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Class 9 — Science
Case-Based Questions · Numerical Drills · Model Paper

Companion volume to *MLI Class 9 Science — Exploration, Notes & NCERT Solutions*
Based on *Exploration — Textbook of Science for Grade 9*, NCERT 2026 · Subject Code 086

FACULTY: MISHRA SIR • CBSE SESSION 2026–27

Why this volume exists. The CBSE paper design for Science 2026–27 allots **30% to Application of Knowledge and Concepts** and **20% to Formulate, Analyse, Evaluate and Create** — half the paper. Those marks are carried by **case, source and passage-based integrated questions** and by **numericals**, not by recall. The main MLI Science volume covers notes, NCERT solutions and extra questions; this companion drills the competency half.

Paper design, as notified. Theory 80 + Internal Assessment 20 = 100. Unit I World of Living 27 · Unit II Matter, Its Nature and Behaviour 25 · Unit III Motion, Force, Work and Sound 23 · Unit IV Earth as a System 5. Typology: Demonstrate Knowledge and Understanding 50% · Application 30% · Formulate, Analyse, Evaluate and Create 20%. Question types include objective/very short answer, assertion–reason, short answer, long answer and source/case/passage-based integrated questions, with roughly 33% internal choice. Duration 3 hours. A separate optional *Science at Advanced Level* paper is also offered from this session.

Diagrams. All figures in the MLI volumes are redrawn schematics for understanding — not to scale and not reproductions of textbook figures. Where a diagram is not clear, refer to the corresponding figure in your own copy of *Exploration*.

Accuracy. Prepared with AI assistance and reviewed by MLI faculty; numerical answers checked against the NCERT Answer Key. Report any error to your faculty.

📜 Contents

SECTION 1

Case, Source and Passage-Based Questions

12 sets · 4 marks each · Solved with reasoning

Method. Read the sub-questions first, then the passage. Sub-parts (i) and (ii) are nearly always answerable from the passage alone. The last sub-part asks you to apply a concept from your notes — that is where the analysis marks sit. Never rewrite the passage as your answer.

C1 — Cell (Unit I) 4 Marks

A student places identical strips of potato in three beakers: A contains distilled water, B a dilute salt solution of the same concentration as the potato cell sap, and C a strong salt solution. After two hours the strip from A is firm and slightly longer, from B unchanged, and from C limp and shorter.

(i) Name the process responsible. (1)

(ii) Explain what happened in beaker A. (1)

(iii) Explain what happened in beaker C and name the condition of those cells. (2)

SOLUTION

- (i) **Osmosis** — the movement of water across a selectively permeable membrane from a region of higher water concentration to one of lower.
- (ii) Distilled water is **hypotonic** to the cell sap, so water entered the cells. They swelled and became **turgid**, making the strip firm and slightly longer. The cell wall prevented them from bursting.
- (iii) The strong salt solution is **hypertonic**, so water moved **out** of the cells. The cytoplasm shrank away from the cell wall — the cells became **plasmolysed** (flaccid), leaving the strip limp and shorter. Beaker B was **isotonic**, so there was no net movement and no change.

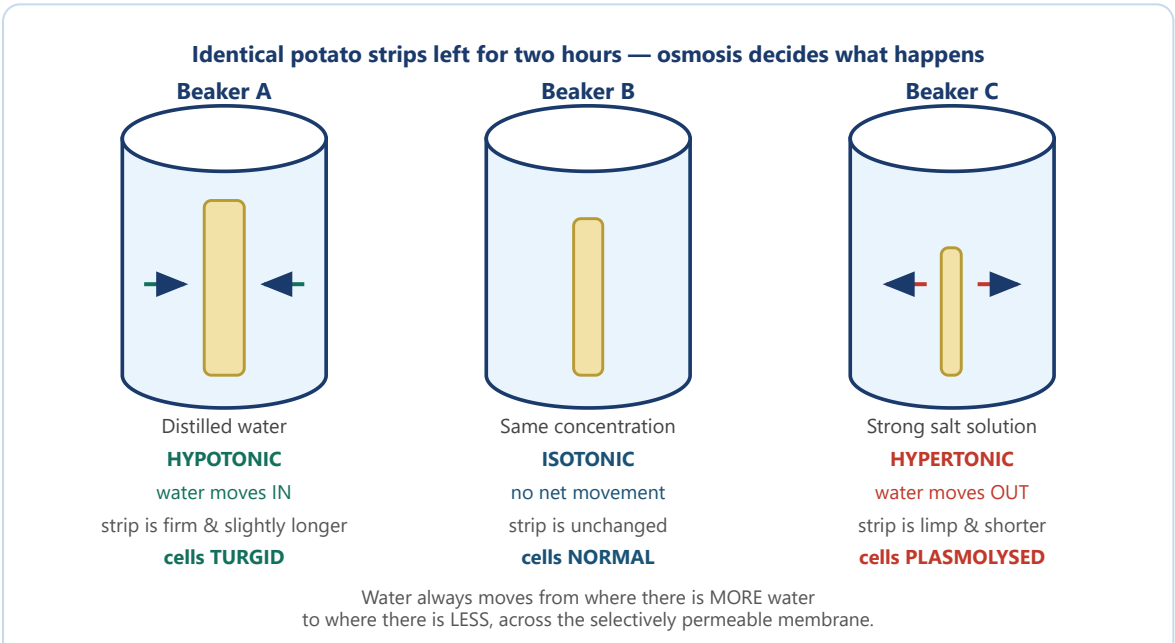


Fig. C1 — Osmosis in the three beakers of the case question

MLI-redrawn schematic — correct in construction but not to scale, and not a reproduction of any textbook figure. If anything is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.

