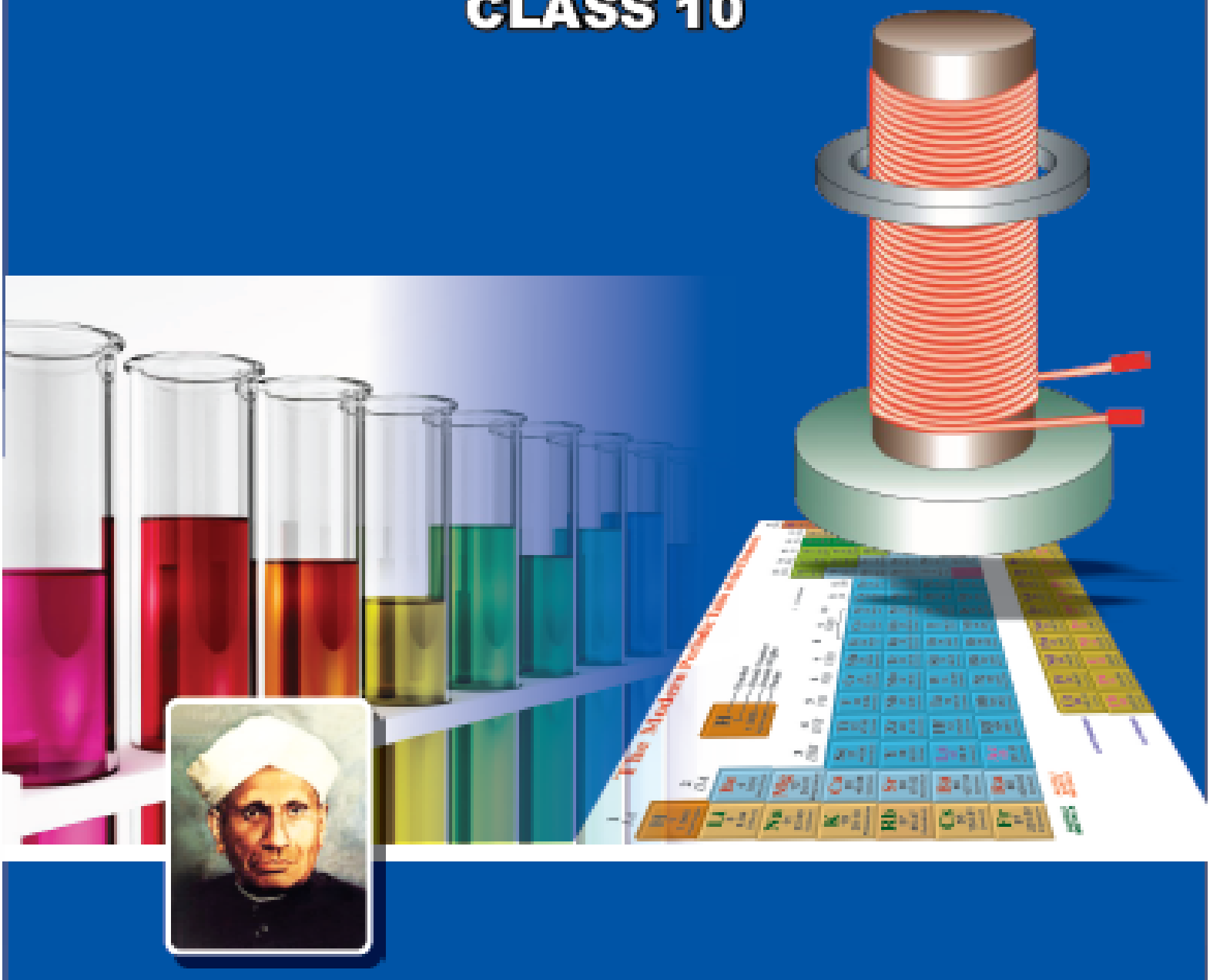
Government of Telangana

# PHYSICAL SCIENCE

## ABHYASA DEEPIKA

(ENRICHMENT MATERIAL)

CLASS 10



# PHYSICAL SCIENCE

## CLASS - 10

# ABHYASA DEEPIKA

**STATE COUNCIL OF EDUCATIONAL RESEARCH & TRAINING**
**Telangana, Hyderabad.**

EDUCATION MINISTER
GOVERNMENT OF TELANGANA

# MESSAGE

Keeping in view of the special conditions prevailing in this academic year, worksheets and digital classes are made available with the objective to facilitate the transaction of lessons in different subjects through alternate modes. Now that the SSC Board Examinations are round the corner, to facilitate easy self learning for the students, SCERT, TS has designed Enrichment Material for Class X, compiling all the major concepts of non-language subjects.

During all critical times and crises, teachers are taking initiative and doing their best to make the learning happen. In similar lines, they may guide the students to understand the aspects of this learning material. This learning material is quite useful to those who need help in different subjects to enhance their performance. I hope students will achieve good results by using this material.

March, 2021
Hyderabad.

**Ms. Patlolla Sabitha Indra Reddy**
Education Minister,
Government of Telangana.

SPECIAL CHIEF SECRETARY GOV-
ERNMENT OF TELANGANA

# MESSAGE

Along with all other fields, the field of education has been severely affected by COVID 19 situation. The whole system, top-down, is struggling to save the academic year by reaching out to students and impart quality education. Teachers are playing a key role connecting to students through various online, social media and electronic media in addition to holding face to face classes for as many days as possible. SCERT, TS has designed an Enrichment Material for Class X to equip teachers and students to face the approaching examinations. Students can enhance their understanding of key concepts in every unit in different subjects using this material. Practice questions are given here to facilitate self assessment with the help of teachers where needed. I hope the students will make use of this material to achieve success.

March, 2021
Hyderabad.

**Ms. Chitra Ramachandran, IAS**
Special Chief Secretary,
Education Department, Telangana.

DIRECTOR OF SCHOOL EDUCATION
GOVERNMENT OF TELANGANA

# MESSAGE

State Council of Educational Research and Training, Telangana, has prepared Enrichment Material to support the teachers and students in facilitating an effective transaction of key concepts in non-language subjects. Due to the special conditions prevailing due to COVID 19 situation, the syllabus for the examinations has been reduced up to 30% for the current academic year. The Enrichment Material covers the remaining 70% syllabus and helps the learners easily understand all the key concepts through self learning. I expect the students will make use of this material and perform well in the examinations.

March, 2021
Hyderabad.

**Ms. A. Sridevasena, IAS**
Director of School Education
Telangana

# FOREWORD

The prevailing situations of COVID-19 have paved way for the development of a comprehensive learning material for class 10th students with an objective to cater the needs of students appearing for Public Examinations.

Department of School Education started online transmission through T-SAT and Door Darshan channels from 1st September, 2020. Apart from this, The District Educational Officers in some districts also started online classes on YouTube involving the subject experts. The ultimate objective is to help the students achieve prescribed Academic Standards. From 1st February, 2021 onwards face to face class room interactive classes started, in view of paucity of time it is not possible to cover all the concepts. Hence, this learning material helps to fill all those gaps.

The Study material for 10th Standard is prepared for the students to have a better understanding of the concepts of Physical Science so as to achieve a good score in the Public Examination.

The Physical Science Text book of 10th class has 12 Chapters out of which a part of *Chapter 5*-Human eye and colourful world and *Chapter 8*-Chemical Bonding, *Chapter 10*-Electromagnetism, *Chapter 12*- Carbon and its Compounds (30% of the syllabus) are meant for activity/Project work. The remaining Chapters are meant for public examinations. The Key concepts for the remaining Chapters (70% of the syllabus) are identified and made easy for the students to learn, practice and understand.

The study material is prepared in a concise and simplified manner and it provides an easy means through self study and strengthens the knowledge of the concepts gained through digital classes and worksheets provided.

The key concepts of every chapter are highlighted and the main points related to every concept are listed below including the relevant diagrams, tables of lab activities and measuring units of physical quantities and related chemical reactions. All related matter is clearly mentioned under each topic. A variety of practice questions are given to facilitate self assessment.

The Teachers are expected to go through the material thoroughly to understand the purpose of the material and in turn guide the students in making effective use of the material. Further, the utilization of study material to the maximum extent by students helps them to achieve good result in Public Examination and provides a good base for conceptual information in the subjects of Physics and Chemistry for higher classes.

**M. Radha Reddy**

Director

SCERT, Telanga

# ACKNOWLEDGEMENT

The State Council of Educational Research and Training, Telangana extends its special thanks to Smt. P.Sabitha Indra Reddy, Hon'ble Minister for Education, Smt. Chitra Ramachandran, Special Chief Secretary to Government, Education Department, Smt. A.Sridevasena, Director of School Education for their valuable guidance and support in developing the enrichment material to students.

We also express our heartfelt gratitude to all the Additional Directors Sri A. Satyanarayana Reddy, Sri Ch. Ramana Kumar, Sri P. V. Srihari, Sri Krishna Rao and Smt. Usha Rani for rendering their support and sharing their ideas in designing the enrichment material for SSC students and in preparing Activity / project based syllabus.

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## Chief Advisor

**Smt. Chitra Ramachandran,** IAS

Special Chief Secretary, Education Department,
Telangana.

## Advisor

**Smt. A. Sridevasena,** IAS

Director of School Education,
Telangana.

## Chief Co - ordinator

**Smt. M. Radha Reddy,**

Director, SCERT,
Telangana.

## Co-ordinator

**Smt. Tahseen Sultana,** Professor & HoD,

Department of Curriculum & Textbooks, SCERT,
Telangana, Hyderabad.

## Asst. Co-ordinator

**Smt. I. Karunasree**

Department of Curriculum & Textbooks, SCERT,
Telangana.

## Subject Incharge

**Sri Yanala Venkat Reddy**

Rtd. School Assistant, Suryapet Dist.

# Writers

**Sri Dandala Madhusudhan Reddy,** ZPHS Kodad, Suryapet.

**Sri Tirumala Srinivasa Chary,** ZPHS Chinnatunla, Ranga Reddy.

**Sri C.V. Harikrishna,** ZPHS Toopranpet, Yadadri Bhongir.

**Sri A. Nagaraja Shekhar,** ZPHS Kudunuru, B.Kothagudem.

**Sri T. Ajay Singh,** ZPHS Somangurthi, Vikarabad.

**Sri Kandula Bhaskar Reddy,** ZPHS Kulkacherla, Vikarabad.

**Sri Bhaskar Desh,** ZPHS Isnapur, Sangareddy.

**Sri P. Narayana Varma,** ZPHS Koratikal, Nirmal.

**Sri M. Aditya Kumar,** ZPHS Rajeshwarapuram, Khammam.

**Sri A. Laxminadam,** ZPHS Indalwai, Nizamabad.

**Sri A. Gnaneshwar,** ZPHS Mallakpally, Warangal (Urban)

**Sri Shaik Jafar,** ZPHS Munagala, Suryapet.

**Sri K. Krishna Mohan,** TSMS&JC Munagala, Suryapet.

**Sri V. Madhusudhan Rao,** TSMS Narayanapur, Yadadri Bhongir

**Smt Jabeen Ruksana,** TSMS & JC Pebbair, Wanaparthy.

**Smt Fareeda Begum,** TSMS Palamakula Ranga Reddy.

**Smt Srilatha Michael,** TSMS&JC Bongloor, Ranga Reddy.

# Team Assistance

**Smt. G. Usha,** SCERT, Telangana, Hyderabad.

**Smt. R. Vasavi,** SCERT, Telangana, Hyderabad.

**Smt. V. Latha Madhavi,** SCERT, Telangana, Hyderabad.

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**Cover page design**

**Sri Md. Ayyub Ahmed,** SA, SCERT, Telangana, Hyderabad.

**Layout and Design**

**Smt Arifa Sultana,** Telangana Academy, Hyderabad

# INDEX

# INSTRUCTIONS TO TEACHERS

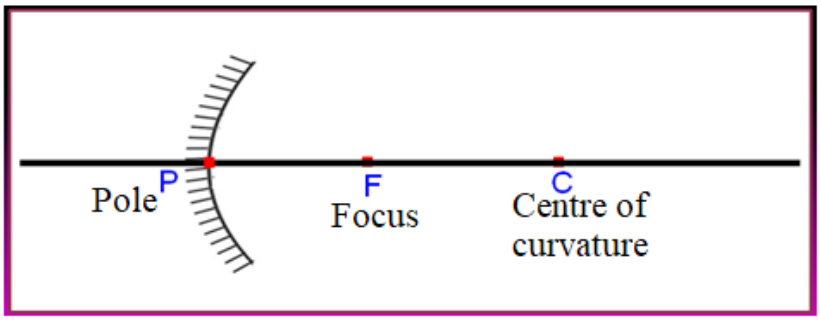
- Practise the given Questions by the students in the Abhyasa Deepika.
- Practise the given Mutiple choice qeustions by the students in the Abhyasa Deepika.
- Focus on Experiments, Analysis of Tables, Daily Life Applications.
- Practise the given diagrams and lables of the diagram given in Abhyasa Deepika.
- Go through the Text Book if doubts raised in the Abhyasa Deepika.
- Efforts should be made to make use of the Learning material to the Maximum Extent for better result.

# INSTRUCTIONS TO STUDENTS

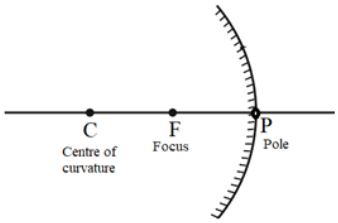
- Work on the learning material thoroughly.
- Understand the concepts lesson wise to answer various types of questions in the public examinations.
- Correlate with text books to clarify doubts in the reading material and approach your teachers.
- Good practice of the learning material helps you to achieve good grades.

# 1. REFLECTION OF LIGHT AT CURVED SURFACES

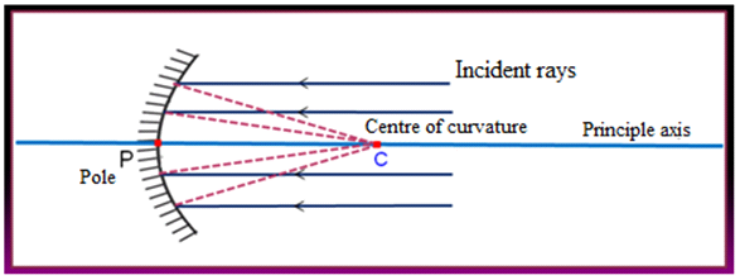
- Spherical mirrors are of two types.
- Concave mirrors and convex mirrors.
- Identifying the pole, centre of curvature and focus of a concave mirror.



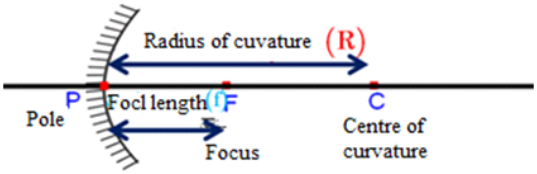

- Identifying the pole, centre of curvature and focus of a convex mirror.




- The point of Inter section of all normals drawn from the point of incidence to mirror is known as centre of curvature. So the centre of curvature can be drawn using a ray diagram.




- Focal length of the mirror is equal to the half the radius of curvature.




- If Focal length (f), radius of curvature (R) then focal length of the mirror (f)= $\frac{R}{2}$

- If Focal length (f ), radius of curvature (R) then focal length of the mirror (f )= $\frac{R}{2}$
- If the radius of curvature of the mirror is 30cm, and then finds the focal length of the mirror?

Ans : radius of curvature of a mirror = 30cm

Focal length of the mirror = $\frac{R}{2} = \frac{30}{2} = \frac{\cancel{30}^{15}}{\cancel{2}_{1}}$ = 15 CM

The material required to find the nature of the image formed when an object is placed at different places on the principle axis of a concave mirror and experimental procedure.

**Material required for the experiment are**

Concave mirror (known focal length), 'V' stand, Screen, Object/candle, Meter scale.

**Precautions :**

i. Adjust the screen without disturbing the incident and reflected rays.

ii. Size of the object adjusted must be as per the height of the lens placed on 'V' stand.

**Procedure:**

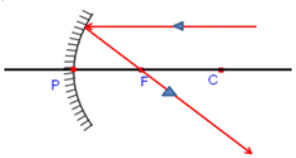
Place the mirror on the 'V' stand, Place the object on the principle axis at different places from the mirror (beyond C, at C, between C and F, at F, between. F and P), Adjust the object to get sharp image on the screen, Measure the object and image distances, Tabulate the values in the following table, Observe and mention the images are inverted or erected.

| S.No. | Object distance | Image distance | Magnified/diminished image | Erected/ inverted image. |
|---|---|---|---|---|
| 1 | | | | |
| 2 | | | | |
| 3 | | | | |
| 4 | | | | |

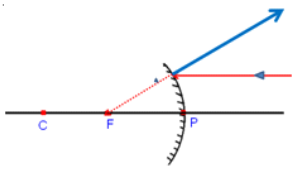
**Spherical Mirrors – Ray diagrams :**

- Rules to draw the ray diagrams of formation of image by spherical mirrors.

i. All the rays that are parallel to the principle axis gets reflected such that they pass through the focal point of the mirror.

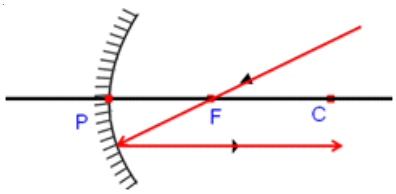



Concave Mirror

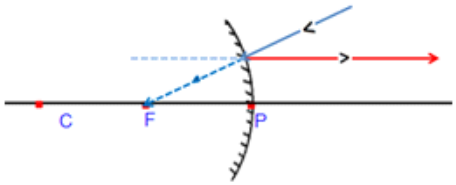



Convex Mirror

ii. All the rays that passes through the focal point of the mirror will travel parallel to the principle axis after reflection.

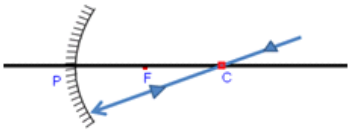



Concave Mirror

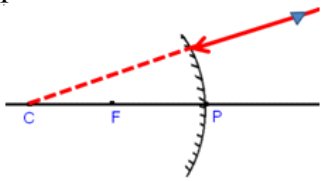



Convex Mirror

iii. A ray coming from the tip of the object passing through the centre of curvature to meet the mirror, after refraction the ray retraces its path.

