CBSE Class 10 Science: Sample Paper 2: Marking Scheme and Solutions

Based on NCERT · the board's 2024 to 2026 pattern | Time: 3 hours · **Maximum marks: 80**

Section A (20 × 1 mark)

1. A cow has a much longer small intestine than a tiger because [1]

(a) the cellulose in grass needs a longer time to digest
(b) a cow eats less often than a tiger
(c) meat contains more water than grass
(d) a tiger absorbs its food in the stomach

Answer: (a) Herbivores eating grass need a longer small intestine to digest cellulose; meat is easier to digest, so carnivores have a shorter one.

2. When 30 C of charge flows through the load of an inverter battery, 360 J of electrical energy is converted. The potential difference across the load is [1]

(a) 0.083 V
(b) 390 V
(c) 10800 V
(d) 12 V

Answer: (d) V = W/Q = 360 J / 30 C = 12 J/C = 12 V. Multiplying (10800) or inverting the ratio (0.083) are the usual slips.

3. Candle wax, a mixture of carbon compounds, melts at about 330 K, while common salt melts only above 1000 K. The low melting point of wax is best explained by [1]

(a) weak bonds between the atoms inside each wax molecule
(b) weak forces between separate wax molecules, though the bonds within each molecule are strong
(c) the presence of ions in wax
(d) the absence of carbon-hydrogen bonds in wax

Answer: (b) Covalent molecules have strong bonds within the molecule but only weak forces between molecules, so little energy separates them and they melt low. Wax has no ions, and it is made of C–H chains.

4. Assertion (A): Four bacteria formed when one bacterium divides twice are very similar, but not exactly identical. Reason (R): Small inaccuracies in DNA copying create very minor differences at each division. [1]

(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 are true, and the copying errors in R are exactly what makes the four cells slightly different.

5. A nursery cannot raise one of these plants from seed, because it has lost the capacity to produce seeds. Which one? [1]

(a) Mustard
(b) Papaya
(c) Watermelon
(d) Jasmine

Answer: (d) Jasmine, like banana, orange and rose, has lost the capacity to produce seeds and is propagated vegetatively. Mustard, papaya and watermelon all form flowers that give seeds.

6. Which of these reactions releases heat but gives out no light? [1]

(a) Respiration in the cells of the body
(b) Burning of a magnesium ribbon
(c) Burning of natural gas on a stove
(d) Photosynthesis in a leaf

Answer: (a) Respiration is exothermic but evolves no light. Burning magnesium and natural gas give both heat and light; photosynthesis absorbs energy.

7. Assertion (A): Gold is often found in nature in the free state. Reason (R): Gold is the most ductile metal. [1]

(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: (b) Both are true. Gold occurs free because it is at the bottom of the activity series and least reactive; its ductility has nothing to do with that, so R does not explain A.

8. A section of cellular DNA that provides the information for making one protein is called [1]

(a) a chromosome
(b) a gene
(c) a germ-cell
(d) a nucleus

Answer: (b) DNA is the information source for making proteins, and the section of DNA that carries the information for one protein is the gene for that protein. A chromosome is a whole piece of DNA carrying many genes.

9. Assertion (A): Light travels faster in water than in crown glass. Reason (R): Crown glass has a higher refractive index than water. [1]

(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) $n = c/v$, so a higher refractive index means a lower speed. Crown glass (1.52) has a higher refractive index than water (1.33), so light is slower in glass and faster in water. R explains A.

10. When a neem tree makes food, the energy change that takes place in its leaves is [1]

(a) chemical energy to light energy
(b) light energy to chemical energy
(c) heat energy to light energy
(d) chemical energy to heat energy

Answer: (b) Autotrophs capture the energy of sunlight and convert it into chemical energy stored in food.

11. In which of the following will the offspring show the greatest variation among themselves? [1]

(a) sugarcane plants raised from stem pieces of one plant
(b) bacteria formed by repeated division of one bacterium
(c) kids born to a pair of goats
(d) hydra buds formed on one parent

Answer: (c) Sexual reproduction generates greater diversity than asexual reproduction. The goat kids come from sexual reproduction; the other three come from a single parent asexually and are very similar.