C2 — Tissues (Unit I) 4 Marks

A gardener notices that after heavy grazing, the grass in a lawn regrows quickly from the base, whereas a young mango sapling whose shoot tip was nibbled off stops growing taller.

(i) Name the tissue responsible for the grass regrowing. (1)

(ii) Name the tissue lost by the mango sapling. (1)

(iii) Explain why losing this tissue stops the sapling growing taller but not thicker. (2)

SOLUTION

- (i) **Intercalary meristem**, present at the base of leaves and internodes in grasses.
- (ii) The **apical meristem** at the shoot tip.
- (iii) The apical meristem is the only tissue that adds to **length** (primary growth); once it is removed there is no region producing new cells at the tip, so vertical growth stops. Increase in **girth** comes from the **lateral meristem (cambium)** in the sides of the stem, which is untouched — so the sapling can still thicken.

C3 — Motion (Unit III) 4 Marks

An athlete runs once around a circular track of radius 35 m, starting and finishing at the same point, in 44 seconds. (Take π = 22/7.)

(i) Find the distance covered. (1)

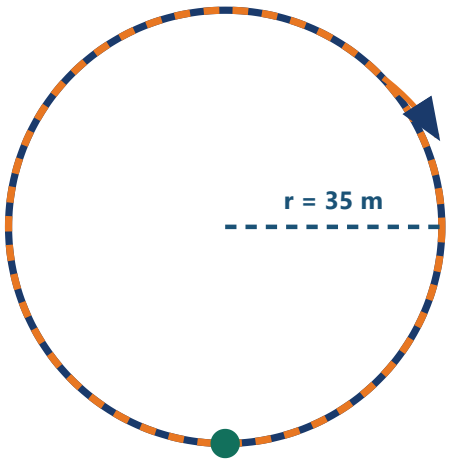
(ii) Find the displacement. (1)

(iii) Find the average speed and the average velocity, and explain the difference. (2)

SOLUTION

- (i) Distance = circumference = 2πr = 2 × (22/7) × 35 = **220 m**.
- (ii) The athlete returns to the starting point, so the shortest distance between the initial and final positions is zero. **Displacement = 0**.
- (iii) Average speed = total distance / total time = 220/44 = **5 m s^{-1}**. Average velocity = displacement / time = 0/44 = **0 m s^{-1}**. Speed is a **scalar** measuring the whole path travelled; velocity is a **vector** depending only on the net change of position. Over a closed loop the two differ completely.

One complete lap of a circular track



start AND finish — same point

Distance = whole path = circumference = 2πr = 220 m

Displacement = straight line from start to finish = 0 (they are the same point)

So average speed = 220/44 = 5 m s^{-1}, but average velocity = 0/44 = 0 m s^{-1}

Fig. C3 — Why distance and displacement differ over a closed loop

MLI-redrawn schematic — correct in construction but not to scale, and not a reproduction of any textbook figure. If anything is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.

C4 — Motion graphs (Unit III) 4 Marks

A velocity–time graph for a car shows: velocity rising uniformly from 0 to 20 m s^{-1} in the first 10 s; constant at 20 m s^{-1} for the next 20 s; then falling uniformly to 0 in the last 5 s.

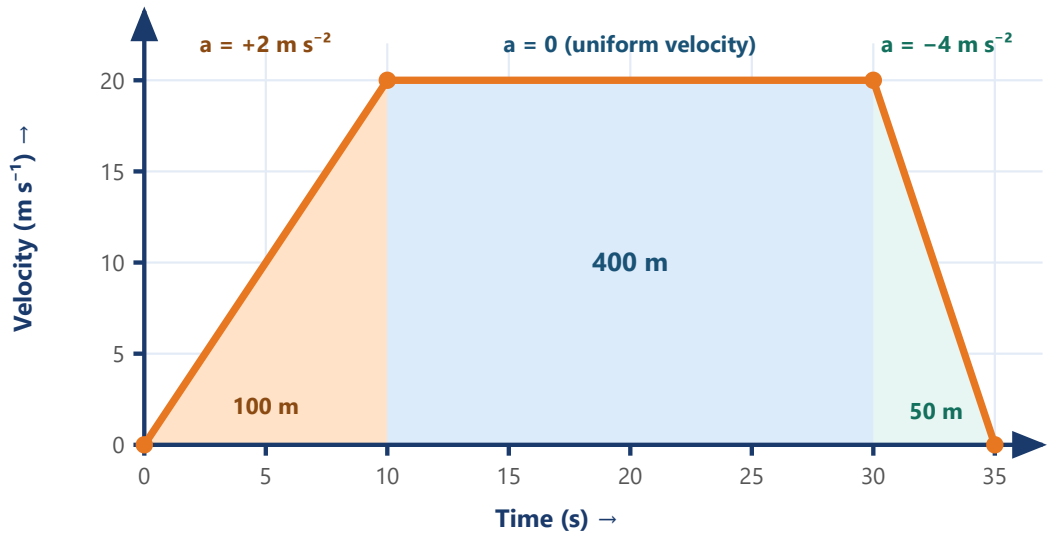
(i) Find the acceleration in the first phase. (1)

(ii) Find the retardation in the last phase. (1)

(iii) Find the total distance travelled. (2)

SOLUTION

- (i) a = (v − u)/t = (20 − 0)/10 = **2 m s^{-2}**.
- (ii) a = (0 − 20)/5 = −4, i.e. a **retardation of 4 m s^{-2}**.
- (iii) Distance = area under the v–t graph, which is a trapezium. Phase 1 (triangle) = ½ × 10 × 20 = 100 m. Phase 2 (rectangle) = 20 × 20 = 400 m. Phase 3 (triangle) = ½ × 5 × 20 = 50 m. **Total = 550 m.**



Total distance = area under the graph = 100 + 400 + 50 = 550 m

Fig. C4 — The velocity–time graph described in the question; slope gives acceleration, area gives distance

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C5 — Forces (Unit III)

4 Marks

A passenger standing in a stationary bus falls backwards when the bus suddenly starts, and lurches forward when it brakes sharply. The conductor advises holding the overhead rail.

