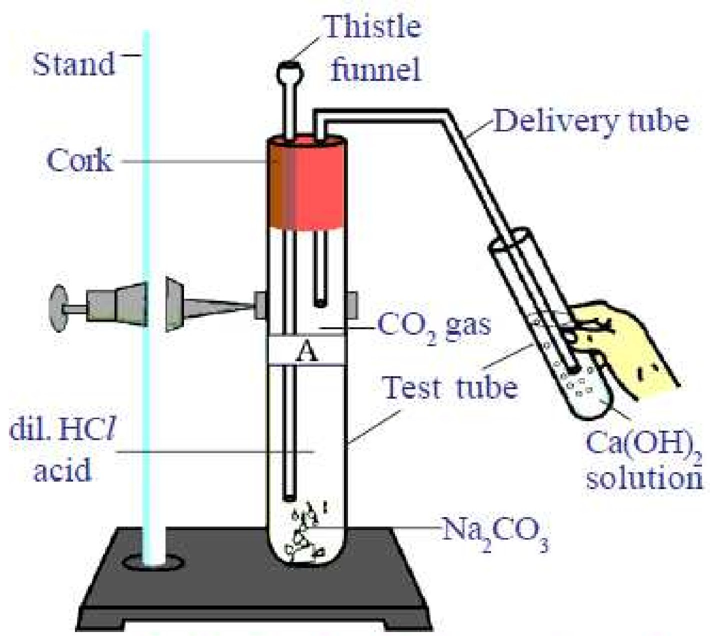


fig-2: Passing CO_2 gas through $Ca(OH)_2$ solution

Chapter -14

Carbon and its Compounds

SYNOPSIS

Due to allotropy, the carbon forms many compounds. Another penults behavior of carbon is its ability to form longest chains with its own atoms.

The compounds containing only carbon and hydrogen in their molecular are called Hydrocarbons. Hydrocarbons are classified into two categories known as - open chain hydro carbons and closed chain hydrocarbons. Open chain hydrocarbons also called aliphatic hydrocarbons or acyclic hydrocarbons. All hydrocarbons are again classified as Alkanes, Alkenes and Alkynes.

We have millions of orgasmic compounds. As number of organic compounds is very big, it is difficult to remember their names individually. To overcome this problem they have to be properly named. For this, the International Union of Pure and Applied Chemistry (IUPAC) has been formed. This organization gives information about the nomenclature of organic compounds.

Some important chemical properties of carbon compounds are

1) Combustion; 2) Oxidation; 3) Addition; 4) Substitution.

Some important carbon compounds are -

1) Ethanol (Ethyl alcohol);

2) Ethanoic acid.

2Mark Questions

1. What are the general molecular formulae of alkanes, alkenes and alkynes? (AS1)

A. the general molecular formulae of alkane: C_nH_{2n+2}

for alkene: C_nH_{2n}

alkyne: C_nH_{2n-2}

2. How an addition reaction is used in vegetable ghee industry? Explain with the help of a chemical equation. (AS1)

A. Hydrogenation of oils converts fats in vegetable ghee industry. During this addition reaction, unsaturated fatty acids (contain double bond) are converted into saturated fatty acids (contain single bond).

$$unsaturated\ fatty\ acids + H_2 \xrightarrow{Ni} Saturate.Fattyacids$$

$$Oil + H_2 \longrightarrow fats$$

Eg:

```
   H   H                       H   H
   |   |                       |   |
R – C = C – COOH + H2  →  R – C = C – COOH + H2
```

3. Give an example for esterification reaction.

A. The reaction between a carboxylic acid and an alcohol in the presence of conc. H_2SO_4 form a fruity ordered substance, which is ester. This process is known as esterification reaction.

For example:

Ethyl alcohol reacts with ethanoic acid in the presence of conc. H_2SO_4 to form ethyl acetate, an ester with sweet odour.

$$C_2H_5OH + CH_3COOH \xrightarrow[\Delta]{cone\, H_2SO_4} CH_3COOC_2H_5$$

(ethanol) (Acetic acid)

4. Name the product obtained when ethanol is oxidized by either chromic anhydride or alkaline potassium permanganate. (AS1)

A. When ethanol undergoes Oxidation, it forms the product acetaldehyde initially and acetic acid finally.

The reaction is as follows:

$$\underset{(ethanol)}{C_2H_5OH} \xrightarrow[ac\,K_2Cr_2O_4\Delta]{alk\,KMnO_4/\Delta(heat)} \underset{(ethanol)}{CH_3CHOO} \xrightarrow{(0)} \underset{(ethanoic\,acid)}{CH_3COOH}$$

5. Write the chemical equation representing the reaction of preparation of ethanol from ethane.

A. Ethene(C_2H_4) by the addition of water vapor to it in the presence of catalyst like P_2O_5, tungsten Oxide at high pressure and temperature.

$$\underset{(ethene)}{H_2C = CH_2} + H_2O \xrightarrow[100-300\,atm]{P_2O_5} C_2H_5OH.$$

6. Write the IUPAC name of the next homologous of $CH_3OHCH_2CH_3$. (AS1)

A. **Given homologous:**

$CH_3 - CH_2 - CH_2$

1 – propanol

Next homologous:

OH

|

$CH_3 - CH_2 - CH_2 - CH_3$

2- Butanol.

7. Give the names of following functional groups-

(i) -CHO

O

||

(ii) – C = o (C)

**/ **

A. (i) – CHO is aldehyde

(ii) – C = 0 is ketone

8. Why does carbon form compounds mainly by covalent bonding? (AS1)

A. Carbon has 4 electrons in its valence shell. The formation of C^{+4} ions by losing 4 electrons or the formation of C^{-4} ions by gain of 4 electrons is very differcult process. So it has to form four covalent bonds either with its own atoms or atoms of other elements.

9. Allotropy is a property shown by which class substance: elements, compounds or mixtures? Explain allotropy with suitable examples.

A. Allotropy is the property of an element to exist in 2 or more physical forms having more or less similar chemical properties but different physical properties is called as allotropy.

Eg: The allotropes of carbon are classified into 2 types they are-

1) **Amorphous form:** Coal, Coke, Camp black etc,

2) **Crystalline form:** Diamond, Graphite, and Buck minster fullerene.

10. Explain how sodium ethoxide is obtained from ethanol? Give chemical equations.

A. Ethanol (or) ethyl alcohol reacts with metallic sodium to liberate hydrogen and form sodium ethoxide.

$$\underset{(ethanol)}{2C_2H_5OH} + 2Na \longrightarrow \underset{(Sodium\ ethoxide)}{2C_2H_5ONa} + H_2$$

11. Describe with chemical equation how ethanoic acid may be obtained from ethanol.

A. Ethanol on Oxidation in the presence of acidified potassium permanganate (or) potassium dichromate forms ethanol (or) acetaldehyde initially and ethanoic acid (or) acetic acid finally.

$$\underset{(ethanol)}{C_2H_5OH} + (O) \xrightarrow{Kmno_4/H^+} \underset{(ethanal)}{CH_3CHO} \xrightarrow[(o)]{KMnO_4/H^+} \underset{(rhanic\ acid)}{CH_3CHOOH}$$

12. Two carbon compounds A and B have molecular formula C_3H_8 and C_3H_6 respectively. Which one of the two is most likely to show addition? Justify your answer. (AS2)

A. The molecular formula of A is C_3H_8

B is C_3H_6

The carbon compound with molecular formula C_3H_6 shows addition reaction.

Since, compound A is propane is alkene. It is mostly like to participate in substation reaction because it contains all single bonds between carbon atoms.

While compound B is propane is an alkene. So, it shows addition reaction because it contain double bond (=) between 2 carbon atoms.

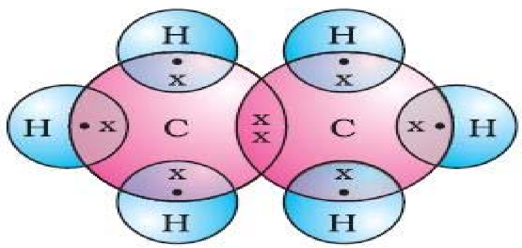
$$\underset{propene}{H_3C-HC=CH_2} \xrightarrow[H_2]{Ni\ catalyst} \underset{propane}{CH_3-CH_2-CH_3}$$

13. Draw the electronic dot structure of ethane molecule (C_2H_6). (AS5)

A. Ethane- C_2H_6:

```
      H   H
      |   |
H – C – C – H
      |   |
      H   H
```

Electronic dot structure:



14. How do you appreciate the role of esters in everyday life?

A. Esters are very useful to our daily life. The uses of esters are:

1. Esters are used for making artificial flavors and essences there are used in cold drinks, ice – creams sweets and perfumes
2. Esters are used as solvents for oils, fats, gums, resins, cellulose, paints, varnishes etc.
3. Esters are used as plasticizes.

15. Mention the hybridization of carbon in the following compounds.

a) C_2H_4; b) CH_4; c) C_2H_2

A. a) C_2H_4 — sp^2

b) CH_4 — sp^3

c) C_2H_2 — sp

16. Carbon is versatile in nature. Justify the statement.

A. The ability of carbon to form bonds in so many ways made it as versatile in nature i.e.,

i) To form largest carbon compounds

ii) Catenation

iii) To form various types of bonds.

17. Draw the isomers of C_5H_{12} & C_6H_{14}.

A. For C_5H_{12}:

$CH_3 - CH_2 - CH_2 - CH_3$ (n – pentane)

$CH_3 - CH - CH_2 - CH_3$
|
CH_3 (2 – methyl butane)

CH_3
|
$CH_3 - C - CH_3$
|
CH_3 (2, 2 dimethyl pentane)

For C_6H_{14}:

$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$ (n - hexane)

$CH_3 - CH_2 - CH_2 - CH - CH_3$
| (2 – methyl pentane)
CH_3

$CH_3 - CH_2 - CH - CH_2 - CH_3$
| (3 – methyl pentane)
CH_3

$$\begin{array}{l} CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH_2}}-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3 \end{array}$$

(2,3 – dimethyl butane)

$$CH_3-CH_3-\overset{\displaystyle CH_3}{\overset{|}{\underset{\displaystyle CH_3}{\underset{|}{C}}}}-CH_3$$

(2,2 dimethyl butane)

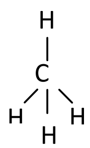
$$CH_3-\underset{\displaystyle \underset{\displaystyle CH_3}{\underset{|}{CH_2}}}{\underset{|}{CH}}-CH_2-CH_3$$

(2 ethyl butane)

1 Mark Questions

1. Name the simplest hydrocarbon. (AS1)

A. The simplest hydrocarbon is methane (CH_4)



2. Name the carboxylic acid used as a preservative. (AS1)

A. Acetic acid (or) ethanoic acid (CH_3COOH) is used as a preservative.

3. Name the product other than water formed on burning of ethanol in air (AS1).

A. When ethanol is burnt in air the product formed other than water is carbon dioxide (CO_2) .

The reaction is as follows

$C_2H_5OH + 3O_2 \rightarrow 2CO_2\,(9) + 3H_2O$ + energy

4. Name the simplest ketone and write its molecular formula (AS1)

A. The simplest ketone is acetone.

Formula:

$$\begin{array}{c} O \\ \| \\ CH_3 - C - CH_3 \end{array}$$

IUPAC Name: 2 – propanone

5. What do we call the self linking property of carbon?

A. The self linking property of carbon is called "Catenation". If any element forms bonds between its own atoms to give any big molecule, we call this property as catenation property.

6. Name the compound formed by heating ethanol at 443 K with excess of conc. H_2SO_4. (AS1)

A. Ethanol when heating with excess of cone. H_2SO_4 at 443k produces ethane

$$C_2H_5OH \xrightarrow[443K]{cone\,H_2SO_4} C=C+H_2O$$

$$(ethane)$$

It is a dehydration reaction.

H_2SO_4 is an dehydrating agent and removes H_2O.

7. Name the acid present in vinegar. (AS1)

A. The acid present in vinegar is us 5 - 8% ethanoic acid (or) Acetic acid.

Its formula is CH_3COOH.

8. What happens when a small piece of sodium is dropped into ethanol?

A. When a small piece of sodium is dropped into ethanol releases hydrogen gas.

$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2(\uparrow)$

9. Give the electronic configurations of carbon in both group state and exited states.

A. Electronic configuration of carbon atom,

In ground states $\rightarrow 1s^2 2s^2 sp^2$

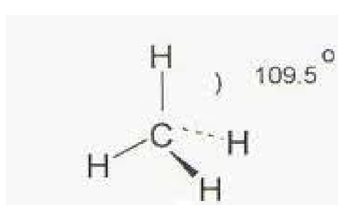
In excited state $\rightarrow 1s^2\ 2s^1 2p^3$

10. Mention the bond angles between H-C-H in

a) CH_4

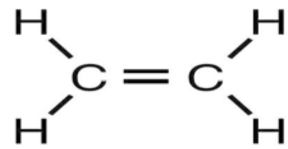
b) C_2H_4

c) C_2H_2



A. a) CH_4 ---- $109^0 28'$

b) C_2H_4

120 

c) $C_2H_2 - 180^0$

$H - C \equiv C - H$

11. How are Allotropes formed?

A. Allotropes are formed due to difference in arrangement of atoms in the molecule.

12. Mention the structure of each carbon atom in diamond & graphite.

A. Diamond – tetragonal

Graphite – trigonal

13. What is meant by homologous?

A. The individual compound in a homologous series is known as homologos.

14. Define combustion reaction?

A. The process of burning of carbon (or) carbon compounds in excess of Oxygen to give heat & light is termed as combustion reaction.

4 Mark Questions

1. Give the IUPAC name of the following compounds. If more than one compound is possible name all of them.

i. An aldehyde derived from ethane.

ii. A ketone derived from butane.

iii. A chloride derived from propane.

iv. An alcohol derived from pentane.

A. i. Ethanol is the aldehyde derived from ethane

$$C_2H_6 \longrightarrow CH_3CHO \left[CH_3 - \overset{\overset{o}{\|}}{C} - H \right]$$

ii. 2-Butanone is the ketone derived from butane

$$\underset{\text{batane}}{C-C-C-C} \longrightarrow \underset{\text{(2–Butanone)}}{C-C-\overset{\overset{o}{\|}}{C}-C}$$

iii. On reaction of propane with chlorine gas it forms, 1- chloropropane and 2 – chloropropane

$$CH_3CH_2CH_3 + Cl_2 \xrightarrow[125°c]{} \underset{\substack{(Major) \\ (1-\ \text{chloropropane})}}{CH_3CH_2CH_2 - Cl} + \underset{\substack{(Minor) \\ (2\ -\ \text{chloropropane})}}{CH_3\overset{\overset{Cl}{\|}}{CH}CH_2} + 2HCl$$

iv.

$$C_5H_{12} \longrightarrow CH_3CH_2CH_2CH_2CH_2-OH \quad (1-\text{ pentanol})$$

$$+$$

$$CH_3-CH_2-CH_2-\underset{\substack{|\\ OH}}{CH}-CH_3 \quad (2-\text{ pentanol})$$

$$+$$

$$CH_3-CH_2-\underset{\substack{|\\ OH}}{CH}-CH_2-CH_3 \quad (3-\text{ pentanol})$$

2. A mixture of oxygen and ethyne is burnt for welding; can you tell why a mixture of ethyne and air is not used? (AS1)

A.

1) The heat and temperature produced by an acetylene flame depend upon the amount of oxygen used to burn it.
2) Air-acetylene produces a flame temperature of around (4ooo^{o}F) 2200^{0}c. This is hot enough to solder aluminum work glass, repair radiators and braze plumbing fixtures. It is not hot enough to weld steel.
3) When acetylene is burned in pure oxygen, the flame temperature may be as high as 5730^{0}c (3166^{0}c). However, the flame temperature and the amount of heat generated (Measured as BTUs (or) kilogram calories) depend upon the ratio of oxygen to acetylene used.

3. a. What are the various possible structural formulae of a compound having molecular formula C_3H_6O?

b. Give the IUPAC names of the above possible compounds and represent them in structures.

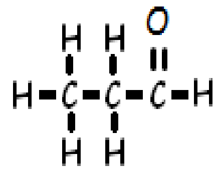
c. What is the similarity in these compounds?

A. a) For molecular formula (C_3H_6O):

i. Ethanol — $CH_3-CH_2-\overset{\substack{o\\ \|}}{C}-H \quad (CH_3CH_2CHO)$

ii. Propanone — $CH_3-\overset{\overset{o}{\parallel}}{C}-CH_3$

b) For ethanol ---



IUPAC NAME: Propanal

For: $CH_3-\overset{\overset{o}{\parallel}}{C}-CH_3$

IUPAC NAME: propanone

c) In both the compounds

i. Contains functional groups ($-\overset{\overset{o}{\parallel}}{C}-$) [Carbonyl functional group]

ii. Having same molecular formula

iii. Both are having 2sp^3 hybridised carbons and one sp^2 hybridised carbon atom.

4. Define homologous series of carbon compounds. Mention any 2 characteristics of homologous series.

A. Homologous Series: The series of carbon compounds in which successive series compounds differ by [CH_2] unit is called Homologous series.

$CH_4 \leftrightarrow C_2H_6 \leftrightarrow C_3H_8$

difference by CH_2 group   difference by CH_2 group

Characteristics of Homologous Series:

i. They have general formula.

General formulas of alkanes – C_nH_{2n+2}

alkanes – $C_n H_{2n}$

alynes – C_nH_{2n-2}

ii. Successive compounds in the series possess a difference of (CH_2) unit.

iii. They posses similar chemical properties due to same functional group.

iv. They show a regular gradation in their physical properties.

5. Explain the cleaning action of soap.

A.

i. Soaps and detergents make oil and dirt present on the cloth come out into water, thereby making the cloth clean.

ii. Soap has one polar end (the end with $-\overset{\overset{o}{\parallel}}{C}-OH$ carboxyl) and one non-polar end (the end with hydrocarbon chain) as shown here.

iii. The polar end is hydrophilic in nature and attracted towards water.

iv. The non-polar end is hydrophobic in nature and attracted towards grease or oil on the cloth, but not towards water.

v. When soap dissolves in water, its hydrophobic ends attach themselves to dirt and remove it from cloth, as shown sequentially in the figure.

vi. The hydrophobic end of the soap molecules move towards the dirt or grease particle.

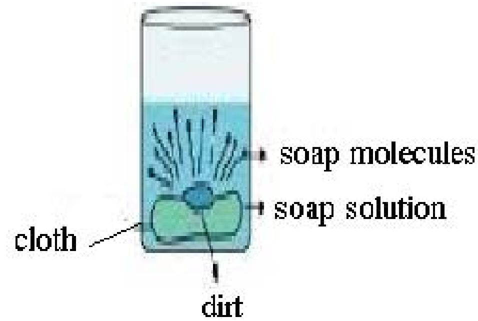
vii. The hydrophobic ends attach themselves to dirt particle and try to pull out.

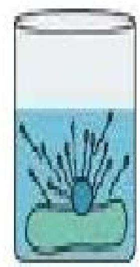
viii. The molecule of soap surrounds the dirt particles at the centre of the cluster and forms a spherical structure called micelle.

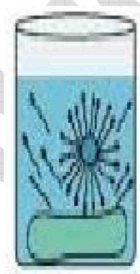
ix. These micelles remain suspended in water-like particles in a colloidal solution.

x. The various micelles present in water do not come together to form a precipitate as each micelle repels. The other because of the ion-ion repulsion.

xi. Thus, the dirt particles remain trapped in micelles and are easily rinsed away with water. Hence, soap micelles remove dirt by dissolving in water.







Dirt with micelle

Clean cloth

6. Distinguish between Esterification and Saponification reactions of organic compounds.

A. Esterification:

Esterification is the reaction in which a carboxylic acid combines with an alcohol in the presence of little cone. H_2SO_4 to from an ester. These ester so formed are pleasant smelling

Ex:

$$CH_3-\overset{\overset{O}{\|}}{C}-O-H+C-C-OH \xrightleftharpoons{conc\,H_2SO_4} CH_3-\overset{\overset{O}{\|}}{C}-O-CH_2-CH_3+H_2O$$

$$(Ethanoic\,acid) \qquad ethanol \qquad\qquad (Ethyl\,acetate)$$

- This is a reversible reaction
- This is an example of dehydration reaction
- This is used to prepare different types of esters.

Saponification:

Saponification is defined as the hydrolys is of oil under basic conditions leading to the formation of sodium sate of carboxylic acid and glycerol.

$$\begin{array}{l} CH_2-O-\overset{\overset{o}{\|}}{C}-C_{17}H_{35} \\ \quad | \\ CH_2-O-\overset{\overset{o}{\|}}{C}-C_{17}H_{35}+3NaOH \longrightarrow \\ \quad | \\ CH_2-O-\overset{\overset{o}{\|}}{C}-C_{17}H_{35} \\ (Tristerain) \end{array} \qquad \begin{array}{l} CH_2-OH \\ | \\ CH_2 \qquad -OH+3C_{17}H_{35}COONa \\ | \\ CH_2-OH \\ (Glycerol) \qquad (Sodium\,stearate) \end{array}$$

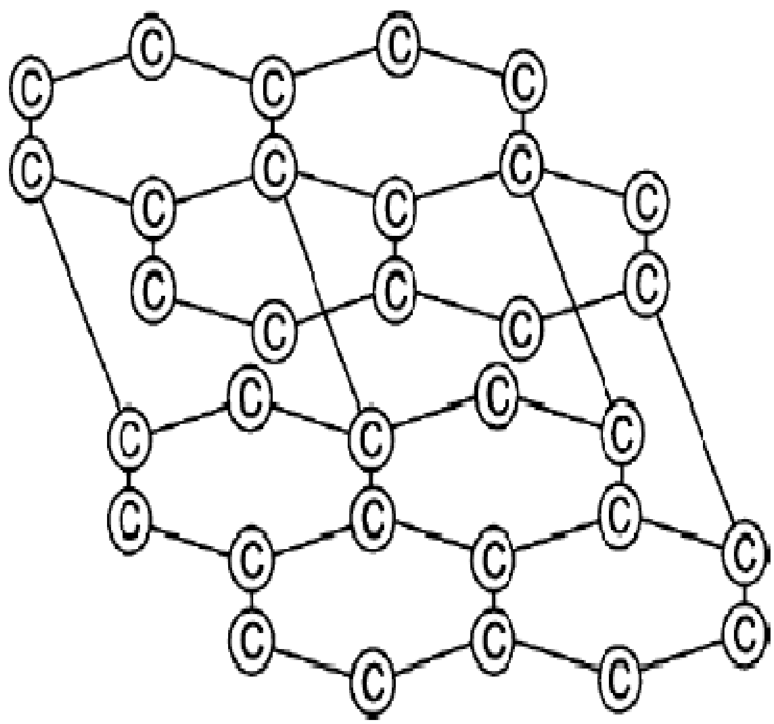
- This is irreversible reaction
- This reaction is an example for hydrolysis
- It is used to prepare soaps from long chain esters or glycerol

7. Explain the structure of graphite in term of bonding and give one property based on this structure.

A.

1. Graphite forms a 2 dimensional layer structure with c–c bonds within the layers. There are relatively weak in interaction between the layers

2. In a layer structure, the carbon atoms are in a trigonal planar environment. This is consistent with each carbon atom in sp^2 hybridisation
3. Integrations between sp^2 orbitals leads to the formation of c – c bonds
4. Each carbon atoms is with one unhybridised 'p' orbital.
5. The unhyrdised 'p' orbital interacts to form 'x' system that is delocalized over the whole layer.
6. The interactions (or) London dispersion forces between the layers which are separated by a distance of 3.35^0A are weakened by the presence of water molecules so that it is easy to leave graphite.
7. For this reason graphite is used as lubricant and as the 'lead' in pencils.



8. Suggest a test to find the hardness of water and explain the procedure.

A. Hardness of water can be tested with the help of good quality soap.

Procedure:

1. Take 50ml of water from different sources i.e., tap water, well water, lake water, pond water, rives water, etc, in different test tubes and label them as A, B, C, D etc.,
2. Add 1gm of good quality soap to each test tube.
3. Close the each test tube with rubber corks.
4. Shake test tube A for 15 seconds and keep it. Undisturbed for 30 seconds. Measure the height of the foam formed. Note the height of form in our notebook.
5. Repeat the process for each test tube and record your observation in your note book.
6. The water which gives less foam is considered as hard water.

9. Suggest a chemical test to distinguish between ethanol and ethanoic acid & explain the procedure.

A.

1. Take ethanol and ethanoic acid in 2 different test tubes
2. Add nearly 18ml of sodium bicarbonate ($NaHCO_3$) to each test tube.
3. Lots and lots of bubbles and foam can be observed from the test tube containing ethanoic acid. This is due to release of CO_2.

   $NaHCO_3 + CH_3COOH \rightarrow CH_3COONa + H_2O + CO_2$
4. Ethanol will not react with sodium bicarbonate and thus we won't observe any change in the test tube containing ethanol.