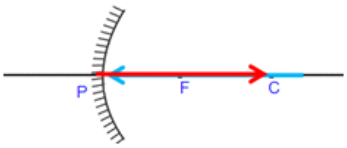



Concave Mirror

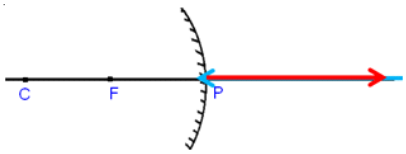



Convex Mirror

iv. A ray coming from the object passing through the principle axis to meet the mirror, it will get reflected along the principle axis.




Concave Mirror

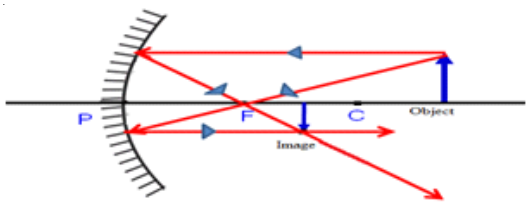



Convex Mirror

- Concave Mirror – Characteristics of the image formed when the object is placed beyond **'C'** .

**Characteristics of the image.**

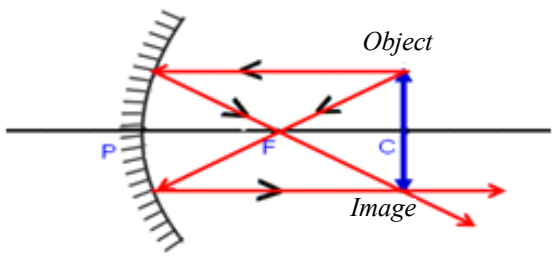
i. Inverted
ii. Enlarged than the object ,
iii. Real image,
iv. Formed between "F" and 'C'




- Concave Mirror – Characteristics of the image formed when the object is placed at **'C'**

**Characteristics of the image.**

i. Inverted
ii. Equal to the size of the object ,
iii. Real image,
iv. Formed at 'C'



- Concave Mirror – Characteristics of the image formed when the object is placed between "F" and 'C'

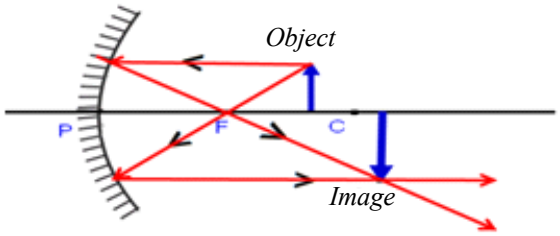
  **Characteristics of the image.**

  i. Inverted

  ii. Diminished ,

  iii. Real image,

  iv. Formed beyond 'C'




- Concave Mirror – Characteristics of the image formed when the object is at 0 "F"

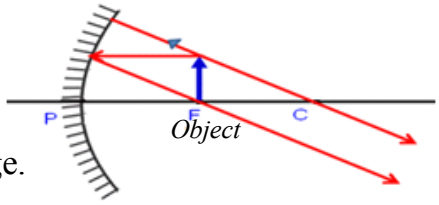
  **Characteristics of the image.**

  i. Two reflected rays are parallel to each other.

  ii. They do not intersect if extended either sides.

  iii. So we cannot say whether they are real or virtual image.

  iv. But we can say that the image is enlarged and formed at infinite.



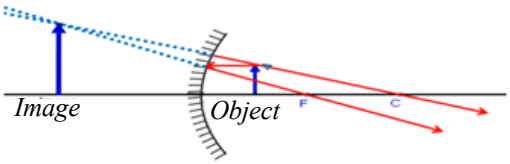

- Concave Mirror –Characteristics of the image formed when the object is placed between "P" and 'F'

  **Characteristics of the image.**

  i. Erected

  ii. Enlarged ,

  iii. Virtual image formed.

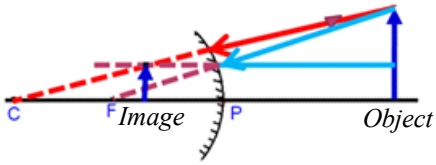



- Characteristics of the image formed by a concave mirror when an object is placed in front of the concave mirror.

  i. Erected

  ii. Diminished

  iii. Virtual image formed.



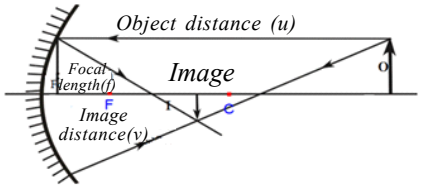

- Mirror formula

  i. Object distance = u

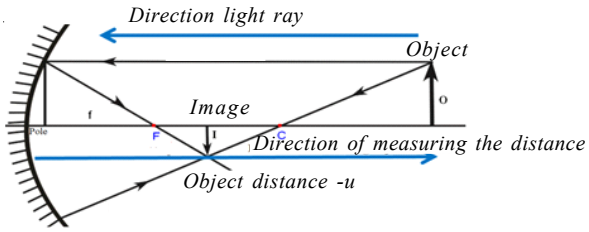
  ii. Image distance = v

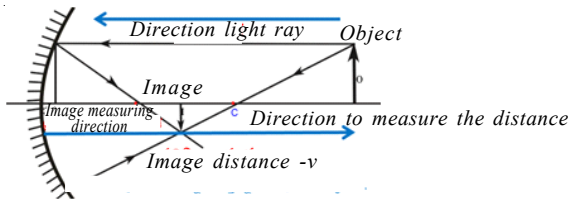
  iii. Focal length -= f

  iv. Mirror formula = $\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

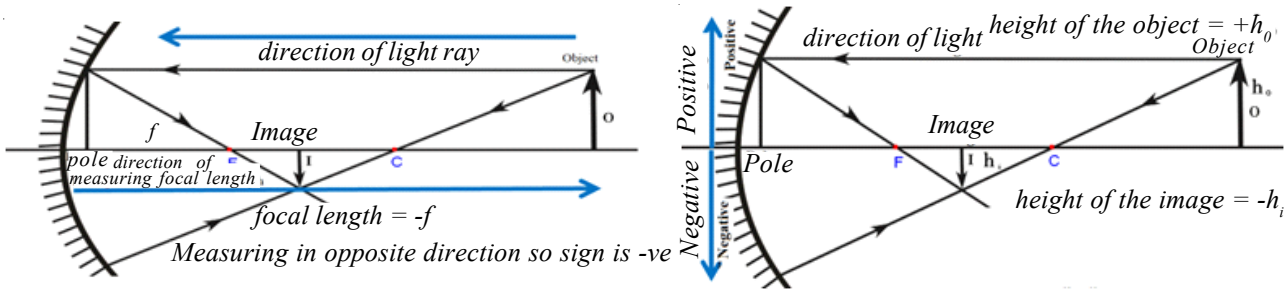



- Sign convention for spherical mirrors.



- **Sign convention for the parameters related to the mirror equation**




- All distances should be measured from the pole.
- The distances measured in the direction of incident light, to be taken positive and those measured in the direction opposite to incident light are to be taken negative.
- Height of object (ho) and height of image (hi) are positive if measured upwards from the axis and negative if measured downwards.
- Magnification of spherical mirrors.
- A magnification shows the changes in the size of the image. A magnification shows the changes in the length of the image.
- Magnification is the relation between object distance and image distance.

$$\text{Magnification(m)} = \frac{-\text{Image distance(v)}}{\text{Object distance(u)}} = \frac{\text{Height of the image}(h_i)}{\text{Height of the object}(h_0)}$$

**Uses of the concave mirrors.**

i. Dentists use this mirror to check the teeth.

ii. In the microscopes,

iii. In the security systems.

iv. In the preparation of solar cooker.

**Uses of the convex mirrors.**

i. These mirrors are used as rear-view mirrors in vehicles,

ii. At junctions of the roads,

iii. In the shopping malls,

iv. At curved roads.

- What would happen if the concave mirrors weren't discovered?

**Ans :** If the concave mirrors were not discovered the dentist can't check the teeth, the solar cooker couldn't be in use and the car headlights would be different.

- Differences between the Real image and virtual image:

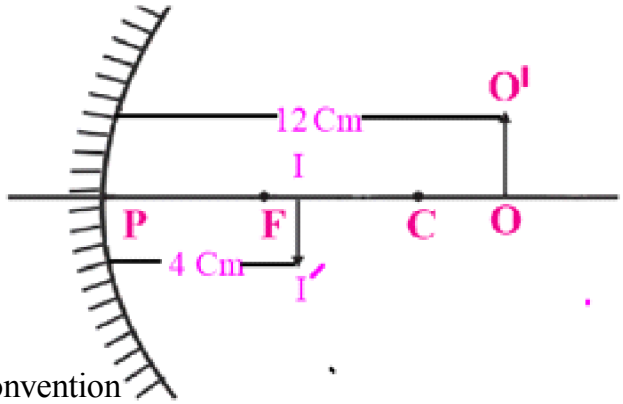
| Real image | Virtual image |
|---|---|
| i. It is a inverted image.<br>ii. It can be caught on the screen<br>iii. It can be formed by using concave mirrors but not with convex mirrors.<br>iv. It is formed by the reflected rays. | i. It is a erected image<br>ii. It cannot be caught on the screen<br>iii. It can be formed by both concave and convex mirrors.<br>iv. It can be formed extending lines of reflected rays. |

- An object is placed at 12 cm distance from the pole of concave mirror and the image formed at 4 cm from the pole. Find the focal length of the mirror?

Ans: Object distance u = 12cm

Image distance v = 4 cm.

Focal length f = ?




Mirror formula $= \frac{1}{f} = \frac{1}{v} + \frac{1}{u}$

Substitute the above values using sign convention

$$\frac{1}{f} = \frac{1}{-4} + \frac{1}{-12}$$

$$\frac{-3-1}{12} = \frac{-4}{12}$$

$$\frac{1}{f} = \frac{-1}{3}$$

Focal length $= f = -3$

## ASSESSMENT

### Very short answer questions

1. What would happen if spherical mirrors were not invented?
2. Write the uses of spherical mirrors.
3. What happens if concave mirrors are used as rear view mirrors of vehicles?

## Short Answer questions

4. An object is placed in front of concave mirror whose magnification is +1.75. What does it mean?
5. Is the focal length of the mirrors are same in all media? Guess.
6. What changes may happen to the images formed by a concave mirror when an object is moving from beyond 'C' to towards pole of the mirror on its principal axis?
7. Draw ray diagrams when an object is placed 8cm from the pole of a convex mirror.
8. Write the differences between the images formed by a concave mirror when an object is placed beyond 'C' and an object is placed in front of the convex mirror.

## Long Answer questions

9. 2cm height object is placed at 12 cm distance from the pole of concave mirror and the image formed at 4 cm from the pole. Find the focal length of the mirror and height of the image.
10. Write the material required to find the focal length of concave mirror and mention the precautions to be taken. Write the experimental procedure. Suggest a table to record the observations of the experiment.
11. List out the material required and write the experimental procedure to find the image distance using concave mirror when an object is kept in front of it on its principal axis at different locations.
12. Observe the following information and answer the following questions

| S.No. | object | Image | Magnification |
|---|---|---|---|
| 1 | A | Erected | +2.75 |
| 2 | B | Inverted | -2.75 |
| 3 | C | Equal to that of objects size | -1.00 |

i. Which of the object forms virtual image?

ii. Which object is placed at radius of curvature?

iii. Which object forms erected image?

iv. If the height of the object 'C' is 3cm, then what is the height of the image?

## Multiple Choice Questions:

1. Focal length of the concave mirror is 30 cm. Object distance is 60 cm, Then the image distance is ( )

A) + 60 cm B) -30 cm C) – 40 cm D) -60 cm

2. The focal length of the concave mirror if the radius of curvature is 10 cm. ( )

A) 20 cm B) 15 cm C) 10 cm D) 5 cm

3. The formula of the magnification of the Image formed by the object using concave mirror is ( )

$m = \frac{-v}{u}$ then , 'u' indicates

A) image distance from pole B) object distance from pole

C) Image distance from focus D) object distance from focus

4. Which one is not possible for the magnification by a concave mirror. ( )

A) M<1 B) M <-1 C) M>-1 D) M = -1

5. Virtual image formed due to ( )

A) Intersection of incident rays B) Intersection of reflected rays

C) Inter section of extending back of reflected rays

D) Intersection of incident and reflected rays

6. Formula is used to find the focal length of the mirror is ( )

A) $f = \frac{vu}{u - v}$ B) $f = \frac{v + u}{uv}$ C) $f = \frac{v - u}{uv}$ D) $f = \frac{vu}{u + v}$

7. The rays are incident on the concave mirror parallel and converging at 20 cm. on the principle axis. Then the radius of curvature of the mirror is ( )

A) 20 cm B) 40 cm C) 10 cm D) 5 cm

8. Which of the following is used in the solar cooker ( )

A) Concave lens B) convex lens C) concave mirror D) convex mirror

9. Which of the following always gives virtual image. ( )

A) Convex Mirror B) Concave mirror

C) prism D) glass slab

# 2. CHEMICAL EQUATIONS

## I) Chemical Equations :

- A chemical reaction expressed in terms of formulae and symbols is called chemical equation. A chemical equation of a reaction is written in the form to show the change of **reactants in to products** by an arrow placed between them.

**Example**: The reaction between calcium oxide and water can be written as:

Word equation: Calcium oxide + water → Calcium hydroxide

Chemical equation: $CaO + H_2O \rightarrow Ca(OH)_2$

The substances which undergo chemical change in the reaction are called **reactants** and the new substances formed are called **products**.

- In the above equation calcium oxide and water are reactants and calcium hydroxide is product.
- Change of reactants to products is shown by an arrow placed between them.
- The arrow head point faces the products showing the direction of reaction.
- The reactants are written on the left side of the arrow and products are on right side (head) of it

Some more chemical equations:

- $Zn + 2HCl \rightarrow ZnCl_2 + H_2$
- $2H_2 + O_2 \rightarrow 2H_2O$
- $Fe_2O_3\ (s) + 2Al\ (s) \rightarrow 2Fe\ (s) + Al_2O_3\ (s)$

## II) Balanced Chemical Equation : "According to the law of conservation of mass, in a chemical reaction, mass is neither created nor destroyed." In other words in a chemical reaction, the total mass of the products formed must be equal to the total mass of reactants consumed. .

- An atom is a smallest particle of an element that takes part in a chemical reaction. It is the atom which accounts for the mass of any substance.
- The number of atoms of each element before and after the reaction must be the same.
- A chemical equation in which the number of atoms of different elements on the reactant side is as same as those on product side is called a **balanced chemical equation**.
- Balancing a chemical equation involves finding out how many formula units of each substance take part in the reaction.

**Formula unit** is one unit of atom or ion or molecule corresponding to a given formula.

Ex. a) Formula unit of sodium chloride (NaCl) is one $Na^+$ ion and one $Cl^-$ ion.

b) Formula unit of magnesium bromide ($MgBr_2$) is one $Mg^{+2}$ ion and two $Br^-$ ions.

**Steps to write Balanced Chemical Equations:**

Ex: Let us consider chemical reaction of hydrogen with oxygen to form water

**Step 1:** Write the equation with the correct formula for each reactant and product.

**Primary Equation:** Chemical equation which has only molecular formulae of the substance and not got balanced is called "**Primary Equation**". Write primary equation.

$$H_2 + O_2 \rightarrow H_2O$$

**Step 2:** Identify the suitable coefficient:

"Whole number written before formula for balancing chemical equation is called coefficient"

- Coefficient indicates number of formula units required to balance the equation.
- During balancing a chemical equation, only coefficients should be changed but not the formulae.
- To balance this equation coefficient 2 is written before $H_2O$ and $H_2$

$$2H_2 + O_2 \rightarrow 2H_2O$$

**Step 3:** Coefficients should be the smallest possible whole numbers.

- If necessary divide all the coefficients with same number to get the smallest number possible.
- In the above equation, coefficients of reactants and products are the smallest whole numbers. Therefore it does not require any division.

$$2H_2 + O_2 \rightarrow 2H_2O$$

**Step 4:** Verify the equation for balancing of atoms on both sides of the equation.

- In the equation 4 atoms of hydrogen and 2 atoms of oxygen are same on both sides of arrow mark.

$2H_2 + O_2 \rightarrow 2H_2O$

Hence chemical equation is balanced.

**III) Making Chemical Equations more informative :** Chemical equations can be made more informative by expressing physical state, heat evolved, pressure etc.

**Physical State** : The physical states of the substances must be mentioned along with their physical formulae.

Ex: (a) $Fe_2O_3$ (s) + 2Al (s) $\rightarrow$ 2Fe (s) + $Al_2O_3$ (s)

(b) $Na_2SO_4$ (aq) + $BaCl_2$ (aq) $\rightarrow$ $BaSO_4$(s) + 2NaCl (aq)

(c) Zn(s) + $H_2SO_4$ (l) $\rightarrow$ $ZnSO_4$ (l) + $H_2$ (g) (s-solid, l-liquid, g-gas, aq(aqueous)- substance is present as a solution in water)

**Heat changes :** Heat is liberated in a **exothermic** reactions and heat is absorbed in **endothermic** reactions.

Ex. (a) C(s) + $O_2$ (g) $\rightarrow$ $CO_2$ (g) + Q (Exothermic)

(b) $N_2$ (g) + $O_2$ (g) $\rightarrow$ 2NO (g) - Q (Endothermic); 'Q' is heat energy which is shown with (+) sign on product side for exothermic reactions and minus (-) sign on product side for endothermic reactions.

**Gas evolved if any :** If a gas is evolved in a reaction, it is denoted by an upward arrow ( $\uparrow$ ).

Ex. (a) Zn(s) + $H_2SO_4$(l) $\rightarrow$ $ZnSO_4$(l)+ $H_2$(g) $\uparrow$ + Q

(b) C(s) + $O_2$ (g) $\rightarrow$ $CO_2$(g) $\uparrow$ + Q

**Precipitate formed if any :** If a precipitate is formed in the reaction it is denoted by downward arrow ($\downarrow$).

Ex. (a) $AgNO_3$ (aq) + NaCl (aq) $\rightarrow$ AgCl (s) $\downarrow$ + $NaNO_3$ (aq)

(b) $Na_2SO_4$ (aq) + $BaCl_2$ (aq) $\rightarrow$ $BaSO_4$ (s ) $\downarrow$ + 2NaCl (aq)

Temperature, pressure or catalyst etc is usually written over or below the arrow in the equation.

