MATH LOVE INSTITUTE

CBSE Class 9 Science (Code: 086)

Sample Paper 4 - Home Exam 2025-26 with Complete Solutions

Based on Latest CBSE Syllabus & Exam Pattern 2025-26

Maximum Marks	80 (Theory)
Time Allowed	3 Hours
Class	IX (Nine)
Subject	Science (086)

📋 GENERAL INSTRUCTIONS:

1. This question paper contains **38 questions** divided into **Five Sections A, B, C, D and E**.
2. **Section A**: 20 MCQs of 1 mark each (20 marks)
3. **Section B**: 5 Very Short Answer Type questions of 2 marks each (10 marks)
4. **Section C**: 6 Short Answer Type questions of 3 marks each (18 marks)
5. **Section D**: 4 Long Answer Type questions of 5 marks each (20 marks)
6. **Section E**: 3 Case Study Based questions of 4 marks each (12 marks)
7. All questions are **compulsory**. However, internal choices have been provided in some questions.
8. Draw neat and labelled diagrams wherever required.
9. Use of calculators is **NOT** permitted.

SECTION A - MULTIPLE CHOICE QUESTIONS (1 × 20 = 20 Marks)

Q1. The temperature at which a solid melts to become a liquid at atmospheric pressure is called: **[1]**

(a) Boiling point

(b) Fusion point

(c) Melting point

(d) Both (b) and (c)

Q2. During summer, water kept in an earthen pot (matka) becomes cool because: **[1]**

(a) The pot absorbs heat

(b) Water seeps through pores and evaporates causing cooling

(c) Earthen pot has high thermal conductivity

(d) Water undergoes sublimation

Q3. Which of the following is a chemical change? **[1]**

(a) Cutting of trees

(b) Melting of butter

(c) Dissolving sugar in water

(d) Digestion of food

Q4. One atomic mass unit (1 u) is defined as: **[1]**

(a) Mass of one atom of Hydrogen

(b) Mass of one atom of Carbon-12

(c) 1/12th of the mass of one atom of Carbon-12

(d) Mass of one atom of Oxygen

Q5. How many moles of oxygen atoms are present in 1 mole of Al_2O_3? **[1]**

(a) 1

(b) 2

(c) 3

(d) 6

Q6. In Rutherford's alpha-particle scattering experiment, most alpha particles: **[1]**

(a) Were deflected by large angles

(b) Were reflected back

(c) Passed straight through the gold foil without deflection

(d) Were absorbed by the gold foil

Q7. An element has atomic number 12. How many electrons are there in its outermost shell? **[1]**

(a) 1

(b) 2

(c) 3

(d) 8

Q8. Which organelle is known as the "powerhouse of the cell"? **[1]**

(a) Chloroplast

(b) Ribosome

(c) Nucleus

(d) Mitochondria

Q9. Cork cells are impervious to water because of the deposition of a substance called: **[1]**

(a) Lignin

(b) Suberin

(c) Pectin

(d) Cellulose

Q10. A body covers a semicircular path of radius 7 m. The ratio of the distance to displacement is: **[1]**

(a) 11 : 7

(b) 7 : 11

(c) 7 : 2

(d) 2 : 7

Q11. A car moves 30 km at a uniform speed of 60 km/h and the next 30 km at a uniform speed of 40 km/h. The average speed of the car is: **[1]**

(a) 50 km/h

(b) 48 km/h

(c) 45 km/h

(d) 52 km/h

Q12. According to Newton's second law, F = ma. If the same force acts on two objects of masses m_1 and m_2 (where $m_1 > m_2$), then: **[1]**

(a) $a_1 > a_2$

(b) $a_1 < a_2$

(c) $a_1 = a_2$

(d) Cannot be determined

Q13. The unit of gravitational constant G is: **[1]**

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

(b) N m kg^{-2}

(c) N m^2 kg^2

(d) N kg m^{-2}

Q14. The value of acceleration due to gravity 'g' is maximum at: **[1]**

(a) The equator

(b) The poles

(c) The centre of the earth

(d) A height equal to the radius of the earth

Q15. A body of mass 2 kg has a momentum of 6 kg m/s. The kinetic energy of the body is: **[1]**

(a) 3 J

(b) 6 J

(c) 9 J

(d) 12 J

Q16. 1 kWh is equal to: **[1]**

(a) 3.6×10^3 J

(b) 3.6×10^5 J

(c) 3.6×10^6 J

(d) 3.6×10^8 J

Q17. Sound cannot travel through: **[1]**

(a) Solids

(b) Liquids

(c) Gases

(d) Vacuum

Q18. Green Revolution in India was achieved primarily by the development of: **[1]**

(a) High yielding varieties of crops

(b) New irrigation systems

(c) Chemical pesticides

(d) Organic farming methods

Q19. **Assertion (A):** Naphthalene balls (mothballs) disappear with time without leaving any solid residue. **[1]**

Reason (R): Naphthalene undergoes sublimation, changing directly from solid to gas.

(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 (A):** Two bodies of different masses dropped from the same height reach the ground at the same time (in vacuum). **[1]**

Reason (R): Acceleration due to gravity is independent of the mass of the falling body.

(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 - VERY SHORT ANSWER TYPE QUESTIONS (2 × 5 = 10 Marks)

Q21. Convert the following temperatures: (i) 37°C to Kelvin scale, (ii) 373 K to Celsius scale. What is the significance of 0 K (absolute zero)? **[2]**

Q22. Calculate the number of molecules present in 3.6 g of water (H_2O). [Atomic mass: H = 1 u, O = 16 u, $N_A = 6.022 \times 10^{23}$] **[2]**

Q23. What are the functions of (i) Golgi apparatus, and (ii) Endoplasmic Reticulum? **[2]**

Q24. An object moves along a straight line with a uniform acceleration of 4 m/s². If its initial velocity was 2 m/s, what will be its velocity after 5 seconds? Also find the displacement in this time. **[2]**

Q25. Why does a sharp knife cut objects more easily than a blunt knife? Explain using the concept of pressure. **[2]**

SECTION C - SHORT ANSWER TYPE QUESTIONS (3 × 6 = 18 Marks)

Q26. (a) What is chromatography? Name the principle on which it works. **[3]**
(b) List any two applications of chromatography.
(c) How would you separate a mixture of two miscible liquids that have a difference of more than 25°C in their boiling points?

