MATH LOVE INSTITUTE

Education as a Service (EaaS)

SAMPLE PAPER - SET 3

SESSION: 2025-26

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Class	IX	Subject	Science (086)
Time Allowed	3 Hours	Maximum Marks	80
Date	_____	Student Name	_____

GENERAL INSTRUCTIONS:

1. This question paper consists of **39 questions** in **5 sections**.
2. **All questions are compulsory.** However, an internal choice is provided in some questions. A student is expected to attempt only one of these questions.
3. **Section A** consists of 20 Objective Type questions carrying **1 mark each**.
4. **Section B** consists of 6 Very Short Answer questions carrying **2 marks each**. Answers to these questions should be in the range of 30 to 50 words.
5. **Section C** consists of 7 Short Answer type questions carrying **3 marks each**. Answers to these questions should be in the range of 50 to 80 words.
6. **Section D** consists of 3 Long Answer type questions carrying **5 marks each**. Answers to these questions should be in the range of 80 to 120 words.
7. **Section E** consists of 3 source-based/case-based units of assessment of **4 marks each** with sub-parts.

SECTION A (20 × 1 = 20 Marks)

Q1. Which of the following has maximum kinetic energy at a given temperature? [1]

(a) Molecules in solid state

(b) Molecules in liquid state

(c) Molecules in gaseous state

(d) All have equal kinetic energy

Q2. The atomicity of ozone (O_3) is: [1]

(a) Monoatomic

(b) Diatomic

(c) Triatomic

(d) Polyatomic

Q3. The maximum number of electrons that can be accommodated in the L shell is: [1]

(a) 2

(b) 8

(c) 18

(d) 32

Q4. Which organelle is known as the "powerhouse of the cell"? [1]

(a) Chloroplast

(b) Mitochondria

(c) Ribosome

(d) Golgi apparatus

Q5. Xylem and phloem are components of: [1]

(a) Epithelial tissue

(b) Connective tissue

(c) Vascular tissue

(d) Meristematic tissue

Q6. If a car travels 100 m in 5 seconds, what is its speed? **[1]**

(a) 10 m/s

(b) 15 m/s

(c) 20 m/s

(d) 25 m/s

Q7. Newton's third law of motion states that: **[1]**

(a) Force equals mass times acceleration

(b) An object at rest stays at rest

(c) For every action, there is an equal and opposite reaction

(d) Momentum is conserved

Q8. The SI unit of gravitational constant G is: **[1]**

(a) $N\ m^2\ kg^{-2}$

(b) $N\ m\ kg^{-1}$

(c) $kg\ m^{-2}\ s^{-2}$

(d) $m^3\ kg^{-1}\ s^{-2}$

Q9. Work done is said to be zero when the angle between force and displacement is: **[1]**

(a) 0°

(b) 45°

(c) 90°

(d) 180°

Q10. The frequency of sound waves is measured in: **[1]**

(a) Hertz

(b) Decibel

(c) Meter per second

(d) Watt

Q11. Which of the following represents a homogeneous mixture? **[1]**

(a) Oil in water

(b) Salt solution

(c) Sand in water

(d) Muddy water

Q12. The process of converting solid directly into gas is called: **[1]**

(a) Evaporation

(b) Condensation

(c) Sublimation

(d) Freezing

Q13. The valency of carbon in methane (CH_4) is: **[1]**

(a) 1

(b) 2

(c) 3

(d) 4

Q14. Lysosomes are also known as: **[1]**

(a) Protein factories

(b) Suicide bags

(c) Power houses

(d) Storage sacs

Q15. Cork cells are dead because they lack: **[1]**

(a) Nucleus

(b) Cytoplasm

(c) Cell wall

(d) Both (a) and (b)

Q16. ASSERTION-REASON TYPE QUESTIONS **[1]**

Assertion (A): The velocity-time graph of a uniformly accelerated motion is a straight line.

Reason (R): In uniformly accelerated motion, velocity changes by equal amounts in equal intervals of time.

(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

Q17. ASSERTION-REASON TYPE QUESTIONS **[1]**

Assertion (A): The value of g is zero at the center of the earth.

Reason (R): The mass of the earth is concentrated at its center.

(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

Q18. ASSERTION-REASON TYPE QUESTIONS **[1]**

Assertion (A): Plasma membrane is selectively permeable.

Reason (R): Plasma membrane allows only certain substances to pass through it.

(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

Q19. ASSERTION-REASON TYPE QUESTIONS **[1]**

Assertion (A): Atoms and molecules are electrically neutral.

Reason (R): Atoms contain equal number of protons and electrons.

(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

Q20. ASSERTION-REASON TYPE QUESTIONS **[1]**

Assertion (A): Sound cannot travel through vacuum.

Reason (R): Sound waves require a material medium for propagation.

(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

SECTION B (6 × 2 = 12 Marks)

Q21. Define: (a) Tyndall effect (b) Colligative properties **[2]**

Q22. An atom has electronic configuration 2, 8, 7. State its (a) atomic number and (b) valency. To which group and period of the periodic table does it belong? **[2]**

Q23. Differentiate between diffusion in liquids and gases based on rate of diffusion. **[2]**

Q24. What is plasmolysis? Under what conditions does it occur? **[2]**

Q25. A body is moving with a velocity of 15 m/s. If the motion is uniform, what will be the velocity after 10 seconds? **[2]**

Q26. State Newton's second law of motion and express it mathematically. **[2]**

SECTION C (7 × 3 = 21 Marks)

Q27. (a) Why is the cover of manhole made of iron and not of wood? **[3]**

(b) A gas completely fills the vessel in which it is kept. Why?

(c) Can matter change its state? If yes, name the processes involved.

Q28. How would you separate a mixture of: **[3]**

(a) Salt and camphor

(b) Alcohol and water

(c) Iodine from a mixture of iodine and sand

Q29. Calculate the mass of 0.5 mole of each of the following: **[3]**

(a) Oxygen atoms (O)

(b) Oxygen molecules (O_2)

(c) Ozone molecules (O_3)

[Given: Atomic mass of oxygen = 16 u]

Q30. OR **[3]**

(a) State Avogadro's law.