Ex: $2AgCl \xrightarrow{\text{sunlight}} 2Ag + Cl_2$

**Interpreting a balanced chemical equation:** Chemical equations give information about

1. Reactants and products in the reaction,
2. Ratio of molecules of reactants and products,
3. Atomic masses of reactants and products,
4. Molar mass of reactants and products,
5. Relative masses and mole number of the reactants and products,

Ex: Consider the following chemical equation

$C(s) + O_2(g) \rightarrow CO_2(g)$

- In this equation reactants are C, $O_2$ and product is $CO_2$; ratio of moles of C, $O_2$ and $CO_2$ is 1:1:1
- Atomic mass of C-12U, $O_2$-32 (2x16=32) U; $CO_2$ – 44 (12+2x16=44) U.
- Molar mass of C-12g, $O_2$-32 (2x16=32) g; $CO_2$ – 44 (12+2x16=44) g
- Here to burn 12g of carbon 32g of oxygen is required and it gives 44g of carbon dioxide.
- 32g of oxygen gas and 44g of carbon dioxide gas occupy 22.4litre volume at STP
- 12g of carbon 32g of oxygen and 44g of carbon dioxide have same number of molecules or atoms that is equal to Avogadro's number ($6.023 \times 10^{23}$)

**Limiting reagent:** In a reaction, the reactant available less in amount is called limiting reagent. It limits the amount of product formed.

## ASSESSMENT

### Very Short Answer Questions

1. Write chemical equation for the reaction between zinc and hydrochloric acid and balance it.
2. Write reactants and products in the following equations and mention their physical states.

   (a) $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2NaCl$

   (b) $Ca\,CO_3 \rightarrow CaO + CO_2$
3. Balance the following equations:

   (a) $C + O_2 \rightarrow CO$

   (b) $Fe_2O_3 + CO \rightarrow Fe + CO_2$

4. Give an example each for exothermic, endothermic reactions. Write its chemical equations.

5. What type of reaction is $N_2$ (g) + $O_2$ (g) → 2NO(g) – Q based on heat change?

## Short Answer type questions

6. Why is it necessary to balance a chemical equation?

7. From the equation C(s) +$O_2$ (g)→ $CO_2$ (g) find number of $CO_2$ molecules formed when 24g of carbon is burnt in adequate oxygen.

## Essay type questions

8. What information does a chemical equation give? Explain with an example.

9. What are the changes that may happen to the substances during a chemical change? Explain with an example.

## Multiple choice Questions

1. In Accordance with this law chemical equations are balanced ( )

   A) Charles' B) equal proportion

   C) conservation of mass D) Moseley's

2. The white precipitate formed in the reaction between $Na_2SO_4$ and $BaCl_2$ is ( )

   A) $Na_2SO_3$ B) $BaNa_2$ C) $BaSO_4$ D) NaCl

3. Products in the reaction Ca $CO_3$→ CaO + $CO_2$ are ( )

   A) $CaCO_3$, $CO_2$ B) $CaCO_3$ C) $CO_2$ D) CaO, $CO_2$

4. Number of hydrogen atoms in 2g hydrogen gas at STP are ( )

   A) $6.02x10^{23}$ B) $6.02x10^{24}$ C) $6.02x10^{-23}$ D) $6.02x10^{22}$

5. A balanced chemical equation is ( )

   A) $Fe_2O_3$ (s) + 2Al (s) → 2Fe (s) + $Al_2O_3$ B) $2Fe_2O_3$ (s) + 2Al (s) → 2Fe (s)+ $Al_2O_3$

   C) $Fe_2O_3$ (s) + Al (s) → 2Fe (s) + $Al_2O_3$ D) $Fe_2O_3$ (s) + 2Al (s) → 2Fe (s)+ $3Al_2O_3$

6. Amount of hydrochloric acid required to consume 100g calcium carbonate completely is (*H -1U, Cl - 35.5U, C- 12, Ca – 40U*) ( )

   A) 7.3g B) 73g C) 0.73g D) 730g

# 3. ACIDS, BASES AND SALTS

Acids are sour to taste and turn blue litmus to red, bases are soapy to touch and turn red litmus to blue.

Reactions of acids and bases with different indicators :

| Substance | Blue litmus Paper | Red litmus Paper | Methyl orange indicator | Phenolphthalein indicator |
|---|---|---|---|---|
| Acid | Turns to red | No change in colour | Turns to red | No change in colour |
| Base | No change in colour | Turns to blue | Turns to yellow | Turns to pink |

## Chemical Properties of acids and bases

- Acids and bases react with metals and release Hydrogen gas.

  Ex: 1) $2HCl + Zn \rightarrow ZnCl_2 + H_2$

  2) $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

- Acids reacts with carbonates and metal hydrogen carbonates and produce carbon dioxide gas.

  Ex: 1) $Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$

  2) $NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$

- Metal oxides react with Acids to give salt and water.

  $CuO + 2HCl \rightarrow CuCl_2 + H_2O$

- Non-metal oxides react with bases to give salt and water.

  $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

- The reaction of acid with a base to give a salt and water is known as a **neutralization reaction.**

  Acid + Base → Salt + Water.

  Ex: $NaOH + HCl \rightarrow NaCl + H_2O$

- Acids have $H^+$ ions in them and Bases have $OH^-$ ions in them.
- Acids produce $H^+$ ions only in aqueous solutions.

## Making dilute acids

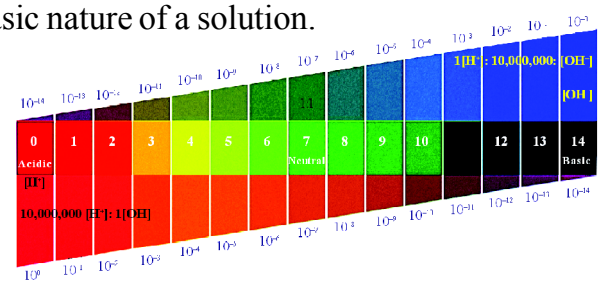
The process of dissolving an acid or a base in water is an exothermic process. The acid must always be added slowly to water with constant stirring. If water is added to a concentrated acid, the heat generated may cause the mixture to splash out and cause burns.

## Strength of Acids and Bases

The strength of acids or bases depends on the concentration of $H_3O^+$ ions or $OH^-$ ions produced in solution. This can be measured by pH value.

## pH Scale

- A scale for measuring hydrogen ion concentration in a solution is called pH scale. This is simply a number which indicates the acidic or basic nature of a solution.
- pH scale ranges from 0 to 14.
  - ➢ If pH <7, then the solution is acidic
  - ➢ If pH >7, then the solution is basic
  - ➢ If pH = 7, then the solution is neutral.




- As pH value increases from 0 to 7, the strength of acid decreases.
- As pH value increases from 7 to 14, the strength of base increases.

## Plants and animals are pH sensitive

Living organisms can survive only in a narrow range of pH changes. When pH of rain water is less than 5.6, it is called acid rain. When acid rain flows in to the rivers the pH of the river water is lowered. The survival of aquatic life in such rivers becomes difficult.

## pH in stopping tooth decay

The tooth decay starts when the pH of mouth is lower than 5.5. We use toothpaste, which is a base to neutralize the excess acid to prevent tooth decay.

## pH in digestive system

Our stomach produces *HCl*, which helps in digestion of food without harming the stomach. During indigestion, we use bases called antacids. These antacids neutralize the excess acid in the stomach.

## pH of the soil

Plants require a specific pH range for their healthy growth. It is necessary to find out the pH of the soil to use required fertilizers for the healthy growth of the plants.

## Salts

Salts of strong acid and strong base are neutral. The salts of a strong acid and weak base are acidic. The salts of a strong base and weak acid are basic in nature.

- Salts extracted from common salt are Sodium hydroxide (NaOH), Baking soda ($NaHCO_3$), Washing soda ($Na_2CO_3$).

1. **Common salt (or) Sodium Chloride (*NaCl*)**

   Sodium chloride (*NaCl*) is the chemical name of common salt or table salt. It can be extracted from sea water. These crystals are often brown due to impurities. This is called rock salt.

2. **Sodium hydroxide (*NaOH*)**

   When electricity is passed through an aqueous solution of sodium chloride, it decomposes to form sodium hydroxide. This process is called chloro-alkali process.

3. **Bleaching Powder ($CaOCl_2$)**

   Bleaching powder is produced by the action of chlorine on dry slaked lime.

$$Ca(OH)_2 + Cl_2 \rightarrow CaOCl_2 + H_2O$$

**Uses of Bleaching powder:**

- It is used for bleaching cotton and linen in textile industry.
- It is used for bleaching wood pulp in paper industry.
- It is used for bleaching washed clothes in laundry.
- It is used as an oxidizing agent in many chemical industries.
- It is used for disinfecting drinking water to make it free of germs.
- It is used as a reagent in the preparation of chloroform.

**4. Baking soda ($NaHCO_3$)**

Baking soda is added for faster cooking. Its chemical name is Sodium Hydrogen Carbonate. It is prepared as follows

$$NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$$

**Uses of Baking soda (Sodium Hydrogen Carbonate):**

- Baking soda produces $CO_2$ which rises through bubbling dough into cake or bread. This results cake and bread are smooth and spongy.
- Sodium hydrogen carbonate is also an ingredient in antacids.
- It is also used as soda-acid in fire extinguishers.
- It acts as mild antiseptic.

**5. Washing Soda (or) Sodium carbonate ($Na_2CO_3$)**

Sodium carbonate can be obtained by heating baking soda. Recrystallisaion of sodium carbonate gives washing soda. It is also a basic salt.

$$Na_2CO_3 + 10\,H_2O \rightarrow Na_2CO_3.10H_2O$$

**Uses of washing soda:**

- Sodium carbonate is used in glass, soap and paper industries.
- It is used in the manufacture of Sodium compounds such as borax.
- Sodium carbonate can be used as a cleaning agent for domestic purposes.
- It is used for removing permanent hardness of water.

## Water of crystallization

Water of crystallization is the fixed number of water molecules present in one formula unit of a salt.

Ex: $CuSO_4.5H_2O$, $Na_2CO_3.10H_2O$, $CaSO4.2H_2O$, **etc.**

## Plaster of Paris ($CaSO_4.\ ½\ H_2O$)

On careful heating of gypsum ($CaSO4.2H_2O$) at 373K, it loses water molecules partially to become calcium sulphate hemihydrate ($CaSO_4.\ ½\ H_2O$). This is called plaster of paris. It is a white powder and on mixing with water, it sets into hard solid mass due to the formation of gypsum.

$$CaSO_4.\ ½\ H_2O + 1\ ½\ H_2O \rightarrow CaSO_4.2H_2O$$

**Uses of Plaster of paris**

- It is used by doctors for supporting fractured bones in the right position.
- It is used for making toys.
- It is used for making materials for decoration and for making surfaces smooth.

# Reaction of acids and bases with metals

**Aim:** To observe the reaction of acids and bases with metals.

## Materials required

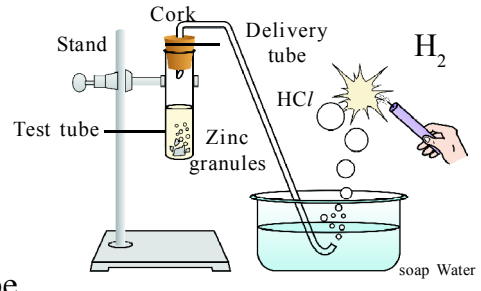
Test tube, Delivery tube, glass trough, candle, soap water, dil.HCl, and zinc granules, cork etc.

## Precautions

1. Care must be taken while handling with glass items.
2. Always wear hand gloves and laboratory spectacles.
3. Always use diluted acid only
4. Keep a bucket of soap water or ordinary water at the working place.

## Procedure

- Setup the apparatus as shown in the figure.
- Take about 10ml of dilute *HCl* in a test tube and add a few zinc granules to it.
- A gas is evolved from the top of the test tube.
- Pass the gas being evolved through the soap water.
- Bring a burning candle near the gas filled bubbles.




## Observations

- We observe a gas is evolved from the top of the test tube.
- If we pass this gas through the soap water, bubbles are formed.
- Wen we bring a burning candle near the gas bubbles, we hear a 'POP' sound.
- This 'POP' sound indicates that the gas evolved is hydrogen.

## Conclusion

- When acids react with metals hydrogen gas is evolved.
- $2HCl + Zn \rightarrow ZnCl_2 + H_2$

# Reaction of acids with carbonates and metal hydrogen carbonates

**Aim:** To observe the reaction of acids with carbonates and metal hydrogen carbonates

### Materials required

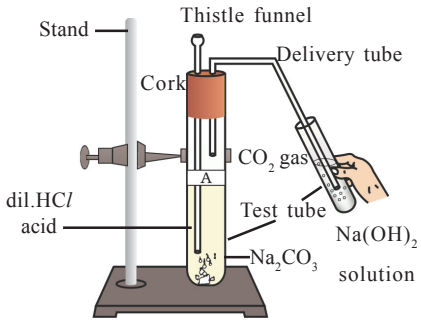
Two test tubes, Sodium carbonate ($Na_2CO_3$), Sodium hydrogen carbonate $(NaHCO_3)$, dil HCl, lime water, delivery tube, thissel funnel, Stand etc.

### Precautions

1. Care must be taken while handling with glass items.
2. Always wear hand gloves and laboratory spectacles.
3. Always use diluted acid only
4. Keep a bucket of soap water or ordinary water at the working place.

### Procedure

- Take two test tubes and label them as A and B.
- Take about 0.5gm of sodium carbonate ($Na_2CO_3$) and 0.5gm of sodium hydrogen carbonate $(NaHCO_3)$ in test tube B.
- Set up the apparatus as shown in the figure.
- Add about 2ml of dilute *HCl* to both the test tubes.
- Pass the gas produced in each case through lime water and record your observations.




### Observations

- We observe that the lime water turns into milky white after passing the gas evolved during the reaction.
- This indicates that the gas evolved during reaction is Carbon dioxide $(CO_2)$

### Conclusion

- When acids react with carbonates and metal carbonates, carbon dioxide $(CO_2)$ gas is evolved.

$$Na_2CO_3 + 2HCl \rightarrow 2NaCl + H_2O + CO_2$$
$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$

- When the evolved gas is passed through lime water, the reaction taken place is

$$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$$

# Acids show electrical conductivity

**Aim:** To show that acids show electrical conductivity

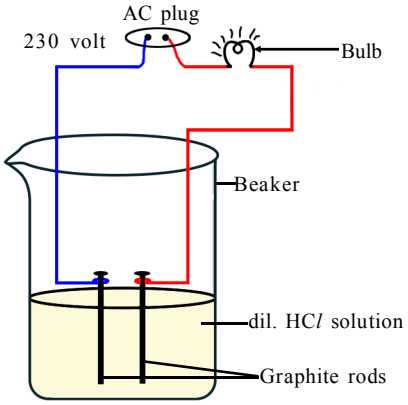
### Materials required

Different aqueous solutions of glucose, alcohol, hydrochloric acid and sulphuric acid etc, beaker, two different coloured wires, bulb, switch, 230V AC power supply socket, graphite rods.

### Precautions

1. Care must be taken while handling with glass items.
2. Always wear hand gloves and laboratory spectacles.

3. Always use diluted acid only
4. Keep a bucket of soap water or ordinary water at the working place.
5. Make sure that the electrical switch is in **off** position while setting up of experiment.




### Procedure

- Connect two different coloured electrical wires to graphite rods separately in a 100ml beaker as shown in the figure.
- Connect free ends of the wire to a 230V AC plug and complete the circuit as shown in the figure by connecting a bulb to one of the wires.
- Now pour some dilute *HCl* in the beaker and switch on the current. Record your observations.
- Repeat this activity with dilute sulphuric acid, and glucose and alcohol solutions separately and record your observations.

### Observations

- We observe that the bulb glows in acid solutions but not in glucose or alcohol solutions.
- Glowing of bulb indicates that there is flow of electric current through the solution.

### Conclusion

- Acids have $H^+$ ions and the moment of these ions in solution helps for flow of electric current.
- The positive ion present in all acid solutions is $H^+$ ions in the form of $H_3O^+$ ions.

# Removing water of crystallization

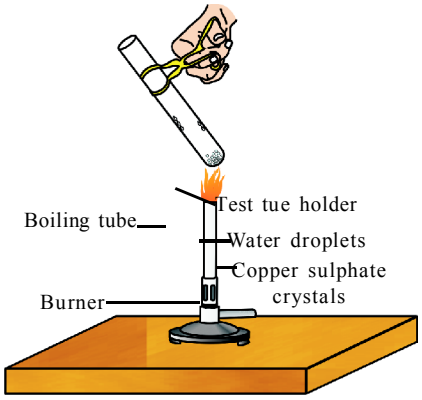
**Aim :** To observe water of crystallization and to remove the water of crystallization.

### Materials required

Copper sulphate crystals, test tube, test tube holder, Bunsen burner, white paper, water etc.

### Precautions

1. Care must be taken while handling with glass items.
2. Always wear hand gloves and laboratory spectacles.
3. Keep away from fire to avoid fire accidents.
4. Keep a bucket full of water at the working place.




### Procedure

- Take a few crystals of copper sulphate in a dry test tube.
- Heat the test tube on the Bunsen burner or spirit lamp

### Observations

- We observe that the blue colour of copper sulphate crystals will change into white.
- We hear a crackling sound while heating.
- We also observe small water droplets on the sides of the test tube.

**Conclusion**

- Copper sulphate crystals contain water of crystallization, when these crystals are heated, water present in crystals is evaporated and the salt turns white.
- When the crystals are moistened with water, the blue colour re-appears.

## ASSESSMENT

### Very short answer questins

1. What is the colour of acid in the presence of methyl orange indicator, phenolphthalein indicator?
2. What is the result of the experiment to observe the reaction of acids with metals?
3. How to test the gas evolved when acid reacts with carbonates?
4. Give an example for neutralization reaction.
5. Write an example for reaction of base with non-metal oxide.
6. Why did not the bulb glow in the glucose solution during electricity is passed through it?
7. Write the names of two salts obtained from common salt.
8. If a solution turns red litmus into blue, what will be the possible pH value of that solution?
9. Two solutions have their pH values as 13.5 and 10.5. Which of them is strong base and which is weak base?
10. What is the difference between baking soda and baking powder?
11. Write about water of crystallization in your own words.

