

Model Question Paper 2
Half-Yearly Examination 2026-27
SCIENCE

Time Allowed: 3 Hours

Maximum Marks: 80

General Instructions:

1. This question paper has 5 sections: A, B, C, D and E.
2. Section A has 20 objective type questions carrying 1 mark each.
3. Section B has 6 questions carrying 2 marks each. Answers to these should not exceed 40-50 words each.
4. Section C has 7 questions carrying 3 marks each. Answers to these should not exceed 60-80 words each.
5. Section D has 3 questions carrying 5 marks each. Answers to these should not exceed 120 words each.
6. Section E has 3 source/case-based questions carrying 4 marks each with sub-parts.
7. There is no overall choice. However, internal choices have been provided in some questions. A student has to attempt only one of the choices in such questions.
8. Wherever necessary, neat and labelled diagrams should be drawn.

SECTION A

Question numbers 1 to 20 carry 1 mark each. Choose the most appropriate answer.

1. A scientist wants to test whether the number of hours of sunlight received affects how fast a plant grows. The height of the plant, which she measures every week, is called the: [1]

- (a) Independent variable
- (b) Dependent variable
- (c) Controlled variable
- (d) Hypothesis

Answer: (b) — The dependent variable — the quantity measured, which may change in response to the independent variable.

2. Two students measure the length of the same table using the same metre scale but get slightly different readings each time. The best way to obtain a more reliable value of the length is to: [1]

- (a) Use only the very first reading taken
- (b) Take several readings and calculate their average
- (c) Guess the length by looking at the table
- (d) Use two different scales and simply add the two readings

Answer: (b) — Taking several readings and averaging them reduces the effect of small random errors.

3. Organisms that are too small to be seen with the naked eye and can be observed only with the help of a microscope are called: [1]

- (a) Microorganisms
- (b) Macro-organisms
- (c) Fossils
- (d) Vertebrates

Answer: (a) — Microorganisms — living things too small to be seen without a microscope.

4. A student examines a drop of pond water under a microscope and observes a tiny single-celled organism moving about using hair-like structures. This organism most likely belongs to the group called: [1]

- (a) Bacteria
- (b) Protozoa
- (c) Fungi
- (d) Algae

Answer: (b) — Protozoa — single-celled microorganisms, many of which move using hair-like or whip-like structures.

5. Rhizobium bacteria present in the root nodules of pulse (leguminous) plants are considered useful to farmers mainly because they: [1]

- (a) Cause diseases in the plant's roots
- (b) Convert atmospheric nitrogen into a usable form, enriching the soil
- (c) Produce antibiotics used in medicines
- (d) Decompose only dead leaves on the soil surface

Answer: (b) — Rhizobium fixes atmospheric nitrogen into compounds plants can use, enriching soil fertility.

6. A person who has been vaccinated against a disease usually does not fall sick even after later coming in contact with that disease's pathogen. This is because vaccination causes the body to: [1]

- (a) Destroy all microorganisms in the environment permanently
- (b) Produce antibodies and memory cells specific to that pathogen in advance
- (c) Permanently raise body temperature
- (d) Avoid the pathogen completely by chance

Answer: (b) — Vaccination trains the immune system to produce specific antibodies and memory cells in advance.

7. Which of the following is an example of a non-communicable disease? [1]

- (a) Common cold
- (b) Tuberculosis
- (c) Diabetes
- (d) Chickenpox

Answer: (c) — Diabetes — not caused by an infectious pathogen and does not spread from person to person.

8. Washing hands with soap before eating mainly helps prevent disease by: [1]

- (a) Cooling down the hands
- (b) Removing or killing disease-causing microorganisms present on the hands
- (c) Increasing appetite
- (d) Hardening the skin of the hands

Answer: (b) — Handwashing removes/kills pathogens on the hands, preventing their entry into the body.