(b) One mole of any substance contains 6.022×10^{23} particles. What is this number known as?

(c) Calculate the number of molecules present in 4.4 g of carbon dioxide (CO_2).

[Given: Atomic mass C = 12 u, O = 16 u]

Q31. (a) State Thomson's model of atom. **[3]**

(b) What are the limitations of Thomson's model?

(c) Name the experiment which led to the discovery of nucleus.

Q32. OR **[3]**

(a) What are valence electrons?

(b) Write the electronic configuration of calcium (atomic number = 20).

(c) How many valence electrons are present in calcium?

Q33. (a) Define endocytosis and exocytosis. **[3]**

(b) Which cell organelle is involved in exocytosis?

(c) Give one example of endocytosis.

Q34. A bus starting from rest moves with a uniform acceleration of 0.1 m/s^2 for 2 minutes. Find: **[3]**

(a) The speed acquired

(b) The distance travelled in this time

Q35. OR **[3]**

The velocity-time graph of a body is given below. Calculate:

(a) The acceleration from 0 to 5 s

(b) The retardation from 5 to 7 s

(c) The distance travelled in 7 seconds

[Graph shows: velocity increases uniformly from 0 to 10 m/s in 5 s, then decreases uniformly to 0 m/s in next 2 s]

SECTION D (3 × 5 = 15 Marks)

Q36. (a) State the law of conservation of momentum. **[5]**

(b) Explain how this law can be verified using two colliding balls.

(c) A bullet of mass 20 g is fired from a gun of mass 5 kg with a velocity of 500 m/s. Calculate the recoil velocity of the gun.

OR

(a) What is meant by buoyant force? State the factors on which it depends.

(b) State Archimedes' principle.

(c) A piece of iron weighs 50 N in air and 45 N when completely immersed in water. Calculate:

(i) Loss in weight of iron in water

(ii) Upthrust or buoyant force

(iii) Weight of water displaced

Q37. (a) Define gravitational potential energy. Write its formula. **[5]**

(b) Derive an expression for gravitational potential energy of a body of mass m raised to a height h above the ground.

(c) A ball of mass 0.5 kg is thrown vertically upward with a velocity of 20 m/s. Calculate:

(i) The kinetic energy at the instant of throw

(ii) The potential energy at maximum height

(iii) The maximum height reached (Take $g = 10\ m/s^2$)

OR

(a) Define power and write its SI unit.

(b) Derive the relation between power, force and velocity.

(c) Two persons A and B do the same amount of work in 10 minutes and 15 minutes respectively. Calculate the ratio of power delivered by A to that by B.

Q38. (a) Draw a neat labeled diagram of a plant cell and an animal cell. **[5]**

(b) State three differences between plant cell and animal cell.

(c) What would happen if the plasma membrane ruptures or breaks down?

OR

(a) Draw a well-labeled diagram showing different parts of a neuron.

(b) State three functions of nervous tissue.

(c) Why are neurons called the longest cells in the body?

SECTION E (3 × 4 = 12 Marks)

CASE STUDY 1: STUDY OF UNIFORM CIRCULAR MOTION

Ravi ties a stone to a string and rotates it in a horizontal circle. He observes that when he increases the speed of rotation, the string becomes tighter and the stone tries to fly away from the center. When he releases the string, the stone flies off tangentially. This demonstrates uniform circular motion where the object moves in a circular path with constant speed but continuously changing direction. The centripetal force required for

circular motion is provided by the tension in the string.

(i) What provides the centripetal force when the stone is rotated in a horizontal circle? [1 mark]

(ii) Why does the stone fly off tangentially when the string is released? [1 mark]

OR
What happens to the centripetal force if the speed of rotation is doubled? [1 mark]

(iii) A stone of mass 0.5 kg is tied to a string and rotated in a circle of radius 0.5 m with a speed of 4 m/s. Calculate the centripetal force acting on the stone. [2 marks]

CASE STUDY 2: ISOTOPES AND THEIR APPLICATIONS

Isotopes are atoms of the same element having the same atomic number but different mass numbers. For example, carbon has three isotopes: C-12, C-13, and C-14. Carbon-12 and carbon-13 are stable isotopes, while carbon-14 is radioactive. Isotopes have found numerous applications in various fields. Carbon-14 is used in carbon dating to determine the age of ancient artifacts and fossils. Iodine-131 is used in the treatment of thyroid disorders. Uranium isotopes are used as fuel in nuclear reactors.

(i) What are isotopes? Give one example. [1 mark]

(ii) Name the isotope used in carbon dating. [1 mark]

OR
Why do isotopes of the same element show similar chemical properties? [1 mark]

(iii) Chlorine has two isotopes with mass numbers 35 and 37 in the ratio 3:1. Calculate the average atomic mass of chlorine. [2 marks]

CASE STUDY 3: OSMOSIS IN PLANT CELLS

A biology teacher performed an experiment with raisins. She took two beakers - Beaker A containing plain water and Beaker B containing concentrated sugar solution. She placed dry raisins in both beakers and observed them after 2 hours. The raisins in Beaker A swelled up and became turgid, while the raisins in Beaker B shrank and became flaccid. This happens due to osmosis - the movement of water molecules from a region of higher water concentration to a region of lower water concentration through a semi-permeable membrane. The raisin skin acts as a semi-permeable membrane.

(i) What is osmosis? [1 mark]

(ii) Why did the raisins swell in plain water? [1 mark]

OR

What type of solution is present in Beaker B with respect to the raisin cells? [1 mark]

(iii) Explain what would happen if a plant cell is placed in a hypotonic solution. Draw a diagram to support your answer. [2 marks]

*** END OF QUESTION PAPER ***

Total Marks: 80

All the Best!

