MATH LOVE INSTITUTE

Education as a Service (EaaS)

SAMPLE PAPER - SET 9

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. The relationship between velocity (v), frequency (ν) and wavelength (λ) of sound is: **[1]**

(a) $v = \nu/\lambda$

(b) $v = \nu\lambda$

(c) $v = \nu + \lambda$

(d) $v = \nu - \lambda$

Q2. Thrust is: **[1]**

(a) Force per unit area

(b) Force acting perpendicular to a surface

(c) Mass per unit volume

(d) Work per unit time

Q3. The maximum number of electrons in M shell is: **[1]**

(a) 2

(b) 8

(c) 18

(d) 32

Q4. The valency of an element with electronic configuration 2, 8, 5 is: **[1]**

(a) 2

(b) 3

(c) 5

(d) 8

Q5. Which organelle is known as the "traffic controller" of the cell? **[1]**

(a) Endoplasmic reticulum

(b) Golgi apparatus

(c) Ribosome

(d) Mitochondria

Q6. Blood is an example of which type of tissue? **[1]**

(a) Epithelial tissue

(b) Connective tissue

(c) Muscular tissue

(d) Nervous tissue

Q7. If a body is moving with constant velocity, its acceleration is: **[1]**

(a) Positive

(b) Negative

(c) Zero

(d) Cannot be determined

Q8. The momentum of a body depends on: **[1]**

(a) Mass only

(b) Velocity only

(c) Both mass and velocity

(d) Neither mass nor velocity

Q9. The pressure at a point inside a liquid depends on: **[1]**

(a) Depth of the point from surface

(b) Density of the liquid

(c) Acceleration due to gravity

(d) All of the above

Q10. SONAR stands for: **[1]**

(a) Sound Navigation and Radar

(b) Sound Navigation and Ranging

(c) Sound Notation and Ranging

(d) Sound Notation and Radar

Q11. Infrasound has frequency: **[1]**

(a) Less than 20 Hz

(b) Between 20 Hz to 20,000 Hz

(c) Greater than 20,000 Hz

(d) Equal to 20 Hz

Q12. Which of the following is a suspension? **[1]**

(a) Sugar solution

(b) Salt solution

(c) Muddy water

(d) Vinegar

Q13. The maximum number of electrons in any shell is given by: **[1]**

(a) 2n

(b) $2n^2$

(c) n^2

(d) n

Q14. Permanent slides are made of which tissue for observing under microscope? **[1]**

(a) Living tissue

(b) Dead tissue

(c) Preserved tissue

(d) Fresh tissue

Q15. The SI unit of frequency is: **[1]**

(a) Second

(b) Hertz

(c) Meter

(d) Decibel

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

Assertion (A): Sound waves cannot travel through vacuum.

Reason (R): Sound waves are mechanical waves and require a 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

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

Assertion (A): Action and reaction forces do not cancel each other.

Reason (R): Action and reaction forces act on different objects.

(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): Sharp knives are more effective in cutting than blunt knives.

Reason (R): Sharp knives have less surface area, thus exerting more pressure.

(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): The valency of chlorine is 1.

Reason (R): Chlorine has 7 electrons in its outermost shell.

(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): Epithelial tissue forms a protective layer on the skin.

Reason (R): Epithelial tissue has cells closely packed with little intercellular space.

(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 echo. What is the minimum distance required between the source and the reflecting surface to hear a clear echo? **[2]**

Q22. State Newton's second law of motion. Write its mathematical form. **[2]**

Q23. What is pressure? Write its SI unit. How does pressure depend on area? **[2]**

Q24. An element has valency 2. Write its electronic configuration if its atomic number is 12. **[2]**

Q25. Name the tissue responsible for movement in our body. Write two types of this tissue. **[2]**

Q26. Why does sound travel faster in solids than in gases? Give reason. **[2]**

SECTION C (7 × 3 = 21 Marks)

Q27. (a) What is reverberation? How can it be reduced? **[3]**

(b) Give two differences between echo and reverberation.

(c) Why are concert halls designed with sound-absorbing materials?

Q28. (a) What is valency? How is it determined? **[3]**

(b) Write the valency of following elements:

(i) Sodium (atomic number 11)

(ii) Oxygen (atomic number 8)

(iii) Aluminum (atomic number 13)

Q29. A sound wave has frequency 500 Hz and wavelength 0.68 m. Calculate: **[3]**

(a) The speed of sound

(b) The time period of the wave

(c) How far the sound will travel in 5 seconds

Q30. OR **[3]**

A man stands between two parallel cliffs and fires a gun. He hears the first echo after 1.5 seconds and the second echo after 2.5 seconds. Calculate:

(a) The distance of the man from each cliff

(b) The distance between the two cliffs

[Speed of sound in air = 340 m/s]

Q31. (a) What is the function of the Golgi apparatus in a cell? **[3]**

(b) Why is endoplasmic reticulum important for protein synthesis?

(c) Name the organelle that helps in detoxification of drugs.

Q32. OR **[3]**

(a) Draw a labeled diagram showing different types of simple permanent tissues in plants.

(b) Write one function of each tissue.

(c) Which tissue provides flexibility to plants without breaking?

Q33. (a) Differentiate between striated and non-striated muscles. **[3]**

(b) Where is cardiac muscle found?

(c) Write one characteristic feature of cardiac muscle.

Q34. A force of 50 N acts on a body of mass 10 kg which is initially at rest. The body moves in a straight line. Calculate: **[3]**

(a) The acceleration produced

(b) The velocity after 4 seconds

(c) The change in momentum after 4 seconds

Q35. OR **[3]**

(a) State the principle of conservation of momentum with an example.

(b) A rifle of mass 4 kg fires a bullet of mass 50 g with a velocity of 400 m/s. Calculate the recoil velocity of the rifle.

SECTION D (3 × 5 = 15 Marks)

Q36. (a) Define thrust and pressure. Write their SI units. **[5]**

(b) Why does a ship made of iron float on water while an iron nail sinks? Explain.

(c) Calculate the pressure exerted by a force of 200 N on an area of:

(i) 2 m^2

(ii) 0.5 m^2

(iii) 0.1 m^2

What conclusion do you draw about the relation between pressure and area?

OR

(a) State the laws of reflection of sound.

(b) Explain how SONAR works with the help of a diagram.

(c) A SONAR device sends ultrasound waves and receives the echo after 0.4 seconds. If the speed of sound in water is 1500 m/s, calculate the depth of the sea.

Q37. (a) Describe Thomson's model of atom. Why was it rejected? **[5]**
(b) Describe Rutherford's model of atom with a diagram.
(c) Write two limitations of Rutherford's model.

OR

(a) Explain Bohr's model of atom. Draw a diagram showing electron distribution in the first three shells.
(b) Write the postulates of Bohr's model (any three).
(c) An element has electronic configuration 2, 8, 7. Identify the element and determine its position in the periodic table (group and period).

Q38. (a) Draw a well-labeled diagram of the human ear. **[5]**
(b) Explain how we hear sound. Describe the function of each part of the ear.
(c) What is the audible range of frequency for human ears?

OR

(a) What are complex permanent tissues? Name two types.
(b) Draw labeled diagrams showing the structure of xylem and phloem.
(c) Write three differences between xylem and phloem.
(d) Why is phloem called living tissue while most of xylem is dead?