9. The glowing filament of an ordinary electric bulb is an example of the _____ effect of electric current. [1]

- (a) Chemical
- (b) Heating
- (c) Purely magnetic
- (d) Cooling

Answer: (b) — Heating effect of electric current — the filament heats up and glows.

10. A compass needle kept near a wire deflects only when current flows through the wire, and returns to its normal position when the current is switched off. This experiment shows that: [1]

- (a) Current has no effect on magnets
- (b) A current-carrying wire produces a magnetic effect
- (c) All wires are magnetic even without current
- (d) Compass needles have no relation with electricity

Answer: (b) — A current-carrying conductor produces its own magnetic effect, deflecting a nearby compass needle.

11. In an electric fan, the current supplied to the motor makes the blades rotate continuously. This working of the fan's motor is mainly based on the: [1]

- (a) Heating effect of current
- (b) Magnetic effect of current

- (c) Chemical effect of current
- (d) Lighting effect of current only

Answer: (b) — Magnetic effect of current — the motor uses interacting magnetic fields to produce rotation.

12. A shopping trolley continues to roll forward for some distance even after a person stops pushing it, before finally coming to rest. The force that eventually brings it to rest is: [1]

- (a) Muscular force
- (b) Gravitational force pulling it downward
- (c) Frictional force between the wheels and the floor
- (d) Magnetic force

Answer: (c) — Frictional force opposes the trolley's motion and gradually brings it to rest.

13. A gymnast lands on a soft, cushioned mat instead of a hard floor after a jump, to avoid injury. This works mainly because the soft mat: [1]

- (a) Increases the force felt by the gymnast
- (b) Increases the time taken to stop the gymnast, reducing the force experienced
- (c) Has no effect on the force experienced
- (d) Applies a non-contact force on the gymnast

Answer: (b) — A longer stopping time reduces the force experienced for the same change in momentum.

14. The force by which the Earth pulls all objects towards its centre is called: [1]

- (a) Frictional force
- (b) Magnetic force
- (c) Gravitational force
- (d) Muscular force

Answer: (c) — Gravitational force.

15. A hand-held pump used to inflate a bicycle tyre pushes air into it, compressing it into a smaller volume. The pressure of the air inside the tyre after pumping, compared to atmospheric pressure outside, is: [1]

- (a) Much lower than atmospheric pressure
- (b) Exactly equal to atmospheric pressure
- (c) Much higher than atmospheric pressure
- (d) Zero

Answer: (c) — Compressing air into a smaller volume raises its pressure well above atmospheric pressure.

16. The layer of gases surrounding the Earth, which exerts pressure on all objects at its surface, is called the: [1]

- (a) Hydrosphere
- (b) Atmosphere
- (c) Lithosphere
- (d) Biosphere

Answer: (b) — Atmosphere — the layer of air surrounding the Earth.

17. On a hot summer afternoon near the coast, a cool sea breeze blows from the sea towards the land. This happens mainly because, in the afternoon: [1]

- (a) Land heats up faster than the sea, and the warm air rising above the land creates lower pressure that draws in cooler air from the sea
- (b) The sea becomes hotter than the land
- (c) Pressure over the sea suddenly becomes very low
- (d) Wind always blows from land to sea

Answer: (a) — Land heats up faster than sea; rising warm air over land creates a low-pressure region drawing in the cooler sea breeze.

18. Sugar crystals dissolve faster in hot tea than in cold tea mainly because, at a higher temperature, the water particles: [1]

- (a) Stop moving completely
- (b) Move faster and collide with the sugar particles more often, speeding up dissolving
- (c) Turn solid
- (d) Repel the sugar particles strongly

Answer: (b) — Faster-moving particles at higher temperature collide more often, speeding up dissolving.

19. *This question consists of two statements — Assertion (A) and Reason (R). Choose the correct option: [1]*

Assertion (A): It is much easier to compress the air inside a syringe (with its outlet closed) than to compress water inside the same syringe.

