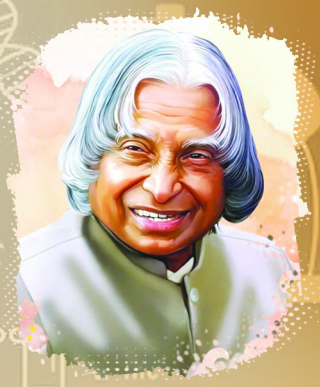
PHYSICAL SCIENCE
HANDBOOK



9th Class
(Semester-2)

REVISED VERSION



FEATURES

- Mind Map
- Main Points
- Intext Questions and Answers
- Exercises
- Activities
- Multiple choice questions
- CBA Questions

"Strengthening Foundations, Inspiring Excellence"

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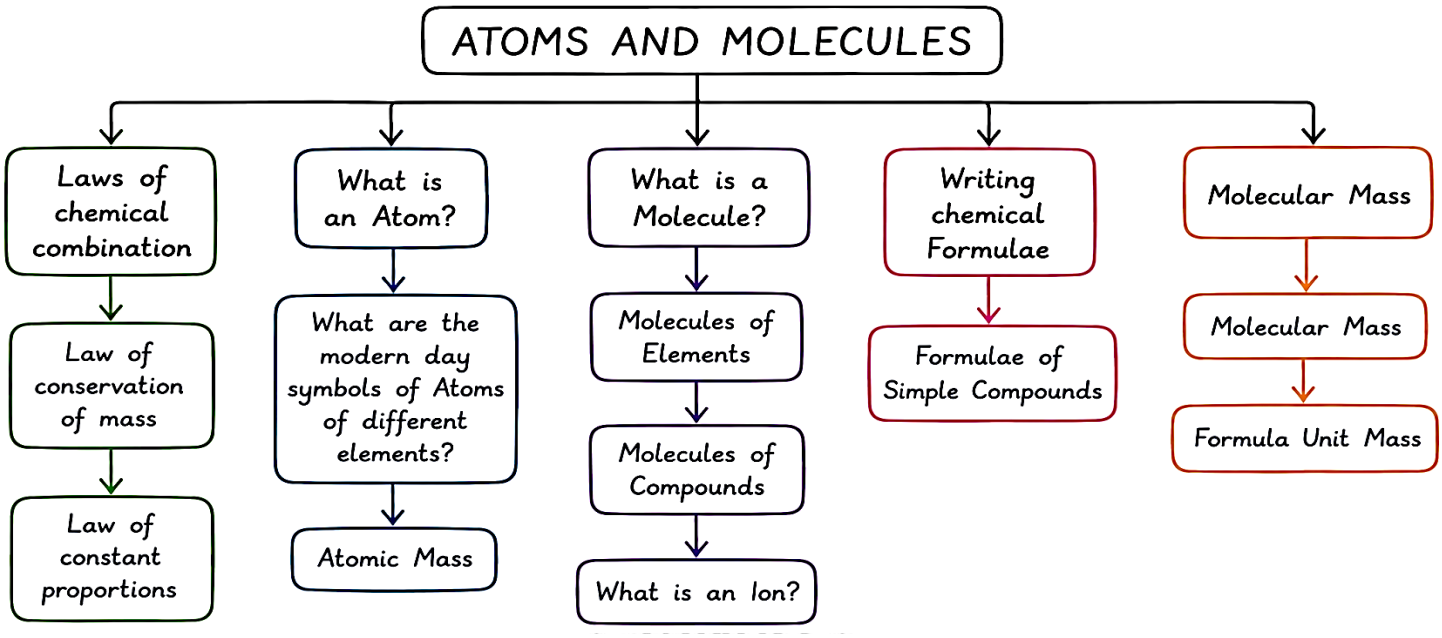
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Chapter - 6

ATOMS AND MOLECULES

MIND MAP



Main Points

1. An Indian philosopher Maharishi Kanad, postulated that if we go on dividing matter (padarth), we shall get smaller and smaller particles.
2. Antoine L. Lavoisier laid the foundation of chemical sciences by establishing two important laws of chemical combination.
3. During a chemical reaction, the sum of the masses of the reactants and products remains unchanged. This is known as the Law of Conservation of Mass.
4. In a pure chemical compound, elements are always present in a definite proportion by mass. This is known as the Law of Definite Proportions.
5. According to Dalton's atomic theory, all matter, whether an element, a compound or a mixture is composed of small particles called atoms.
6. An atom is the smallest particle of the element that cannot usually exist independently and retain all its chemical properties.
7. Atomic radius is measured in nanometres.
8. Dalton was the first scientist to use the symbols for elements in a very specific sense.
9. Berzilius suggested that the symbols of elements be made from one or two letters of the name of the element.
10. Now-a-days, IUPAC (International Union of Pure and Applied Chemistry) is an international scientific organisation which approves names of elements, symbols and units.
11. One atomic mass unit is a mass unit equal to exactly one-twelfth the mass of one atom of carbon-12.
12. A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance.
13. The number of atoms constituting a molecule is known as its atomicity.
14. Ion is a charged particle and can be positively or negatively charged.
15. A negatively charged ion is called an 'anion' and the positively charged ion, a 'cation'.
16. A group of atoms carrying a charge is known as a polyatomic ion.
17. In ionic compounds, the charge on each ion is used to determine the chemical formula of the compound.
18. The chemical formula of a compound is a symbolic representation of its composition.
19. The chemical formula of a molecular compound is determined by the valency of each element.
20. The combining capacity of an element is known as its valency.
21. The simplest compounds, which are made up of two different elements are called binary compounds.
22. The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance.
23. The formula unit mass of a substance is a sum of the atomic masses of all atoms in a formula unit of a compound.

Exercises

1. A 0.24 g sample of compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Ans: % of boron in the sample = $\frac{0.096}{0.24}$ x 100 = 40%

% of boron in the sample = $\frac{0.144}{0.24}$ x 100 = 60%

So, the compound contains 40% boron and 60% oxygen by weight.

2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combination will govern your answer?

Ans: Carbon + Oxygen → Carbon dioxide

3 g of carbon is reacting with 8 g of oxygen to produces 11 g of carbon dioxide.

If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen. The remaining 42 g of oxygen will be left un-reactive. So, only 11 g of carbon dioxide will be formed.

The above answer is governed by the law of constant proportions.

3. What are polyatomic ions? Give examples.

Ans: Clusters of atoms that act as an ion are called polyatomic ions. They carry a fixed charge on them.

Example:- OH^-, SO_4^{2-}, CO_3^{2-}.

4. Write the chemical formulae of the following.

(a) Magnesium chloride (b) Calcium oxide (c) Copper nitrate

(d) Aluminium chloride (e) Calcium carbonate

Ans: (a) Magnesium chloride – $MgCl_2$ (b) Calcium oxide – CaO (c) Copper nitrate – $Cu(NO_3)_2$

(d) Aluminium chloride – $AlCl_3$ (e) Calcium carbonate – $CaCO_3$

5. Give the names of the elements present in the following compounds.

(a) Quick lime (b) Hydrogen bromide (c) Baking powder (d) Potassium sulphate.

Ans: (a) Quick lime – Calcium and Oxygen

(b) Hydrogen bromide – Hydrogen and Bromine

(c) Baking powder – Sodium, Hydrogen, Carbon and Oxygen

(d) Potassium sulphate – Potassium, Sulphur and Oxygen

6. Calculate the molar mass of the following substances.

(a) Ethyne, C_2H_2 **(b) Sulphur molecule, S_8**

(c) Phosphorus molecule, P_4 (Atomic mass of phosphorus = 31) **(d) Hydrochloric acid, HCl**

(e) Nitric acid, HNO_3

Ans: (a) C_2H_2 = 2 x 12 + 2 x 1 = 26 g

(b) S_8 = 8 x 32 = 256 g

(c) P_4 = 4 x 31 = 124 g

(d) HCl = 1 x 1 + 1 x 35.5 = 1 + 35.5 = 36.5 g

(e) $HN0_3$ = 1 x 1 + 1 x 14 + 3 x 16 = 1 + 14 + 48 = 63 g

7. Assertion (A): Water obtained from a river and water prepared in a laboratory always contain hydrogen and oxygen in the ratio 1:8 by mass

Reason (R): In a chemical compound, elements are always present in a fixed proportion by mass.

Choose the correct option.

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

B) Both A and R are true but R is not the correct explanation of A.

C) A is true but R is false.

D) A is false but R is true.

Ans: A) Both A and R are true and R is the correct explanation of A.

In Textbook Questions

1. In a reaction, 5.3 g of sodium carbonate reacted with 6 g of acetic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium acetate. Show that these observations are in agreement with the law of conservation of mass. (Page No:06&08)

sodium carbonate + acetic acid → sodium acetate + carbon dioxide + water

Ans: Mass of reactants = Mass of sodium carbonate + Mass of acetic acid = 5.3 + 6 = 11.3g

Mass of products = Mass of sodium acetate + Mass of carbon dioxide + Mass of water =2.2 + 0.9 + 8.2 =11.3g

The mass of products = The mass of reactions

The observation made is in agreement with the law of conservation of mass.

2. Hydrogen and oxygen combine in the ratio of 1:8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Ans: The ratio of hydrogen and oxygen by mass to form water is 1:8.

Oxygen required to react with 3 g hydrogen to form water = 3 x 8 = 24 g

3. Which postulate of Dalton's atomic theory is the result of the law of conservation of mass?

Ans: "Atoms are indivisible particles, which cannot be created or destroyed in a chemical reaction"

4. Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans: "The relative number and kinds of atoms are constant in a given compound".

1. Define the atomic mass unit. (Page No:12)

Ans: One atomic mass unit is a mass unit equal to exactly one-twelfth the mass of one atom of carbon-12.

2. Why is it not possible to see an atom with naked eyes?

Ans: The size of an atom is very small that it is not possible to see it with naked eyes. Also, the atom of an element does not exist independently.

1. Write down the formulae of (Page No:20)

(i) sodium oxide (ii) aluminium chloride (iii) sodium sulphide (iv) magnesium hydroxide

Ans: (i) sodium oxide - Na_2O (ii) aluminium chloride - $AlCl_3$

(iii) sodium sulphide - Na_2S (iv) magnesium hydroxide – $Mg(OH)_2$

2. Write down the names of compounds represented by the following formulae:

(i) $Al_2(SO_4)_3$ (ii) $CaCl_2$ (iii) K_2SO_4 (iv) KNO_3 (v) $CaCO_3$.

Ans: (i) $Al_2(SO_4)_3$ - Aluminium sulphate

(ii) $CaCl_2$ - Calcium chloride

(iii) K_2SO_4 - Potassium sulphate

(iv) KNO_3 - Potassium nitrate

(v) $CaCO_3$ - Calcium carbonate

3. What is meant by the term chemical formula?

Ans: The chemical formula of a compound is a symbolic representation of its composition.

4. How many atoms are present in a (i) H_2S molecule and (ii) PO_4^{3-} ion?

Ans: (i) 3 atoms (ii) 5 atoms

1. Calculate the molecular masses of H_2 , O_2 , Cl_2 , CO_2 , CH_4 , C_2H_6 , C_2H_4 , NH_3 , CH_3OH. (Page No:22)

Ans: The molecular masses of

H_2 = 2 x 1 u = 2 u

O_2 = 2 x 16 u = 32 u

Cl_2 = 2 x 35.5 u = 71 u

CO_2 = 1 x 12 u + 2 x 16 u = 44 u

CH_4 = 1 x 12 u + 4 x 1 u = 16 u

C_2H_6 = 2 x 12 u + 6 x 1 u = 30 u

C_2H_4 = 2 x 12 u + 4 x 1 u = 28 u

NH_3 = 1 x 14 u + 3 x 1 u = 17 u

CH_3OH = 1 x 12 u + 3 x 1 u + 1 x 16 u + 1 x 1 u = 32 u

2. Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3 , given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Ans: The formula unit mass of

(i) ZnO = 65 u + 16 u = 81 u

(ii) Na_2O = (2 x 23 u) + 16 u = 46 u + 16 u = 62 u

(iii) K_2C0_3 = (2 x 39 u) + 12 u + 3 x 16 u = 78 u + 12 u + 48 u = 138 u

Activities

1. Explain with help of an activity shows that the laws of conservation of mass in chemical reactions.

Aim: To verify the laws of conservation of mass in chemical reactions.

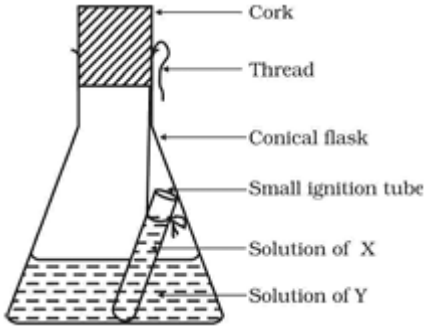
Materials required: Copper sulphate, Sodium carbonate, Barium chloride, Sodium sulphate, Lead nitrate, Sodium chloride, Conical flask, Ignite tune.

Procedure:

1. Take one of the following sets, X and Y of chemicals—

X	Y
(i) copper sulphate	sodium carbonate
(ii) barium chloride	sodium sulphate
(iii) lead nitrate	sodium chloride

2. Prepare separately a 5% solution of any one pair of substances listed under X and Y each in 10 mL in water.
3. Take a little amount of solution of Y in a conical flask and some solution of X in an ignition tube.
4. Hang the ignition tube in the flask carefully; see that the solutions do not get mixed. Put a cork on the flask.
5. Weigh the flask with its contents carefully.
6. Now tilt and swirl the flask, so that the solutions X and Y get mixed.
7. Weigh again.
8. Some precipitate is formed in all cases.
9. A chemical reaction takes place in all cases.
10. Cork is put on the mouth of the flask so that no material escapes out or splits out on swirling.
11. The mass of the flask and its contents are the same before the reaction and after the reaction.



Observation/Conclusion: The mass can neither be created nor destroyed in a chemical reaction.

Multiple Choice Questions

1. The law of conservation of mass states that
a) Matter can be created but not destroyed
b) Matter can be destroyed but not created
c) Matter can neither be created nor destroyed
d) Matter can be created and destroyed simultaneously
Ans: c) Matter can neither be created nor destroyed

2. The law of constant proportions states that
a) The ratio of the masses of the elements in a compound is always the same
b) The ratio of the masses of the elements in a compound can vary
c) The ratio of the masses of the elements in a compound is always different
d) The ratio of the masses of the elements in a compound is not fixed
Ans: a) The ratio of the masses of the elements in a compound is always the same

3. The modern day symbols of atoms of different elements are based on
a) The English alphabet b) Random symbols
c) Greek alphabets d) Latin names of elements
Ans: c) Greek alphabets

4. Formula unit mass refers to
a) The mass of an individual molecule
b) The mass of one mole of a substance
c) The mass of one molecule of a substance
d) The mass of one atom of a substance
Ans: b) The mass of one mole of a substance

5. A molecule is
a) The smallest particle of an element that retains the properties of that element
b) The smallest particle of a compound that retains the properties of that compound
c) The smallest particle of a mixture that retains the properties of that mixture
d) A combination of atoms bonded together
Ans: d) A combination of atoms bonded together

6. All noble gas molecules are
a) Monoatomic b) Diatomic
c) Triatomic d) Both a and b
Ans: a) Monoatomic

7. The valency of nitrogen in NH_3 is
a) 1 b) 3 c) 4 d) 5
Ans: b) 3

8. Number of moles present in 28g of nitrogen atoms are
a) 1 mole b) 2.3 moles c) 0.5 mole d) 2 moles
Ans: d) 2 moles

9. The mass of one mole of a substance is equal to its
a) Atomic mass b) Molecular mass
c) Formula unit mass d) Molar mass
Ans: d) Molar mass

10. Atomic mass of Chlorine is _____
a) 34 b) 34.5 c) 35 d) 35.5
Ans: d) 35.5

11. What is the value of Avogadro's number?
a) 6.02×10^{-23} b) 6.02×10^{23}
c) 6.02×10^{-22} d) 6.02×10^{22}
Ans: b) 6.02×10^{23}

12. The formula of Ammonium Sulphate is _____
a) NH_4SO_4 b) NH_4SO_2
c) $(NH_4)_2SO_4$ d) NH_2SO_4
Ans: c) $(NH_4)_2SO_4$

13. The atomic symbol of Iron is _____
a) I b) Fe c) Ir d) Au
Ans: b) Fe

14. The atomicity of oxygen is
a) 1 b) 2 c) 3 d) 4

15. The formula for quicklime is
a) $CaCl_2$ b) $CaCO_3$ c) $Ca(OH)_2$ d) CaO
Ans: d) CaO

16. The molecular mass of A is 106. A can be
a) $CaCO_3$ b) SO_3 c) Na_2CO_3 d) NaCl
Ans: c) Na_2CO_3

17.The combining capacity of an element is called
a) Valency b) Atomicity
c) Atomic Number d) Valence electrons
Ans: a) Valency

18. Identify the correct symbol of gold
a) Go b) Ge c) Gd d) Au
Ans: d) Au

19. One atomic mass unit is equal to weight of
a) one atom of hydrogen
b) $1/16^{th}$ of oxygen atom
c) $1/12^{th}$ of natural carbon atom
d) 1/12 of C-12 isotopes of carbon
Ans: d) 1/12 of C-12 isotopes of carbon

20. In SO_2, the mass of sulphur in combination with 3 g of oxygen is
a) 3 g b) 4 g c) 32 g d) 16 g
Ans: a) 3 g

21.Which of the following is not a postulate of Dalton's atomic theory
a) All matter is made up of atoms
b) Atoms are tiny indisible and indestructive ultimate particles
c) Atoms combine in small whole number ratios to form compounds
d) Atoms of different elements can have the same mass
Ans: d) Atoms of different elements can have the same mass

Competency - Based Questions

Multiple Choice Questions

1. Which of the following elements shows monoatomicity only?
A) He B) N C) O D) Cl
Ans: A) He

2. Few elements and their atomic masses are given below. Choose the correct matching.

Element	Atomic Mass
a) Carbon	1) 23
b) Calcium	2) 16
c) Sodium	3) 32
d) Oxygen	4) 12
	5) 40

Options:
A) a-1, b-5, c-4, d-2 B) a-4, b-5, c-2, d-3 C) a-4, b-5, c-1, d-2 D) a-4, b-5, c-3, d-2
Ans: C) a-4, b-5, c-1, d-2

3. 1 nanometer = _____ meters.
A) 10^{9} B) 10^{-9} C) 10^{-6} D) 10^{10}
Ans: B) 10^{-9}

4. Carbon monoxide contains 12 g of Carbon and 16 g of Oxygen. If 48 g of carbon is combined with sufficient oxygen to form the same compound, how much oxygen is required?