(i) Which law explains both observations? (1)

(ii) Explain the backward fall when the bus starts. (1)

(iii) A bus of mass 4000 kg accelerates from rest to 10 m s^{-1} in 8 s. Find the force applied by the engine. (2)

SOLUTION

- (i) **Newton's first law of motion** — the law of inertia.
- (ii) When the bus starts, the passenger's feet move forward with the floor, but the upper body **tends to remain at rest** because of inertia of rest. The lower body advances while the upper lags, so the passenger falls backwards.
- (iii) a = (v − u)/t = (10 − 0)/8 = 1.25 m s^{-2}. F = ma = 4000 × 1.25 = **5000 N**.

C6 — Work and Energy (Unit III)

4 Marks

A boy of mass 40 kg climbs a staircase of 20 steps, each 15 cm high, in 25 seconds. (Take g = 10 m s^{-2}.)

(i) Find the total height climbed. (1)

(ii) Find the work done against gravity. (1)

(iii) Find his power, and state why the work done would be the same if he climbed in 50 s. (2)

SOLUTION

- (i) h = 20 × 0.15 m = **3 m**.
- (ii) W = mgh = 40 × 10 × 3 = **1200 J**.
- (iii) P = W/t = 1200/25 = **48 W**. The work depends only on the force and the displacement (mgh) — not on how long it takes. Climbing in 50 s does the same 1200 J of work but at half the power, 24 W.

C7 — Sound (Unit III) **4 Marks**

A person claps near a tall cliff and hears the echo 0.8 s later. The speed of sound in air that day is 340 m s^{-1}.

(i) Why is an echo heard? (1)

(ii) Find the distance of the cliff. (2)

(iii) State the minimum distance needed to hear a distinct echo, and why. (1)

SOLUTION

- (i) The sound wave is **reflected** from the large, hard surface of the cliff and returns to the listener.
- (ii) In 0.8 s the sound travels to the cliff **and back**. Total path = v × t = 340 × 0.8 = 272 m. Distance to cliff = 272/2 = **136 m**.
- (iii) About **17 m** at the speed given here. The ear holds the sensation of a sound for about 0.1 s, so the reflected sound must arrive at least 0.1 s later: distance = (340 × 0.1)/2 = **17 m**. The figure **17.2 m** printed in most books is the same calculation done at 344 m s^{-1} (air at 22 °C) — always use the speed given in the question.

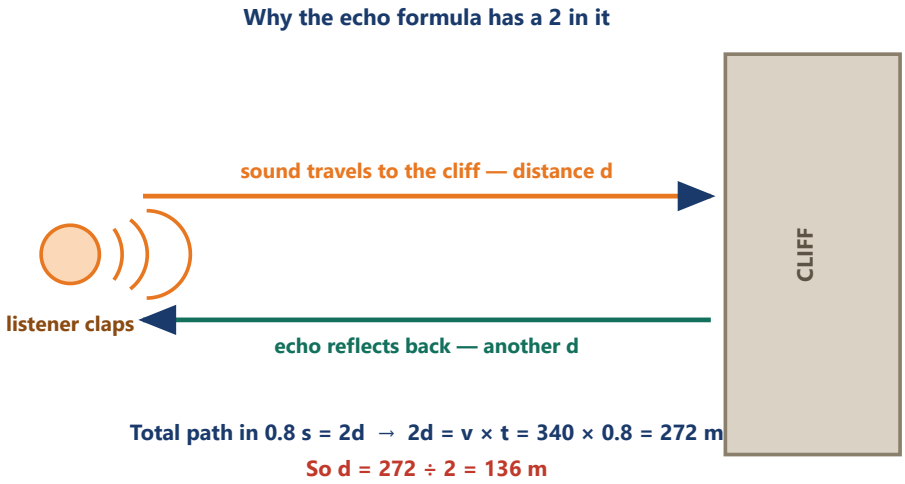

Fig. C7 — The sound covers the distance twice, which is why 2d = v × t

MLI-redrawn schematic — correct in construction but not to scale, and not a reproduction of any textbook figure. If anything is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.

C8 — Mixtures (Unit II)

4 Marks

A chemist is given a mixture of common salt, sand and iodine and must separate all three.

(i) Which single technique removes the iodine first, and why? (2)

(ii) How is the sand then separated from the salt? (1)

(iii) How is pure dry salt finally obtained? (1)

SOLUTION

- (i) **Sublimation**. Iodine changes directly from solid to vapour on heating and re-forms as a solid on a cool surface, while salt and sand do not sublime — so heating the mixture in a covered dish collects pure iodine on the inverted funnel or cold surface.
- (ii) Add water and stir: salt **dissolves** while sand does not. Separate the insoluble sand by **filtration** — sand is the residue, salt solution the filtrate.
- (iii) **Evaporate** (or crystallise) the filtrate to drive off the water, leaving dry salt. Crystallisation gives purer salt than simple evaporation.

C9 — Atomic structure (Unit II)

4 Marks

An element X has atomic number 17 and mass number 35. Another species Y has the same atomic number but mass number 37.