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🔑 DETAILED ANSWER KEY 🔑

CBSE CLASS 9 SCIENCE - SAMPLE PAPER 3

Complete Step-by-Step Solutions with Marking Scheme

Prepared by Expert Faculty of Math Love Institute

SECTION A - ANSWERS (20 × 1 = 20 Marks)

OBJECTIVE TYPE QUESTIONS - ANSWERS:

Q.No.	Answer	Q.No.	Answer	Q.No.	Answer	Q.No.	Answer
Q1	(c)	Q6	(c)	Q11	(b)	Q16	(a)
Q2	(c)	Q7	(c)	Q12	(c)	Q17	(c)
Q3	(b)	Q8	(a)	Q13	(d)	Q18	(a)
Q4	(b)	Q9	(c)	Q14	(b)	Q19	(a)
Q5	(c)	Q10	(a)	Q15	(d)	Q20	(a)

DETAILED EXPLANATIONS:

Q1. Answer: (c) Molecules in gaseous state

Explanation: At a given temperature, molecules in the gaseous state have maximum kinetic energy because they move freely and rapidly with negligible intermolecular forces.

Q16-Q20. ASSERTION-REASON EXPLANATIONS:

Q16: (a) - Both statements are true and R correctly explains A

Q17: (c) - A is true but R is false. Mass is distributed throughout Earth

Q18: (a) - Both true and R correctly explains A
Q19: (a) - Both true and R correctly explains A
Q20: (a) - Both true and R correctly explains A

SECTION B - ANSWERS (6 × 2 = 12 Marks)

Q21. Define: (a) Tyndall effect (b) Colligative properties

Marking Scheme: 1 mark each definition

Solution:

(a) Tyndall Effect:
The Tyndall effect is the phenomenon of scattering of light by colloidal particles. When a beam of light passes through a colloid, the path of the beam becomes visible due to scattering of light by the colloidal particles. This effect is used to distinguish between a true solution and a colloidal solution.
Example: Sunlight entering a dark room through a small opening becomes visible due to scattering by dust particles in air.

(b) Colligative Properties:
Colligative properties are those properties of solutions which depend only on the number of solute particles (molecules or ions) present in the solution and not on the nature of the solute particles.
Examples: Lowering of vapor pressure, elevation of boiling point, depression of freezing point, and osmotic pressure.

Q22. An atom has electronic configuration 2, 8, 7. State its (a) atomic number and (b) valency. To which group and period does it belong?

Marking Scheme: ½ mark each for atomic number, valency, group, and period

Solution:

Electronic configuration: 2, 8, 7

(a) Atomic Number: 17
(Sum of electrons in all shells = 2 + 8 + 7 = 17)

(b) Valency: 1
(The outermost shell has 7 electrons, so it needs 1 more electron to complete the octet. Hence valency = 1)

Group: 17 (Group of halogens)
(Number of valence electrons = 7, so it belongs to Group 17)

Period: 3
(Number of shells = 3, so it belongs to Period 3)

Note: This is the electronic configuration of Chlorine (Cl).

Q23. Differentiate between diffusion in liquids and gases based on rate of diffusion.

Marking Scheme: 1 mark for each state with explanation

Solution:

Diffusion in Gases:
• Rate of diffusion is very high and fast
• Gas particles have maximum kinetic energy and move freely
• Intermolecular spaces are very large
• Intermolecular forces are negligible
• Example: When perfume is sprayed in one corner of a room, its smell spreads quickly throughout the room within seconds

Diffusion in Liquids:

• Rate of diffusion is slower compared to gases

• Liquid particles have less kinetic energy than gases

• Intermolecular spaces are smaller than in gases

• Intermolecular forces are stronger than in gases

• Example: When a drop of ink is added to water, it takes several minutes to spread and color the entire water

Conclusion: The rate of diffusion is maximum in gases, less in liquids, and least in solids due to differences in intermolecular spaces and kinetic energy of particles.

Q24. What is plasmolysis? Under what conditions does it occur?

> **Marking Scheme:** 1 mark for definition + 1 mark for conditions

Solution:

Plasmolysis:

Plasmolysis is the process in which a plant cell loses water when placed in a hypertonic solution (solution with higher concentration than the cell sap). Due to exosmosis (outward movement of water), the cell membrane shrinks and detaches from the cell wall. The cell becomes flaccid and the protoplasm contracts away from the cell wall.

Conditions for Plasmolysis:

• Occurs when a plant cell is placed in a hypertonic solution (concentrated salt or sugar solution)

• Water moves out of the cell by osmosis from region of higher water concentration (inside the cell) to region of lower water concentration (outside in the solution)

• The cell membrane shrinks and separates from the rigid cell wall

• The space between cell wall and cell membrane is filled with the external solution

Example: When fresh vegetables are kept in salt solution, they lose water and become flaccid due to plasmolysis.

Q25. A body is moving with a velocity of 15 m/s. If the motion is uniform, what will be the velocity after 10 seconds?

Marking Scheme: 1 mark for answer + 1 mark for explanation

Solution:

Given:
Initial velocity = 15 m/s
Motion is uniform
Time = 10 seconds

Concept:
In uniform motion, the velocity remains constant throughout the motion. There is no acceleration (a = 0).

Answer:
The velocity after 10 seconds will be **15 m/s** (same as initial velocity).

Explanation:
Since the motion is uniform, the body maintains a constant velocity of 15 m/s. The velocity does not change with time in uniform motion. Therefore, after 10 seconds or even after any amount of time, the velocity will remain 15 m/s as long as the motion continues to be uniform.

Q26. State Newton's second law of motion and express it mathematically.

Marking Scheme: 1 mark for statement + 1 mark for mathematical expression

Solution:

Newton's Second Law of Motion:

Statement:
The rate of change of momentum of a body is directly proportional to the applied force and takes place in the direction in which the force acts.

Mathematical Expression:

Force = Rate of change of momentum

$F \propto (mv - mu)/t$
$F \propto m(v - u)/t$
$F \propto ma$

Therefore, **F = kma**

where k is a constant of proportionality.