A) 64 g B) 32 g C) 48 g D) 16 g

Ans: B) 32 g

5. Elements that are present in Quick Lime are _____.

A) C and O only B) Ca and O only C) Ca, O and H only D) C, O and H only

Ans: B) Ca and O only

6. Using the criss-cross method, what is the correct formula of Aluminium Oxide?

A) AlO B) AlO_3 C) Al_2O D) Al_2O_3

Ans: D) Al_2O_3

7. A baker used 500 g of flour, 200 g of sugar and 100 g of butter to make a cake. After baking, the total mass of the cake (ignoring water and air loss) should be

A) 700 g B) 800 g C) 900 g D) 1000 g

Ans: B) 800 g

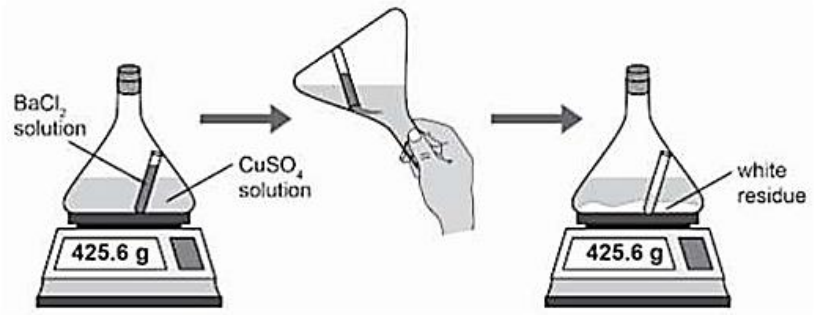
8. Identify the correct matching from the following:

Name of Compound	Chemical Formula
a) Calcium carbonate	1) $AlCl_3$
b) Magnesium chloride	2) $CaCO_3$
c) Aluminium chloride	3) $MgCl_2$

A) a-1, b-3, c-2 B) a-2, b-3, c-1 C) a-3, b-2, c-1 D) a-1, b-2, c-3

Ans: B) a-2, b-3, c-1

9. Mahathi mixed $BaCl_2$ solution and $CuSO_4$ solution in a closed conical flask.



What can concluded from the result of the experiment?

A) Total mass of the chemicals remain the same. B) Total volume of the chemicals remain the same.
C) State of matter of the chemicals remain the same. D) Composition of the chemicals remain the same.

Ans: A) Total mass of the chemicals remain the same.

10. Which of the following molecules is triatomic?

A) H_2 B) C C) CO D) H_2O

Ans: D) H_2O

11. The atomic mass of two elements are given below.

Oxygen = 16 u Sulphur = 32 u

What is the ratio by atomic mass of Sulphur and Oxygen in SO_2?

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

Ans: A) 1:1

2 Marks Questions

1. In a chemical reaction, 12 g of carbon reacts with 32 g of oxygen to form carbon dioxide.

a) Calculate the mass of carbon dioxide formed.

b) Which law of chemical combination supports your answer?

Ans: a) Mass of carbon dioxide = Mass of carbon + Mass of oxygen = 12 + 32 = 44 g

b) Law of Conservation of Mass

2. A student collects two water samples from different sources. One sample contains 2 g of hydrogen and 16 g of oxygen, while the other contains 4 g of hydrogen and 32 g of oxygen.

a) Calculate the mass ratio of hydrogen to oxygen in both samples.

b) Name the law demonstrated by these observations.

Ans: a) First sample: Mass ratio of hydrogen to oxygen = 2 : 16 = 1 : 8

Second sample: Mass ratio of hydrogen to oxygen = 4 : 32 = 1 : 8

Both samples have the same mass ratio.

b) Law of Constant Proportions.

3. A student claims that atoms are neither created nor destroyed during a chemical reaction. Which postulate of Dalton's atomic theory supports this statement? Explain briefly.

Ans: Dalton proposed that atoms can neither be created nor destroyed in a chemical reaction. During a chemical reaction, atoms are rearranged to form new substances. Therefore, the total mass remains constant.

4. A student writes the chemical symbols of aluminium and cobalt as AL and CO, respectively. Identify the mistakes and write the correct symbols. Why is the use of capital and lowercase letters important?

Ans: **Aluminium:** Al (not AL)

Cobalt: Co (not CO)

The first letter of a chemical symbol is always capitalised, and the second letter, if present, is lowercase.

5. Magnesium has a valency of 2, and chlorine has a valency of 1. Write the chemical formula of magnesium chloride and explain why two chlorine atoms are required for each magnesium atom.

Ans: The chemical formula of magnesium chloride is **$MgCl_2$**.

Magnesium has a valency of 2, while chlorine has a valency of 1. Therefore, one magnesium atom combines with two chlorine atoms to balance the valencies and form a neutral compound.

6. Calculate the formula unit mass of calcium chloride ($CaCl_2$). Given: Ca = 40 u; Cl = 35.5 u.

Ans: Formula unit mass of $CaCl_2$ = Atomic mass of Ca + 2 × Atomic mass of Cl

= 40 + 2 × 35.5

= 40 + 71

= 111 u

7. Define one atomic mass unit (u). Why is carbon-12 used as the standard reference for measuring atomic masses?

Ans: One atomic mass unit is a mass unit equal to exactly one-twelfth the mass of one atom of carbon-12. Carbon-12 atomic mass is exactly 12 u, making it convenient to compare the atomic masses of other elements.

8. Water (H_2O) contains two hydrogen atoms and one oxygen atom. Calculate the relative molecular mass of water.

Ans: Relative molecular mass of water (H_2O) = (2 × Atomic mass of H) + (1 × Atomic mass of O)

= (2 × 1) + (1 × 16)

= 2 + 16 = 18 u

9. The atomic mass of four elements are given below

Element	Carbon	Helium	Calcium	Nitrogen
Atomic mass (u)	12	4	40	14

a) What element has the highest molar mass?

b) In which of elements is the mass of 1 mole atom equal to the mass of 1 mole molecule?

Ans: a) Calcium

b) Helium

10. What is valency? What is its use?

Ans: The combining capacity of an element is known as its valency. It can be used to find out how many atoms of an elements will combine with the other element to form a chemical compound.

4 Marks Questions

1. When 3.0 g of carbon is burnt in 8.0 g oxygen, 11.0 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.0 g of carbon is burnt in 50.0 g of oxygen? Which law of chemical combination governs your answer?

Ans: Carbon + Oxygen → Carbon dioxide

3 g of carbon is reacting with 8 g of oxygen to produces 11 g of carbon dioxide.

If 3 g of carbon is burnt in 50 g of oxygen, then 3 g of carbon will react with 8 g of oxygen. The remaining 42 g of oxygen will be left un-reactive. So, only 11 g of carbon dioxide will be formed.

The above answer is governed by the law of constant proportions.

2. Using the Criss-cross method, write the chemical formula of Magnesium Oxide. Find the ratio by mass of Mg and O in it.

Ans: Valency of Magnesium (Mg) = 2, Valency of Oxygen (O) = 2

Formula for calcium oxide:

Symbol: Mg O

Charge: 2+ 2−

Chemical formula: **Mg_2O_2 = MgO**

Atomic mass of Mg = 24 u, Atomic mass of O = 16 u

Mass ratio of Mg : O = 24 : 16 = **3 : 2**

3. An atom forms a positively charged ion, while another forms a negatively charged ion.

a) What are these ions called?

b) Give one example of each.

Ans: a) Positively charged ion: **Cation**

Negatively charged ion: **Anion**

b) **Cation:** Na^+ (sodium ion)

Anion: Cl^- (chloride ion)

4. Hydrogen gas exists as H_2, whereas helium gas exists as He.

a) How many atoms are present in each molecule or particle?

b) What are these types of particles called in terms of atomicity?

Ans: a) Hydrogen (H_2): 2 atoms

Helium (He): 1 atom

b) H_2: Diatomic molecule (atomicity = 2)

He: Monoatomic particle (atomicity = 1)

5. Calculate the molecular masses of H_2O and CO_2.

Ans: Given: H = 1 u, C = 12 u and O = 16 u.

(a) Molecular mass of Water (H_2O) = Molecular mass = 2 × atomic mass of H + atomic mass of O

= 2 × 1 + 16

= 18 u

(b) Molecular mass of Carbon dioxide (CO_2) = Atomic mass of C + 2 × atomic mass of O

= 12 + 2 × 16

= 44 u

6. What are ions? Explain the two types of ions with examples.

Ans: An ion is an atom or a group of atoms carrying an electric charge.

Cation: A positively charged ion is called a Cation. Example: Na^+

Anion: A negatively charged ion is called an Anion. Example: Cl^-

8 Marks Questions

1. Explain Dalton's Atomic Theory.

Ans: 1. All matter is made up of tiny particles called atoms.

2. Atoms cannot be created, destroyed or divided during a chemical reaction.
3. All atoms of a given element are identical in mass and chemical properties.
4. Atoms of different elements have different masses and properties.
5. Atoms combine in simple whole-number ratios to form compounds.
6. In a chemical reaction, atoms are only rearranged.

Importance

1. Explains the laws of chemical combination.
2. Forms the basis of modern atomic theory

2. Complete the following table:

S.No	Element / Compound	Symbol / Formula
1	Copper	
2		Fe
3	Ozone	
4		NH_3
5	Carbon dioxide	
6		KNO_3
7	Calcium chloride	
8		$AlCl_3$

Ans:

S.No	Element / Compound	Symbol / Formula
1	Copper	**Cu**
2	**Iron**	Fe
3	Ozone	**O_3**
4	Ammonia	NH_3
5	Carbon dioxide	**CO_2**
6	**Potassium nitrate**	KNO_3
7	Calcium chloride	**$CaCl_2$**
8	**Aluminium chloride**	$AlCl_3$

3. Define the following

a) Atom **b) Atomic mass** **c) Valency** **d) Atomicity**

e) Molecule **f) Molecular mass** **g) Formula unit mass**

Ans: a) An atom is the smallest particle of the element that cannot usually exist independently and retain all its chemical properties.

b) One atomic mass unit is a mass unit equal to exactly one-twelfth the mass of one atom of carbon-12.

c) The combining capacity of an element is known as its valency.

d) The number of atoms constituting a molecule is known as its atomicity.

e) A molecule can be defined as the smallest particle of an element or a compound that is capable of an independent existence and shows all the properties of that substance.

f) The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance.

g) The formula unit mass of a substance is a sum of the atomic masses of all atoms in a formula unit of a compound.

4. What are the rules to be followed while writing a chemical formula?

Ans: i) The valencies or charges on the ions must balance.

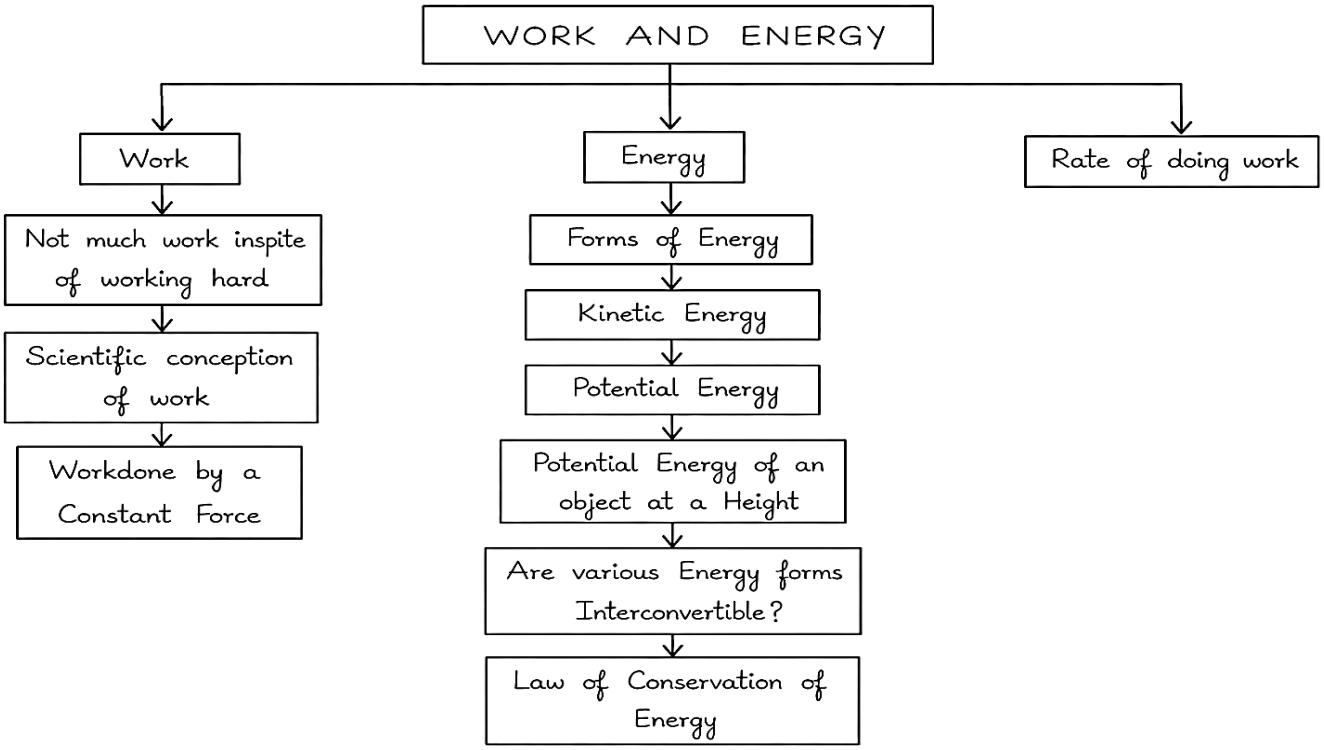
ii) When a compound consists of a metal and a non-metal, the symbol of the metal is written first, followed by the symbol of the non-metal.
Example: Calcium oxide (CaO), Sodium chloride (NaCl).

iii) In compounds formed with polyatomic ions, the number of ions present in the compound is indicated by enclosing the formula of the ion in brackets and writing the number of ions outside the bracket.
Example: $Mg(OH)_2$. If the number of polyatomic ions is one, brackets are not required.

Chapter - 7

WORK AND ENERGY

MIND MAP



Main Points

1. The conditions need to be satisfied for work to be done: (i) a force should act on an object, and (ii) the object must be displaced.
2. Work done on an object is defined as the magnitude of the force multiplied by the distance moved by the object in the direction of the applied force.
3. Work done = Force x Displacement (or) W = Fs
4. The unit of work is joule. 1 joule = 1 newton x 1 metre.
5. Types of work: a) Positive work b) Negative work c) Zero work
6. Work done is positive when the force is in the direction of displacement. Work done is negative when the force acts opposite to the direction of displacement.
7. 1 J is the amount of work done on an object when a force of 1 N displaces it by 1 m along the line of action of the force.
8. An object having capability to do work is said to possess energy. Energy has the same unit as that of work.
9. Forms of energy: Mechanical energy, Sound energy, Heat energy, Light energy, Chemical energy, Nuclear energy, Electric energy, Magnetic energy, Solar energy etc.
10. The sum of the kinetic and potential energies of an object is called its mechanical energy.

Mechanical energy = Potential energy (PE) + Kinetic energy (KE)

11. The energy possessed by a body by virtue of its motion is called its kinetic energy.

Kinetic energy (KE) = $\frac{1}{2}$ mv^2

12. Kinetic energy of the object depends on mass(m) and velocity(v).
13. Work done (W) = Change in Kinetic energy = $\frac{1}{2} m(v^2-u^2)$
14. The energy possessed by a body by virtue of its position or shape is called its potential energy.

Potential energy (PE) = mgh

15. Potential energy of the object depends on mass(m) and height(h).
16. The gravitational potential energy of an object at a point above the ground is defined as the work done in raising it from the ground to that point against gravity.
17. Law of conservation of energy: Energy can neither be created nor destroyed. It can be transformed from one form to another. The total energy before and after the transformation always remains constant.

18. Power is defined as the rate of doing work.

Power (P) = Work(W) / Time(t)

19. The SI unit of power is watt. 1 Watt = 1 Joule/second

20. 1 kilowatt = 1000 watts = 1000 w = 1000 J s^{-1}

21. 1 kWh = 1 Unit = 3.6 x 10^6 J

22. The average power defined as dividing the total energy consumed by the total time taken.

Exercises

1. Look at the activities listed below. Reason out whether or not work is done in the light of your understanding of the term 'work'.

- **Suma is swimming in a pond.**
- **A donkey is carrying a load on its back.**
- **A wind-mill is lifting water from a well.**
- **A green plant is carrying out photosynthesis.**
- **An engine is pulling a train.**
- **Food grains are getting dried in the sun.**
- **A sailboat is moving due to wind energy.**

Ans:

- Yes, Suma is doing work by pushing water in the backward direction.
- No, the force exerted by donkey in the upward direction is perpendicular to the horizontal displacement of the load.
- Yes, work is done in lifting water against the force of gravity.
- No, the leaves of plants remain at rest during photosynthesis.
- Yes, engine is doing work in pulling the train.
- No, food gains remain at rest.
- Yes, work is done by the wind is moving the sailboat.

2. An object thrown at a certain angle to the ground moves in a curved path and falls back to the ground. The initial and the final points of the path of the object lie on the same horizontal line. What is the work done by the force of gravity on the object?

Ans: When the object moves upwards, the work done by gravity is negative and when the object come downwards, work done by gravity is positive. So, the total work down is zero.

(or)

The net displacement of the object is in the horizontal while the force of gravity acts in the vertical downward direction. So, work done is zero.

3. A battery lights a bulb. Describe the energy changes involved in the process.

Ans: Battery converts chemical energy into electrical energy. This electrical energy is further converted into light and heat energy.

4. Certain force acting on a 20 kg mass changes its velocity from 5 m s^{-1} to 2 m s^{-1}. Calculate the work done by the force.

Ans: Mass of the body (m) = 20 kg Initial velocity (u) = 5 m/s Final velocity (v) = 2 m/s

$$Work\ done = change\ in\ kinetic\ energy$$

$$= \frac{1}{2} m(v^2 - u^2)$$

$$= \frac{1}{2} (20)\ (5^2 - 2^2)$$

$$= 10\ (25 - 4)$$

$$= -\ 210\ J$$

5. A mass of 10 kg is at a point A on a table. It is moved to a point B. If the line joining A and B is horizontal, what is the work done on the object by the gravitational force? Explain your answer.

Ans: The work done is zero, because the gravitational force and displacement both are perpendicular to each other.

6. The potential energy of a freely falling object decreases progressively. Does this violate the law of conservation of energy? Why?

Ans: No, the law of conservation of energy is not violated. The loss in PE appears as an equal gain in KE of the

object.