SECTION E (3 × 4 = 12 Marks)

CASE STUDY 1: SONAR AND ULTRASOUND APPLICATIONS

During a science exhibition, students learned about SONAR (Sound Navigation and Ranging), a technique that uses ultrasound waves to detect objects underwater. A SONAR device fitted at the bottom of a ship sends ultrasound signals vertically downward into the sea. These signals travel through water, hit the seabed, and reflect back to the ship. By measuring the time taken for the echo to return and knowing the speed of sound in water, the depth of the sea can be calculated. Ultrasound has many other applications too. Doctors use ultrasound for medical imaging (sonography) to

examine organs inside the body. It is also used to break kidney stones into smaller pieces and to clean delicate instruments. Bats use ultrasound for navigation and hunting their prey in the dark through a process called echolocation.

(i) What is ultrasound? Write its frequency range. [1 mark]

(ii) A SONAR device on a ship sends a signal and receives an echo after 3 seconds. If the speed of sound in seawater is 1500 m/s, calculate the depth of the sea. [1 mark]

OR
Why can't humans hear ultrasound? [1 mark]

(iii) (a) Name two medical uses of ultrasound.
(b) Explain how bats use ultrasound to catch their prey. [2 marks]

CASE STUDY 2: NEWTON'S LAWS IN DAILY LIFE

Newton's three laws of motion govern the motion of all objects in the universe. The first law states that an object at rest stays at rest and an object in motion stays in motion unless acted upon by an external force - this is why passengers jerk forward when a bus suddenly stops. The second law establishes the relationship between force, mass, and acceleration (F = ma), explaining why it's harder to push a heavy car than a light bicycle. The third law states that for every action, there is an equal and opposite reaction - this is why a gun recoils backward when a bullet is fired forward. These laws have countless applications. Athletes use Newton's laws to improve performance, engineers design vehicles considering these principles, and space agencies launch rockets using the third law. Understanding these laws helps us predict and control motion in our daily lives.

(i) State Newton's first law of motion. [1 mark]

(ii) A force of 100 N is applied on an object of mass 20 kg. Calculate its acceleration. [1 mark]

OR
Why do we fall forward when a moving bus stops suddenly? [1 mark]

(iii) A ball of mass 0.5 kg moving with velocity 10 m/s strikes a wall and rebounds with the same speed. Calculate the change in momentum. [2 marks]

CASE STUDY 3: ATOMIC STRUCTURE AND ELECTRON DISTRIBUTION

The structure of an atom consists of a small dense nucleus containing protons and neutrons, surrounded by electrons revolving in shells or orbits. The distribution of electrons in different shells follows specific rules. The first shell (K) can hold maximum 2 electrons, the second shell (L) can hold 8 electrons, and the third shell (M) can hold 18 electrons. The general formula for maximum electrons in any shell is $2n^2$, where n is the shell number. Electrons first fill the inner shells before moving to outer shells. The number of electrons in the outermost shell determines the chemical properties and valency of an element. Elements with the same number of valence electrons show similar chemical behavior. For example, all noble gases have completely filled outermost shells, making them chemically inert.

(i) What is the maximum number of electrons that can be accommodated in the outermost shell of an atom? [1 mark]

(ii) Write the electronic configuration of an element with atomic number 16. [1 mark]

OR

Why do elements in the same group have similar chemical properties? [1 mark]

(iii) An element X has electronic configuration 2, 8, 1.
(a) What is its atomic number and valency?
(b) To which group and period does it belong? [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 9

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	(b)	Q6	(b)	Q11	(a)	Q16	(a)
Q2	(b)	Q7	(c)	Q12	(c)	Q17	(a)
Q3	(c)	Q8	(c)	Q13	(b)	Q18	(a)
Q4	(b)	Q9	(d)	Q14	(c)	Q19	(a)
Q5	(b)	Q10	(b)	Q15	(b)	Q20	(a)

DETAILED EXPLANATIONS:

Q1. Answer: (b) $v = \nu\lambda$

Explanation: The relationship between velocity (v), frequency (ν), and wavelength (λ) is $v = \nu\lambda$. This is the fundamental wave equation.

Q2. Answer: (b) Force acting perpendicular to a surface

Explanation: Thrust is the total force acting perpendicular to a surface. Pressure is thrust per unit area.

Q3. Answer: (c) 18

Explanation: M shell (n=3) can hold maximum $2n^2 = 2(3)^2 = 18$ electrons.

Q4. Answer: (b) 3

Explanation: Configuration 2,8,5 has 5 electrons in outermost shell. Valency = 8-5 = 3.

Q16-Q20. ASSERTION-REASON EXPLANATIONS:

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

Q17: (a) - Both true and R correctly explains A

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 echo. What is minimum distance for clear echo?

> **Marking Scheme:** 1 mark for definition + 1 mark for minimum distance

Solution:

Echo:

An echo is the repetition of sound caused by the reflection of sound waves from a surface back to the listener. When sound waves strike a hard surface like a wall, cliff, or building, they get reflected and the reflected sound reaches our ears after some time, producing an echo.

Minimum Distance Required:

The minimum distance between the source of sound and the reflecting surface to hear a clear echo is **17.2 meters** (approximately 17 m).

Calculation:

For a distinct echo, the time interval between original sound and reflected sound should be at least 0.1 second (persistence of hearing).

Speed of sound in air = 344 m/s (approximately)
Total distance = Speed × Time = 344 × 0.1 = 34.4 m
Since sound travels to the surface and back, actual distance = 34.4/2 = 17.2 m

Note: If distance is less than 17 m, the echo merges with original sound causing reverberation instead of a distinct echo.

Q22. State Newton's second law of motion. Write mathematical form.

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

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 Form:

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

Therefore, **$F = kma$**

In SI units, k = 1, so:
$F = ma$

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

SI Unit of Force: Newton (N) or kg m/s²

Q23. What is pressure? SI unit? How does pressure depend on area?

Marking Scheme: 1 mark for definition & unit + 1 mark for relation with area

Solution:

Pressure:
Pressure is defined as the force acting perpendicular to a surface per unit area.

Formula:
Pressure = Force/Area
$P = F/A$

SI Unit of Pressure: Pascal (Pa) or Newton per square meter (N/m^2)
1 Pascal = 1 N/m^2

Other units: Atmosphere (atm), Bar, Torr, mm of Hg

Dependence on Area:
Pressure is inversely proportional to area when force is constant.
$P \propto 1/A$

This means:
• **Smaller area → Higher pressure:** When the same force acts on a smaller area, pressure increases. This is why a sharp knife cuts better than a blunt one - the sharp edge has smaller area of contact, thus exerting more pressure.

• **Larger area → Lower pressure:** When the same force acts on a larger area, pressure decreases. This is why broad straps of a school bag are more comfortable than thin straps - the force is distributed over larger area, reducing pressure on shoulders.

Practical Examples:

1. Nails have pointed tips (small area) to create high pressure for easy penetration
2. Camels have broad feet to reduce pressure and prevent sinking in sand
3. Buildings have wide foundations to reduce pressure on ground

Q24. Element has valency 2 and atomic number 12. Write electronic configuration.

Marking Scheme: 1 mark for electronic configuration + 1 mark for verification of valency

Solution:

Given:
Atomic number = 12
Valency = 2

Electronic Configuration:
Atomic number 12 means the element has 12 electrons.