   Thus we can distinguish ethanol from ethanoic acid.

9. An organic compound 'x' with molecular formula C_2H_6O undergoes Oxidation with alkaline $KMnO_4$ and forms the compound y, which has molecular formula $C_2H_4O_2$.

a) Indentify X and Y.

b) Write your observation regarding the product when the compound 'X' is made to react with compound 'Y' which is used as a preservative for pickles.

A. a) X – ethanol [C_2H_6O]

Y – Ethanoic Acid [$C_2H_4O_2$]

Ethanol undergoes Oxidation to form the product Acetaldehyde and finally forms acetic acid.

$$\underset{(ethanol)}{C_2H_5OH} + \xrightarrow{alk,KMno_4} \underset{(ethanal)}{CH_3CHO} \xrightarrow{(0)} \underset{(acetic\ acid)}{CH_3CHOOH}$$

Here CH_3COOH is used as a preservative for pickles.

b) When (X) ethanol reacts with y (Acetic acid) produces an ester, a ethyl acetate which is used as a preservative for pickles

$$\underset{(ethanol)}{C_2H_5OH} + \underset{(acetic\ acid)}{CH_3COOH} \longrightarrow \underset{(ethyl\ Acetate)}{CH_3COOC_2H5} + H_2$$

10. Collect information about artificial ripening of fruits by ethylene. (AS4)

A. Chemistry of Ripening:

1) During ripening, the starch in the fruit breaks down to form sugar. The colour of fruit skin changes.
2) The ripening of fruit depends on the season. The plant can detect the changes in season, produces ethylene (C_2H_4) and spreads across the plant.
3) When ethylene reaches the fruits, it sends a signal to all the cells in the fruit to make enzymes which breaks starch into sugar.
4) The cell in the start making pigments, which give the fruit its colour.

Artificial Ripening:

1. Raw fruits are kept in hay- lined wooden boxes called crates. These crates are stacked on shelves and a wood fire is lit below them. The smoke contains ethylene and acetylene gases and they induce ripening.
2. Fruits are placed in a room in which ethylene gas (or) acetylene gas is introduced.
3. In another method calcium carbide (CaC_2) is applied over fruits. It reacts with moisture to form acetylene, which induces ripening.

11. How do you condemn the use of alcohol as a social practice?

A. Consumption of alcohol leads to the many problems in the society and it must be regulated in the society; otherwise we may face so many social problems. We may condemn the use of alcohols by -

1. Educate people on positive values that would help them to avoid alcohol. The alcohol consumption adversely affects the country's development. We need to regret over the manner in which have taken to alcohol.
2. There are inscriptions on the bottles of such drinks saying they are only meant for those above 18. However, many times this rule is not being observed.
3. Take the initiative of developing a bye-law that will debar the drinking bar keepers from selling alcoholic beverages.
4. The government must control the alcohol consumption, if not entirely bars it, by taking measures such as issuing less number of permits and leaving heavy taxes on liquor products.

12. An Organic compound with molecular formula $C_2H_4O_2$ produces brick effervescence on addition of sodium carbonate bicarbonate. Answer the following.

a. Identify the organic compound.

b. Write the chemical equation for the above reaction.

c. Name the gas evolved.

d. How will you test the gas evolved?

e. List 2 important uses of the above compound.

A. a) Acetic acid [CH_3COOH]

b) $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2 + Co_2$

$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

c) Carbon di Oxide (CO_2)

d) When the evolved gas is passed into lime water, lime water turns to milky white basing on the observation, we conduce that the evolved gas is carbon dioxide.

e) Ethanoic acid is used as

i. Preservation for pickles

ii. Solvent in industry

iii. Preparation of dyes, drugs

v. Curing meat, fish.

13. 1 ml of glacial acetic acid &1ml of ethanol are mixed together in a test tube. Few drops of Conc.H_2SO_4 is added in the mixture are warmed in a water bath for 5 min. Answer the following:

a. Name the resultant compound formed.

b. Represent the above change by a chemical equation.

c. What term is given to such a reactions.

d. What are the special characteristics of the compound formed?

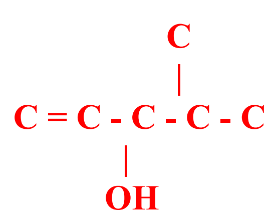
A. a) Ethyl acetate ($CH_3COOC_2H_5$) an ester

b) $CH_3COOH + C_2H_5OH \xrightarrow[-H_2O\Delta]{H_2SO_4} CH_3COOC_2H_5 + H_2$

c) Etherification reaction

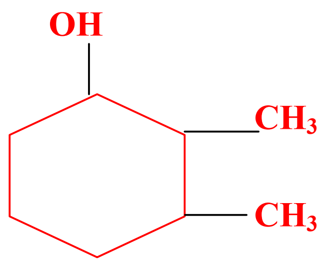
d) The formed compound when poured into water, we observed a sweet fruit odor.

14. Name the compound, based on IUPAC Nomenclature.

a) 

b) C – OH
|
C – OH
|
C – OH

c)



A. a)
$$\begin{array}{ccccc} & & & C & \\ & & & | & \\ C = & C - & C & - C - & C \\ 1 & 2 & |3 & 4 & 5 \\ & & OH & & \end{array}$$

3- hydroxyl, 4 – methyl pent-1-ene

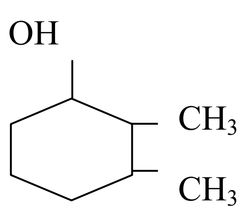
b)

C – OH
|
C – OH
|
C – OH

1,2,3 – trihydroxy propane

c)

2,3 dimethylcyclohexane -1-01



Multiple Choice Questions

1. Which of the four test tubes containing the following chemicals shows the brisk effervescence when dilute acetic acid was added to them? [ ]

i) KOH **ii) $NaHCO_3$**

iii) $K2CO_3$ **iv) NaCl**

a) i & ii b) ii & iii

c) i & iv d) ii & iii

2. Which of the following solution of acetic acid in water can be used as preservative? [ ]

a) 5-10% b) 10-15%

c) 15-20% d) 100%

3. The suffix used for naming an aldehyde is? [ ]

a) - ol b) – al c) – one d) – ene

4. Acetic acid, when dissolved in water, it dissociates into ions reversibly, because it is a: [ ]

a) Weak acid b) Strong acid

c) Weak base d) Strong base

5. Which one of the following hydrocarbon can show isomerism? [ ]

a) C_2H_4 b) C_2H_6 c) C_3H_8 d) C_4H_{10}

6. **Combustion of hydrocarbon is generally accompanied by the evolution of: [ ]**

a) Heat b) Light

c) Both heat and light d) Electric current.

7. 2 ml of ethanoic acid was taken in each of the three test tubes A, B and C and 2 ml, 4ml and 8ml water was added to them, respectively. A clear solution is obtained in: [ ]

a) Test tube A only b) Test tubes A & B only.

c) Test tubes B and C only d) All the test tubes.

8. If 2 ml of acetic acid was added slowly in drops to 5ml of water, then we will notice [ ]

a) The acid forms a separate layer on the top of water.

b) Water forms a separate layer on the top of the acid.

c) Formation of a clear and homogenous solution.

d) Formation of a pink and clear solution.

9. A few drops of ethanoic acid were added to solid sodium carbonate. The possible results of the reactions are: [ ]

a) A hissing sound evolved b) Brown fumes evolved.

c) Brisk effervescence occurred d) A pungent smelling gas evolved

10. When acetic acid reacts with ethyl alcohol, we add conc. H_2SO_4, it acts as _____ and the process is called ____ [ ]

a) Oxidizing agent, Saponification b) Dehydrating agent, Esterification

c) Reducing agent, Esterification d) Acid & Esterification

11. Hybridisation deals with? [ ]

a) Electrons b) Orbitals c) Both d) None of them

Key: 1.b; 2. a; 3. b; 4. a; 5. d; 6. c; 7. d; 8. c; 9. c; 10. b. 11. B.

Fill in the Blanks

1. Carbon compounds containing double and triple bonds are called ________.
2. A compound which is basic constituent of many cough syrups is __________.
3. Very dilute solution of ethanoic acid is ____________.
4. A sweet odour substance formed by the reaction of an alcohol and a carboxylic acid is _________.
5. When sodium metal is dropped in ethanol, _________ gas will be released.
6. The functional group present in methanol is _____________.
7. IUPAC name of alkene containing 3 carbon atoms is _______________.
8. The first member of homologous series among alkynes is ___________.
9. The product that is formed by dehydration of ethanol in conc. sulphuric acid is ______.
10. Number of single covalent bonds in ammonia are __________.
11. Type of reactions shown by alkenes is ______________.
12. Bond angle is CH_4 is _______
13. 10% ethanol in gasoline is known as _______.
14. In periodic table (Modern periodic table), to which group, does the carbon belongs to _________.
15. As per heat energy is considered, combustion reaction is ________ in nature.

Key:

1) **Unsaturated hydrocarbons;** 2) **Ethanol;** 3) **vinegar;**
4) **Ester;** 5) **Hydrogen;** 6) **Alcohol;**
7) **1- propene;** 8) **Acetylene /Ethyne;** 9) **Ethene;**
10) **Three (3);** 11) **Substitution reactions;** 12) **$109^0 28'$;**
13) **Gasohol;** 14) **IVA;** 15) **Exothermic;**

Match the Following

1.	Alcohols	[ ]	a) CHO
2.	Aldehydes	[ ]	b) COOR
3.	Kctone	[ ]	c) OH
4.	Carboxylic acids	[ ]	d) CO
5.	Esters	[ ]	e) COOH

Key: 1.c; 2. a; 3. d; 4. e; 5. B.

II.

1.	CH_4	[ ]	a) Ethanoic acid
2.	C_2H_5OH	[ ]	b) Ethyne
3.	CH_3COOH	[ ]	c) Ethane
4.	C_2H_4	[ ]	d) Methane
5.	C_2H_2	[ ]	e) Ethanol

Key: 1.d; 2. e; 3. a; 4. c; 5. B.

III

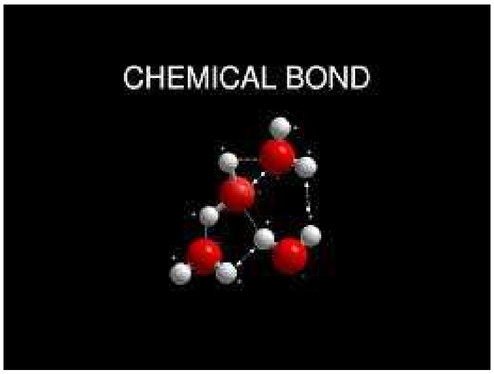
1.	Welding Industry	[ ]	a) Graphite
2.	Syrups	[ ]	b) acetylene
3.	Preservative of pickle	[ ]	c) Graphene
4.	Lead pencil	[ ]	d) Acetic acid
5.	Electric conductor	[ ]	e) Ethanol

Key: 1.b; 2. e; 3. d; 4. a; 5. C.

Chapter -10

Chemical Bonding

Synopsis



Atoms of elements which have the atoms are electrical neutral. All atoms have a tendency to attain the 8 electrons in their valency orbit as in noble gases.

For this, they form bonds with another atom.

There are two kinds of bonds -

i) Ionic bond

ii) Covalent bond

Ionic bond is formed between atoms of two dissimilar elements due to transfer of electrons from the atom of one element to the other. The covalent bond is formed by the sharing of electrons between atoms.

Electronic theory of valency, valence – shell – electron – pair repulsion- theory (VSEPRT) are two theories which explains the formation on these bounds.

These theories are also explain the bond angles and bond nature of between atoms.

2 Mark Questions

1. List the factors that determine the type of bond that will be formed between 2 atoms?

A. There are several factors that determine the type of bond will be formed between the two atoms. They are-

a) The force of attraction or repulsion between the electrons and protons

b) Number of valence electrons present in the valence shell of the atom

c) Electro negativity (Electronegative) difference between the atoms ($\Delta EN \approx$ electronegative difference)

i) If $\Delta EN > 1.9$, ionic bond is formed.

ii) If $\Delta EN \alpha 1.9$, covalent bond is formed.

d) Atomic size

e) Ionization potential

f) Electron affinity.

2. Explain the difference between the valence electrons and the covalencey of an element.

A.

Valence Electrons	Covalence of an Element
1. Number of electrons present in the valence shell is known as valence electrons.	1. The capacity of atoms to neither gain, nor loose or share electrons is known as covalence.
2. Number of valence electrons is equal to the group number of the atom.	2. Covalence is equal to the number of electrons participate in the bonding

3. Valence electrons number is always a positive integer	3. Covalence may be positive or negative

3. Predict the reasons for low melting point for covalent compounds when compared with ionic compound.

A. In general, melting points depend on the force of attraction among the molecules & the atoms.

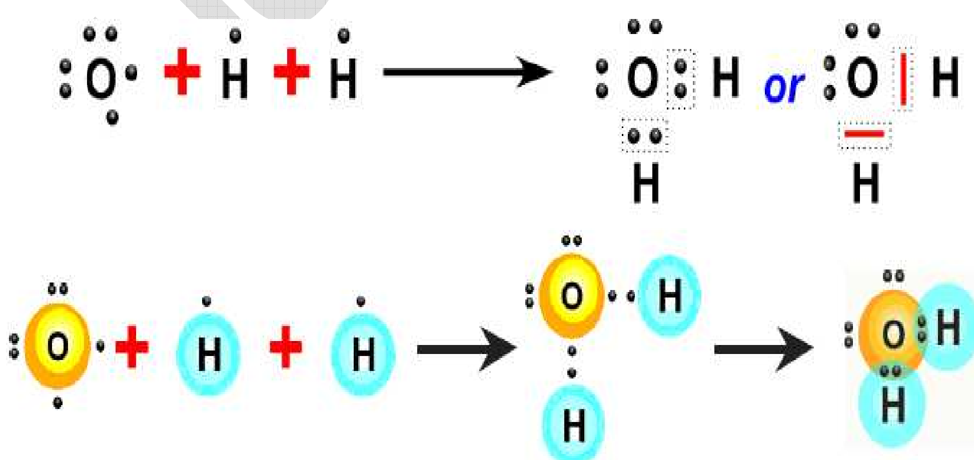
1) In case of covalent compounds, there exists a weak van der Walls force between the molecules. So, these covalent compounds posses low melting points.

2) While in case of ionic compounds, there exists on strong electrostatic attractions, between the Molecules. So, these requires high amount of energy to break the bond between the molecules, so, these posses high melting points.

But, in case of some covalent compounds like Diamond and graphite, Melting points & Boiling points are quite high, due to its giant structure.

4. Represent the molecule H_2O using Lewis notation.

A. One atom of Oxygen to from a water molecule i.e.-



2 hydrogen atoms One Oxygen atom water molecule (H_2O)

5. Represent each of the following atoms using Lewis notation:

a) Beryllium

b) Calcium

c) Lithium

A. a) Beryllium: $({}_4Be^9) \rightarrow 1s^2\ 2s^2$

Its inner shell electrons are 2 & outer shell electrons are 2 we can represent its Lewis notation as $\left[\dot{B}\dot{e}\right]$

b) Calcium: $({}_{20}Ca^{40}) \rightarrow 1s^2\ 2s^2\ 2p^6 3s^2 3p^6 4s^2$

(2, 8, 8, 2)

It has 2e$^-$ in I shell, Be$^-$ in 2nd shell, 8e$^-$ in 3rd shell & it has 2e$^-$ in 4th shell i.e., in valence shell.

So, its Lewis structure is $\left[\dot{C}\dot{a}\right]$

c) Lithium $({}_3Li^6) \rightarrow 1s^2\ 2s^2$

It has 2e$^-$s in I shell & 1e$^-$ in II shell ie in valence shell

So, its Lewis structure is $\left[\dot{L}\dot{i}\right]$

6. Represent each of the following molecules using Lewis notation:

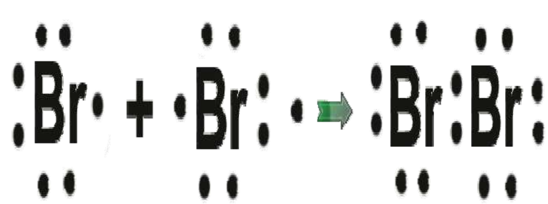
(a) Bromine gas (Br_2)

(b) Calcium chloride ($CaCl_2$)

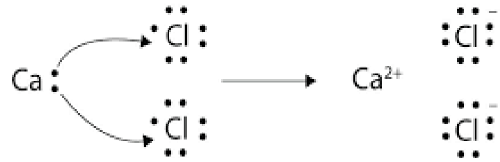
(c) Carbon dioxide (CO_2)

(d) Which of the three molecules listed above contains a double bond?

A. a) Bromine gas (Br_2):



b) Calcium chloride ($CaCl_2$):



c) Carbon dioxide (CO_2)

d) In the above, Carbon dioxide (CO_2) contains double bond

$CO_2 \approx (O = C = O)$

7. How Lewis dot structure helps in understanding bond formation between atoms?

A. The valence electrons with the atom of an element are represented in a short form by Lewis symbol is electron dot structure. We represent the nucleus and inner shell electrons of the atom by the symbol of the element and electrons in the outer shell by dots or cross mark.

Basing, on the Lewis structure we can understand the valence of an element. Basing on the valence we can predict that it may form ionic bond or covalent bond.

1 Mark Question

1. What is Octet rule?

A. "Generally atoms of elements undergo chemical reaction, that to form stable electronic configuration either by loss or gain of electrons to forms atoms with eight outer shell electrons.

This phenomenon is defined as the octet law.

2. What is hybridization?

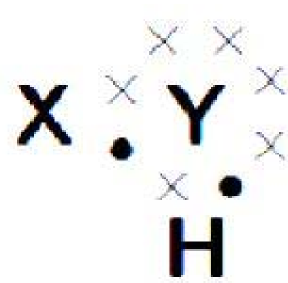
A. It is a phenomenon of inter mixing of orbitals of almost equal energies which are present in the outer shells of the atom and their resulting (or) redistributing (or) reshuffling into the same number of orbitals but with equal properties like energy and shape.

3. Define Co-ordination Number?

A. Number of ions of opposite charge that surrounds a given ion in a crystal is known as co-ordination number.

4 Mark Questions

1. A chemical compound has the following Lewis notation:



a) How many valence electrons does element Y have?

b) What is the valency of element Y?

c) What is the valency of element X?

d) How many covalent bonds are there in the molecule?

e) Suggest a name for the elements X and Y.

A. a) Six (6)

b) Two (2)

c) One (1)

d) Two (2)

e) Element X – hydrogen ($_1H^1$)

Element Y – Oxygen ($_8O^{16}$)

The formed molecule may be H_2O.

2. Why do only valence electrons involve in bond formation? Why not electron of inner shells? Explain.

A. 1. The electrons present in the outermost orbital of an atom are known as valence electrons.

2. They are very active.

3. They are weakly attracted to the nucleus. So that involves a chemical bond formation

4. Electrons present in the inner shells cannot participate in bond formation because.

i) The electrons present in the inner shells are stable.

ii) Inner electrons are strongly attracted by the nucleus.

3. Explain the formation of sodium chloride and calcium oxide on the basis of the concept of electron transfer from one atom to another atom.

A. Formation of sodium chloride (NaCl):

1. Sodium chloride is formed from the elements sodium (Na) and chlorine (C*l*).

2. When sodium (Na) atom loses one electron to get octet electron configuration, it forms action (Na^+)

3. Now Na^+ gets electron configuration that of Neon (Ne) atom.

$$N^a \rightarrow Na^+ \; e^-$$

4. Chlorine, has storage of one electron to get octet in its valence shell.

5. So, it gains the electron that was lost by Na to form anion and gets electron configuration of Argon(Ar)

$$Cl + e^- \rightarrow Cl^-$$

6. Transfer of electrons between Na and C*l* atoms, results in the formation of Na^+ and Cl^- ions.

7. These oppositely charged ions get attracted towards each other due to electrostatic forces and forms the compound sodium chloride (Nac*l*)

$Na^+ + Cl^- \rightarrow NaCl$

Formation of Calcium Oxide (CaO):

1. Calcium (Ca) reacts with Oxygen (O) to from an ionic compound calcium Oxide(CaO).
2. Calcium atomic number is 20. Its electronic configuration is 3. 8, 8, 2.
3. $Ca \rightarrow Ca^{+2} + 2e^-$

   i.e., calcium losses $2e^-$ and becomes Ca^{+2}.
4. Oxygen atomic number is 8. Its electronic configuration is 2, 6.
5. $O \xrightarrow[2e^-]{} O^{-2}$ i.e., Oxygen $2e^-$ and becomes O^{-2}.
6. These oppositely charged ions gets attracted towards each other due to electrostatic forces and form the compound calcium Oxide (CaO)

   $Ca^{+2} + O^{-2} \rightarrow CaO$

4. A, B, and C are three elements with atomic number 6, 11 and 17 respectively.

i. Which of these cannot form ionic bond? Why?

ii. Which of these cannot form covalent bond? Why?

iii. Which of these can form ionic as well as covalent bonds?

A. Here given elements are

A – Carbon ($_6C^{12}$)

B – Sodium ($_1Na^{23}$)

C – Chlorine ($_{17}Cl^{34}$)

i) A – Carbon ($_6C^{12}$) forms covalent bonds and cannot form ionic bond. Its valence electrons are 4. It is difficult to lose or gain $4e^-$ to get octet configuration. So, it forms bond by sharing of electron, i.e., it forms covalent bond.

ii) B – Sodium ($_1Na^{23}$) forms ionic bond and cannot form covalent bonds. It valence electrons are only 1. So, it is so easy to donate that one electron for other atom, rather than sharing it and then it becomes an ion. So, it can form ionic bond.

iii) Element C – Chlorine ($_{17}Cl^{34}$) forms both ionic & covalent bonds. As its atomic number is 17. It is able to in H*cl* molecule to form covalent bond.

5. How bond energies and bond lengths of molecule help us in predicting their chemical properties? Explain with examples.

A. Bond length: It is defined as the distance between the 2 nuclei of the atoms which involved in bonding.

Bond Energy: It is defined as the energy required to break the bond between 2 atoms of a diatomic covalent compound in its gaseous state.

Generally, bond energies and bond lengths of molecule help us in predicting their chemical properties. If a molecule is having low bond energy and high bond length values, it is a very active one. They are having polar nature. They actively participate in chemical reactions.

For example:

In Iodine molecule, as the bond length between the atoms is high due to its large sized atoms. So, amount of energy required for bond breakage is low. So, it is highly reactive in reactions.

$$i.e\left(Bond\ energy\ \alpha \frac{1}{Bond\ length} \right)$$

So, higher the bond energy, more stable and less reactive in case of chemical reactions.

Similarly, Melting and Boiling points of a substance can also be determined by this bond energies and bond lengths.

6. Collect the information about properties and uses of covalent compounds and prepare a report.

A. Properties of covalent compounds:

1) These are usually liquids or gases in nature, but some of them are solids.

2) These are having low melting and boiling points.

3) These are freely soluble in non polar solvents like benzene, carbon tetrachloride, but soluble in polar solvents like water.

4) These are bad conductors of electricity.

5) Covalent bond is a directional bond. So, covalent compounds exhibit the phenomenon of isomerism.

Uses of covalent compounds:

1) 99% of our body, was made up of covalent compounds
2) Water is a covalent compound. We know its many uses.
3) Sugars, tea, coffee as many food materials are all a form of covalent compounds.
4) Covalent bonding can change ability of ice to melt itself, because when the CO_2 interact with the hydrogen atoms, the atoms of water splits into lower. Molecules with molecular compounds.
5) Almost everything on earth other than most simple inorganic salts are covalent.