7. What are the various energy transformations that occur when you are riding a bicycle?

Ans: The muscular energy of the cyclist is converted into mechanical energy (kinetic energy) of wheels of cycle which is further converted into heat energy to run the bicycle.

8. Does the transfer of energy take place when you push a huge rock with all your might and fail to move it? Where is the energy you spend going?

Ans: Yes, we transfer our muscular energy while pushing rock. This energy is entirely spent in doing work against friction between the rock and the ground.

9. A certain household has consumed 250 units of energy during a month. How much energy is this in joules?

Ans: 1 unit of energy = 1 kWh = 3.6×10^6 J

250 units of energy = $250 \times 3.6 \times 10^6$

$= 9 \times 10^8$ J

10. An object of mass 40 kg is raised to a height of 5 m above the ground. What is its potential energy? If the object is allowed to fall, find its kinetic energy when it is half-way down.

Ans: Mass(m) = 40 kg, height (h) = 5 m

Potential Energy = mgh = 40 x 9.8 x 5 = 1960 J

According to law of conservation of energy, the total mechanical energy (Kinetic and potential energy) of an object remains constant.

Kinetic energy when it is half-way down = $\frac{1960}{2} = 980$ J

11. What is the work done by the force of gravity on a satellite moving round the earth? Justify your answer.

Ans: When a satellite revolves around the earth in a circular orbit the work done is zero. Because gravitational force acting on satellite is perpendicular to its displacement.

12. Can there be displacement of an object in the absence of any force acting on it? Think. Discuss this question with your friends and teacher.

Ans: Yes.

Ex: Rain drops fall on the earth while the net force on them is zero.

Ex: According to Newton 2nd law, if force is zero then either acceleration is zero or mass is zero. Mass does not zero, so either at rest or in a state of uniform motion in a straight line. In case the object is moving in a straight line, there must be displacement.

13. A person holds a bundle of hay over his head for 30 minutes and gets tired. Has he done some work or not? Justify your answer.

Ans: No, because no displacement takes place in the direction of applied force.

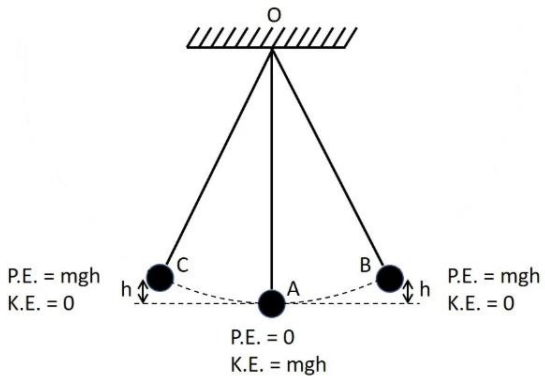
14. An electric heater is rated 1500 W. How much energy does it use in 10 hours?

Ans: Given P = 1500 W = $\frac{1500}{1000}$ = 1.5 kW, t = 10 h

Energy = P x t = 1.5 x 10 = 15 kWh or 15 units

15. Illustrate the law of conservation of energy by discussing the energy changes which occur when we draw a pendulum bob to one side and allow it to oscillate. Why does the bob eventually come to rest? What happens to its energy eventually? Is it a violation of the law of conservation of energy?

Ans: Observe the below figure.



At the points B and C, the pendulum bob is at its maximum height, so its potential energy is maximum and kinetic energy is zero. In this way the total mechanical energy remains constant.

At the point A, the pendulum bob is at its lowest point, total potential energy is converted into kinetic energy. Now the kinetic energy is maximum and potential energy is zero. Once again, the total mechanical energy

remains constant.

It loses energy due to friction at the point of support and air resistance acting on the bob. Some of this energy might be dispersed in an isolated system. There is no violation of the law of conservation of energy.

16. An object of mass, m is moving with a constant velocity, v. How much work should be done on the object in order to bring the object to rest?

Ans: *Work done = change in kinetic energy*

$= \frac{1}{2} m(v^2 - u^2) = \frac{1}{2} m (v^2 - 0^2) = \frac{1}{2} m v^2$

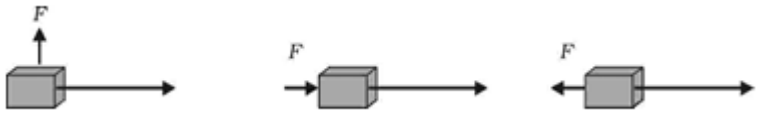
17. Calculate the work required to be done to stop a car of 1500 kg moving at a velocity of 60 km/h?

Ans: m = 1500 kg, $v = 60 \times \frac{5}{18} = \frac{50}{3}\ m/s$

Work done = change in kinetic energy

$= \frac{1}{2} m(v^2 - u^2) = \frac{1}{2} \times 1500 [(50/3)^2 - 0^2] = \frac{1}{2} \times 1500 \times (50/3)^2 = 208333.3$ J

18. In each of the following a force, F is acting on an object of mass, m. The direction of displacement is from west to east shown by the longer arrow. Observe the diagrams carefully and state whether the work done by the force is negative, positive or zero.



Ans: In the first case, the force and displacement are perpendicular to each other, so work done is zero.

In the second case, the force and displacement are in the same direction, so the work done is positive.

In the third case, the force and displacement are in the opposite direction, so the work done is negative.

19. Soni says that the acceleration in an object could be zero even when several forces are acting on it. Do you agree with her? Why?

Ans: Yes, the acceleration of the object would be zero when the several forces acting on the object. According to Newton 2nd law, if force is zero then either acceleration is zero or mass is zero. Mass does not zero, so acceleration is zero.

20. Find the energy in joules consumed in 10 hours by four devices of power 500 W each.

Ans: P = 500 W $= \frac{500}{1000} = 0.5\ kW$ t = 10 h

Energy consumed by 4 devices = 4 x P x t = 4 x 5 kWh = 20 kWh

We know that, 1 kWh = 3.6×10^6 J

Energy consumed in joules = $20 \times 3.6 \times 10^6$ J = 72×10^6 J

21. A freely falling object eventually stops on reaching the ground. What happens to its kinetic energy?

Ans: The kinetic energy of the object changes into heat and sound.

22. A student lifts a 2 kg school bag from the floor and places it on a shelf 1.5 m high. Then the bag accidentally falls back to the floor.

Which of the following statements is correct during this process?

A) The bag has maximum potential energy when it is on the shelf.

B) The bag has maximum kinetic energy when it is kept on the shelf.

C) The bag has maximum potential energy just before it hits the ground.

D) The bag has equal kinetic and potential energy when lying on the floor.

Ans: A) The bag has maximum potential energy when it is on the shelf.

In Textbook Questions

1. A force of 7 N acts on an object. The displacement is, say 8 m, in the direction of the force (Fig. 7.3). Let us take it that the force acts on the object through the displacement. What is the work done in this case? (Page No:32)

Ans: F = 7 N, s = 8 m

Work done = F x s = 7 x 8 = 56 J

1. When do we say that work is done? (Page No:34)

Ans: Work is done when a force acts on a object and the object displacement in the direction of the force.

2. Write an expression for the work done when a force is acting on an object in the direction of its displacement.

Ans: Work done = Force x Displacement

3. Define 1 J of work.

Ans: 1 J of work is defined as 1N force acting on the object and its displacement by 1 m in the direction of force.

4. A pair of bullocks exerts a force of 140 N on a plough. The field being ploughed is 15 m long. How much work is done in ploughing the length of the field?

Ans: F = 140 N, s = 15 m

Work done (W) = F x s = 140 x 15 = 2100 J

1. What is the kinetic energy of an object? (Page No:40)

Ans: The energy possessed by an object by virtue of its motion is called its kinetic energy.

2. Write an expression for the kinetic energy of an object.

Ans: KE = $\frac{1}{2}$ mv^2

3. The kinetic energy of an object of mass, m moving with a velocity of 5 m s^{-1} is 25 J. What will be its kinetic energy when its velocity is doubled? What will be its kinetic energy when its velocity is increased three times?

Ans: Initial kinetic energy KE = 25 J

We know that KE α v^2

a) When velocity is doubled, its KE = $(2)^2$ x Initial KE = 4 x 25 = 100 J
b) When velocity is tripled, its KE = $(3)^2$ x Initial KE = 9 x 25 = 225 J

1. What is power? (Page No:48)

Ans: Power is defined as the rate of doing work.

2. Define 1 watt of power.

Ans: 1 watt of power is defined as the work done at rate of 1 joule per second.

3. A lamp consumes 1000 J of electrical energy in 10 s. What is its power?

Ans: Power = $\frac{W}{t} = \frac{1000}{10} = 100\ W$

4. Define average power.

Ans: The average power defined as dividing the total energy consumed by the total time taken.

MIDDE SRINIVASA RAO

Activities

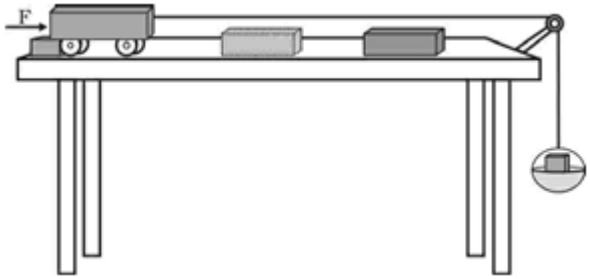
1. Explain with help of an activity to understand the concept of Kinetic energy.

Aim: To understand the concept of kinetic energy

Material required: Table, Wooden block, Trolley, Pulley, Pan, Weights

Procedure:

1. Set up the apparatus as shown in Figure.
2. Place a wooden block of known mass in front of the trolley at a convenient fixed distance.
3. Place a known mass on the pan so that the trolley starts moving.
4. The trolley moves forward and hits the wooden block.
5. Fix a stop on the table in such a manner that the trolley stops after hitting the block. The block gets displaced.
6. Note down the displacement of the block. This means work is done on the block by the trolley as the block has gained energy.
7. Repeat this activity by increasing the mass on the pan.
8. Larger the mass in the pan, larger is the force with the trolley hits the block.
9. Consequently, larger will be the displacement and larger will be the work done.
10. In this activity, the moving trolley does work and hence it possesses energy.



Observation/Conclusion: The energy possessed by an object by virtue of its motion.

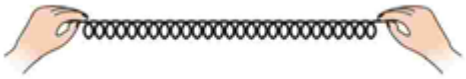
2. Explain with help of an activity to understand the concept of Potential energy.

Aim: To understand the concept of potential energy

Material required: Slinky

Procedure:

1. Take a slinky as shown below.
2. Ask a friend to hold one of its ends. You hold the other end and move away from your friend. Now you release the slinky.
3. When released, the slinky regains its original length.
4. The slinky has acquired energy due to the work done during stretching.
5. The slinky would also acquire energy when it is compressed.



Observation/Conclusion: The energy possessed by a body by virtue of its position or shape

Multiple Choice Questions

1. Which of the following is the scientific conception of work?
a) Physical effort put into a task
b) Achieving the desired result
c) Force applied on an object to change its position
d) Effort required to complete a task
Ans: c) Force applied on an object to change its position

2. The unit of work done is
a) Newton b) Joule c) Watt d) Kilogram
Ans: b) Joule

3. When a force moves an object in the direction of the force, it
a) Increases the potential energy of the object
b) Decreases the kinetic energy of the object
c) Decreases the potential energy of the object
d) Increases the kinetic energy of the object
Ans: d) Increases the kinetic energy of the object

4. If the force and displacement are in the same direction, then work done is:
a) Positive b) Negative
c) Zero d) None of the above
Ans: a) Positive

5. The work done by a gravitational force on a body is
a) Positive b) Negative
c) Zero d) None of the above
Ans: b) Negative

6. If a force of 20 N moves an object a distance of 5 meters, the work done is
a) 25 J b) 100 J c) 5 J d) 4 J
Ans: B) 100 J

7. If the angle between force and displacement is 90°, then work done is
a) Maximum b) Minimum c) Zero d) Negative
Ans: C) Zero

8. The energy possessed by a body due to its motion is called:
a) Kinetic energy b) Potential energy
c) Gravitational energy d) Mechanical energy
Ans: A) Kinetic energy

9. Which of the following is an example of potential energy?
a) A moving car b) A burning candle
c) A stretched rubber band d) A flowing river
Ans: c) A stretched rubber band

10. What is the rate at which work is done called?
a) Power b) Energy c) Force d) Velocity
Ans: a) Power

11. Which of the following has zero work done when a force is applied?
a) Lifting a book b) Pushing a wall
c) Holding a bag d) Kicking a ball
Ans: c) Holding a bag

12. Which of the following is a unit of work?
a) Nm b) N/s c) N/kg d) N/m
Ans: a) Nm

13. When a simple pendulum is at its mean position, it primarily possesses
a) Kinetic energy b) Potential energy
c) Kinetic + Potential energy d) Sound energy
Ans: a) Kinetic energy

14. The conservation of energy principle states that
a) Energy can be created but not destroyed
b) Energy can neither be created nor destroyed
c) Energy is always conserved in an isolated system
d) Energy is only conserved in mechanical systems
Ans: b) Energy can neither be created nor destroyed

15. Which of the following is a form of potential energy?
a) Sound energy b) Thermal energy
c) Chemical energy d) Kinetic energy
Ans: c) Chemical energy

16. The SI unit of power is
a) Joule b) Watt c) Newton d) Kilogram
Ans: B) Watt

17. Kg m^2 s^{-2} is associated with
a) Energy b) Force c) Power d) Momentum
Ans: a) Energy

18. Two particles of masses 1 g and 3 g have equal momentum. What is the ratio between their kinetic energies?
a) 1:3 b) 3:1 c) √3:1 d) 1:√3
Ans: b) 3:1

19. 1 kWh =
a) 3.6×10^{-6} J b) 3.6×10^{5} J
c) 3.6×10^{6} J d) 3.6×10^{-5} J
Ans: c) 3.6×10^{6} J

20. If the mass of a body is doubled, its kinetic energy
a) remains same b) gets doubled
c) become half d) increases 4 times
Ans: b) gets doubled

21. A total of 4900 J was expended in lifting a 50 kg mass. The mass was raised to a height of
a) 1 m b) 98 m c) 960 m d) 10 m
Ans: d) 10 m

22. In the case of negative work, the angle between the force and displacement is
a) 0^0 b) 45^0 c) 90^0 d)180^0
Ans: d)180^0

23. Work done is measured by
a) mass x velocity b) mass x acceleration
c) force x displacement d) force x time
Ans: c) force x displacement

24. Potential energy of your body is minimum when you
a) are standing b) are sitting on a chair
c) are sitting on the ground d) lie down on the ground
Ans: d) lie down on the ground

Competency - Based Questions

Multiple Choice Questions

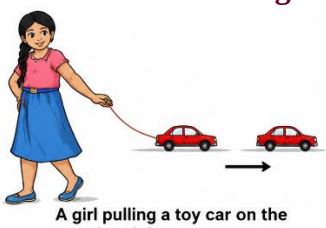
1. Which of the following does not represent work or energy?
A) ½mv² B) mgh C) F × S D) mv
Ans: D) mv

2. Joule/Second is the S.I. unit of _____.
A) Energy B) Power C) Force D) Velocity
Ans: B) Power

3. Which of the following factor does kinetic energy of an object depend on?
A) Velocity B) Height of the object C) Acceleration due to gravity D) Displacement of the object
Ans: A) Velocity

4. A ball is dropped from a certain height. As it falls, which statement is correct?
A) Total energy decreases.
B) Kinetic energy remains zero until it hits the ground.
C) Decrease in potential energy equals increase in kinetic energy.
D) Potential energy turns into heat, reducing total energy.
Ans: C) Decrease in potential energy equals increase in kinetic energy.

5. In which of the following cases, the work done is zero?


A girl pulling a toy car on the ground and the toy car moves a distance


A boy is trying to push a huge rock


A man lifts cement bag from ground


A person pushes a chair and it slides

A) A girl pulls a toy car and it moves forward. B) A boy pushes a huge rock but it does not move.
C) A man lifts a cement bag from the ground. D) A person pushes a chair and it slides on the floor.
Ans: B) A boy pushes a huge rock but it does not move.

6. A person lifts a bag from the ground to a certain height. Identify the correct form of representation of work done by the gravitational force.
A) W = F × S B) W = – (F × S) C) F = ma D) W = F / S
Ans: B) W = – (F × S)

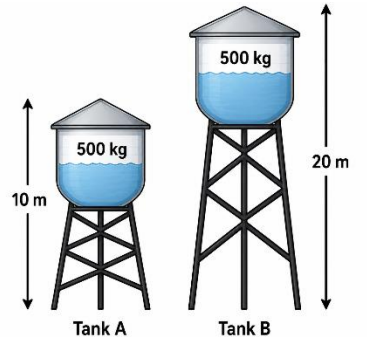
7. A cyclist is moving at a certain speed on a straight road. If the cyclist doubles his speed, what happens to the kinetic energy?
A) Does not change B) Becomes twice C) Becomes four times D) Becomes eight times
Ans: C) Becomes four times

8. Which of these involves the conversion of kinetic energy to potential energy?
A) A person diving into a pool of water from a board B) A person gliding in air with the help of a parachute
C) A person sliding down from the top of a water slide D) A person riding a motorbike to the top of an overbridge

Ans: D) A person riding a motorbike to the top of an overbridge

9. Which of the following is the correct statement about the potential energy (PE) of the two tanks shown below?

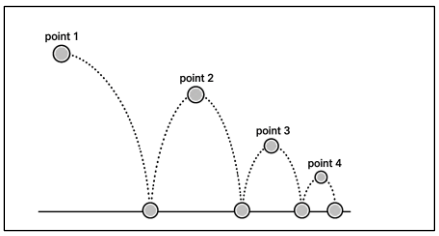
A) Tank A has more potential energy than Tank B.
B) Tank B has more potential energy than Tank A.
C) Both tanks have the same potential energy.
D) Neither tank has potential energy.



Ans: B) Tank B has more potential energy than Tank A.

10. At which point was the potential energy of the ball maximum?

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



Ans: A) Point 1

11. Identify the incorrect statement about a freely falling body

A) Gravity and air resistance act in opposite directions
B) Air resistance does negative work on the body
C) Gravity does positive work on the body.
D) No force acts on the body.

Ans: D) No force acts on the body.

2 Marks Questions

1. A person pushes a wall with great force, but the wall does not move. Is any work done? Why?

Ans: No work is done because there is no displacement of the wall. Work is done only when force produces displacement.

2. Why is the work done by gravity positive when an object falls freely?

Ans: During free fall, the displacement of the object is in the same direction as the gravitational force. Therefore, the work done by gravity is positive.

3. Why is the work done by gravity negative when a ball is thrown vertically upward?

Ans: The displacement is upward while gravity acts downward. Since force and displacement are in opposite directions, the work done by gravity is negative.