Distribution of electrons in shells:
K shell (n=1): Maximum 2 electrons → 2 electrons
L shell (n=2): Maximum 8 electrons → 8 electrons
M shell (n=3): Remaining electrons → 2 electrons

Electronic Configuration: 2, 8, 2

Verification of Valency:
The outermost shell (M shell) has 2 electrons.
Since the outermost shell has less than 4 electrons, the valency equals the number of electrons in the outermost shell.
Therefore, **Valency = 2** ✓

Note: This is the electronic configuration of **Magnesium (Mg)**, which belongs to Group 2 (alkaline earth metals) and Period 3 of the periodic table.

Q25. Name tissue responsible for movement. Write two types.

Marking Scheme: 1 mark for naming tissue + 1 mark for two types

Solution:

Tissue Responsible for Movement:
Muscular tissue is responsible for movement in our body.

Muscular tissue is composed of elongated cells called muscle fibers that contain contractile proteins (actin and myosin). These proteins enable the muscle cells to contract and relax, producing movement.

Two Types of Muscular Tissue:

1. Striated Muscles (Skeletal Muscles):
• Show alternate light and dark bands (striations) under microscope
• Voluntary muscles - controlled by our will
• Attached to bones and help in body movement
• Cylindrical, unbranched, multinucleated fibers
• Example: Muscles of limbs, back, abdomen

2. Non-striated Muscles (Smooth Muscles):
• Do not show striations - smooth appearance
• Involuntary muscles - not under our control
• Found in internal organs
• Spindle-shaped, uninucleated fibers
• Example: Muscles of alimentary canal, blood vessels, iris of eye

3. Cardiac Muscles:
• Show faint striations
• Involuntary muscles
• Found only in the heart

• Cylindrical, branched, uninucleated fibers
• Rhythmic contraction and relaxation throughout life

Q26. Why does sound travel faster in solids than gases? Give reason.

Marking Scheme: 1 mark for statement + 1 mark for reason/explanation

Solution:

Statement:
Sound travels fastest in solids, slower in liquids, and slowest in gases.

Speed of sound approximately:
• In solids: 5000-6000 m/s (e.g., in steel ~5960 m/s)
• In liquids: 1400-1500 m/s (e.g., in water ~1500 m/s)
• In gases: 300-350 m/s (e.g., in air ~344 m/s)

Reasons:

1. Intermolecular Distance:
• In solids, molecules are very closely packed with minimum intermolecular distance
• In gases, molecules are far apart with large intermolecular distance
• Sound waves are transmitted by vibrations passing from one molecule to another
• When molecules are closer, vibrations are transferred more quickly

2. Elasticity:
• Solids are more elastic than liquids and gases
• Higher elasticity means molecules return to original position faster after disturbance
• This helps in faster propagation of sound waves

3. Density Effect:
• Although solids are denser, the effect of elasticity dominates over density
• The strong intermolecular forces in solids facilitate rapid energy transfer

Conclusion:
The speed of sound depends on the medium's elasticity and density. Due to closely packed molecules and high elasticity, sound travels much faster in solids compared to gases.

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

Q27. (a) Reverberation and reduction (b) Differences (c) Concert halls

Marking Scheme: 1 mark each part

Solution:

(a) Reverberation and How to Reduce It:

Reverberation:
Reverberation is the persistence of sound in a closed space due to repeated reflections from walls, ceiling, and floor. When sound is produced in an enclosed space, it undergoes multiple reflections before dying out, causing the sound to continue even after the source stops producing it.

How to Reduce Reverberation:
1. Cover walls and ceiling with sound-absorbing materials like compressed fiberboard, felt, or acoustic tiles
2. Use carpets and curtains to absorb sound
3. Install perforated cardboard on walls
4. Upholster seats in auditoriums
5. Design halls with proper dimensions and avoid parallel reflecting surfaces

(b) Differences between Echo and Reverberation:

Echo	Reverberation

Echo is a distinct repetition of sound	Reverberation is persistence of sound with no distinct repetition
Heard after a time gap (minimum 0.1 s)	Sound continues without clear separation
Requires minimum distance of 17.2 m	Occurs in closed spaces regardless of distance
Original and reflected sounds are heard separately	Multiple reflections overlap, causing prolonged sound

(c) Why Concert Halls Use Sound-Absorbing Materials:

Concert halls are designed with sound-absorbing materials to:

• Control reverberation and prevent excessive echoes

• Ensure clarity of sound and music

• Prevent sound distortion and overlapping

• Create optimal acoustics for audience to hear clear, distinct sounds

• Maintain proper balance between sound absorption and reflection for the best listening experience

Excessive reverberation makes speech unintelligible and music unpleasant, hence sound-absorbing materials are essential.

Q28. (a) Valency and determination (b) Valency of Na, O, Al

Marking Scheme: 1 mark for definition + 1 mark for method + 1 mark for all three valencies

Solution:

(a) What is Valency? How is it Determined?

Valency:

Valency is the combining capacity of an element. It is the number of electrons that an atom can lose, gain, or share to achieve a stable electronic configuration (complete octet

or duplet).

How Valency is Determined:

1. Write the electronic configuration of the element
2. Find the number of valence electrons (electrons in outermost shell)
3. Apply the rule:

• If valence electrons ≤ 4: Valency = Number of valence electrons

• If valence electrons > 4: Valency = 8 - Number of valence electrons

• If valence electrons = 8 (or 2 for first shell): Valency = 0 (inert/stable)

(b) Valency of Elements:

(i) Sodium (Na) - Atomic number 11:

Electronic configuration: 2, 8, 1

Valence electrons = 1

Since valence electrons ≤ 4, Valency = 1

Valency of Sodium = 1

(Sodium loses 1 electron to achieve stable configuration)

(ii) Oxygen (O) - Atomic number 8:

Electronic configuration: 2, 6

Valence electrons = 6

Since valence electrons > 4, Valency = 8 - 6 = 2

Valency of Oxygen = 2

(Oxygen gains 2 electrons to complete octet)

(iii) Aluminum (Al) - Atomic number 13:

Electronic configuration: 2, 8, 3

Valence electrons = 3

Since valence electrons ≤ 4, Valency = 3

Valency of Aluminum = 3

(Aluminum loses 3 electrons to achieve stable configuration)

Q29. Sound wave: frequency 500 Hz, wavelength 0.68 m. Calculate speed, time period, distance in 5s

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

Solution:

Given:
Frequency, $\nu = 500$ Hz
Wavelength, $\lambda = 0.68$ m

(a) Speed of Sound:
Using the wave equation: $v = \nu\lambda$
$v = 500 \times 0.68$
$v = 340$ m/s

Therefore, the speed of sound is **340 m/s**

(b) Time Period of the Wave:
Time period (T) is the reciprocal of frequency
$T = 1/\nu$
$T = 1/500$
$T = 0.002$ s or 2×10^{-3} s or 2 ms

Therefore, the time period is **0.002 seconds or 2 milliseconds**

(c) Distance Travelled in 5 Seconds:
Using: Distance = Speed × Time
Distance = $v \times t$
Distance = 340×5
Distance = 1700 m or 1.7 km

Therefore, sound will travel **1700 meters or 1.7 kilometers** in 5 seconds.

Summary of Relationships:
• $v = \nu\lambda$ (Wave equation)
• $T = 1/\nu$ (Time period and frequency are reciprocals)

- $v = 1/T$
- Distance = Speed × Time

Q30. OR - Man between cliffs, first echo 1.5s, second echo 2.5s. Calculate distances.