7. **Draw simple diagrams to show how electrons are arranged in the following covalent molecules:**

a) Calcium oxide (CaO)

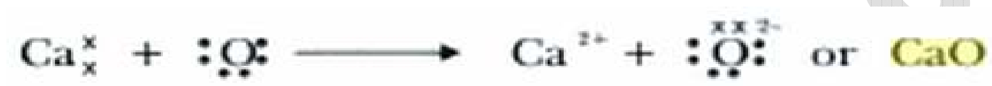
b) Water (H_2O)

c) Chlorine (Cl_2)

A. **a) Calcium oxide (CaO):**

$$CaO \rightleftharpoons Ca^{+2} : O^{-2}$$

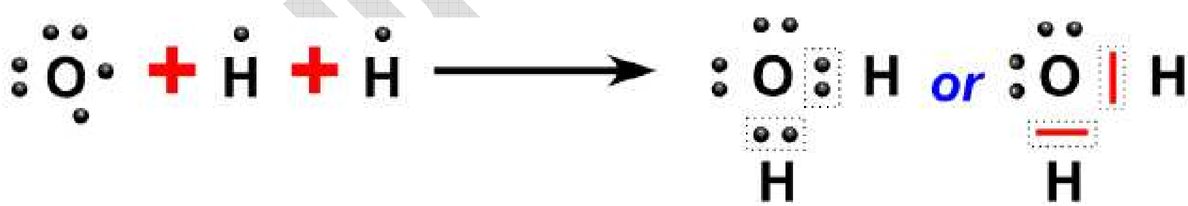
$$Ca^{+2} + O^{-2} \longrightarrow CaO$$

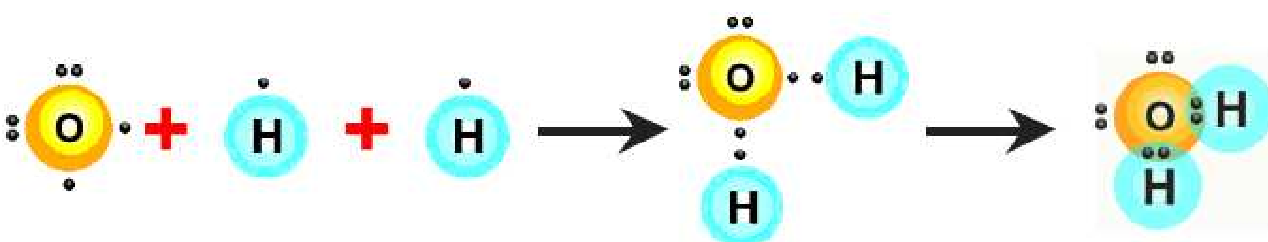


Calcium atom 2, 8, 8, 2 **Oxygen atom 2, 6** **Calcium ion 2, 8, 8** **Oxygen ion 2, 8**

b) Water (H_2O):

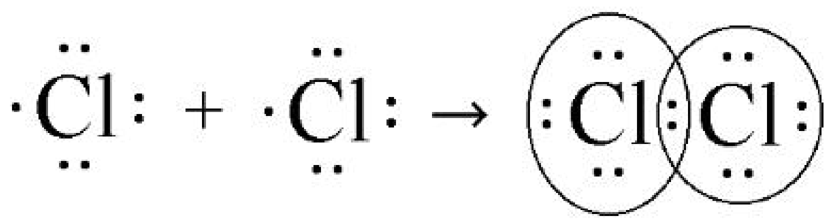
The formation of water molecule of 2-hydrogen atoms, one oxygen atom can be shown like this also:





c) Chlorine (Cl_2):

Shared pair of electrons



Cl atom 2, 8, 7 Cl atom 2, 8, 7 Chlorine molecule (2, 8, 8) ; (2, 8,8)

8. Two chemical reactions are described below.

i) Nitrogen and hydrogen react to form ammonia (NH_3)

ii) Carbon and hydrogen bond to form a molecule of methane (CH_4).

For each reaction, give:

a) The valency of each of the atoms involved in the reaction.

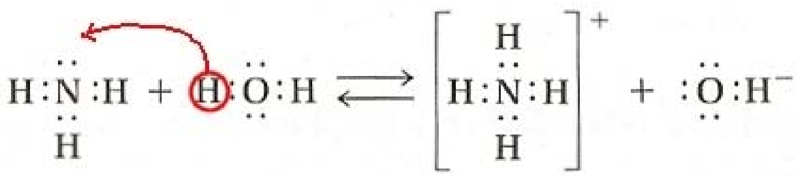
b) The Lewis structure of the product that is formed.

A. i) Nitrogen and hydrogen reacts to form Ammonia (NH_3).

$N_2 + 3H_2 \rightarrow 2NH_3$

a) Valency of Nitrogen is 3 & hydrogen is 1.

b) The chemical formula of the product is NH_3

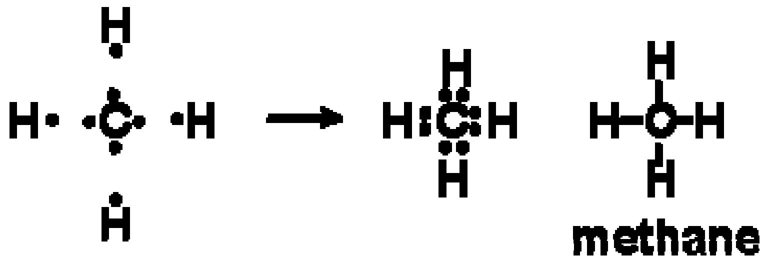


ii) Carbon and hydrogen reacts to form methane (CH_4).

$C + cH_2 \rightarrow CH_4$

a) Valency of carbon is 4 & hydrogen is 1.

b) Chemical formula of formed product is CH_4.



9. What is octet rule? How do you appreciate role of the octet rule in explaining the chemical properties of elements?

A. Octet rule:

It states that the atoms of elements tend to undergo chemical changes that help to leave their atoms with eight outer shell electrons.

It was found that the elements which participate in chemical reaction get Octet (or) ns^2 np^6 configuration similar to that of nobel gas elements.

Chemically active elements do not have an octet of electrons in the valence shell of their atoms. Their reactivity arises from their tendency to achieve the octet, by forming bonds either with atoms of their own type or with atoms of other elements.

10. Explain the formation of the following molecules using valence bond theory.

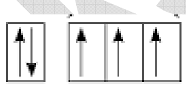
a) N_2 molecule

b) O_2 molecule.

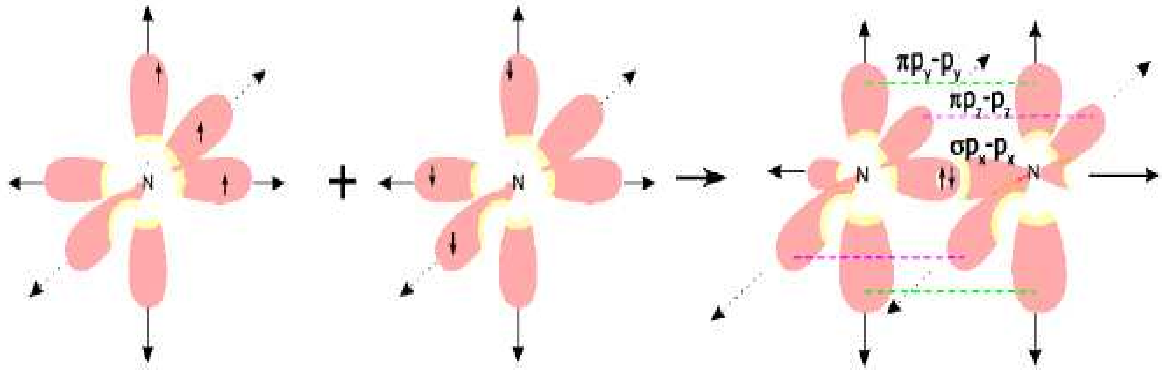
A. a) formation of N_2 molecule:

Nitrogen ($_7N^{14}$) has electronic configuration $1s^2$ $2s^2sp^3$ i.e., in its valence shell

$2s^2$ $2p^3$ $(2p^1_x\ 2p^1_y\ 2p^1_z)$



If the Px one of the Orbital of 'N' atom overlaps with px orbital of another 'N' atom giving $(\sigma p_x - p_x)$ bound, along the internuclear axis. Similarly p_y and p_z orbitals of one N atom, overlap with p_y and p_z orbital of other N atom N atom laterally. Respectively perpendicular to internuclear axis given $(\pi\ p_y - p_y)$ $(\pi p_z - p_z)$ bonds. So, N_2 molecule has a triple bond between 2 Nitrogen atoms.



b) Formation of O_2 molecule:

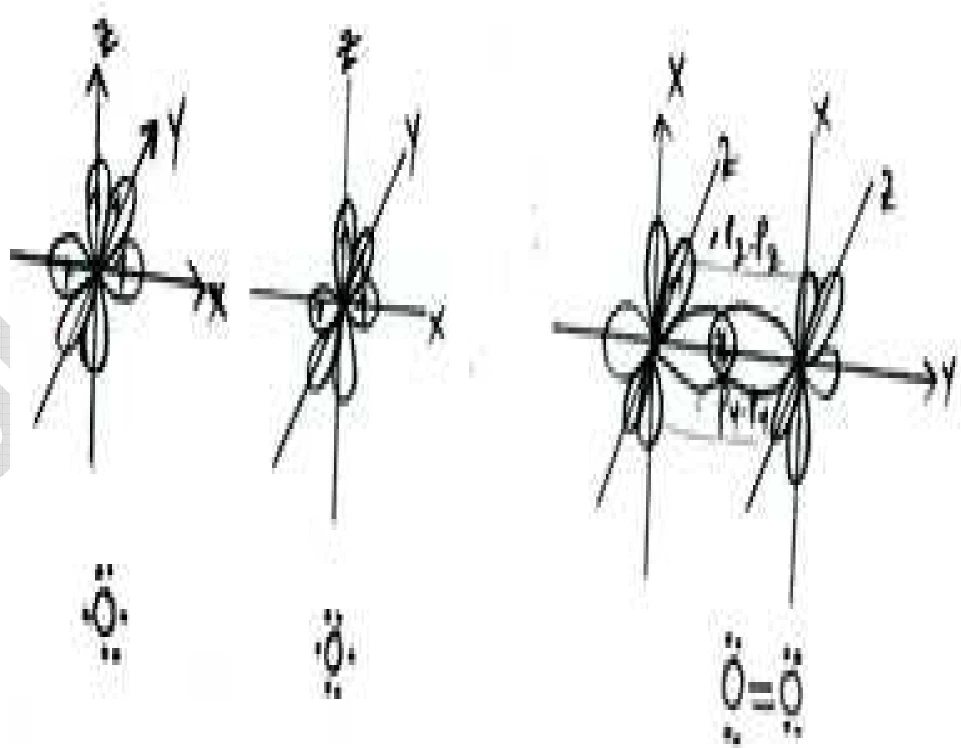
Oxygen ($_8O^{16}$) – has electronic configuration $1s^2 2s^2 2p^4$ i.e., in its valence shell $2s^2\ 2p^4\ (p^2_x p^1_y p^1_z)$

$\boxed{\uparrow\downarrow}\ \boxed{\uparrow\downarrow}\boxed{\uparrow\ }\boxed{\uparrow\ }$

If the py orbital of one Oxygen atom overlaps with p_y orbital of another Oxygen atom along the intern clear axis, a sigma $p_y - p_y$ bond (σp_y - p_y) is formed.

Similarly p_z orbital of 'O' atom overlaps with p_z orbital opf other 'O' atom laterally, perpendicular to the internuclear axis giving a $\pi p_z - p_z$ bond.

O_2 molecule has a double bond between 2 Oxygen atom.



11. What is hybridization? Explain the formation of the following molecules using hybridization.

a) Be Cl_2 b) BF_3

A. Hybridization:

The phenomenon of intermixing of orbitals of the same atom which have near same atom and near same energy to form equal number of new orbitals of equivalent energy is known as hybridization

a) Formation of $BeCl_2$:

$BeCl_2$- Beryllium chloride

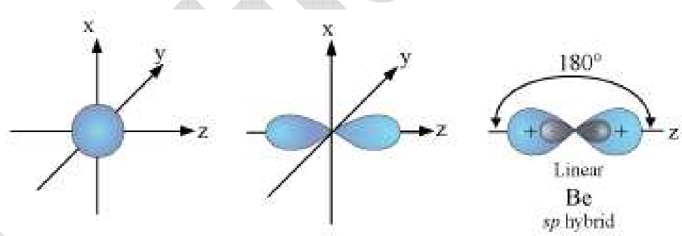
The atomic number of Beryllium = 4

The electronic configuration of Beryllium atom in its ground state is $1s^2 2s^2$

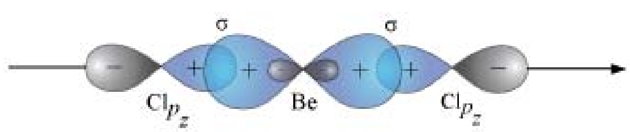
↑↓ ↑↓

The electronic configuration of beryllium atom in its excited state us $1s^2\ 2s^1\ 2p^1$

In the excited state beryllium atom '2s' and '2p' orbital's intermix to give 2 equivalents of be is $1s^2 2s^1 2p^1$.



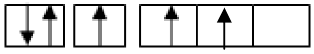
It has one half filled p-orbital. The half filled 3px orbitals of 2 chlorine atoms overlap with 'sp' hybrid orbitals of beryllium atom in their axes to form σsp –p bonds.



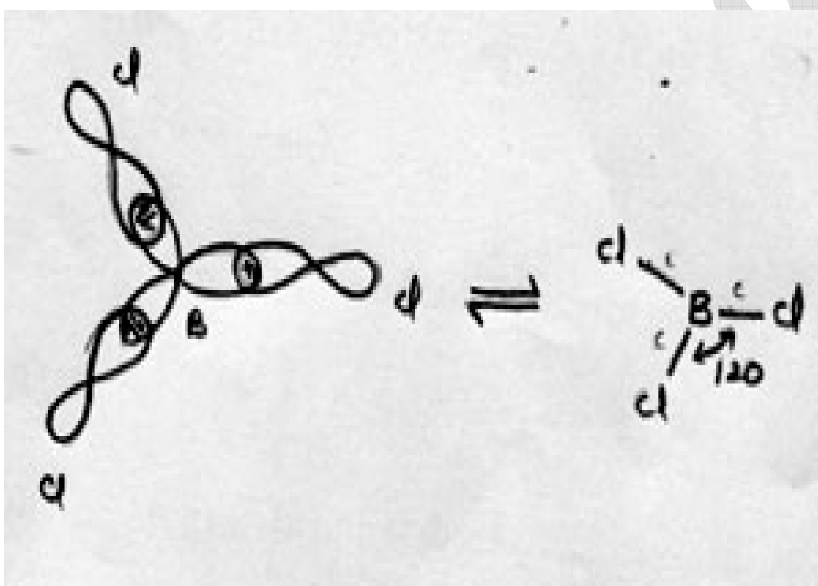
$BeCl_2$ Molecule so found has liner shape. The bond angle in $BeCl_2$ is 180^0.

b) Formation of Boron Trichloride (BCl_3):

The central atom in BCl_3 is boron. The electronic configuration of boron atom in its excited state is $1s^2\ 2s^1 2p^2$.

B (7 = 5) is 

In the excited boron atom '2s' orbital and 2 '2p' orbital intermix to give three equivalent sp2 hybrid orbitals. In the formation of BCl_3 Molecule, 3 $8p^2$ hybrid orbitals of boron overlap with half filled $3p_z$ orbital's of boron overlap with half filled 3px orbital of 3 chlorine atoms in their axes to give three σsp^2 –p bonds. BCl_3 molecule so formed has trigonal planar structure. The bond angle in BCl_3 is 120^0.



Fill in the Blanks

1. Electrons in _______ shell are called valence electrons.
2. Except _______ gas all other noble gases have octet in their valence shell.
3. Covalency of elements explains about member of _________ formed by the atom.
4. Valence bond theory was proposed by _______.
5. In ___________bonding, the valence electrons are shared among all the atoms of the metallic elements.
6. Expand USEPRT ________.
7. Water molecule having _______ shape.

Key:

1) Valency / Outermost; 2) Helium (He); 3) Bonds;

4) Linus Pauling; 5) Covalent;

6) Valence shell Electron pair repulsion theory;

7) Angular/v;

Multiple Choice Questions

1) Which of the following elements is electronegative? [ ]

a) Sodium (Na) b) Oxygen (O)

c) Magnesium(Mg) d) Calcium (Ca)

2) An element $_{11}X^{23}$ forms an ionic compound with another element 'Y'. Then the charge on the ion formed by X is [ ]

a) +1 b) +2 c) -1 d) -2

3) An element 'A' forms a chloride ACl4. The number electrons in the valence shell of 'A' is? [ ]

a) 1 b) 2 c) 3 d) 4

4. General electronic configuration (valence shell) of inert gas is- [ ]

a) $ns^2 np^4$ b) $ns^2 np^3$ c) $ns^2 np^5$ d) $ns^2 np^6$

5. Ionic bond is formed between atoms of elements with EN (electronegativity differences) is _________. [ ]

a) > 1.7 b) < 1.7 c) > 1.9 d) < 1.9

Key:

1) b; 2) a; 3) d; 4) c; 5) c.

Match the following

I. Group-I **Group-II**

	Compound		Shape
1.	$BeCl_2$	[ ]	A) Angular or Bent
2.	BCl_3	[ ]	B) Pyramidal
3.	CH_4	[ ]	C) Linear
4.	NH_3	[ ]	D) Tetrahedral
5.	H2O	[ ]	E) Trigonal planar

Key:

1. C; 2. E; 3. D; 4. B; 5. A.

II. Group-I **Group-II**

1.	Ionic Bonding	[ ]	A) Attraction of electronic clouds
2.	Covalent Bond	[ ]	B) Negative ion
3.	Cation	[ ]	C) Formed by electrostatic forces
4.	Anion	[ ]	D) Formed by sharing of electors
5.	Metallic bond	[ ]	E) Positive ion

Key:

1. C; 2. D; 3. E; 4. B; 5. A.

III. Group-I **Group-II**

	Compound		**Bond angle**
1.	$BeCl_2$	[ ]	A) $104^0 28^1$
2.	BCl_3	[ ]	B) $109^0 28^1$
3.	CH_4	[ ]	C) 107^0
4.	NH_4	[ ]	D) 120^0
5.	H_2O	[ ]	E) 180^0

Key:

1. E; 2. D; 3. B; 4. C; 5. A.

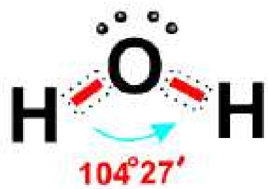
5 Mark Questions

1. Formation Of different elements

1. H_2O 2) $BeCl_2$ 3) BF_3 4) CH_4 5) NH_3

A.

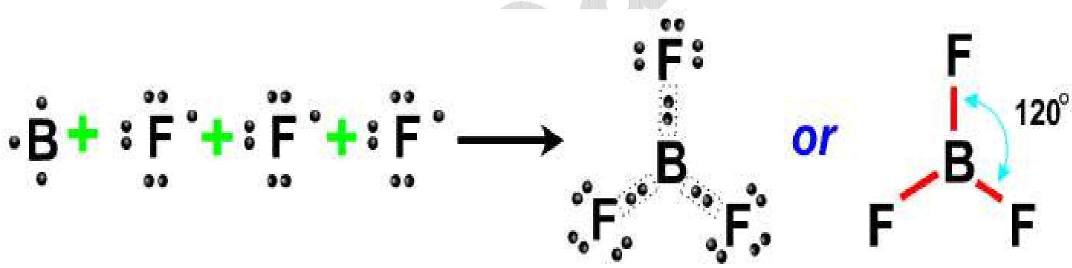
1. H_2O

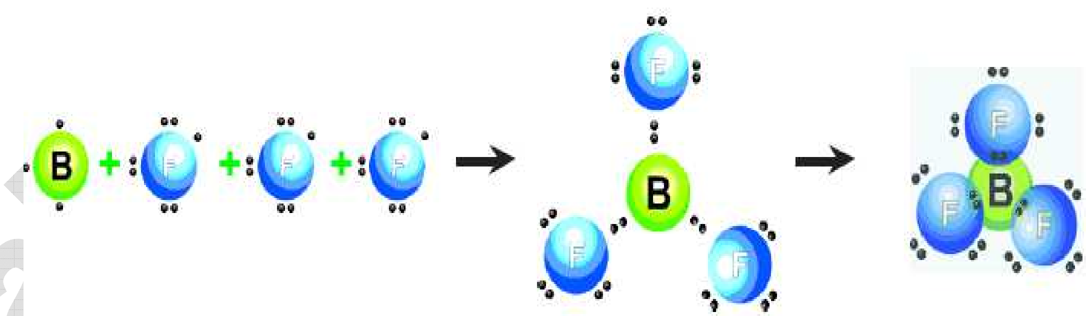


2) $BeCl_2$

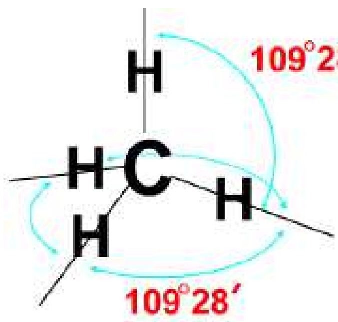
Cl — Be — Cl

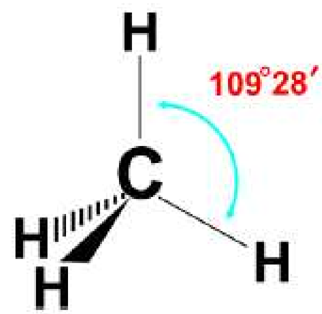
3) BF_3



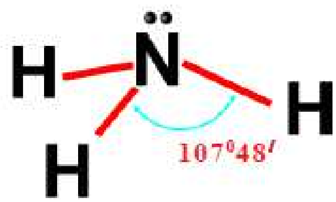


4) CH_4





5) NH_3



Chapter -2
Chemical Reactions and Equations

SYNOPSIS

In nature, we come across temporary, permanent, natural and manmade changes. A permanent change in which new substance or substances formed with completely unlike those of the original substances is called a chemical change. Chemical changes are represented by formulae or equation is known as chemical equations. All the chemical equations must balance, because atoms are neither created nor destroyed in chemical reactions.

Chemical reactions are generally of four types; they are

1. Chemical Decomposition
2. Chemical Combination
3. Displacement Reactions
4. Double Displacement Reactions.

Oxidation is a reaction that involves the addition of oxygen or removal of hydrogen. Reduction is a reaction that involves the addition of hydrogen or removal of oxygen. If oxidation and reduction occur in the same reaction, such reactions are called oxidation - reduction reactions or redox reactions.

When some metals are exposed to moisture, acids etc, they tarnish due to the formation of respective metal oxides on their surface. This process is called corrosion damage to car bodies, bridges, iron railings, ships etc., and to all other objects that are made of metals. Especially corrosion of iron is a serious problem.

Corrosion can be prevented by shielding the metal surface from oxygen and moisture. It can be prevented by painting, oiling, greasing, galvanizing chrome plating or making alloys.

When food materials that were left for a long period, the fat/oil containing in food materials oxidized and become rancid. The spoilage of food can be prevented by adding preservatives like vitamin C and vitamin E.

Keeping food in air tight containers helps to slow down oxidation process. Manufactures of potato chips flush bags of chips with nitrogen gas to prevent the chips from getting oxidized.

Problems

1) Calculate the amount of aluminum required to get 1120Kg of iron by the reaction.

$$Al_{(s)} + Fe_2O_{3_{(S)}} \longrightarrow Al_2O_{3_{(S)}} + Fe_{(S)}$$

Atomic masses of Al = 27 U, Fe = 56 U and O= 16U

Sol: Given Equation is

$$Al_{(s)} + Fe_2O_{3_{(S)}} \longrightarrow Al_2O_{3_{(S)}} + Fe_{(S)}$$

Balancing the equations

$$2Al_{(s)} + Fe_2O_{3_{(S)}} \longrightarrow Al_2O_{3_{(S)}} + 2Fe_{(S)}$$

$$2\,mol\ Al + 1mol\ Fe_2O_3 \longrightarrow 1mol\ Al_2O_3 + 2mol\ Fe$$

(2×27) U + (56×2+16×3)U → (27×2+16×3)U+2×56U

54U + 160U → 102U+112U

54 g + 160g → 102g+112g

As per the balancing equation 54g

For 112g of iron we required 54g Aluminum for 1120 kg of iron required aluminum is-

$$\frac{\overset{10}{\cancel{1120}} \times 1000}{\cancel{112}} \times 54$$

= 540,000g

Or 540kg

To get 1120kg or iron the required aluminum is 540 kg.

2.) Calculate the volume, liberate when 230g of sodium reacts with excess water at STP-

Sol: Skeleton equation is -

$Na_{(s)} + H_2O \rightarrow 2NaOH + H_2$

(2×23)U + 2(2×1+1×16) U → 2(23+16+1) U+ (2×1)

46U + 36U+ → 80U+2U

46G+36g → 80g+2g

Mass

As per the balanced equation

46g. of sodium gives 2g of hydrogen

230g of sodium gives _____g of hydrogen

$$\frac{230}{46}\times 2$$

$$=10g$$

230g of sodium gives 10g of hydrogen

Volume:

At STP

2g of hydrogen occupies 24.4 lt

10g of hydrogen occupies____ lt

$$\frac{10}{2} \times 24.4 = 112\text{lt}$$

∴ 10g of hydrogen occupies 112 lt volumes

Number of molecules

2g o hydrogen i.e. 1 mole of H_2 contains 6.02×10^{23} molecules

10g of hydrogen i.e. 5mole of H_2 contains.

$5\times6.02\times10^{23}$ molecules

$=30.10\times10^{23}$

$= 3.01\times10^{24}$ molecules

$\therefore$ 10g of hydrogen contains 3.01×10^{24} molecules

4 Mark Questions

1. What is a balanced chemical equation? Why should chemical equations be balanced?

(AS1)

Sol: Balanced chemical equation: A chemical equation in which the numbers of atoms of different elements on the reactants side (left side) are same as those on product side (right side) is called a balanced reaction.