12. A long straight wire carries a steady current. Point P is 2 cm from the wire on one side, and point Q is 2 cm from it on the exactly opposite side, both in the same plane perpendicular to the wire. The magnetic fields at P and Q are [1]

(a) equal in size and in the same direction
(b) both zero
(c) unequal, the one at P being larger
(d) equal in size and opposite in direction

Answer: (d) The field lines are concentric circles centred on the wire. P and Q lie on the same circle, at opposite ends of a diameter, so the field has the same size there but the tangents to the circle point in opposite directions.

13. Which of these can a young adult with normal vision not see distinctly? [1]

(a) the Moon
(b) a page held 30 cm from the eye
(c) a bus 40 m away
(d) a coin held 10 cm from the eye

Answer: (d) A normal eye sees clearly from its near point, about 25 cm, out to infinity. The coin at 10 cm is nearer than the near point; the page, the bus and the Moon all lie within the range.

14. A small bulb is placed 35 cm in front of a concave mirror of focal length 10 cm. The image of the bulb is formed [1]

(a) beyond C; enlarged, real and inverted
(b) between F and C; diminished, real and inverted
(c) at C; same size, real and inverted
(d) behind the mirror; enlarged, virtual and erect

Answer: (b) C is at 2f = 20 cm, so the bulb at 35 cm is beyond C. With the object beyond C a concave mirror forms the image between F and C: diminished, real and inverted.

15. A sealed glass ampoule in a school store holds a dark red-brown liquid. The label says the element is a non-metal. The element is [1]

(a) mercury
(b) iodine
(c) bromine
(d) sulphur

Answer: (c) Non-metals are solids or gases, the one exception being bromine, which is a liquid. Mercury is a liquid but a metal; iodine and sulphur are solids.

16. Assertion (A): The metal body of a table fan is connected to the earth wire. Reason (R): The earth wire in house wiring has green insulation. [1]

(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: (b) Both are true. The body is earthed because the earth wire gives a low-resistance path that carries away any leakage of current, keeping the body at the earth's potential; the colour of the insulation does not explain this.

17. Sana places a small plotting compass at a point near a magnet lying on her desk. The north pole of the needle points towards the east edge of the desk. The magnetic field at that point is directed towards the [1]

(a) north
(b) west
(c) east
(d) south

Answer: (c) The direction of the field at a point is the direction in which the north pole of a compass placed there points: east. West is where the south pole points.

18. A student sorting elements finds a solid that shines like a metal, yet it is classed as a non-metal. The element is [1]

(a) bromine (b) sulphur
(c) iodine (d) oxygen

Answer: (c) Iodine is a non-metal but it is lustrous. Sulphur is a dull solid, bromine a liquid and oxygen a gas.

19. Two drops of phenolphthalein are added to four colourless liquids. The liquid that turns pink is [1]

(a) dilute hydrochloric acid (b) sodium hydroxide solution
(c) vinegar (d) lemon juice

Answer: (b) Phenolphthalein is pink in a basic solution and colourless in an acidic one. Only sodium hydroxide solution is basic; the other three are acidic.

20. A toxin stops the axon endings of a neuron from releasing their chemicals, but leaves the neuron otherwise unharmed. The most direct result is that [1]

(a) the dendrites of the poisoned neuron cannot pick up information (b) no impulse is started in the dendrite of the next neuron
(c) the impulse travels backwards from the axon to the dendrite (d) the cell body of the poisoned neuron stops working

Answer: (b) At the axon end the impulse releases chemicals which cross the synapse and start a similar impulse in the next neuron's dendrite. With no chemicals released, the impulse still reaches the axon end but goes no further.

Section B (6 × 2 marks)

21. A motorcyclist wears a helmet to protect his head. Name the two natural protections the body gives the brain and the one it gives the spinal cord. [2]

The brain sits inside a bony box, and within it is contained in a fluid-filled balloon that absorbs shocks. The spinal cord is protected by the vertebral column, or backbone.