4. Two students carry the same bag to the same height. One takes 10 seconds and the other 20 seconds. Who does more work?

Ans: Both do the same amount of work because the force applied and displacement are the same. However, the student taking less time has greater power.

5. Why does a moving bullet possess more kinetic energy than a slowly moving stone of the same mass?

Ans: Kinetic energy depends on the square of velocity. Since the bullet moves much faster, it has much greater kinetic energy.

6. A body has kinetic energy. What can you conclude about its state?

Ans: The body must be in motion because kinetic energy is the energy possessed by an object due to its motion.

7. Why does a stretched rubber band possess energy?

Ans: Work is done in stretching the rubber band. This work gets stored in it as potential energy due to its changed shape.

8. A stone at the top of a building and another on the ground have the same mass. Which possesses more energy and why?

Ans: The stone at the top possesses more gravitational potential energy because it is at a greater height above the ground.

9. Why does a falling object gain speed as it approaches the ground?

Ans: Its potential energy continuously converts into kinetic energy during the fall, increasing its speed.

10. Can an object have energy even when it is at rest? Give an example.

Ans: Yes. An object at rest can possess potential energy. For example, water stored in a dam or a stretched bow has potential energy.

11. Why is a powerful motor preferred for lifting heavy loads?

Ans: A powerful motor can do more work in less time. Power is the rate of doing work.

12. A car and a bicycle move with the same speed. Which has more kinetic energy?

Ans: The car has more kinetic energy because kinetic energy depends on mass as well as velocity. The car has a much larger mass than the bicycle.

13. Why does a wound-up toy car move when released?

Ans: The spring stores potential energy when wound. On release, this potential energy converts into kinetic energy, making the toy move.

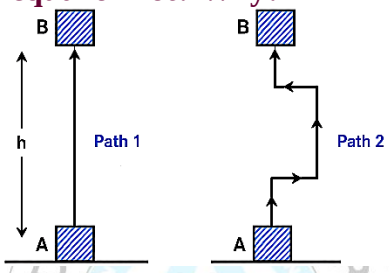
14. Why is total mechanical energy conserved during the free fall of an object?

Ans: During free fall, potential energy decreases while kinetic energy increases by the same amount. Hence, total mechanical energy remains constant.

15. Two electric bulbs consume the same energy. One consumes it in less time. Which bulb is more powerful?

Ans: The bulb that consumes the same energy in less time is more powerful because power equals energy consumed per unit time.

16. The given figure shows a case where a block is raised from position A to B by taking two different paths. Does the work done in both the cases equal or not? Why?



Ans: Yes, the work done is equal in both cases. The work done in raising a block against gravity depends only on the vertical height, not on the path followed.

4 Marks Questions

1. Two friends, Rani and Seema, both shifted the same weight of 500 N to an upper floor at a height of 5 m. Rani takes 10 s while Seema takes 15 s.

a) Calculate the work done by each. b) Who has greater power and why?

Ans: a) Given Force (weight) = 500 N, Height = 5 m

Work done by Rani (W) = F x S = 500 x 5 = 2500 J

Work done by Seema (W) = F x S = 500 x 5 = 2500 J

b) Power developed by Rani (P)= $\frac{W}{t} = \frac{2500}{10} = 250\ W$

Power developed by Seema (P)= $\frac{W}{t} = \frac{2500}{15} = 166.67\ W$

Rani has greater power because she does the same amount of work in less time.

2. The table shows that four persons separately pulled a 100 kg cart for a distance of 500 m. The table shows the time each person took to cover the distance. Answer the following questions.

Person	Person 1	Person 2	Person 3	Person 2
Time Taken	12 min	15 min	10 min	18 min

a) Define power.

b) Identify the person with maximum power.

c) Identify the person with minimum power.

d) Arrange the persons in descending order of power.

Ans: a) Power is the rate at which work is done.

b) Maximum power: Person 3 (10 min).

c) Minimum power: Person 4 (18 min).

d) Person 3 > Person 1 > Person 2 > Person 4.

3. Why does a driver speed up his vehicle when he moves up a hill?

Ans: As the vehicle moves up the hill, its kinetic energy gradually changes into potential energy. So to move further, it needs more of kinetic energy which is obtained by increasing its speed.

4. A student performs the following activities:

(a) Pushes a wall that does not move.
(b) Lifts a schoolbag from the floor onto a desk.
(c) Holds a heavy book without moving.
(d) Pulls a trolley that moves forward.
Identify the activities in which scientific work is done and justify your answers.

Ans:

Activity	Scientific work done?	Reason
(a) Pushing a stationary wall	No	There is no displacement.
(b) Lifting a schoolbag	Yes	Force produces upward displacement.
(c) Holding a stationary book	No	There is no displacement.
(d) Pulling a moving trolley	Yes	The applied force produces displacement in its direction.

5. State the law of conservation of energy. Explain it using a freely falling object.

Ans: Law of conservation of energy: Energy can neither be created nor destroyed. It can only be converted from one form to another. The total energy remains constant.

Explanation using a freely falling object:

1. At the initial height, the object has maximum gravitational potential energy and zero kinetic energy if released from rest.
2. As it falls, its potential energy decreases.
3. Its kinetic energy increases as its speed increases.
4. Ignoring air resistance, the sum of potential energy and kinetic energy remains constant.
5. This demonstrates the law of conservation of energy.

6. Differentiate between kinetic energy and potential energy.

Ans:

Kinetic Energy	**Potential Energy**
Energy possessed by an object due to its motion.	Energy possessed by an object due to its position or configuration.
It depends on the mass and velocity of the object.	Gravitational potential energy depends on mass, height and gravitational acceleration.
Formula: $E_k = \frac{1}{2} mv^2$	Formula: $E_p = mgh$
Ex: A moving car and flowing water.	Ex: A raised stone and a stretched rubber band.

7. An object of mass 20 kg is dropped from a height of 4 m. Fill in the following table by calculating the potential energy and kinetic energy at each height.
Complete the following table

Height at which object is located (m)	**Potential Energy $E_p = mgh$ (J)**	**Kinetic Energy $E_k = \frac{1}{2} mv^2$ (J)**	**$E_p + E_k$ (J)**
4 m	800		800
3 m	600		
2 m		400	
1 m		600	
Just above the ground (0 m)	0		800

Ans:

Height at which object is located (m)	**Potential Energy $E_p = mgh$ (J)**	**Kinetic Energy $E_k = \frac{1}{2} mv^2$ (J)**	**$E_p + E_k$ (J)**
4 m	800	0	800
3 m	600	200	800
2 m	400	400	800
1 m	200	600	800
Just above the ground (0 m)	0	800	800

8. An object of mass 12 kg is at a certain height above the ground. If the potential energy of the object is 480 J, find the height at which the object is with respect to the ground. Given, g = 10 m s^{-2}

Ans: Mass of the object, m = 12 kg
potential energy, E_p = 480 J
$E_p = mgh$

480 = 12 x 10 x h

h = $\frac{480}{120} = 4\ m$

The object is at the height of 4 m

8 Marks Questions

1. Identify the types of energies involved in the following situations:

a) A stretched bow before releasing the arrow
b) A coconut hanging on a tree
c) A compressed spring
d) A running athlete
e) A rolling football on the ground
f) Water falling from a dam
g) A bird flying in the sky
h) A moving bullet

Ans: a) Potential energy
b) Gravitational potential energy
c) Potential energy
d) Kinetic energy
e) Kinetic energy
f) Gravitational potential energy and kinetic energy
g) Kinetic energy and gravitational potential energy
h) Kinetic energy

2. Define Kinetic Energy. Write its formula. Give any six examples.

Ans: The energy possessed by an object by virtue of its motion is called **kinetic energy**.

Formula: Kinetic energy (K.E) = ½ mv^2

SI unit of kinetic energy = joule (J)

Examples:

1. A moving car possesses kinetic energy.
2. A moving bicycle possesses kinetic energy.
3. A running person possesses kinetic energy.
4. A rolling ball possesses kinetic energy.
5. A flying bird possesses kinetic energy.
6. Flowing water possesses kinetic energy.

3. Define Potential Energy. Write its formula. Give any six examples.

Ans: The energy possessed by an object by virtue of its position or configuration is called **potential energy**.

Formula: Potential energy (P.E) = mgh

SI unit of potential energy = joule (J)

Examples:

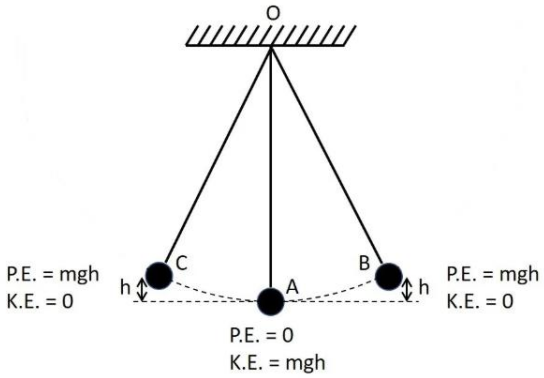
1. A book kept on a high shelf possesses gravitational potential energy.
2. A stone held at a height above the ground possesses gravitational potential energy.
3. Water stored in a dam possesses gravitational potential energy.
4. A flowerpot kept on a balcony possesses gravitational potential energy.
5. An object raised above the ground possesses gravitational potential energy.
6. A stretched rubber band possesses potential energy due to its changed configuration.

4. State the law of conservation of energy.

a) Explain this law with the example of a pendulum.
b) Why does the bob of a pendulum finally come to rest, and what happens to its energy?

Ans: The law of conservation of energy states that *energy can neither be created nor destroyed. It can only be converted from one form to another. The total energy before and after the transformation remains the same.*

a) Consider a simple pendulum oscillating between two extreme positions, B and C, with the mean position A.



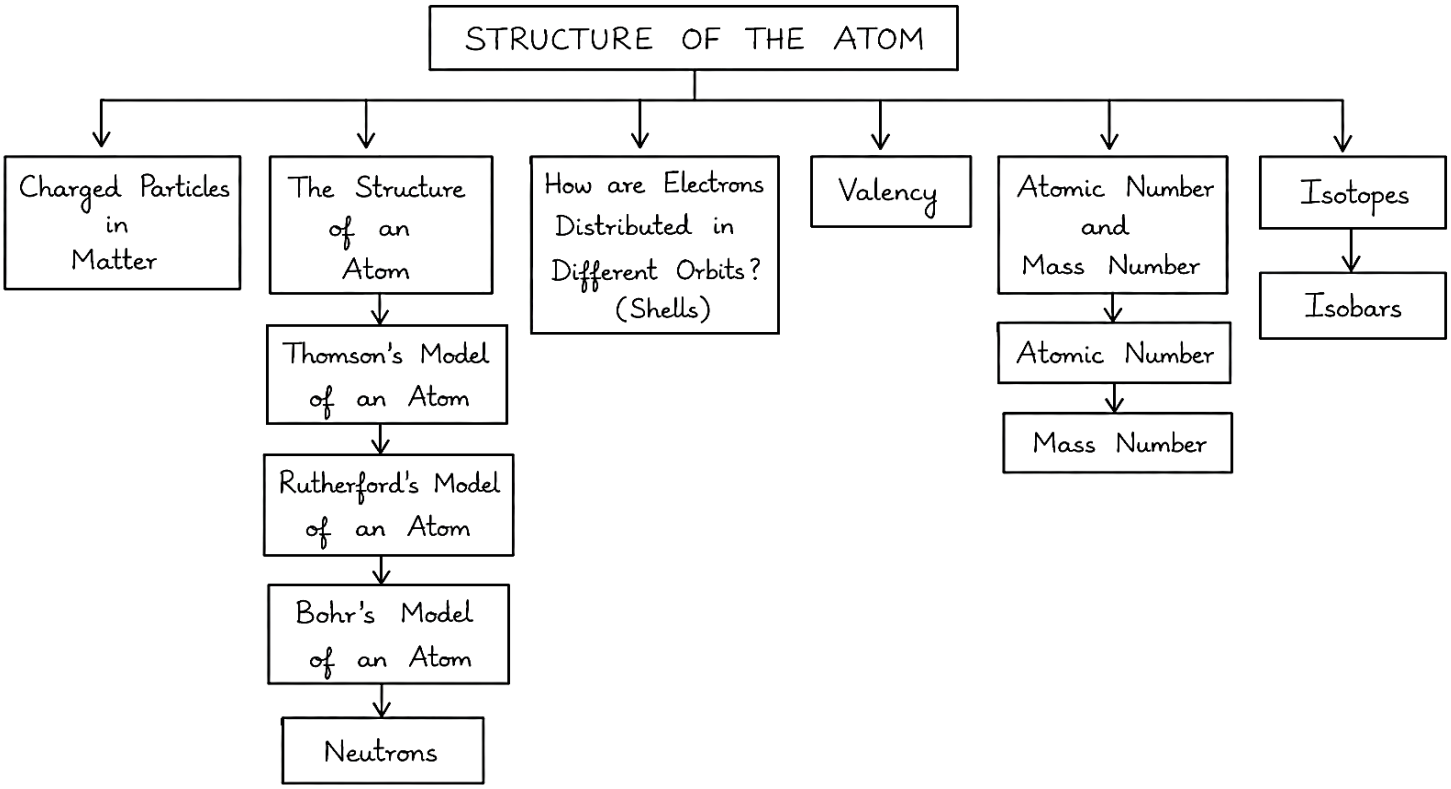
At extreme position B: The bob has maximum potential energy and zero kinetic energy because its velocity is zero.
While moving from B to A: The potential energy of the bob gradually decreases and its kinetic energy increases.
At mean position A: The bob has maximum kinetic energy and minimum potential energy.
While moving from A to C: The kinetic energy gradually decreases and the potential energy increases.
At extreme position C: The bob again has maximum potential energy and zero kinetic energy.
Thus, the potential energy of the bob continuously changes into kinetic energy and vice versa. The total mechanical energy remains constant.
b) Due to air resistance and friction at the point of suspension**.** Therefore, the amplitude of oscillation gradually decreases, and the bob finally comes to rest.

MIDDE SRINIVASA RAO
INSPIRATION-INNOVATION-CREATION-ASPIRATION
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Chapter - 8

STRUCTURE OF THE ATOM

MIND MAP



Main Points

1. Credit for the discovery of electron, proton and neutron goes to J.J. Thomson, E.Goldstein and Chadwick respectively.
2. Electrons, Protons and Neutrons are called sub-atomic particles.
3. Proton mass was approximately 2000 times as that of the electron.
4. Electrons are negatively charged, protons are positively charged and neutrons have no charges.
5. The mass of a proton and a neutron is taken as one unit each
6. Dalton's atomic theory suggested that the atom was indivisible and indestructible.
7. J.J. Thomson proposed that an atom consists of a positively charged sphere and electrons are embedded in it.
8. Rutherford's alpha-particle scattering experiment led to the discovery of the atomic nucleus.
9. Rutherford's model of the atom proposed that a very tiny nucleus is present inside the atom and electrons revolve around this nucleus. The stability of the atom could not be explained by this model.
10. The radius of the nucleus is about 10^5 times less than the radius of the atom.
11. α -particles means nucleus of helium atom.
12. Neils Bohr's model of the atom proposed that Only certain special orbits known as discrete orbits of electrons, are allowed inside the atom. While revolving in discrete orbits the electrons do not radiate energy.
13. Shells of an atom are designated as K,L,M,N,….
14. The maximum number of electrons present in a shell is given by the formula $2n^2$, where 'n' is the orbit number
15. Bohr-Bury scheme, the maximum number of electrons that can be accommodated in the outermost orbit is 8.
16. The electrons present in the outermost shell of an atom are known as the valence electrons.
17. Valency is the combining capacity of an atom.
18. The atomic number is defined as the total number of protons present in the nucleus of an atom.It is denoted by Z.
19. The mass number of an atom is equal to the number of nucleons in its nucleus. It is denoted by A.
20. Isotopes are defined as the atoms of the same element, having the same atomic number but different mass numbers. Example: ${}^{1}_{1}H$, ${}^{2}_{1}H$, ${}^{3}_{1}H$
21. The chemical properties of isotopes are similar but their physical properties are different.
22. Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars. Example: ${}^{40}_{18}Ar$, ${}^{40}_{20}Ca$

23. Uranium isotope is used as a fuel in nuclear reactors, cobalt isotope is used in the treatment of cancer, iodine isotopes is used in the treatment of goitre.

Exercises

1. Compare the properties of electrons, protons and neutrons.

Ans:

	Electron	Proton	Neutron
Symbol	e^-	p^+	n^0
Nature of Charge	Negative	Positive	Neutral
Charge	-1.6×10^{-19} C	$+1.6 \times 10^{-19}$ C	No charge
Mass	9.0×10^{-31} kg	1.672×10^{-27} kg	1.672×10^{-27} kg
Location	Outside the nucleus	Inside the nucleus	Inside the nucleus

2. What are the limitations of J.J. Thomson's model of the atom?

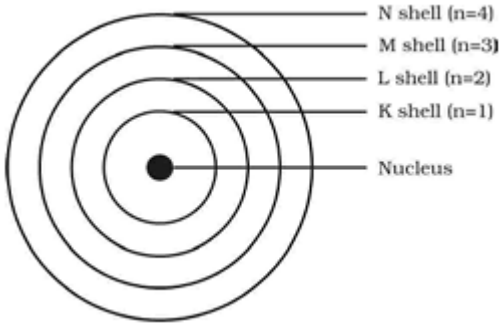
Ans: According to J.J. Thomson's model of an atom, the electrons are embedded all over in the positively charged spheres. But experiments done by other scientists showed that protons are present only in the centre of the atom and electrons are distributed around it.

3. What are the limitations of Rutherford's model of the atom?

Ans: According to Rutherford's model of an atom the electrons are revolving in a circular orbit around the nucleus. Any such particle that revolves would undergo acceleration and radiate energy. The revolving electron would lose its energy and finally fall into the nucleus, the atom would be highly unstable. But we know that atoms are quite stable.

4. Describe Bohr's model of the atom.

Ans: (i) Only certain special orbits known as discrete orbits of electrons, are allowed inside the atom.
(ii) While revolving in discrete orbits the electrons do not radiate energy.
(iii) These orbits or shells are called energy levels.