**Short answer questions**

1. Write the procedure of the experiment to observe the reaction of acids with carbonates and metal hydrogen carbonates and also write your observations.
2. Explain neutralization reaction with examples.
3. Why do we add acid to water while diluting an acid, but not water to acid?
4. How is pH useful to prevent tooth decay?
5. What is the use of maintaining suitable pH in our digestive system?
6. Write the uses of sodium hydrogen carbonate in our daily life.
7. Write the uses of plaster of paris in our daily life.
8. Write the uses of bleaching powder in our daily life.
9. Explain the experimental process of removing of water of crystallization.
10. What happens if pH of the soil is not maintained properly?

## Essay questions

1. Observe the following table

| Substance | A | B | C | D | E | F | G |
|---|---|---|---|---|---|---|---|
| pH value | 7 | 8.5 | 3 | 5.5 | 12.5 | 13.5 | 9 |

Now answer the following questions

i) Identify the acids and bases in the above table and write them under correct heading.

ii) Which of the above are strong acid and weak base?

iii) If the substance A is tested with Phenolphthalein indicator, what will be the result?

iv) If the substances B and C reacts, then what is the nature of the salt formed?

2. Write the experimental procedure, observations and conclusions of the experiment to observe the reaction of acids with metals.
3. Write the procedure of the experiment to observe that the acids show electrical conductivity.
4. Write the procedure to get the washing soda from sodium chloride and write its uses in our daily life.

## Multiple Choice Questions

1. Which of the following turns blue litmus to red ( )

A) NaOH B) $Ca(OH)_2$ C) $H_2SO_4$ D) KOH

2. The value of pH is more than 7 in the following ( )

A) HCl B) $H_2SO_4$ C) $HNO_3$ D) NaOH

3. Non metal oxide + _____ → salt + water ( )

A) Acid B) Base C) Neutral solution D) None

4. Which of the following is used for making toys ( )

A) $CaSO_4$ ½ $H_2O$ B) $CaSO_4.2H_2O$ C) $CaOCl_2$ D) $CaCO_3$

5. When will the rain is treated as acid rain ( )

A) pH of rain water is 7 B) pH of rain water is <5.6

C) pH of rain water is >5.6 D) pH of rain water is 14

# 4. REFRACTION OF LIGHT AT CURVED SURFACES

- When a light ray travels from optically rarer medium to optically denser medium, it bends towards normal.
- When a light ray travels from denser to rarer medium, it bends away from the normal.
- The light ray which travels along the normal drawn to the surface does not deviate from its path.
- **Curved surface formula**: $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$
- This formula can also use for plane surfaces, radius of curvature (R) approaches to infinity. Hence $\frac{1}{R}$ becomes zero.
- **Formula for Plane surface:** $\frac{n_2}{v} - \frac{n_1}{u} = 0$

  That is $\frac{n_2}{v} = \frac{n_1}{u}$

**Lenses:**

**Convex Lenses**

Double Convex lens (Biconvex lens)

Plano-convex lens

Concavo-convex lens

**Concave Lenses**

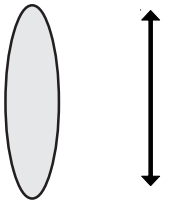
Double Concave lens (Biconcave lens)

Plano-concave lens

Convexo-concave lens

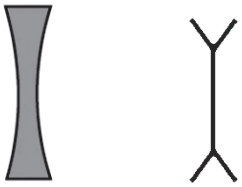
## Symbols of lenses while drawing:

Convex Lens



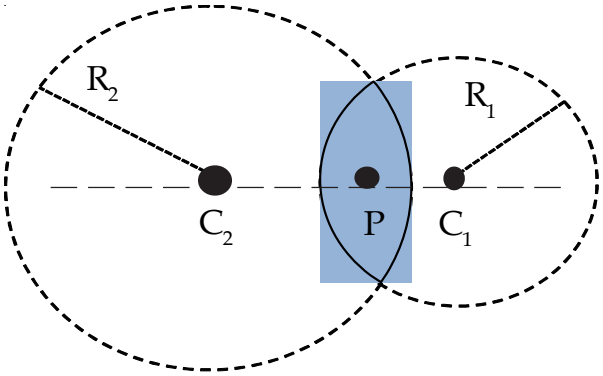
| Convex Lens | Symbol |
|---|---|

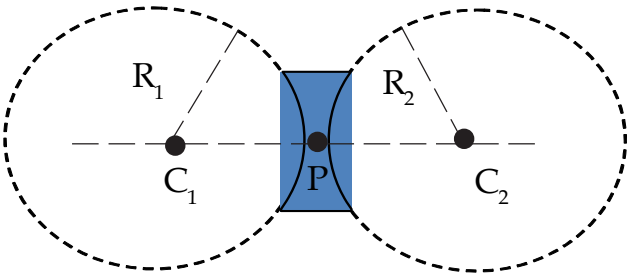
Concave Lens



| Concave Lens | Symbol |
|---|---|

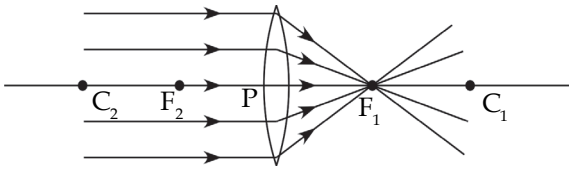
- Each curved surface of a lens is part of sphere. The centre of the sphere which contains the part of curved surface is called centre of curvature. If a lens contains two curved surfaces then their centres of curvature are $C_1$ and $C_2$ respectively.
- The distance between centre of curvature and surface is called radius of curvature, in the diagram $R_1$ and $R_2$ are radii of curvature for surface-1 and surface -2 respectively.
- The line joining the points $C_1$ and$C_2$ is called Principal Axis.
- The midpoint of a thin lens is called Optic centre, and it is denoted by 'P'.



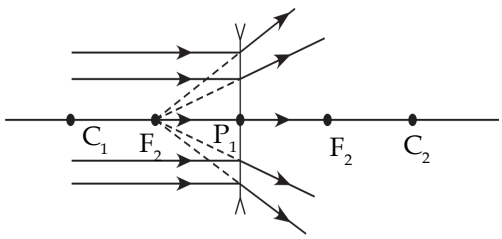

## Focus(F) or Focal Point of Convex lens:

A Parallel beam of light incident on a convex lens converges at a point on the principal axis. The point of convergence is called *Focus or focal point(F).*




## Focus(F) or Focal Point of Concave lens:

A Parallel beam of light incident on a concave lens seems to be emanate from a point on the principal axis. The point from which rays seem to be emanate is called *Focus or Focal Point (F).*

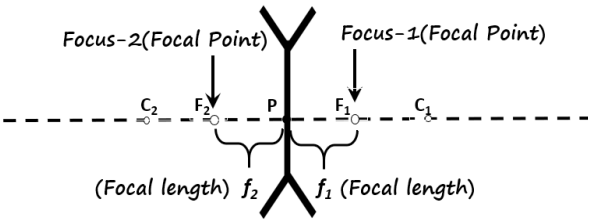


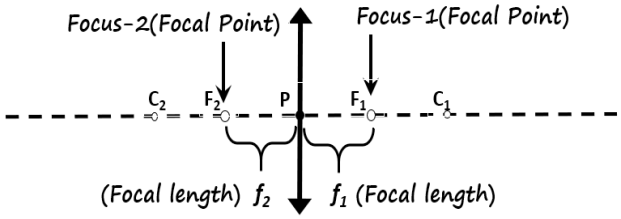



$F_2$

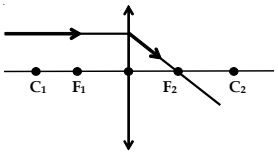
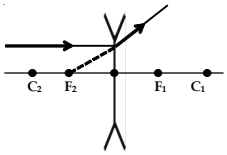
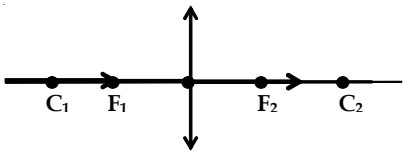
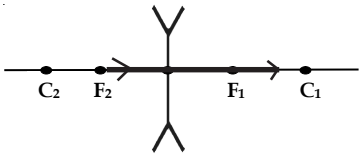
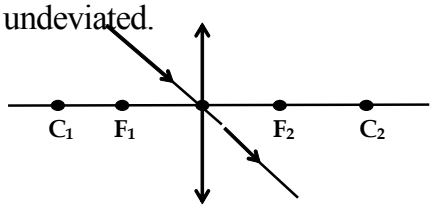
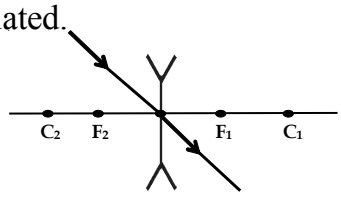
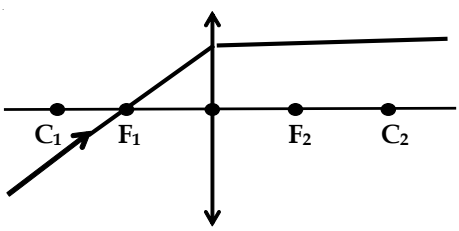
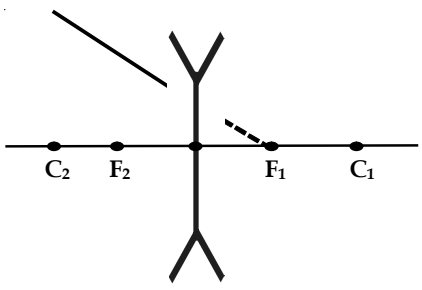
**Focal length(f)**

The distance between optic centre (P) and focus (F1 or F2) is called Focal length (f), these are denoted by $f_1$ and $f_2$ respectively.

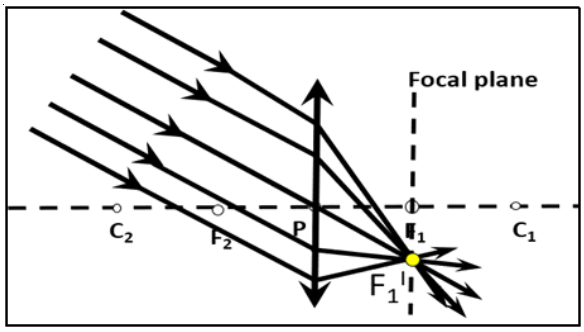


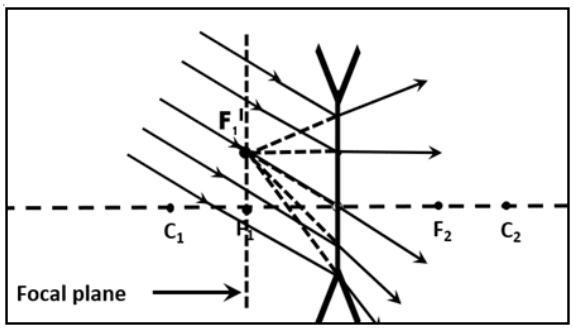




# Behaviour of Certain light rays when they are incident on a lens:

| Convex Lens | Concave Lens |
|---|---|
| 1. Ray travelling Parallel to Principal axis passes through focus after reflection.   | 1. Ray travelling Parallel to principal axis seems to emanate from focus.   |
| 2. Ray Passing along principal axis is undeviated   | 2. Ray Passing along principal axis is undeviated.   |
| 3. Ray Passing through optic centre is undeviated.   | 3. Ray Passing through optic centre is undeviated.   |
| 4. Ray Passing through focus will take the path parallel to principal axis   | 4. Ray passsing through focus will take the path parallel to principal axis   |

**Focal Plane:** A Parallel beam of light making an angle with principal axis falls on a lens, the rays converage to a point lying on the focal plane.



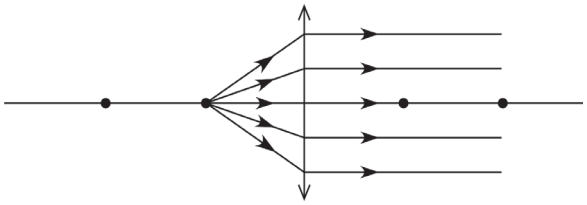




## Rules to draw Ray diagrams for image formation by lenses:

1. Select a point on the object placed at a point on the principal axis.
2. Draw two rays that were chosen by you from rays mentioned in above situations.
3. Extend both rays to intersect at a point. The point gives position of the image.
4. Draw a normal from point of intersection to the principal axis.
5. Normal represents size of the image.

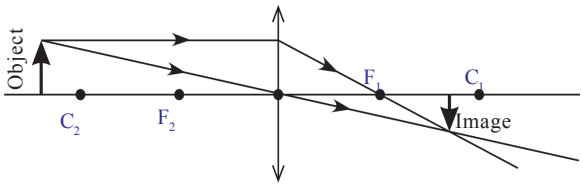
## Ray Diagrams for Convex Lens:

Case-1: Object at Infinity:



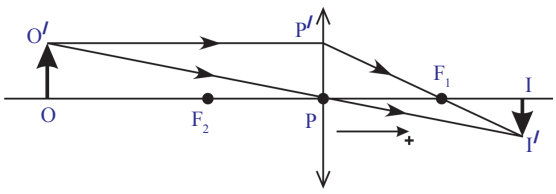
**Characteristics of the Image:**
1. Image formed at focal point
2. Point size image
3. Real image

### Case-2: Object Placed beyond centre of curvature($C_2$) on the principal axis:



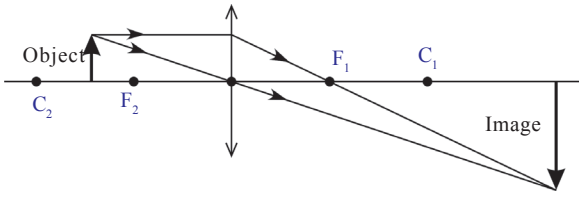

**Characteristics of the Image:**
1. Image formed between $F_1$ & $C_1$
2. Real image
3. Inverted
4. Diminished

### Case-3: Object Placed at the centre of curvature($C_2$):




**Characteristics of the Image:**
1. Image formed at $C_1$
2. Real image
3. Inverted
4. Same size that of object

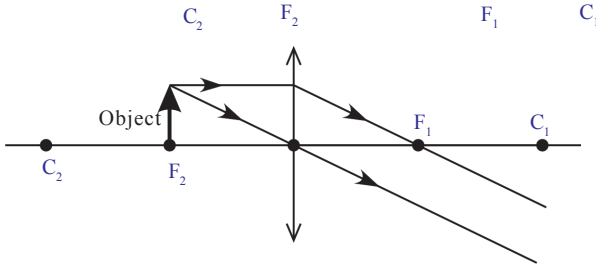
## Case-4: Object Placed between centre of curvature($C_2$) and Focal Point ($F_2$):




**Characteristics of the Image:**

1. Image formed beyond $C_1$
2. Real Image
3. Inverted
4. Magnified image

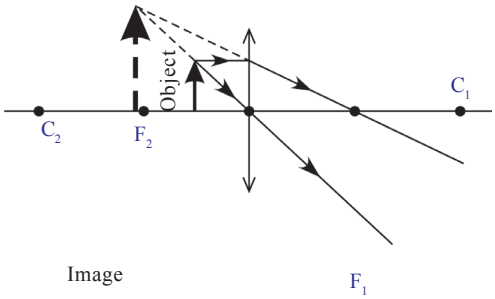
## Case-5: Object Placed at the Focal Point ($F_2$):




**Characteristics of the Image:**

1. Image formed at infinity

## Case-6: Object Placed between Focal Point ($F_2$) and Optic centre (P):

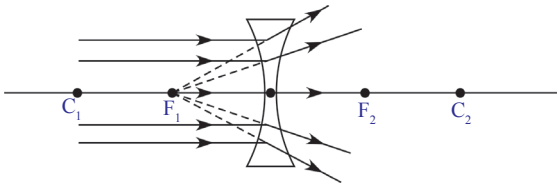



**Characteristics of the Image:**

1. Image formed on the same side of the lens where the object is placed.
2. Virtual Image
3. Erected Image
4. Magnified Image

## Ray Diagrams for Concave Lens:

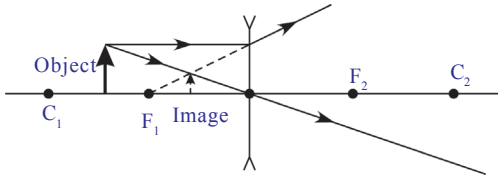
Case-1: Object at Infinity:




**Characteristics of the Image:**

1. Image formed at focal point
2. Point size image
3. Virtual image

Case-2: Object placed at any point Infront of the lens:




**Characteristics of the Image:**

1. Image formed between optic centre (P) and Focal Point ($F_1$).
2. Virtual Image
3. Erected Image
4. Diminished Image

## OBSERVING THE TYPES OF IMAGES AND MEASURING THE OBJECT DISTANCE AND IMAGE DISTANCE.

- **Aim :** Observing the types of images and measuring the object distance and image distance.
- **Material required:** A candle, Paper, Convex lens of known focal length, V-stand, Scale.
- **Precautions:**
  i. Aline the lens and flame of the candle at same height
  ii. Ensure that you get a sharp image on the paper (Screen) before measuring the object distance.
- **Procedure:**

  Take a V-Stand and place it on a long table (nearly 2 meter) at the middle. Place a convex lens of known focal length on the V-stand. Imagine the principal axis of the lens. Identify F,C on both sides of the lens. Light a candle and put it far away from the lens along the principal axis. Adjust the screen (a white paper placed perpendicular to the axis) which is on other side of the lens until get an image on it. Measure the object distance(u) and image distance(v) from the lens. Record the values. Repeat the experiment with different object distances and measure the image distances. When you do not get an image on the screen, try to see the image with your eye in the lens from the place of the screen.

- **Observations:**

| Position of the object | Position of the image | Characteristics of the image |
|---|---|---|
| At far distance (Infinity) | Focal Point | Point size image, Real image |
| Beyond "$C_1$" | Between "$F_2$" and "$C_2$" | Inverted, Diminished, Real |
| At "$C_1$" | At "$C_2$" | Inverted, same size, Real |
| Between "$F_1$" and "$C_1$" | Beyond "$C_2$" | Inverted, Magnified, Real |
| At "$F_1$" | Infinity | ——— |
| Between "$F_1$" and "P" | Beyond "$F_2$"(Same side of the lens) | Erected, Magnified, Virtual |

**Result:**

i. In most of the conditions convex lens forms real and inverted image.

ii. While we move the object towards the lens image moves away from the lens generally

iii. In every situation $\frac{1}{v} - \frac{1}{u}$ is constant.