- brain: bony box and fluid-filled balloon (shock absorption) (1)
- spinal cord: vertebral column (backbone) (1)

22. Balance the following equations. (a) $Fe + Cl_2 \rightarrow FeCl_3$ (b) $Al + HCl \rightarrow AlCl_3 + H_2$ [2]

Or *Balance the following equations. (a) $P + O_2 \rightarrow P_2O_5$ (b) $KClO_3 \rightarrow KCl + O_2$*

(a) Chlorine: 3 on the right in $FeCl_3$, 2 in Cl_2; the lowest common number is 6, so $3Cl_2$ and $2FeCl_3$, then 2Fe: $2Fe + 3Cl_2 \rightarrow 2FeCl_3$. (b) Chlorine: 3 in $AlCl_3$, so 6HCl with $2AlCl_3$; hydrogen 6 on the left needs $3H_2$; aluminium 2: $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$.

- $2Fe + 3Cl_2 \rightarrow 2FeCl_3$ (1)
- $2Al + 6HCl \rightarrow 2AlCl_3 + 3H_2$ (1)

Or:

(a) Oxygen: 5 in P_2O_5 and 2 in O_2; the lowest common number is 10, so $5O_2$ and $2P_2O_5$, then 4P: $4P + 5O_2 \rightarrow 2P_2O_5$. (b) Oxygen: 3 in $KClO_3$, 2 in O_2; 6 atoms means $2KClO_3$ and $3O_2$, then 2KCl: $2KClO_3 \rightarrow 2KCl + 3O_2$.

- $4P + 5O_2 \rightarrow 2P_2O_5$ (1)
- $2KClO_3 \rightarrow 2KCl + 3O_2$ (1)

23. Ethanol is heated to 443 K with excess concentrated sulphuric acid, and a gas X is given off. Name X, write the equation for its formation, and state the role of the acid. [2]

X is ethene. $CH_3–CH_2OH \rightarrow$ (hot conc. H_2SO_4, 443 K) $CH_2=CH_2 + H_2O$. The concentrated sulphuric acid acts as a dehydrating agent, removing water from ethanol.

- X is ethene, with the equation $CH_3CH_2OH \rightarrow CH_2=CH_2 + H_2O$ (conditions shown) (1)
- concentrated sulphuric acid is the dehydrating agent (1)

24. A wire inside the plug of a room heater works loose and touches the other wire, and the fuse of that circuit blows at once. Explain what happened to the current and why the fuse wire melted. [2]

The two wires touching make a short circuit: the current no longer passes through the heater, and it rises sharply. This large current through the fuse wire, which is in series, raises its temperature until it melts and breaks the circuit, before the appliances are damaged.

- short circuit: the current rises sharply (1)
- the large current heats the fuse wire until it melts and breaks the circuit (1)

25. State the role of (a) the fine hairs and mucus lining the nostrils, and (b) the residual volume of air the lungs always retain. [2]

(a) They filter the air entering the body. (b) The air retained during the breathing cycle gives enough time for oxygen to be absorbed and carbon dioxide to be released.

- (a) filter the incoming air (1)
- (b) allows sufficient time for oxygen absorption and carbon dioxide release (1)

26. Name the part of the eye that carries the light-sensitive cells, and state how the signals they produce lead to vision. [2]

The retina. On illumination its light-sensitive cells generate electrical signals, which travel through the optic nerves to the brain; the brain interprets them and we perceive the object.

- names the retina (1)
- electrical signals travel by the optic nerves to the brain, which interprets them (1)

Section C (7 × 3 marks)

27. In a soda-acid fire extinguisher, sodium hydrogencarbonate solution reacts with dilute sulphuric acid. (a) Write the balanced equation for the reaction. (b) Name the gas released and give a test for it. (c) How does this gas put out the fire? [3]

(a) $2NaHCO_3 + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O + 2CO_2$. (b) Carbon dioxide. Passed through lime water, it turns it milky, because insoluble calcium carbonate forms: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$. (c) The carbon dioxide smothers the fire.