Reason (R): Particles in a gas like air are far apart with large empty spaces between them, whereas particles in a liquid like water are closely packed with very little empty 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

Answer: (a) — Both true; R correctly explains A — the large spacing between gas particles allows easy compression.

20. *This question consists of two statements — Assertion (A) and Reason (R). Choose the correct option: [1]*

Assertion (A): Wet clothes dry faster when spread out in the sun on a windy day than when bunched up in a shaded corner on a still day.

Reason (R): Increasing the exposed surface area and the temperature, together with moving air carrying away water vapour particles, all speed up the rate of evaporation.

- (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

Answer: (a) — Both true; R correctly explains A — surface area, temperature and moving air all affect evaporation rate.

SECTION B

Question numbers 21 to 26 carry 2 marks each.

21. A student wants to test which of two brands of paper towel absorbs water better. Suggest two things she should keep the same (controlled) in her testing, apart from the brand of towel. [2]

Marking Scheme / Value Points:

- Same size/area of the towel piece used for each brand — 1 mark
- Same amount (volume) of water used and the same method/time of testing for each brand — 1 mark

22. State two harmful effects of microorganisms on human beings, giving one disease-causing example each for two different types of microbes. [2]

Marking Scheme / Value Points:

- Bacteria can cause diseases such as cholera or typhoid — 1 mark
- Viruses can cause diseases such as the common cold, chickenpox or influenza — 1 mark

23. A locality reports a sudden outbreak of diarrhoea among several residents after the water supply pipeline develops a leak near a drain. Explain, in terms of microorganisms, how this could cause such an outbreak, and suggest one preventive measure. [2]

Marking Scheme / Value Points:

- Drain/sewage water contains disease-causing microorganisms; when it leaks into and contaminates the drinking water supply, people who consume this water ingest the pathogens, causing widespread illness — 1 mark

- Preventive measure: boiling or otherwise purifying drinking water, or repairing the leak promptly and keeping water and sewage lines separate — 1 mark

24. State two safety precautions that should be followed while handling household electrical appliances or wiring. [2]

Marking Scheme / Value Points:

- Do not touch electrical switches or appliances with wet hands — 1 mark
- Use appliances and wires with proper insulation and the correct fuse rating; avoid overloading sockets — 1 mark

25. A block of wood is pulled with a spring balance across two different surfaces — smooth glass and rough sandpaper — and the reading on the balance is noted each time. (a) On which surface would the reading be higher, and why? (b) What does this reading actually measure? [2]

Marking Scheme / Value Points:

- (a) Higher reading on the rough sandpaper, because rougher surfaces produce more friction, requiring a greater applied force to move the block at constant speed — 1 mark
- (b) The reading measures the force of friction acting between the block and the surface (equal and opposite to the applied pulling force) — 1 mark

26. Explain why a gas cylinder used for cooking gas is designed to be very strong and made of thick metal, using the idea of the pressure exerted by a gas. [2]

Marking Scheme / Value Points:

- A gas fills its container completely and exerts pressure uniformly on all its walls in every direction; inside the cylinder, the gas is stored under very high pressure — 1 mark
- The cylinder must be strong and made of thick metal so it can safely withstand this high internal pressure without bursting or leaking — 1 mark

SECTION C

Question numbers 27 to 33 carry 3 marks each.

27. A group of students wants to investigate whether the mass of a paper boat affects how long it stays afloat before sinking. (a) Suggest one reasonable hypothesis they could test. (b) Name one variable (besides the shape of the boat) they must keep constant across all trials. (c) Why is keeping this variable constant important? [3]

Marking Scheme / Value Points:

- (a) Any reasonable, testable hypothesis, e.g. 'a heavier paper boat sinks faster than a lighter one' — 1 mark
- (b) Any valid controlled variable, e.g. same type/size of paper, same amount and calmness of water, same way of placing the boat in the water — 1 mark
- (c) Keeping this variable constant ensures that any difference observed in floating time is genuinely due to the mass of the boat and not some other factor, making the comparison fair — 1 mark