**Lens Formula:** $\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$

Where f – Focal length

v-image distance

u-object distance.

**Magnification:** The ratio of height of image to the height of the object is known as magnification. In the case of lens, it is equal to ratio of image distance to the object distance.

$$m = \frac{h_i}{h_o} = \frac{v}{u}$$

## TO CHECK WHETHER THE FOCAL LENGTH OF A LENS DEPENDS ON THE SURROUNDING MEDIUM OR NOT.

- **Aim:** To check whether the focal length of a lens depends on the surrounding medium or not.
- **Material required:** Convex lens of known focal length, cylindrical vessel having much greater than the focal length of the lens, black stone, water, circular lens holder.
- **Precautions:**

i. Move the lens upward slowly.

ii. Observe carefully that at what distance the clarity of vision is missing through the lens.

- **Procedure:**

  Take a cylindrical vessel having height/depth much greater than the focal length of the lens taken. Place a black stone inside the vessel at the bottom. Pour water into the vessel up to the height such that the height of the water level from the top of the stone is four times more than the focal length of the lens. Take the lens and fix it in circular lens holder. Now dip the lens horizontally in water using holder. Set the distance between stone and the lens that it is less than the focal length of the lens. Look at the stone through the lens. Increase the distance between lens and stone until you can't see the stone through the lens.

- **Observations:** You can see the stone through the lens place in water even the distance between the lens and stone is more than the focal length of the lens measured in air.
- **Result:**

  i. Focal length of the lens is more, when it is measured in water than that of when it is measured in air.

  ii. Focal length of the lens depends on surrounding medium.

➢ Convex lens behaves like a diverging lens when it is kept in a transparent medium with greater refractive index than that of the lens.

➢ Concave lens behaves like a converging lens when it is kept in a transparent medium with greater refractive index than that of the lens.

➢ Lens Makers formula: $\frac{1}{f} = (n-1)\left[\frac{1}{R_1} - \frac{1}{R_2}\right]$

Where f – Focal length.

n- Relative refractive index of lens and surrounding medium.

$R_1$- Radius of curvature of first surface of the lens.

$R_2$- Radius of curvature of second surface of the lens.

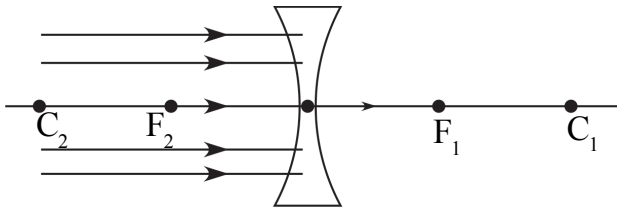
**Sign convention for the problems related to all the formulae of lenses:**

1. All the distances should be measured from the optic centre.
2. The distances measured in the direction of incident light to be taken positive and those measured in the direction opposite to incident ray to be taken negative.
3. Height of the object ($h_o$) and height of the image ($h_i$) are positive if measured upwards from the principal axis and negative if measured downwards.

## ASSESSMENT

### Very Short Answer questions

1. Compete the following diagram.

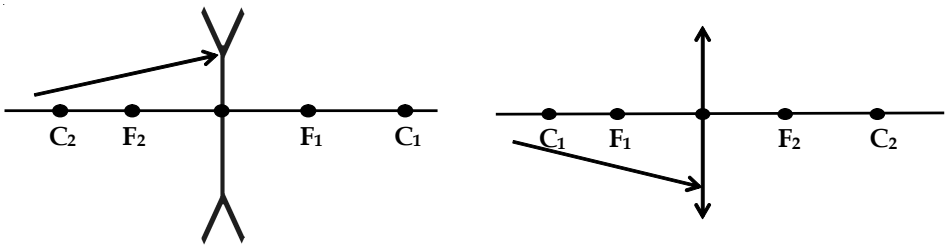



1. What happen, if a parallel beam of light incident on a convex lens making some angle with principal axis?
2. How do you represent convex lens and concave lens while drawing ray diagrams?
3. Why convex lens used as magnifier?
4. Write the names of apparatus used in the experiment to show that focal length of a lens depends on surrounding medium where it was placed.
5. How do you say that focal length of concave lens is always negative?

### Short Answer questions:

1. How light rays behave when passing through optic centre of convex lens and concave lens?
2. Write the difference between real and virtual images.
3. Write any two precautions taken by you while conducting an experiment to find image distances for different object distances.
4. What happens, if concave lens is used as magnifier instead of convex lens in micro scope?

5. Complete the following diagrams.




6. Magnification of an image formed due to a convex lens is -1.5. Guess and write the position of object and image.
7. Draw a ray diagram to obtain an image formed due to a concave lens, when object placed between centre of curvature and focus on the principal axis.
8. How do you differentiate between convex and concave lens?

**Long Answer Questions.**

1. Write rules to draw ray diagrams for image formation by lenses.
2. Draw ray diagrams to obtain images, when object placed at centre of curvature and focus on the principal axis convex lens, and also write characteristics of images.
3. Write the names of the apparatus which are used in the experiment to find image distances for different object distances, also write experimental procedure.

**Multiple Choice questions:**

1. Identify convexo-concave lens in the following ( )

A)  B)  C)  D) 

2. A parallel beam of light incident on a convex lens, after refraction they converge to a point on the principal axis at 15 cm. Focal length of the lens ( )

A) 5 cm B) 7.5 cm C) 15 cm D) 30 cm

3. Magnification of an image formed due to a lens is -0.75. Then the image is ( )

A)Real, Magnified B) Real, diminished

C) Virtual, Magnified D) Virtual, Diminished 30 cm

4. Which of the following light ray is undeviated, when its incident on convex lens ( )

A) Ray passing through "$C_1$" B) Ray passing through "$F_1$"

C)Ray passing through "P" D) Ray passing parallel to principal axis

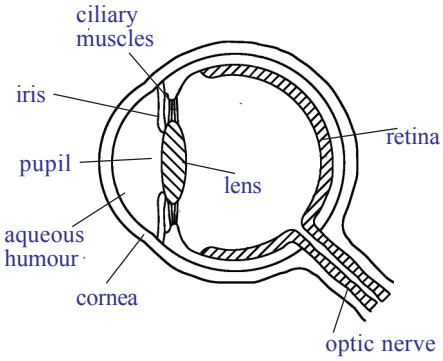
5. An object placed between centre of curvature and focus of convex lens, then the signs of object distance and image distance respectively are ( )

**A) +, -** B) +, + C)**-, -** D) **-, +**

# 5. HUMAN EYE AND COLOURFUL WORLD

## Chapter at glance :

- The human eye, it is the most valuable and sensitive sense organ which help us to see the beauty and the colorful world around us. It is similar to a camera. We all have been gifted with two eyes which give a wider field of view.
- The least distance up to which we can see the objects clearly without any strain is called **least distance of distinct vision**. Least distance of distinct vision for a normal human being is 25cm.
- The various parts of the human eye and their respective functions include




| *Part* | *Function* |
|---|---|
| Cornea | Protective layer of the eye. |
| Pupil | Regulates the amount of light entering the eye. |
| Iris | Controls the size of the pupil. |
| Retina | Acts as a screen for forming the image. |
| Ciliary muscles | Adjust the focal length of the lens. |
| Optic nerves | Send signals to the brain. |

- The numerous light-sensitive cells contained (125 millions) in the retina of the eye are of two types:
  - ➢ Rod-shaped cells which respond to the brightness or intensity of light.
  - ➢ Cone-shaped cells which respond to the colour of light.

## Power of Accommodation of the Human Eye

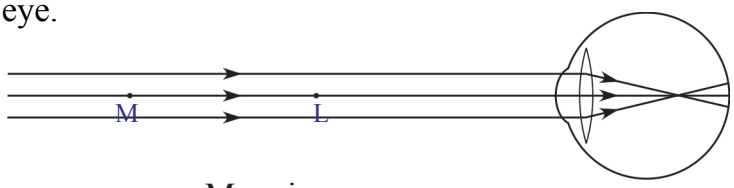
- The ability of the eye lens to adjust its focal length by the action of the ciliary muscles holding the lens accordingly as the distances is called **power of accommodation**.
- The farthest point up to which the eye can see objects clearly is called the far point (F) of the eye. It is ideally infinity for a normal eye.

- The point of closest distance at which an object can be seen clearly by the eye is called the near point (N) of the eye. For a normal eye, the near point is 25 cm, which is called the least distance of distinct vision (d) of a normal eye.
- The distance between the far point (F) and near point (N) is called the range of vision of the eye.
- Maximum focal length of human eye lens is 2.5 cm.
- Minimum focal length of human eye lens is 2.27 cm.

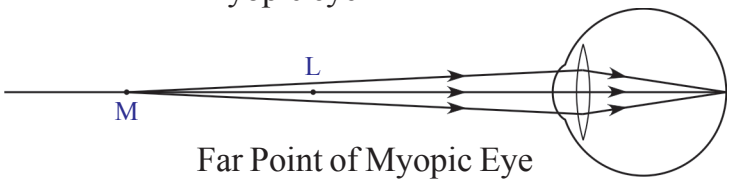
## Defects of Vision

### Myopia or Short-Sightedness

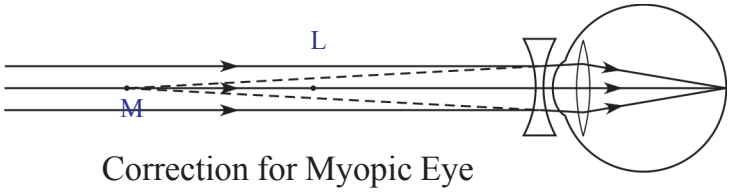
A person with myopia can see nearby objects clearly but cannot see distant objects distinctly, as if the far point of the eye has shifted from infinity to some particular distance from the eye.




Myopic eye




Far Point of Myopic Eye




Correction for Myopic Eye

This defect may arise due to

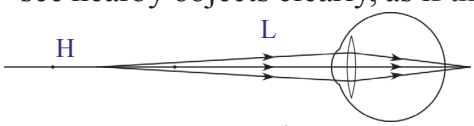
(i) Less focal length of the eye lens (ii) elongation of the eyeball.

To correct myopia, the person has to wear spectacles with a concave lens of focal length equal to the distance of far point of the myopic eye.

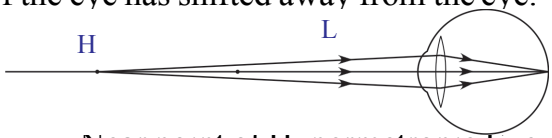
(ii) The lens used to correct myopia has a negative focal length and the power of lens is also negative.

### Hypermetropia or Long-Sightedness

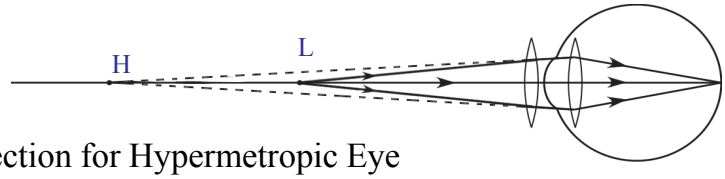
A person with hypermetropia can see objects lying at large distances clearly but cannot see nearby objects clearly, as if the near point of the eye has shifted away from the eye.




Hypermetropic Eye




Near point of Hypermetropic Eye




Correction for Hypermetropic Eye

This defect may arise due to

(i) More in the focal length of the eye lens

(ii) Short of the eyeball.

To correct hypermetropia, the person has to wear spectacles with a convex lens of focal length f, given by

$f = \frac{25d}{d-25}$, where 'd' is the distance of near point of the hypermetropic eye.

- The lens used to correct hypermetropia has a possitive focal length and the power of lens is also positive.

## Presbyopia

- Presbyopia is a human eye defect because of which an old person cannot read and write comfortably.
- It occurs in old age when the ciliary muscles holding the eye lens weaken and the eye lens loses some of its flexibility.
- To correct this type of defect of vision we need bi-focal lenses which are formed using both concave and convex lenses.The upper part of a bi-focal lens consists of concave lens facilitating distant vision, and the lower part consists of convex lens facilitating nearby vision.

## Power of lens:

The degree of convergence or divergence of light rays that can be achieved by a lens is expressed in terms of its power. The reciprocal of focal length is called power of lens.

Let 'f' be the focal length of lens.

Power of lens P = 1 / f(in m); P = 100 / f (in cm)

The unit of power is dioptre. It is denoted by the letter 'D'.

## ASSESSMENT

### Very short answer questins

1. Explain power of accommodation of the eye?
2. Write one function of iris in human eye.
3. A person with a myopic eye cannot see objects beyond 1.2 m distinctly. Which type of lens is to be used to restore proper vision?
4. Write about far point and near point of the human eye with normal vision?

### Short answer questions

1. I can comfortably read a book but find a difficulty to read the number on a bus parked 5 m away from me. Name the type of defect of vision that I am suffering from. Which type of lens should I use to correct my vision?

2. If we increase the distance of an object from the eye, what happens to the image distance in the eye?

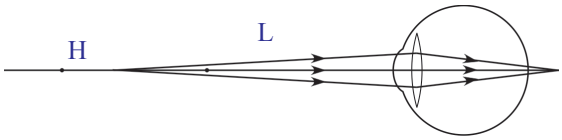
3. We will not able to see the things clearly when we come out of a darkroom, why?

4. What is the cause for Presbyopia? Name the type of lens used to correct it.

5. What happens if ciliary muscles does not function well?

## Essay questions

1. Observe the diagram given below and answer the questions.




(a) Which defect of vision is represented here? Give reason for your answer.

(b) What could be the two causes of this defect?

2. A 14-year old student is not able to see clearly the questions written on the blackboard placed at a distance of 5 m from him.

(a) Name the defect of vision he is suffering from.

(b) Name the type of lens used to correct this defect.

## Multiple Choice Questions

1. The minimum focal length of the eye lens is ( )

A) 2.5 m B) 2.5 cm C) 2.27 cm D) 2.05 cm

2. The least distance of distinct vision for an adult with normal vision is about ( )

A) 25 m B) 2.5 cm C) 25 cm D) 2.5 m

3. Name the defect of vision whose near point is more than 25 cm away. ( )

A) Myopia B) Hypermetropia C) presbyopia D) No defect

4. Which Lens is useful to read the small letters found in the Dictionary. ( )

A) Convex lens of focal length 50 cm

B) Concave lens of focal length 50 cm

C) Convex lens of focal length 5 cm

D) Concave lens of focal length 5 cm

# 6. ATOMIC STRUCTURE

## Bohr's model of hydrogen atom and its limitations

- Electrons in an atom occupy 'stationary orbits' of fixed energy at different distances from the nucleus. They are indicated by K, L, M, N....
- The electrons which are revolving in the orbits will neither loose nor gain energy. These are known as stationary orbits.
- When an electron jumps from a lower energy state to higher energy state, it absorbs energy.
- Similarly, when the electron jumps from a higher energy level to lower energy level, it emits energy.
- The energies in an atom can have only certain values.
- The states corresponding to these energies are called stationary states and the possible values of the energy are called energy levels.
- The electron cannot stay for a long time in excited state. It loses its energy and come back to its ground state. The energy emitted by the electron is seen in the form of electromagnetic energy and when the wavelength is in the visible region, it is visible as an emission line.

$$E_2 - E_1 = h\nu$$

**Limitations:**

- Bohr's model failed to account for splitting of line spectra.
- It could not explain the spectrum of atoms with more than one electron.

Quantum numbers are useful to explain the structure of atom

- These numbers indicates the probability of finding electron in the space around the nucleus.
- Principal Quantum number: It gives the information about the size and energy of an orbit.
- The angular momentum Quantum number: It gives the information about the shapes of sub energy levels.
- The magnetic Quantum number: These values describe the orientation of the orbital in space relative to the other orbitals in the atom.
- Spin Quantum number: This quantum number refers to the spin of an electron.

**Quantum numbers are useful to interpret the electronic configuration of atoms**

- Principal quantum number indicates the orbit (main energy level) in which the electron is present.

Ex: In the orbits 1s, 2s, 3s, 3p etc, the numbers 1,2,3… indicate the Principal quantum numbers.

- The angular momentum quantum number ($l$) gives the information about the orbital into which the electron enters.

| Orbital (Sub energy level) | *s* | *p* | *d* | *f* |
|---|---|---|---|---|
| *l* value | 0 | 1 | 2 | 3 |

- The magnetic quantum number ($m_l$) indicates the degenerate orbital into which the electron enters.

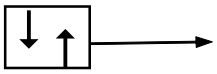
| Sub energy level | *l* value | $m_l$ value | orbital |
|---|---|---|---|
| s | 0 | 0 | s |
| p | 1 | -1,0,+1 | px, $p_y$, $p_z$ |
| d | 2 | -2, -1, 0, +1, +2 | $d_{xy}$, $d_{yz}$ $d_{xz}$, $d_{x^2-y^2}$, $d_{z^2}$ |

- The spin quantum number gives the information about the direction of spin of the electron.

| Direction of spin of electron | Spin quantum number ($m_s$) |
|---|---|
| Clock wise (↑) | + ½ |
| Anti clock wise (↓) | -½ |

To find the set of four quantum numbers of a given electron.