- balanced equation with Na_2SO_4, H_2O and CO_2 (1)
- names CO_2 and the lime water test (1)
- CO_2 smothers the fire (1)

28. Prakash winds two circular coils of the same radius: coil X has 25 turns and coil Y has 100 turns. [3] The same current flows in both. (a) Compare the magnetic fields at their centres. (b) Why do the turns of a coil not cancel each other's field? (c) Describe how the field lines appear near the centre of either coil.

(a) A coil of n turns gives n times the field of a single turn, so the field at the centre of Y is 100/25 = 4 times that at the centre of X. (b) The current in each turn flows in the same direction, so every turn, and every section of each turn, contributes field in the same direction inside the coil; the fields add up. (c) Near the centre the circles round each section of wire have grown so large that the field lines appear as straight lines.

- Y gives four times the field of X (1)
- current in every turn in the same direction, so fields add (1)
- lines appear straight near the centre (1)

29. For each observation, name the tropic movement and say whether the plant part grows towards [3] or away from the stimulus. (i) A pot of balsam seedlings falls on its side; in a few days the stem tips curve upwards. (ii) The roots of mustard seedlings in a glass jar lit from one side bend away from the lit side. (iii) A pollen tube grows down the style of a flower to the ovule.

(i) Geotropism: the shoot grows away from the earth, against the pull of gravity. (ii) Phototropism: the roots bend away from light. (iii) Chemotropism: the pollen tube grows towards the ovule.

- (i) geotropism, shoot away from gravity (1)
- (ii) phototropism, roots away from light (1)
- (iii) chemotropism, towards the ovule (1)

30. Classify each as exothermic or endothermic, giving a reason: (a) natural gas burning on a kitchen [3] stove (b) barium hydroxide stirred with ammonium chloride, after which the beaker feels cold (c) limestone decomposing in a kiln.

(a) Exothermic: $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$ gives out heat. (b) Endothermic: the mixture absorbs heat from the beaker, which turns cold. (c) Endothermic: decomposition needs a continuous supply of heat to break the calcium carbonate down.

- (a) exothermic, heat given out (1)
- (b) endothermic, heat absorbed (1)
- (c) endothermic, energy needed to decompose (1)

31. A ray of light in air falls on one face of a rectangular glass slab at an angle of incidence of 40°. [3] Describe how the ray bends at each face of the slab, give the angle at which it finally emerges into air, and name the shift between the incident and the emergent rays.

At the first face the ray goes from air into glass, rarer to denser, and bends towards the normal (angle of refraction less than 40°). At the second face it goes from glass into air and bends away from the normal. The bending at the two parallel faces is equal and opposite, so it emerges at 40°, parallel to the incident ray. The sideways shift is the lateral displacement.

- towards the normal at the first face, away at the second (1)
- emerges at 40°, parallel to the incident ray (1)
- names lateral displacement (1)

32. In a species with a complex body, the two germ-cells are very unlike each other. (i) Describe the two kinds. (ii) Which is called the male gamete and which the female? (iii) In very simple organisms, how do the two germ-cells compare with each other? [3]

(i) One germ-cell is large and contains food stores; the other is smaller and likely to be motile. (ii) The motile one is the male gamete; the one with stored food is the female gamete. (iii) In very simple organisms the two germ-cells may be similar to each other.

- one large with food stores, one small and motile (1)
- motile = male, food-storing = female (1)
- in simple organisms the two germ-cells may be similar (1)

33. In a lake, the phytoplankton fix 30 000 kJ of energy. The chain is phytoplankton → zooplankton → small fish → kingfisher. (a) Using the average rule for transfer, find the energy available to the kingfisher. (b) Use this to explain why kingfishers are few in number. [3]

(a) About 10% passes at each step: 30 000 → 3000 kJ (zooplankton) → 300 kJ (small fish) → 30 kJ (kingfisher). (b) Energy diminishes at every level, so only a little reaches the kingfisher; it supports only a small population, and numbers fall at each step up the chain.