28. A greenish-black mould (*Rhizopus*) is often seen growing on bread left in a warm, humid place for a few days. (a) Name the kind of microorganism responsible. (b) State two conditions that favour its growth on the bread. [3]

Marking Scheme / Value Points:

- (a) A fungus (a type of mould) — 1 mark
- (b) Warmth (a suitable temperature) is needed for the fungal spores to germinate and grow — 1 mark
- Moisture/humidity and the presence of organic nutrients (in the bread) are also needed, since fungi cannot make their own food — 1 mark

29. Explain the difference between communicable and non-communicable diseases, giving one example of each, and state why lifestyle-related diseases like diabetes and heart disease are classified as non-communicable. [3]

Marking Scheme / Value Points:

- Communicable diseases are caused by pathogens (bacteria, viruses, etc.) and can spread from an infected person to a healthy one, e.g. tuberculosis or the common cold — 1 mark
- Non-communicable diseases are not caused by an infectious pathogen and do not spread from person to person, e.g. diabetes or heart disease — 1 mark
- Diabetes and heart disease result mainly from the body's own internal malfunction (such as insufficient insulin) or long-term lifestyle/genetic factors, not from an infectious agent passing between people, so they are classified as non-communicable — 1 mark

30. The heating element (coil) of an electric kettle is usually made of nichrome, not copper, even though copper is a good conductor. Explain why nichrome is preferred, in terms of the heating effect of current. [3]

Marking Scheme / Value Points:

- Nichrome is an alloy with much higher resistance than copper — 1 mark
- Because of its higher resistance, more electrical energy is converted into heat in a nichrome wire for the same current, so it heats up strongly without melting easily, and it resists oxidation at high temperature — 1 mark
- Copper has low resistance and would not produce enough heat efficiently, and would also oxidise, melt or wear out faster if used as a heating element — 1 mark

31. State whether each of the following forces is a contact force or a non-contact force, giving a one-line reason: (a) A magnet attracting a paperclip. (b) The force applied when kicking a ball. (c) Gravity pulling a falling leaf downward. [3]

Marking Scheme / Value Points:

- (a) Non-contact force — the magnet attracts the paperclip even without physically touching it — 1 mark
- (b) Contact force — the foot must touch the ball to kick it — 1 mark
- (c) Non-contact force — gravity acts on the leaf even though the Earth is not touching it directly — 1 mark

32. Explain, using the idea of air pressure, why it is easy to drink a liquid using a straw, and state what would happen if you tried to use a straw that had a small hole punctured in its side. [3]

Marking Scheme / Value Points:

- Sucking through the straw creates a region of lower pressure inside it; the greater atmospheric pressure on the liquid's surface outside pushes the liquid up through the straw — 1.5 marks
- If there is a hole in the side of the straw, air leaks in through it, so the pressure inside the straw cannot be lowered enough, and the liquid will not rise properly (or will rise only weakly) through the straw — 1.5 marks

33. Naphthalene balls placed in a cupboard slowly become smaller over several weeks and eventually disappear completely, without leaving any liquid behind, while the cupboard begins to smell of naphthalene. Explain this observation in terms of the particle nature of matter, naming the specific process involved. [3]

Marking Scheme / Value Points:

- Naphthalene balls undergo sublimation — they change directly from the solid state to the gaseous state without passing through the liquid state — 1 mark
- Naphthalene particles at the surface gain enough energy to break free from the solid directly as gas particles, which spread throughout the cupboard by diffusion, producing the smell — 1 mark
- Since the solid converts straight into gas, skipping the liquid state, no liquid residue is left behind, and the ball gradually shrinks in size until it disappears — 1 mark

SECTION D

Question numbers 34 to 36 carry 5 marks each.