Q27. (a) State the law of constant proportions (law of definite proportions) with an example. **[3]**
(b) 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?

Q28. (a) Draw a neat diagram of a prokaryotic cell and label: (i) Cell wall, (ii) Cell membrane, (iii) Ribosome, (iv) Nucleoid. **[3]**
(b) Name any two differences between a prokaryotic cell and a eukaryotic cell.
OR
(a) What are the functions of: (i) Stomata, (ii) Epidermis?
(b) Why are xylem and phloem called complex permanent tissues?

Q29. A cyclist goes around a circular track of circumference 314 m in 157 seconds. **[3]**
Calculate:
(i) the speed of the cyclist
(ii) the magnitude of the velocity of the cyclist at any instant
(iii) Is the cyclist accelerating? Give reason.

Q30. (a) Define momentum. What is its SI unit? **[3]**
(b) A bullet of mass 20 g is horizontally fired with a velocity of 150 m/s from a pistol of mass 2 kg. What is the recoil velocity of the pistol?

Q31. (a) What is SONAR? Write its full form. **[3]**

(b) A ship sends out ultrasound that returns from the seabed in 3.5 seconds. What is the depth of the sea if the speed of sound in sea water is 1530 m/s?

SECTION D - LONG ANSWER TYPE QUESTIONS (5 × 4 = 20 Marks)

Q32. (a) Describe Rutherford's alpha-particle scattering experiment. What were his observations and conclusions? **[5]**

(b) State two drawbacks of Rutherford's model of atom.

(c) How did Bohr's model overcome the drawbacks of Rutherford's model?

OR

(a) What are isotopes? Give two examples.

(b) Write the electronic configuration and draw Bohr's model for: (i) Chlorine (Z = 17), (ii) Calcium (Z = 20).

(c) An element has 2 electrons in its M-shell. What is its atomic number? To which group does it belong? (Identify the element)

Q33. (a) Draw a neat labelled diagram of a plant cell. Label any six parts. **[5]**

(b) Explain how the following cell structures are different from each other: (i) Cell wall and Cell membrane, (ii) Chloroplast and Mitochondria.

(c) "Cells are the basic units of life." Who proposed this and what is this theory called?

Q34. (a) Derive the third equation of motion: $v^2 = u^2 + 2as$. **[5]**

(b) A stone is thrown vertically upward with a velocity of 40 m/s. Find: (i) the maximum height reached, (ii) the total time of journey, (iii) the velocity with which it returns to the ground. [Take g = 10 m/s²]

OR

(a) State the universal law of gravitation. Write the mathematical expression.

(b) What would happen to the gravitational force between two objects if: (i) the mass of one object is tripled? (ii) the distance between the objects is halved?

(c) Why do we not feel the gravitational force of attraction between two students sitting close together in a classroom?

Q35. (a) Describe an activity to show that sound needs a material medium for its propagation. **[5]**

(b) Derive the relationship between speed, frequency and wavelength of a sound wave.

(c) Distinguish between longitudinal waves and transverse waves with one example each.

SECTION E - CASE STUDY BASED QUESTIONS (4 × 3 = 12 Marks)

Q36. **[4]**

CASE STUDY 1: States of Matter and Interconversion

Matter exists in three states — solid, liquid and gas. These states are interconvertible. A solid can be converted into a liquid by heating (melting), and a liquid can be converted into a gas by heating (boiling/evaporation). The reverse processes are freezing and condensation. Some substances can change directly from solid to gas state — this process is called sublimation. The interconversion of states is caused by change in temperature or pressure. At the particle level, increasing temperature increases the kinetic energy of particles, allowing them to overcome intermolecular forces and change state.

Based on the above information, answer the following questions:

(i) What is the effect of increasing pressure on a gas at constant temperature? **[1 mark]**

(ii) Name the process by which camphor disappears without leaving any residue. What is the reverse of this process called? **[1 mark]**

(iii) At what temperature does water exist in all three states simultaneously? What is this point called? Explain why adding common salt to ice causes the temperature to decrease below 0°C. **[2 marks]**

Q37. **[4]**

CASE STUDY 2: Newton's Laws and Seat Belts

When a car suddenly stops due to an emergency, the passengers tend to get thrown forward. To prevent injuries, seat belts are mandatory in cars. The seat belt exerts a force on the body of the passenger to slow them down along with the car. Airbags in vehicles inflate during a collision and increase the time over which the passenger's momentum changes, thereby reducing the force on the passenger's body.

Based on the above information, answer the following questions:

(i) Which law of motion explains why passengers are thrown forward when a car stops suddenly? **[1 mark]**

(ii) A car of mass 1000 kg is moving at 20 m/s and comes to rest in 4 seconds when brakes are applied. Calculate the braking force. **[2 marks]**

(iii) How do airbags reduce the force experienced by a passenger during a collision? Relate your answer to Newton's second law. **[1 mark]**

Q38. **[4]**

CASE STUDY 3: Cattle Farming and Milk Production

India has the largest population of cattle in the world. Cattle farming is done for two main purposes — milk production (dairy cattle) and farm labour/transportation (draught cattle). Indian cattle breeds (indigenous) include Red Sindhi and Sahiwal, while exotic breeds like Jersey and Holstein-Friesian are known for their high milk yield. Cross-breeding of indigenous and exotic breeds is done to develop varieties that can produce more milk and are also resistant to local diseases. Proper shelter, clean water, balanced feed, and regular veterinary check-ups are essential for maintaining healthy cattle.