In SI units, k = 1, so:

F = ma

Where:
F = Force applied (in Newton, N)
m = Mass of the body (in kilogram, kg)
a = Acceleration produced (in m/s^2)

SI Unit of Force: Newton (N) or kg m/s^2

SECTION C - ANSWERS (7 × 3 = 21 Marks)

Q27. (a) Why is manhole cover made of iron? (b) Why gas fills vessel completely? (c) Can matter change state?

> **Marking Scheme:** 1 mark each part

Solution:

(a) Manhole cover made of iron:
The cover of a manhole is made of iron and not of wood because iron has much higher density and weight compared to wood. The heavy iron cover cannot be easily displaced by the pressure of water or sewage flowing below it. Additionally, iron is more durable, does not rot or decay like wood, and can withstand heavy loads of vehicles passing over it. Wood would float if water accumulates and would also decay over time.

(b) Gas fills the vessel completely:
A gas completely fills the vessel in which it is kept because gas particles have very high kinetic energy and negligible intermolecular forces of attraction. The particles move freely and randomly in all directions at high speed. Due to very large intermolecular spaces and weak forces, gas particles spread out to occupy all the available space in the container, taking the shape and volume of the container.

(c) Matter changing its state:
Yes, matter can change its state by changing temperature or pressure.
Processes involved:
• **Melting/Fusion:** Solid to liquid (heating)
• **Freezing/Solidification:** Liquid to solid (cooling)
• **Evaporation/Vaporization:** Liquid to gas (heating)
• **Condensation:** Gas to liquid (cooling)
• **Sublimation:** Solid to gas (heating)
• **Deposition:** Gas to solid (cooling)

Q28. Separate mixtures: (a) Salt and camphor (b) Alcohol and water (c) Iodine and sand

Marking Scheme: 1 mark each method with explanation

Solution:

(a) Separation of Salt and Camphor:

Method: Sublimation

Procedure:

• Take the mixture in a china dish and cover it with an inverted funnel

• Close the stem of the funnel with cotton

• Heat the china dish gently

• Camphor will sublime (convert directly from solid to gas)

• Camphor vapors rise up and get deposited on the cooler inner walls of the funnel

• Salt remains in the china dish as residue

• Camphor can be collected by scraping it from the funnel

(b) Separation of Alcohol and Water:

Method: Fractional Distillation

Procedure:

• Take the mixture in a distillation flask fitted with a fractionating column and thermometer

• Heat the mixture gradually

• Alcohol has lower boiling point (78°C) than water (100°C)

• Alcohol vaporizes first and condenses in the condenser

• Pure alcohol is collected in the receiver

• Water with higher boiling point remains in the flask and can be collected later

(c) Separation of Iodine from Iodine and Sand:

Method: Sublimation

Procedure:

• Take the mixture in a china dish and cover with an inverted funnel

• Heat the dish gently

• Iodine sublimes (converts from solid to gas directly)

• Iodine vapors deposit on the cooler surface of the funnel

• Sand remains in the china dish

• Iodine can be collected from the funnel

Q29. Calculate mass of 0.5 mole: (a) Oxygen atoms (b) Oxygen molecules (c) Ozone

> **Marking Scheme:** 1 mark each calculation

Solution:

Given: Atomic mass of oxygen = 16 u
Number of moles = 0.5 mole

Formula: Mass = Number of moles × Molar mass

(a) Mass of 0.5 mole of Oxygen atoms (O):
Atomic mass of O = 16 u
Molar mass of O = 16 g/mol

Mass = 0.5 × 16
Mass = 8 g

(b) Mass of 0.5 mole of Oxygen molecules (O_2):
Molecular mass of O_2 = 2 × 16 = 32 u
Molar mass of O_2 = 32 g/mol

Mass = 0.5 × 32
Mass = 16 g

(c) Mass of 0.5 mole of Ozone molecules (O_3):
Molecular mass of O_3 = 3 × 16 = 48 u
Molar mass of O_3 = 48 g/mol

Mass = 0.5 × 48
Mass = 24 g

Q30. OR - (a) Avogadro's law (b) Avogadro's number (c) Calculate molecules in 4.4 g CO_2

> **Marking Scheme:** 1 mark each part

Solution:

(a) Avogadro's Law:

Avogadro's law states that equal volumes of all gases at the same temperature and pressure contain equal number of molecules or moles.

OR

At constant temperature and pressure, the volume of a gas is directly proportional to the number of moles (or molecules) of the gas.

Mathematical form: $V \propto n$ (where V = volume, n = number of moles)

(b) Avogadro's Number:

The number 6.022×10^{23} is known as **Avogadro's number** or **Avogadro's constant**.

It represents the number of particles (atoms, molecules, or ions) present in one mole of any substance.

(c) Calculate number of molecules in 4.4 g of CO_2:

Given:

Mass of CO_2 = 4.4 g

Atomic mass: C = 12 u, O = 16 u

Molecular mass of CO_2 = $12 + (2 \times 16) = 12 + 32 = 44$ u

Molar mass of CO_2 = 44 g/mol

Number of moles = Mass/Molar mass

= 4.4/44

= 0.1 mole

Number of molecules = Number of moles × Avogadro's number

= $0.1 \times 6.022 \times 10^{23}$

= 6.022×10^{22} molecules

Q31. (a) Thomson's model (b) Limitations (c) Experiment discovering nucleus

Marking Scheme: 1 mark each part

Solution:

(a) Thomson's Model of Atom (Plum Pudding Model):

According to J.J. Thomson's model:

• An atom consists of a positively charged sphere in which the positive charge is uniformly distributed

• The negatively charged electrons are embedded in this positively charged sphere

• The positive and negative charges are equal in magnitude, making the atom electrically neutral

• The model is also called the "plum pudding model" - the positive charge is like the pudding and electrons are like plums embedded in it

(b) Limitations of Thomson's Model:

• It could not explain the results of Rutherford's alpha particle scattering experiment

• According to this model, alpha particles should pass through the atom without much deflection, but Rutherford found that some particles were deflected at large angles and some even bounced back

• It failed to explain how the positive charge is distributed in the atom

• It did not explain the stability of the atom

• It could not explain the line spectrum of hydrogen and other elements

(c) Experiment that led to discovery of nucleus:

Rutherford's Alpha Particle Scattering Experiment (also called Gold Foil Experiment) led to the discovery of the nucleus.