Marking Scheme: 1.5 marks for distance to each cliff + 1.5 marks for distance between cliffs

Solution:

Given:
Time for first echo, $t_1 = 1.5$ seconds
Time for second echo, $t_2 = 2.5$ seconds
Speed of sound in air, $v = 340$ m/s

(a) Distance of Man from Each Cliff:

The echo is heard when sound travels to the cliff and returns back to the man.
Therefore, Total distance = 2 × Distance to cliff

For First Cliff (nearer cliff):
Total distance = Speed × Time
$2 \times d_1 = 340 \times 1.5$
$2d_1 = 510$
$d_1 = 510/2$
$d_1 = 255$ m

For Second Cliff (farther cliff):
Total distance = Speed × Time
$2 \times d_2 = 340 \times 2.5$
$2d_2 = 850$
$d_2 = 850/2$
$d_2 = 425$ m

Therefore:

• Distance of man from nearer cliff = **255 m**
• Distance of man from farther cliff = **425 m**

(b) Distance Between the Two Cliffs:
Since the man is standing between the two parallel cliffs:
Distance between cliffs = $d_1 + d_2$
= 255 + 425
= 680 m

Therefore, the distance between the two cliffs is **680 meters**

Q31. (a) Golgi function (b) ER importance (c) Detoxification organelle

Marking Scheme: 1 mark each part

Solution:

(a) Function of Golgi Apparatus:
The Golgi apparatus (also called Golgi body or Golgi complex) performs the following main functions:

1. **Packaging and Modification:** It receives proteins and lipids from the endoplasmic reticulum, modifies them, and packages them into vesicles

2. **Secretion:** It prepares materials for secretion outside the cell (exocytosis). The packaged materials in vesicles are sent to the cell membrane for release

3. **Formation of Lysosomes:** It forms lysosomes by packaging digestive enzymes

4. **Glycoprotein Synthesis:** It adds carbohydrate groups to proteins to form glycoproteins

5. **Storage and Transport:** It stores and transports proteins and lipids to various parts of the cell

The Golgi apparatus acts as the "post office" or "traffic controller" of the cell, managing the packaging and distribution of cellular products.

(b) Importance of Endoplasmic Reticulum for Protein Synthesis:
The Endoplasmic Reticulum (ER), specifically the **Rough Endoplasmic Reticulum (RER)**, is important for protein synthesis because:

1. **Ribosome Attachment:** The RER has ribosomes attached to its surface, which are the sites of protein synthesis

2. **Protein Folding and Processing:** Proteins synthesized by ribosomes enter the ER lumen where they are properly folded and modified

3. **Quality Control:** ER ensures proteins are correctly folded before sending them to Golgi apparatus

4. **Transport Pathway:** It provides channels for transporting proteins to different parts of the cell and to Golgi apparatus for further processing

5. **Protein Packaging:** ER packages proteins into vesicles for transport

Without ER, proper protein synthesis, folding, and distribution would not be possible.

(c) Organelle for Detoxification of Drugs:
Smooth Endoplasmic Reticulum (SER) is the organelle that helps in detoxification of drugs and harmful substances.

The SER contains enzymes that:
• Break down toxic substances, including drugs and alcohol
• Convert harmful chemicals into less toxic forms
• Help in the metabolism of drugs

SER is particularly abundant in liver cells, which are the main detoxification centers of the body.

Q32. OR - (a) Diagram of simple permanent tissues (b) Functions (c) Flexibility tissue

> **Marking Scheme:** 1 mark for diagram + 1 mark for functions + 1 mark for identifying tissue

Solution:

(a) Labeled Diagram of Simple Permanent Tissues:
[Diagrams should show three types: Parenchyma, Collenchyma, and Sclerenchyma with proper labels]

1. Parenchyma:
• Thin-walled cells
• Large intercellular spaces
• Living cells with prominent vacuoles

2. Collenchyma:
• Thickened corners
• Small intercellular spaces
• Living elongated cells

3. Sclerenchyma:
• Thick lignified walls
• No intercellular spaces
• Dead cells at maturity

(b) Functions of Each Simple Permanent Tissue:

1. Parenchyma:
Functions:
• Storage of food materials (starch, sugars, proteins)
• Photosynthesis when cells contain chlorophyll (chlorenchyma)
• Provides buoyancy to aquatic plants (aerenchyma with air cavities)
• Helps in gaseous exchange
• Fills spaces between other tissues

2. Collenchyma:

Functions:

• Provides mechanical support and strength to young stems and leaf stalks

• Provides flexibility to plants, allowing bending without breaking

• Assists in photosynthesis when cells contain chloroplasts

• Allows growth of plant parts as cells are living

3. Sclerenchyma:

Functions:

• Provides maximum mechanical strength and rigidity to plant parts

• Makes stems, branches, and trunks hard and stiff

• Protects seeds and nuts with hard coverings

• Provides support to mature plant parts

(c) Tissue Providing Flexibility Without Breaking:

Collenchyma tissue provides flexibility to plants without breaking.

Reason:

• Collenchyma cells are living and have thickened cell walls at corners

• The thickening provides strength while the living cytoplasm maintains flexibility

• This tissue allows plant parts like young stems and petioles to bend in wind without breaking

• Found mainly below the epidermis in dicot stems and leaf stalks

This is why young green stems can bend easily but don't break - collenchyma provides both support and flexibility.

Q33. (a) Differentiate striated and non-striated muscles (b) Cardiac location (c) Cardiac feature

> **Marking Scheme:** 1 mark for differences + 1 mark for location + 1 mark for feature

Solution:

(a) Differences Between Striated and Non-striated Muscles:

Feature	Striated Muscles	Non-striated Muscles
Appearance	Show alternate light and dark bands (striations)	Smooth appearance, no striations
Control	Voluntary - under conscious control	Involuntary - not under conscious control
Shape	Long, cylindrical, unbranched fibers	Spindle-shaped (pointed at both ends)
Nuclei	Multinucleated (many nuclei)	Uninucleated (single nucleus)
Contraction	Rapid and powerful but tires quickly	Slow and sustained contraction
Location	Attached to bones (skeletal muscles)	Internal organs (stomach, intestine, blood vessels)
Function	Body movement, posture, locomotion	Movement of food, blood, internal organ functions

(b) Location of Cardiac Muscle:
Cardiac muscle is found exclusively in the **heart wall (myocardium)**.

It forms the middle layer of the heart wall and is responsible for the rhythmic contraction and relaxation of the heart throughout life. Cardiac muscle is not found in any other part of the body.

(c) Characteristic Feature of Cardiac Muscle:
One important characteristic feature of cardiac muscle is:

Rhythmic Automatic Contraction:
Cardiac muscles contract and relax rhythmically and automatically throughout life without getting fatigued. This property is called **rhythmicity** or **automaticity**.