- uses 10% at each step (1)
- 30 kJ for the kingfisher (1)
- little energy reaches the top, so few individuals (1)

Section D (3 × 5 marks)

34. Arjun pulls apart a mustard flower in the laboratory, layer by layer. (a) Which of the parts he removes are not reproductive, and what does each of them do? (b) Name the male reproductive part and what it produces. (c) Name the three parts of the female reproductive part, from base to tip, and what the base contains. (d) After fertilisation, what does the zygote, the ovule and the ovary each become? [5]

Or *Meena tags a mustard flower and visits it every few days. Its petals and sepals fall, and the centre swells into a long pod with seeds. (a) Before they fell, what work did the sepals and the petals do? (b) Which part of the flower made the pollen? (c) Name the three parts of the central structure and say which one swelled into the pod. (d) What fused inside it to start each seed, and what does the seed contain?*

(a) Sepals protect the flower while it is a bud; petals are usually coloured and attract the insects and birds that carry pollen. (b) The stamen, which produces yellowish pollen grains. (c) Pistil: ovary (swollen base), style (middle, elongated), stigma (tip, may be sticky). The ovary contains ovules, each with an egg cell. (d) The zygote divides to form an embryo; the ovule develops a tough coat and becomes a seed; the ovary ripens into a fruit.

- sepals protect the bud, petals attract pollinators (1)
- stamen produces pollen grains (1)
- ovary, style, stigma in order (1)
- ovary holds ovules, each with an egg (1)
- zygote → embryo, ovule → seed, ovary → fruit (1)

Or:

(a) Sepals protected the flower in the bud; petals, coloured, attracted insects and birds that carry pollen. (b) The stamens, which produce yellowish pollen grains. (c) The pistil: ovary, style and stigma; the ovary ripened into the pod (fruit). (d) The male germ-cell from the pollen grain fused with the egg in the ovule, giving a zygote; the zygote divided into an embryo, and the ovule with a tough coat became the seed, holding the embryo.

- sepals protect the bud, petals attract pollinators (1)
- pollen from the stamens (1)
- ovary, style, stigma named (1)
- ovary became the pod (fruit) (1)
- male germ-cell fuses with the egg in the ovule; seed holds the embryo (1)

35. (a) What does the pH scale measure, and over what range does it generally run? (b) Solution P has a pH of 3 and solution Q a pH of 11. Which one turns phenolphthalein pink, and which has the higher hydrogen ion concentration? Give reasons. (c) Explain why tooth decay starts when the pH in the mouth falls below a certain value, name that value, and state how it can be prevented. [5]

Or *(a) What does the 'p' in pH stand for, and what does pH measure? (b) Solution R has a pH of 1 and solution S a pH of 6. Which is more acidic, and what colour does R give with blue litmus? Give reasons. (c) What is tooth enamel made of? Explain why eating sugary food without brushing can damage it, and why toothpaste helps.*

(a) The pH scale measures the hydrogen ion concentration of a solution; it generally runs from 0 (very acidic) to 14 (very alkaline). (b) Q, pH 11, is basic (pH greater than 7), so it turns phenolphthalein pink. P, pH 3, has the higher hydrogen ion concentration, because a lower pH means more H^+ ions. (c) Bacteria in the mouth degrade sugar and food particles to acids. When the pH falls below 5.5, tooth enamel (calcium hydroxyapatite) is corroded. Brushing with a basic toothpaste after eating neutralises the acid.

- (a) hydrogen ion concentration, 0 to 14 (1)
- (b) Q turns phenolphthalein pink, being basic (1)
- (b) P has more H^+, lower pH (1)
- (c) bacterial acid corrodes enamel below pH 5.5 (1)
- (c) basic toothpaste neutralises the acid (1)

Or:

(a) 'p' stands for potenz, the German word for power; pH measures the hydrogen ion concentration of a solution. (b) R is more acidic: the lower pH means a higher hydrogen ion concentration. R is acidic (pH below 7), so it turns blue litmus red. (c) Enamel is calcium hydroxyapatite, a crystalline form of calcium phosphate. Bacteria degrade sugar left in the mouth into acids; below pH 5.5 the enamel is corroded. Toothpaste is basic and neutralises the acid.