In this experiment, Rutherford bombarded a thin gold foil with alpha particles and observed their scattering pattern, which led him to conclude that the atom has a small, dense, positively charged nucleus at its center.

Q32. OR - (a) Valence electrons (b) Electronic config of calcium (c) Valence electrons in calcium

> **Marking Scheme:** 1 mark each part

Solution:

(a) Valence Electrons:
Valence electrons are the electrons present in the outermost shell (valence shell) of an atom. These electrons take part in chemical bonding and determine the chemical properties and reactivity of the element.
Example: Sodium (Na) has electronic configuration 2, 8, 1, so it has 1 valence electron.

(b) Electronic Configuration of Calcium:
Atomic number of Calcium (Ca) = 20
Number of electrons = 20

Distribution of electrons in shells:
K shell (n=1) can hold maximum 2 electrons → 2 electrons
L shell (n=2) can hold maximum 8 electrons → 8 electrons
M shell (n=3) can hold maximum 18 electrons → 8 electrons
N shell (n=4) → 2 electrons

Electronic Configuration: 2, 8, 8, 2
OR in spdf notation: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

(c) Number of Valence Electrons in Calcium:
From the electronic configuration 2, 8, 8, 2
The outermost shell (N shell) has **2 electrons**
Therefore, calcium has **2 valence electrons**

Note: Since calcium has 2 valence electrons, its valency is 2, and it belongs to Group 2 (alkaline earth metals) of the periodic table.

Q33. (a) Define endocytosis and exocytosis (b) Organelle involved (c) Example

> **Marking Scheme:** 1 mark each part

Solution:

(a) Definitions:

Endocytosis:
Endocytosis is the process by which the cell membrane folds inward to bring materials from outside the cell into the cell. The cell membrane engulfs the material and forms a vesicle around it, which then moves into the cytoplasm. It is a way of taking in large particles or macromolecules that cannot pass through the cell membrane.
Types: Phagocytosis (cell eating) and Pinocytosis (cell drinking)

Exocytosis:
Exocytosis is the process by which materials are expelled or secreted out of the cell. Vesicles containing the material move to the cell membrane, fuse with it, and release their contents outside the cell. It is the reverse process of endocytosis.

(b) Cell Organelle Involved in Exocytosis:
Golgi apparatus (Golgi body) is the cell organelle primarily involved in exocytosis. It packages materials in vesicles which then move to the cell membrane and release their contents outside through exocytosis.

(c) Example of Endocytosis:
Example 1: Amoeba engulfs its food (bacteria or other small organisms) by extending its pseudopodia around the food particle and forming a food vacuole. This is an example of phagocytosis.

Example 2: White blood cells (WBCs) engulf bacteria and other foreign particles to protect our body from infections. This process is called phagocytosis.

Example 3: Unicellular organisms take in liquid droplets containing dissolved nutrients through pinocytosis.

Q34. Bus with acceleration 0.1 m/s² for 2 minutes. Find speed and distance.

> **Marking Scheme:** 1.5 marks each calculation

Solution:

Given:
Initial velocity, u = 0 (starting from rest)
Acceleration, a = 0.1 m/s²
Time, t = 2 minutes = 2 × 60 = 120 seconds

(a) Speed acquired:
Using first equation of motion: v = u + at
v = 0 + 0.1 × 120
v = 0 + 12
v = 12 m/s

Therefore, the speed acquired by the bus is **12 m/s**

(b) Distance travelled:
Using second equation of motion: s = ut + ½at²
s = 0 × 120 + ½ × 0.1 × (120)²
s = 0 + 0.05 × 14400
s = 720 m

Alternatively, using third equation:
v² = u² + 2as
(12)² = 0² + 2 × 0.1 × s
144 = 0.2s
s = 144/0.2 = 720 m

Therefore, the distance travelled by the bus is **720 m**

Q35. OR - From v-t graph: (a) Acceleration (b) Retardation (c) Distance

Marking Scheme: 1 mark each calculation

Solution:

From the given velocity-time graph:
• From 0 to 5 s: velocity increases uniformly from 0 to 10 m/s
• From 5 to 7 s: velocity decreases uniformly from 10 m/s to 0

(a) Acceleration from 0 to 5 s:
Initial velocity, u = 0 m/s
Final velocity, v = 10 m/s
Time, t = 5 s

Acceleration = (v - u)/t
a = (10 - 0)/5
a = 2 m/s²

(b) Retardation from 5 to 7 s:
Initial velocity, u = 10 m/s
Final velocity, v = 0 m/s
Time, t = 7 - 5 = 2 s

Acceleration = (v - u)/t
a = (0 - 10)/2
a = -5 m/s²

Retardation = 5 m/s² (magnitude of negative acceleration)

(c) Total distance travelled in 7 seconds:
Distance = Area under velocity-time graph

The graph forms a triangle with:
Base = 7 s (from 0 to 7 s)
Height = 10 m/s (maximum velocity)

Method 1: Using triangle area

Total distance = Area of triangle

= ½ × base × height

= ½ × 7 × 10

= 35 m

Method 2: Dividing into two parts

Distance in first 5 s = ½ × 5 × 10 = 25 m

Distance in next 2 s = ½ × 2 × 10 = 10 m

Total distance = 25 + 10 = **35 m**

SECTION D - ANSWERS (3 × 5 = 15 Marks)

Q36. (a) Law of conservation of momentum (b) Verification (c) Recoil velocity

Total Marks: 5

Part (a): 1 mark | Part (b): 2 marks | Part (c): 2 marks

Solution:

(a) Law of Conservation of Momentum:

The law of conservation of momentum states that when two or more bodies interact with each other in an isolated system (no external force), the total momentum of the system remains constant.