(i) State the number of protons, neutrons and electrons in X. (2)

(ii) What is the relationship between X and Y called? (1)

(iii) Will X and Y differ in chemical properties? Justify. (1)

SOLUTION

- (i) Protons = atomic number = **17**. Electrons in the neutral atom = **17**. Neutrons = mass number − atomic number = 35 − 17 = **18**.
- (ii) They are **isotopes** — same atomic number, different mass numbers.
- (iii) **No.** Chemical properties are decided by the number and arrangement of **electrons**, which is identical (17, arranged 2, 8, 7). Only physical properties that depend on mass, such as density, differ.

C10 — Atoms and molecules (Unit II)

4 Marks

In an experiment, 3 g of carbon burns completely in 8 g of oxygen to give 11 g of carbon dioxide. In a second trial, 3 g of carbon is burnt in 50 g of oxygen.
(i) Which law does the first trial illustrate? (1)
(ii) How much carbon dioxide forms in the second trial, and how much oxygen remains? (2)
(iii) Which law explains your answer to (ii)? (1)

SOLUTION

- (i) The **law of conservation of mass** — 3 + 8 = 11 g, so mass is neither created nor destroyed.
- (ii) Carbon and oxygen always combine in the fixed ratio 3 : 8 by mass. So 3 g of carbon can react with only **8 g** of oxygen, producing **11 g of carbon dioxide**, and **42 g of oxygen remains unreacted**.
- (iii) The **law of constant (definite) proportions** — a chemical compound always contains the same elements in the same fixed proportion by mass, whatever the amounts supplied.

C11 — Diversity (Unit I)

4 Marks

A student examines four organisms: a bacterium, an *Amoeba*, a mushroom and a mango tree.
(i) Which one is prokaryotic, and what makes it so? (2)
(ii) Which two have a cell wall but differ in its chemical composition? (1)
(iii) Which one is unicellular but eukaryotic? (1)

SOLUTION

- (i) The **bacterium**. It lacks a true, membrane-bound **nucleus** (its genetic material lies free in the cytoplasm as a nucleoid) and has no membrane-bound organelles such as mitochondria.
- (ii) The **mushroom** and the **mango tree** — the fungal wall is made of **chitin** while the plant wall is made of **cellulose**.
- (iii) **Amoeba** — a single cell, but with a true nucleus and organelles.

C12 — Earth as a System (Unit IV) 4 Marks

A village clears a patch of forest to grow crops. Within a few years the soil is less fertile, the stream nearby runs muddy after rain, and local temperatures feel higher.

(i) Name the Earth subsystem most directly disturbed by removing the trees. (1)

(ii) Explain why the stream runs muddy. (1)

(iii) Explain, using a biogeochemical cycle, why the soil loses fertility. (2)

SOLUTION

- (i) The **biosphere** — though the change immediately affects the lithosphere (soil), hydrosphere (stream) and atmosphere (temperature) too, which is exactly the point of studying Earth as a system.
- (ii) Without roots to bind the soil and a canopy to break the force of rain, the topsoil is washed away as **run-off erosion**, carrying sediment into the stream.
- (iii) In the forest, the **carbon and nitrogen cycles** were closed locally: leaf litter and dead matter were decomposed by microbes and the nutrients returned to the soil. Once the trees are removed, that litter input stops, decomposition slows, and the nitrogen and organic carbon held in the topsoil are lost by erosion and by harvesting crops away from the land. Nothing replaces them, so fertility falls.

SECTION 2

Numerical Drill

Motion · Force · Work, Energy and Power · Sound

📏 **Formula sheet**

Motion. speed = distance/time | velocity = displacement/time | a = (v − u)/t

Equations of motion: $v = u + at$ | $s = ut + \frac{1}{2}at^2$ | $v^2 = u^2 + 2as$

Distance = area under a velocity–time graph; acceleration = its slope.

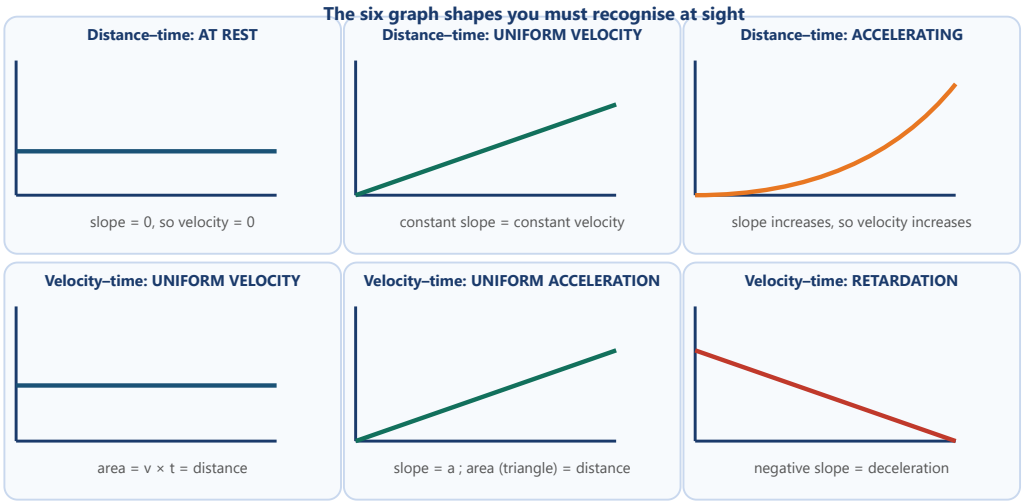

Fig. N.1 — Reference sheet: what each graph shape means

MLI-redrawn schematic — correct in construction but not to scale, and not a reproduction of any textbook figure. If anything is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.