(iv) These orbits or shells are represented by the letters K,L,M,N,… or the numbers, n=1,2,3,4,…

5. Compare all the proposed models of an atom given in this chapter.

Ans:

Feature	Thomson's Atomic Model	Rutherford's Atomic Model	Bohr's Atomic Model
1. Structure of the atom	An atom consists of a positively charged sphere with electrons embedded in it.	An atom has a small, positively charged nucleus at its centre.	Electrons revolve around the nucleus in certain permitted orbits.
2. Positive charge	Distributed throughout the sphere.	Concentrated in the nucleus.	Concentrated in the nucleus.
3. Position of electrons	Embedded in the positively charged sphere.	Revolve around the nucleus in circular paths.	Revolve around the nucleus in permitted discrete orbits.
4. Distribution of mass	The model does not describe a central nucleus containing nearly all the mass.	Nearly all the mass is concentrated in the nucleus.	Retains the nuclear structure of Rutherford's model.
5. Space inside the atom	Does not describe the atom as mostly empty space.	Most of the space inside the atom is empty.	Electrons occupy permitted orbits around the nucleus.

6. Summarise the rules for writing of distribution of electrons in various shells for the first eighteen elements.

Ans: (i) The maximum number of electrons present in a shell is given by the formula = $2n^2$
where 'n' is the orbit number or energy level index, 1,2,3,….
1^{st} orbit or K-shell will be = $2 \times 1^2 = 2$
2^{nd} orbit or L-shell will be= $2 \times 2^2 = 8$
3^{rd} orbit or M-shell will be= $2 \times 3^2 = 18$
4^{th} orbit or N-shell will be= $2 \times 4^2 = 32$, and so on.
(ii) The maximum number of electrons that can be accommodated in the outermost orbit is 8.
(iii) Electrons are not accommodated in a given shell, unless the inner shells are filled. That is, the shells are filled in a step-wise manner.

7. Define valency by taking examples of silicon and oxygen.

Ans: Valency is the combining capacity of an atom. The valency of an element is determined by the number of valence electrons present in the atom
Valency of Silicon: Silicon electronic configuration: 2,8,4.
Thus, the valency of silicon is 4 as these electrons can be shared with others to complete octet.
Valency of Oxygen: Oxygen electronic configuration: 2,6
Thus, the valency of oxygen is 2 as it will gain 2 electrons to complete its octet.

8. Explain with examples
(i) Atomic number, (ii) Mass number, (iii) Isotopes and iv) Isobars. Give any two uses of isotopes.

Ans: **(i) Atomic number:** The atomic number is defined as the total number of protons present in the nucleus of an atom. For hydrogen Z = 1, because in hydrogen atom, only one proton is present in the nucleus.
(ii) Mass number: The mass number of an atom is equal to the number of nucleons in its nucleus.
Example: The mass of carbon is 12 u because it has 6 protons and 6 neutrons, 6 u + 6 u = 12 u.
(iii) Isotopes: Isotopes are defined as the atoms of the same element, having the same atomic number but different mass numbers.
Example: Hydrogen atom, it has three atomic species, namely protium $^{1}_{1}H$, deuterium $^{2}_{1}H$ and tritium $^{3}_{1}H$
iv) Isobars: Atoms of different elements with different atomic numbers, which have the same mass number, are known as isobars.
Example: $^{40}_{18}Ar$, $^{40}_{20}Ca$

9. Na^+ has completely filled K and L shells. Explain.

Ans: Neutral Na atomic number (Z) is 11 and electronic configuration is 2, 8, 1
Na^+ atomic number (Z) is 11 and electronic configuration is 2, 8.
Out of 10 electrons, K-shell contains 2 electrons and L-shell contains 8 electrons. Na^+ has completely filled K and L shells.

10. If bromine atom is available in the form of, say, two isotopes $^{79}_{35}Br$ (49.7%) and $^{81}_{35}Br$ (50.3%), calculate the average atomic mass of bromine atom.

Ans: The average atomic mass of bromine atom = $(79 \times \frac{49.7}{100}) + (81 \times \frac{50.3}{100})$
$= 39.263 + 40.743$
$= 80.006$ u

11. The average atomic mass of a sample of an element X is 16.2 u. What are the percentages of isotopes $^{16}_{8}X$ and $^{18}_{8}X$ in the sample?

Ans: Let the percentages of isotopes $^{16}_{8}X$ = A
Then the percentages of isotopes $^{18}_{8}X$ = 100 - A

$$\frac{16 \times A}{100} + \frac{(100-A) \times 18}{100} = 16.2$$

$16 A + 1800 - 18 A = 1620$
$2 A = 180$
$A = 90$ %

The percentages of isotopes $^{16}_{8}X$ is 90% and $^{18}_{8}X$ is 10%.

12. If Z = 3, what would be the valency of the element? Also, name the element.

Ans: Atomic number is 3. Then the element is Lithium and valency is 1

13. Composition of the nuclei of two atomic species X and Y are given as under

	X	Y
Protons =	**6**	**6**
Neutrons =	**6**	**8**

Give the mass numbers of X and Y. What is the relation between the two species?

Ans: Mass of X = 6 + 6 = 12
Mass of Y = 6 + 8 = 14
X and Y both have same atomic number, but different mass numbers. So, these are isotopes.

14. For the following statements, write T for True and F for False.

(a) J.J. Thomson proposed that the nucleus of an atom contains only nucleons.
(b) A neutron is formed by an electron and a proton combining together. Therefore, it is neutral.
(c) The mass of an electron is about proton. 1 2000 times that of
(d) An isotope of iodine is used for making tincture iodine, which is used as a medicine.

Ans: (a) F (b) F (c) T (d) T

Put tick (√) against correct choice and cross (X) against wrong choice in questions 15, 16 and 17

15. Rutherford's alpha-particle scattering experiment was responsible for the discovery of

(a) Atomic Nucleus (b) Electron (c) Proton (d) Neutron

Ans: (a) Atomic Nucleus (√) (b) Electron (X) (c) Proton (X) (d) Neutron (X)

16. Isotopes of an element have

(a) the same physical properties **(b) different chemical properties**
(c) different number of neutrons **(d) different atomic numbers.**

Ans: (a) the same physical properties (X) (b) different chemical properties (X)
(c) different number of neutrons (√) (d) different atomic numbers (X)

17. Number of valence electrons in Cl^- ion are:

(a) 16 (b) 8 (c) 17 (d) 18

Ans: (a) 16 (X) (b) 8 (√) (c) 17 (X) (d) 18 (X)

18. Which one of the following is a correct electronic configuration of sodium?

(a) 2,8 (b) 8,2,1 (c) 2,1,8 (d) 2,8,1

Ans: (d) 2,8,1

19. Complete the following table.

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	-	10	-	-	-
16	32	-	-	-	Sulphur
-	24	-	12	-	-
-	2	-	1	-	-
-	1	0	1	0	-

Ans:

Atomic number	Mass number	Number of neutrons	Number of protons	Number of electrons	Name of the atomic species
9	19	10	9	9	Fluorine
16	32	16	16	16	Sulphur
12	24	12	12	12	Magnesium
1	2	1	1	1	Deuterium
1	1	0	1	0	Hydrogen

20. Match Column I with Column II and choose the correct pair.

Column I (Scientists)	Column II (Discoveries)
A) J.J. Thomson	1. Proton
B) E. Goldstein	2. Electron
C) James Chadwick	3. Neutron
	4. Nucleus

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

Ans: A) A-2, B-1, C-3

21. The shells of an atom are designated as K, L, M, N, ... by Niels Bohr.
Which of the following statements is correct?

A) The K shell is the outermost shell of an atom.
B) The maximum number of electrons in the L shell is 8.
C) The M shell can hold a maximum of 8 electrons only.

D) The N shell is closer to the nucleus than the K shell.

Ans: B) The maximum number of electrons in the L shell is 8.

In Textbook Questions

1. What are canal rays? (Page No:58)

Ans: Canal rays are positively charged radiations that can pass through perforated cathode plate. These rays consist of positively charged particles known as protons.

2. If an atom contains one electron and one proton, will it carry any charge or not?

Ans: The magnitude of charge on the electron and proton is the same. The atom contains one electron and one proton, will carry no charge.

1. On the basis of Thomson's model of an atom, explain how the atom is neutral as a whole. (Page No:62)

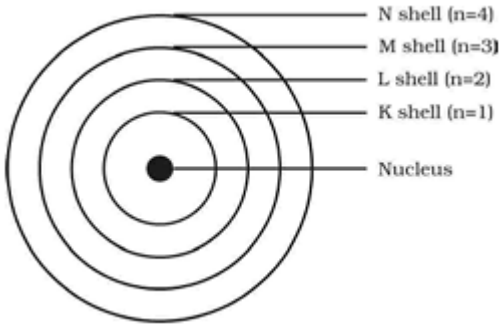
Ans: The negative and positive charges are equal in magnitude. So, the atom as a whole is electrically neutral.

2. On the basis of Rutherford's model of an atom, which sub atomic particle is present in the nucleus of an atom?

Ans: Protons are present in the nucleus of an atom.

3. Draw a sketch of Bohr's model of an atom with three shells.

Ans:



4. What do you think would be the observation if the -particle scattering experiment is carried out using a foil of a metal other than gold?

Ans: If α-particle scattering experiment is carried out using a foil of any metal as thin as gold foil used by Rutherford, there would be no change in observations. But since other metals are not so malleable so, such a thin foil is difficult to obtain. If we use a thick foil, then more α-particles would bounce back and no idea about the location of positive mass in the atom would be available with such a certainty.

1. Name the three sub-atomic particles of an atom. (Page No:62)

Ans: (i) Protons (ii) Electrons and (iii) Neutrons

2. Helium atom has an atomic mass of 4 u and two protons in its nucleus. How many neutrons does it have?

Ans: Number of neutrons = Atomic mass - Number of protons

The number of neutrons in Helium atom = 4 - 2 = 2

1. Write the distribution of electrons in carbon and sodium atoms. (Page No:64)

Ans: Total number of electrons in the Carbon atom is 6. The distribution of electrons as 2,4.

Total number of electrons in the Sodium atom is 11. The distribution of electrons as 2,8,1.

2. If K and L shells of an atom are full, then what would be the total number of electrons in the atom?

Ans: K-shell can be accommodated maximum 2 electrons and L-shell can 8 electrons. So, the total number of electrons in the atom is 10.

1. How will you find the valency of chlorine, sulphur and magnesium? (Page No:68)

Ans: Configuration of Chlorine is 2, 8,7. Hence, Valency of Chlorine = 8-7 = 1

Configuration of Sulphur is 2, 8,6. Hence, Valency of Sulphur = 8-6 = 2

Configuration of Magnesium is 2, 8,2. Hence, Valency of Magnesium = 2

1. If number of electrons in an atom i s 8 and number of protons is also 8, then (i) what is the atomic number of the atom? and (ii) what is the charge on the atom? (Page No:68)

Ans: (i) Atomic number = No.of Protons = 8

(ii) Charge on the atom = 0

2. With the help of Table 4.1, find out the mass number of oxygen and sulphur atom.

Ans: Mass number of oxygen = Number of protons + Number of neutrons

= 8 + 8 = 16

Mass number of sulphur = Number of protons + Number of neutrons
= 16 +16 = 32

1. For the symbol H,D and T tabulate three sub-atomic particles found in each of them. (Page No:70)

Ans:

Sub-atomic particle	Hydrogen (H)	Deuterium (D)	Tritium (T)
Electron	1	1	1
Proton	1	1	1
Neutron	0	1	2

2. Write the electronic configuration of any one pair of isotopes and isobars.

Ans: Isotopes: Configuration of $^{12}_{6}C$, $^{14}_{6}C$ are 2, 6 and 2,6

Isobars: Configuration of $^{40}_{18}Ar$, $^{40}_{20}Ca$ are 2,8,8 and 2,8,8,2

Multiple Choice Questions

1. The subatomic particles present in an atom are
a) Protons, electrons, and neutrons
b) Protons, neutrinos, and electrons
c) Protons, muons, and electrons
d) Positrons, electrons, and neutrinos
Ans: a) Protons, electrons, and neutrons

2. Rutherford's model of an atom showed that most of the mass of an atom is concentrated in
a) Electrons b) Protons c) Neutrons d) Nucleus
Ans: d) Nucleus

3.Who proposed the plum pudding model of an atom?
a) J.J. Thomson b) Ernest Rutherford
c) Niels Bohr d) James Chadwick
Ans: a) J.J. Thomson

4. According to Bohr's model of an atom, electrons revolve around the nucleus in
a) Random orbits b) Definite orbits or shells
c) Multiple energy levels simultaneously d) Spiral paths
Ans: b) Definite orbits or shells

5. What does the atomic number of an element signify?
a) The number of neutrons in an atom
b) The sum of protons and neutrons in an atom
c) The number of protons in an atom
d) The number of electrons in an atom
Ans: c) The number of protons in an atom

6. What is the atomic number of an element with 6 protons and 6 electrons?
a) 12 b) 6 c) 4 d) 8
Ans: b) 6

7. What is the mass of an electron?
a) 1 amu b) 1836 amu c) 1/1836 amu d) 0 amu
Ans: c) 1/1836 amu

8. Which part of an atom contains the protons and neutrons?
a) Nucleus b) Electron cloud c) Shells d) Orbits
Ans: a) Nucleus

9. The discovery of the neutron was made by
a) Niels Bohr b) James Chadwick
c) Ernest Rutherford d) J.J.Thomson
Ans: b) James Chadwick

10. Who proposed the planetary model of an atom?
a) J.J. Thomson b) Ernest Rutherford
c) Niels Bohr d) James Chadwick
Ans: c) Niels Bohr

11. Which subatomic particle has negligible mass?
a) Proton b) Electron c) Neutron d) Nucleus
Ans: b) Electron

12. Which scientist's experiment led to the discovery of the nucleus of an atom?
a) J.J. Thomson b) Ernest Rutherford
c) Niels Bohr d) Dmitri Mendeleev
Ans: b) Ernest Rutherford

13. What is the charge of an alpha particle?
a) Positive b) Negative c) Neutral d) Variable
Ans: a) Positive

14. Isotopes of an element have the same
a) Atomic mass b) Atomic number
c) Number of neutrons d) Number of energy levels
Ans: b) Atomic number

15. The isotope used to remove the brain tumours and treatment of cancer is
a) Uranium isotope b) Sodium isotope
c) Iodine isotopes d) Cobalt isotope
Ans: d) Cobalt isotope

16. What is the atomic mass of an element that has 8 protons and 9 neutrons?
a) 8 b) 9 c) 17 d) 1
Ans: c) 17

17. What is the significance of 1 u or 1 amu?
a) 1/12th the mass of a C-12 atom
b) The mass of a C-12 atom
c) The mass of an O-16 atom
d) The mass of a Hydrogen molecule
Ans: a) 1/12th the mass of a C-12 atom

18. Which of the following represents the correct electronic configuration of oxygen?
a) 2, 6 b) 2, 8 c) 2, 4 d) 2, 2, 4
Ans: b) 2, 8

19. Which subatomic particle carries a negative charge?
a) Proton b) Neutron c) Electron d) Nucleus
Ans: c) Electron

20. $^{1}_{1}H$, $^{2}_{1}H$ and $^{3}_{1}H$ are
a) Isotopes b) Isobars c) Isotone d) Isochores
Ans: a) Isotopes

21. Argon has atomic number 18 and mass number 40. Calcium has atomic number 20 and mass number 40. Argon and Calcium are examples of
a) Isotopes b) Isobars
c) Isotones d) None of these
Ans: a) Isobars

22. When an atom forms ions
a) No.of proton changes b) No.of electron changes
c) No.of neutron changes
d) both no.of electrons and protons changes
Ans: b) No.of electron changes

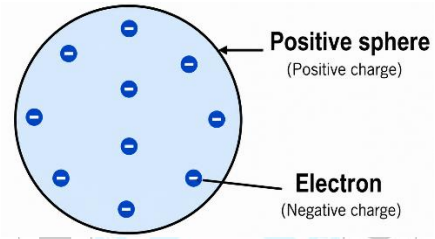
23. Gold foil was used in Rutherford's scattering experiment because it
a) has high refractive index b) has high density
c) is highly malleable d) is high ductile
Ans: c) is highly malleable

24. The size of an atom is decided by
a) mass of the atom b) no.of protons
c) no.of protons and neutrons d) no.of electrons
Ans: d) no.of electrons

Competency - Based Questions

Multiple Choice Questions

1. The given diagram represents which Atomic model?



A) Chadwick's Model of Atom B) Thomson's Model of Atom
C) Rutherford's Model of Atom D) Bohr's Model of Atom
Ans: B) Thomson's Model of Atom

2. Match the subatomic particle with the scientist who discovered it.

Column A: Subatomic Particles	Column B: Scientists
A. Electron	1. James Chadwick
B. Proton	2. J.J. Thomson
C. Neutron	3. E. Goldstein
	4. Niels Bohr

Options:
A) A-2, B-1, C-4 B) A-2, B-1, C-3 C) A-3, B-2, C-4 D) A-2, B-3, C-1
Ans: D) A-2, B-3, C-1

3. The atoms of the same element, having the same atomic number but different mass numbers are _____.
A) Isobars B) Isotopes C) Isotones D) Isomers
Ans: B) Isotopes

4. Neutrons are not present in the nucleus of _____.
A) A normal Hydrogen atom B) Heavy atoms C) Non-metal atoms D) Metal atoms
Ans: A) A normal Hydrogen atom

5. An atom has a valency of 3. Identify the correct distribution of electrons.
A) 2, 8, 1 B) 2, 8, 5 C) 2, 8, 2 D) 2, 8, 7
Ans: B) 2, 8, 5

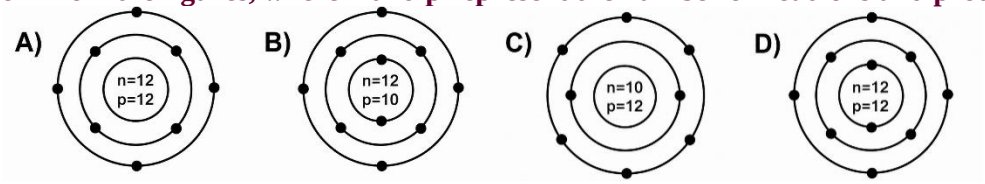
6. The maximum number of electrons that can be accommodated in the N shell is _____.
A) 18 B) 32 C) 8 D) 50
Ans: B) 32

7. Which of the following statements is always correct?
A) A neutral atom has equal number of electrons and protons.
B) A neutral atom has equal number of electrons and neutrons.

C) A neutral atom has equal number of protons and neutrons.
D) A neutral atom has equal number of electrons, protons and neutrons.

Ans: A) A neutral atom has equal number of electrons and protons.