Mathematical form:

Total momentum before collision = Total momentum after collision

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

(b) Verification using two colliding balls:

Experiment Setup:

• Take two balls of masses m_1 and m_2

• Let ball 1 move with velocity u_1 and ball 2 move with velocity u_2 (or be at rest)

• Allow them to collide

• After collision, let their velocities be v_1 and v_2

Procedure:

1. Measure the masses m_1 and m_2 using a balance
2. Measure initial velocities u_1 and u_2 before collision
3. Calculate initial momentum = $m_1u_1 + m_2u_2$
4. After collision, measure final velocities v_1 and v_2
5. Calculate final momentum = $m_1v_1 + m_2v_2$

Observation:

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

This verifies that total momentum is conserved.

(c) Calculate recoil velocity of gun:

Given:

Mass of bullet, $m_1 = 20\ g = 0.02\ kg$

Velocity of bullet, $v_1 = 500\ m/s$

Mass of gun, $m_2 = 5\ kg$

Initial velocity of both, $u_1 = u_2 = 0$ (at rest)

Recoil velocity of gun, $v_2 = ?$

Using conservation of momentum:

Total momentum before firing = Total momentum after firing

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$0 + 0 = m_1v_1 + m_2v_2$

$0 = (0.02 \times 500) + (5 \times v_2)$

$0 = 10 + 5v_2$

$5v_2 = -10$

$v_2 = -2\ m/s$

Recoil velocity of gun = 2 m/s (in opposite direction to bullet)

The negative sign indicates that the gun moves backward (recoils) in the direction opposite to the bullet's motion.

Q36. OR - (a) Buoyant force (b) Archimedes' principle (c) Calculations

Total Marks: 5
Part (a): 1.5 marks | Part (b): 1.5 marks | Part (c): 2 marks

Solution:

(a) Buoyant Force:
Buoyant force (or upthrust) is the upward force exerted by a fluid (liquid or gas) on an object immersed in it. This force acts in the upward direction, opposite to the weight of the object.

Factors on which buoyant force depends:
1. **Volume of the object immersed:** Greater the volume displaced, greater the buoyant force
2. **Density of the fluid:** Greater the density of fluid, greater the buoyant force
3. **Acceleration due to gravity (g)**

Formula: Buoyant force = Volume of fluid displaced × Density of fluid × g
$FB = V \times \rho \times g$

(b) Archimedes' Principle:
Archimedes' principle states that when a body is immersed partially or completely in a fluid, it experiences an upward force (buoyant force) which is equal to the weight of the fluid displaced by the body.

Mathematical form:
Buoyant force = Weight of fluid displaced
$FB = \text{Weight of displaced fluid} = m_{fluid} \times g = V_{fluid} \times \rho_{fluid} \times g$

(c) Calculations:
Given:
Weight of iron in air = 50 N
Weight of iron in water = 45 N

(i) Loss in weight of iron in water:
Loss in weight = Weight in air - Weight in water

= 50 - 45

= 5 N

(ii) Upthrust or Buoyant force:

The loss in weight of a body when immersed in a fluid is equal to the upthrust or buoyant force.

Buoyant force = 5 N

(iii) Weight of water displaced:

According to Archimedes' principle, the buoyant force is equal to the weight of the fluid displaced.

Weight of water displaced = Buoyant force

= 5 N

Q37. (a) Gravitational PE (b) Derivation (c) Calculate KE, PE, height

> **Total Marks: 5**
> Part (a): 1 mark | Part (b): 2 marks | Part (c): 2 marks

Solution:

(a) Gravitational Potential Energy:

Gravitational potential energy is the energy possessed by a body by virtue of its position above the ground level.

Formula: PE = mgh

Where:

m = mass of the body (kg)

g = acceleration due to gravity (m/s^2)

h = height above the ground (m)

(b) Derivation of PE = mgh:

When a body of mass m is raised to a height h above the ground:

Weight of the body = mg (acting downward)
Minimum force required to lift = mg (acting upward)
Displacement = h (upward)

Work done in lifting the body = Force × Displacement
$W = F \times s$
$W = mg \times h$
$W = mgh$

This work done is stored in the body as gravitational potential energy.

Therefore, **Potential Energy = mgh**

SI Unit: Joule (J) or kg m^2/s^2

(c) Calculations for ball thrown upward:
Given:
Mass of ball, m = 0.5 kg
Initial velocity, u = 20 m/s
$g = 10\ m/s^2$

(i) Kinetic energy at the instant of throw:
$KE = \frac{1}{2}mv^2$
$KE = \frac{1}{2} \times 0.5 \times (20)^2$
$KE = 0.25 \times 400$
KE = 100 J

(ii) Potential energy at maximum height:
At maximum height, all kinetic energy is converted to potential energy.
By conservation of energy:
PE at maximum height = KE at the instant of throw
PE = 100 J

(iii) Maximum height reached:
At maximum height, final velocity v = 0
Using $v^2 = u^2 - 2gh$ (negative sign because motion is against gravity)
$0^2 = (20)^2 - 2 \times 10 \times h$

0 = 400 - 20h

20h = 400

h = 20 m

OR using PE = mgh:

100 = 0.5 × 10 × h

100 = 5h

h = 20 m

Q37. OR - (a) Power (b) Derive P=Fv (c) Ratio of power

Total Marks: 5

Part (a): 1 mark | Part (b): 2 marks | Part (c): 2 marks

Solution:

(a) Power:

Power is defined as the rate of doing work or the rate of transfer of energy.