A chemical equation should be balanced because-

1) According to the law of conservation of mass, the total mass of the products formed in chemical reaction must be equal to the mass of reactants consumed.

2) The number of atoms of each element before and after reaction must be the same.

3) Atoms are neither created nor destroyed in chemical reactions.

2. **Write an equation for decomposition reaction where energy is supplied in the form of heat/light/electricity?**

Sol: Heat: on heating calcium carbonate ($Caco_3$) decomposes to calcium oxide

(Cao) and carbon dioxide (Co_2)

$Ca\ Co_{3(s)} \rightarrow Cao_{(s)} + Co_{2\ (g)}$

Lime stone quick lime

Light (photo chemical reaction): silver bromide decomposes to silver and bromine in sun light. Such reactions are called photo chemical reactions.

$2Ag\ Br_{(s)} \xrightarrow{\text{sun light}} 2Ag_{(s)} + Br_{2\ (g)}$

The light yellow colored silver bromide turns to gray due to sunlight.

Electricity (electrolysis):- On passing the electricity water dissociates to hydrogen and oxygen.

$2H_2O_{(l)} \xrightarrow{\text{electrolysis}} 2H_{2(g)} = O_{2(g)}$

3. How chemical displacement reactions defer from chemical decomposition reactions? Explain with an example for each? (As_1)

Displacement Reaction	Decomposition Reaction
1.In Displacement reaction one element displaces another element from its compound.	1. A chemical reaction in which a substance decomposes to form two or more simpler substances.
Ex: $Fe_{(s)} + Cuso_{4(aq)} \rightarrow Feso_{4(aq)} + cu_{(s)}$	Ex: $CaCo_{3(s)} \rightarrow Cao_{(s)} + Co_{2(g)}$
2. Energy is not required in any form for this reaction.	2. Energy is required in the form of heat or light or electricity for this reaction.
3.Reactants are more than one.	3. Reactant is only one substance.

4. Balance the following chemical equations?

a) $Na\,OH + H_2\,So_4 \rightarrow Na_2so_4 + H_2o$.

b) $Hg\,(No_3) + KI \rightarrow HgI_2 + KNo_3$

C) $H_2 + O_2 \rightarrow H_2O$

d) $Kclo_3 \rightarrow Kcl + O_2$

e) $C_3\,H_8 + O_2 \rightarrow Co_2 + H_2o$

4) a) $Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + H_2o$.

Step1: Unbalanced equation.

$Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + H_2o$

Step2: Compare number of atoms of each element on both sides.

Elements	No. of Atoms in Reactants	No of Atoms in Products
Na	1 (in Na OH)	2 (in $Na_2\,So_4$)
S	1 (in $H_2\,So_4$)	1 (in $Na_2\,So_4$)
H	3 (in Na OH, $H_2\,So_4$)	2 (in H_2o)
O	5 (in Na OH, $H_2\,So_4$)	5 (in Na OH, $H_2\,So_4$)

No. of Na atoms equating both sides

$2Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + H_2o$

No. of H atoms equating both sides

$2Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + 2H_2o$

No. of O atoms equating both sides

$2Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + 2H_2o$

Step3: The above equation is balanced and coefficients are also smallest whole number

$2Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + 2H_2o$

Step4: Verify the above equation for the balancing of atoms on both sides of the equation. Hence the equation is a balanced one.

$$2Na\,OH + H_2\,So_4 \rightarrow Na_2\,so_4 + 2H_2o$$

b) Hg $(No_3)_2$ +KI→ Hg I_2 +kNo_3

Sol: Step1: Unbalanced chemical equation

Hg $(No_3)_2$ +KI→ Hg I_2 +kNo_3

Step2: compare no. of atoms of each element on both sides

Elements	No of atoms in reactants	No of atoms in products
Hg	1	1
N	2	1
O	6	3
K	1	1
I	1	2

No. of Hg atoms balancing

Hg $(No_3)_2$ +KI→ Hg I_2 +kNo_3

No. of N atoms balancing

Hg $(No_3)_2$ +KI→ Hg I_2 +$2kNo_3$

No. of O atoms balancing

Hg $(No_3)_2$ +KI→ Hg I_2 +$2kNo_3$

No. of K atoms balancing

Hg $(No_3)_2$ +2KI→ Hg I_2 +$2kNo_3$

No. of I atoms balancing

Hg $(No_3)_2$ +2KI→ 1Hg I_2 +$2kNo_3$

Step3: the above equation is balanced. Write coefficients and also smallest ratio.

Hg $(No_3)_2$ +2KI→ 1Hg I_2 +2kNo_3

Step4: Verified the above equation for the balancing of atom on both sides of the equation. Hence the equation is balanced.

Hg $(No_3)_2$ +2KI→ Hg I_2 +2kNo_3

C) $H_2+O_2 \rightarrow H_2O$

Sol: Step1: Unbalanced equation

$H_2+O_2 \rightarrow H_2O$

Step2: compare no. of atoms of each element on both sides.

Atom	No. of atoms in LHS	No. of atoms in RHS
H	2	2
O	2	1

No. of 'O' atoms balancing

$H_2+O_2 \rightarrow 2\ H_2O$

No. of 'H' atoms balancing

$2H_2+O_2 \rightarrow 2H_2O$

Step3: The above equation is balanced is and write and write the coefficient in smallest ratio.

$2H_2+O_2 \rightarrow 2H_2O$

Step4: Verified above equation for balancing of atoms each element on both sides. Hence the equation is balanced.

$2H_2+O_2 \rightarrow 2H_2O$

d) $Kclo_3 \rightarrow kcl + O_2$

Sol: Step1: Unbalanced equation

$Kclo_3 \rightarrow kcl + O_2$

Step2: Compare no. of atoms of each element on both sides.

Atom	No. of atoms in LHS	No. of atoms in RHS
K	1	1
CL	1	1
O	1	2

Balancing 'O' atoms on both sides

$2Kclo_3 \rightarrow kcl + 3O_2$

Balancing 'K' atoms on both sides

$2Kclo_3 \rightarrow 2kcl + 3O_2$

Step3: The above equation is balanced write the coefficient of smallest ratio.

$2Kclo_3 \rightarrow 2kcl + 3O_2$

Step4: Verified above equation for balancing of atoms of each element on both sides.

$2Kclo_3 \rightarrow 2kcl + 3O_2$

e) $C_3H_8 + O_2 \rightarrow Co_2 + H_2o$

Step1: Unbalanced equation

$C_3H_8 + O_2 \rightarrow Co_2 + H_2o$

Step2: Compare no. of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
C	3	1
H	8	2
O	2	3

No. of C atoms balancing

$C_3H_8+O_2 \rightarrow 3Co_2+H_2o$

No. of H atoms balancing

$C_3H_8+O_2 \rightarrow 3Co_2+4H_2o$

No. of O atoms balancing

$C_3H_8+5O_2 \rightarrow 3Co_2+4H_2o$

Step3: The above equation is balanced and writes the coefficient in smallest ratio.

$C_3H_8+5O_2 \rightarrow 3Co_2+4H_2o$

Step4: Verified above equation for balancing of atoms each element on both sides. Hence the equation is balanced.

$C_3H_8+5O_2 \rightarrow 3Co_2+4H_2o$

5. Write the balanced chemical equations for the following reaction. (As_1)

a) Zinc + silver nitrate → Zinc nitrate + silver

b) Aluminum + Copper chloride → Aluminum chloride + copper

c) Hydrogen + chlorine → Hydrogen chloride

d) Ammonium nitrate → Nitrogen + carbon dioxide +water.

Sol: a) Zinc + silver nitrate → Zinc nitrate + silver

Step1: Write the unbalanced equation using correct chemical formulae for all substances.

$Zn + Ag\ No_3 \rightarrow Zn\ (No_3)_2 + Ag$

Step2: Compare number of atom of each element on both sides.

Element	No. of atoms in LHS	No. of atoms in RHS
Zn	1	1
Ag	1	1
N	1	2
O	3	6

Balancing 'N' atoms on both sides

$Zn + 2Ag\ No_3 \rightarrow Zn\ (No_3)_2 + Ag$

Balancing 'Ag' atoms on both sides

$Zn + 2Ag\ No_3 \rightarrow Zn\ (No_3)_2 + 2Ag$

The above equation is balanced.

Step-3: Write the coefficient of smallest ratio

$1Zn + 2Ag\ No_3 \rightarrow 1Zn\ (No_3)_2 + 2Ag$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$Zn + 2Ag\ No_3 \rightarrow Zn\ (No_3)_2 + 2Ag$

b) Aluminum + Copper chloride → Aluminum chloride + copper

Sol: Step1: Write the equation using the correct chemical symbols and formulae for all the reactants and products.

$Al + Cu\ Cl_2 \rightarrow Al\ Cl_3 + Cu$

Step-2: Compare no of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
Al	1	1
Cu	1	1
CL	2	3

Balancing "CL" atoms on both sides

$Al + 3Cu\ Cl_2 \rightarrow 2Al\ Cl_3 + Cu$

Balancing "Al", "Cl" atoms on both sides

$2Al + 3Cu\ Cl_2 \rightarrow 2Al\ Cl_3 + 3Cu$

The above equation is balanced.

Step-3: Write the coefficient of smallest ratio.

$2Al + 3Cu\ Cl_2 \rightarrow 2Al\ Cl_3 + 3Cu$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$$2Al + 3Cu\ Cl_2 \rightarrow 2Al\ Cl_3 + 3Cu$$

c) Hydrogen + chlorine → Hydrogen chloride

Sol: **Step-1:** Write the unbalanced equation using correct chemical formulae for the reactants and products.

$H_2 + Cl_2 \rightarrow Hcl$

Step-2: Compare no. of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
H	2	1
CL	2	1

Balancing "H" and "CL" atoms in both sides

$1H_2 + 1Cl_2 \rightarrow 2Hcl$

The above equation is balanced

Step-3: Write the coefficient of smallest ratio

$1H_2 + 1Cl_2 \rightarrow 2Hcl$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$H_2 + Cl_2 \rightarrow 2Hcl$

d) Ammonium nitrate → Nitrogen + carbon dioxide +water.

Sol: Step-1: Write the unbalanced equation using correct chemical formulae for all substances.

$NH_4 No_3 \rightarrow N_2 + Co_2 + H_2O$

Step-2: Compare number of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
N	2	2
H	4	2
O	3	3

Balancing "H" atoms in both sides

$NH_4 No_3 \rightarrow N_2 + Co_2 + 2H_2O$

Balancing "N" and "O" atoms in both sides

$NH_4 No_3 \rightarrow N_2 + Co_2 + 2 H_2O$

Step-3: Write the coefficient of smallest ratio.

$NH_4 No_3 \rightarrow N_2 + Co_2 + 2 H_2O$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$NH_4 No_3 \rightarrow N_2 + Co_2 + 2 H_2O$

6. Write the balanced chemical equation for the following and identify the type of reaction in each case (As_1)

a) Calcium hydroxide $_{(aq)}$ + Nitric acid $_{(aq)}$ → Water $_{(l)}$ + calcium nitrate $_{(aq)}$

b) Magnesium$_{(s)}$ + Iodine $_{(g)}$ → Magnesium iodide$_{(s)}$

c) Magnesium$_{(s)}$ + hydrochloric acid $_{(aq)}$ → Magnesium chloride $_{(aq)}$ + Hydrogen $_{(g)}$

d) Zinc$_{(s)}$ + calcium chloride $_{(aq)}$ + → Zinc chloride $_{(aq)}$ + Ca$_{(s)}$

Sol: a) Calcium hydroxide $_{(aq)}$ + Nitric acid $_{(aq)}$ → Water $_{(l)}$ + calcium nitrate $_{(aq)}$

$Ca(OH)_{2(aq)} + HNo_{3\,(aq)} \rightarrow H_2O + Ca(No_3)_2$

It is a skeleton equation.

Balancing the atoms of each element on both sides-

$Ca(OH)_{2\,(aq)} + 2HNo_{3\,(aq)} \rightarrow 2H_2O_{\,(l)} + Ca(No_3)_{2(aq)}$

The reaction is double displacement reaction.

b) Magnesium$_{(s)}$ + Iodine $_{(g)}$ → Magnesium iodide$_{(s)}$

Sol: The skeleton equation for the above reaction.

$Mg_{(s)} + I_{2\,(g)} \rightarrow Mg\,I_{(S)}$

Balancing the atoms of each element on both sides-

$2Mg_{(s)} + I_{2\,(g)} \longrightarrow 2Mg\,I_{(S)}$

This reaction is chemical combination.

c) Magnesium$_{(s)}$ + hydrochloric acid$_{(aq)}$ →Magnesium chloride $_{(aq)}$+Hydrogen $_{(g)}$

Sol: The skeleton equation is-

$Mg_{(s)} + Hcl_{\,(aq)} \rightarrow Mgcl_2 + H_2$

Balancing the atoms of each element on both sides

$1Mg_{(s)} + 2Hcl \rightarrow 1Mgcl_2 + 1H_2$

(Or) $Mg + 2Hcl \rightarrow Mgcl_2 + H_2$

This reaction is displacement reaction.

d) Zinc$_{(s)}$ + calcium chloride $_{(aq)}$ + → Zinc chloride $_{(aq)}$ + Ca$_{(s)}$

Sol: The skeleton equation is-

$Zn_{(S)} + Cacl_{2\,(aq)} \rightarrow Zncl_2 + Ca_3$

Balancing the atoms of each element on both sides-

$1ZN_{(S)} + 1\ Cacl_{2\,(aq)} \rightarrow 1Zncl_{2(aq)} + 1Ca_3$

This reaction is displacement reaction.

7. Balance the chemical equation by including the physical states of the substances for the following reactions. (As_1)

a) Barium chloride and sodium sulphate aqueous solutions react to give insoluble barium sulphate and aqueous solution of sodium chloride

Step-1: Skeleton equation is

$$Bacl_{2\,(aq)} + Na_2\,So_{4\,(aq)} \rightarrow BaSo_{4\,(s)} \downarrow + Nacl_{\,(aq)}$$

Step-2: compare no. of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
Ba	1	1
CL	2	1
Na	2	1
S	1	1
O	4	4

Balancing atoms on both sides

$$1Bacl_{2\,(aq)} + 1Na_2\,So_{4\,(aq)} \rightarrow 1BaSo_{4\,(s)} \downarrow +2\,Nacl_{\,(aq)}$$

Step-3: write the coefficient of smallest ratio

$$1Bacl_{2\,(aq)} + 1Na_2\,So_{4\,(aq)} \rightarrow 1BaSo_{4\,(s)} \downarrow +2\,Nacl_{\,(aq)}$$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$$Bacl_{2\,(aq)} + Na_2\,So_{4\,(aq)} \rightarrow BaSo_4 \downarrow +2\,Nacl_{\,(aq)}$$

b) Sodium hydroxide reacts with hydro chloric acid to produce sodium chloride and water.

Sol: **Step-1:** skeleton equation is

$$NaOH_{(aq)} + Hcl_{(aq)} \rightarrow Nacl_{(aq)} + H_2O_{(l)}$$

Step-2: Compare no. of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
Na	1	1
O	1	1
H	1	1
CL	1	1

Balancing the atoms of each element on both sides

$$1NaOH_{(aq)} + 1Hcl_{(aq)} \rightarrow Nacl_{(aq)} + H_2O_{(l)}$$

Step-3: write the coefficient of smallest ratio

$$1NaOH_{(aq)} + 1Hcl_{(aq)} \rightarrow 1Nacl_{(aq)} + 1H_2O_{(l)}$$

Step-4: Verified above equation for balancing of atoms of each element on both sides

$$1Na\,OH_{(aq)} + 1Hcl_{(aq)} \rightarrow 1Nacl_{(aq)} + 1H_2O_{(l)}$$

C) Zinc pieces react with dilute Hydrochloric acid to liberate hydrogen gas and forms zinc chloride

Sol: **Step-1:** Skeleton equation is-

$$Zn_{(s)} + Hcl_{(aq)} \rightarrow Zncl_{2(aq)} + H_2 \uparrow$$

Step-2: compare no. of atoms of each element on both sides.

Elements	No of atoms in reactants	No of atoms in products
Zn	1	1
H	1	2
CL	1	2

Balancing atoms of each element on both sides-

$Zn_{(s)} + 2Hcl_{\,(aq)} \rightarrow Zncl_{2\,(aq)} + H_2 \uparrow$

Step-3: write the coefficient of smallest ratio

$Zn_{(s)} + 2Hcl_{\,(aq)} \rightarrow Zncl_{2(aq)} + H_2 \uparrow$

Step-4: Verified above equation for balancing of atoms of each element on both sides.

$Zn_{(s)} + 2Hcl_{\,(aq)} \rightarrow Zncl_{2\,(aq)} + H_2 \uparrow$

2Marks Questions

1. Why does respiration considered as an exothermic reaction? Explain (As_1)

A) The term respiration refers to the whole chain of process for the inhalation of air to the use of oxygen in the cells. It is the process of breakdown of complex food molecules or a catabolic process to produce chemical energy.

$$(C\,H_2O)_n + O_2 \rightarrow Co_2 + H_2O + \text{energy}$$

As energy is released in this reaction, it is considered as an exothermic reaction.

2. What is the difference between displacement and double displacement reaction? Write equations for these reactions?

A)

Displacement Reaction	Double Displacement Reaction
1. In displacement reaction, one element displaces another element from its compound $Zn + 2Hcl \rightarrow Zncl_2 + H_2$	1. In double decomposition reaction, two reactants exchange their constituents chemically and form two products $Na_2\,So_4 + Bacl_2 \rightarrow Baso_4 + 2Nacl$
2. An element will displace another element. $Ca + 2Hcl \rightarrow Cacl_2 + H_2$	2. Ions will exchange from two ionic compounds. $NaOH + Hcl \rightarrow Nacl + H_2O$

3. Give two examples of oxidation – Reduction reaction?

A) 1. $2Fe_2O_{3\,(s)} + 3c_{\,(s)} \rightarrow 4Fe_{(s)} + 3Co_{2\,(g)}$

Carbon combines with oxygen to form carbon dioxide. Hence carbon is oxidized. Iron loses oxygen to form iron, hence iron is reduced.

2. $2pbo_{\,(s)} + c_{\,(s)} \rightarrow 2pb_{\,(s)} + Co_{2\,(g)}$

Carbon combines with oxygen to form carbon dioxide. Hence carbon is oxidized.

Lead loses oxygen to form lead, hence lead is reduced.

4. What do mean by corrosion? How can you prevent it?

A) Corrosion: - When some metals are exposed to moisture, acids etc. they tarnish due to the formation of respective metal oxide on their surface. This process is called corrosion.

Corrosion is the oxidative deterioration of a metal.

Prevention: - Corrosion can be prevented by or at least minimized by shielding the metal surface from oxygen and moisture.

It can be prevented by painting, oiling, greasing, galvanizing, chrome plating or making alloys.

5. Explain rancidity? (As_1)

A) When the fat/oil containing food maternal left for a long time, they are oxidized and become rancid.

Rancidity is an oxidation reaction. The spoilage of food can be prevented by adding preservatives like vitamin C and vitamin E.

6. Balance the following chemical equations including the physical state (As_1)

a) $C_6 H_{12} O_6 \rightarrow C_2 H_5 OH + Co_2$

A) $C_6 H_{12} O_{6\,(S)} \rightarrow 2\, C_2 H_5 OH + 2\, Co_2$

b) $Fe + O_2 \rightarrow Fe_2 O_3$

A) $4\, Fe_{(s)}\ 3O_{2\,(g)} \rightarrow 2Fe_2 O_{3\,(S)}$

c) $NH_3 + Cl_2 \rightarrow N_2 H_4 + NH_4Cl$

A) 4$NH_{3\,(g)} + Cl_{2\,(g)} \rightarrow N_2 H_{4\,(g)} + 2NH_4Cl_{\,(aq)}$

D) $Na + H_2o \rightarrow Na\ OH + H_2$

A) 2$Na_{\,(S)} + H_2o_{\,(l)} \rightarrow 2\, Na\ OH_{\,(aq)} + H_{2\,(g)}$

7. Why do we apply paint on iron articles?

A) Iron articles when exposed to air, reacts with oxygen and moisture in air. As a result rusting takes place in the metal deteriorates.

To prevent this rusting and deterioration of iron, we have to apply paint to iron article.

8 What is the use of keeping food in air tight containers?

A) When food materials containing fat/oil left for a long time, their taste and odour changes due to rancidity.

Rancidity is an oxidation process. To prevent rancidity and to slow down the oxidation process food will be stored in air tight containers.

Manufacturers of potato chips flush bags of chips with nitrogen gas to prevent the chips from getting oxidized.

1 Mark Questions

1. What do you mean by precipitation relation? (As_1)

A) Precipitation reaction: A chemical reaction in which one or more of the products are obtained as a precipitate is called precipitation reaction.

$Ag\ No_{3\,(aq)} + Nacl_{(aq)} \rightarrow Ag\ Cl_{(s)} \downarrow + NaNO_{3\,(aq)}$

Silver Nitrate sodium chloride silver chloride

2. Name the reactions taking plane in the presence of sunlight?

A) Reactions occur in the presence of sunlight are called photo chemical reactions.

$$2Ag\ Br_{(s)} \xrightarrow{sunlight} 2Ag_{(s)} + Br_{2\,(g)}$$

$$6Co_{2\,(g)} + 6H_2o_{(aq)} \xrightarrow{sunlight} C_6H_{12}O_6 + Co_2 \uparrow$$

3. $Mno_2 + 4Hcl \rightarrow Mncl_2 + 2H_2o + Cl_2$ In the above equation, name the compound which is oxidized and which is reduced? (As_1)

A) In the above reaction Mno_2 is reduced and Hcl is oxidized.

4. In the refining of silver, the recovery of silver from silver nitrate solution involved displacement by copper metal. Write the reaction involved?

A) Copper displaces silver from silver nitrate solution.

$$2Ag\ No_{3(l)} + Cu_{(s)} \rightarrow Cu\ (No_3)_2 + Ag$$

Copper is more reactive than silver. So, copper displaces silver.