8. Identify the Mg atom from the figures, where n and p represent the number of neutrons and protons respectively.



A) Figure A B) Figure B C) Figure C D) Figure D

Ans: A) Figure A

9. Which of the following shows the correct shell-wise distribution of electrons in Phosphorus?

A) 2, 8, 5 B) 2, 8, 7 C) 2, 8, 8 D) 2, 8, 3

Ans: A) 2, 8, 5

10. Which of the following statements are true regarding an element?

i) Atomic Number = Number of Protons + Number of Electrons
ii) Mass Number = Number of Protons + Number of Neutrons
iii) Isotopic number = Number of Protons = Number of Neutrons
iv) Atomic Number = Number of Protons = Number of Electrons

A) i and ii B) i and iii C) ii and iii D) ii and iv

Ans: D) ii and iv

11. How many neutrons does the element $_4X^9$ contain?

A) 4 B) 5 C) 9 D) 13

Ans: B) 5

12. I am an inert gas, but I do not have 8 electrons in my outermost shell. Predict who am I.

A) Helium B) Oxygen C) Argon D) Neon

Ans: A) Helium

13. A doctor prescribes a radioactive isotope of iodine to a patient for treatment. Which disease is the patient suffering from?

A) Goitre B) Cancer C) Beri-beri D) Tuberculosis

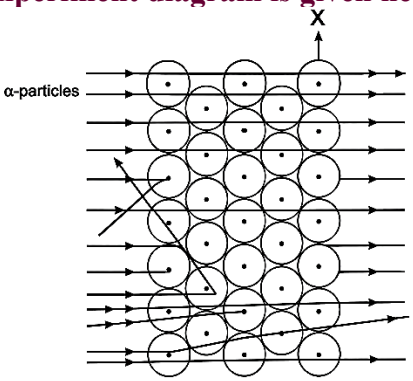
Ans: A) Goitre

14. A metal is used for cooking utensils because it is lightweight and strong. Its atomic number is 13. Identify the metal and the number of electrons present in its outermost shell.

A) Aluminium and 1 B) Magnesium and 2 C) Aluminium and 3 D) Magnesium and 3

Ans: C) Aluminium and 3

15. Rutherford's α-particle scattering experiment diagram is given here. What is 'X' in the figure?



A) Gold atom B) α-particle C) Nucleus D) Hydrogen atom

Ans: A) Gold atom

2 Marks Questions

1. In Rutherford's alpha-particle scattering experiment, most alpha particles passed straight through the gold foil. What does this observation indicate?

Ans: It indicates that most of the space inside an atom is empty.

2. Why is an atom electrically neutral?

Ans: An atom is electrically neutral because the total positive charge of its protons is equal to the total negative charge of its electrons.

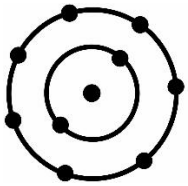
3. What is a neutron? Who discovered it?

Ans: A neutron is a subatomic particle with no electric charge and a mass nearly equal to that of a proton. It was discovered by J. Chadwick in 1932.

4. Write the electronic configurations of carbon and sodium.

Ans: Electronic configuration of Carbon (Z = 6) = 2, 4.
Electronic configuration of Sodium (Z = 11) = 2, 8, 1.

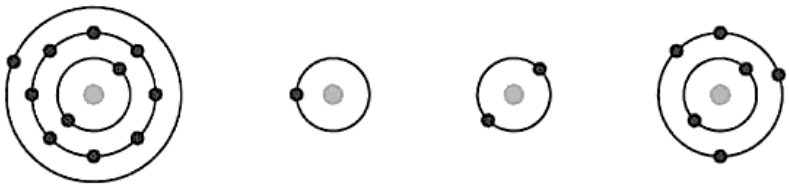
5. Observe the given diagram and answer.



a) Name of the element. b) What is its valency?

Ans: a) Fluorine b) 1

6. The pictures show the arrangement of electrons in the shells of different atoms.



a) Which two atoms have the same valency?
b) Which atom has the highest atomic number?

Ans: a) Atom 1 and Atom 2 b) Atom 1

7. The composition of nuclei of two atomic species X and Y is given below:

Species	Protons	Neutrons
X	6	6
Y	6	8

Find:
a) Mass numbers of X and Y. b) Any two similarities between X and Y.

Ans: a) 12 and 14
b) i) Same atomic number ii) Same no. of Protons iii) Isotopes

8. The picture shows the symbol for sodium.

$$^{23}_{11}Na$$

a) What does the number 23 represent for sodium? b) What can be concluded about sodium from the symbol?

Ans: a) Mass number b) Sodium atom contains 11 protons, 11 electrons and 12 neutrons.

9. An atom has atomic number 17 and mass number 35. Find the numbers of protons and neutrons in the neutral atom.

Ans: Protons (Z) = 17
Neutrons (N) = A - Z =35 − 17 = 18

4 Marks Questions

1. Complete the following table:

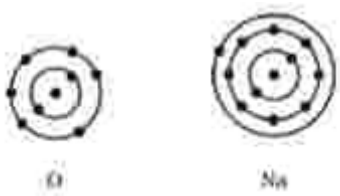
Name of Element	Atomic Number (Z)	Number of Neutrons (N)	Mass Number (A)
Helium	2		4
Sodium		12	23
Argon	18	22	
Boron	5		11

Ans:

Name of Element	Atomic Number (Z)	Number of Neutrons (N)	Mass Number (A)
Helium	2	**2**	4
Sodium	**11**	12	23
Argon	18	22	**40**
Boron	5	**6**	11

2. Draw the schematic atomic structures of the elements having atomic numbers 8 and 11 respectively.

Ans:



3. The electric configuration of an element 'X' is 2, 8, 2.

a) Find the number of electrons present in 'X' element?

b) Write the atomic number.

c) Write the name of the element.

d) Find out the valency of the element 'X'?

Ans: a) 12 b) 12 c) Magnesium d) 2

4. Define Isotopes? Write the applications of isotopes.

Ans: Isotopes are defined as the atoms of the same element, having the same atomic number but different mass numbers.

i) Uranium isotope is used as a fuel in nuclear reactions.

ii) Cobalt isotope is used in the treatment of cancer.

iii) Iodine isotope is used in the treatment of goitre.

5. Complete the following table.

Element	**Atomic number**	**Protons**	**Electrons**	**Neutrons**	**Mass number**
P	17			18	
Q			14	14	
R		9			19

Ans:

Element	Atomic number	Protons	Electrons	Neutrons	Mass number
P	17	**17**	**17**	18	**35**
Q	**14**	**14**	14	14	**28**
R	**9**	9	**9**	**10**	19

6. An element X is represented as $^{27}_{13}X$.

Calculate: 1. The atomic number.

2. The mass number.

3. The number of protons and electrons in a neutral atom.

4. The number of neutrons.

Ans: Given Z = 13 and A = 27

1. Atomic number (Z) = 13.
2. Mass number (A) = 27.
3. Number of protons = 13 and number of electrons = 13.
4. Number of neutrons (N) = A - Z = 27 - 13 =14

8 Marks Questions

1. Write the generalizations made by Rutherford with the Alpha Particle Scattering Experiment on gold foil.

Ans:

1. **Most of the space inside an atom is empty**, because most of the alpha particles passed through the gold foil without getting deflected.
2. **The positive charge of an atom occupies very little space**, because very few alpha particles were deflected from their paths.

3. **All the positive charge and mass of an atom are concentrated in a very small volume** within the atom, because a very small fraction of alpha particles were deflected through an angle of 180°.
4. Rutherford calculated that the radius of the nucleus is about 10^5 times smaller than the radius of the atom.

On the basis of these observations, Rutherford proposed the **nuclear model of an atom**:

1. There is a positively charged centre in an atom called the **nucleus**. Nearly all the mass of an atom resides in the nucleus.
2. The electrons revolve around the nucleus in circular paths.
3. The size of the nucleus is very small compared with the size of the atom.

2. State the important postulates of Bohr's Model of Atom.

Ans: Niels Bohr proposed the following postulates:

1. Only certain special orbits, known as discrete orbits of electrons, are allowed inside the atom.
2. While revolving in discrete orbits, electrons do not radiate energy.
3. These orbits or shells are called energy levels.
4. These orbits or shells are represented by the letters K,L,M,N, …or the numbers n = 1,2,3,4,…

3. Compare Bohr's atomic model, Rutherford's atomic model and Thomson's atomic model.

Ans:

Feature	Thomson's Atomic Model	Rutherford's Atomic Model	Bohr's Atomic Model
1. Structure of the atom	An atom consists of a positively charged sphere with electrons embedded in it.	An atom has a small, positively charged nucleus at its centre.	Electrons revolve around the nucleus in certain permitted orbits.
2. Positive charge	Distributed throughout the sphere.	Concentrated in the nucleus.	Concentrated in the nucleus.
3. Position of electrons	Embedded in the positively charged sphere.	Revolve around the nucleus in circular paths.	Revolve around the nucleus in permitted discrete orbits.
4. Distribution of mass	The model does not describe a central nucleus containing nearly all the mass.	Nearly all the mass is concentrated in the nucleus.	Retains the nuclear structure of Rutherford's model.
5. Space inside the atom	Does not describe the atom as mostly empty space.	Most of the space inside the atom is empty.	Electrons occupy permitted orbits around the nucleus.

4. Explain the rules for the distribution of electrons in different shells.

Ans:

1. The maximum number of electrons in a shell is given by $2n^2$, where *n* is the shell number.
2. The maximum number of electrons in the K shell is 2, in the L shell is 8, in the M shell is 18, and in the N shell is 32.
3. The outermost shell can accommodate a maximum of 8 electrons.
4. Electrons are accommodated in shells step by step; inner shells are filled before electrons are placed in outer shells.

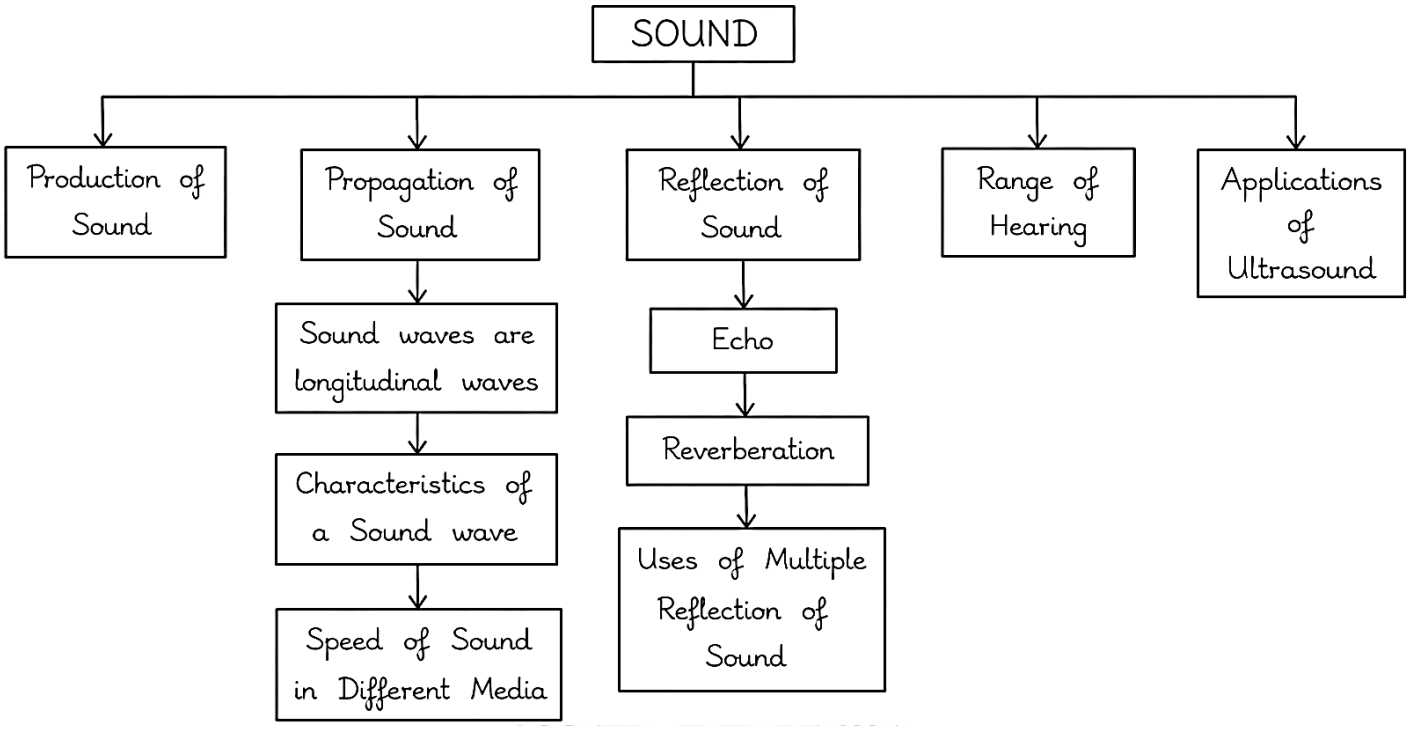
   Example: Carbon: 2, 4

   Sodium: 2, 8, 1

Chapter - 9

SOUND

MIND MAP



Main Points

1. Sound is a form of energy which produces a sensation of hearing in our ears.
2. Sound is produced by vibrating objects.
3. The matter or substance through which sound is transmitted is called a medium.
4. Sound waves are characterised by the motion of particles in the medium and are called mechanical waves.
5. Sound waves are longitudinal waves.
6. When the vibrating object moves forwards, it creates a region of high pressure called compression (C) and When the vibrating object moves backwards, it creates a region of low pressure called rarefaction (R).
7. In longitudinal waves the individual particles of the medium move in a direction parallel to the direction of propagation of the disturbance.
8. In transverse wave the individual particles of the medium move about their mean positions in a direction perpendicular to the direction of wave propagation.
9. Characteristics of a sound wave can be described by Frequency, Amplitude and Speed.
10. The distance between two consecutive compressions or two consecutive rarefactions is called the wavelength.
11. The time taken by the wave for one complete oscillation of the density or pressure of the medium is called the time period. Its SI unit is second.
12. The number of complete oscillations per unit time is called the frequency. Its SI unit is hertz (Hz).
13. The maximum displacement along the mean position of the particles of medium is called the amplitude.
14. Frequency and time period are related as $\upsilon = \frac{1}{T}$
15. How the brain interprets the frequency of an emitted sound is called its pitch.
16. Low pitch sound has low frequency and high pitch of sound has high frequency.
17. Soft sound has small amplitude and louder sound has large amplitude.
18. The loudness or softness of a sound is determined basically by its amplitude.
19. A sound of single frequency is called a tone.
20. The sound which is produced due to a mixture of several frequencies is called a note and is pleasant to listen to.
21. Wave speed = Frequency x Wavelength (or) $v = \upsilon\lambda$
22. The speed of sound depends on the properties of the medium through which it travels. The speed of sound in a medium depends on temperature of the medium.

23. The speed of sound in air is 331 m s^{-1} at 0 ºC
24. Sound waves follows the laws of reflection at the surface of a solid or liquid.
25. The repetition of sound caused by the reflection of sound is called echo. To hear a distinct echo the time interval between the original sound and the reflected one must be at least 0.1s.
26. The persistence of sound in an auditorium is the result of repeated reflections of sound and is called reverberation.
27. Sound properties such as pitch, loudness and quality are determined by the corresponding wave properties.
28. Loudness is a physiological response of the ear to the intensity of sound.
29. The amount of sound energy passing each second through unit area is called the intensity of sound
30. Megaphones, horns, musical instruments, Stethoscope, construction of concert halls, conference halls and cinema halls are the applications of multiple reflection of sound.
31. The audible range of hearing for average human beings is in the frequency range of 20 Hz – 20 kHz.
32. Sound waves with frequencies below the audible range are termed "infrasonic" and those above the audible range are termed "ultrasonic"
33. Ultrasound has many medical (ultrasonography, echocardiography) and industrial (Cleaning parts or areas, odd – shaped) applications.

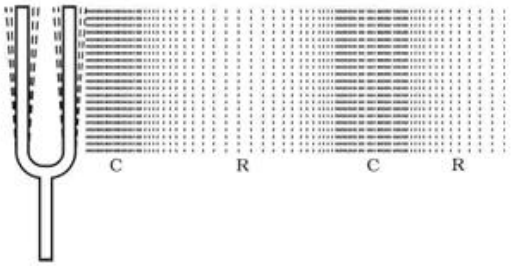
Exercises

1. What is sound and how is it produced?

Ans: Sound is a form of energy. It is produced due to vibration of different objects. When an object vibrates, it produces compression and rarefaction in the medium and sound is produced.

2. Describe with the help of a diagram, how compressions and rarefactions are produced in air near a source of sound.

Ans: When a vibrating object moves forward, it pushes and compresses the air in front of it creating a region of high pressure. This region is called a compression (C). This compression starts to move away from the vibrating object. When the vibrating object moves backwards, it creates a region of low pressure called rarefaction (R). As the object moves back and forth rapidly, a series of compressions and rarefactions is created in the air.



3. Why is sound wave called a longitudinal wave?

Ans: Sound wave is called longitudinal wave because the particles of the medium vibrate in the direction of the propagation of wave.

4. Which characteristic of the sound helps you to identify your friend by his voice while sitting with others in a dark room?

Ans: Quality or timbre.

5. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen, why?

Ans: The speed of sound in air most less than the speed of light in air. Sound of thunder takes more time to reach the Earth as compared to light. Hence, a flash is seen before we hear a thunder.

6. A person has a hearing range from 20 Hz to 20 kHz. What are the typical wavelengths of sound waves in air corresponding to these two frequencies? Take the speed of sound in air as 344 m s^{-1}.

Ans: Frequency, υ_1 = 20 Hz Frequency, υ_2 = 20 kHz = 20000 Hz Speed of sound, v = 344 m s^{-1}

Wavelength, $\lambda_1 = \frac{Speed\ of\ sound}{Frequency(v1)} = \frac{344}{20} = 17.2\ m$

Wavelength, $\lambda_2 = \frac{Speed\ of\ sound}{Frequency(v2)} = \frac{344}{20000} = 0.0172\ m$

7. Two children are at opposite ends of an aluminium rod. One strikes the end of the rod with a stone. Find the ratio of times taken by the sound wave in air and in aluminium to reach the second child.

Ans: Let time taken by the sound in air = t_1 and time taken by the sound in aluminium = t_2

Speed of sound in air (v_1) = 346 m s^{-1}

Speed of sound in aluminium rod (v_2) = 6420 m s^{-1}

We know that $\frac{t1}{t2} = \frac{v2}{v1} = \frac{6420}{346} = \frac{18.55}{1}$

The Ratio = 18.55 : 1

8. The frequency of a source of sound is 100 Hz. How many times does it vibrate in a minute?

Ans: Frequency (υ) = 100 Hz, Time (t) = 1 min = 60 s

Frequency (υ) = $\frac{No.of\ vibrations}{Time\ (t)}$

No.of vibrations = Frequency x time = 100 x 60 = 6000

9. Does sound follow the same laws of reflection as light does? Explain.

Ans: Yes, the sound follows the same laws of reflection.