- If the electronic configuration of an element 'X', whose atomic number 12 is, $1s^2\ 2s^2 2p^6 3s^2$. The set of four quantum numbers of 12$^{th}$ electron is

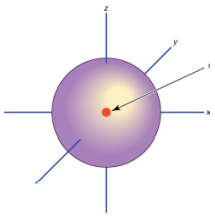
12$^{th}$ electron is in $3s^2$  12$^{th}$ electron

The four quantum numbers:

$$n = 3,\ l = 0,\ m_l = 0,\ m_s = +\tfrac{1}{2}\ or\ -\tfrac{1}{2}$$

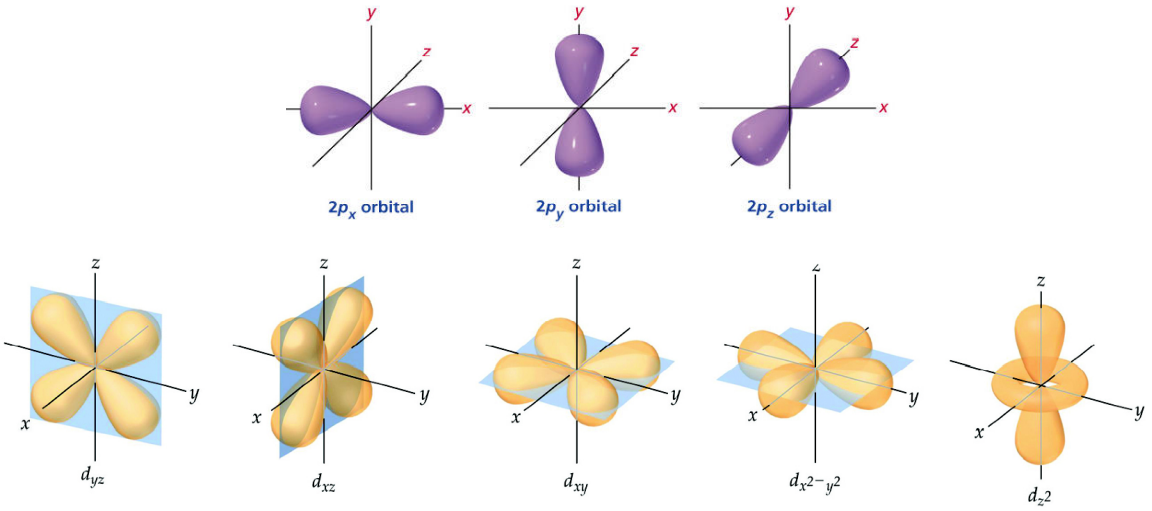
## Shapes of orbitals

- The shape of the orbital whose $n=0$, $l=0$, and $m_l = 0$ is spherical. It is '*1s*' orbital.



1s orbital

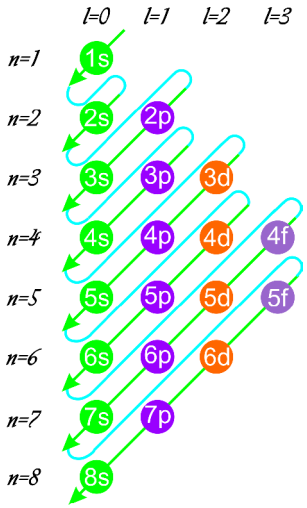
- Shape of ‘p’ orbital is dumbbell.




Shape of Orbital

- Shape of ‘d’ orbital is double dumbbell.

## The filling of order of atomic orbitals (Moeller chart)




## Rules useful to fill up of electron in the orbitals

- **Pauli's exclusion principle:** No two electrons of the same atom can have all four quantum numbers the same.
- **Aufbau Principle:** Electron enters first into the orbital whose *(n+l)* value is less. If *(n+l)* values are same, then electron enters into the orbital whose '*n*' value is less.

Ex: After filling up of 3p, electron enters into 4s, but not 3d. why?

| *Orbital* | *n value* | *l value* | *(n+l) value* |
|---|---|---|---|
| 4s | 4 | 0 | 4 |
| 3d | 3 | 2 | 5 |

According to this the (n+l) value of 4s is less than 3d. Hence the electron first enters into 4s orbital.

- **Hund's rule:** Electron pairing in orbitals starts only when all available empty orbitals of the same energy are singly occupied.

Ex: The electronic configuration of Carbon ($_6C$) is $1s^2 2s^2 2p^2$. In this the first 4 electrons enter into 1s and 2s orbitals. The next two electrons go into separate 2p orbitals, with both electrons having the same spin.

- Electronic configuration of Chlorine is – $1s^2 2s^2 2p^6 3s^2 3p^5$
- Electronic configuration of Copper is – $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10}$
- Write the four quantum numbers of first electron in L shell of Sodium.

Sodium electronic configuration is $1s^2 2s^2 2p^6 3s^1$

The first electron of L shell is $2s^1$

The four quantum numbers are: $n = 2,\ l = 0,\ m_{l=} 0,\ m_s = +\frac{1}{2}$ or $-\frac{1}{2}$

## ASSESSMENT

### Very short answer type questions

1. Write the electronic configurations of Chromium and Sodium.

### Short Answer questions

1. Write the four quantum numbers of the 12th electron of an element 'X' whose electronic configuration is $1s^2\ 2s^2 2p^6 3s^2$.
2. Write about quantum numbers.
3. If Hund's rule is not available, guess and write the changes in the electronic configuration of Nitrogen.
4. If Hund's rule is not available, guess and write the changes in the electronic configuration of Carbon.
5. Draw the shape of the orbital whose $n = 1, l = 0, m_l = 0$.

## Long answer type questions

1. Write the important postulates of Bohr's model of hydrogen atom and its limitations.
2. Explain Aufbau principle with an example.
3. Explain Hund's rule with an example.
4. Write the four quantum numbers of first electron in K shell of Sodium atom whose electronic configuration is $1s^2 2s^2 2p^6 3s^1$
5. Explain the role of quantum numbers in finding the probability of finding electron around the nucleus of an atom.
6. The four quantum numbers of distinguished electron of an atom are as follows:

| $n$ | $l$ | $m_l$ | $m_s$ |
|---|---|---|---|
| 3 | 0 | 0 | + ½ |

i) What is the outer most orbit of this element?

ii) Write the electronic configuration of this element.

iii) What is the atomic number of this element?

iv) What is the valency of this element?

## Multiple Choice Questions

1. The orbital with highest energy level among *3s,3p, 4s, and 3d* is ( )

   A) *3s* B) *4s* C) *3p* D) *3d*

2. If n = 4, then the number of orbitals in the subshells is ( )

   A) 16 B) 9 C) 4 D) 10

3. Which of the following is the correct electronic configuration? ( )

   A) $1s^2 2s^2 2p^7$ B) $1s^2 2s^3 2p^6$

   C) $1s^1 2s^2 2p^6$ D) $1s^2 2s^2 2p^6$

4. Which of the following is the configuration of an inert gas? ( )

   A) $1s^2 2s^1 2p^7$ B) $1s^2 2s^3 2p^5$ C) $1s^1 2s^3 2p^5$ D) $1s^2 2s^2 2p^6$

5. The orbital occupied by the $7^{th}$ electron Na atom is ( )

   A) $2p_x$ B) $2p_y$ C) $2p_z$ D) 2s

6. The atomic number of an element is 19. $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1$. Its valency is ( )

   A) 2 B) 3 C) 4 D) 1

7. The elements with the orbitals fully or partially filled are stable. The valency of copper whose atomic number 29 is ( )

   A) $[Ar]4s^1 3d^{10}$ B) $[Ar]4s^2\ 3d^9$ C) $[Ar]4s^1 3p^5 3d^5$ D) $[Ar]\ 3p^3\ 4s^1 3d^{10}$

8. The electron first occupies the following orbital according to Aufbau rule ( )

   A) 5s B) 4p C) 3d D) 5p

# 7. CLASSIFICATION OF ELEMENTS – THE PERIODIC TABLE

- Robert Boyle defined an element as any substance that cannot be decomposed into further simple substances by a physical or chemical change.
- Scientists discovered more than 118 elements. As the number of elements increased, it became difficult to keep in memory the chemistries of individual elements and their compounds. So, there was a need to classify them in a better way.
- Various ways have been explored to scientifically classify elements based on their physical and chemical properties to form their compounds. Atomic numbers and Atomic weights were used to arrange the elements in order.
- **Atomic number:** The sum of positive charges in the atom of an element is called particles the atomic number.
- **Atomic Weight:** The sum of protons and neutrons in an element is called the atomic weight. For example, Atomic weight of Helium is $A = p + n = 2+2 = 4$.
- The prominent scientists among those who classified the elements were Johann Wolfgang Dobereiner, John Newlands, Mendeleev and Mosley.

## DOBEREINER'S LAW OF TRIADS

- The first classification of elements was made by Johann Wolfgang Dobereiner, a German Chemist. He identified groups of three elements that had the same chemical properties and called them traid.
- According to Dobereiner "the atomic weight of the middle element is the average of the atomic weights of the first and third elements". This statement is called Dobereiner's law of triads.

  Example for Dobereiner triads: A(Li, Na, K), B (Ca, Sr, Ba), C(Cl, Br, I), D(S, Se,Te) E(Mn, Cr, Fe) .

| Group | Atomic weight of element | | | Average weight of 1st and 3rd elements |
|---|---|---|---|---|
| A | Li (7.0) | Na(23.0) | K (39.0) | 7.0+39.0/ 2 = 23. 0 |

### Limitations of Dobereiner's Law of Triads :

- All the known elements at that time could not be arranged in the form of triads.
- The law failed for very low mass or for very high mass elements .
- As the techniques improved for measuring atomic masses accurately the law was unable to remain strictly valid.

## Newland's Law of Octaves

- John Newlands was a British Chemist. He found that when elements were arranged in the ascending order of their atomic weight, they appeared to fall into seven groups, in which their properties repeat at regular intervals.
- According to Newlands when elements are arranged in the ascending order of their atomic weights " Every eighth element starting from a given element resembles in its properties to that of given element". This is called Newlands law of Octaves.

### Limitations of Newland's Law of Octaves :

- He placed two elements into the same slot. Ex: Cobalt and Nickel
- Certain elements were totally dissimilar in their properties and were placed in the same group. For Example, He arranged Co, Ni, Pd and Ir which have different properties compared with Halogens (F, Cl, Br, I ) in the same row.
- This table was restricted to only 56 elements and did not leave any room for new elements.
- He attempted to link the periodicity of the chemical properties of elements with the periodicity found in music as sa, ri, ga, ma, pa, da, ni, sa (A,B,C,D,E,F,G,H)

### Mendeleeff's Periodic Table

- Dimitri Ivanovich Mendeleeff, a Russian Chemist arranged the elements known at that time in a table in a systematic order in the increasing order of their atomic weights.
- **Mendeleeff's Periodic law states that " the physical and chemical properties of the elements are periodic functions of the atomic weights".**
- Mendeleff tried to explain the similarities of elements in the same group in terms of their common valency.
- He divided the table into 8 vertical columns called groups. They are represented by Roman numerals I to VIII. Elements present in a given vertical have similar properties. Each group divided into A, B sub groups.
- The Horizontal rows in Mendeleeffs periodic table are called Periods. Elements in a period differ in their properties.
- He predicted some elements were missing and he left blank spaces at the appropriate places in the table.
- He predicted the properties of these additional elements in advance and named those predicted elements tentatively by adding the prefix 'eka'( eka is Sanskrit word for numeral one ) to the name of the element immediately. eka-boron, eka-aluminium and eka-silicon were almost the same as those of Scandium, Gallium and Germanium respectively which were discovered later.

**PREDICTION OF ELEMENTS BY MENDELEEFF**

| Predicted element | New element |
|---|---|
| eka-boron | scandium |
| eka-aluminium | Gallium |
| eka-silicon | Germenium |

- The placement of elements in Mendeleev's periodic table helped in correcting the atomic masses of some elements like beryllium, indium and gold.

### Limitations of Mendeleeff's Periodic Table:

- Certain elements of the highest atomic weight precede those with lower atomic weight.
- Dissimilar elements placed together in the same group. For example Cl is VII A group element and Mn is VII B element, but Chlorine is a nonmetal, whereas Manganese is a Metal.

## Modern Periodic Table (Long from Periodic Table)

- The modern periodic table which is based on the modern periodic law is called the long form of the periodic table. This was proposed by Moseley.
- **Modern periodic law:-** It may be stated as "The properties of the elements are periodic functions of their atomic numbers.
- The modern periodic table has 18 vertical columns known as groups and 7 horizontal rows known as periods.

### Positions of Elements according to Modern Periodic Table

- The elements with similar outer shell electronic configurations in their atoms are in the same column called **Group.**

**Examples:** Li :$1s^2\ 2s^1$; Na: $1s^2\ 2s^2\ 2p^6\ 3s^1$ etc.

- Depending upon which subshell the differentiating electron i.e., the last coming electron enters in the atom of the given element, the elements are classified as **s, p, d** and **f** block elements.
- ' **s-block Elements:** If the differentiating electron enters into the s- subshell, then such elements are called s-block elements.

  Example: Na = $1s^2\ 2s^2\ 2p^6\ 3s^1$ and Ca= $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
- **p–block Elements:** If the differentiating electron enters into the p – subshell, then such elements are called p-block elements.

  **Example:** Ar = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- **d –block Elements:** If the differentiating electron enters into the d-subshell, then such elements are called d-block elements.

  **Example:** Sc = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^1$
- **f-block Elements:** If the differentiating electron enters into the f-subshell, then such elements are called f-block elements.

  **Example:** Pr = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^{10}\ 4p^6\ 5s^2\ 4d^{10}\ 5p^6\ 6s^2\ 5d^1\ 4f^2$

### Groups:

- The vertical columns in the modern periodic table are known as groups. There are 18 groups, They are represented by using Roman Numbers I to VIII with letters A and B in Traditional notation or According to IUPAC, these groups are represented by Hindu Arabic numbers 1– 18 .

  **Example :-**Group 2 (II A) ; Group 16 (VI A).

**Periods:**

- The horizontal rows in the periodic table are called periods. There are 7 periods. These periods are represented by Arabic Numerals 1 to 7.
- The number of main shells present in the atom of a particular element decides to which period it belongs.
- The first period contains only 2 elements H and He.
- The second period contains 8 elements and consists of two s- block elements ( Li, Be) and Six p –block elements ( B, C, N, O, F & Ne ).
- Third period starts with the third main shell ( M ). $3^{rd}$ period contains only 8 elements, which include 2 s-block elements ( Na, Mg) and six p-block elements ( Al, Si, P, S, Cl & Ar).
- Fourth period contains 18 elements which include 2 s-block (K, Ca) elements; 10 elements from d-block (Sc to Zn) and 6 elements from p-block.
- On the same lines, the Fifth period also contains 18 elements. There are 32 elements in the sixth period which includes 2 elements from s-block ( 6s), 14 elements form f-block (4f), 10 elements from d-block (5d) and 6 elements from p-block (6p).
- $7^{th}$ Period is incomplete.
- 4f elements are called Lanthanoids (or) Lanthanides. 5f elements are called Actinoids (or) Actinides.
- The f-block elements known as Lanthanides & Actinides are shown separately at the bottom of the periodic table.

**Periodic properties of elements in the Modern Periodic Table**

- The physical and chemical properties of the elements in the periodic table are related to their outermost shell electronic configuration.
- The elements in the same group of the periodic table possess the same valence shell electronic configuration. Hence the elements in the same group possess the same chemical properties. Their physical properties change gradually. The recurrence or repetition of properties of the elements with similar(valence) electronic configuration at regular intervals is called periodicity.
- In a period, as we move from left to right the atomic number increases by one unit and so no two elements possess the same valence electronic configuration. Hence in a period the chemical properties of the elements would be different from other elements. The physical properties of the elements in a period change gradually.

**Properties of elements and their trends in Periods and Groups**

**1. Valency:**

- Valency of an element is the combining capacity of an element with respect to hydrogen, oxygen or indirectly any other element through hydrogen and oxygen.

- Valency of an element with respect to hydrogen is the number of hydrogen atoms with which one atom of that element chemically combines.
- Valency of an element with respect to oxygen is twice the number of oxygen atoms with which one atom of that element combines.

Eg: **i. What is the valency of sodium in NaH?**

The number of hydrogen atoms in NaH is 1, so the valency of Na is 1.

**ii. What is the valency of calcium in CaO?**

The number of oxygen atoms in CaO is 1.

So, the valency of Ca is twice the number of oxygen atoms in CaO = 2 x 1 = 2.

**2. Atomic radius**

- Atomic radius or atomic size is defined as the distance from the centre of the nucleus of an element to its outermost shell. It is measured in 'pm' (picometer) units 1 pm = $10^{-12}$m
- In a group, atomic radii increases from top to bottom. This is because of addition of an extra shell in the electronic configuration of elements which results in the increase of the distance between the centre of the nucleus and the outermost shell.

| **Group** | **Element (atomic radius in pm)** |
|---|---|
| **Group1** | Li (152), Na (186), K (231), Rb (244) and Cs (262) |
| **Group 17 (VII)** | F (64), Cl (99), Br (114), I (133) and At (140) |

- In a period, atomic radii decreases as we move from left to right. This is because, as we go from left to right in a period, the atomic number increases by one unit and the incoming electron enters into the same shell with which the nuclear attraction on the outer shell electrons increases. As a result, the size of the atom decreases.

| **Period** | **Element (atomic radius in pm)** |
|---|---|
| **$2^{nd}$ period** | Li (152), Be (111), B (88), C (77), N (74), O (66), F (64) |
| **$3^{rd}$ period** | Na (186), Mg (160), Al (143), Si (117), P (110), S (104), Cl (99) |

## 3. Ionization energy

- The energy required to remove an electron from the outer most orbit or shell of a neutral gaseous atom is called ionization energy. It is measured in KJ/mol units.
- The energy required to remove the first electron from the outermost orbit or shell of a gaseous neutral atom of the element is called its first ionization energy.
- The energy required to remove an electron from a uni-positive ion of the element is called its second ionization energy.
- Usually, the second ionization energy of an element is higher than its first ionization energy.
- $M_{(g)} + IE_1 \longrightarrow M^+_{(g)} + e^-$ ($IE_1$ = First ionization energy).
- $M^+_{(g)} + IE_2 \longrightarrow M^{+2}_{(g)} + e^-$ ($M^+$ = uni-positive ion; $IE_2$ = Second ionization energy).

**Ionization energy of an element depends on the following factors:**

**Ionozation Energy of an element depends on its:**

| | |
|---|---|
| Nuclear Charge | More the nuclear charge more is the ionization energy. |
| Screening Effect or Shielding Effect | As the number of shells increase between the nucleus and the valence electrons increases the ionization energy decreases. |
| Penetration power of the orbitals | Orbitals belonging to the same main shell have different piercing power towards the nucleus. |
| Stable Configuration | Atoms with stable configuration have more ionization energy. |
| Atomic Radius | As the atomic radius increases ionization energy decreases. |

## 4. Electron affinity

- The energy liberated when an electron is added to a neutral gaseous atom of an element is called affinity. Electron affinity of an element is also called electron gain enthalpy of that element. It is expressed in the units of KJ $mol^{-1}$.
- $M_{(g)} + e^- \longrightarrow M^- + E_1$ ( M = neutral gaseous atom, $E_1$ = First electron affinity).
- The energy liberated when an electron is added to a uni-negative ion is called second electron affinity.
- $M^-_{(g)} + e^- \longrightarrow M^{-2} + E_2$ ( $M^-$ = uni negative ion, $E_2$ = Second electron affinity).
- In a period, as we move from left, the value of electron affinity increases gradually.
- In a group, as we move from top to bottom, the value of electron affinity decreases gradually.

| Group | Electron affinity value (in KJ $mol^{-1}$) |
|---|---|
| **VIIA (Halogens)** | F (-328) Cl (-349) Br (-325) I (295) At (270) |
| **Group 17 (VII)** | O (-141), S (-200), Ge (-195), Te (-190), Po (-174) |

- Metals have very low electron affinity. Alkaline earth metals have even positive electron affinity.
- Negative values of electron affinity indicates that energy is liberated or lost.
- Positive values of electron affinity indicates that energy is absorbed or gained.
- All the factors which influence the ionization energy also influence the electron affinity.
- The element with highest electron affinity is Chlorine (Cl).