Based on the above information, answer the following questions:

(i) What is the difference between milch and draught animals? **[1 mark]**

(ii) Why is cross-breeding between indigenous and exotic breeds done? Name one cross-breed variety. **[2 marks]**

(iii) List any two components of a good and balanced cattle feed. **[1 mark]**

📚 END OF QUESTION PAPER 📚

Total Marks: 80

Section A: 20 marks | Section B: 10 marks | Section C: 18 marks

Section D: 20 marks | Section E: 12 marks

Based on CBSE Class 9 Science Syllabus 2025-26
Most Expected Questions for Home Exams — Set 4

🎯 DETAILED SOLUTIONS WITH STEP-BY-STEP EXPLANATIONS

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

Q1. Answer: (d) Both (b) and (c)

Explanation: The melting point is the temperature at which a solid melts to become a liquid at atmospheric pressure. This is also called the fusion point. For example, the melting/fusion point of ice is 0°C (273 K).

Q2. Answer: (b) Water seeps through pores and evaporates causing cooling

Explanation: Earthen pots have tiny pores. Water seeps through these pores and reaches the outer surface, where it evaporates. During evaporation, water absorbs latent heat from the remaining water inside the pot, causing it to cool down. This is an application of cooling by evaporation.

Q3. Answer: (d) Digestion of food

Explanation: Digestion of food is a chemical change because complex food molecules (carbohydrates, proteins, fats) are broken down into simpler molecules (glucose, amino acids, fatty acids) by enzymes. New substances are formed and the process is irreversible. Cutting trees, melting butter, and dissolving sugar are physical changes.

Q4. Answer: (c) 1/12th of the mass of one atom of Carbon-12

Explanation: One atomic mass unit (1 u) is defined as exactly 1/12th of the mass of one atom of Carbon-12 isotope. 1 u = 1.66×10^{-27} kg. This is the standard used to express atomic and molecular masses.

Q5. Answer: (c) 3

Explanation: The formula Al_2O_3 shows that 1 molecule of aluminium oxide contains 3 oxygen atoms. Therefore, 1 mole of Al_2O_3 contains 3 moles of oxygen atoms (and 2 moles of aluminium atoms).

Q6. Answer: (c) Passed straight through the gold foil without deflection

Explanation: In Rutherford's experiment, most alpha particles (about 99%) passed straight through the gold foil without any deflection. This showed that most of the atom is empty space. Only a very small fraction were deflected at large angles or bounced back (indicating a small, dense, positive nucleus).

Q7. Answer: (b) 2

Explanation: Atomic number 12 → Electronic configuration: 2, 8, 2. The outermost shell (M-shell) has 2 electrons. This element is Magnesium (Mg).

Q8. Answer: (d) Mitochondria

Explanation: Mitochondria are called the "powerhouse of the cell" because they carry out cellular respiration — the process of breaking down glucose to release energy in the form of ATP (adenosine triphosphate). ATP is the energy currency of the cell.

Q9. Answer: (b) Suberin

Explanation: Cork cells have a chemical substance called suberin deposited in their walls, which makes them impervious to gases and water. This property makes cork useful as a protective tissue in plants and commercially for bottle stoppers. Lignin is found in sclerenchyma.

Q10. Answer: (a) 11 : 7

Solution: For a semicircular path of radius r = 7 m:
Distance (actual path) = half the circumference = $\pi r = (22/7) \times 7 = 22$ m
Displacement = diameter = $2r = 2 \times 7 = 14$ m
Ratio = Distance : Displacement = 22 : 14 = 11 : 7

Q11. Answer: (b) 48 km/h

Solution: Time for first 30 km = 30/60 = 0.5 h. Time for next 30 km = 30/40 = 0.75 h.
Total distance = 60 km. Total time = 0.5 + 0.75 = 1.25 h.
Average speed = 60/1.25 = **48 km/h**.

Q12. Answer: (b) $a_1 < a_2$

Explanation: $F = ma \rightarrow a = F/m$. For the same force, acceleration is inversely proportional to mass. Since $m_1 > m_2$, $a_1 < a_2$. The heavier object has less acceleration.

Q13. Answer: (a) N m² kg⁻²

Explanation: From $F = Gm_1m_2/d^2$, $G = Fd^2/m_1m_2$. So unit of G = (N × m²)/(kg × kg) = N m² kg⁻². The value of $G = 6.674 \times 10^{-11}$ N m² kg⁻².

Q14. Answer: (b) The poles

Explanation: The value of g is maximum at the poles because Earth is not a perfect sphere — it is slightly flattened at the poles. The poles are closer to the centre of the Earth than the equator, so g is slightly higher there (g at poles ≈ 9.832 m/s², g at equator ≈ 9.78 m/s²). At the centre of Earth, g = 0.

Q15. Answer: (c) 9 J

Solution: $p = mv \rightarrow v = p/m = 6/2 = 3$ m/s.
$KE = \frac{1}{2}mv^2 = \frac{1}{2} \times 2 \times (3)^2 = \frac{1}{2} \times 2 \times 9 =$ **9 J**.
(Or use $KE = p^2/2m = 36/4 = 9$ J)

Q16. Answer: (c) 3.6×10^6 J

Solution: 1 kWh = 1000 W × 3600 s = 3,600,000 J = 3.6×10^6 J. This is the commercial unit of energy.

Q17. Answer: (d) Vacuum

Explanation: Sound is a mechanical wave and requires a material medium (solid, liquid, or gas) for propagation. It cannot travel through vacuum because there are no particles to vibrate and carry the wave. This can be demonstrated by the bell jar experiment.

Q18. Answer: (a) High yielding varieties of crops

Explanation: The Green Revolution in India (1960s-70s) was primarily achieved through the development and adoption of high yielding variety (HYV) seeds, especially for wheat and rice, combined with modern farming techniques, fertilizers, and irrigation. Dr. M.S. Swaminathan is known as the Father of Green Revolution in India.