Other Important Features:
• **Branched Structure:** Cardiac muscle fibers are cylindrical and branched, forming a network
• **Intercalated Discs:** Adjacent fibers are connected by specialized junctions called

intercalated discs that allow synchronized contraction

• **Involuntary Control:** Works continuously without conscious control
• **Uninucleated:** Each fiber has a single centrally located nucleus
• **Striated Appearance:** Shows faint striations like skeletal muscle
• **Fatigue-Resistant:** Never gets tired, continues beating from birth to death

Q34. Force 50N on 10kg body initially at rest. Calculate acceleration, velocity, change in momentum

Marking Scheme: 1 mark each calculation

Solution:

Given:
Force, F = 50 N
Mass, m = 10 kg
Initial velocity, u = 0 (body at rest)
Time, t = 4 seconds

(a) Acceleration Produced:
Using Newton's second law: F = ma
50 = 10 × a
a = 50/10
a = 5 m/s²

Therefore, the acceleration produced is **5 m/s²**

(b) Velocity After 4 Seconds:
Using first equation of motion: v = u + at
v = 0 + 5 × 4
v = 0 + 20
v = 20 m/s

Therefore, the velocity after 4 seconds is **20 m/s**

(c) Change in Momentum After 4 Seconds:

Method 1: Using momentum formula

Initial momentum, $p_1 = mu = 10 \times 0 = 0$ kg m/s

Final momentum, $p_2 = mv = 10 \times 20 = 200$ kg m/s

Change in momentum = $p_2 - p_1$

= 200 - 0

= 200 kg m/s

Method 2: Using impulse-momentum theorem

Change in momentum = Force × Time

= F × t

= 50 × 4

= 200 kg m/s or 200 N s

Therefore, the change in momentum is **200 kg m/s**

Q35. OR - (a) Conservation of momentum with example (b) Recoil velocity calculation

> **Marking Scheme:** 1.5 marks for principle + 1.5 marks for calculation

Solution:

(a) Principle of Conservation of Momentum with Example:

Statement:

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

Mathematical Form:

Total momentum before interaction = Total momentum after interaction

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Example:

Recoil of a Gun:

When a gun is fired, the bullet moves forward with high velocity, and the gun recoils backward. Before firing, both gun and bullet are at rest, so total momentum = 0. After firing, the bullet gains forward momentum and the gun gains backward momentum. The total momentum remains zero, demonstrating conservation of momentum.

Before firing: Total momentum = 0

After firing: Momentum of bullet + Momentum of gun = 0

Therefore: $m_1v_1 + m_2v_2 = 0$

This shows $v_2 = -(m_1v_1)/m_2$ (negative indicates opposite direction)

Other Examples:

• Rocket propulsion in space

• Collision between two balls

• A person jumping from a boat to shore (boat moves backward)

(b) Calculate Recoil Velocity of Rifle:

Given:

Mass of rifle, $m_1 = 4$ kg

Mass of bullet, $m_2 = 50$ g $= 0.05$ kg

Velocity of bullet, $v_2 = 400$ m/s

Initial velocities: $u_1 = u_2 = 0$ (both at rest)

Recoil velocity of rifle, $v_1 = ?$

Using conservation of momentum:

Total momentum before firing = Total momentum after firing

$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

$0 + 0 = m_1v_1 + m_2v_2$

$0 = (4 \times v_1) + (0.05 \times 400)$

$0 = 4v_1 + 20$

$4v_1 = -20$

$v_1 = -20/4$

$v_1 = -5$ m/s

Recoil velocity of rifle = 5 m/s (in the direction opposite to the bullet)

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

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

Q36. (a) Thrust and pressure (b) Ship floats, nail sinks (c) Pressure calculations

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

Solution:

(a) Definitions and SI Units:

Thrust:
Thrust is the total force acting perpendicular to a surface.
SI Unit: Newton (N)

Pressure:
Pressure is defined as the force acting perpendicular to a surface per unit area.
Formula: Pressure = Thrust/Area or P = F/A
SI Unit: Pascal (Pa) or Newton per square meter (N/m^2)
1 Pascal = 1 N/m^2

(b) Why Ship Floats While Nail Sinks:

Although both the ship and nail are made of iron, the ship floats while the nail sinks due to the following reasons:

1. Volume and Density:
• An iron nail is solid and compact, having high density
• A ship is hollow with a large volume, making its average density much less than the

density of water

• Density of iron = 7800 kg/m³ (much greater than water's 1000 kg/m³)

• Average density of ship = (Total mass)/(Total volume including hollow space) < 1000 kg/m³

2. Buoyant Force and Weight:

• **For the ship:** The large volume displaces a large amount of water, creating a large buoyant force. This buoyant force is equal to or greater than the weight of the ship, so it floats

• **For the nail:** The small volume displaces very little water, so the buoyant force is small. Since the weight of the nail is greater than the buoyant force, it sinks

3. Principle:

According to Archimedes' principle, a body floats when:

Weight of body ≤ Weight of water displaced

• Ship: Weight of ship = Weight of large volume of water displaced → Floats

• Nail: Weight of nail > Weight of small volume of water displaced → Sinks

(c) Pressure Calculations:

Given: Force, F = 200 N

(i) When Area = 2 m²:

Pressure = Force/Area

P = 200/2

P = 100 Pa or 100 N/m²

(ii) When Area = 0.5 m²:

Pressure = Force/Area

P = 200/0.5

P = 400 Pa or 400 N/m²

(iii) When Area = 0.1 m²:

Pressure = Force/Area

P = 200/0.1

P = 2000 Pa or 2000 N/m²

Conclusion About Relation Between Pressure and Area:
From the calculations above, we can conclude that:

Pressure is inversely proportional to area when force is constant.
$P \propto 1/A$

• When area decreases, pressure increases
• When area increases, pressure decreases
• When area is halved, pressure doubles
• When area is reduced to 1/10, pressure becomes 10 times

This principle explains why:
• Sharp knives cut better than blunt ones
• Nails have pointed tips
• Camels have broad feet to walk on sand
• Buildings have wide foundations

Q36. OR - (a) Laws of reflection of sound (b) SONAR working (c) Depth calculation

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

Solution:

(a) Laws of Reflection of Sound:
Sound waves follow the same laws of reflection as light waves:

First Law:
The incident sound wave, the reflected sound wave, and the normal to the reflecting surface at the point of incidence all lie in the same plane.

Second Law:
The angle of incidence (i) is equal to the angle of reflection (r).
$\angle i = \angle r$

These laws are applicable to all types of reflecting surfaces (plane, curved, rough, or smooth).

(b) How SONAR Works:

SONAR (Sound Navigation and Ranging) is a technique that uses ultrasound waves to detect and locate objects underwater.

Working Principle:

Step 1: Emission
• A SONAR device (transmitter) fitted at the bottom of a ship sends ultrasound signals vertically downward into the sea
• These are high-frequency sound waves (above 20,000 Hz)

Step 2: Propagation
• The ultrasound waves travel through water at the speed of sound in water (approximately 1500 m/s)
• They travel down toward the seabed or underwater object

Step 3: Reflection
• When the ultrasound waves hit the seabed, submarine, or any underwater object, they get reflected back

Step 4: Detection
• The reflected waves (echo) are detected by a receiver (detector) on the ship
• The time interval (t) between transmission and reception of the signal is measured

Step 5: Calculation
• Knowing the speed of sound in water (v) and the time taken (t), the distance is calculated using:
• $2d = v \times t$
• Therefore: $d = (v \times t)/2$

Diagram Description:
[Should show: Ship on water surface, SONAR transmitter at bottom, ultrasound waves

going down, seabed reflecting waves back, detector receiving echo, with labels and arrows]

Applications of SONAR:

• Determining depth of sea/ocean
• Locating underwater objects (submarines, shipwrecks, icebergs)
• Detecting schools of fish
• Navigation and communication
• Creating underwater maps

(c) Calculate Depth of Sea:

Given:
Time for echo to return, t = 0.4 seconds
Speed of sound in water, v = 1500 m/s
Depth of sea, d = ?