Power = Work done/Time taken

P = W/t

SI Unit of Power: Watt (W) or Joule per second (J/s)

1 Watt = 1 Joule/second

Larger unit: Kilowatt (kW)

1 kW = 1000 W

(b) Derive relation between power, force and velocity (P = Fv):

We know that:

Power = Work done/Time taken

P = W/t

Also, Work done = Force × Displacement

$W = F \times s$

Substituting in the power equation:

$P = (F \times s)/t$

We know that velocity = Displacement/Time

$v = s/t$

Therefore, $s/t = v$

Substituting:

$P = F \times (s/t)$

$\mathbf{P = F \times v}$

$\mathbf{P = Fv}$

Where:

P = Power (Watt)

F = Force (Newton)

v = Velocity (m/s)

(c) Calculate ratio of power:

Given:

Both persons do the same amount of work (W)

Time taken by A, $t_1 = 10$ minutes

Time taken by B, $t_2 = 15$ minutes

Power delivered by A:

$P_1 = W/t_1 = W/10$

Power delivered by B:

$P_2 = W/t_2 = W/15$

Ratio of power:

$P_1/P_2 = (W/10)/(W/15)$

$P_1/P_2 = (W/10) \times (15/W)$

$P_1/P_2 = 15/10$

$P_1/P_2 = 3/2$

$P_1 : P_2 = 3 : 2$

Therefore, the ratio of power delivered by A to that by B is **3:2**

Conclusion: Person A delivers more power as they complete the same work in less time.

Q38. (a) Draw plant and animal cell (b) Differences (c) If membrane breaks?

Total Marks: 5
Part (a): 2 marks | Part (b): 2 marks | Part (c): 1 mark

Solution:

(a) Diagrams:
[Note: Detailed labeled diagrams should show:]

Plant Cell Diagram should include:
• Cell wall (outermost)
• Cell membrane (below cell wall)
• Nucleus with nuclear membrane
• Cytoplasm
• Large central vacuole
• Chloroplasts
• Mitochondria
• Golgi apparatus
• Endoplasmic reticulum
• Ribosomes

Animal Cell Diagram should include:
• Cell membrane (outermost, no cell wall)
• Nucleus with nuclear membrane
• Cytoplasm
• Small vacuoles (multiple)
• Mitochondria
• Golgi apparatus

• Endoplasmic reticulum
• Ribosomes
• Centrosome with centrioles
• Lysosomes

(b) Three Differences between Plant Cell and Animal Cell:

Feature	Plant Cell	Animal Cell
Cell Wall	Present (made of cellulose)	Absent
Chloroplasts	Present (for photosynthesis)	Absent
Vacuoles	One large central vacuole	Many small vacuoles
Centrioles	Absent (except in lower plants)	Present
Shape	Fixed and rectangular	Round or irregular

(c) What happens if plasma membrane ruptures or breaks down:
If the plasma membrane ruptures or breaks down:
• The cell will lose its boundary and protection
• All the cell contents (cytoplasm, organelles, genetic material) will spill out
• The cell will no longer be able to maintain its internal environment
• Exchange of materials between the cell and its surroundings will be uncontrolled
• The cell will not be able to carry out its vital functions
• **The cell will die**

Therefore, the plasma membrane is essential for the survival and functioning of the cell.

Q38. OR - (a) Draw neuron (b) Functions (c) Why longest cells?

Total Marks: 5
Part (a): 2 marks | Part (b): 2 marks | Part (c): 1 mark

Solution:

(a) Diagram of Neuron:

[A well-labeled diagram should show:]

• **Cell Body (Cyton/Soma):** Contains nucleus and cytoplasm

• **Dendrites:** Short, branched extensions from cell body

• **Axon:** Long fiber extending from cell body

• **Myelin Sheath:** Fatty covering around axon (with gaps called Nodes of Ranvier)

• **Schwann Cells:** Form the myelin sheath

• **Axon Terminal/Nerve Endings:** Branched endings of axon

• **Synapse:** Junction between two neurons

• **Nucleus:** In the cell body

(b) Three Functions of Nervous Tissue:

1. Reception and Transmission of Stimuli:

Nervous tissue receives stimuli from the external and internal environment and transmits nerve impulses (signals) from one part of the body to another. This helps in quick communication within the body.

2. Control and Coordination:

Nervous tissue controls and coordinates all the activities of different parts of the body. It integrates information from various receptors and sends appropriate commands to effectors (muscles and glands).

3. Processing of Information:

The brain, which is made of nervous tissue, processes information received from sense organs, stores information (memory), and makes decisions. It enables thinking, learning, and conscious activities.

(c) Why are neurons called the longest cells in the body?

Neurons are called the longest cells in the body because they have a very long axon that can extend up to 1 meter or more in length. For example:

• The neurons that carry signals from the spinal cord to the toes can be over 1 meter long in tall humans

• The axon of a single neuron can run from the brain down to the lower spinal cord

• Some neurons in giraffes can be several meters long

This extraordinary length is necessary for neurons to transmit electrical impulses over long distances rapidly, enabling quick responses and coordination throughout the body.

SECTION E - ANSWERS (3 × 4 = 12 Marks)

Q39. CASE STUDY 1 - UNIFORM CIRCULAR MOTION - ANSWERS:

Total Marks: 4

(i) What provides centripetal force when stone is rotated? [1 mark]

Solution:
The **tension in the string** provides the necessary centripetal force when the stone is rotated in a horizontal circle. This tension acts towards the center of the circular path and keeps the stone moving in a circle by continuously changing its direction.

(ii) Why does stone fly off tangentially when string is released? [1 mark]

Solution:
The stone flies off tangentially when the string is released because according to Newton's first law of motion, a body in motion continues to move in a straight line unless acted upon by an external force. When the string is released, the centripetal force (tension) is no longer acting on the stone. Due to inertia of motion, the stone continues to move in the direction it was moving at that instant, which is along the tangent to the circular path at that point.

OR: What happens to centripetal force if speed is doubled? [1 mark]

Solution:
The centripetal force is given by: $F = mv^2/r$

From this formula, we can see that centripetal force is directly proportional to the square of the velocity ($F \propto v^2$).

If the speed is doubled (v becomes 2v):
New force = $m(2v)^2/r = m(4v^2)/r = 4(mv^2/r) = 4F$

Therefore, **the centripetal force becomes 4 times (quadruples)** when the speed of rotation is doubled.

(iii) Calculate the centripetal force. [2 marks]

> **Marking Scheme:** 1 mark for formula + 1 mark for calculation

Solution:
Given:
Mass of stone, m = 0.5 kg
Radius of circle, r = 0.5 m
Speed, v = 4 m/s

Formula for centripetal force:
$F = mv^2/r$

Substituting values:
$F = (0.5 \times 4^2)/0.5$
$F = (0.5 \times 16)/0.5$
$F = 8/0.5$
F = 16 N

Therefore, the centripetal force acting on the stone is **16 N** directed towards the center of the circular path.