Q19. Answer: (a) Both A and R are true and R is the correct explanation of A

Explanation: Naphthalene is a sublime substance — it changes directly from solid to gas (sublimation) at room temperature without passing through the liquid state. This is why naphthalene balls gradually disappear without leaving any residue. R correctly explains this phenomenon.

Q20. Answer: (a) Both A and R are true and R is the correct explanation of A

Explanation: In vacuum (no air resistance), all objects fall with the same acceleration 'g', regardless of their mass. Since g does not depend on mass (from the equation $g = GM/R^2$), both heavy and light objects take the same time to reach the ground. R correctly explains A. Galileo demonstrated this famously.

SECTION B - SOLUTIONS (2 × 5 = 10 Marks)

Q21. Solution:

Marking Scheme: ½ mark for each conversion + 1 mark for significance of absolute zero

(i) 37°C to Kelvin:

K = °C + 273 = 37 + 273 = **310 K [½ mark]**

(ii) 373 K to Celsius:

°C = K − 273 = 373 − 273 = **100°C** (This is the boiling point of water) **[½ mark]**

Significance of 0 K (Absolute Zero):

0 K (or −273°C) is called absolute zero. It is the lowest possible temperature. At this temperature, the kinetic energy of the particles becomes minimum (theoretically zero), and all molecular motion stops. It is practically not achievable. The Kelvin scale starts from absolute zero, which is why there are no negative values on the Kelvin scale. **[1 mark]**

Q22. Solution:

> **Marking Scheme:** 1 mark for molar mass and moles + 1 mark for number of molecules

Given: Mass of water = 3.6 g

Molar mass of H_2O:
= 2(1) + 1(16) = 2 + 16 = **18 g/mol [½ mark]**

Number of moles:
n = Given mass / Molar mass = 3.6 / 18 = **0.2 moles [½ mark]**

Number of molecules:
= $n \times N_A = 0.2 \times 6.022 \times 10^{23}$
= **1.2044×10^{23} molecules [1 mark]**

Q23. Solution:

> **Marking Scheme:** 1 mark for each organelle's function

(i) Functions of Golgi Apparatus: [1 mark]
The Golgi apparatus (also called Golgi complex or Golgi body) functions as the "packaging and dispatching" department of the cell. It receives proteins and lipids synthesized in the ER, modifies them, packages them into vesicles, and dispatches them to various targets inside or outside the cell. It is also involved in the formation of lysosomes and storage/modification of products in vesicles.

(ii) Functions of Endoplasmic Reticulum (ER): [1 mark]
The ER is a network of membrane-bound tubules that acts as a transport channel for materials within the cell. It provides a large surface area for biochemical reactions. Rough ER (with ribosomes) helps in protein synthesis. Smooth ER (without ribosomes) is involved in the synthesis of fats/lipids and also plays a role in detoxification of drugs and poisons. It also functions as a cytoplasmic framework, providing mechanical support.

Q24. Solution:

Marking Scheme: 1 mark for velocity + 1 mark for displacement

Given: $a = 4\ m/s^2$, $u = 2\ m/s$, $t = 5\ s$

Velocity after 5 seconds:
$v = u + at = 2 + 4(5) = 2 + 20$
v = 22 m/s [1 mark]

Displacement:
$s = ut + \frac{1}{2}at^2 = 2(5) + \frac{1}{2}(4)(5)^2$
$s = 10 + \frac{1}{2}(4)(25) = 10 + 50$
s = 60 m [1 mark]

Q25. Solution:

Marking Scheme: 2 marks for explanation with concept of pressure

A sharp knife has a very thin edge, meaning the area of contact with the object is very small. A blunt knife has a thicker edge, so the area of contact is larger. **[½ mark]**

Pressure = Force / Area. For the same force applied: **[½ mark]**

Sharp knife: Smaller area → Higher pressure → Cuts easily. **[½ mark]**
Blunt knife: Larger area → Lower pressure → Does not cut easily. **[½ mark]**

Since pressure is inversely proportional to area (for the same force), the sharp knife exerts much higher pressure on the object, making it easier to cut through.

SECTION C - SOLUTIONS (3 × 6 = 18 Marks)

Q26. Solution:

Marking Scheme: 1 mark for definition + principle, 1 mark for applications, 1 mark for separation technique

(a) Chromatography: [1 mark]

Chromatography is a technique used for the separation of those solutes that dissolve in the same solvent. It is used to separate coloured substances (dyes, pigments) and also colourless substances.

Principle: It works on the principle that different components of a mixture are adsorbed differently on an adsorbent (stationary phase) and are carried at different rates by a mobile phase (solvent). The component that is more soluble in the solvent rises faster and higher.

(b) Applications of Chromatography: [1 mark]

(i) To separate colours/pigments from natural sources (e.g., separating the dyes present in ink, or separating pigments from leaf extract).

(ii) To detect drugs in blood samples (used in forensic science and doping tests in sports).

(c) Separation of miscible liquids with boiling point difference > 25°C: [1 mark]

The technique used is **simple distillation**. The mixture is heated in a distillation flask. The liquid with the lower boiling point vaporizes first, rises through the flask, and enters the condenser where it cools and condenses back into liquid form, which is collected in a separate container. The liquid with the higher boiling point remains in the flask. Example: Separation of a mixture of acetone (b.p. 56°C) and water (b.p. 100°C).

Q27. Solution:

Marking Scheme: 1½ marks for law + example + 1½ marks for numerical

(a) Law of Constant Proportions (Law of Definite Proportions): [1½ marks]

This law was given by Joseph Proust in 1799. It states: **"In a chemical substance, the elements are always present in definite proportions by mass."**

Example: In water (H_2O), the ratio of the mass of hydrogen to the mass of oxygen

is always 1:8, regardless of the source of water. So, in 9 g of water: hydrogen = 1 g, oxygen = 8 g. Whether the water is from a river, ocean, or well, this ratio remains constant.