The incident sound wave and the reflected sound wave make the same angle with the normal to the surface at the point of incidence. Also, the incident sound wave, the reflected sound wave, and the normal to the point of incidence all lie in the same plane.

10. When a sound is reflected from a distant object, an echo is produced. Let the distance between the reflecting surface and the source of sound production remains the same. Do you hear echo sound on a hotter day?

Ans: An echo is heard when the time interval between the reflected sound and the original sound is at least 0.1 seconds.

Speed of sound increases with temperature. Hence, on a hotter day, as speed of sound in air will be more, for same distance, time taken by the reflected sound to reach the ear will be less. Time interval being less than 0.1 seconds, so we might not hear an echo sound on a hotter day.

11. Give two practical applications of reflection of sound waves.

Ans: **Stethoscope**- It is used by doctors to measure heartbeat. Doctor is able to hear sound due to multiple reflection of sound in stethoscope.

Curved ceilings of concert halls- This is to ensure that sound after reflection reaches all parts of hall

12. A stone is dropped from the top of a tower 500 m high into a pond of water at the base of the tower. When is the splash heard at the top? Given, g = 10 m s^{-2} and speed of sound = 340 m s^{-1}.

Ans: Distance(s) = 500 m, Initial velocity (u) = 0 m/s speed of sound (v) = 340 m s^{-1}, g = 10 m s^{-2}

From second law of motion, $s = ut + \frac{1}{2} at^2$

$500 = 0 \times t + \frac{1}{2} \times 10 \times t^2$

$500 = \frac{1}{2} \times 10 \times t^2$

$t = 10$ s

Thus in 10 seconds the stone reaches the pond.

Time taken by sound = $\frac{Distance}{Speed\ of\ sound} = \frac{500}{340} = 1.47\ s$

Total time taken by the flash heard at the top = 10 + 1.47 = 11.47 s

13. A sound wave travels at a speed of 339 m s^{-1}. If its wavelength is 1.5 cm, what is the frequency of the wave? Will it be audible?

Ans: v = 339 m s^{-1} λ = 1.5 cm = 0.015 m

Frequency (υ) = $\frac{speed\ of\ the\ wave\ (V)}{Wave\ length\ (\lambda)} = \frac{339}{0.015} = 22600$ Hz

It is not audible.

14. What is reverberation? How can it be reduced?

Ans: The persistence of sound in an auditorium is the result of repeated reflections of sound and is called reverberation. To reduce reverberation, the roof and walls of the auditorium are generally covered with sound-absorbent materials like compressed fibreboard, rough plaster or draperies.

15. What is loudness of sound? What factors does it depend on?

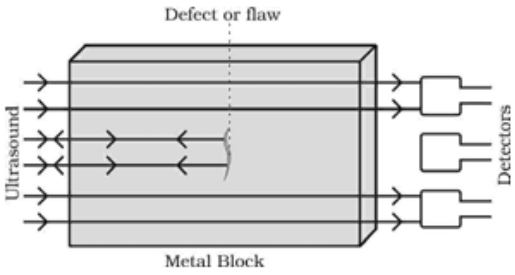
Ans: Loudness is a physiological response of the ear to the intensity of sound. Loudness depends on the amplitude

16. How is ultrasound used for cleaning?

Ans: Objects to be cleaned are placed in a cleaning solution and ultrasonic waves are sent into the solution. Due to the high frequency, the particles of dust, grease and dirt get detached and drop out. The objects thus get thoroughly cleaned.

17. Explain how defects in a metal block can be detected using ultrasound.

Ans: Ultrasonic waves are allowed to pass through the metal block and detectors are used to detect the transmitted waves. If there is even a small defect, the ultrasound gets reflected back indicating the presence of the flaw or defect.



18. STATEMENT-A: Elephants communicating using sounds that humans cannot hear.
STATEMENT-B: A doctor uses sound waves to scan a patient's internal organs.
Identify the correct type of sound used in these two situations.
A) Elephants – Ultrasonic; Hospital scan – Infrasonic
B) Elephants – Infrasonic; Hospital scan – Ultrasonic
C) Elephants – Audible; Hospital scan – Ultrasonic
D) Elephants – Infrasonic; Hospital scan – Audible
Ans: B) Elephants – Infrasonic; Hospital scan – Ultrasonic

19. A heavy machine in a factory vibrates at a frequency of 15 Hz. Workers standing nearby say that no sound is produced because they cannot hear anything.
Which of the following statements is scientifically correct?
A) No sound is produced because frequencies below 20 Hz cannot travel through air.
B) Sound is produced, but it is infrasonic and cannot be heard by humans.
C) Sound is not produced because slow vibrations do not generate sound waves.
D) Sound is produced only when vibrations are fast enough to be audible to humans.
Ans: B) Sound is produced, but it is infrasonic and cannot be heard by humans.

In Textbook Questions

1. How does the sound produced by a vibrating object in a medium reach your ear? (Page No:82)
Ans: When an object vibrates, it sets the particles of the medium around it vibrating. A particle of the medium in contact with the vibrating object is first displaced from its equilibrium position. It then exerts a force on the adjacent particle. As a result of which the adjacent particle gets displaced from its position of rest. After displacing the adjacent particle, the first particle comes back to its original position. This process continues in the medium till the sound reaches your ear.

2. Explain how sound is produced by your school bell.
Ans: When the school bell is hit by hummer, it begins to vibrate. The vibrating bell produces compression and rarefaction in the medium and sound is produced.

3. Why are sound waves called mechanical waves?
Ans: Sound waves are called mechanical waves because they require a material medium for propagation. They propagate by causing particles in the medium to oscillate, transmitting energy through mechanical vibrations.

4. Suppose you and your friend are on the moon. Will you be able to hear any sound produced by your friend?
Ans: No, I will not be able to hear sound. Because moon has no atmosphere and sound waves are mechanical waves.

1. Which wave property determines (a) loudness, (b) pitch? (Page No:88)
Ans: (a) The amplitude of the determines the loudness.
(b) The pitch is determining by the frequency of the wave.

2. Guess which sound has a higher pitch: guitar or car horn?
Ans: Car horn has a higher pitch than a guitar.

1. What are wavelength, frequency, time period and amplitude of a sound wave? (Page No:88)
Ans: Wavelength(λ): The distance between two consecutive compressions or two consecutive rarefactions is called the wavelength.
Time period(T): The time taken by the wave for one complete oscillation of the density or pressure of the medium is called the time period.
Frequency(υ): The number of complete oscillations per unit time is called the frequency.
Amplitude(A): The maximum displacement along the mean position of the particles of medium is called the amplitude.

2. How are the wavelength and frequency of a sound wave related to its speed?

Ans: Wave speed = Frequency x Wavelength (or) v = υλ

3. Calculate the wavelength of a sound wave whose frequency is 220 Hz and speed is 440 m/s in a given medium.

Ans: Frequency (ν) = 220 Hz, Speed (v) = 440 m/s

Wavelength (λ) = $\frac{Wave\ speed}{Frequency} = \frac{440}{220} = 2\ m$

4. A person is listening to a tone of 500 Hz sitting at a distance of 450 m from the source of the sound. What is the time interval between successive compressions from the source?

Ans: Frequency (ν) = 500 Hz

The time interval between successive compressions (Time period), T = $\frac{1}{v} = \frac{1}{500} = 0.002\ s$

1. Distinguish between loudness and intensity of sound. (Page No:90)

Ans: Loudness of sound is determined of amplitude and intensity of the sound wave is determined by frequency of sound waves.

1. In which of the three media, air, water or iron, does sound travel the fastest at a particular temperature? (Page No:90)

Ans: At particular temperature sound travels fastest in iron.

1. An echo is heard in 3 s. What is the distance of the reflecting surface from the source, given that the speed of sound is 342 m s^{-1}? (Page No:92)

Ans: Speed of sound (v) = 342 ms^{-1}

Time taken for hearing the echo (t) = 3 s

Distance travelled by sound = $\frac{v\ x\ t}{2} = \frac{342\ x\ 3}{2} = \frac{1026}{2}$ = 513 m

1. Why are the ceilings of concert halls curved? (Page No:94)

Ans: The ceilings of concert halls are curved so that sound after reflection reaches all corners of the hall.

1. What is the audible range of the average human ear? (Page No:96)

Ans: The audible range of the average human ear from 20 Hz to 20,000 Hz.

2. What is the range of frequencies associated with (a) Infrasound? (b) Ultrasound?

Ans: (a) Frequency sound less than 20 Hz.

(a) Frequency sound greater than 20 Hz.

Activities

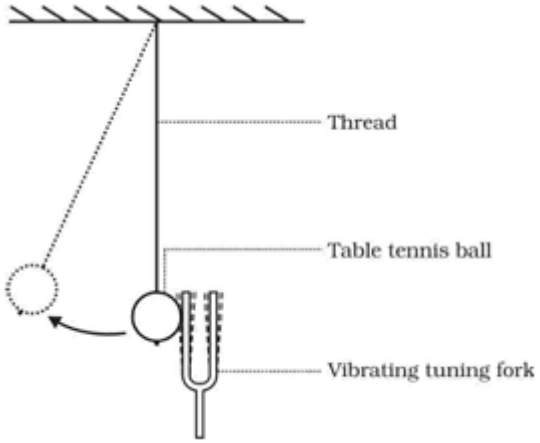
1. Explain with help of an activity which shows that the vibrating body produces sound.

Aim:

Materials required: Tuning fork, Table tennis ball, Thread.

Procedure:

1. Take a tuning fork and set it vibrating by striking its prong on a rubber pad. Bring it near your ear.
2. Touch one of the prongs of the vibrating tuning fork with your finger and share your experience with your friends.
3. Touch one of the prongs of the vibrating tuning fork with your finger and share your experience with your friends.
4. Now, suspend a table tennis ball or a small plastic ball by a thread from a support [Take a big needle and a thread, put a knot at one end of the thread, and then with the help of the needle pass the thread through the ball].
5. Touch the ball gently with the prong of a vibrating tuning fork.
6. When the prong of the tuning fork is struck against a rubber pad, the tuning fork starts vibrating and produces sound.



Observation/Conclusion: Vibrating body produces sound.

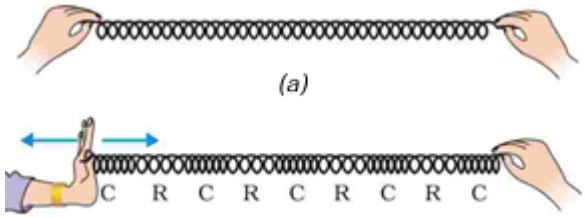
2. Explain with help of an activity shows which that the sound waves are longitudinal waves.

Aim: To shows that sound waves are longitudinal waves.

Materials required: Slinky

Procedure:

1. Take a slinky.
2. Ask your friend to hold one end. You hold the other end.
3. Now stretch the slinky as shown in Figure (a).
4. Then give it a sharp push towards your friend.
5. What do you notice?
6. If you move your hand pushing and pulling the slinky alternatively, what will you observe?
7. If you mark a dot on the slinky, you will observe that the dot on the slinky will move back and forth parallel to the direction of the propagation of the disturbance.



Observation/Conclusion: 1. The regions where the coils become closer are called compressions (C) and the regions where the coils are further apart are called rarefactions (R).
2. Sound propagates in the medium as a series of compressions and rarefactions.

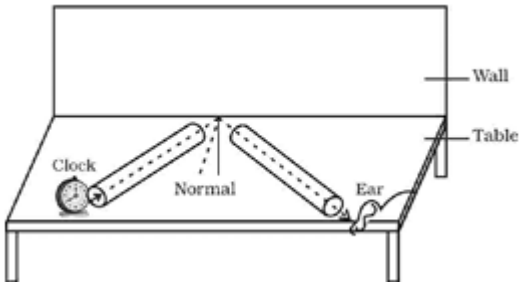
3. Explain with help of an activity on reflection of sound.

Aim: To study the laws of reflection of sound.

Materials required: Two identical tubes, Chart paper, Clock

Procedure:

1. Take two identical pipes, as shown in figure. You can make the pipes using chart paper. The length of the pipes should be sufficiently long as shown.
2. Arrange them on a table near a wall.
3. Keep a clock near the open end of one of the pipes and try to hear the sound of the clock through the other pipe.
4. Adjust the position of the pipes so that you can best hear the sound of the clock.
5. Now, measure the angles of incidence and reflection and see the relationship between the angles.
6. Lift the pipe on the right vertically to a small height. (In place of a clock, a mobile phone on vibrating mode may also be used.)



Observation/Conclusion: Sound waves are following the laws of reflection.

Multiple Choice Questions

1. Which of the following is a longitudinal wave?
a) Water wave b) Light wave
c) Sound wave d) Radio wave
Ans: c) Sound wave

2. The frequency of a sound wave determines its:
a) Loudness b) Speed c) Wavelength d) Pitch
Ans: d) Pitch

3. The speed of sound is maximum in:
a) Air b) Water c) Steel d) Vacuum
Ans: c) Steel

4. Which part of the ear amplifies sound vibrations?
a) Cochlea b) Eardrum c) Ear canal d) Ear ossicles
Ans: d) Ear ossicles

5. The phenomenon of persistence of sound after the source has stopped is called:
a) Reverberation b) Echo c) Resonance d) Reflection
Ans: a) Reverberation

6.The minimum distance from a sound-reflecting surface required to hear an echo is:
a) 10 meters b) 17 meters c) 20 meters d) 34 meters
Ans: b) 17 meters

7. The SI unit of sound intensity is:
a) Decibel b) Hertz
c) Pascal d) Watt per square meter
Ans: d) Watt per square meter

8. Sound cannot travel through:
a) Solids b) Liquids c) Gases d) Vacuum
Ans: d) Vacuum

9. Which of the following animals does not use echolocation?
a) Bat b) Dolphin c) Whale d) Ostrich
Ans: d) Ostrich

10. The phenomenon of bending of sound waves around obstacles is called:
a) Refraction b) Diffraction
c) Interference d) Polarization
Ans: b) Diffraction

11. A sound wave with a frequency of 2000 Hz and a wavelength of 0.35 meters, what is the speed of the sound wave?
a) 700 m/s b) 70 m/s c) 7 m/s d) 0.7 m/s
Ans: a) 700 m/s.

12. At 0°C, the speed of sound in air is –
a) 330 m/s b) 331 m/s c) 334 m/s d) 344 m/s
Ans: b) 331 m/s

13. At 22°C, the speed of sound in air is
a) 330 m/s b) 331 m/s c) 334 m/s d) 344 m/s
Ans: d) 344 m/s

14. At 25°C, the speed of sound in water is –
a) 4700 m/s b) 3980 m/s c) 1531 m/s d) 1498 m/s
Ans: c) 1531 m/s

15. The sensation of sound persists in our brain for about-
a) 0.1 second b) 0.2 second
c) 0.3 second d) 0.4 second
Ans: a) 0.1 second.

16. The minimum distance for hearing distinct echoes from the source is –
a) 17.0 m b) 17.2 m c) 17.3 m d) 17.4 m
Ans: b) 17.2 m.

17. The audible range of sound for human beings extends from about
a) 10Hz to 2000Hz b) 20Hz to 20000Hz
c) 10Hz to 2000Hz d) 20Hz to 2000Hz
Ans: (b) 20Hz to 20000Hz

18. Which of the following is correct?
a) 1Hz=4cycle/s b) 1Hz=3cycles
c) 1Hz=2cycle/s d) 1Hz=1cycle/s
Ans: d) 1Hz=1cycle/s.

19. Which of the following animals can hear a sound of the frequency up to 25000Hz?
a) above 18 years old man
b) above 14 years old
c) above the age of 7 years old children
d) under the age of 5 years children
Ans: d) under the age of 5 years children.

20. Rhinoceroses communicate using infrasound of frequency as low as –
a) 7Hz b) 6Hz c) 5Hz d) 4Hz
Ans: c) 5Hz.

21. Which wave property determines loudness?
a) pitch b) frequency c) amplitude d) All of these
Ans: c) amplitude

22. Infrasonic waves have frequencies
a) below 20 Hz b) between 20 Hz and 20,000 Hz
c) above 20,000 Hz
d) no upper or lower limit of frequencies
Ans: a) below 20 Hz

23. The maximum displacement of the particle of the mean from its mean position is called the
a) Amplitude b) wavelength
c) wave number d) Time period
Ans: a) Amplitude

24. Wave motion transfers
a) momentum b) velocity c) energy d) mass
Ans: c) energy

25. The distance between a consecutive crest and trough is x. The wavelength of the wave is
a) 4x b) x c) x/2 d) 2x
Ans: d) 2x

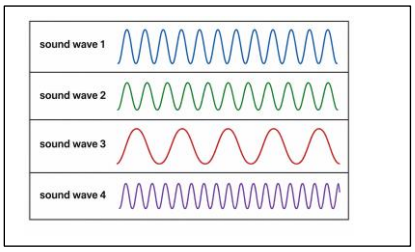
Competency - Based Questions

Multiple Choice Questions

1. A patient is undergoing an ultrasound scan. The machine produces vibrations at 15 Hz.
What will the patient experience while standing near the machine?
A) He will hear a loud sound of machine. B) He will not hear the sound of machine.
C) He will hear a high-pitched sound of machine. D) He will hear a musical sound of machine.

Ans:

2. The picture shows four sound waves. Which sound wave has the highest frequency?
A) Sound wave 1
B) Sound wave 2
C) Sound wave 3
D) Sound wave 4



Ans: D) Sound wave 4

3. Which of these is the frequency of an infrasound?
A) 10 Hz B) 75 Hz C) 15000 Hz D) 35000 Hz

Ans: A) 10 Hz

4. Which of these depends on the intensity of a sound?
A) Speed of the sound B) Loudness of the sound C) Frequency of the sound D) All of these

Ans: B) Loudness of the sound

5. What is likely to cause loss of hearing when a pointed object is inserted into the ear?
A) Cut in the ear canal B) Puncture in the pinna C) Rupture of the eardrum D) Rupture of the auditory nerve

Ans: C) Rupture of the eardrum

6. In which of these conditions will an echo be heard?
A) A man playing drums on a beach. B) A man reciting poems in a small room.
C) A man shouting from the middle of an open farm. D) A man shouting from a place that is surrounded by hills.

Ans: D) A man shouting from a place that is surrounded by hills.

2 Marks Questions

1. Flash and thunder are produced simultaneously. But thunder is heard a few seconds after the flash is seen. Why?
Ans: Light travels much faster than sound. Therefore the flash of lightning reaches our eyes before the sound of thunder reaches our ears.

2. State the laws of reflection of sound.
Ans: a) Angle of incidence equals angle of reflection.
b) Incident sound, reflected sound and normal lie in the same plane.