Q40. CASE STUDY 2 - ISOTOPES - ANSWERS:

> **Total Marks: 4**

(i) What are isotopes? Give example. [1 mark]

Solution:
Isotopes are atoms of the same element having the same atomic number (same number

of protons) but different mass numbers (different number of neutrons).

Since they have the same atomic number, they belong to the same element and have the same chemical properties but differ in physical properties.

Example: Carbon has three isotopes:
• Carbon-12 ($_6C^{12}$): 6 protons, 6 neutrons
• Carbon-13 ($_6C^{13}$): 6 protons, 7 neutrons
• Carbon-14 ($_6C^{14}$): 6 protons, 8 neutrons

Other examples: Hydrogen isotopes (Protium, Deuterium, Tritium), Chlorine-35 and Chlorine-37

(ii) Name isotope used in carbon dating. [1 mark]

Solution:
Carbon-14 (C-14) is the isotope used in carbon dating (also called radiocarbon dating).

Carbon-14 is a radioactive isotope that decays at a known rate. By measuring the amount of C-14 remaining in ancient organic materials (fossils, wood, artifacts), scientists can determine their age, typically up to about 50,000 years old.

OR: Why do isotopes show similar chemical properties? [1 mark]

Solution:
Isotopes of the same element show similar chemical properties because they have the same number of electrons and the same electronic configuration.

Chemical properties of an element are determined by the number and arrangement of electrons, especially the valence electrons in the outermost shell. Since isotopes have the same atomic number (same number of protons and electrons), they have identical electronic configurations and therefore exhibit the same chemical behavior.

Example: Both Chlorine-35 and Chlorine-37 have 17 electrons with the same configuration 2, 8, 7, so both react similarly with other elements.

(iii) Calculate average atomic mass of chlorine. [2 marks]

> **Marking Scheme:** 1 mark for formula/method + 1 mark for calculation

Solution:

Given:

Isotopes of chlorine: Cl-35 and Cl-37

Ratio = 3:1

This means: For every 4 atoms, 3 are Cl-35 and 1 is Cl-37

Percentage of Cl-35 = (3/4) × 100 = 75%

Percentage of Cl-37 = (1/4) × 100 = 25%

Formula for average atomic mass:

Average atomic mass = $[(Mass_1 \times Abundance_1) + (Mass_2 \times Abundance_2)] / 100$

Substituting values:

Average atomic mass = [(35 × 75) + (37 × 25)] / 100

= [2625 + 925] / 100

= 3550 / 100

= 35.5 u

Therefore, the average atomic mass of chlorine is **35.5 u**

Note: This matches the atomic mass of chlorine given in the periodic table, which is approximately 35.5 u.

Q41. CASE STUDY 3 - OSMOSIS IN PLANT CELLS - ANSWERS:

Total Marks: 4

(i) What is osmosis? [1 mark]

Solution:

Osmosis is the process of movement of water molecules from a region of higher water concentration (dilute solution) to a region of lower water concentration (concentrated solution) through a semi-permeable membrane.

The semi-permeable membrane allows the passage of solvent (water) molecules but

does not allow the passage of solute molecules.

Osmosis is a special type of diffusion involving only water molecules.

(ii) Why did raisins swell in plain water? [1 mark]

Solution:
The raisins swelled in plain water because water moved into the raisin cells by the process of osmosis.

The concentration of water is higher in plain water (Beaker A) and lower inside the dry raisin cells. The raisin skin acts as a semi-permeable membrane. Water molecules move from higher concentration (outside) to lower concentration (inside the raisin) through osmosis. This causes the raisin cells to absorb water, swell up, and become turgid (firm and swollen).

OR: What type of solution is in Beaker B? [1 mark]

Solution:
Beaker B contains a **hypertonic solution** with respect to the raisin cells.

A hypertonic solution is one which has higher solute concentration (lower water concentration) compared to the cell sap. Since the sugar solution in Beaker B is more concentrated than the contents of raisin cells, it is hypertonic. This causes water to move out of the raisin cells by osmosis, making them shrink and become flaccid.

(iii) Explain when plant cell is placed in hypotonic solution. Draw diagram. [2 marks]

> **Marking Scheme:** 1 mark for explanation + 1 mark for diagram

Solution:

Explanation:
When a plant cell is placed in a hypotonic solution (solution with lower solute concentration than cell sap):

1. **Endosmosis occurs:** Water molecules move into the cell through the semi-permeable cell membrane by osmosis

2. **Cell swells:** The cell absorbs water and swells up

3. **Vacuole enlarges:** The central vacuole increases in size as it fills with water

4. **Turgidity develops:** The cell becomes turgid (fully swollen and firm)

5. **Turgor pressure:** The cell contents press against the rigid cell wall, creating turgor pressure

6. **No bursting:** Unlike animal cells, plant cells do not burst due to the presence of the strong, rigid cell wall that can withstand the pressure

7. **Cell becomes fully turgid:** Water continues to enter until the cell reaches maximum turgidity and equilibrium is established

Diagram:
[Diagram should show:]
• Normal plant cell (before) with labeled cell wall, cell membrane, vacuole, cytoplasm
• Arrows showing water entering the cell
• Turgid plant cell (after) with enlarged vacuole, swollen appearance, cell membrane pressed against cell wall
• Labels: "Hypotonic solution (dilute)", "Water enters by osmosis", "Turgid cell"

Importance: Turgidity is important for plants as it provides mechanical support to soft tissues and helps maintain the shape of leaves and young stems.

📚 END OF ANSWER KEY 📚

Total Marks: 80

Section A: 20 marks | Section B: 12 marks | Section C: 21 marks

Section D: 15 marks | Section E: 12 marks | Internal Choice: Available

This comprehensive answer key follows strict CBSE marking schemes and includes detailed step-by-step solutions for better understanding and scoring.

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