(b) Numerical: [1½ marks]
Given: H : O = 1 : 8 by mass
Mass of hydrogen = 3 g **[½ mark]**

If 1 g of H reacts with 8 g of O,
then 3 g of H will react with = 3 × 8 = **24 g of oxygen [1 mark]**

Q28. Solution:

Marking Scheme: 1½ marks for diagram + 1½ marks for differences

(a) Diagram of Prokaryotic Cell: [1½ marks]
[Students should draw a simple cell with the following labelled parts:]
(i) **Cell wall** — rigid outer layer providing shape and protection
(ii) **Cell membrane (Plasma membrane)** — just inside the cell wall, controls entry and exit of substances
(iii) **Ribosomes** — small granules scattered in cytoplasm, site of protein synthesis
(iv) **Nucleoid** — region in the cytoplasm where the circular DNA is located (not enclosed by a nuclear membrane)
[Additional labels: Flagellum, Pili, Capsule, Cytoplasm, Plasmid]

(b) Differences between Prokaryotic and Eukaryotic Cell: [1½ marks]

Prokaryotic Cell	**Eukaryotic Cell**
No well-defined nucleus; DNA lies in the nucleoid region (no nuclear membrane).	Has a well-defined nucleus enclosed by a nuclear membrane.
Membrane-bound organelles (like mitochondria, ER, Golgi) are absent.	Membrane-bound organelles are present.

OR

(a) Functions: [2 marks]

(i) Stomata: Stomata are tiny pores on the surface of leaves (mainly the lower surface), each surrounded by two bean-shaped guard cells. They allow the exchange of gases (CO_2 enters, O_2 exits during photosynthesis) and are the site of transpiration (loss of water vapour). Guard cells regulate the opening and closing of stomata. **[1 mark]**

(ii) Epidermis: Epidermis is the outermost layer of cells covering the entire plant body. It forms a protective barrier against mechanical injury, loss of water, and entry of parasites and pathogens. It is usually one cell thick. In desert plants, the epidermis has a thick waxy coating called cuticle to reduce water loss. In roots, root hair cells (extensions of epidermal cells) increase the surface area for absorption of water and minerals. **[1 mark]**

(b) Why xylem and phloem are called complex permanent tissues: [1 mark]

Xylem and phloem are called complex permanent tissues because they are made up of more than one type of cell. In xylem: tracheids, vessels, xylem parenchyma, and xylem fibres work together to transport water. In phloem: sieve tubes, companion cells, phloem parenchyma, and phloem fibres work together to transport food. Since multiple cell types coordinate to perform a common function, they are called complex tissues.

Q29. Solution:

> **Marking Scheme:** 1 mark for speed + 1 mark for velocity + 1 mark for acceleration

Given: Circumference = 314 m, Time for one round = 157 s

(i) Speed of the cyclist: [1 mark]

Speed = Distance / Time = 314 / 157

Speed = 2 m/s

(ii) Magnitude of velocity at any instant: [1 mark]

Since the cyclist is on a circular track, at any instant, the velocity is directed along the tangent to the circular path. The magnitude of velocity (speed) at any instant = **2 m/s**.

However, the **average velocity** over one complete round = displacement / time = 0 / 157 = 0 m/s (since displacement for a complete round is zero — the cyclist returns to the starting point).

(iii) Is the cyclist accelerating? [1 mark]

Yes, the cyclist is accelerating. Even though the speed (magnitude of velocity) is constant at 2 m/s, the **direction of velocity is continuously changing** along the circular path. Since velocity is a vector quantity (has both magnitude and direction), a change in direction means a change in velocity, which means acceleration exists. This is called **centripetal acceleration**, directed towards the centre of the circle.

Q30. Solution:

> **Marking Scheme:** 1 mark for definition + SI unit + 2 marks for numerical

(a) Momentum: [1 mark]

Momentum of a body is defined as the product of its mass and velocity. It is a vector quantity (has both magnitude and direction).

$p = m \times v$

SI unit: kg m/s (kilogram metre per second)

(b) Numerical (Recoil velocity of pistol): [2 marks]

Given: Mass of bullet (m_1) = 20 g = 0.02 kg

Velocity of bullet (v_1) = 150 m/s

Mass of pistol (m_2) = 2 kg

Recoil velocity of pistol (v_2) = ? **[½ mark]**

Before firing: Both are at rest, so total momentum = 0

By law of conservation of momentum:

Total momentum before = Total momentum after

$0 = m_1v_1 + m_2v_2$ **[½ mark]**

$0 = (0.02)(150) + (2)(v_2)$

$0 = 3 + 2v_2$

$2v_2 = -3$

$v_2 = -1.5$ m/s [1 mark]

The negative sign indicates that the pistol recoils in the **opposite direction** to the bullet. The recoil velocity is **1.5 m/s** backward.

Q31. Solution:

> **Marking Scheme:** 1 mark for SONAR definition + 2 marks for numerical

(a) SONAR: [1 mark]

SONAR stands for **Sound Navigation And Ranging**. It is a device that uses ultrasonic waves (high-frequency sound waves) to measure distances, directions, and speed of underwater objects. A SONAR device consists of a transmitter (which sends ultrasonic waves) and a receiver/detector (which receives the reflected waves/echo). It is used in ships and submarines to determine the depth of sea, locate underwater objects (submarines, icebergs, sunken ships), and map the ocean floor.

(b) Numerical: [2 marks]

Given: Total time (t) = 3.5 s, Speed of sound in sea water (v) = 1530 m/s **[½ mark]**

The ultrasound travels from ship to seabed and back. So the total distance = 2d (where d = depth).