Force. $F = ma$ | momentum $p = mv$ | $F = (mv - mu)/t$ | conservation of momentum: $m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$

Work and Energy. $W = F \times s \times \cos\theta$ (W = Fs when force and displacement are along the same line) | $KE = \frac{1}{2}mv^2$ | $PE = mgh$ | $P = W/t$ | 1 kWh = 3.6×10^6 J

Sound. $v = \nu\lambda$ | $T = 1/\nu$ | echo: $2d = v \times t$ | audible range 20 Hz to 20,000 Hz

Unit discipline. Convert everything to SI before substituting: km h^{-1} → m s^{-1} by multiplying by 5/18; cm → m by dividing by 100; g → kg by dividing by 1000; minutes → seconds. Most lost marks in this unit are unit-conversion errors, not concept errors.

➤ Solved drill

N1 — 2 Marks

A bus travels 72 km in 1.5 hours. Find its average speed in m s^{-1}.

Step 1 verage speed = 72 km / 1.5 h = 48 km h^{-1}

Step 2 onvert: 48 × 5/18 = 13.33 m s^{-1}

≈ 13.3 m s^{-1}

N2 — 3 Marks

A car starting from rest accelerates uniformly at 3 m s^{-2} for 8 s. Find its final velocity and the distance covered.

Step 1 = 0, a = 3, t = 8

Step 2 = u + at = 0 + 3 × 8 = 24 m s^{-1}

Step 3 = ut + ½at^2 = 0 + ½ × 3 × 64 = 96 m

v = 24 m s^{-1}; s = 96 m

N3 — 3 Marks

A train moving at 20 m s^{-1} is brought to rest in 40 s. Find its retardation and the distance travelled before stopping.

Step 1 = 20, v = 0, t = 40. a = (0 − 20)/40 = −0.5 m s^{-2}

Step 2 sing $v^2 = u^2 + 2as$: 0 = 400 + 2(−0.5)s ⇒ s = 400

Retardation 0.5 m s^{-2}; distance 400 m

N4 — 3 Marks

A force of 15 N acts on a body of mass 5 kg initially at rest. Find the acceleration, the velocity after 4 s, and the momentum at that instant.

Step 1 = F/m = 15/5 = 3 m s^{-2}

Step 2 = u + at = 0 + 3 × 4 = 12 m s^{-1}

Step 3 = mv = 5 × 12 = 60 kg m s^{-1}

a = 3 m s^{-2}; v = 12 m s^{-1}; p = 60 kg m s^{-1}

N5

3 Marks

A bullet of mass 20 g travelling at 200 m s^{-1} strikes a wooden block and stops in 0.02 s. Find the force exerted on the block.

Step 1 m = 20 g = 0.02 kg; u = 200 m s^{-1}; v = 0; t = 0.02 s

Step 2 $F = (mv - mu)/t = (0 - 0.02 \times 200)/0.02 = -4/0.02$

Step 3 −200 N. The minus sign shows the force opposes the motion.

200 N (retarding)

N6

3 Marks

A force of 50 N pushes a box 8 m along the floor in the direction of the force. Find the work done, and the power if it takes 10 s.

Step 1 $W = F \times s = 50 \times 8 = 400$ J

Step 2 $P = W/t = 400/10 = 40$ W

W = 400 J; P = 40 W

N7

3 Marks

Find the kinetic energy of a 1200 kg car moving at 72 km h^{-1}.

Step 1 Convert: $72 \times 5/18 = 20$ m s^{-1}

Step 2 $E_k = \frac{1}{2}mv^2 = \frac{1}{2} \times 1200 \times 400$

Step 3 240000 J = 2.4×10^5 J

2.4×10^5 J (240 kJ)

N8 5 Marks

A stone of mass 2 kg is dropped from a height of 20 m. Taking g = 10 m s^{-2} and ignoring air resistance, find (a) its potential energy at the top, (b) its kinetic energy just before hitting the ground, (c) its velocity on striking the ground, (d) its kinetic energy at a height of 5 m above the ground.

Step 1 **(a)** PE = mgh = 2 × 10 × 20 = **400 J**

Step 2 **(b)** By conservation of mechanical energy, all the PE has converted to KE at the ground: **KE = 400 J**