- (a) potenz, power; measures H^+ concentration (1)
- (b) R more acidic, lower pH means more H^+ (1)
- (b) R turns blue litmus red (1)
- (c) calcium hydroxyapatite; bacterial acid corrodes it below pH 5.5 (1)
- (c) basic toothpaste neutralises the acid (1)

36. (a) Starting from P = VI, use Ohm's law to show that electric power can also be written as P = I^2R and P = V^2/R. (2) (b) A family replaces a 2 kW storage geyser, used for 45 minutes a day, with a 3 kW instant water heater used for 12 minutes a day. Find the units each would consume in 30 days and the money saved in that time at ₹7 per unit. (2) (c) Which fuse, of 5 A, 10 A or 15 A, should protect the 3 kW heater on a 230 V supply? (1) [5]

Or *(a) Show, using Ohm's law, that P = VI can be written as P = I^2R and as P = V^2/R. (2) (b) A tailoring shop runs a 1100 W iron for 2 hours a day and two sewing-machine motors of 100 W each for 6 hours a day. Find its bill for 25 working days at ₹8 per unit. (2) (c) Which fuse, of 2 A, 5 A or 10 A, should protect the iron alone on a 230 V supply? (1)*

(a) V = IR, so P = VI = (IR)I = I^2R; and I = V/R, so P = V(V/R) = V^2/R. (b) Geyser: 2 kW × 0.75 h × 30 = 45 kW h = 45 units. Instant heater: 3 kW × 0.2 h × 30 = 18 units. Saving = 27 units × ₹7 = ₹189. (c) I = 3000/230 ≈ 13 A, so the 15 A fuse, the next rating above the working current.

- P = I^2R from V = IR (1)
- P = V^2/R from I = V/R (1)
- 45 units and 18 units (1)
- saving 27 units = ₹189 (1)
- 13 A, so the 15 A fuse (1)

Or:

(a) P = VI with V = IR gives P = I^2R; with I = V/R gives P = V^2/R. (b) Iron: 1.1 kW × 2 h × 25 = 55 units. Motors: 2 × 0.1 kW × 6 h × 25 = 30 units. Total 85 units × ₹8 = ₹680. (c) I = 1100/230 ≈ 4.8 A, so the 5 A fuse.

- P = I^2R from V = IR (1)
- P = V^2/R from I = V/R (1)
- 55 + 30 = 85 units (1)
- bill ₹680 (1)
- 4.8 A, so the 5 A fuse (1)

Section E (3 × 4 marks)

37. Read the passage and answer the questions that follow. [4]

Meera runs a small jewellery and repair shop in Thrissur. She explains to a customer that the chains she sells are 22 carat, not pure 24-carat gold. Her brother repairs radios at the back of the shop. He joins wires with solder, and he never uses brass strips to carry current in a circuit, though brass is cheaper than copper. Both of them work with alloys every day, made by melting a primary metal and dissolving other elements in it in definite proportions.

(a) A 22-carat chain has a mass of 36 g. The mass of pure gold in it is [1]

(a) 22 g (b) 33 g
(c) 34 g (d) 30 g

Answer: (b) 22 carat is 22 parts gold in 24: 36 × 22/24 = 33 g. 22 g takes the carat number as grams; 34 g subtracts 2 g instead of 2 parts in 24.

(b) Which metals are mixed with gold to make it 22 carat, and why is this done? [1]

Silver or copper, 2 parts to 22 parts of gold, because pure 24-carat gold is too soft for jewellery.

- silver or copper, because pure gold is too soft (1)

(c) Name the metals in solder and state the property that makes it suitable for joining wires. Why is brass not used to carry current? [2]

Or *An alloy is a homogeneous mixture. Name the metals in bronze, and state how its melting point and its electrical conductivity compare with those of pure copper.*

Solder is an alloy of lead and tin; it has a low melting point. Brass, an alloy of copper and zinc, is not a good conductor, as the conductivity of an alloy is lower than that of the pure metal.