$2d = v \times t$ **[½ mark]**

$2d = 1530 \times 3.5$

$2d = 5355$

$d = 5355 / 2$

d = 2677.5 m [1 mark]

The depth of the sea at that point is **2677.5 m (≈ 2.68 km)**.

SECTION D - SOLUTIONS (5 × 4 = 20 Marks)

Q32. Solution:

> **Marking Scheme:** 3 marks for experiment + observations + conclusions, 1 mark for drawbacks, 1 mark for Bohr's improvement

(a) Rutherford's Alpha-Particle Scattering Experiment: [1½ marks]

Setup: Rutherford bombarded a thin gold foil (about 1000 atoms thick) with fast-moving alpha particles (α-particles, which are helium nuclei with +2 charge) emitted by a radioactive source. A fluorescent screen (ZnS screen) was placed around the gold foil to detect the scattered alpha particles.

Observations: [1 mark]

(i) Most α-particles passed straight through the gold foil without any deflection.
(ii) A small fraction of α-particles were deflected by small angles.
(iii) Very few (about 1 in 20,000) α-particles bounced back (deflected by nearly 180°).

Conclusions: [½ mark]

(i) Most of the space inside the atom is **empty** (since most α-particles passed through).
(ii) The positive charge of the atom is concentrated in a very small, dense region called the **nucleus** (since a few α-particles were deflected or bounced back).
(iii) The **electrons** revolve around the nucleus in circular orbits (like planets around the sun).
(iv) The size of the nucleus is very small compared to the size of the atom.

(b) Two Drawbacks of Rutherford's Model: [1 mark]

(i) According to electromagnetic theory, an electron revolving around the nucleus should continuously emit energy (radiation). This would cause the electron to lose energy, slow down, and eventually spiral into the nucleus, causing the atom to collapse. But atoms are stable — Rutherford's model could not explain this stability.
(ii) Rutherford's model did not explain the distribution of electrons around the nucleus (i.e., how electrons are arranged in different energy levels/shells).

(c) How Bohr's Model Overcame the Drawbacks: [1 mark]

Bohr proposed that electrons revolve around the nucleus only in certain fixed orbits

(called energy levels or shells: K, L, M, N...). While revolving in these fixed orbits, electrons do not radiate energy — they are in a stable state. Energy is emitted or absorbed only when an electron jumps from one orbit to another. This explained the stability of the atom and also explained the arrangement of electrons in discrete energy levels.

OR

(a) Isotopes: [1 mark]

Isotopes are atoms of the **same element** that have the **same atomic number (Z)** but **different mass numbers (A)** (i.e., different number of neutrons).

Examples:

(i) Carbon: ^{12}C (6p, 6n), ^{13}C (6p, 7n), ^{14}C (6p, 8n)

(ii) Hydrogen: Protium ^{1}H (0n), Deuterium ^{2}H (1n), Tritium ^{3}H (2n)

(b) Electronic Configuration and Bohr's Model: [2 marks]

(i) Chlorine (Z = 17):

Electronic configuration: K: 2, L: 8, M: 7 → **2, 8, 7**

[Draw 3 concentric circles. Nucleus: "17p, 18n". K-shell: $2e^-$, L-shell: $8e^-$, M-shell: $7e^-$] **[1 mark]**

(ii) Calcium (Z = 20):

Electronic configuration: K: 2, L: 8, M: 8, N: 2 → **2, 8, 8, 2**

[Draw 4 concentric circles. Nucleus: "20p, 20n". K: $2e^-$, L: $8e^-$, M: $8e^-$, N: $2e^-$] **[1 mark]**

(c) Element with 2 electrons in M-shell: [2 marks]

M-shell is the third shell (n = 3). If it has 2 electrons:

K: 2, L: 8, M: 2 → Total electrons = 2 + 8 + 2 = 12

Atomic number = 12 → This is **Magnesium (Mg)**.

It belongs to **Group 2** (alkaline earth metals) because it has 2 electrons in its outermost shell (valency = 2).

Q33. Solution:

Marking Scheme: 2 marks for diagram + 2 marks for comparisons + 1 mark for cell theory

(a) Diagram of a Plant Cell: [2 marks]

[Students should draw a rectangular cell and label at least six of the following parts:]

1. **Cell wall** — rigid outermost boundary made of cellulose
2. **Cell membrane (Plasma membrane)** — inside the cell wall, selectively permeable
3. **Nucleus** — contains chromosomes and nucleolus, bounded by nuclear membrane
4. **Large central vacuole** — large, membrane-bound sac filled with cell sap
5. **Chloroplast** — green plastid containing chlorophyll, site of photosynthesis
6. **Mitochondria** — double-membrane organelle, powerhouse of the cell

[Other parts: Endoplasmic Reticulum, Golgi apparatus, Ribosomes, Cytoplasm]

(b) Differences: [2 marks]

(i) Cell Wall vs Cell Membrane: [1 mark]

Cell Wall	**Cell Membrane**
Present only in plant cells, fungi, and bacteria. Absent in animal cells.	Present in all cells (both plant and animal).
Made of cellulose (in plants). It is rigid and provides structural support and shape.	Made of lipid bilayer and proteins. It is flexible and selectively permeable.

(ii) Chloroplast vs Mitochondria: [1 mark]

Chloroplast	**Mitochondria**
Found only in plant cells (and some protists). Contains chlorophyll (green pigment).	Found in both plant and animal cells. Does not contain chlorophyll.
Site of photosynthesis — converts light energy to chemical energy (glucose).	Site of cellular respiration — breaks down glucose to release energy (ATP).

(c) Cell Theory: [1 mark]

The cell theory was proposed by two German scientists — **Matthias Schleiden** (a botanist, 1838) and **Theodor Schwann** (a zoologist, 1839). It is called the **Cell**

Theory. Its main postulates are: (i) All living organisms are composed of cells, (ii) The cell is the basic structural and functional unit of life. Later, **Rudolf Virchow** (1855) added that all cells arise from pre-existing cells ("Omnis cellula e cellula").