## 5. Electronegativity

- The electronegativity of an element is defined as the relative tendency of its atom to attract electrons towards itself when it is bonded to the atom of another element.
- It has no units but expressed in Pauling‘s scale. Pauling assigned the electronegativity values for elements on the basis of their bond energies.

- All the factors that influence the ionization energy and the electron affinity of elements also influence the electronegativity values of those elements.
- Mulliken proposed that the electronegativity of an element is the average of its ionization energy and electron affinity.
- Electronegativity $= \frac{\text{ionization energy + electron affinity}}{2}$
- In a period, as we go from left to right, electronegativity values increase.
- In a group, as we from top to bottom, electronegativity values decrease.
- The most electropositive element is Fluorine (F).
- The least electronegative element is Cesium (Cs).

## 6. Metallic and Non-metallic Properties:

- Metals present in compounds generally show a tendency to remain as positive ions. This property of metals is called electropositivity.
- Generally metals show more electropositive character and less electronegative character.
- Non-metals are generally more electronegative due to their smaller atomic radii and are generally least electropositive.
- The elements present on the left side of the periodic table are metals and the elements present on the right side of the periodic table are non-metals.
- So, in a period, we find the metals on the left side and the nonmetals on the right side.
- Hence, as we move from left to right in a period, the metallic character decreases and the non-metallic character increases.
- The groups present on the left side of the periodic table have all the elements as metals whereas the groups present on the right side of the periodic table have non-metals in them at the top and have metals at the bottom.
- Hence, as we move from top to bottom in a group, metallic character increases and the non-metallic character decreases.

**Periodic properties of elements and their trends in groups and periods.**

| **Periodic property** | **Trend in** | |
|---|---|---|
| | **Groups (From top to bottom)** | **Periods (From left to right)** |
| Valency | Same for all elements | Increasing from 1 to 04 and gradually decreases to 0 |
| Atomic radius | Increasing | Decreasing |
| Ionisation energy | Decreasing | Generally Increasing |
| Electron affinity | Decreasing | Increasing |
| Electronegativity | Decreasing | Increasing |
| Metallic Nature | Increasing | Decreasing |
| Non-metallic Nature | Decreasing | Increasing |

## ASSESSMENT

### Very short answer questions

1. Write the electron configuration of $Na^+$ and $Cl^-$ ions.
2. An element with atomic number 21. What is the place of the element in the periodic table? Why?
3. Arrange the following elements in the increasing order of their atomic radii. P, Al, Cl, Na, S, Si, Mg.
4. Why do the elements present in the right side of the periodic table have least values of electronegativity?
5. Why does nitrogen have less electron affinity value compared to oxygen.

### Short Answer questions

6. Which one between Cl and $Cl^-$ would have more size? Why?
7. The ionization energy required to remove an electron from $Mg^+$ is higher than the ionization energy required to remove an electron from Mg. Why?
8. In the periodic table, elements arranged in a group possess similar properties, but elements in a period do not show similarities in their properties. Why?
9. An element X belongs to the $3^{rd}$ period and group 2 of the periodic table. State
   a. The number of valence electrons
   b. Metalic property
10. 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 the second period?
    ii) Which element belongs to the second group?

### Long Answer questions

11. State the Modern Periodic Law. Discuss the construction of the long form of the periodic table.
12. Explain Ionization energy and the factors that influence the ionization energy.
13. The element 'X' belongs to the 1st group, the element 'Y' belongs to the 2nd group and both 'X' and 'Y' elements belong to the same period in the periodic table. What are the similarities between 'X' and 'Y' elements of the following.
    a. The number of electrons in valence shell ( outermost shell )
    b. Their atomic size and valency
    c. Their ionisation potential and metallic character
    d. Symbols of their chlorides, sulphates.

14. 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 of the elements belong to same period?
2. Which of the elements belong to the same group?
3. Which are noble gas elements?
4. Which group and period does the element 'C' belong to?

15. What is a periodic property? How do the following properties change in a group and in a period of the modern periodic table.

a) Atomic radius b) Ionization energy

c) Electron affinity d) Metallic and Non-metallic character.

## Multiple Choice Questions:

1. Which of the following shells have a maximum of 32 electrons? [ ]

A) N B) M C) L D) K

2. 11,12,13 and 14 are the atomic numbers of the elements Na, Mg, Al and Si respectively. Which element has more atomic radius? [ ]

A) Na B) Mg C) Al D) Si

3. The element with Atomic number = 7 belongs to _____ group [ ]

A) 1st Period IA group B) 2nd Period VA group

C) 2nd Period IIIA group D) 2nd period IV A group

4. Increasing order of electronegativity of the elements Si, N, P and C is [ ]

A) N, Si, C, P B) P, Si, N, C

C) C, N, Si, P D) Si, P, C, N

5. Dobereiner, Newlands and Mendeleeff classified the elements on the basis of [ ]

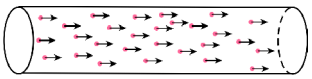
A) Atomic number B) Atomic Weight

C) Atomic structure D) electronic configuration

# 9. ELECTRIC CURRENT

- **Conductor :** The material which allows the flow of electrons is called a conductor.

  Ex: Copper wire.



*Ordered motion of electrons*

- **Non conductor :** The material which does not allow the flow of electrons is called a non-conductor.

  Ex: Nylon wire.

- When the ends of a conductor are connected to the terminals of a battery (source) the free electrons move in an orderly manner. This ordered motion leads to electric current.

**Electric current :**

The electric current is defined as the amount of charge crossing any cross-section of the conductor in one second.

If 'Q' coulomb of charge crossing through any cross-section in time 't' then

electric current $I = Q/t$

- The S.I unit of electric current is Ampere. 1 Ampere= 1coulumb / 1second.
- One coulomb of charge contains $6.25 \times 10^{18}$ electrons.
- The electric current is measured by an ammeter.

**Potential difference :**

The work done by the electric force on unit positive charge to move it from one point to another in electric field is called potential difference. It is denoted by 'y'

$V = W/q$ where W=Work done and q=charge

- The S.I unit of potential difference is 'Volt'. 1 Volt= 1 joule /1 coulomb

**Electromotive force(emf):**

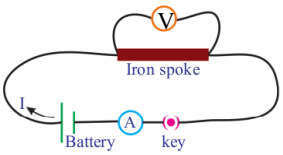
- The work done by chemical force to move unit positive charge from negative terminal to positive terminal of the battery is called emf. $\varepsilon = F_e\, d/q$
- An electric cell is a device that maintains constant potential difference between its terminals. The electric cell converts chemical energy into electrical energy.
- Voltmetre is used to measure potential difference and emf between two terminals of battery. It is connected parallally in the circuit.

## OHM'S LAW

**Aim** :**To show that the ratio V/I is constant for a conductor.**

**Material required:** 5 dry-cells of 1.5 V each, conducting wires, an ammeter, a voltmeter, thin iron spoke of length 10 cm, LED and key.

**Precautions:**




1. Take care while connecting wires to the source.
2. The readings of voltmeter and ammeter are to be taken without parallax error.
3. The temperature of the iron spoke is constant during the flow of current through it.

**Procedure:**

a) Let us take a iron spoke and solder it with conducting wires at both ends.

b) These two wires connected to a cell of 1.5 V through an ammeter and key.

c) Connect a voltmeter across two ends of iron spoke.

d) Close the key and note the readings of current in ammeter and potential difference in voltmeter.

e) Now connect two cells in series in the circuit and note the readings of ammeter and voltmeter.

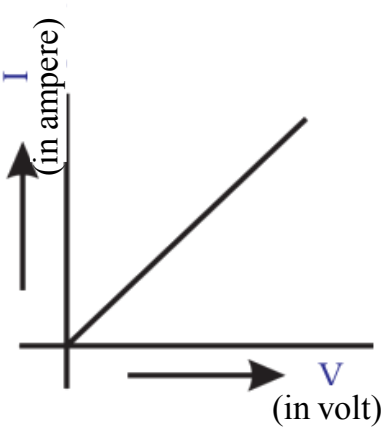
f) Repeat the experiment with 3,4 and 5 cells in series and record the values of current and potential difference in the given tabular form and calculate V/I value in each case.

| S.No | Potential difference(V) | Current(I) | V/I |
|---|---|---|---|
| | | | |
| | | | |
| | | | |

**Observations:**

As the potential difference increases electric current also increases. And the ratio between them is constant. i.e.,

V/I = Constant




**Result :** From the table we can conclude that the potential difference between the ends of iron spokes is directly proportional to current passing through it.

A graph is drawn with 'V' on X-axis and 'I' on Y-axis gives a straight line passing through origin.

That is V∝ I and V/I=constant.Hence 2

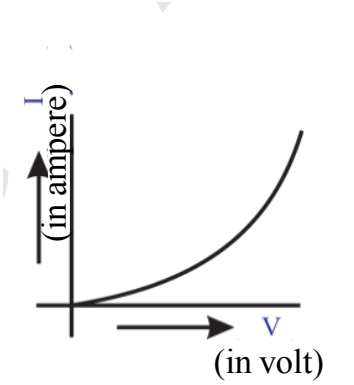
iron spoke is a ohmic material

**Ohmic materials:** The materials which obey the ohm's law are called ohmicmaterials.

Ex.Metals.

By using a LED instead of iron spoke and record the values of

potential difference and current and draw a graph between 'V' and 'I',



the nature of the graph is a nonlinear curve. That is V/I is not constant.

Hence LED is a non ohmic material.

**Non ohmic materials :**The materials which do not obey the ohm's law are called non-ohmic materials .

Ex. LED , Thermistors.

**OHM'S LAW:** "At constant temperature the potential difference between ends of a conductor is directly proportional to electric current passing through it."

$V \alpha I$

V=IR , R is a constant called resistance.

**Limitation of ohm's law:**

1. The ohm's law can be applied only to metal conductors provided temperature and other physical conditions remain constant.
2. It is not applicable to gaseous conductors, semiconductors.

R**esistance**: The property of a material which obstructs the flow of electrons in a conductor is called resistance.

Resistance R=V/I

The SI unit of resistance is 'Ohm' It is denoted by 'Ω'

1 Ohm=1Volt /1Ampere;

**1 Ohm:** When 1 volt potential difference applied across ends of wire and 1ampere current flows through it then the resistance is said to be 1ohm.

**Electric shock:**

- Electric shock can be experienced when a potential difference exists between one part of the body and another part.
- The electric shock is a combined effect of potential difference, electric current and resistance.
- When a bird stands on a high voltage wire the potential difference does not exist between its legs because it stands on a single wire. Hence it does not feel any electric shock.

**Factors affecting the resistance of a material:**

The factors affecting the resistance of a material are,

1) length (l) 2) Area of cross section (A) 3) Temperature and 4) Nature of material.

**Length of the conductor and resistance :**

**Aim:** To prove resistance of a conductor is directly proportional to the length (l)

**Materials required:** Iron spokes of different lengths with same cross sectional area,

Battery,ammeter,key,wires.

**Precautions:**

1. Iron spokes must have same area of cross-section.
2. The readings of ammeter is taken as without parallax error.

**Procedure:**

- Connect the iron spoke across the battery and ammeter using connecting wires.
- Close the key and measure current (I) in the ammeter which is connected in series.
- Repeat the experiment with iron spokes of different lengths and note the current(I) in ammeter.

**Observations:** We observe that as length of spoke increases the current in ammeter decreases when potential difference is constant which implies resistance of circuit increases.

**Result:** Hence we conclude that resistance of conductor increases with length of the conductor.

$R \propto l$

## Cross section area and resistance:

**Aim:** To prove resistance of a conductor is inversely proportional to area of cross section of conductor(A)

**Materials required:** Iron spokes of different cross sectional area of same length

Battery, ammeter, key, wires etc.

**Precautions:**

1. Length of the iron spokes must be the same.
2. The readings of ammeter is taken as without parallax error.

**Procedure:**

a) Connect the iron spoke across the battery and ammeter using connecting wires.

b) Close the key and measure current (I) in the ammeter.

c) Repeat the experiment with iron spokes of different cross sectional areas and note the current(I) in ammeter.

**Observations:** We observe that as area of cross section of spoke increases the current in ammeter increases when Potential difference is constant which implies resistance of the circuit decreases.

**Result:** Hence we conclude that resistance of conductor decreases with increase in cross sectional area of the conductor. $R \propto \frac{1}{A}$

**"The resistance of a conductor (R) is directly proportional to length (l) and inversely proportional to area of cross-section (A)."**

i.e., R and R ,Therefore R (for a given material)

**Specific resistance :** The resistance of a conductor of unit length and unit area of cross-section is called specific resistance.

- S.I unit of specific resistance or resistivity is ohm-metre. (Ω - m)

- The resistivity depends on temperature and nature of the material. It is independent of physical dimensions like length and area of cross section of the conductor.
- Resistance depends on temperature, nature of the material and also Physical parameters like length and area of cross section.

**Applications of specific resistance (Resistivity):**

The value of resistivity determines the conductivity of materials.

1. Metals like copper behave as good conductors used in preparing electric wires due to low resistivity.
2. The filament of an electric bulb is usually made of tungsten, because of its high resistivity and high melting point($3422^0$ C).
3. The alloys like nichrome possess larger values of resistivity and this makes them suitable for use of heating elements in electric irons, electric toasters etc.

**Electric Circuits:**

The closed path created by the connecting wires through a battery along which electrons flow is called an electric circuit.

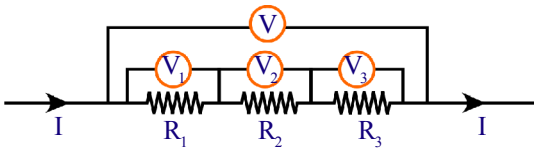
**Series combination of resistors:**

- The number of resistors connected such that same current flows through each resistor then is said to be a series combination.
- In series combination the potential difference is different acrosseach resistor.

Let us consider three resistors $R_1$, $R_2$ and $R_3$ connected in series across a battery of potential difference'V' and current through each resistor is "I"

where $R_{eq}$=equivalent resistance

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

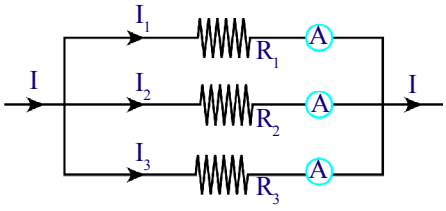



"**The equivalent resistance of three resistors connected in series is equal to the sum of their individual resistances.**"

**Parallel combination of resistors:**

- The number of resistors connected such that the potential difference across each resistor is the same then it is said to be a parallel combination.
- In parallel, combination the current through each resistor is different.

Let us consider three resistors $R_1$, $R_2$ and $R_3$ connected in parallel across a battery of potential difference 'V' and $I_1$, $I_2$ and $I_3$ are the currents through resistors $R_1$, $R_2$ and $R_3$ respectively.




$$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$$

$R_{eq}$=equivalent resistance

**"The reciprocal of equivalent resistance $R_{eq}$ is equal to the sum of the reciprocals of the individual resistances."**

- ➢ The electrical appliances in house-hold circuit are connected in parallel because if any appliance is switched off, the other appliances are not affected. If they are connected in series, if one appliance is switched off all the other appliances will switch off.
- ➢ The headlights of a car are connected in parallel, Because in parallel wiring both headlights get the power. If one light goes off the other will work.

## Kirchoff's laws:

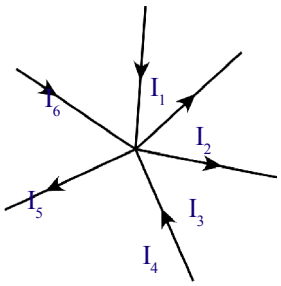
**a) Junction Law:**

The sum of the currents entering into the junction is equal to sum of the currents leaving the junction.

This law is based on the law of conservation of charge.

Let $i_1$ , $i_4$ and $i_6$ are the currents entering the junction whereas $i_2$ , $i_3$, and $i_5$ are the currents leaving the junction then

$$i_1 + i_4 + i_6 = i_2 + i_3 + i_5$$



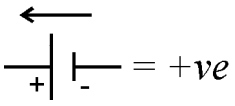

**b) Loop Law:**

The algebraic sum of all the potential differences in a closed circuit is zero.

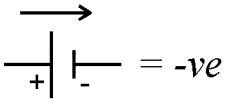
This law is based on the law of conservation of energy.

## Sign conventions:

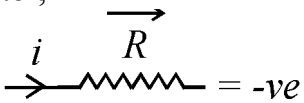
a) When we move from negative terminal to positive terminal across a battery, emf is taken as positive.



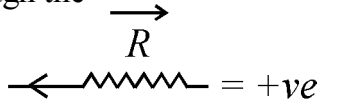

b) When we move from positive terminal to negative terminal across a battery, emf is taken as negative.




c) When we move in the direction of electric current through the resistor, the potential difference is taken as negative.




d) When we move in the direction opposite to electric current through the resistor, the potential difference is taken as positive.




**Electric power:**

The rate at which electric energy is consumed is termed as electric power.

Electric power P = Work done x Time of flow of current

$P = W \times t$

$P = I^2R$

$P = V^2/R$

- S.I unit of electric power is watt (W)
- Generally power consumption expressed in bigger units of power like KiloWatt.
- 1kW=1000W Power also expressed in horsepower 1HP = 746 W
- The consumption of electric energy is expressed in kiloWatt hour.
- 1kiloWatt hour (kWh) $= 3.6 \times 10^6$ J

**Overloading :**

If the value of current flow goes above the required value of the circuit then the wire fails to bear the load of electric current. This is called overloading.

- This leads to fire accidents.
- To protect from overloading we use electric fuses in the household circuits.

**Fuse:**

The fuse consists a thin wire having low melting point Due to this, if current in a circuit increase above a particular point the fuse wire gets heated and melts.