34. A farmer wants to increase the fertility of his field without using too many chemical fertilisers. His neighbour suggests growing a crop of beans (a leguminous/pulse plant) every third season and ploughing the plant residue back into the soil. (a) Name the bacteria present in the root nodules of such pulse plants that help improve soil fertility. (b) Explain how these bacteria enrich the soil with a nutrient plants need. (c) Name the overall process by

which atmospheric nitrogen gas is converted into a usable form for plants. (d) Suggest one other way (apart from growing pulse crops) in which microorganisms are useful in agriculture. [5]

OR

A school nurse notices that several students report similar cold-like symptoms one after another over a week, while only one particular student has diabetes, regardless of how much contact he has with classmates. (a) Classify the cold as communicable or non-communicable, and justify your answer. (b) Explain why the diabetic student's condition did not spread to classmates. (c) Suggest two general hygiene practices that could help reduce the spread of the cold among students. (d) Name one vaccine-preventable communicable disease other than the common cold.

Marking Scheme / Value Points:

- (a) Rhizobium bacteria — 1 mark
- (b) These bacteria live in the root nodules of leguminous plants in a mutually beneficial relationship; they take atmospheric nitrogen gas, which most plants cannot use directly, and convert it into nitrogen compounds that plants can absorb and use to make proteins, enriching the soil — 2 marks
- (c) Nitrogen fixation — 1 mark
- (d) Any valid example, e.g. microorganisms used in preparing compost/manure from decaying plant and animal waste (decomposition), improving soil quality — 1 mark

OR (value points):

- (a) Communicable disease — it is caused by a virus that spreads from an infected student to healthy ones through air/droplets/contact, explaining why multiple students fall sick one after another — 1.5 marks
- (b) Diabetes is a non-communicable disease caused by the body's own insufficient insulin production/action, not by any infectious pathogen, so it cannot pass from one person to another through contact — 1.5 marks
- (c) Any two valid practices, e.g. covering the mouth/nose while coughing or sneezing, washing hands regularly, not sharing personal items like handkerchiefs or water bottles with a sick classmate — 1 mark
- (d) Any valid example, e.g. measles, polio, chickenpox, whooping cough, hepatitis B — 1 mark

35. A delivery company tests two types of packaging trolleys — Trolley A has small, hard plastic wheels, while Trolley B has larger wheels fitted with ball bearings. Workers report that Trolley B is noticeably easier to push, even with the same load. (a) Name the force that makes pushing a loaded trolley difficult. (b) Explain, in terms of this force, why Trolley B is easier to push than Trolley A. (c) State one factor (other than the wheel type) that affects the amount of this force between two surfaces. (d) Give one everyday example where this same force is essential and must not be reduced too much. [5]

OR

A science exhibit shows a coil of wire wrapped around an iron nail, connected to a battery through a switch. When the switch is closed, the nail picks up small iron pins; when the switch is opened, the pins fall off immediately. (a) Name the device created by this coil-and-nail arrangement. (b) Explain why the pins fall off as soon as the switch is opened. (c) State two ways the strength of this device could be increased. (d) Name one everyday device that uses this same principle to work.

Marking Scheme / Value Points:

- (a) Force of friction — 1 mark
- (b) Ball bearings in Trolley B's wheels allow smooth rolling rather than sliding, reducing the direct rubbing between moving parts and hence the friction; Trolley A's hard plastic wheels without bearings experience more friction, making it harder to push — 1.5 marks
- (c) Any valid factor, e.g. the roughness or smoothness of the surfaces in contact, or the force pressing the two surfaces together — 1 mark
- (d) Any valid example, e.g. friction between shoe soles and the ground is needed to walk without slipping; friction between vehicle tyres and the road is needed for braking and grip — 1.5 marks

OR (value points):

- (a) An electromagnet — 1 mark
- (b) An electromagnet is magnetic only as long as current flows through its coil; opening the switch stops the current, so the iron core loses its magnetism almost immediately, and the pins (no longer attracted) fall off — 1.5 marks
- (c) Any two valid ways, e.g. increasing the number of turns of wire in the coil; increasing the current (e.g. using more or stronger cells) — 1.5 marks