Q34. Solution:

Marking Scheme: 2 marks for derivation + 3 marks for numerical (1 mark each part)

(a) Derivation of $v^2 = u^2 + 2as$ (Third Equation of Motion): [2 marks]

We know:

$v = u + at$ ...(i) [First equation of motion]

$s = ut + \frac{1}{2}at^2$ ...(ii) [Second equation of motion]

From equation (i): $t = (v - u)/a$

Substituting in equation (ii):

$s = u[(v - u)/a] + \frac{1}{2}a[(v - u)/a]^2$

$s = u(v - u)/a + \frac{1}{2}a \times (v - u)^2/a^2$

$s = u(v - u)/a + (v - u)^2/2a$

$s = [2u(v - u) + (v - u)^2] / 2a$

$2as = 2u(v - u) + (v - u)^2$

$2as = (v - u)[2u + v - u]$

$2as = (v - u)(v + u)$

$2as = v^2 - u^2$

$\therefore$ **$v^2 = u^2 + 2as$**

(b) Numerical:

Given: $u = 40$ m/s (upward), $g = 10$ m/s² (downward, so $a = -10$ m/s²)

(i) Maximum height (H): [1 mark]

At maximum height, $v = 0$.

$v^2 = u^2 + 2as \rightarrow 0 = (40)^2 + 2(-10)(H)$

$0 = 1600 - 20H$

$20H = 1600$

H = 80 m

(ii) Total time of journey: [1 mark]

Time to reach max height: $v = u + at \rightarrow 0 = 40 + (-10)t \rightarrow t = 4$ s

Total time = Time up + Time down = 4 + 4 = **8 seconds**

(Time of ascent = Time of descent for vertical throw)

(iii) Velocity on return to ground: [1 mark]

The stone returns with the same speed but in opposite direction (downward).

v = 40 m/s (downward)

[Verification: $v^2 = 0 + 2(10)(80) = 1600 \rightarrow v = 40$ m/s ✓]

OR

(a) Universal Law of Gravitation: [1½ marks]

Newton's Universal Law of Gravitation states: **"Every body in the universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between their centres."**

Mathematical Expression:

$F = G \times (m_1 \times m_2) / d^2$

Where: F = gravitational force, G = universal gravitational constant (6.674×10^{-11} N m^2 kg^{-2}), m_1 and m_2 = masses of the two bodies, d = distance between their centres.

(b) Effect on gravitational force: [2 marks]

(i) If mass of one object is tripled:

$F' = G(3m_1)(m_2)/d^2 = 3 \times Gm_1m_2/d^2 =$ **3F**

The force becomes 3 times (tripled). **[1 mark]**

(ii) If distance is halved:

$F' = Gm_1m_2/(d/2)^2 = Gm_1m_2/(d^2/4) = 4Gm_1m_2/d^2 =$ **4F**

The force becomes 4 times. **[1 mark]**

(c) Why we don't feel gravitational force between two students: [1½ marks]

The gravitational force between two students is extremely small because their

masses are very small compared to celestial bodies like the Earth. For example, two students of 50 kg sitting 1 m apart would experience a force of only:
$F = 6.674 \times 10^{-11} \times 50 \times 50 / 1^2 = 1.67 \times 10^{-7}$ N
This force is negligibly small (about 0.000000167 N), which is far too weak for humans to perceive or for any visible effect. The gravitational constant G is extremely small, making the force between everyday objects practically zero.

Q35. Solution:

> **Marking Scheme:** 2 marks for activity + 1½ marks for derivation + 1½ marks for distinction

(a) Activity: Sound needs a material medium (Bell Jar Experiment): [2 marks]
Setup: Take an electric bell and hang it inside a bell jar (a glass jar connected to a vacuum pump). Connect the bell to a power source so it starts ringing. Initially, the jar is full of air.

Observation 1: We can hear the bell ringing clearly because sound travels through the air inside the jar.

Procedure: Now, use the vacuum pump to gradually remove the air from the bell jar (create a partial vacuum).

Observation 2: As the air is pumped out, the sound of the bell becomes fainter and fainter. When most of the air is removed (near-vacuum), the sound can barely be heard, even though the bell is still vibrating (we can see the hammer hitting the bell).

Conclusion: This proves that sound requires a material medium (like air) for its propagation. In the absence of a medium (vacuum), sound cannot travel.

(b) Relationship between Speed, Frequency, and Wavelength: [1½ marks]
Let the frequency of a sound wave = f (number of oscillations per second)
Wavelength = λ (distance between two consecutive compressions or rarefactions)
Speed of sound = v

In one oscillation (time period T = 1/f seconds), the wave travels a distance equal to one wavelength (λ).
Speed = Distance / Time = λ / T = λ × (1/T) = λ × f
∴ v = f × λ
(Speed = Frequency × Wavelength)

(c) Longitudinal Waves vs Transverse Waves: [1½ marks]

Longitudinal Waves	**Transverse Waves**
The particles of the medium vibrate parallel (along) the direction of propagation of the wave.	The particles of the medium vibrate perpendicular to the direction of propagation of the wave.
Consist of compressions and rarefactions.	Consist of crests and troughs.
Can travel through solids, liquids, and gases.	Can travel through solids and on the surface of liquids, but not through gases.
Example: Sound waves in air.	Example: Light waves, waves on a string, ripples on water surface.

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

Q36. Solution: CASE STUDY 1 - States of Matter and Interconversion

> **Marking Scheme:** 1 + 1 + 2 = 4 marks

(i) Effect of increasing pressure on a gas: [1 mark]
Increasing pressure on a gas at constant temperature compresses it — the particles come closer together, and the volume of the gas decreases. If sufficient pressure is applied, the gas can be compressed into a liquid. This is how gases like CO_2, LPG, etc. are stored in cylinders as liquids under high pressure.