The ultrasound travels to the seabed and back, so:
Total distance travelled = 2 × depth

Using: Distance = Speed × Time
$2d = v \times t$
$2d = 1500 \times 0.4$
$2d = 600$
$d = 600/2$
$d = 300$ m

Therefore, the depth of the sea is **300 meters**

Q37. (a) Thomson's model (b) Rutherford's model (c) Limitations

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

Solution:

(a) Thomson's Model and Why It Was Rejected:

Thomson's Plum Pudding Model (1904):

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

• Negatively charged electrons are embedded in this positive sphere like plums in a pudding

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

• Atom is a solid sphere with no empty space

Why It Was Rejected:

Thomson's model was rejected because it could not explain:

1. **Results of Rutherford's Alpha Scattering Experiment:**

• According to Thomson's model, alpha particles should pass through with little or no deflection

• But Rutherford found that most passed through, some deflected at large angles, and a few bounced back

• This could not be explained by uniformly distributed positive charge

2. **Distribution of Positive Charge:**

• Failed to explain how positive charge is concentrated

• Could not account for the presence of a nucleus

3. **Line Spectrum:**

• Could not explain the line spectrum of hydrogen and other elements

(b) Rutherford's Model of Atom:

Rutherford's Nuclear Model (1911):

Based on his alpha particle scattering experiment, Rutherford proposed:

Main Features:

1. **Nucleus:**

• Atom has a small, dense, positively charged central core called the nucleus

• Almost all the mass of the atom is concentrated in the nucleus
• Size of nucleus is about 10^{-15} m (very small compared to atom's size of 10^{-10} m)

2. **Electrons:**
• Negatively charged electrons revolve around the nucleus in circular orbits
• Electrons are held in orbits by electrostatic force of attraction between positive nucleus and negative electrons

3. **Empty Space:**
• Most of the atom is empty space
• This explains why most alpha particles passed through the gold foil

4. **Electrical Neutrality:**
• The number of protons in nucleus equals the number of electrons revolving around it
• This makes the atom electrically neutral

Diagram:
[Should show: Small central nucleus with +ve charge, electrons revolving in circular orbits around nucleus, mostly empty space, labels for nucleus, electrons, orbits]

(c) Two Limitations of Rutherford's Model:

1. Stability of Atom:
• According to electromagnetic theory, a charged particle (electron) moving in a circular path continuously loses energy in the form of electromagnetic radiation
• If electrons lose energy, they should spiral into the nucleus and the atom should collapse
• But atoms are stable and do not collapse
• Rutherford's model could not explain this stability

2. Line Spectrum:
• If electrons continuously lose energy, they should emit radiation of all possible wavelengths, producing a continuous spectrum
• However, elements emit radiation only of certain specific wavelengths, giving line spectra
• Rutherford's model could not explain the discrete line spectrum of hydrogen and other elements

3. Position of Electrons:

• The model did not explain how electrons are arranged around the nucleus

• No information about energy levels or shells

These limitations were later addressed by Niels Bohr in his atomic model (1913).

Q37. OR - (a) Bohr's model with diagram (b) Postulates (c) Identify element 2,8,7

Total Marks: 5

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

Solution:

(a) Bohr's Model of Atom:

Bohr's Atomic Model (1913):

Niels Bohr modified Rutherford's model to explain the stability of atoms and line spectra.

Key Features:

• Electrons revolve around the nucleus in specific circular paths called orbits or energy levels or shells

• These orbits are designated as K, L, M, N... or numbered as 1, 2, 3, 4...

• Each orbit has a fixed energy level

• Electrons do not lose energy while revolving in these stationary orbits

• When an electron jumps from higher to lower orbit, it emits energy; when it jumps from lower to higher orbit, it absorbs energy

Diagram Showing Electron Distribution in First Three Shells:

[Diagram should show:]

• Central nucleus with positive charge

• K shell (n=1) - closest to nucleus - can hold maximum 2 electrons

• L shell (n=2) - second shell - can hold maximum 8 electrons

• M shell (n=3) - third shell - can hold maximum 18 electrons

• Electrons shown as dots or small circles in their respective shells
• Labels: Nucleus, K shell, L shell, M shell, electrons

(b) Postulates of Bohr's Model (Any Three):

Postulate 1: Stationary Orbits
Electrons revolve around the nucleus only in certain fixed circular paths called stationary orbits or energy levels. Each orbit has a definite energy associated with it.

Postulate 2: No Energy Loss in Stationary Orbits
As long as an electron remains in a particular orbit, it does not radiate or lose energy. These orbits are therefore called stationary orbits or non-radiating orbits.

Postulate 3: Energy Absorption and Emission
Energy is emitted or absorbed only when an electron jumps from one orbit to another. When an electron jumps from a higher orbit to a lower orbit, it emits energy in the form of electromagnetic radiation. When it jumps from a lower to a higher orbit, it absorbs energy.
Energy change: $\Delta E = E_2 - E_1 = h\nu$
Where h is Planck's constant and ν is the frequency of radiation.

Postulate 4: Angular Momentum
The angular momentum of an electron in a stationary orbit is an integral multiple of $h/2\pi$.
$mvr = nh/2\pi$ (where n = 1, 2, 3...)

(c) Identify Element with Configuration 2, 8, 7:

Electronic configuration: 2, 8, 7

Atomic Number:
Total electrons = 2 + 8 + 7 = 17
Atomic number = Number of electrons = **17**

Identification:
The element with atomic number 17 is **Chlorine (Cl)**

Position in Periodic Table:

Group:
Number of valence electrons (electrons in outermost shell) = 7
For elements with valence electrons 1-8, Group number = 10 + Number of valence electrons
Group = 10 + 7 = **17** (Group of Halogens)

Period:
Number of shells = 3 (K, L, M)
Period = Number of shells = **3**

Valency:
Since valence electrons = 7 (more than 4)
Valency = 8 - 7 = **1**

Summary:
Element: Chlorine (Cl)
Atomic Number: 17
Group: 17 (Halogens)
Period: 3
Valency: 1

Q38. (a) Human ear diagram (b) How we hear (c) Audible range

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

Solution:

(a) Labeled Diagram of Human Ear:
[Diagram should include the following labeled parts:]

Outer Ear:
• Pinna (auricle)

• Ear canal (auditory canal)
• Eardrum (tympanic membrane)

Middle Ear:
• Three small bones (ossicles): Hammer (Malleus), Anvil (Incus), Stirrup (Stapes)
• Eustachian tube

Inner Ear:
• Cochlea
• Auditory nerve
• Semicircular canals (for balance)

(b) How We Hear Sound - Function of Each Part:

Sound Hearing Process:

Step 1: Sound Collection
• **Pinna (Outer Ear):** The outer part of the ear shaped like a funnel. It collects sound waves from the surroundings and directs them into the ear canal.

Step 2: Sound Transmission Through Air
• **Ear Canal:** Sound waves travel through this tube-like passage and reach the eardrum.

Step 3: Vibration of Eardrum
• **Eardrum (Tympanic Membrane):** A thin, flexible membrane that vibrates when sound waves hit it. The frequency of vibration matches the frequency of the sound wave.