Step 3 **(c)** ½mv^2 = 400 ⇒ v^2 = 400 ⇒ v = **20 m s^{-1}**

Step 4 **(d)** At 5 m, PE = 2 × 10 × 5 = 100 J

Step 5 Total energy is constant at 400 J, so KE = 400 − 100 = **300 J**

(a) 400 J (b) 400 J (c) 20 m s^{-1} (d) 300 J

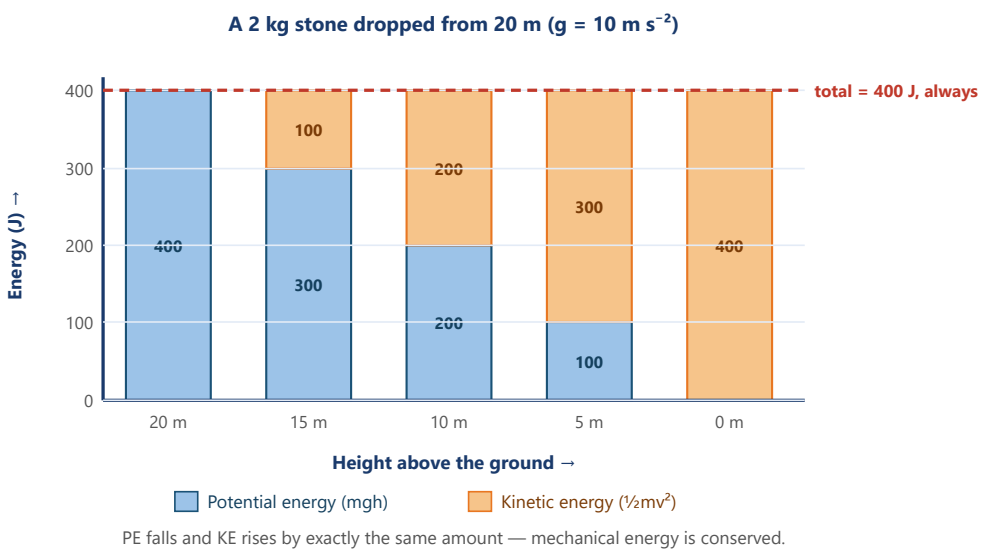

Fig. N.2 — Conservation of energy during free fall (question N8)

MLI-redrawn schematic — correct in construction but not to scale, and not a reproduction of any textbook figure. If anything is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.

N9 3 Marks

A sound wave has frequency 500 Hz and wavelength 0.68 m. Find its speed and its time period.

Step 1 = $v\lambda$ = 500 × 0.68 = 340 m s^{-1}

Step 2 = 1/v = 1/500 = 0.002 s = 2 ms

v = 340 m s^{-1}; T = 0.002 s

N10 3 Marks

A ship sends a sonar pulse to the sea bed and receives the echo after 3 s. If the speed of sound in sea water is 1500 m s^{-1}, find the depth.

Step 1 otal path travelled = v × t = 1500 × 3 = 4500 m

Step 2 he pulse goes down and returns, so depth = 4500/2

2250 m

Ten more for self-practice (answers in brackets): 1. A body covers 40 m in 5 s then 60 m in 5 s — find the average speed. [10 m s^{-1}] 2. u = 5 m s^{-1}, a = 2 m s^{-2}, t = 6 s — find v and s. [17 m s^{-1}; 66 m] 3. A 60 kg skater is pushed with 120 N — find a. [2 m s^{-2}] 4. Momentum of a 0.5 kg ball at 12 m s^{-1}. [6 kg m s^{-1}] 5. Work done lifting 25 kg through 4 m (g = 10). [1000 J] 6. Power of a pump doing 9000 J in 30 s. [300 W] 7. KE of a 5 kg body at 4 m s^{-1}. [40 J] 8. A wave of speed 330 m s^{-1} and frequency 220 Hz — find λ. [1.5 m] 9. Echo heard after 0.5 s, v = 344 m s^{-1} — find the distance of the reflector. [86 m] 10. A 3 kg body falls freely from 45 m — find its speed on landing (g = 10). [30 m s^{-1}]

SECTION 3

Diagram Checklist

The figures you must be able to draw and label from memory

Why this matters. A "well-labelled diagram" question gives roughly half its marks for the labels. Practise each figure three times on blank paper until you can produce it without looking. In the examination, draw large, use pencil, label horizontally with straight lines, and give the figure a title.

Ch.	Diagram	Labels that must appear
2	Plant cell	cell wall, cell membrane, nucleus with nucleolus, cytoplasm, chloroplast, large central vacuole, mitochondrion, ribosomes, Golgi apparatus, ER
2	Animal cell	cell membrane, nucleus with nucleolus, cytoplasm, mitochondrion, ribosomes, Golgi apparatus, rough and smooth ER, lysosome, centriole, small vacuoles
3	Plant tissue types	parenchyma, collenchyma, sclerenchyma; xylem (tracheid, vessel, fibre, parenchyma); phloem (sieve tube, companion cell)
3	Types of movable joint	ball-and-socket (shoulder/hip), hinge (elbow/knee), pivot (neck), with bone names
3	Neuron	cell body, nucleus, dendrites, axon, myelin sheath, nerve endings
4	Distance–time and velocity–time graphs	axes with quantity and unit, uniform and non-uniform cases, shaded area marked as displacement
5	Separation apparatus	filtration set-up; distillation set-up (round-bottom flask, thermometer at the side arm, condenser with water in at the bottom, receiver); separating funnel; chromatography strip; sublimation with inverted funnel
7	Simple machines	the three classes of lever with fulcrum, effort and load marked; pulley; inclined plane
8	Atomic models	Thomson's model; Rutherford's α-scattering experiment with gold foil and deflection paths; Bohr's shells (K, L, M, N)
9	Electron-dot (Lewis) structures	H_2, Cl_2, O_2 (double bond), N_2 (triple bond), HCl, H_2O with lone pairs; NaCl and MgO electron transfer
10	Sound wave	compression, rarefaction, wavelength, amplitude, crest, trough on a displacement–distance graph
10	Human ear	pinna, ear canal, eardrum, hammer–anvil–stirrup, cochlea, auditory nerve
11	Reproduction	structure of a flower (sepal, petal, stamen with anther and filament, carpel with stigma, style, ovary); binary fission and budding
12	Classification hierarchy	Kingdom → Phylum → Class → Order → Family → Genus → Species, as a flow chart
13	Biogeochemical cycles	water cycle; carbon cycle; nitrogen cycle — with nitrogen fixation, nitrification, assimilation, ammonification, denitrification all named

Note: *the MLI volumes contain redrawn schematics of most of these — correct in construction but not to scale and not reproductions of textbook figures. Where any figure is unclear, refer to the corresponding figure in the NCERT textbook Exploration — Textbook of Science for Grade 9.*