(ii) Camphor disappearing: [1 mark]

Camphor disappears without leaving any residue by the process of **sublimation** — it changes directly from solid to gas (vapour) without passing through the liquid state.

The reverse process is called **deposition (or desublimation)** — the direct conversion of gas/vapour into solid without passing through the liquid state.

(iii) Triple point of water and effect of salt: [2 marks]

Water exists in all three states simultaneously at a temperature of **0.01°C (273.16 K)** and a pressure of 611.73 Pa (about 6.1×10^{-3} atm). This is called the **Triple Point** of water. **[1 mark]**

When common salt is added to ice, it lowers the melting point of ice (this is called **freezing point depression**). The salt dissolves in the thin layer of water on the surface of ice, forming a salt solution. A salt solution has a lower freezing point than pure water. As the ice melts to form this solution, it absorbs heat (latent heat of fusion) from the surroundings, causing the temperature to drop below 0°C. This principle is used in making ice cream and in de-icing roads in cold countries. **[1 mark]**

Q37. Solution: CASE STUDY 2 - Newton's Laws and Seat Belts

> **Marking Scheme:** 1 + 2 + 1 = 4 marks

(i) Newton's First Law of Motion (Law of Inertia) explains this. When the car stops suddenly, the lower body of the passenger stops with the car (due to friction with the seat), but the upper body continues to move forward due to inertia of motion. The body tends to maintain its state of uniform motion. **[1 mark]**

(ii) Braking force: [2 marks]

Given: m = 1000 kg, u = 20 m/s, v = 0, t = 4 s **[½ mark]**

Acceleration: $a = (v - u)/t = (0 - 20)/4 = -5$ m/s² **[½ mark]**

Braking force: $F = ma = 1000 \times (-5) =$ **−5000 N [1 mark]**

The braking force is **5000 N** (negative sign indicates it acts opposite to the direction of motion).

(iii) How airbags reduce force: [1 mark]

According to Newton's second law: $F = \Delta p/\Delta t$ (Force = rate of change of momentum). For the same change in momentum (Δp), if the time (Δt) over which the momentum changes is increased, the force (F) decreases. Airbags inflate during a collision and cushion the passenger's body, increasing the time of impact. This increases Δt, which reduces the force F experienced by the passenger, thereby reducing injuries.

Q38. Solution: CASE STUDY 3 - Cattle Farming and Milk Production

> **Marking Scheme:** 1 + 2 + 1 = 4 marks

(i) Difference between Milch and Draught animals: [1 mark]

Milch animals (dairy animals) are those that are used for **milk production**. Example: Sahiwal, Holstein-Friesian cows.

Draught animals are those that are used for **farm labour and transportation** (ploughing, carting, irrigation). Example: Bullocks, Nageri breed.

(ii) Purpose and example of cross-breeding: [2 marks]

Purpose of cross-breeding: Cross-breeding between indigenous (Indian/local) breeds and exotic (foreign) breeds is done to combine the desirable qualities of both: **[1 mark]**

— Exotic breeds (like Jersey, Holstein-Friesian) have **high milk yield** but are less resistant to local diseases and heat.

— Indigenous breeds (like Red Sindhi, Sahiwal) have **disease resistance** and can tolerate hot climate, but have lower milk yield.

Cross-breeding produces offspring that gives more milk AND is better adapted to local conditions.

Example of cross-breed: Karan Swiss (cross between Brown Swiss × Sahiwal) or **Karan Fries** (cross between Holstein-Friesian × Tharparkar). **[1 mark]**

(iii) Two components of balanced cattle feed: [1 mark]

(i) **Roughage** — fibre-rich food containing mainly cellulose, e.g., green fodder, hay, silage, legumes (provides bulk and fibre for digestion).

(ii) **Concentrates** — nutrient-rich food low in fibre but high in proteins and other

nutrients, e.g., cotton seeds, oilseed cakes, grains, bran (provides energy and promotes milk production).
(In addition, feed additives containing micronutrients like vitamins, minerals, and salts are also provided.)

✅ END OF SOLUTIONS ✅

All solutions strictly based on CBSE Class 9 Science Syllabus 2025-26

Comprehensive step-by-step explanations with marking schemes

Key Topics Covered in Set 4:

• Matter in Our Surroundings (Melting Point, Earthen Pot Cooling, Sublimation, Triple Point, Freezing Point Depression)

• Is Matter Around Us Pure (Chemical Change, Chromatography, Distillation, Law of Constant Proportions)

• Atoms and Molecules (Atomic Mass Unit, Mole Calculations — Molecules of Water, Percentage Composition)

• Structure of the Atom (Rutherford's Experiment — Full Description, Bohr's Model, Isotopes, Electronic Configuration of Cl & Ca)

• The Fundamental Unit of Life (Plant Cell Diagram, Cell Wall vs Membrane, Chloroplast vs Mitochondria, Cell Theory, Golgi & ER Functions)

• Tissues (Cork & Suberin, Prokaryotic Cell Diagram, Stomata, Epidermis, Complex Tissues)

• Motion (Semicircular Path — Distance vs Displacement, Average Speed, Circular Motion & Acceleration, Uniform Acceleration Numerical)

• Force and Laws of Motion (Momentum & Recoil Velocity, Newton's 2nd Law — F=ma Comparison, Seat Belt & Airbag Physics)

• Gravitation (Universal Law Derivation, Effect of Mass & Distance Changes, g at Poles, Gravitational Constant Unit)

• Work and Energy (KE from Momentum, 1 kWh Conversion, Pressure Concept — Sharp vs Blunt Knife)

• Sound (Bell Jar Experiment, $v = f\lambda$ Derivation, Longitudinal vs Transverse Waves, SONAR Depth Calculation)

• Improvement in Food Resources (Cattle Farming, Milch vs Draught, Cross-Breeding, Green Revolution)