Step 4: Amplification
• **Middle Ear Bones (Hammer, Anvil, Stirrup):** These three tiny bones form a chain. They pick up vibrations from the eardrum, amplify them, and transmit them to the inner ear. The stirrup (stapes) is the smallest bone in the human body and connects to the cochlea.

Step 5: Conversion to Electrical Signals
• **Cochlea:** A snail-shaped, fluid-filled structure in the inner ear. When vibrations from the stirrup reach the cochlea, they create waves in the fluid. The cochlea contains thousands of tiny hair cells that convert these mechanical vibrations into electrical nerve

impulses.

Step 6: Signal Transmission to Brain

• **Auditory Nerve:** Carries the electrical signals from the cochlea to the brain.

Step 7: Sound Perception

• **Brain:** The brain interprets these electrical signals as sound, allowing us to recognize and understand what we hear.

Additional Function:

• **Eustachian Tube:** Connects the middle ear to the throat and helps equalize air pressure on both sides of the eardrum.

• **Semicircular Canals:** Help maintain body balance (not involved in hearing).

(c) Audible Range of Frequency for Human Ears:

The audible range of frequency for human ears is:

20 Hz to 20,000 Hz (or 20 kHz)

Details:

• **Infrasound:** Frequencies below 20 Hz (cannot be heard by humans)

• **Audible Sound:** Frequencies between 20 Hz and 20,000 Hz (can be heard by humans)

• **Ultrasound:** Frequencies above 20,000 Hz (cannot be heard by humans)

Note:

• This range can vary slightly from person to person

• As people age, their ability to hear higher frequencies decreases

• Children can hear higher frequencies better than adults

• Some animals like dogs (up to 50,000 Hz), bats (up to 120,000 Hz), and dolphins can hear ultrasound

Q38. OR - (a) Complex permanent tissues (b) Diagrams (c) Differences (d) Living vs dead

Total Marks: 5

> Part (a): 1 mark | Part (b): 1.5 marks | Part (c): 1.5 marks | Part (d): 1 mark

Solution:

(a) Complex Permanent Tissues:
Complex permanent tissues are made up of more than one type of cell working together as a unit to perform a common function.

Two Types:
1. **Xylem** - Conducts water and minerals
2. **Phloem** - Conducts food (organic nutrients)

Both are also called **vascular tissues** or **conducting tissues**.

(b) Labeled Diagrams:

XYLEM STRUCTURE:
Xylem consists of four types of cells:

1. **Tracheids:**
• Long, tube-like cells with tapering ends
• Thick lignified walls with pits
• Dead cells (no protoplasm)
• Found in gymnosperms and pteridophytes

2. **Vessels:**
• Long cylindrical tubes
• Thick lignified walls
• Dead cells with perforated end walls
• Found in angiosperms
• More efficient for water transport

3. **Xylem Parenchyma:**
• Living cells with thin walls
• Stores food and helps in sideways conduction

4. **Xylem Fibers (Sclerenchyma):**
• Provide mechanical support

• Dead cells with thick lignified walls

[Diagram should show all four components with proper labels]

PHLOEM STRUCTURE:
Phloem consists of four types of cells:

1. **Sieve Tubes:**
• Long tube-like structures
• Living cells but no nucleus
• End walls have pores (sieve plates)
• Main conducting elements

2. **Companion Cells:**
• Living cells with nucleus
• Present alongside sieve tubes
• Control functioning of sieve tubes
• Only in angiosperms

3. **Phloem Parenchyma:**
• Living cells
• Store food
• Absent in monocots

4. **Phloem Fibers (Bast Fibers):**
• Provide mechanical support
• Dead cells with thick walls
• Used commercially (jute, hemp)

[Diagram should show all four components with proper labels]

(c) Three Differences Between Xylem and Phloem:

Feature	**Xylem**	**Phloem**
Function	Conducts water and minerals from roots to all parts of plant	Conducts prepared food (sugars, amino acids) from leaves to all parts

Direction	Unidirectional - upward movement only (roots to leaves)	Bidirectional - can move up or down as needed
Living/Dead	Mostly dead (except xylem parenchyma)	Living tissue (all components alive)
Cell Wall	Thick lignified walls	Thin cellulose walls
Position	Located towards the center of vascular bundle	Located towards the periphery of vascular bundle

(d) Why Phloem is Living While Most Xylem is Dead:

Phloem is Living Because:

• Phloem transports food (sugars, amino acids, hormones) which are organic substances
• This transport requires active processes and energy (ATP)
• Sieve tubes, companion cells, and phloem parenchyma are all living cells
• Living cells are needed to regulate the complex process of translocation
• Companion cells actively control the functioning of sieve tubes
• The process of loading and unloading of food requires metabolic activity

Most of Xylem is Dead Because:

• Xylem mainly transports water and minerals (inorganic substances)
• This transport is a passive physical process requiring no energy
• Tracheids and vessels are dead cells with thick lignified walls
• The thick walls provide mechanical strength to support the plant
• Dead cells create hollow tubes that allow efficient water flow without obstruction
• Lignification makes walls impermeable and prevents water loss
• Only xylem parenchyma remains living for storage purposes

Note: The death of xylem conducting elements (tracheids and vessels) is actually beneficial as it creates continuous hollow tubes for efficient water conduction throughout the plant's height.

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

Q39. CASE STUDY 1 - SONAR AND ULTRASOUND - ANSWERS:

Total Marks: 4

(i) What is ultrasound? Write frequency range. [1 mark]

Solution:
Ultrasound is sound with frequency higher than the upper limit of human audible range.

Frequency Range: Greater than 20,000 Hz (or 20 kHz)
Typically: 20,000 Hz to several gigahertz

Ultrasound cannot be heard by human beings but can be detected by certain animals like dogs, bats, dolphins, and porpoises.

(ii) Calculate depth of sea. [1 mark]

Solution:
Given:
Time for echo, t = 3 seconds
Speed of sound in seawater, v = 1500 m/s

The sound travels to the seabed and back, so:
Total distance = 2 × depth

$2d = v \times t$
$2d = 1500 \times 3$
$2d = 4500$
$d = 4500/2$
$d = 2250$ m or 2.25 km

Therefore, the depth of the sea is **2250 meters or 2.25 kilometers**

OR: Why can't humans hear ultrasound? [1 mark]

Solution:
Humans cannot hear ultrasound because the frequency of ultrasound (above 20,000 Hz) is beyond the upper limit of the human audible range (20 Hz to 20,000 Hz).

Our ear's structure, particularly the eardrum and cochlea, is designed to respond to vibrations within the audible frequency range only. The hair cells in our cochlea cannot detect vibrations of such high frequencies, so we cannot perceive ultrasound.

However, some animals like bats, dogs, and dolphins have ear structures that can detect these high-frequency sounds.