SECTION 4

MLI Model Question Paper — Science

80 marks · 3 hours · All 13 chapters, all four units

MATH LOVE INSTITUTE — CLASS IX SCIENCE

Model Paper · Subject Code 086 · Session 2026–27 · Time: 3 hours · Maximum Marks: 80

General Instructions

1. The paper has five sections A to E. All questions are compulsory.
2. Section A — 16 objective questions and 4 assertion–reason questions, 1 mark each.
3. Section B — 6 very short answer questions of 2 marks each. Section C — 7 short answer questions of 3 marks each.
4. Section D — 3 long answer questions of 5 marks each. Section E — 3 case-based questions of 4 marks each.
5. Internal choice is provided in about one-third of the questions. Draw neat labelled diagrams wherever required.
6. Take g = 10 m s^{-2} and the speed of sound in air = 340 m s^{-1} unless stated otherwise. Use of a calculator is not permitted.

SECTION A — 20 × 1 = 20 marks

1. The cell organelle called the "powerhouse of the cell" is the (a) ribosome (b) mitochondrion (c) lysosome (d) Golgi apparatus 1

2. The plant cell wall is made mainly of (a) chitin (b) cellulose (c) protein (d) lipid 1

3. The tissue that joins muscle to bone is (a) ligament (b) tendon (c) cartilage (d) areolar 1

4. Growth in the girth of a stem is due to the (a) apical (b) intercalary (c) lateral meristem (d) epidermis 1

5. The SI unit of acceleration is (a) m s^{-1} (b) m s^{-2} (c) m^2 s^{-1} (d) N 1

6. The area under a velocity–time graph gives (a) acceleration (b) displacement (c) force (d) momentum 1

7. Newton's second law gives (a) F = mv (b) F = ma (c) F = mgh (d) F = ½mv^2 1

8. The SI unit of work is the (a) watt (b) newton (c) joule (d) pascal 1

9. Sound cannot travel through (a) solids (b) liquids (c) gases (d) vacuum 1

10. The audible range for a healthy human is (a) 2–200 Hz (b) 20–20,000 Hz (c) 200–2000 Hz (d) above 20,000 Hz 1

11. Iodine is separated from a mixture by (a) filtration (b) sublimation (c) decantation (d) magnetic separation 1

12. A colloid differs from a true solution in that it (a) is homogeneous (b) shows the Tyndall effect (c) settles on standing (d) can be filtered by ordinary filter paper 1

13. Rutherford's α-scattering experiment led to the discovery of (a) the electron (b) the neutron (c) the nucleus (d) the plum-pudding model 1

14. Atoms of the same element with different mass numbers are (a) isobars (b) isotopes (c) ions (d) isomers 1

15. The maximum number of electrons in the L shell is (a) 2 (b) 8 (c) 18 (d) 32 1

16. Nitrogen fixation in the soil is carried out mainly by (a) fungi (b) certain bacteria (c) earthworms (d) algae only 1

17. Assertion (A): The cell wall does not control what enters the cell. **Reason (R):** The cell wall is fully permeable while the cell membrane is selectively permeable. 1
(a) Both true, R explains A (b) Both true, R does not explain A (c) A true, R false (d) A false, R true

18. Assertion (A): A body moving in a circle at constant speed is accelerating. **Reason (R):** Its direction of motion changes continuously. 1
(a) Both true, R explains A (b) Both true, R does not explain A (c) A true, R false (d) A false, R true

19. Assertion (A): We hear a thunderclap some time after seeing the lightning. **Reason (R):** Sound travels much more slowly than light. 1
(a) Both true, R explains A (b) Both true, R does not explain A (c) A true, R false (d) A false, R true

20. Assertion (A): Isotopes of an element have identical chemical properties. **Reason (R):** They have the same number of neutrons. 1
(a) Both true, R explains A (b) Both true, R does not explain A (c) A true, R false (d) A false, R true

SECTION B — 6 × 2 = 12 marks

21. State two differences between the plasma membrane and the cell wall. 2

22. Distinguish between distance and displacement with one example. 2

23. Why is the epidermis of a desert plant thicker than that of a plant in a moist place? 2
OR Give two reasons why most plant support tissue can be dead while animal support tissue must be living.

24. A body of mass 6 kg is acted on by a force of 30 N. Find its acceleration and its velocity after 5 s from rest. 2

25. What is an echo? State the minimum distance required to hear a distinct echo in air. 2

26. Define isotopes and give one use of any isotope. 2
OR State the law of conservation of mass with one example.

SECTION C — 7 × 3 = 21 marks

27. Describe three differences between a plant cell and an animal cell. **3**

28. Compare xylem and phloem under three heads: components, living or dead, and direction of transport. **3**

29. Derive the equation v = u + at from a velocity–time graph. **3**

OR A car accelerates uniformly from 18 km h^{-1} to 36 km h^{-1} in 5 s. Find the acceleration and the distance covered.

30. State Newton's three laws of motion, with one everyday example of the third law. **3**

31. A body of mass 10 kg is raised to a height of 6 m and then released. Find its potential energy at the top, its kinetic energy on reaching the ground, and its speed on landing. **3**

32. Describe, with a labelled sketch of the apparatus, how you would separate a mixture of two miscible liquids with different boiling points. **3**

OR Explain how you would obtain pure copper sulphate crystals from an impure sample.

33. Write the electronic configuration of an element with atomic number 19, state its valency, and name the shell in which the valence electron lies. **3**

SECTION D — 3 × 5 = 15 marks

34. Draw a well-labelled diagram of a plant cell and describe the functions of any four organelles shown. **5**

OR Describe the four types of animal tissue, giving the structure, one location and the function of each.