3. Why can astronauts not hear each other directly on the Moon even when they are standing close to one another?
Ans: Sound requires a material medium for propagation. Since the Moon has no atmosphere (vacuum), sound cannot travel. Therefore astronauts communicate using radio devices.

4. A student strikes a tuning fork and immediately touches it with his finger. The sound stops. Why?
Ans: Sound is produced by vibrations. When the tuning fork is touched, its vibrations stop due to damping, so sound production also stops.

5. Why does a bat fly safely in complete darkness without hitting obstacles?
Ans: Bats produce ultrasonic sounds and receive the reflected waves (echoes). From these echoes they detect the position of obstacles and fly safely.

6. Why is a train whistle heard from a long distance while normal conversation is not?
Ans: A train whistle produces sound with greater amplitude and energy. Therefore it is louder and can travel longer distances than ordinary conversation.

7. Why are the ceilings of auditoriums and conference halls curved?
Ans: Curved ceilings reflect sound uniformly to all parts of the hall, ensuring that every listener can hear clearly.

8. A loudspeaker and a tuning fork produce sounds of the same frequency. Will they have the same loudness? Why?
Ans: No. Loudness depends on amplitude, not frequency. If their amplitudes differ, their loudness will also differ.

9. Why does a child generally hear higher-frequency sounds better than an elderly person?
Ans: As people grow older, their ears become less sensitive to high-frequency sounds. Children can hear a wider range of frequencies.
10. Why does shouting in an empty hall produce a prolonged sound?
Ans: Sound undergoes repeated reflections from the walls, roof and floor. This persistence of sound is called reverberation.
11. Why are soft materials used on the walls of auditoriums?
Ans: Soft materials absorb sound and reduce repeated reflections, thereby reducing reverberation.
12. Two sounds have the same loudness but different pitches. What can you conclude?
Ans: Their amplitudes are the same, but their frequencies are different. The sound with higher frequency has higher pitch.
13. Why is ultrasound used to detect cracks inside metal blocks?
Ans: Ultrasonic waves are reflected by cracks and defects inside metals. The reflected waves help locate the defects accurately.
14. Why does an echo not occur in a small classroom?
Ans: The reflecting surfaces are too close, so the reflected sound returns in less than 0.1 second and merges with the original sound.
15. A sound wave enters water from air. What happens to its speed?
Ans: Its speed increases because sound travels faster in liquids than in gases.

4 Marks Questions

1. Why are sound waves called mechanical waves?
Ans: a) Sound requires a material medium for propagation.
b) Sound travels through solids, liquids and gases.
c) It cannot travel through vacuum.
d) Therefore sound waves are called mechanical waves.
2. Distinguish between loudness and pitch.
Ans:

Loudness	Pitch
Depends on amplitude	Depends on frequency
Large amplitude → Loud sound	High frequency → High pitch
Measured in decibel	Indicates shrillness of sound
Related to energy of sound	Related to frequency of vibration

3. State the characteristics of a sound wave.
Ans: 1. Amplitude 2. Frequency 3. Speed 4. Wavelength 5. Time Period
4. Mention any four applications of ultrasound.
Ans: 1. Detecting cracks in metal blocks. 2. Medical imaging (Ultrasonography).
2. Echocardiography. 3. Breaking kidney stones.
5. Cleaning hard-to-reach machine parts.
5. A student hears the original sound and its reflection separately. State the conditions required to hear a distinct echo.
Ans: 1. Sound must strike a suitable reflecting surface, such as a tall building or mountain.
2. The reflected sound must return to the listener after a time interval of at least 0.1 s.
3. At a sound speed of 344 m/s, the sound travels a total distance of:
$d = v\,t = 344 \times 0.1 = 34.4$
4. Since the sound travels to the reflecting surface and back, the minimum distance between the source and the reflecting surface is:
$d = 34.4/2 = 17.2$ m
This value applies at the stated temperature and sound speed.

8 Marks Questions

1. Explain propagation of sound through a medium.
Ans: 1. Sound is produced by vibrating objects.
2. Vibrating objects create compressions and rarefactions in the medium.
3. Energy is transferred from one particle to another.

4. Particles only oscillate about their mean positions.
5. Sound travels as a longitudinal wave.
6. Sound requires a material medium and cannot travel in vacuum.
7. The disturbance travels through the medium carrying sound energy.
8. Thus sound reaches the listener's ear.

2. Explain reflection of sound and its applications.

Ans: Reflection of sound is the bouncing back of sound waves after striking a surface.

Applications:

1. Megaphones and horns direct sound in one direction.
2. Stethoscope helps doctors hear internal body sounds.
3. Curved ceilings in auditoriums distribute sound uniformly.
4. Sound boards behind stages improve sound distribution.

3. Explain echo and conditions required to hear an echo.

Ans: 1. Echo is the repetition of sound due to reflection.
2. The reflected sound must be heard separately from the original sound.
3. The time gap between original sound and reflected sound should be at least 0.1 s.
4. At 22°C, speed of sound is about 344 m/s.
5. The reflecting surface should be sufficiently far away.
6. Minimum distance of obstacle from source should be about 17.2 m.
7. Echoes are commonly heard near hills, buildings and valleys.
8. Rolling thunder is due to multiple reflections.

4. Explain the human audible range and classify sounds according to frequency.

Ans: The audible range of sound for human beings from 20 Hz to 20,000 Hz (20 kHz)**.**

Classification of sounds

1. Infrasonic sound

Frequency is below 20 Hz.

Example: Elephants and whales produce sounds in the infrasonic range.

2. Audible sound

Frequency is approximately 20 Hz to 20,000 Hz.

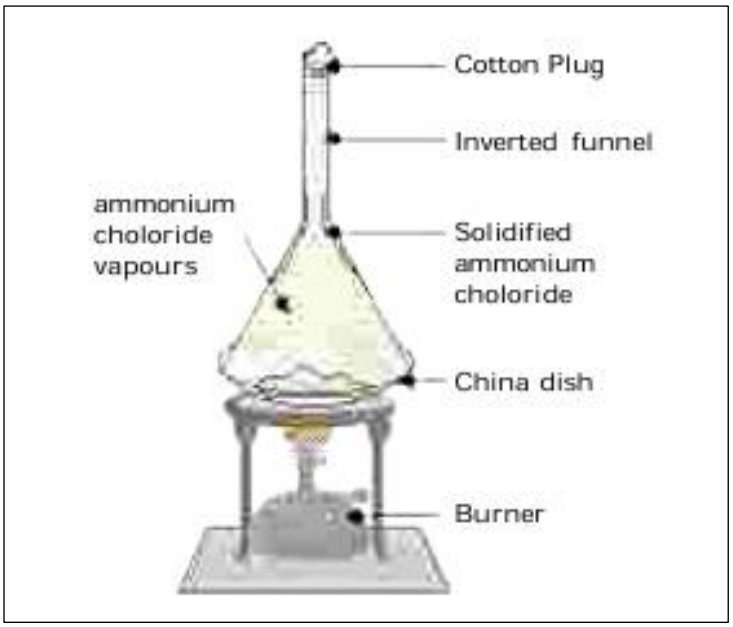
These sounds can normally be heard by human beings.

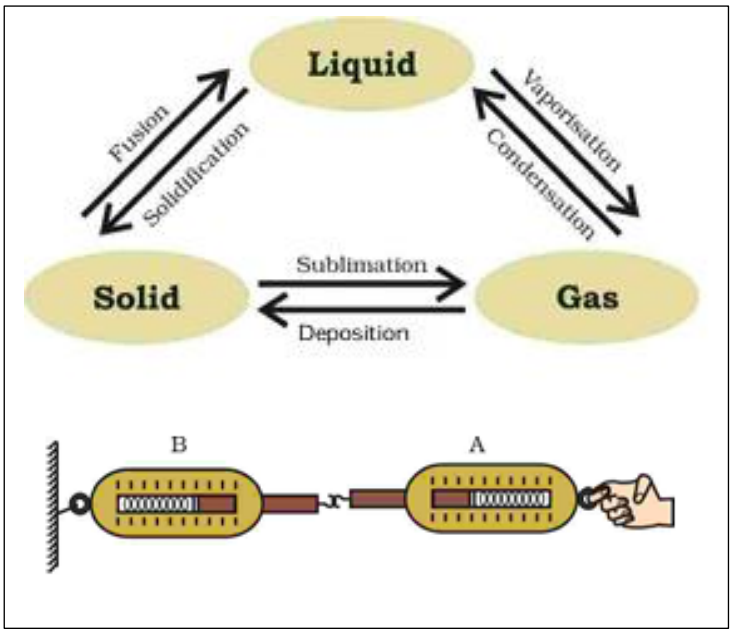
3. Ultrasonic sound

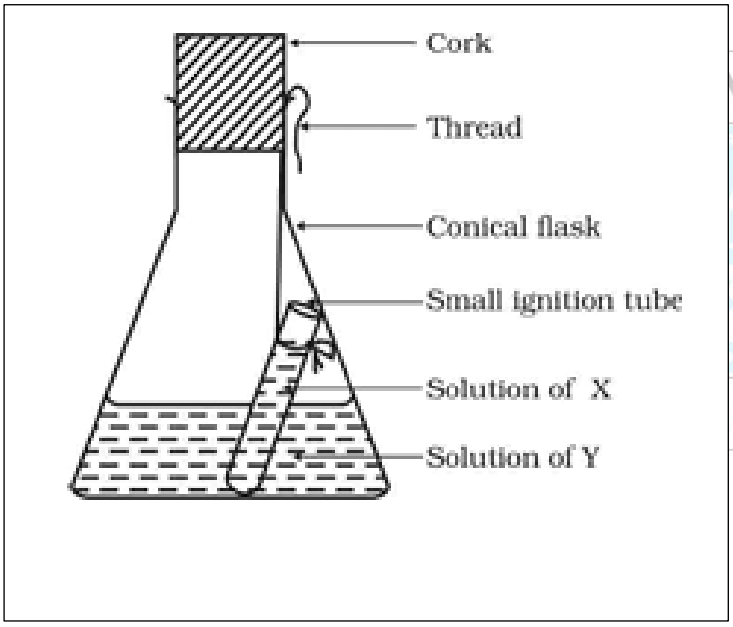
Frequency is above 20,000 Hz.

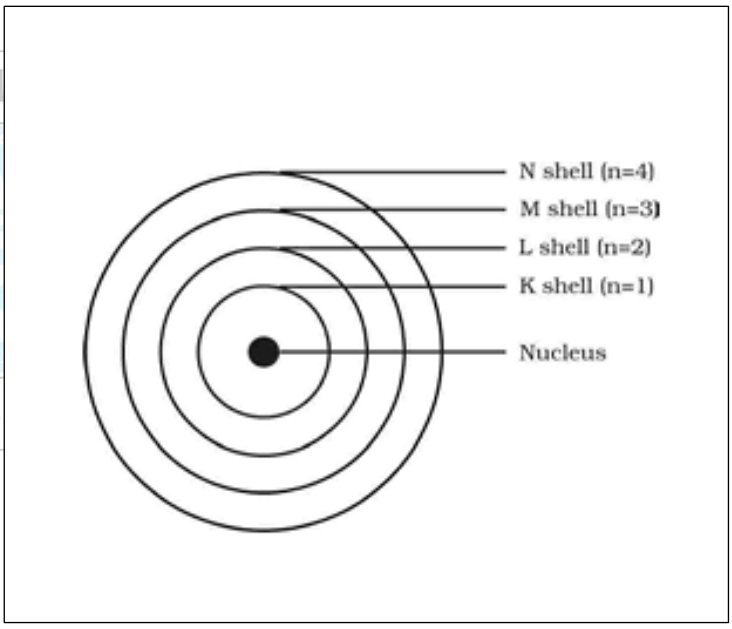
Example: Bats, dolphins and porpoises produce ultrasound.

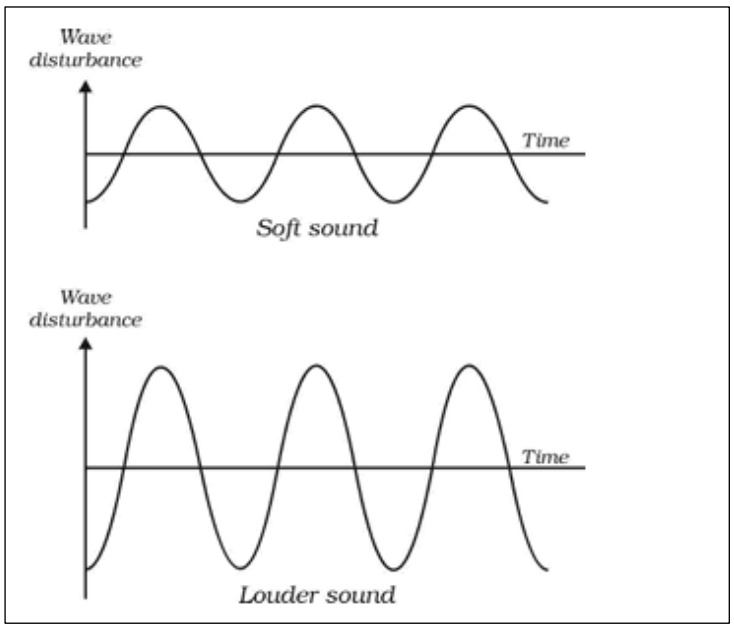
Important Diagrams

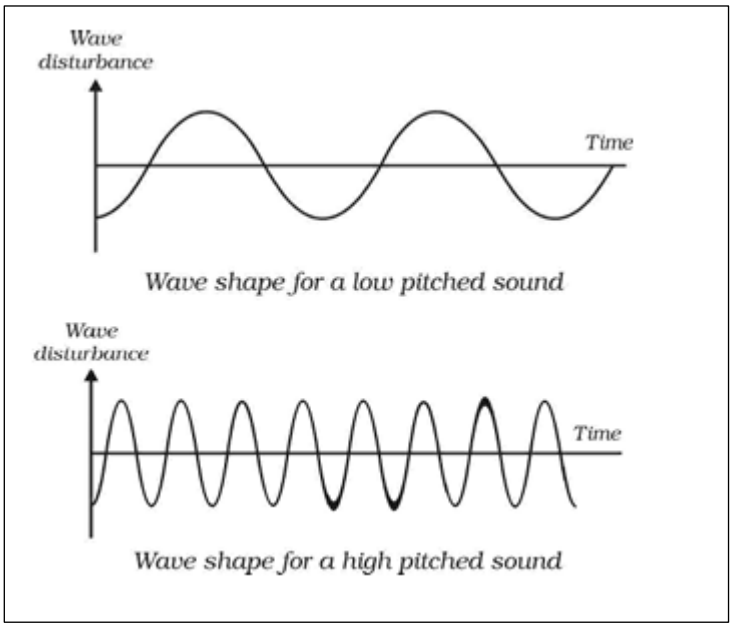




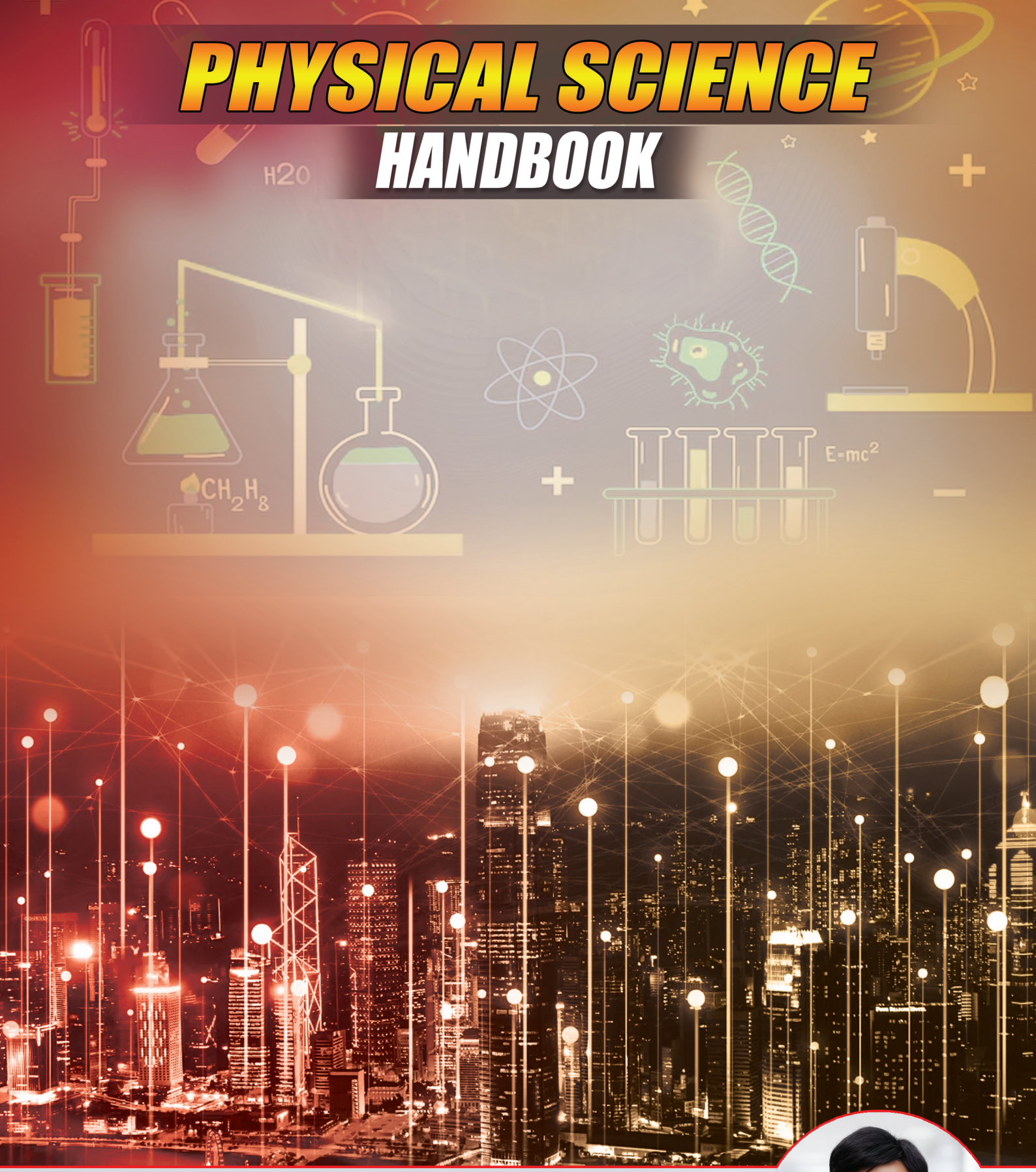








PHYSICAL SCIENCE
HANDBOOK



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