(iii) (a) Medical uses of ultrasound (b) How bats use ultrasound [2 marks]

> **Marking Scheme:** 1 mark for medical uses + 1 mark for bat echolocation

Solution:

(a) Two Medical Uses of Ultrasound:

1. Medical Imaging (Ultrasonography/Sonography):
• Used to create images of internal organs, tissues, and blood flow
• Commonly used during pregnancy to monitor fetal development (prenatal care)
• Helps examine heart (echocardiography), liver, kidneys, gallbladder, and other organs
• Safe, non-invasive, and does not use harmful radiation like X-rays

2. Breaking Kidney Stones (Lithotripsy):
• High-intensity ultrasound is used to break kidney stones and gallstones into smaller pieces
• The small pieces can then pass out of the body through urine naturally
• Avoids the need for surgery

Other Medical Uses:
• Cleaning delicate surgical instruments and electronic components
• Treating muscle strains and joint pains
• Dentistry for cleaning teeth

(b) How Bats Use Ultrasound to Catch Prey (Echolocation):

Bats use a technique called **echolocation** or **biosonar** to navigate and hunt in complete darkness:

Step 1: Emission

• Bats produce high-frequency ultrasound waves (typically 50,000 to 120,000 Hz) through their mouth or nose while flying

Step 2: Propagation

• These ultrasound waves travel through the air in all directions

Step 3: Reflection

• When these waves strike an object (insect, tree, obstacle), they get reflected back

Step 4: Detection

• The bat's highly sensitive ears detect the reflected ultrasound (echoes)

Step 5: Processing

• The bat's brain analyzes the time taken for the echo to return and the pattern of echoes
• From this, the bat can determine:
  - Distance of the object
  - Size and shape of the object
  - Direction and speed of movement
  - Whether it's prey or an obstacle

Step 6: Action

• Based on this information, the bat can accurately locate and catch flying insects even in complete darkness
• It can also avoid obstacles while flying at high speeds

Advantages of Echolocation:

• Allows hunting in complete darkness
• Can detect very small insects
• Extremely accurate - can detect objects as thin as a human hair
• Works effectively even in dense forests or caves

Q40. CASE STUDY 2 - NEWTON'S LAWS - ANSWERS:

Total Marks: 4

(i) State Newton's first law of motion. [1 mark]

Solution:
Newton's First Law of Motion (Law of Inertia):

A body at rest will remain at rest, and a body in motion will continue to move with uniform velocity in a straight line unless acted upon by an external unbalanced force.

In simpler terms:
Every object continues in its state of rest or uniform motion unless compelled to change that state by an external force.

This law introduces the concept of **inertia** - the tendency of an object to resist changes in its state of motion.

(ii) Calculate acceleration. [1 mark]

Solution:
Given:
Force, F = 100 N
Mass, m = 20 kg
Acceleration, a = ?

Using Newton's second law: F = ma
100 = 20 × a
a = 100/20
a = 5 m/s²

Therefore, the acceleration is **5 m/s²**

OR: Why do we fall forward when bus stops suddenly? [1 mark]

Solution:
When a moving bus stops suddenly, we tend to fall forward due to **inertia of motion**.

Explanation:

• When the bus is moving, our whole body (including lower part in contact with the bus) is in motion

• When the bus suddenly stops, the lower part of our body (feet and legs) in contact with the bus floor comes to rest due to friction

• However, the upper part of our body (which is not in direct contact with the bus floor) continues to remain in motion due to inertia

• This causes the upper part to move forward while the lower part has stopped

• As a result, we tend to fall forward

This is a direct application of Newton's first law of motion - the body tries to maintain its state of motion.

(iii) Calculate change in momentum. [2 marks]

> **Marking Scheme:** 1 mark for calculation + 1 mark for direction/explanation

Solution:

Given:

Mass of ball, m = 0.5 kg

Initial velocity, u = 10 m/s (towards wall)

Final velocity, v = -10 m/s (rebounds with same speed, opposite direction)

Taking direction towards wall as positive:

Initial momentum, $p_1 = mu$

$p_1 = 0.5 \times 10$

$p_1 = 5$ kg m/s (towards wall)

Final momentum, $p_2 = mv$

$p_2 = 0.5 \times (-10)$

$p_2 = -5$ kg m/s (away from wall)

Change in momentum = Final momentum - Initial momentum

$\Delta p = p_2 - p_1$

$\Delta p = (-5) - (5)$

$\Delta p = -10$ kg m/s

Magnitude of change in momentum = 10 kg m/s

Alternatively (considering magnitude only):
Change in momentum = m(v - u)
= 0.5 × [(-10) - (10)]
= 0.5 × (-20)
= -10 kg m/s

Magnitude = 10 kg m/s

Direction: The negative sign indicates that the change in momentum is in the direction away from the wall (opposite to the initial direction).

Note: Even though the ball rebounds with the same speed, there is a significant change in momentum because velocity is a vector quantity (has both magnitude and direction). The reversal of direction causes the change.

Q41. CASE STUDY 3 - ATOMIC STRUCTURE - ANSWERS:

Total Marks: 4

(i) Maximum electrons in outermost shell? [1 mark]

Solution:
The maximum number of electrons that can be accommodated in the **outermost shell** of an atom is **8 electrons**.

This is known as the **octet rule**. Atoms tend to gain, lose, or share electrons to achieve a stable configuration of 8 electrons in their outermost shell (similar to noble gases).

Exception: The first shell (K shell) can hold maximum only **2 electrons** (duplet rule). This applies to elements like Hydrogen and Helium.

(ii) Electronic configuration of element with atomic number 16. [1 mark]

Solution:

Atomic number = 16

Number of electrons = 16

Distribution of electrons in shells:

K shell (n=1): Maximum 2 electrons → 2 electrons

L shell (n=2): Maximum 8 electrons → 8 electrons

M shell (n=3): Remaining electrons → 6 electrons

Electronic Configuration: 2, 8, 6

Note: This is the electronic configuration of **Sulfur (S)**.

OR: Why do elements in same group have similar chemical properties? [1 mark]

Solution:

Elements in the same group have similar chemical properties because they have the **same number of valence electrons** (electrons in the outermost shell).

Explanation:

• Chemical properties of an element are determined by the number of valence electrons

• Elements in the same group have the same number of electrons in their outermost shell

• Therefore, they have the same valency

• They react in similar ways with other elements

• They form similar types of compounds

Examples:

• Group 1 (Alkali metals): Li, Na, K all have 1 valence electron - all react vigorously with water

• Group 17 (Halogens): F, Cl, Br all have 7 valence electrons - all form salts with metals

• Group 18 (Noble gases): All have 8 valence electrons (complete octet) - all are chemically inert

(iii) Element X: 2,8,1 - (a) Atomic number, valency (b) Group, period [2 marks]

> **Marking Scheme:** 1 mark for part (a) + 1 mark for part (b)

Solution:

Electronic configuration of element X: 2, 8, 1

(a) Atomic Number and Valency:

Atomic Number:
Total electrons = 2 + 8 + 1 = 11
Since number of electrons = atomic number (in a neutral atom)
Atomic Number = 11

Valency:
Number of valence electrons (electrons in outermost shell) = 1
Since valence electrons ≤ 4, valency = number of valence electrons
Valency = 1

The element loses 1 electron to achieve stable electronic configuration (2, 8).

(b) Group and Period:

Period:
Number of shells = 3 (K, L, M)
Period = Number of shells
Period = 3

Group:
Number of valence electrons = 1
For elements with 1 or 2 valence electrons:
Group = Number of valence electrons
Group = 1 (Alkali metals)

Identification:
The element with atomic number 11 is **Sodium (Na)**

Summary:
• Element: Sodium (Na)
• Atomic Number: 11
• Valency: 1
• Group: 1 (Alkali metals)

• Period: 3

Chemical Properties:

Sodium is a highly reactive metal that:

• Reacts vigorously with water to form sodium hydroxide and hydrogen gas

• Forms ionic compounds by losing one electron

• Has similar properties to other Group 1 elements (Li, K, Rb, Cs)

📚 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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