35. (a) State the law of conservation of momentum. (2) (b) A 2 kg ball moving at 6 m s^{-1} collides head-on with a stationary 4 kg ball and they move off together. Find their common velocity. (3) **5**

OR (a) Define work, energy and power with their SI units. (3) (b) A pump lifts 500 kg of water through 10 m in 25 s. Find its power. (2)

36. Draw a labelled diagram of the nitrogen cycle and explain any three processes shown in it. **5**

SECTION E — 3 × 4 = 12 marks (Case-Based)

37. Answer the potato-strip osmosis case — set **C1** in Section 1 of this volume. **4**

38. Answer the velocity–time graph case — set **C4** in Section 1 of this volume. **4**

39. Answer the carbon-and-oxygen combustion case — set **C10** in Section 1 of this volume. **4**

⚖ Mole concept drill

Formulae. $n = m \div M$ $n = N \div N_0$ $N_0 = 6.022 \times 10^{23}\ mol^{-1}$ Molar mass in g mol^{-1} = molecular mass in u.

M1

2 Marks

Calculate the number of moles in 44 g of carbon dioxide. (C = 12 u, O = 16 u)

Step 1 of CO_2 = 12 + (2 × 16) = 44 g mol^{-1}

Step 2 = 44 ÷ 44

1 mole

M2

2 Marks

Find the mass of 0.25 mole of calcium carbonate, $CaCO_3$. (Ca = 40, C = 12, O = 16 u)

Step 1 = 40 + 12 + (3 × 16) = 100 g mol^{-1}

Step 2 = n × M = 0.25 × 100

25 g

M3

3 Marks

How many molecules are present in 8 g of oxygen gas? (O = 16 u)

Step 1 xygen gas is O_2, so M = 32 g mol^{-1}

Step 2 = 8 ÷ 32 = 0.25 mole

Step 3 = 0.25 × 6.022 × 10^{23}

1.5055 × 10^{23} molecules of O_2

If the question had said "oxygen **atoms**", the answer would be double: 3.011 × 10^{23}.

M4 3 Marks

What is the mass of 1.2044×10^{22} atoms of magnesium? (Mg = 24 u)

Step 1 = $N \div N_0 = (1.2044 \times 10^{22}) \div (6.022 \times 10^{23}) = 0.02$ mole

Step 2 = 0.02×24

0.48 g

M5 3 Marks

Calculate the number of aluminium ions present in 0.051 g of aluminium oxide, Al_2O_3. (Al = 27, O = 16 u)

Step 1 = $(2 \times 27) + (3 \times 16) = 54 + 48 = 102$ g mol^{-1}

Step 2 = $0.051 \div 102 = 5 \times 10^{-4}$ mole of Al_2O_3

Step 3 ach formula unit has **2** Al^{3+} ions, so moles of $Al^{3+} = 2 \times 5 \times 10^{-4} = 10^{-3}$

Step 4 = $10^{-3} \times 6.022 \times 10^{23}$

6.022×10^{20} aluminium ions

Five more for self-practice (answers in brackets): 1. Moles in 36 g of water. [2] 2. Mass of 3 moles of NaCl (Na 23, Cl 35.5). [175.5 g] 3. Molecules in 22 g of CO_2. [3.011×10^{23}] 4. Atoms in 0.5 mole of nitrogen gas, N_2. [6.022×10^{23}] 5. Mass of one mole of H_2SO_4 (H 1, S 32, O 16). [98 g]

✅ Answer Key and Marking Guidance

Q	1	2	3	4	5	6	7	8	9	10
Ans	b	b	b	c	b	b	b	c	d	b
Q	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans	b	b	c	b	b	b	a	a	a	c

Note on Q20. A is true — isotopes do have identical chemical properties — but R is **false**: isotopes have the same number of **protons and electrons** and **different** numbers of neutrons. It is the identical electron arrangement, not the neutrons, that makes the chemistry the same. Answer (c).

Sections B–D — what earns the marks. Q21: cell wall is rigid, non-living, made of cellulose, fully permeable, present only in plants/fungi/bacteria; plasma membrane is thin, living, made of lipids and proteins, selectively permeable, present in all cells (any two contrasts, 1 mark each). Q24: a = F/m = 5 m s^{-2}; v = 0 + 5 × 5 = 25 m s^{-1}. Q25: reflection of sound from a large hard surface (1) + about 17.2 m, because the ear retains a sound for about 0.1 s (1). Q29 OR: 18 km h^{-1} = 5 m s^{-1}, 36 km h^{-1} = 10 m s^{-1}; a = (10 − 5)/5 = 1 m s^{-2}; s = ut + ½at^2 = 25 + 12.5 = 37.5 m. Q31: PE = 10 × 10 × 6 = 600 J; KE = 600 J; ½(10)v^2 = 600 ⇒ v = √120 ≈ 10.95 m s^{-1}. Q33: 2, 8, 8, 1 — valency 1, valence electron in the N shell. Q34: diagram 2 marks (1 for outline, 1 for at least six correct labels) + four functions, ¾ mark each. Q35(b): total momentum before = 2 × 6 + 4 × 0 = 12; after = (2 + 4)v = 6v; so v = 2 m s^{-1}. Q35 OR (b): W = mgh = 500 × 10 × 10 = 50,000 J; P = 50,000/25 = 2000 W = 2 kW. Q36: diagram 2 marks + three processes explained, 1 mark each — choose from nitrogen fixation, nitrification, assimilation, ammonification, denitrification.