5. A shiny brown colored element 'x' on heating in air becomes black in color. Can you predict the element 'x' and the black colored substance formed? How do you support your prediction? (As_2)

A) A Shiny brown colored element X may be Cu. Cu on heating in air become black colored copper oxide (Cuo)

$$\underset{\text{(Brown)}}{2Cu} + O_2 \rightarrow \underset{\text{(Black)}}{2Cuo}$$

Important Images

1. Formation of Hydrogen Gas

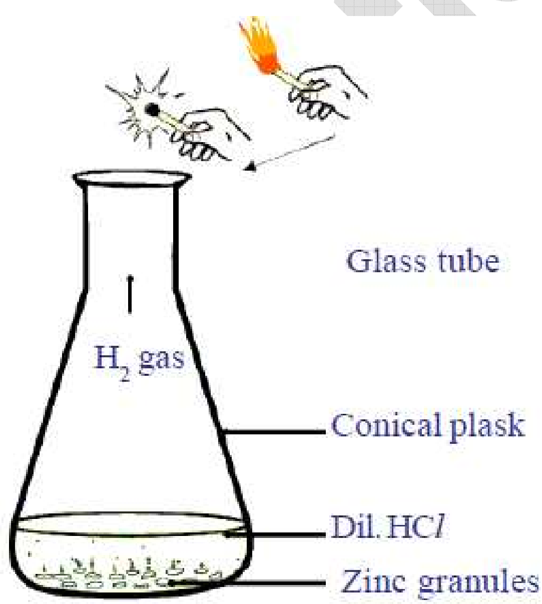


fig-2:Formation of hydrogen gas by action of dilute HCl on zinc and testing of H_2 gas

2. Heating of Carbonate

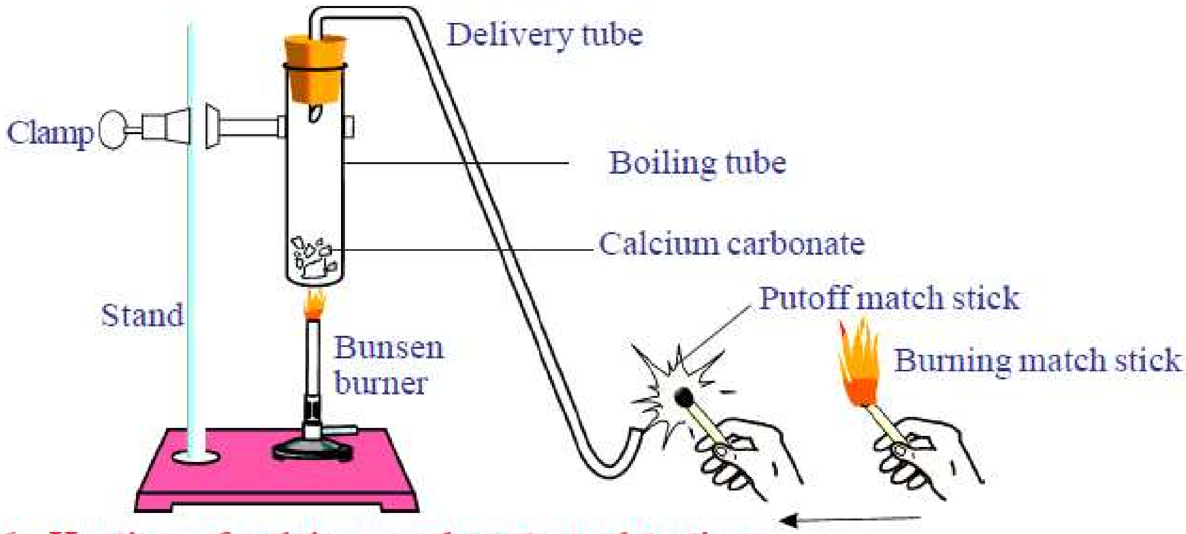


fig-6: Heating of calcium carbonate and testing the gas evolved with burning match stick

3. Electrolysis of water

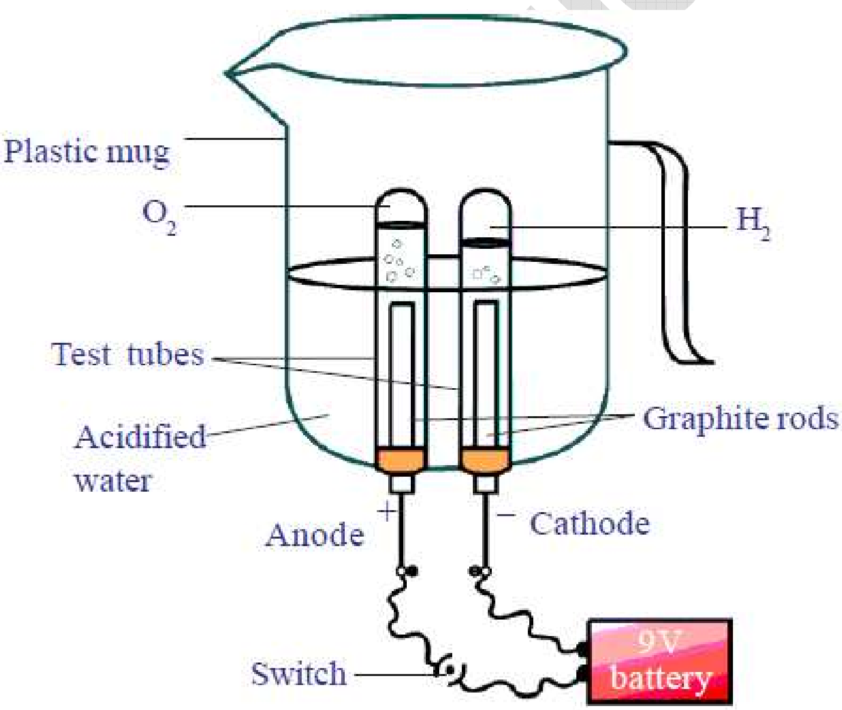


fig-8: Electrolysis of water

4. Reduction of copper oxide to copper

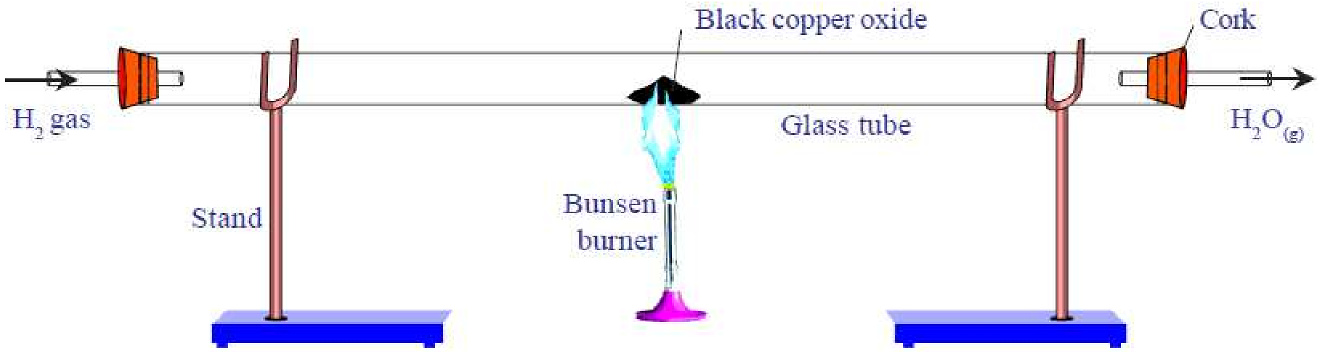


fig-14: Reduction of copper oxide to copper

Multiple Choice Questions

1. $Fe_2O_3 + 2AL \rightarrow Al_2O_3 + Fe$ [c]

a) Combination reaction b) Decomposition reaction

c) Displacement reaction d) Double decomposition reaction.

2. What happen when dil. Hydrochloric acid is added to iron filings? Choose the correct answer. [a]

a) Hydrogen gas and iron chloride are produced

b) Chlorine gas and iron hydroxide are produced

c) No reaction takes plane

d) Iron self and water are produced

3. $2pbo_{(s)} + c_{(s)} \rightarrow 2pb_{(s)} + co_{2\,(g)}$ [b]

Which of the following statements are correct for the above chemical reaction?

1) Lead is reduced 2) carbon dioxide is oxidized

3) Carbon is oxidized 4) lead oxide is reduced

a) 1&2 b) 1&3 c) 1, 2, 3 d) All

4. The chemical equation [d]

$Bacl_2 + Na_2So_4 \rightarrow BaSo_4 + 2Nacl$ represents following type of chemical reaction.

a) Displacement b) Combination

c) Decomposition d) Double displacement

5. The reaction of formation hydrogen chloride from hydrogen and chloride represents following- [c]

a) Decomposition b) Displacement

c) Combination d) Double displacement

6. Which of this is a chemical reaction? [d]

a) Coal is burnt b) Milk is converted into curd

c) Crackers are burnt d) All the above

7. When sodium sulphate ($Na_2\ So_4$) solution mixed with barium chloride ($Bacl_2$) solution barium sulphate precipitate formed. What is the color of this precipitate? [b]

a) Yellow b) white c) Blue d) Black

8. Chemical changes may be - [c]

a) Exothermic b) Endothermic

c) Exothermic or endothermic d) None

9. **$Zn + Hcl \rightarrow$ ____ $+ H_2 \uparrow$** [b]

a) Zn CL b) $Zncl_2$ c) ZnH d) Cl_2

10. For balancing the given chemical equation, the coefficient of oxygen (0_2) is $C3\,H_8 + O_2 \rightarrow Co_2 + H_2O$ [c]

a) 3 b) 4 c) 5 d) 6

11. $C_{(s)} + O_{2\,(g)} \rightarrow Co_{2\,(g)}$ is which type of reaction? [a]

a) Exothermic reaction b) endothermic reaction

c) Decompose reaction d) displacement reaction

12. The chemical formula of marble is- **[b]**

a) $ZnCo_3$ b) $CaCo_3$ c) KCL d) Nacl

13. When iron nail chipped in copper sulphate solution and left undisturbed for some time, the iron nail becomes brown due to formation of? **[a]**

a) $Feso_4$ b) Feo c) So_2 d) Fes

14. Corrosion can be prevented by? **[d]**

1) Painting 2) oiling

3) Greasing 4) galvanizing

a) 1 b) 1&2

c) 1, 2&3 d) 1, 2, 3&4

15. Which of the following is not a alloy? **[d]**

a) Brass b) Bronze

c) Steel d) Iron

16. Metal oxide is electric---- **[d]**

a) Conductor b) good conductor

c) Semi conductor d) insulator

17. Which is the good preservative of food? **[c]**

a) $Cuso_4$ b) Bacl

c) Vitamin C and vitamin E d) vitamin A

18. To prevent the potato chips from getting oxidization flush bags of chips are filled with? **[a]**

a) Nitrogen gas b) Oxygen

c) Hydrogen gas d) Fluorine

19. The color of copper oxide (Cuo) is? **[d]**

a) Blue b) Light red

c) Bluish green d) Black

20. Which enzyme is caused for the change the color on the cut surface of the fruits like apples, bananas? **[d]**

a) Inverts b) Zymase

c) Glycerol d) Tyrosimase

21. $2Fe_2O_3 + 3c \rightarrow 4Fe + 3Co_2$

The above chemical reaction is an example of? **[c]**

a) Oxidation reaction b) reduction reaction

c) Redox reaction d) None

22. When light yellow colored silver bromide exposed to sunlight, which colour does it change into? **[c]**

a) White b) Black c) Gray d) Red

23. Metals + Acid → ______ **[b]**

a) Hydrochloride b) Hydrogen c) Oxygen d) Ammonia

Fill in the Blanks

1. Quick lime's another name is _____. (**Calcium oxide**)

2. Zn + Hcl → $ZncL_2$ ____________. (**H_2**)

3. Propane used as ____________ fuel. (**Cooking**)

4. Unbalanced chemical equation containing molecular formulae of the substance is known as ____________. (**Skeleton equation**)

5. Heat is _______in exothermic reaction. (**Liberated**)

6. If a precipitate is formed in the reaction it is denoted by _____.( )$\downarrow$(**Downward arrow**)

7. If chemical reaction atoms are neither ____ nor _________. (**created, destroyed**)

8. Chemical reactions occur with the formulation a breaking of ___. (**Chemical bonds**)

9. The chemical formula of marble is ___________. (**$CaCo_3$**)

10. ______is the color of silver bromide (**Light yellow color**)

11. Oxidation is a reaction that involves the addition of___ or removed of _______.

(**Oxygen, Hydrogen**)

12. Color of copper oxide _______. (**Black**)

13. Burring of crackers is also ____ process of variety of chemicals. (**Oxidation**)

14. Galvanizing is a method o protecting iron form _________. (**Rusting**)

15._____ Steel does not rust. (**Stainless**)

16. Rancidity is a ______ reaction. (**Oxidation**)

17._______ Gas is used to prevent the chips from getting oxidized. (**Nitrogen**)

18. ____ is the smallest particle of an element that takes part in chemical reaction. (**Atom**)

Matching

1. Group-A **Group-B**

Group-A		Group-B
1. Vitamin E	**[b]**	a) Heat energy release
2. Greasing	**[d]**	b) Preservative
3. Tyrosine's	**[c]**	c) Enzyme
4. Dazzling white flame	**[e]**	d) corrosion
5. Exothermic	**[a]**	e) Magnesium
		f) Heat absorption.

1. Group-A **Group-B**

Group-A		Group-B
1. $2Mg + O_2 \rightarrow 2Mgo$	**[e]**	a) Redox reaction
2. $2CaCo_3 \rightarrow Cao + Co_2$	**[d]**	b) Double displacement
3. $Zn + 2Hcl \rightarrow Zncl_2 + H_2$	**[c]**	c) Displacement
4. $Na_2 So_4 + Bacl_2 \rightarrow Baso_4 + 2Nacl$	**[b]**	d) Decomposition
5. $2Fe_2 O_3 + 3c \rightarrow 4Fe + 3Co_2$	**[a]**	e) Combination
		f) Rancidity.

Chapter -13
Principles of Metallurgy

SYNOPSIS

Metallurgy is the process of extraction of metals from their ores. There are three stages in the extraction of metals from the ores. They are 1) Concentration or dressing 2) Extraction of crude metal 3) Refining or purification of the metal.

Corrosion is an electrochemical reaction and prevention of corrosion is of prime importance. It not only saves money but also helps in preventing accidents.

The important processes used in metallurgy are 1) Smelting, 2) Roasting, 3) Calcinations.

2 Mark Questions

1. List 3 metals that are found in nature as Oxide ores. (AS1)

A. Aluminum, manganese, ferrous (Iron) and zinc are the metals which are found in nature as Oxide ores.

Aluminum — $Al_2O_3.2H_2O$ [Bauxite]

Manganese — pyrolusite [MnO_2]

Ferrous — Haematite [Fe_2O_3]

Magnetite [Fe_3O_4]

Zinc — Zincite[Zno]

2. List three metals that are found in nature in uncombined form. (AS1)

A. Gold (Au), Silver (Ag) and Copper (Cu) are some metals that are found in the nature in uncombined form because they are least reactive.

3. Write a note on dressing of ore in metallurgy? (AS1)

A. Concentration or dressing of the ore:

Concentration or dressing means, simply getting rid of as much of the unwanted rocky materials as possible before the ore is converted into the metal. The impurities are known as “gangue”.

Physical methods like hand picking, washing, froth floatation and magnetic separation are used to enrich the ore depending on the physical properties of ore and gangue.

4. What is an Ore? On what basis a mineral is chosen as an ore? (AS1)

A. **Ore:** The mineral from which the metals are extracted without economical loss are called ores.

A mineral is chosen as an ore based on the following conditions.

1) Availability of metal in a high percentage.
2) Economically profitable while extracting the metal from mineral.

5. When do we use magnetic separation method for concentration of an ore? Explain with an example.

A. Magnetic Separation Method: In the ore and gangue, if one of them is magnetic and the other is non-magnetic. Then they are separated by magnetic separation method.

Eg: The magnetic ores like Iron pyrites (Fe_3) and magnetic (Fe_3O_4) are concentrated by this method. The crushed ore is allowed to pass through electromagnetic belts, then the mineral particles are retained and gangue particles are thrown away.

6. What is the difference between roasting and calcinations? Give one example for each.

A.

Roasting	Calcinations
1. The ore is heated in the presence of air.	1. The ore is heated in the absence of air.
2. It is used for sulphide ores	2. It is used for carbonate ores
Eg: $2znS+3O_2 \rightarrow 2ZnO+2SO_2$	Eg: $CaCO_3 \rightarrow CaO + CO_2$

7. Define the terms-
a) Gangue
b) Slag

A. **a) Gangue:**
In unwanted rocky materials (or) impurities in the ore are called as gangue.
b) Slag:
The impurities obtained during the poling process get oxidized to form scum (slag) over the surface of the molten metal.

8. Which method do you suggest for extraction of highly reactive metals? Why?

A. High reactivity metals like K, Ca, Mg, Ca etc, can be extracted by electrolysis.

Reason:

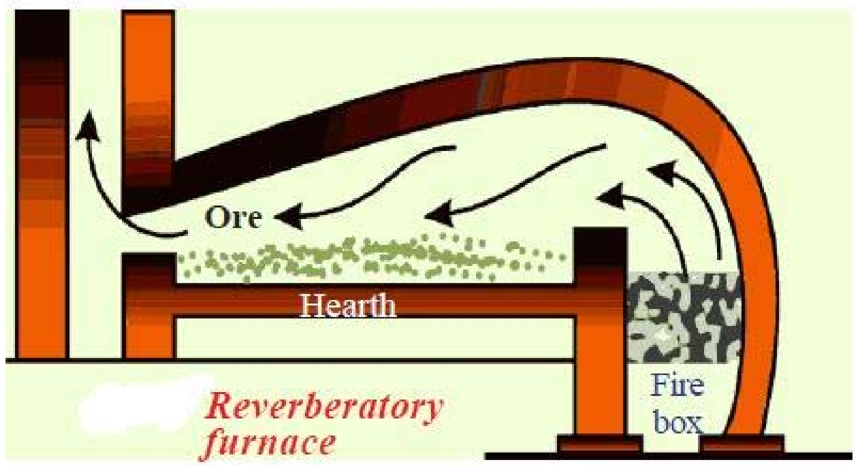
i. Simple reduction methods like heating with C, Co, etc. to reduce the ores of these metals are not feasible.

ii. The temperature required for the reduction is too high and more expensive.

iii. Hence electrolysis is the suggestible method to extract high reactive metals.

9. Draw a neat diagram of reverberatory furnace and label it neatly?

A.



1 Mark Questions

1. Write the names of any 2 ores of iron?

A. The two ores of Iron are Haematite (Fe_2O_3) and Magnetite (Fe_3O_4).

2. Magnesium is an active metal if it occurs as a chloride in nature, which method of reduction is suitable for its extraction?

A. Magnesium is an active metal. It occurs in chloride form as Mgcl_2. Hence electrolysis is suitable method for its reeducation.

3. Mention two methods which produce very pure metals?

A. Electrolysis and reduction are the two methods that produce pure metals.

4. In nature, Ag, Au, Cu available in free state. Justify the statement?

A. In nature, Ag, Au and Cu are available in free state due to their least reactive nature with their surroundings.

5. What are minerals?

A. The elements (or) compounds of the metals that occur in nature in earth crust are called as Minerals.

6. Define Ores?

A. The minerals from which metals are extracted profitably are known as ores.

7. VI group was known as chalcogens, Justify?

A. VI group was known as chalcogens, Since, most of the ores are in the form of oxides (or) sulphides and so on. These are called as chalcogens which means ore forming elements.

8. Define the process of refining of metal?

A. The process of obtaining of pure metal from the impure metal is known as refining of metal.

4 Mark Questions

1. How do metals occur in nature? Give examples to any two types of minerals. (AS1)

A. The earth's crust is the major source of metals. In that, some metals are available in nature in free state as they are least reactive.

Eg: Gold (Acl), silver (Ag) and copper (Au).

Most of the metals are found in nature in the combined form due to their move reactivity.

The compounds of the metals which occur in nature in the earth crust are called minerals.

The compounds of the metals which occur in nature in the earth crust are called minerals.

There are many types of minerals or ores. Some of them are-

Oxide minerals:

Bauxite ($Al_2O_3.2H_2O$)

Haematite (Fe_2O_3)

Zinncite (zno)

Sulphide Minerals:

Zinc Blende (zns)
Cinnabar (Hgs)
Galena (pbs)

Chloride Minerals:

Horn silver ($AgCl$)
Rock salt ($NaCl$)

Carbonate Minerals:

Magnesite ($MgCo_3$)
Limestone ($CaCo_3$)

2. Write a short note on froth floatation process?

A. Froth floatation process:

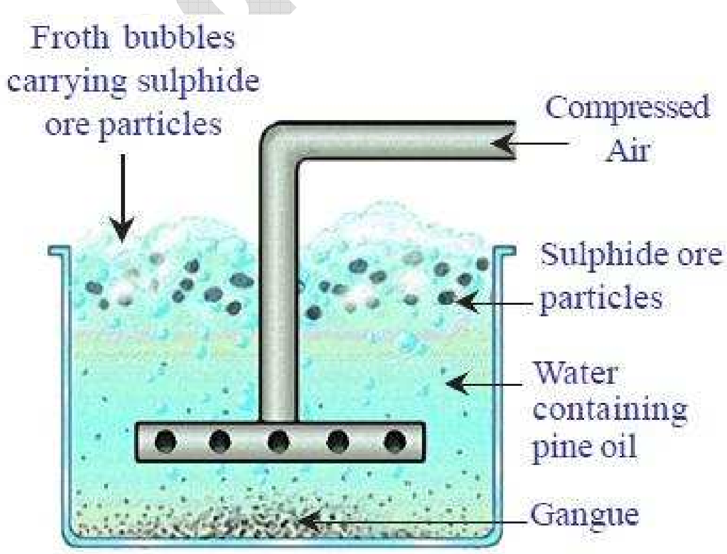
i. This method is mainly useful for sulphide ores which have no wetting property where as the impurities get wetted.

ii. The ore with impurities is finely powdered and kept in water, containing pine oil taken in a floatation cell.

iii. Air under pressure is blown to produce froth in water.

iv. Froth so produced, takes the ore particles to the surface, whereas impurities settle at the bottom.

v. Forth is separated and washed to get ore particles.



Froth floatation process for the concentration of sulphide ores

3. Write a short note on each of the following.
a) Roasting
b) Calcination
c) Smelting

A. a) Roasting:

i. Roasting is a pyrochemical process in which the ore is heating in the presence of Oxygen (or) air below its melting point.
ii. The sulphide ores are converted to oxides by roasting.
iii. The products obtained in this process also are in solid state.
Eg: $2znS+3O_2 \rightarrow 2ZnO+2SO_2$

b) Calcination:
Calcination is a pyrochemical process in which the ore is heated in the absence of air.
i. The ore is generally decomposed in the process.
Eg:

$$\underset{(s)}{Mg\,Co_3} \longrightarrow \underset{(s)}{Mg\,O} + Co_{2g}$$

$$\underset{(s)}{Ca\,Co_3} \longrightarrow \underset{(s)}{Ca\,O} + Co_{2g}$$

c) Smelting:

i. Smelting is a pyrochemical process, in which the ore is mixed with flux and fuel, and then it is strongly heated.
ii. During smelting, the impurities (gangue) in the ore react with flux to form slag which is removed.
iii. For haematite ore, coke is used as fuel and lime stone is used as flux.
Eg:

$$Fe_2O_3 + 3CO \rightarrow 2\,Fe + 3Co_2$$

4. Suggest an experiment to prove that the presence of air and water are essential for corrosion. Explain the procedure.

A. Corrosion: corrosion is the deterioration of a metal, as a result of chemical reactions between it and its surrounding environment.

Experiment:
Aim: To prove that the presence of air and water are essential for corrosion
Materials required: 3 test tubes, 3 iron nails, oil, water, anhydrous calcium chloride, rubber corks.

Procedure:

i. Take 3 test tubes and place clean iron nails in each of them. Label the test tubes A, B and C.

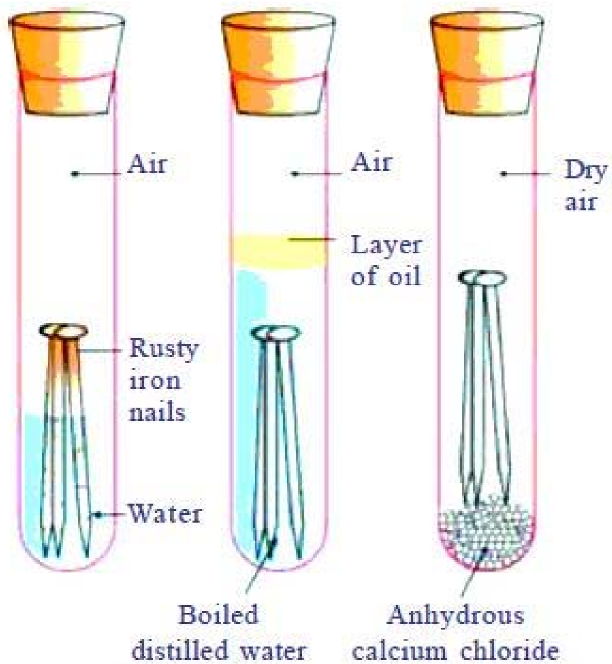
ii. Pour some water in test tube A and cork it.

iii. Pour boiled distilled water in test tube B, and about 1ml of oil and cork it.

iv. Put some anhydrous calcium chloride in test tube C and cork it.

v. Leave these test tubes for a few days and then observe.

vi. After a few days, we will observe that iron nails rust in test tube A, but they do not rust in test tubes B&C.



Investigating the conditions under which iron rusts

Reason:

i. In test tube A, the nails are exposed to air and water. Hence the nails rusted.

ii. In test tube B, the nails are exposed only to water, but not to air, because the oil float on water and prevent the air not rested.

iii. In test tube c, the nails are exposed to dry air, because anhydrous $CaCl_2$ will absorb the moisture, if any from the air. Hence the nails are not rusted.

From the above experiment, we can prove that air and water are essential for corrosion.

5. Collect information about extraction of metals of low reactivity silver, platinum and gold and prepare a report.

A.

i. Metals of low reactivity such as silver, mercury, platinum and gold are often found in free state

ii. Their reactivity with other atoms is very low.

iii. The Oxides of these metals can be reduced to metals by heat alone and sometimes by displacement from their aqueous solution.