- (d) Any valid example, e.g. electric bell, electric crane for lifting scrap iron, electric motor, MRI scanner — 1 mark

36. A steel tumbler filled with ice-cold water soon has tiny water droplets forming on its outer surface, while a covered pot of boiling water on the stove shows its lid rattling and steam escaping from the sides. (a) Name the three common states of matter. (b) Explain, using the particle model, why ice, water and steam, all made of the same substance, have such different properties. (c) Name the process by which invisible water vapour in the air around the cold tumbler turns into visible water droplets on its surface. (d) Explain briefly why steam escaping from the boiling pot can cause a more severe burn than the same mass of boiling water. [5]

OR

A weather balloon released from the ground rises high into the atmosphere, expanding in size as it goes higher, and eventually bursts at a great height. (a) Explain, in terms of atmospheric pressure, why the balloon expands as it rises. (b) State how atmospheric pressure changes with increasing height/altitude. (c) Explain briefly why the balloon eventually bursts. (d) Name one instrument, other than a simple mercury barometer, that is commonly used to measure atmospheric pressure or altitude using pressure changes.

Marking Scheme / Value Points:

- (a) Solid, liquid and gas — 1 mark
- (b) In the solid state (ice), particles are closely packed and only vibrate about fixed positions, giving a fixed shape and volume; in the liquid state (water), particles are less tightly packed and can move past one another, giving a fixed volume but no fixed shape; in the gaseous state (steam), particles are far apart and move freely and rapidly, giving no fixed shape or volume — 2 marks
- (c) Condensation — 1 mark
- (d) Steam carries extra hidden (latent) heat energy used to convert water into vapour; when steam touches the skin, it condenses back into water, releasing this large amount of extra heat energy onto the skin in addition to its own heat, causing a more severe burn than the same mass of boiling water alone — 1 mark

OR (value points):

- (a) As the balloon rises, the atmospheric pressure of the air outside it decreases; since the gas pressure inside the balloon is now greater than the reduced pressure outside, the gas inside pushes outward more strongly, expanding the balloon — 1.5 marks
- (b) Atmospheric pressure decreases with increasing height/altitude — 1 mark
- (c) As the balloon keeps rising, the outside pressure keeps dropping while the gas inside keeps expanding; eventually the balloon's material stretches beyond its limit and bursts — 1.5 marks
- (d) Any valid example, e.g. an aneroid barometer, or an altimeter (which uses pressure changes to indicate altitude) — 1 mark

SECTION E

Question numbers 37 to 39 are source/case-based questions carrying 4 marks each with four sub-parts each.

Case Study 1 — Question 37 [4 Marks]

During the monsoon, a village health worker records a rise in cases of a waterborne disease among people who fetch drinking water directly from a nearby pond, while those in the same village who use a hand pump connected to a covered underground source stay largely unaffected. She also notes that all children in the village have been given the oral polio vaccine as part of a government health drive.

(i) Name one disease that can spread through contaminated pond water. [1]

Answer: Any valid answer, e.g. cholera, typhoid, diarrhoea, or jaundice (hepatitis A).

(ii) Explain why people drawing water from the covered hand pump remain largely unaffected compared to those using the open pond. [1]

Answer: The hand pump draws water from a covered underground source that is largely protected from contamination by sewage, animal waste or surface dirt, unlike the open pond, which is easily contaminated, allowing disease-causing microorganisms to enter the water people drink.

(iii) Explain how the oral polio vaccine protects children from getting polio. [1]

Answer: The vaccine contains a weakened form of the polio virus, which cannot cause the disease but stimulates the child's immune system to produce antibodies against it; if the child is later exposed to the actual virus, these antibodies quickly destroy it, preventing the disease.

- (iv) Suggest two measures the village could adopt to make pond water safer for those who must still use it. [1]
OR Explain why it is important for ALL children in a community to be vaccinated, and not just a few, to control the spread of a communicable disease.