- A piece of wire made of lead and tin alloy is used in making a fuse.

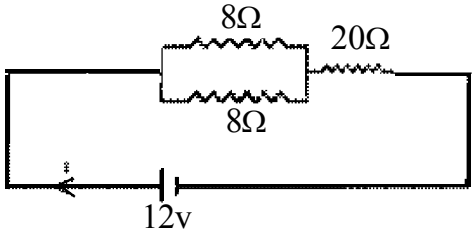
## ASSESSMENT

### VERY SHORT ANSWER QUESTIONS:

1. What happens if a high melting point conductor is used as a fuse in house-hold connections?
2. Do electric bulbs in houses and decorative bulbs are connected in the same way?
3. What happens to the resistance of a conductor if we increase its length?
4. Why does overload occurs in a circuit? Explain.
5. In a house-hold circuit 220 voltage and 440Ω of resistance are connected, then find the electric current?

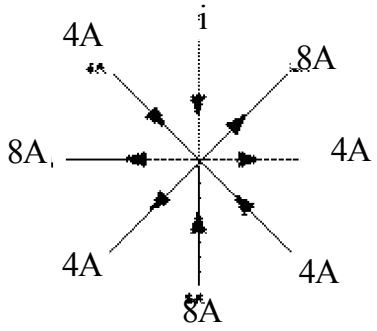
### SHORT ANSWER QUESTIONS:

6. Two resistances 4Ω & 8Ω are connected to get least resistance then find resultant resistance in the circuit?
7. Two resistances 4Ω & 8Ω are connected to get high resistance then find resultant resistance in the circuit?
8. Find the resultant resistance and current flowing in the given circuit?




9. Draw a simple circuit using Battery, Ammeter,Voltmeter, Connecting wires, switch.

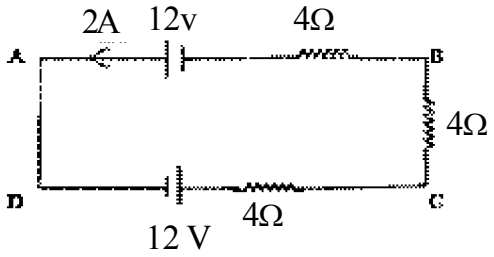
10. Observe the given Junction and then find the value of i.




11. Two bulbs have ratings 100W, 220V, and 60W, 220V. Which bulb has the greater resistance?

**ESSAY QUESTIONS:**

12. Write the required materials, procedure, precautions and observations in an activity to prove ohm's law.
13. Write the required materials, procedure, precautions and observations in an activity to find relation between resistance and cross-section area.
14. Write the required materials, procedure, precautions and observations in an activity to find relation between resistance and length of the conductor.
15. Solve the loop 1) ABCDA 2) ADCBA




## Multiple choice questions

1. This is used to measure potential difference ( )
   A) Ammeter B)Voltmeter C) Thermistor D) electric motor
2. In an electric cell chemical energy converts into ( )
   A) Mechanical energy B) Magnetic energy C) Electric energy D) Heat energy
3. Joule/coulomb is same as ( )
   A) Watt B) Ampere C) Volt D) Ohm
4. The material which obey the ohm's law is ( )
   A) Copper B) Silicon C) LED D) Transistor
5. The resistance of the material will not depends on ( )
   A) length B) Cross sectional area
   C) Nature of the material D) No. of electrons
6. The filament of an electric bulb usually made of ( )
   A) Tungsten B) copper C) Silver D) lead
7. The resistors of values 2Ω , 4Ω and 6Ω are connected in series. The equivalent resistance of the circuit is ( )
   A) 2Ω B) 4Ω C)6Ω D)12Ω
8. Junction law is based on Law of conservation of ( )
   A) mass B) charge C) energy D) Momentum

# 11. PRINCIPLES OF METALLURGY

- Metals like gold(Au), silver(Ag) and copper(Cu) are available in nature in free state as they are least reactive. Other metals mostly are found in nature in the combined form due to their high reactivity.
- The elements or compounds of the metals which occur in nature in the earth crust are called minerals.
- The minerals from which the metals are extracted without economical loss are called ores.
- The ores of many metals are oxides sulphides, chlorides and carbonates.

Ex: Oxide Ores : $Al_2O_3.2H_2O.$; ZNO, $Fe_3O_4$

Chloride Ores: NaCl, AgCl, KCl, $MgCl_2.6H_2O$

Sulphide Ores: ZnS, HgS, CuFeS

Carbonate Ores: $MgCO_3$, $CaCO_3$

**Reactivity of metals**

Based on reactivity we can arrange metals in descending order of their reactivity as shown below:

- **High reactivity metals** : K, Na, Ca,Mg,Al
- **Moderate reactivity metals** : Zn, Fe,Pb,Cu
- **Low reactivity metals** : Hg, Ag, Pt, Au

**Extraction of metals from the ores**:

Extraction of a metal from its ore involves mainly three stages.They are

1. Concentration or dressing of the ore.
2. Extraction of crude metal from the ore.
3. Refining or purification of the metal.

## 1. Concentration or dressing of the ore:

Ores contain large amount of impurities. The impurities like sand and clay are called gangue. Dressing of the ore means removing unwanted material like gangue from the ore.The physical methods adopted in dressing of the ore are:

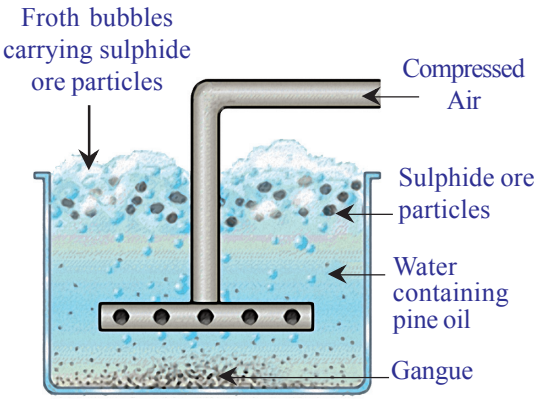
**Hand picking :**This method is used if the ore particles and impurities are different in one of the properties like colour,size, etc.The ore particles are handpicked and separated from impurities.

**Washing:**

This method is used when ore particles are more denser than impurities.Ore particles are crushed and kept on a slopy surface.They are washed with controlled flow of water. Less dense impurities are washed away by water flow. Ore particles are left behind on the slope.

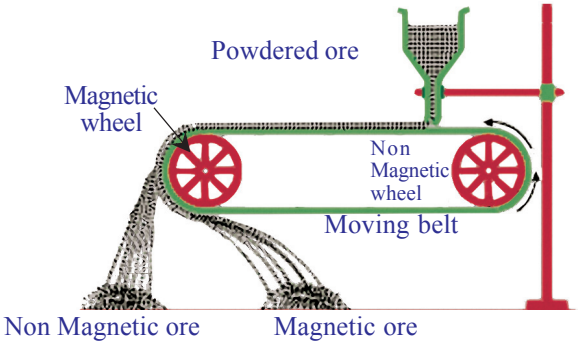
**Froth flotation:**

This method is used for sulphide Ores which have no wetting property whereas the impurities get wetted. Water containing pine oil is taken in flotation cell.The ore with impurities is finely powdered and kept in flotation cell. Air under pressure is blown to produce froth in water. Froth so produced, takes ore particles to the surface whereas impurities settle at the bottom. Froth is separated and washed to get ore particles.




**Magnetic separation:**

This method is used if either ore or impurity is a magnetic substance.The impurities are separated using electromagnetic wheel as shown in figure.




## 2. Extraction of crude metal from the ore:

Extraction of the metal from its Ore depends on the reactivity of the metal.

**A) Extraction of metals at the top of the activity series:**

- The ores of highly reactive metals like K,Na,Ca,Mg and Al cannot be reduced by simple chemical methods as they need very high temperatures.
- Again electrolysis of their aqueous solutions also is not feasible because water in the solution would be discharged at the cathode in preference to the metal ions.
- The only method available is electrolysis of their fused compounds.
- In this method, fused metal compound is used as electrolyte. Graphite rod is used as anode and steel rod is used as cathode. A large quantity of electricity is passed to keep the ore in molten state.
- Example: On electrolysis of molten NaCl , sodium metal Is deposited at cathode and chlorine will be liberated at anode.

**B) Extraction of metals in the middle of the activity series:**

- The ores of Zn, Fe, Sn, Pb and Cu metals are generally present as sulphides or carbonates in nature. Sulphide ores are roasted to convert them into oxides before reducing them to metal.
- The metal oxides can be reduced to the corresponding metal by using reducing agents such as carbon or carbon monoxide.
- The metals can be obtained by the reaction of metal oxides with highly reactive metals such sodium, calcium, aluminium etc. These displacement reactions are highly exothermic. The amount of heat evolved is so large that the metals produced are in molten state.

- The reaction of iron oxide($Fe_2O_3$) with aluminium produces molten iron which is used to join railings of railway tracks or cracked machine parts.

  $Fe_2O_3 + 2\,Al$ ——-> $2Fe + Al_2O_3$ +heat.

  This reaction is known as **thermite reaction**.

**C) Extraction of metals at the bottom of the activity series:**

- Metals at the bottom of the activity series are often found in free state. Their reactivity with other atoms is very low. The oxides of these metals can be reduced to metals by heat alone and sometimes by displacement from their aqueous solutions.

## 3. Refining or purification of the metal:

- The process of obtaining the pure metal from the impure metal is called refining of the metal.
- Some refining methods are:

**a) Distillation:**

On distillation, low boiling metals like zinc and mercury can be separated from high boiling impurities. The pure metal is obtained as distillate.

**b) Poling:**

- The molten metal is stirred with logs(poles) of green wood. The impurities are removed either as gases or they get oxidized and form scum over the surface of the molten metal. Blister copper is purified by this method.

**c) Liquation:**

- In this method a low melting metal like tin can be made to flow on a slopy surface to separate it from high melting impurities.

**d) Electrolytic refining:**

- In this method, the impure metal is used as anode,pure metal is used as cathode and soluble salt of the same metal is used as electrolyte.
- On electrolysis,the required metal gets deposited on the cathode in the pure form. Using this method, pure copper can be obtained from blister copper.

**Corrosion**:

- The rusting of iron, tarnishing of silver, development of green coating on copper and bronze are some of the examples of corrosion.

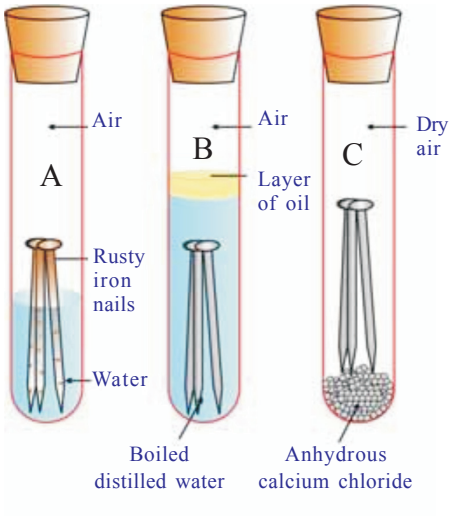
### To investigate the conditions under which Iron rusts.

**Aim:** To investigate the conditions under which Iron rusts.

**Material required:**

Test tubes, clean Iron nails, distilled water, oil, anhydrous calcium chloride.

**Procedure:**




- Take three test tubes and place clean Iron nails in each of them.
- Label these test tubes as A, B and C.
- Pour some water in test tube A and cork it.
- Pour boiled distilled water in test tube B, add about 1 ml of oil and cork it.The oil will float on water and prevent the air from dissolving in the water.
- Put some anhydrous calcium chloride in test tube C and cork it. Anhydrous calcium chloride will absorb the moisture, if any,from the air.
- Leave these test tubes for a few days and then observe.

**Observations:**

- Iron nails rust in test tube A.
- Iron nails do not rust in test tubes B and C

**Analysis:**

- In test tube A, the nails are exposed to both air and water.
- In test tube B, the nails are exposed to only water.
- In test tube C, the nails are exposed to dry air .

**Result :** Corrosion of iron (commonly known as rusting) occurs in the presence of water and air.

**Precautions:**

Clean Iron nails without any rust should be taken.

**Methods to prevent Corrosion:**

Corrosion can be prevented by

- Painting the surface of metals
- Oiling or greasing the surface.
- Galvanization.
- Electroplating
- Alloying

**A few important processes used in Metallurgy:**

**Smelting:** Smelting is a pyrochemical process, in which the ore mixed with flux and fuel is strongly heated. The product obtained is a molten metal.The smelting is carried out in blast furnace.

**Flux:** Flux is a substance added to the ore to remove the gangue from it .The impurities(gangue) in the ore react with flux and form slag which is removed.If the gangue is acidic substance,flux used will be basic substance.

**Roasting:** Roasting is a process of heating the ore strongly in free supply of air or oxygen.

**Calcination:** Calcination is a process of heating the ore strongly in the absence of air or oxygen.

**FURNACE:**

Furnace is the one which is used to carry out pyrochemical processes in metallurgy. We have mainly three parts in a furnace known as hearth, chimney and fire box.

## ASSESSMENT

### Very Short Answer Questions

1. Why do metals like gold, silver are used in making ornaments?
2. Write the physical methods followed for concentration of ore.
3. Arrange the metals copper(Cu), Gold(Au), Zinc(Zn), Alluminium(Al) and Sodum(Na) in descending order of their reactivity.
4. Write the chemical equation showing the thermite reaction.
5. Suggest any two methods to prevent corrosion of metals in daily life.
6. Guess and write what happens if there is no oxidation in nature.

### Short Answer Questions

7. Classify the given ores into oxides and sulphides.

   Bauxite ($Al_2O_3$), Zinc blende (ZnS), Haematite ($Fe_2O_3$) Cinnabar(HgS).
8. Differentiate roasting and calcination of ores.
9. Which method do we adopt for extraction of high reactivity metals? Explain.

### Long Answer Questions

10. Write experimental procedure to prove that air and water are required for corrosion of metal.
11. Explain the methods of extraction of metals with different reactivities from their ores.

### Multiple choice questions

1. The impurity present in the ore is called as

   A) gangue. B) flux C) slag. D) mineral
2. The oil used in the froth flotation process is

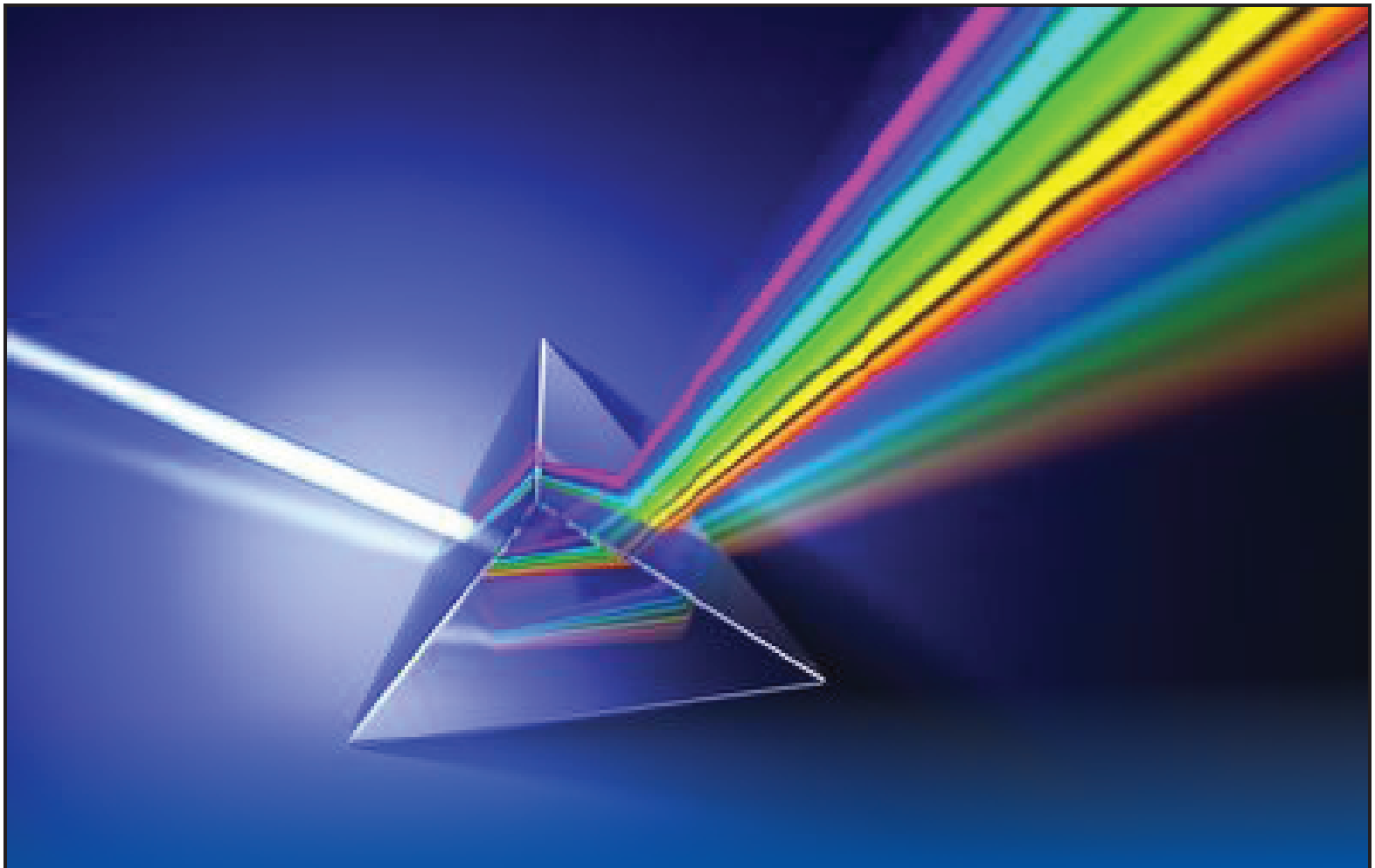
   A) kerosene oil B) pine oil C) coconut oil D) olive oil
3. The metal that occurs in the native form is

   A) Pb B) Au C) Fe D) Hg
4. The most abundant metal in the earth's crust is

   A) Silver B) Aluminium C) Zinc D) Iron
5. The reducing agent in thermite process is

   A) Al B) Mg C) Fe. D) Si
6. Blister copper is purified using

   A) Distillation B) Liquation C) Electrolytic refining D) Magnetic separation.



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Telangana, Hyderabad