Eg:

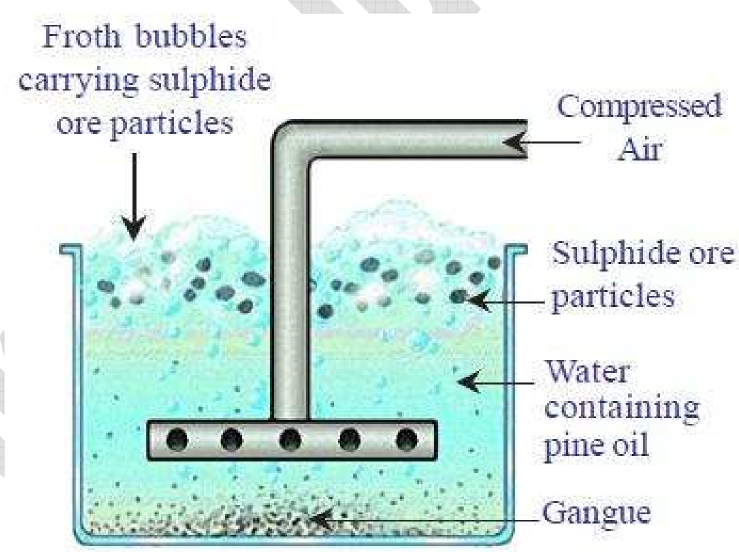
i. When cinnabar (Hgs) heated in air, first converted into Hgo, then get reduced to mercury on further heating.

$$2Hgs + 3O_2 \rightarrow 2HgO + 2\ SO_2$$

$$Hgo \xrightarrow[\Delta]{} 2Hg + O_2$$

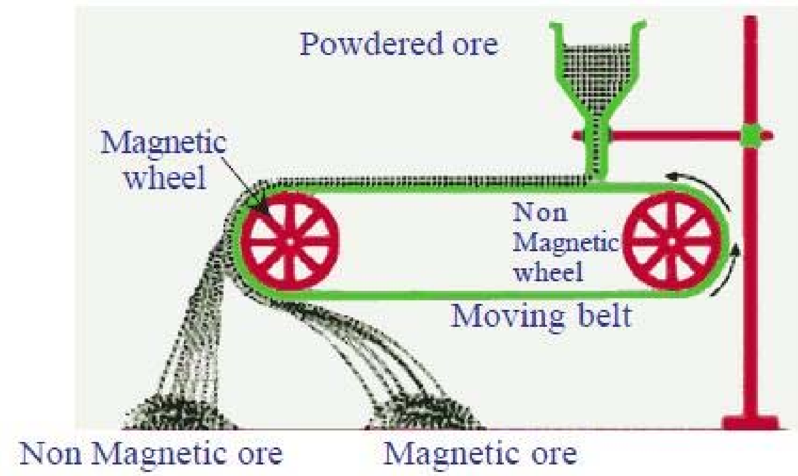
6. Draw the diagram showing.
i) Froth floatation
ii) Magnetic separation.

A. i) Froth floatation



Froth floatation process for the concentration of sulphide ores

ii) Magnetic separation.



Magnetic separation

7. What is activity series? How it helps in extraction of metals?

A. Activity series:

To understand the order of reactivity of metals that are very familiar, we study their chemical reactions with cold water, steam, diluted and strong acids and cl_2 and based on their rigorous activity order in these reactions, we frame out activity series.

Arrangement of the metals in decreasing order of their reactivity is known as activity series.

Use of Activity series in extraction of metals:

i. The method used for a particular metal for the reduction of its ore to the metal depends mainly on the position of the metal in the activity series.

Eg: 1) The metals at the top of the activity series (highly reactive) can be extracted by electrolysis.

ii. The metals at the middle of the activity series can be extracted by
1) Reduction of metal oxide with carbon
2) Reduction of oxide ores with co(Carbon monoxide)
3) Self reduction of sulphide ores
4) Reduction of ores with more reactive metals (thermite process)

iii. The metals at the bottom of the activity series (less reactive) can be extracted by heating alone, because they are often found in free state.

8. What is thermite process? Mention its applications in daily life.

A.

1) The thermite process involves the reaction of metal oxides with Aluminum.
2) When highly reactive metals such as sodium (Na), calcium (Ca) aluminum (Al) are used as reducing agents, they displace metals of lower reactivity from the compound.
3) These displacement reactions are highly exothermic. The amount of heat evolved is so large that metals produced would be in molten state.

   Ex:

$$TiCl_4 + 2Mg \xrightarrow{350°c} Ti + 2MgCl_2$$

$$TiCl_4 + 4Na \xrightarrow{350°c} Ti + 4NaCl$$

Applications of thermite processes:

1) The reaction of Iron Oxide (Fe_2O_3) with aluminum is used to join railings of railway tracks (or) cracked machine parts.
2) Joining of cracked metal utensils in the house.

9. Where do we use handpicking and washing methods in our daily life? Give examples. How do you correlate these examples with enrichment of ore?

A. Hand pickling:

Hand pickling can be used in cleaning rice, cereals, grading of vegetables and fruits etc, in our daily life.

In the ore, particles and the impurities are different in size, colour etc, using that property, the ore particles are handpicked separating them from other impurities.

Washing:

1) Washing can be used in our daily life to separate the impurities from cloth, rice, cereals etc.
2) Ore particles are crushed and kept on a soapy surface they are washed with controlled flow of water. Less densive impurities are carried away by water flow, leaving the more densive ore particles behind.

10. Collect information about extraction of metals of low reactivity silver, platinum and gold and prepare a report.

A.

1) Silver occurs in both combined state as well as in free state. The important ores of silver are Argentite (Ag_2S) copper, Silver glance, Horn silver, Ruby silver etc.
2) Silver is extracted from the ore-Argentite (Ag_2S)
3) The ore is crushed, concentrated and then treated with sodium cyanide solution.
4) The reaction forms sodium argento cyanide $[Na[Ag(CN)_2]]$

$Ag_2S + 4\ NacN \rightarrow 2\ Na\ [Ag(cN)_2] + 2\ Ag.$

5) This solution of sodium argento cyanide combined with zinc dust forms tetra ayano zincate and principle silver. This precipitated silver is called spongy silver.
   $zn + 2\ Na\ [Ag(cN)_2] \rightarrow Na_2\ [zn(cN)_4] + 2\ Ag.$
6) The spongy silver is fused with potassium nitrate to obtain pure silver. Then the silver obtained is purified by electrolytic process.

Extraction of Platinum:

1) Platinum is rarely found on its own, but in combination with other base & precious metals.
2) The extraction process of platinum is quite complex, which includes milling the ore and smelting it at high temperatures. This removes base metals notably the concentrate PGM (platinum Group Metals) – gold, platinum & palladium.
3) The PGM matter is further processed by electrolysis to remove nickel, cobalt & copper.
4) The high grade concentrate is treated by solvent extraction distilling, ion-exchange treatments to separate the PGM's into its separate metals.

Extraction of Gold:

1) Gold is usually found alone or alloyed with mercury (or) silver
2) In all methods of gold ore refining, the ore is usually washed and filtered at the mine, then sent to the mill. At the mill, the ore is ground into smaller particles with water, then ground again in a ball mill to further pulverize the ore.
3) Several processes can be used to separate the gold from its ore, They are-

a) Cyanide process:

i) The ground ore is put in a tank containing a weak cyanide solution and then zinc is added.
ii) The zinc causes a chemical reaction which separates the gold from the ore.
iii) The gold is then removed from the solution with a filter press.

b) Carbon-in-pulp Method:

i. In this method, the ground ore is mixed with water before cyanide is added. Then carbon is added to bond with the gold.
ii. The carbon-gold particles are put into caustic carbon solution, separating out in the gold.

c) Heap leaching:

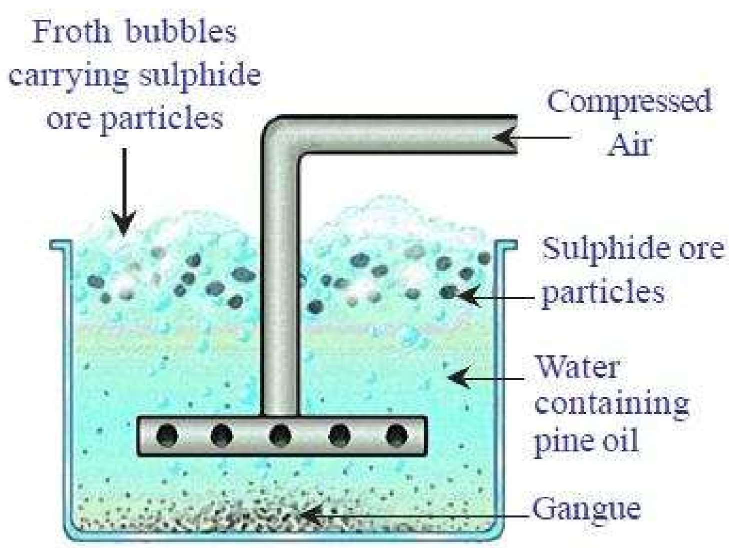
i. The ore is placed on open-air pads and cyanide is sprayed over them, taking several weeks to leach down to an imperious base.

ii. The solution then poured and pad into a pound and is pumped from there to a recovery plant, where the gold is recovered.

iii. Heap-leaching helps recover gold from ore that would be otherwise too expensive to process.

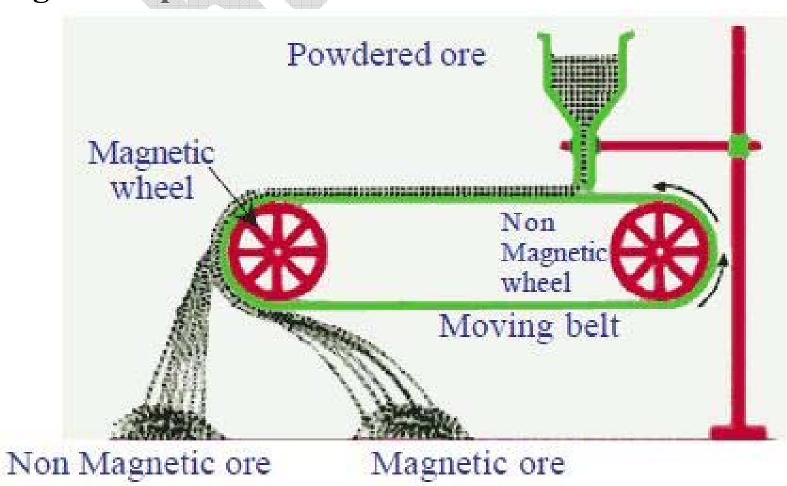
5 Mark Questions

1. Froth floatation:



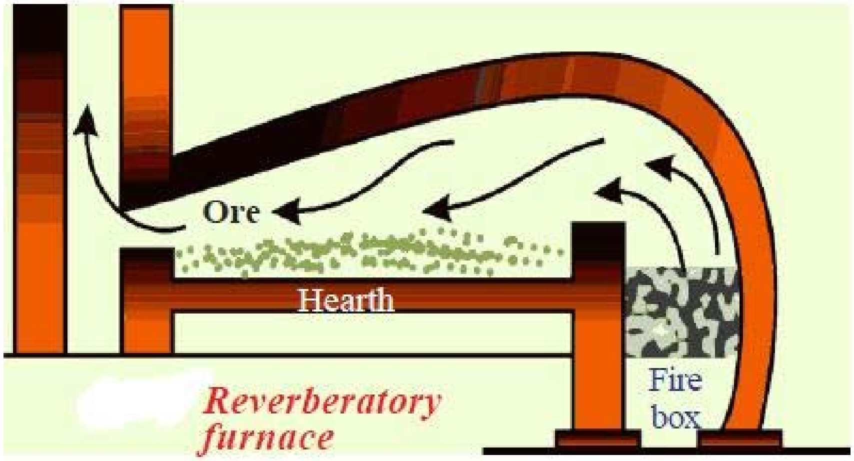
Froth floatation process for the concentration of sulphide ores

2. Magnetic separation:



Magnetic separation

3. **Reverberatory furnace:**



Multiple Choice Questions

1. The impurity present in the ore is called as _________ [ ]
a) Gangue b) flux c) Slag d) Mineral

2. Which of the following is a carbonate ore? [ ]
a) Magnesite b) Bauxite c) Gypsum d) Galena

3. Which of the following is the correct formula of Gypsum? [ ]
a) $CuSO_4.\ 2H_2O$ b) $CaSO_4.\ ½\ H_2O$
c) $CuSO_4.\ 5H_2O$ d) $CaSO_4.\ 2H_2O$

4. The oil used in the froth floatation process is __________. [ ]
a) Kerosene oil b) Pine oil c) Coconut oil d) Olive oil.

5. Froth floatation is method used for the purification of ______ore. [ ]
a) Sulphide b) Oxide c) Carbonate d) Nitrate

6. Galena is an ore of ————————. [ ]
a) Zn b) Pb c) Hg d) Al

7. The metal that occurs in the native form is __________. [ ]
a) Pb b) Au c) Fe d) Hg

8. The most abundant metal in the earth's crust is ————. [ ]

a) Silver b) Aluminum c) Zinc d) Iron

9. The reducing agent in thermite process is ___________ [ ]
a) Al b) Mg c) Fe d) Si

10. The purpose of smelting an ore is to __________ it. [ ]
a) Oxidise b) Reduce c) Neutralize d) none of these

Key:

1.a; 2. a; 3. a; 4. b; 5. a; 6. b; 7. b; 8. b; 9. a; 10. b.

Fill in the Blanks

1. The method suitable to enrich the sulphide ores is________
2. Arranging metals in the decreasing order of their reactivity is called _______.
3. The method suitable for purification of low boiling metals is ________.
4. Corrosion of iron occurs in the presence of _____ and ______.
5. The chemical process in which the ore is heated in the absence of air is called ______.
6. Mention the ores of zinc (zn) _________ Zns(Zinc blende)
Manganese (Mn) _____ pyroluite(Mno_2)
Silver (Ag) ____ Horn silver (Agcl).

Key:

1) Roasting; 2) Activity series; 3) distillation; 4) air, water;
5) calcinations; 6) zno (zincite);

Match the following

I.	Group – I		Group – II
i)	Bauxite	[ ]	a) Fe_2O_3
ii)	Magnetite	[ ]	b) Fe_3O_4
iii)	Haematite	[ ]	c) $MgSO_4.7H_2O$
iv)	Epsom salt	[ ]	d) $Al_2O_3.2H_2O$
v)	Magnetite	[ ]	e) $MgCO_3$

Key:

i) d; ii) e; iii) a; iv) c; v) b;

II.	Group - I		Group - II
i)	Handpicking	[ ]	a) Gangue
ii)	Washing	[ ]	b) Magnetic & non-magnetic substances are separated
iii)	Froth floatation	[ ]	c) Particles are handpicked
iv)	Magnetic separation	[ ]	d) Densive impurities are carried away by water flow
v)	The impurities	[ ]	e) used for sulphide ore

Key:

i) c; ii) d; iii) e; iv) b; v) a;

III.	Group – I		Group – II
i)	Horn silver	[ ]	a) Hgs
ii)	Rock salt	[ ]	b) $CaCo_3$
iii)	Cinnabar	[ ]	c) Agcl
iv)	Galena	[ ]	d) NaCl
v)	Lime stone	[ ]	e) Dbs

Key:

i) c; ii) d; iii) a; iv) e; v) b;

IV.	Group – I		Group – II
i)	Copper iron pyrites	[ ]	a) $CaSO_4.2H_2O$
ii)	Zinc blende	[ ]	b) Mno_2
iii)	Pyrolusite	[ ]	c) $CuFes_2$
iv)	Zincite	[ ]	d) zns
v)	Gypsum	[ ]	e) zno

Key:

i) c; ii) d; iii) b; iv) e; v) a;

Chapter – 8

Structure of Atom

Synopsis

Energy propagates as electromagnetic waves and can have a wide variety of wavelengths. The entire range of wavelengths is known as the electromagnetic spectrum.

Max Planck broke with the continuous energy tradition of electromagnetic energy by assuming that the energy is always emitted in multiples of "hν" with his Planck's constant which has the value 6.626×10^{-34}J-S. Where "ν" is the frequency.

Using Planck's theory and Rutherford model, Bohr proposed his famous atomic model. The defects of this model were rectified by Somerfield. This Bohr- Somerfield model, though successful in accounting for the fine line structure of hydrogen atomic spectra, failed to provide a satisfactory picture of the structure of atom in general.

For finding the electron in the space around the nucleus, quantum numbers are proposed by different scientists.

There are four quantum numbers .Those are

1. Principal quantum number (n).

2.The angular-momentum quantum number (l).

3. The magnetic quantum number (m_{l}).

4. Spin Quantum number (m_{s}).

The Pauli Exclusion Principle states that two electrons of same atom can have all four quantum numbers the same.

Aufbau Principle gives the information about how orbitals are filled in the order of increasing energy.

Hund's rule of electron pairing in orbitals starts only when all available empty orbitals of the same energy are singly occupied.

1. What information does the electronic configuration of an atom provide?

Ans: 1) The distribution of electrons in shells, sub-shells, and orbitals in an atom is known as electronic configuration.

2) The distribution of electrons in various atomic orbitals provides an understanding of electron behaviour of the atom and in turn its reactivity.

3) The short notation it can be written as nl^x.

n- Denotes the principle Quantum Number.

l- Denotes the Azimuthal/Angular Quantum Number.

x- Denotes the number of electrons in orbital.

2. Rainbow is an example for continuous spectrum-Explain.

Ans: 1) Rainbow is a natural spectrum appearing in the sky just after a rain shower.

2) It is caused by dispersion of sunlight by ting water droplets present in atmosphere.

3) In rainbow in which there are no sharp boundaries in between colours.

4) Such a spectrum in which there are no sharp boundaries in between colours is known as continuous spectrum.

5) So, rainbow is also a continuous Spectrum.

3) How may elliptical Orbits are added by Somerfield in third Bohr's Orbit? What was the purpose of adding these elliptical Orbits?

Ans: In case of third Bohr's Orbit, Somerfield added 2 elliptical Orbits.

Purpose of adding elliptical Orbit:

1) Bohr's model failed to account for splitting of line spectra.

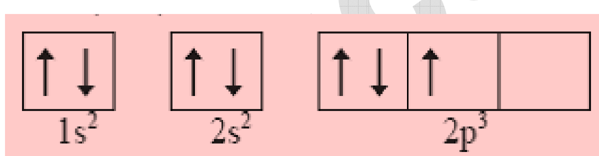
2) In an attempt to account for the structure of line spectrum, Somerfield modified Bohr's atomic model by adding elliptical Orbits.

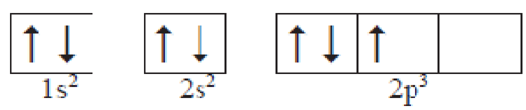
4) What is an Orbital? How is it different from Bohr's Orbit?

Ans: The region (or) space around the nucleus where the probability of finding the electron is maximum and such space is called an Orbital.

1) Bohr's Orbit has a definite boundary and fixed energy at different distances from the nucleus. They are circular in shape.
2) Orbitals have no definite boundary. It is region, where we find maximum possibility of electrons. The shape of each orbital is different.
3) Bohr's Orbit can accommodate maximum of 2n2 electrons in it, but Orbital can accommodate only 2 electrons.

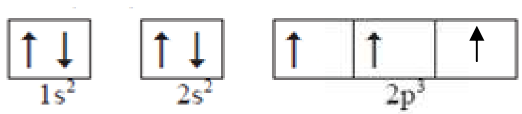
5) Following orbital diagram shows the electron configuration of nitrogen atom. Which rule doesn't support this?

N (z=7) ≈ 

Ans: Given electron configuration of Nitrogen is 

This is not supported by Hund's rule. According to Hund's rule, the orbitals of equal energy are occupied with one electron each before pairing of electrons starts.

The correct electronic configuration is as follows



6) i) An electron in an atom has the following set of four quantum numbers to which orbital it belongs to:

n	*l*	m	S
2	0	0	½

ii) Write the four quantum numbers for $1s^1$ electron.

Ans: i) The electron belongs to S-orbital. Since, (l=0) and with clockwise spin rotation.

ii) For $1s^1$ electron-

n	*l*	m	S
1	0	0	½

7) Collect the information regarding wave length and corresponding frequencies of three primary colours-red, blue and green.

Ans:

Colour	Frequency(THz)	Wavelength(nm)
Red	400 – 484	620 – 750
Green	526 – 606	495 – 570
Blue	606 – 668	450 – 495

1 Mark Questions

1) What is an Absorption Spectrum?

Ans: Absorption spectrum is spectrum obtained when the substances absorb energy.

It contains dark lines on bright background.

2) What is nl^x method? How it is useful?

Ans: nl^x is a short hand notation of electronic configuration. It consists of the principal quantum energy level (n) sublevel (l) and the no. of electron (x) in the sublevel. It helps to predict the values of all the four quantum number of any electron.

3) Which rule is violated in the electronic configuration? $1S^0\ 2S^2\ 2P^4$.

Ans: Aufbau principle is violated in this electronic configuration because according to Aufbau principle, Electron enters into orbital of lower energy.

Among 1s, 2s, 2p; 1s has least energy. So 1s orbital must be filled before the electron should enter into 2s.

4) Write the four Quantum Numbers for the differentiating electron of Sodium(Na) atom?

Ans: Sodium (Na). (Z=11) ---- $1s^2\ 2s^2\ 2p^6\ 3s^1$.

The differentiating electron is in 3s orbital.

The four quantum numbers.

n – 3

l – 0

m – 0

s – ½

5) What is Emission Spectrum?

Ans: The spectrum of radiation emitted by a substance from its excited state is an emission spectrum.

6) Which electronic shell is at a higher energy level K or L?

Ans: In given K, L shells

L shell is at higher energy shell. Since, it is for away from nucleus than K-shell.

7) The wave length of a radio wave is 1.0m. Find its frequency?

Ans: Wavelength of radio wave ($\lambda\nu$)= 1 m

As $C = \lambda\nu \Rightarrow 3 \times 10^8 = 1 \times \nu$

$\nu = 3 \times 10^8$ Osc/sec

C = velocity of radio wave (EM waves)

8) State Heisenberg principle of uncertainty?

Ans: According to Heisenberg's uncertainty principle,

"It is not possible to find the exact position and velocity of electron simultaneously".

4 – Mark Questions

1. **a. What is the maximum number of electrons that can be accommodated in a principal energy shell?**

   b. What is the maximum number of electrons that can be accommodated in a sub shell?

   c. What is the maximum number of electrons that can be accommodated in an orbital?

   d. How many sub-shells present in a principal energy shell?

   e. How many spin orientations are possible for an electron in an orbital?

Ans: a) The Maximum number of electrons that can be accommodate in a principal energy shell, of 'n' principal quantum number is $2n^2$

b) The maximum number of electrons that can be accommodated in a sub-shell is $2(2l + 1)$

l – Azimuthal (or) Angular Quantum number

Sub-shell	**Number of Orbitals ($2l + 1$)**	**Number of ēs $2(2l + 1)$**
S ($l = 0$)	1	2
P ($l = 1$)	3	6
d ($l = 2$)	5	10
F ($l = 3$)	7	14

c) The maximum of number of electrons that can be accommodated in an orbital is two

d) In a principal energy shell $(n)_1$ there (n^2) sub-shells

e) For an electron in an orbital only 2 spin orientations are possible ie,-1/2

2. In an atom, the number of electrons in M-shell is equal to the number of electrons in K and L-shells. Answer the following questions.

a) What is the outermost shell?

b) How many electrons are there in the outermost shell?

c) What is the atomic number of the element?

d) Write electronic configuration of that element.

Ans: Number of electrons in M shell is equal to the number of the electrons in K and L shells-

i.e. the number of electrons in M shell is $2 + 8 = 10$ electrons

Total electrons in the element = $\underset{(K)}{2} + \underset{(L)}{8} + \underset{(M)}{10} + \underset{(N)}{2} = 22$ electrons

So,

a) 4^{th} spell (N) is the outermost shell

b) 2 electrons were there in N-shell (outer most shell)

c) Atomic number of that element is 22

d) Electronic configuration of that element is $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$

3. Explain the significance of three Quantum numbers in predicting the positions of an electron in an atom.

Ans: Each electron in an atom is described by a set of three quantum numbers – n, *l*, m.

These numbers indicate the probability of finding the electron in the space around nucleus.

1. Principal Quantum Number (n)

The Principal Quantum number is related to size and energy of the main shell. It is denoted by ‘n’.

- ‘n’ has positive integer values (1, 2, 3, …)

- Number of electrons in a shell is limited to $2n^2$

2. Azimuthal (or) Angular Quantum Number (*l*)

This Azimuthal Quantum Number defines the shape of the Orbital occupied by the electron and the orbital angular momentum of the electrons in motion.

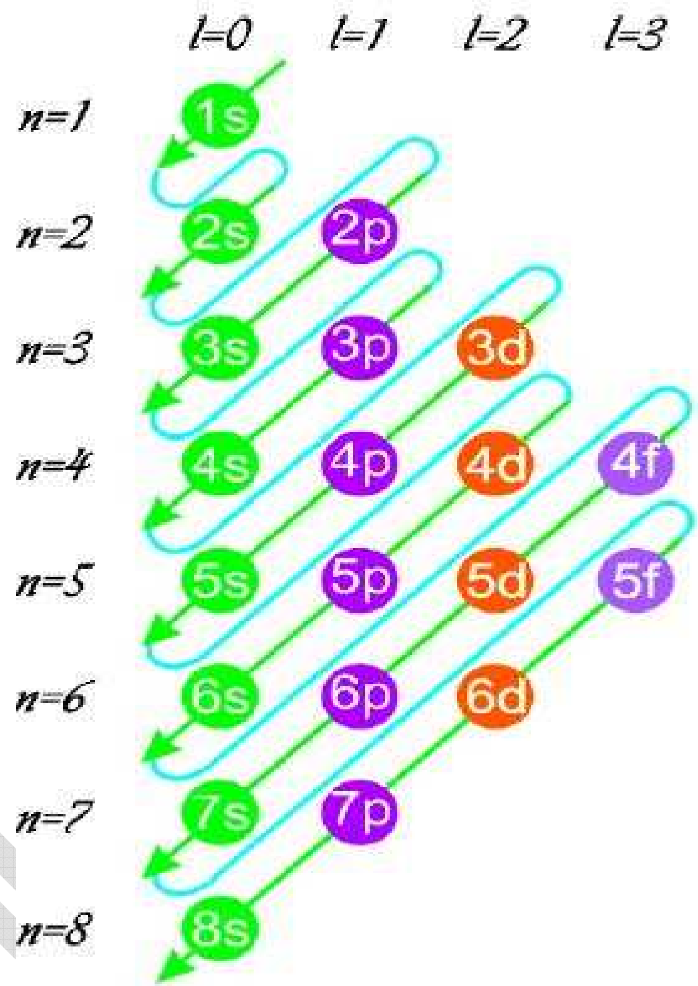
- Due to this, it is also called as Angular Quantum momentum
- It is denoted by *l*
- ‘*l*’ has integer values from 0 to (n+1) for each value of n
- The Quantum number ‘*l*’ also governs the degree with which the electron is attached the nucleus.
- The larger is the value of ‘*l*’, smaller is bond with which it attached with the nucleus.