Answer: Any two valid measures, e.g. boiling the water before use, using water purification tablets or filters, disinfecting the pond, fencing it off from animals and waste, or building a covered well/pump instead.

OR Answer: If most children in a community are vaccinated (herd immunity), the disease-causing pathogen finds very few unvaccinated hosts to infect and spread through, so outbreaks are prevented or contained even for the few who could not be vaccinated; leaving many children unvaccinated allows the disease to keep spreading and can lead to outbreaks.

Case Study 2 — Question 38 [4 Marks]

In a school sports day, a shot-put ball, a badminton shuttlecock and a rubber ball are all thrown or hit by students. The teacher points out that the shuttlecock slows down and drops much faster than the rubber ball, even though both are hit with a similar force, and that all three objects eventually fall back to the ground rather than flying off forever.

- (i) Name the force that pulls all three objects back down towards the ground after they are thrown. [1]

Answer: Gravitational force (force of gravity).

- (ii) Suggest one reason why the shuttlecock slows down and falls faster than the rubber ball, even when hit with a similar force. [1]

Answer: The shuttlecock's shape (a light body with a feathered/skirted top) experiences much greater air resistance compared to the more compact, streamlined rubber ball, which slows it down more quickly.

- (iii) Is air resistance a contact force or a non-contact force? Justify your answer. [1]

Answer: It is a contact force — air resistance arises because the moving object's surface is in direct contact with, and pushes against, the surrounding air particles.

- (iv) The heavier shot-put ball is not affected much by air resistance and follows a smooth curved path to the ground. Name the shape of this path and briefly explain why the ball's path curves downward instead of continuing in a straight line forever. [1]

OR Explain why a badminton shuttlecock is deliberately designed to experience high air resistance, considering how the game of badminton is played.

Answer: The path is a curved path (a parabola, in simple terms); it curves downward because, although the ball moves forward due to the force of the throw, the constant downward pull of gravity continuously acts on it as well, changing its direction of motion so it follows a curved path towards the ground rather than a straight line.

OR Answer: High air resistance quickly slows the shuttlecock after each hit, making it change speed and direction rapidly and fall within the court, which allows precise, controlled and fast-paced rallies between players — an effect players rely on for the sport.

Case Study 3 — Question 39 [4 Marks]

A student performs a simple activity: she places a few crystals of purple potassium permanganate at the bottom of a beaker of still water without stirring, and observes that the purple colour slowly spreads throughout the water over several minutes, eventually colouring all the water evenly. She then repeats the activity with hot water instead of cold water and notices the colour spreads much faster.

- (i) Name the process by which the purple colour spreads through the water without stirring. [1]

Answer: Diffusion.

- (ii) Explain, in terms of particles, why the colour eventually spreads evenly throughout the water. [1]

Answer: The dissolved potassium permanganate particles are in continuous, random motion and move from the region where they are highly concentrated (near the crystals) towards regions of lower concentration, gradually spreading until they are evenly distributed throughout the water.

- (iii) Explain why the colour spreads faster in hot water than in cold water. [1]

Answer: In hot water, the particles (of both water and the dissolved substance) have more kinetic energy and move faster, so diffusion occurs more quickly than in cold water, where particles move more slowly.

(iv) Would you expect this purple colour to spread faster, slower, or at about the same rate if similar crystals were placed in a jar of air instead of in water (assuming they could dissolve in air)? Justify your answer in terms of the particle model. [1]

OR Suggest what would happen to the rate of spreading of the colour if the same experiment were repeated using ice-cold water straight from the refrigerator.

Answer: The colour would spread much faster in air, because gas particles are much farther apart, move faster and more freely, and experience far fewer collisions restricting their motion compared to particles in a liquid like water, so diffusion happens more rapidly in gases than in liquids.

OR Answer: The colour would spread more slowly than in ordinary water, because the particles in ice-cold water have less kinetic energy and move more slowly, so diffusion (spreading of the coloured particles) would take a longer time.