3. Magnetic Orbital Quantum Number(m):

- To Explain the Zeeman Effect and Stark Effect, magnetic orbital quantum number is introduced.
- The orientation of orbital with external magnetic field determine magnetic orbital quantum number(m_l)
- Magnetic Quantum number (m_l) has integer values between $-l$ *to* $+l$ including zero.
- Thus for a certain value of l there are $(2l + 1)$ integer values of m_l

5 Mark Questions

Moeller Chart



Fill in the Blanks

1. If n = 1 then angular momentum quantum number (l) =_________. (0)

2. If a sub-shell is denoted as 2p then its magnetic quantum number values are ____, ____, ____. (-1,0,1)

3. Maximum number of electrons that an M-shell contains is/are _________. (18)

4. For 'n', the minimum value is ______and the maximum value is ______. (1, n)

5. For 'l', the minimum value is _______and the maximum value is _______. (1, n-1)

6. For 'm_l' the minimum value is _____and the maximum value is _____. (-l, l)

7. According to _________ Principle no two electrons of the same atom can have the four quantum numbers the same. (Pauli's exclusion)

8. Spectrum is a group of _________. (wavelengths)

9. The space around the nucleus where the probability of finding of electron is maximum is called_________. (orbital)

10. As long as electron revolves in a _________Orbit nether loses (or) gains energy. (stationary)

11. Quantum theory is proposed by _________. (Max Planck)

12. _________Principle states that lowest energy orbitals are filled first. (Aufbau's)

13. The orbitals of equal energy are occupied with one electron each. It is ………… Rule. (Hund's)

14. Electromagnetic energy of radiation is given by the equation E _______. (hν)

15. According to wave theory, light is considered as wave_______. (electro magnetic)

16. _________Quantum number defines the shape of the orbital. (Azimuhal / angular)

17. Quantum mechanical model of atom was developed by_____. (Erwin Schrodinger)

Multiple Choice Questions

1. **An emission spectrum consists of bright spectral lines on a dark back ground. Which one of the following does not correspond to the bright spectral lines?**

[ ]

a) Frequency of emitted radiation

b) Wave length of emitted radiation

c) Energy of emitted radiations

d) Velocity of light

2. **The maximum number of electrons that can be accommodated in the L – shell of an atom is :**

a) 2 b) 4 c) 8 d) 16

[ ]

3. **If l = 1 for an atom then the number of orbitals in its sub-shell is**

a) 1 b) 2 c) 3 d) 0

[ ]

4. **The quantum number which explains about size and energy of the orbit or shell is?**

[ ]

a) Principal b) Azimuthal c) Magnetic d) Spin

5. **Shape of a –orbital is …………..**

[ ]

a) Dumbell b) Double dumbel

c) Spherical d) No shape

6. **Quantum theory was proposed by?**

[ ]

a) Bohr b) Max Planck

c) Sommerfeld d) Erwin Schrödinger

7. **Splitting of spectral lines in electric field is known as?**

[ ]

a) Zeeman Effect b) Stark Effect

c) Photoelectric Effect d) None

8. **The lowest energy state of the electron is known as …………. State.**

[ ]

a) Excited b) Stationary

c) Ground d) Higher energy

9. Name the orbital for l = 1 is-

[ ]

a) s b) p

c) d d) f

10. The number of electrons in a shell is limited to?

[ ]

a) 2l + 1 b) 2(2l + 1)

c) $2n^2$ d) n^2

11. If there are no sharp boundaries in between colours, then the spectrum is called as ______.

[ ]

a) Line spectrum b) Band spectrum

c) Continuous spectrum d) None

12. ________ Quantum number explains about the size and energy of the orbital.

[ ]

a) Principal b) Orbital

c) Magnetic d) Spin

13. Quantum mechanical model of atom was developed by ________.

[ ]

a) Bohr b) Erwin Schrödinger

c) Max Planck d) Somerfield

14. Splitting of spectral lines in magnetic field is known as …………. [ ]

a) Zeeman Effect b) Stark Effect

c) Photo Electric Effect d) None

15. The region of space around the nucleus where the probability of finding an electron is minimum is called? [ ]

a) Orbit b) Node

c) Orbital d) Energy level

Key:

1) d; 2) c; 3) c; 4) a; 5) b; 6) b;

7) b; 8) c; 9) b; 10) c; 11) c; 12) a;

13)b; 14) a; 15) b.

Matching

1.	Group – A		Group – B
i)	Value of n	[ ]	a) o to (n - 1)
ii)	Value of l	[ ]	b) +1/2, -1/2
iii)	Value of M_l	[ ]	c) Non- zero integers
iv)	Value of M_s	[ ]	d) $-l$ to $+l$
v)	d- orbital	[ ]	e) l = 1
			f) $l = 2$

Key:

i) c; ii) a; iii) d; iv) b; v) f;

2. Group – A | **Group – B**

	Group – A		Group – B
i)	Size and energy of an orbit	[ ]	a) Hund's rule
ii)	Shape of orbit	[ ]	b) Aufbau's principle
iii)	Building up rule	[ ]	c) Principal Quantum number
iv)	Spin of electrons about own axes	[ ]	d) Azimuthal Quantum number
v)	Orientation of orbital with external magnetic field	[ ]	e) Magnetic Quantum number
			f) Spin Quantum number

Key:

i) c; ii) d; iii) b; iv) f; v) e;

3.

	Group – A		Group – B
i)	Quantum theory	[ ]	a) Moeller
ii)	Stationary orbits	[ ]	b) Max plank
iii)	Relative energies of orbits	[ ]	c) Erwin Schrödinger
iv)	Quantum model of an atom	[ ]	d) Niels Bohr
v)	No two electrons have same set of four Quantum numbers	[ ]	e) Wolfgang Pauli

Key:

i) b; ii) d; iii) a; iv) c; v) e;

4. **Group – A** **Group – B**

i)	Continuous spectrum	[ ]	a) Gaseous atoms
ii)	Line spectrum	[ ]	b) 589nm – 589.6nm
iii)	Band spectrum	[ ]	c) Rainbow
iv)	Absorption spectrum	[ ]	d) Molecules
v)	Wave length range of sodium vapour	[ ]	e) Absorption energy

Key:

i) c; ii) a; iii) d; iv) e; v) b;

5. Group – A **Group – B**

i)	Size and shape of main shell	[ ]	a) l
ii)	sub- shells	[ ]	b) M_s
iii)	Orientation of orbitals	[ ]	c) n
iv)	Direction of spin	[ ]	d) electronic configuration
v)	Distribution of electrons	[ ]	e) m_l

Key:

i) c; ii) a; iii) e; iv) b; v) d;

Important images

1. An electromagnetic wave

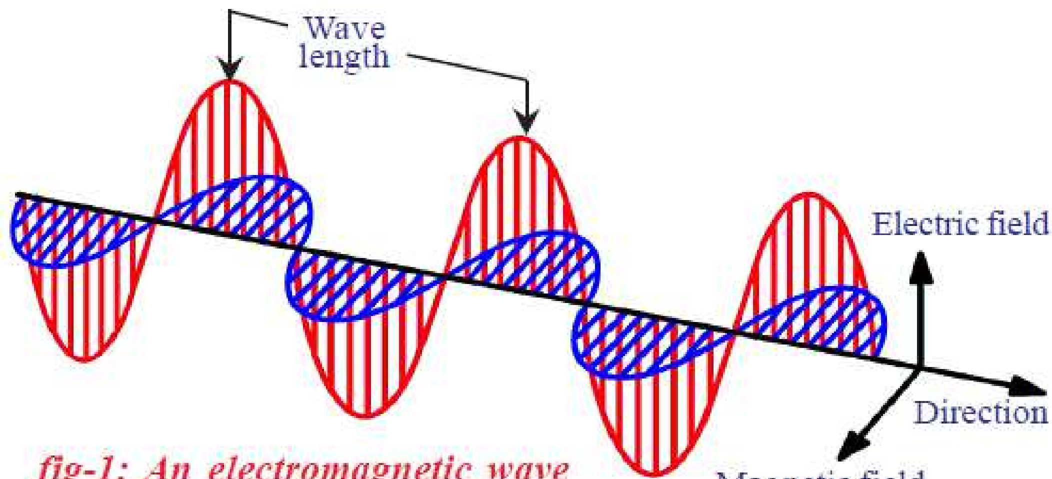


fig-1: An electromagnetic wave

2. Electromagnetic spectrum

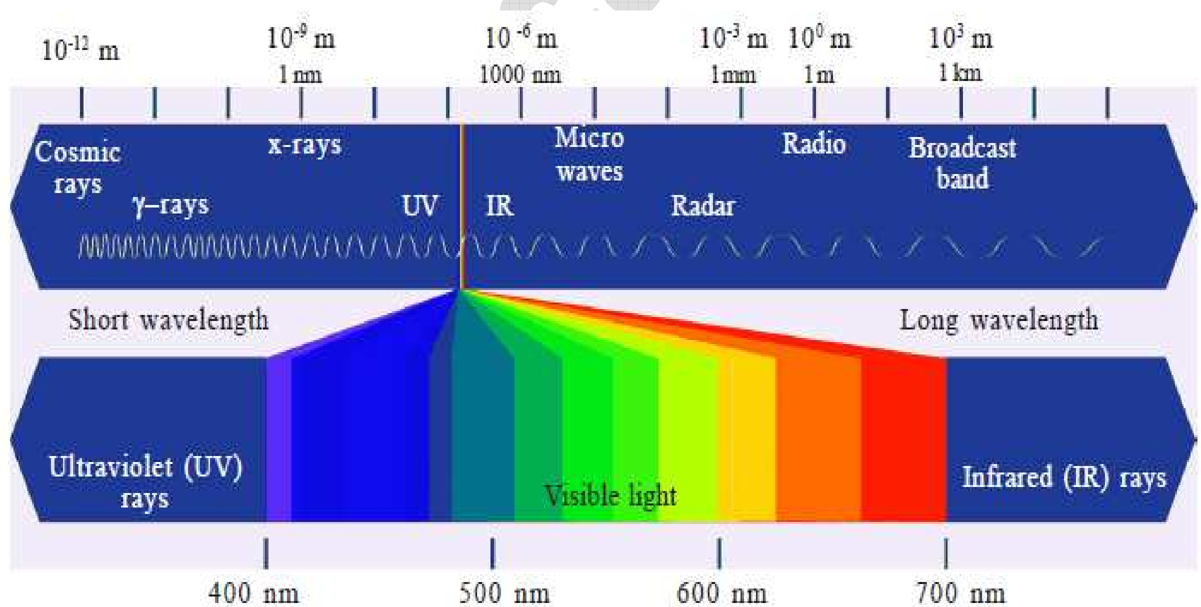


fig-2: Electromagnetic Spectrum

3. Hydrogen spectrum

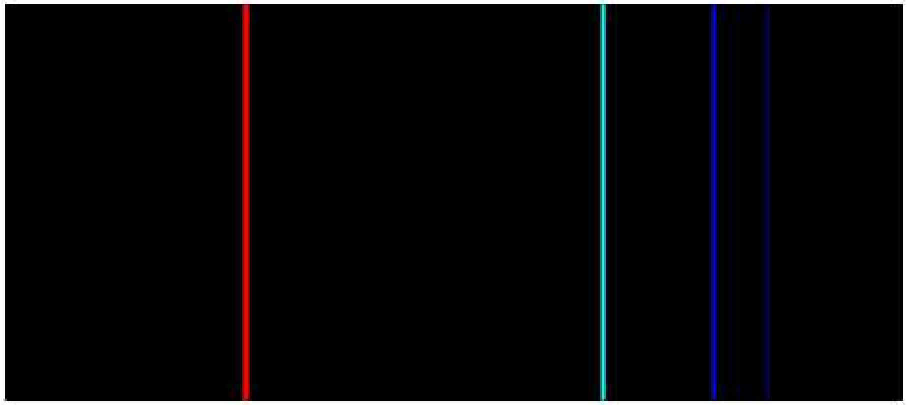


fig-3: Hydrogen Spectrum

4. Bohr - Sommerfield model

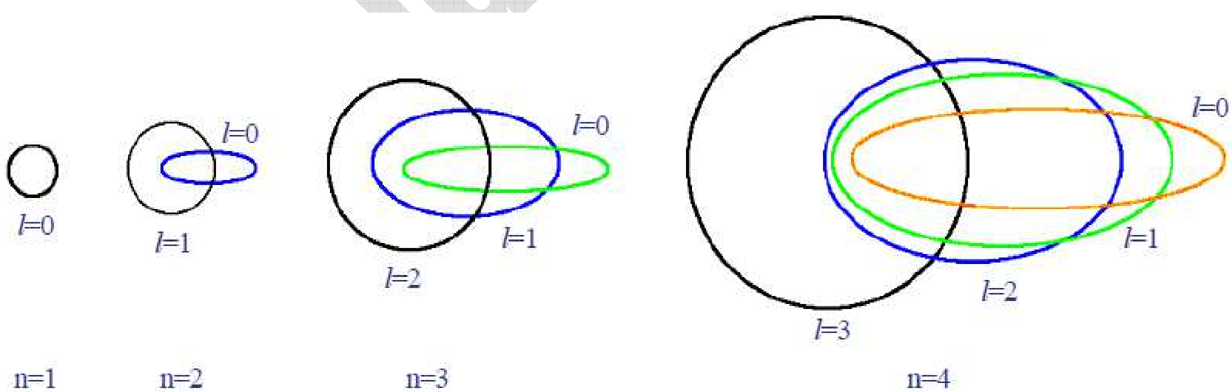


fig-4: The allowed electronic orbits for the main Quantum numbers by Bohr - Sommerfeld model

5. Shapes of orbitals in s, p and d subshells

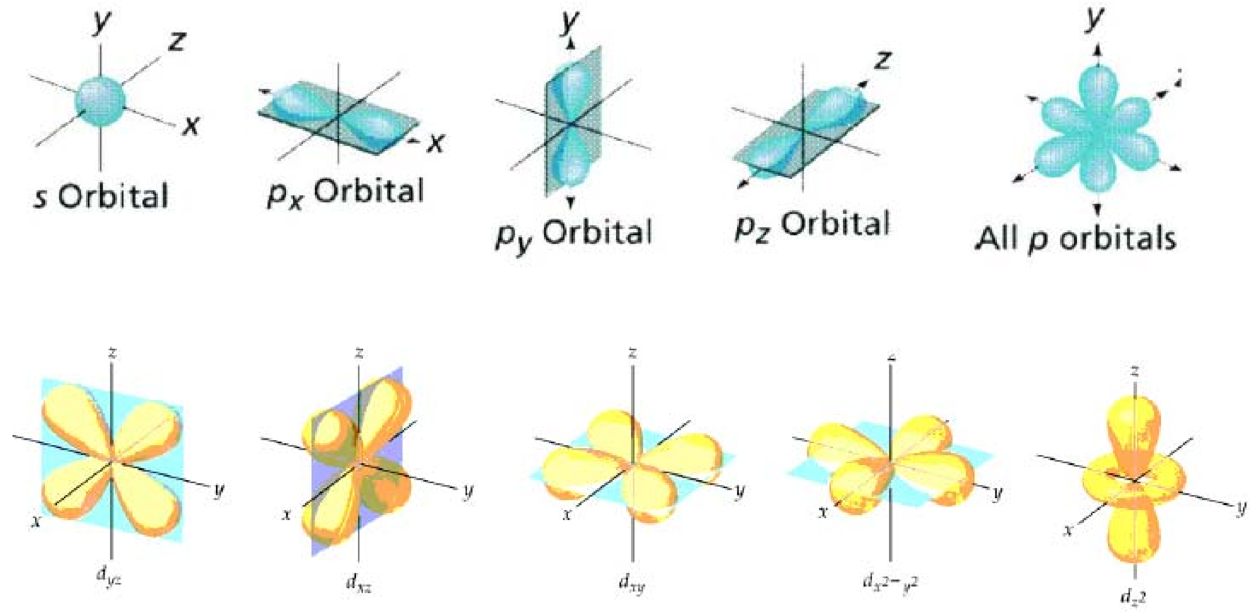


fig-5: Shapes of orbitals in s, p and d subshells

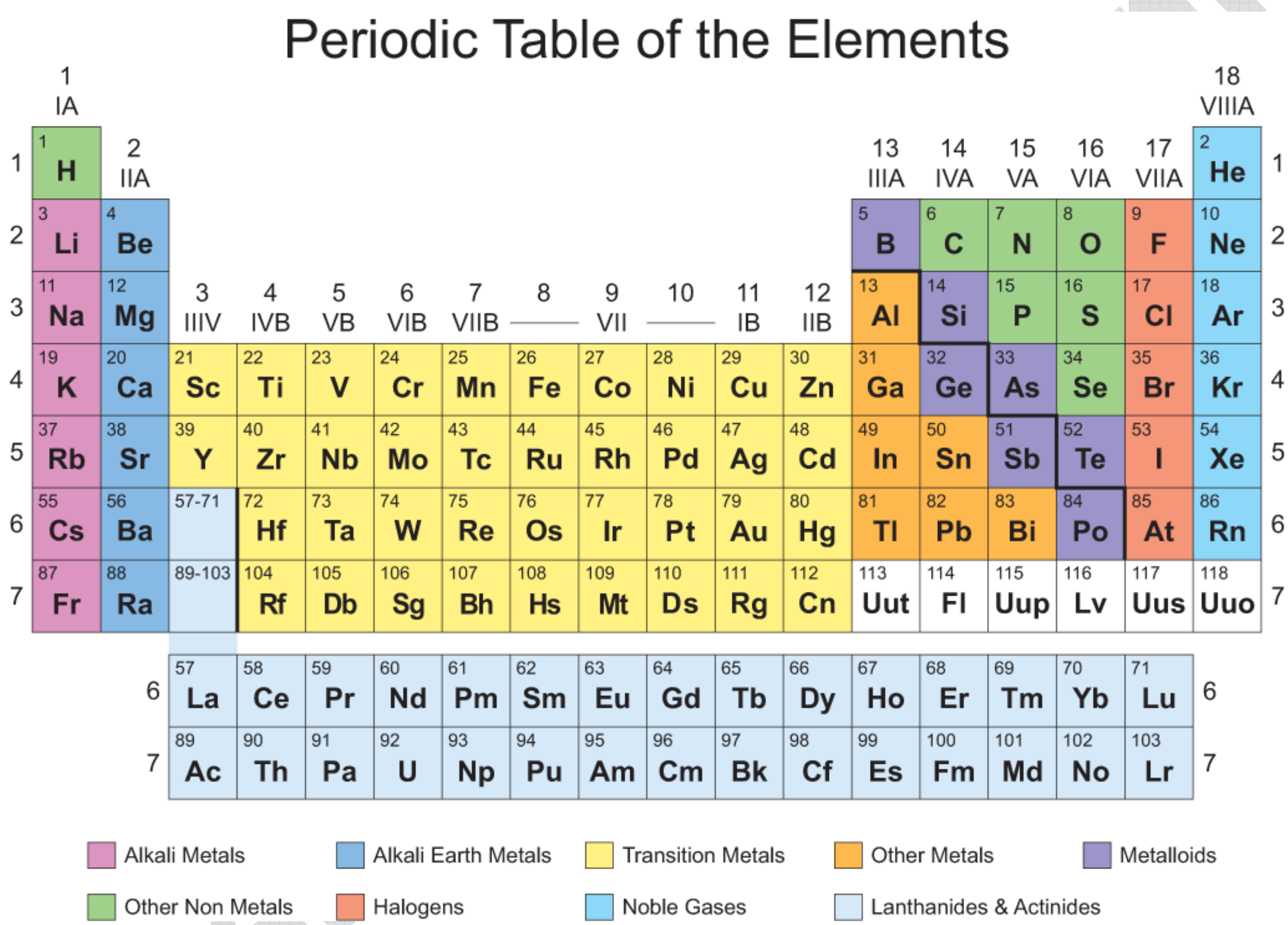
6. Electron configuration of H, He, Li, Be, B

H(Z=1)	$1s^1$	↑				
He(Z=2)	$1s^2$	↑↓				
Li(Z=3)	$1s^2 2s^1$	↑↓	↑			
Be(Z=4)	$1s^2 2s^2$	↑↓	↑↓			
B(Z=5)	$1s^2 2s^2 2p^1$	↑↓	↑↓	↑		

Chapter -9

Classification of Elements – The periodic Table

SYNOPSIS



From the earliest times, scientists have been trying to classify the available elements on the basis of their properties.

Dobereiner proposed 'law of triads'. Newland proposed law of octaves. Mendeleeff divide the elements into groups on the basis of "atomic weights". The limitations in mendeleev's periodic table are removed in modern periodic table.

In modern periodic table eighteen groups and seven periods. There are 's' block, 'p' block, 'd' block and 'f' block elements.

Atomic radius, Ionization energy, electron affinity, Electro negativity are the main characteristic of the enlacements both in groups and periods

2Mark Questions

1. Elements in a group generally possess similar properties, but elements along a period have different properties. How do you explain this statement?

A. According to modern periodic law, the physical and chemical properties of elements are the periodic function of their atomic number or electronic configuration.

That means that elements having the similar valency electronic configuration have similar properties.

But, the valency electronic configuration of different elements in the same period is different so, the properties of different elements in a period are different.

2. s - block and p - block elements except 18^{th} group elements are sometimes called as 'Representative elements' based on their abundant availability in the nature. Is it justified? Why?

A. s - block and p - block elements except 18^{th} group elements are called 'Representative elements'.

All these elements have incomplete shells. So they are chemically reactive to obtain stable electronic configuration of noble gases ns^2np^6.

So, they are abundant in nature in the form of compounds.

3. How does metallic character change when we move?

i. Down a group **ii. Across a period**

A. i. As we go down the group, tendency to loose on electron increases. So metallic character increases.

ii. Across a period, from left to right, metallic character decreases. i.e., non-metallic character increases.

4. Complete the following table using the periodic table.

Period Number	Filling up orbital's (sun shells)	Maximum of electrons, filled in all the sub shells	Total no.of electrons in the period
1			
2			
3			
4	4s, 3d, 4p	18	18
5			
6			
7	7s, 5f, 6d, 7p	32	incomplete

A.

Period Number	Filling up orbital's (sun shells)	Maximum of electrons, filled in all the sub shells	Total no.of electrons in the period
1	1s	2	2
2	2s, 2p	8	8
3	3s, 3p	8	8
4	4s, 3d, 4p	18	18
5	5s, 4d, 5p	18	18
6	6s, 4f, 5d, 6d	32	32
7	7s, 5f, 6d, 7p	32	incomplete

5. The electronic configuration of the elements X, Y and Z are given below?

a) X = 2

b) Y = 2, 6

c) Z = 2, 8, 2

i) Which element belongs to second period?

ii) Which element belongs to second group?

iii) Which element belongs to 18th group?

A. i) Y belongs to second period, since, differentiating electron enter into second shell.

ii) Element ‘Z’ belongs to second group. Because, its velence is 2

iii) Element ‘X’ belongs to 18^{th} group, because its 1^{st} shell completely filled with electrons.

6. Identify the element that has the largest atomic radius in each pair of the following and mark it with a symbol (✓). (AS1)

(i) Mg or Ca **(ii) Li or Cs** **(iii) N or D** **(iv) B or A*l***

A. i) **Mg or Ca:** Ca (✓) →[Ca > Mg]

Since as we go down the group, atomic sizes of elements increases

ii) **Li or Cs:** Cs (✓) [Cs > Li]

In since, as we go down the group, atomic sizes of elements increases

iii) **N or D:** D (✓) [N < D]

iv) **B or A*l*:** A*l* (✓) [A*l* > B]

7. **Complete the following table using the periodic table.**

Period number	Total no. of elements	Elements		Total no. of elements in			
		From	To	s-block	p-block	d-block	f-block
1.							
2.							
3.							
4.							
5.							
6.							
7.							

A.

Period number	Total no. of elements	Elements		Total no. of elements in			
		From	To	s-block	p-block	d-block	f-block
1.	2	H	He	1	1		
2.	8	Li	Ne	2	6		
3.	8	Na	Ar	2	6		
4.	18	K	Kr	2	6	10	
5.	18	Rb	Xe	2	6	10	
6.	32	Cs	Rn	2	6	10	14
7.	Incomplete	Fr	-	2	2(Incomplete)	10	14

8. Identify the element that has the lower Ionization energy in each pair of the following and mark it with a symbol (✓).

(i) Mg or Na

(ii) Li or O

(iii) Br or F

(iv) K or Br

A. i) Mg (or) Na — Na (✓)

ii) Li (or) O — Li (✓)

iii) Br (or) F — Br (✓)

iv) K (or) Br — K (✓)

9. Why was the basis of classification of elements changed from the atomic mass to the atomic number?

A. i) The properties of elements depends upon the number of electrons present in the valence shell which are related to atomic number.

ii) Thus the properties of different elements can be compared if we know their atomic numbers.

iii) On the other hand, atomic mass can in no way determine the chemical properties of elements, because it does not vary regularly with gradation in the chemical properties of elements.

iv) So, the basis, of the classification of elements changed from atomic mass to the atomic number.

10. On the basis of atomic numbers predict to which block the elements with atomic number 9, 37, 46 and 64 belongs to?

A. The elements with atomic number a, belong to group 17 (VIIA). So, it belongs to p-block.

The element with atomic number 37, belongs to Group 1(IA). So, it belongs to s-

block.

The elements with atomic number 46, belongs to Group10 (vIIB). So, it belongs to d-block.

The elements with atomic number 64, belongs to Lanthanides. So, it belongs to f-block.

11. An element X belongs to 3rd period and group 2 of the periodic table. State

a) The no. of valence electrons

b) The valency

c) Whether it is metal or a nonmetal.

A. An element X belongs to 3rd period and group 2 is Mg

a) The no. of valence electrons is 2

b) The valency of atom 2

c) The element belongs to IIA group. It is of the periodic table.

So, it is a metal.

12. An element has atomic number 19. Where would you expect this element in the periodic table and why?

A. Atomic number of the element -19

Arrangement of these 19 electrons is 2, 8, 8, 1

So, the differentiating electron enters into 4th shell. So, the element belongs to 4th period. So the element belongs to 4th period.

The no. of valence electrons = 1. So it belongs to 1st group

$\therefore$ The element with atomic number 19 belongs to 4th period and I group.

13. Collect the information about reactivity of VIII A group elements (noble gases) from internet or from your school library and prepare a report on their special character when compared to other elements of periodic table.

A. The VIIIA group elements are chemically inactive. All of them have stable "octet" in their valence shells except helium the nobel gases have high ionization energy and zero electron affinity values. Consequence to this loosing or gaining an electron or sharing of electrons is difficult.

But some compounds of these gases have been prepared under suitable conditions.

Xenon (Xe) shows a tendency to lose an electron and exist in a positive oxidation state. Therefore it reacts with highly electronegative elements like F_2 & O_2 only .

EG. XeO_3; XeO_4; XeF_2, XeF_4

14. Comment on the position of hydrogen in periodic table.

A. i) The position of hydrogen in the periodic table is unique.

ii) Its properties resemble with both Alkali metals (IA) and halogens (VIIIA) because it can loose one electron like alkali metals as well as gain one electron as halogens

iii) So, it is placed at the top of both alkali metals and halogens.

15. How do you appreciate the role of electronic configuration of the atoms of elements in periodic classification?

A. According to modern periodic law, the properties of elements are the periodic function of their atomic number or electronic configuration.

So, the classification of elements have done basing on electronic configuration. The electronic having same outer shell electronic configuration are kept in the same group. The elements have same chemical properties.

So, I appreciate the role of electronic configuration of the atoms of element which plays a key role in the process of classification of elements.

1 Mark Questions

1. Name two elements that you would expect to have chemical properties similar to Mg. What is the basis for your choice?

A. Calcium (Ca) and strontium (Sr) are the two elements, which are similar to Mg in chemical properties.

Because, they belong to the same group IIA. All the elements which are in the same group have same electronic configuration and same chemical properties.

2. Using the periodic table, predict the formula of compound formed between and element X of group 13 and another element Y of group 16.

A. Element X of group 13   Element X of group 13

Valency of X is 13   Valency = 18 – 16 = 2

Formula of the compound formed between X and Y

$$X^3 \quad Y^{-2}$$

$$(X_2\, Y_3)$$

3. How does the valency vary on going down a group?

A. The valency doesn’t changes on going down a group.

4. Sate Modern Periodic Law.

A. The Physical and chemical Properties of the elements are the periodic functions of their Electronic Configurations of the atoms.

5. How does the valency vary in a period on going from left to right?

A. The valency starts from a and increases upto 4 and then decreases to get o, while mulling from left to right.

6. State law of triads.

A. Dobereiner stated that when elements with similar properties are taken

three at a time and arranged in the ascending order of their atomic weights,

the atomic weight of the middle element is the average of the atomic

weights of the first and third elements.

7. Which elements are called as Lanthanoids and Actinoids?

A. i) 4f elements from $_{58}Ce$ to $_{11}Lu$ posses almost the same properties as $_{57}$ la. So they were called as Lanthanoids.

ii) 5f elements from $_{90}Th$ to $_{103}Lr$ posses almost the same properties as $_{89}Ac$. So they were called as Actinoids.

8. According to Mosley, what is atomic number?

A. According to Mosley, the number of positive charges (protons) in the atom of an element is the atomic number of those elements.

4 Mark Questions

1. Newlands proposed the law of octaves. Mendeleeff suggested eight groups for elements in his table. How do you explain these observations in terms of modern periodic classification?

A. Newlands proposed the law of octaves. According to newlads law of octaves, every eighth elements starting from a given one be a repetition of the first with regard to its properties.

Mendeleeff suggested eight groups for elements in his table. The elements in the same group have same properties that means every eighth element starting from a given element have same property with that.

In terms of modern concept, after completion of one shell. The properties of elements are repeated. After completion of one shell of the properties of elements are repeated.

So, Newlands law of octaves and Mendeleeff's suggestion of eight groups for elements are also reliable according to modern concepts.

2. What are the limitations of Mendeleeff's periodic table? How could the modern periodic table overcome the limitations of Mendeleeff's table?

A. Limitations of Mendeleeff's periodic table:

1) Position of Hydrogen: The position of hydrogen in table is not certain because it can be placed in group IA as well as in group VIIA as it resembles both with alkali

Metals of IA group and halogens of VIIA group.

2) Anomalous pair of elements: Certain elements of higher atomic mass precede those with lower atomic mass.

Eg: Tellurium precedes iodine;

Potassium (A = 39) placed after Argon (A = 40).

3) Dissimilar elements placed together: Elements with dissimilar properties were placed in same group as sub-group A and sub-group B.

Eg: Li, Na, K of IA group have little resemblance with Cu, Ag, Au of IB group.

4) Some similar elements are separated: Some similar elements like 'copper and mercury' 'Silicon and thallium', etc, are placed in different groups of periodic table.

5) Position of Isotopes: Isotopes of elements are placed in the same position in the table. Modern periodic table removes various anomalous of Mendeleeff's table in the following way:

1) Hydrogen is placed in IA group according to its electronic configuration. But it is not included in IA group elements (Alkali metals).
2) Basing on their electronic configuration anomalous pairs (R and Ar) are put in order according to their atomic number.
3) Dissimilar elements were placed in different groups
4) Copper and Mercury come in different groups according their electronic configuration.
5) All the istopes of same element have same atomic number. So all Isotopes are put in same group as a single element in modern periodic.

3. Define modern periodic law. Discuss the construction of the long of the periodic table.

Modern periodic law: The Physical and chemical Properties of the elements are the periodic functions of their Electronic Configurations.

i) The modern periodic table has eighteen vertical columns known as groups and seven horizontal rows known as periods.

ii) Elements are arranged in the order of increasing atomic numbers in periods.

iii) In groups the elements are placed having similar electronic configuration a having similar number of electrons in their outermost shells.

s-block elements: The elements with valence shell electronic configuration ns^1 and sn^2 are called s-block elements.

p-block elements: The elements with valence shell electronic configuration ns^2np^6 are called p-block elements.

These s and p block elements together known as representative elements.

d-block elements: The elements with valence shell configuration $ns^2np^6(n-1)d^1$ to $ns^2np^6(n-1)d^{10}$ are called d-block elements. These are also called as Transition elements.

f-block elements: The elements in which orbitals are being filled in their atoms are called f-block elements. These elements are also called as inner transition elements.

Inert gases:

The elements with complete outermost shell configuration (ns^2np^6) are known as inert gases. He, Ne, Ar, Kr, Xe and radon do not react with any other elements. So these are called inert gases.

First period contains 2 elements

2^{nd} and 3^{rd} periods contains 8 elements each.

4^{th} and 5^{th} periods contains 18 elements each.

6^{th} period contains 32 elements

7^{th} period is incomplete

- The elements from Ce_{58} to Lu_{71} are called Lanthanides.
  These elements are 4f block elements
- The elements from Th_{90} to Lr_{103} are called as Actinoids.
  These elements are 5f block elements.
- Lanthanides & Actinoides are shown separately at the bottom of the periodic table.

4.Explain how the elements are classified into s, p, d and f block elements in the periodic table and give the advantages of this kind of classification.

A. Depending on the valency shell electronic configuration elements are classified into s, p, d and f block

s-block elements: The elements with valence shell electronic configuration ns^1 and sn^2 are called s-block elements.

p-block elements: The elements with valence shell electronic configuration ns^2np^{1-6} are called p-block elements. s and p block elements are known as representative elements.

d-block elements: The elements with valence shell electronic configuration $ns^2(n-1)d^{1-10}$ are called d-block elements.

These are known as Transition elements.

f-block elements: The elements in which f-block are being filled in their atoms are called f-block elements. These are known as Inner Transition elements.

Advantage:

The division of elements into blocks is useful to divide the elements into groups. Every group has the elements with same valence electronic configuration. So they have similar chemical properties

s-block elements – IA & IIA groups
p-block elements – IIIA & VIIIA groups
d-block elements – IB & VIIIB groups
f-block elements – Lanthanides & Actinoides.

5. Given below is the electronic configuration of elements A, B, C, D.

A.$1s^2\ 2s^2$

B.$1s^2\ 2s^2\ 2p^6\ 3s^2$

C.$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

D.$1s^2\ 2s^2\ 2p^6$

1) Which are the elements coming with in the same period

2) Which are the ones coming with in the same group?

3) Which are the noble gas elements?

4) To which group and period does the elements 'C 'belong.

A. 1) A and D elements belongs to same period, since their outmost shell is same (II period)

C and D elements belongs to same period, since their outermost shell is same (III period)

2) Element A,B belongs to same group because of their similar outermost electronic configuration.

3) Element D is the Noble gas due to its completely filled electronic configuration in its outermost orbit.

4) The element the C - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ belongs to III period & 15^{th} group (VA)

6. Write down the characteristics of the elements having atomic number 17.

Electronic configuration _______________ ($1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$)

Period number _______________________ (III)

Group number _______________________ (17^{th} (or) VIIA)

Element family _______________________ (Halogens)

No. of valence electrons ________________ (2 + 5 = 7 electrons)

Valency ______________________________ (-1)

Metal or non-metal ____________________ (Non metal)

7. **a) State the number of valence electrons, the group number and the period number of each element given in the following table:**

Element	**Valence electrons**	**Group number**	**Period number**
Sulphur			
Oxygen			
Magnesium			
Hydrogen			
Fluorine			
Aluminum			

b) State whether the following elements belong to a Group (G), Period (P) or Neither Group nor Period (N).

Elements	**G/P/N**
Li,C,O	
Mg, Ca, Ba	
Br, Cl, F	
C,S, Br	
Al, Si, Cl	

Li, Na, k	
C,N,O	
K, Ca, Br.	

A. a)

Element	**Valence electrons**	**Group number**	**Period number**
Sulphur	6	16 (VIA)	3
Oxygen	6	16 (VIA)	2
Magnesium	2	2 (IIA)	3
Hydrogen	1	1(IA)	1
Fluorine	7	17 (VIIA)	2
Aluminum	3	13 (IIIA)	3

b)

Elements	**G/P/N**
Li,C,O	D
Mg, Ca, Ba	G
Br, Cl, F	G
C,S, Br	N
Al, Si, Cl	P

Li, Na, k	G
C,N,O	P
K, Ca, Br.	P

8. In period 2, element X is to the right of element Y. Then, find which of the elements have:

i) Low nuclear charge

ii) Low atomic size

iii) High ionization energy

iv) High electronegativity

(v) More metallic character

A. i) In a period, nuclear charge increases from left to right so, Y has low nuclear than X.

ii) In a period, atomic radius decreases from left to right so, X has low atomic radius than Y.

iii) In a period, ionization energy increases from left to right so, X has high ionization energy than Y.

iv) In a period, electro negativity increases from left to right so, X has high electro negativity value than Y.

v) In a period, metallic character decreases from left to right so, Y has more metallic character than X.

9. a) What is a periodic property? How do the following properties change in a group and period? Explain.

(a) Atomic radius

(b) Ionization energy

(c) Electron affinity

(d) Electro negativity.

(b) Explain the ionization energy order in the following sets of elements:

a) Na, Al, Cl

b) Li, Be, B

c) C, N, O

d) F, Ne, Na

e) Be, Mg, Ca.

A. **Periodic property:** The repetition of chemical properties and regular gradation in physical properties in groups as well as in periods according to their outermost shell configuration is called as periodicity.

The property of an element which is related and repeated according to electronic configuration of the atoms of elements is known as periodicity.

a) Atomic radius:

The distance between the centers of the nucleus to the outermost shell of an atom is called atomic radius.

In groups: Atomic radius increases from top to bottom in a group. This is due to the addition of new shell.

In periods: Atomic radius decreases from left to right in a period. As we go to right electrons enter in a same shell. So the nuclear attraction on the outer shell increases. As a result size of the atom increases.

b) Ionization energy:

The energy required to remove an electron from the outer most orbit of a neutral gaseous is called ionization energy.

Ionization energy decreases as we go, down in a group. Ionization energy generally increases from left to right in period.

c) Electron affinity:

The electron affinity of an element is defined as the energy liberated when an electron is added to its neutral gaseous atom.

Electron affinity decreases as we go down in a group. Electron affinity increases along a period from left to right.

d) Electro negativity:

The electro negativity of an element is defined as the relative tendency of its atom to attract electrons towards it when it is bounded to the atoms of another element.

Electro negativity decreases ads we go down in a group. Electro negativity increases along a period from left to right.

ii) a) Na, A*l*, C*l*

Na < A*l* < c*l*

All these elements belong to same period. The order of their atomic size is [Na > A*l* > C*l*]. As we move from left to right in a period Ionization energy increases.

b) Li, Be, B — I.E – Be > Li > B

As these 3 elements belongs to same period. The electronic configuration of

Li – $1s^2\ 2s^2$; Be- $1s^2\ 2s^2$; B- $1s^2 2s^2\ 2p^1$

The penetration power of 2p is less compared to 2s. So, it is easy to remove electron from 2p.

c) C, N, O :— I.E : N > C > O

C, N, O belongs to some period. The electronic configuration of

c – $1s^2\ 2s^2\ 2p^2$: N- $1s^2\ 2s^2\ 2p^3$; O – $1s^2\ 2s^2\ 2p^4$

Nitrogen has half filled configuration in degenerated orbital. So, it is more stable compare to C & O, so, N has high ionization energy.

d) F, Ne, Na: (Ne > F > Na) — I.E

Ne is an inert gas, so it has highest ionization energy. Na has larger size compare to F. So, it has low ionization energy.

e) Be, Mg, Ca: IE (Ca < Mg < Be)

These elements belongs to same group the atomic size of these elements is in the order of Ca > Mg > Ba.

As atomic size increases ionization energy decreases.

10. Aluminum does not react with water at room temperature but reacts with both dil. HC*l* and NaOH solutions. Verify these statements experimentally. Write your observations with chemical equations. From these observations, can we conclude that A*l* is a metalloid?

A. Metalloids are elements which resemble both metals and non-metals. The valency shell of metalloids contain 3, 4, 5, 6 elements starting from periods 2 to 5 respectively. A*l* belongs to 3rd period. It contains 3 valence electrons. So, it is not a metalloid as it contains 3 valence electrons instead of 4.

A*l* doesn't react with water at room temperature. But it reacts at high temperature with water

$2Al + 6H_2O \rightarrow 2Al(OH)_3 + 3H_2$

Al reacts with dil Hcl & liberates Hydrogen gas

$2Al + 6\ HCl \rightarrow 2AlCl_3 + 3H_2$

Al reacts with dil NaOH and liberates hydrogen gas

$2Al + 2NaOH + 6\ H_2O \rightarrow [Na_2\ Al(OH)_4] + 3H_2(4)$

From the above reactions, we conclude that all react with both acids as well as bases. So, it is Amphoteric.

11. Collect information regarding metallic character of elements of IA group and prepare report to support the idea of metallic character increases in a group as we move from top to bottom

A. The tendency of an element to lose electron and form positive ions is called metallic character.

The elements to the left of the periodic table i.e., IA group have greater tendency to lose electrons so, they are strong metals. Li, Na, K, Rb, Cs (IA) are strong metals as they lose one electron and posses high reactivity.

As we go down in a group the atomic size increases and electrons in the outer shell experiences less nuclear attractions and so can lose electron easily. Thus increased metallic character.

Ionization energies decreases from LI to Cs and atomic radius increases from Li to Cs in IA group. So, metallic character increases from Li to Cs in IA group.

12. Without knowing the electronic configurations of the atoms of elements Mendeleev still could arrange the elements nearly close to the arrangements in the Modern periodic table. How can you appreciate this?

A. 1) Mendeleeff arranged the element known at that time in a chart in a systematic order in the increasing order of their atomic weight.

2) Mendeleeff tried to explain the similarities of elements in the same group in terms of their common valency.

3) Elements present in a given vertical column (group) have similar properties.

4) Each group is divided into 2 sub- group A and B. The elements within any sub group resemble each other to great extent.

5) A period comprises the entire range of elements after which properties repeat themselves. There are 7 periods in the Mendeleeff's periodic table.

6) Based on the arrangements of the elements in the table he predicted that some elements were missing and left blank spaces at the appropriate places in the table.

7) His predicted properties were almost the same as the observed properties of those elements after their discovery.

8) In this way, without knowing the electronic configuration of the atoms of elements Mendeleeff still could arrange the elements nearly close to the arrangements in the modern periodic table.

13. How the positions of elements in the periodic table help you to predict its chemical properties? Explain with an example.

A. Position of elements in the periodic table helps us to predict their chemical properties i.e, If the elements are present at extreme left or extreme right, they are highly reactive metals & non metals respectively.

- The elements which are almost left in the periodic table are metals and highly reactive.

Eg: Li, Na, K, Mg & Ca etc, are left in the periodic table these are metals and highly reactive.

- The elements which are right in the periodic table are non-metals and gases.

Eg: O, F, Cl, S etc, are right in the periodic table. These are non metals.

- The elements which are in the 18th group are noble gases and inert for chemical reactions

Eg: He, Ne, Ar etc, are noble gases which are in 18th group (VIIIA). These are inert for chemical reactions.

Fill in the Blanks

1. Lithium, ______________ and potassium constitute a Dobereiner's triad. (Na(sodium))
2. ________ was the basis of the classifications proposed by Dobereiner, Newlands and Mendeleeff (Atomic Mass).
3. Noble gases belongs to ________________ group of periodic table. (18^{th} ($VIII_A$))
4. The incomplete period of the periodic table is _____________. (7^{th} period)
5. The measure of tendency to attract shared electron pair towards itself is called __________. (Electro magnetivity)
6. The energy required to remove an electron from neutral gaseous atom is called _________. (Ionization energy)
7. d-block elements are also called as ___________. (Transition elements)
8. Elements in the same group have ________ chemical properties. (Similar)
9. Metallic character ________ while move from top to bottom. (Increases)
10. If an element A is present in the third group of periodic table, the formula o fits Oxide ________. (A_2O_3)
11. ___________ is the most electronegative element. (F(flourine))

Multiple Choice Questions

1. **Number of elements present in period – 2 of the long form of periodic table** **[ ]**

   a) 2 b) 8 c) 18 d) 32

2. **Nitrogen (Z = 7) is the element of group V of the periodic table. Which of the following is the atomic number of the next element in the group?** **[ ]**

   a) 9 b) 14 c) 15 d) 17

3. **Electron configuration of an atom is 2, 8, 7 to which of the following elements would it be chemically similar?** **[ ]**

   a) nitrogen(Z=7) b) fluorine(Z=9)

   c) phosphorous(Z=15) d) argon(Z=18)

4. **Which of the following is the most active metal?** **[ ]**

   a) lithium b) sodium c) potassium d) rubidium

5. **IE_2 — IE_1** **[ ]**

   a) α b) = c) > d) None

Key:

1) b; 2) c; 3) b; 4) d; 5) c.

Match the following

I. Group-I | **Group-II**

1.	Alkali family	[ ]	A) Be
2.	Noble gas	[ ]	B) Na
3.	Halogen family	[ ]	C) N
4.	Boron family	[ ]	D) C*l*
5.	Alkali Earth family	[ ]	E) Ar

Key:

1. B; 2. E; 3. D; 4. C; 5. A.

II. Group-I | **Group-II**

Orbital | **Maximum number of electrons filled**

1.	s. orbital	[ ]	A) 6
2.	p	[ ]	B) 2
3.	d	[ ]	C) 14
4.	f	[ ]	D) $2h^2$
5.	For ‘n’ orbit	[ ]	E) 10

Key:

1. B; 2. A; 3. E; 4. C; 5. D.

III.	Element family		Valence shell electronic configuration
1.	Alkali metal	[ ]	A) $ns^2\ np^1$
2.	Alkaline earth metal	[ ]	B) ns^2np^2
3.	Boron family	[ ]	C) ns^2
4.	Carbon family	[ ]	D) ns^2np^6
5.	Noble gas family	[ ]	E) ns^1

Key:

1. E; 2. C; 3. A; 4. B; 5. D.

Important Tables

1. Group A, B, C, D, E elements atomic weight, Arithmetic mean

Group	Elements and their Atomic weight			Arithmetic mean of Atomic weight
A	Lithium (Li) 7.0	Sodium (Na) 23.0	Potassium (K) 39.0	$\frac{7.0 + 39.0}{2} = 23.0$
B	Calcium (Ca) 40.0	Strontium(Sr) 87.5	Barium (Ba) 137.0	
C	Chlorine (C*l*) 35.5	Bromine (Br) 80.0	Iodine (I) 127.0	
D	Sulphur (S) 32.0	Selenium (Se) 78.0	Tellurium (Te) 125.0	
E	Manganese(Mn) 55.0	Chromium(Cr) 52.0	Iron (Fe) 56.0	

2. Newland's table of elements

Table 1: Newlands' table of elements.

Element	No.	Element	No.	Element	No.	Element	No.	Element	No.	Element	No.	Element	No.	Element	No.
H	1	F	8	C*l*	15	Co&Ni	22	Br	29	Pd	36	I	42	Pt&Ir	50
Li	2	Na	9	K	16	Cu	23	Rb	30	Ag	37	Cs	44	Os	51
G	3	Mg	10	Ca	17	Zn	24	Sr	31	Cd	38	Ba&V	45	Hg	52
Bo	4	Al	11	Cr	19	Y	25	Ce&La	33	U	40	Ta	46	Tl	53
C	5	Si	12	Ti	18	In	26	Zr	32	Sn	39	W	47	Pb	54
N	6	P	13	Mn	20	As	27	Di&Mo	34	Sb	41	Nb	48	Bi	55
O	7	S	14	Fe	21	Se	28	Ro&Ru	35	Te	43	Au	49	Th	56

3. Mendeleef's periodic table

Table-2 : Mendeleeff's Periodic Table (1871 version)

Reihen	Gruppe I. — R^2O	Gruppe II. — RO	Gruppe III. — R^2O^3	Gruppe IV. RH^4 RO^2	Gruppe V. RH^3 R^2O^5	Gruppe VI. RH^2 RO^3	Gruppe VII. RH R^2H^7	Gruppe VIII. — RO^4
1	H = 1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	–=44	Ti=48	V=51	Cr=52	Mn=55	Fo=56, Co=59 Ni=59, Cu=63
5	(Cu=63)	Zn=65	–=68	–=72	As=75	So=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	–=100	Ru=104, Rh=104 Pd=106, Ag=108
7	(Ag=108)	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140	–	–	–	– – – –
9	(–)	–	–	–	–	–	–	
10	–	–	?Ek=178	?La=180	Ta=182	W=184	–	Os=195, Ir=197, Pt=198, Au=199
11	(Au=198)	Hg=200	Tl=204	Pb=207	Bi=208	–	–	
12	–	–	–	Th=231	–	U=240	–	– – – –