- lead and tin, low melting point (1)
- brass a poorer conductor than pure copper (1)

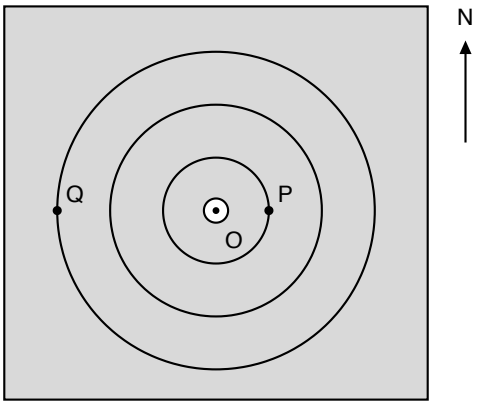
Or:

Bronze is an alloy of copper and tin. Both its melting point and its electrical conductivity are lower than those of pure copper, which is why bronze is not used as a conductor.

- copper and tin (1)
- melting point and conductivity both lower (1)

38. Read the passage and answer the questions that follow. [4]

In a workshop, a long straight cable rises vertically out of a hole O in a horizontal wooden shelf, and a steady current flows up the cable. Anil maps the field on the shelf with a plotting compass and draws three of its field lines, shown from above in the figure. He then places one small compass at P, close to the cable, and another at Q, three times as far away on the opposite side. The arrow marked N shows north.



(a) The north pole of the compass at P points towards the [1]

(a) north (b) south
(c) east (d) cable at O

Answer: (a) Right-hand thumb rule, thumb up along the current: seen from above the field lines go anticlockwise, so at P, which is east of the cable, the field points north.

(b) Compared with the field at P, the field of the cable at Q is [1]

(a) smaller (b) larger
(c) the same (d) zero

Answer: (a) The field decreases as the distance from the conductor increases; Q is farther from the cable than P.

(c) Anil reverses the current and also doubles it. State the effect on the compass at P, with reasons. [2]

Or *State the rule Anil should use to find the direction of the field lines, and use it to say whether, seen from above, they run clockwise or anticlockwise.*

Reversing the current reverses the field, so the north pole at P now points south. Doubling the current makes the field at P larger, so the cable's effect on the needle is stronger.

- needle at P turns to point south, as the field reverses (1)
- larger current gives a stronger field at P (1)

Or:

Right-hand thumb rule: hold the cable in the right hand with the thumb along the current; the fingers wrap round in the direction of the field lines. With the thumb pointing up, out of the shelf, the fingers curl anticlockwise as seen from above.

- right-hand thumb rule stated (1)
- anticlockwise seen from above (1)

39. Read the passage and answer the questions that follow. [4]

Harpreet crossed pure-breeding tall pea plants with round seeds and pure-breeding short plants with wrinkled seeds. All the F1 plants were tall with round seeds. She self-pollinated the F1 plants and grew the seeds into F2 plants. She recorded the height of every F2 plant and the shape of the seeds it grew from, as shown in the table.

F2 class	Number of plants
Tall, round seeds	452
Tall, wrinkled seeds	148
Short, round seeds	152
Short, wrinkled seeds	48
Total	800

(a) How many F2 plants show a combination of traits not found in either original parent? [1]

(a) 48 (b) 300
(c) 452 (d) 500

Answer: (b) The parents were tall-round and short-wrinkled. The new combinations are tall-wrinkled and short-round: 148 + 152 = 300.

(b) The factor pairs of the F1 plants are [1]

(a) TT RR (b) Tt Rr
(c) tt rr (d) TT rr

Answer: (b) Each F1 plant got T and R from the tall-round parent and t and r from the short-wrinkled parent: Tt Rr.

(c) What do the classes in your answer to the first part prove about plant height and seed shape? Why could they not appear if each parent passed on one whole gene set? [2]

Or *Work out the number of plants expected in each class from a 9 : 3 : 3 : 1 ratio, and say whether Harpreet's counts fit it.*

New combinations show that height and seed shape are inherited independently of each other. If a whole gene set were inherited from each parent, T would always travel with R and t with r, the traits would be linked, and only tall-round and short-wrinkled plants could appear.

- height and seed shape inherited independently (1)
- whole sets would link T with R and t with r (1)

Or:

800/16 = 50, so the expected numbers are 9 × 50 = 450 tall-round, 3 × 50 = 150 tall-wrinkled, 150 short-round and 50 short-wrinkled. The counts 452, 148, 152, 48 are very close, so they fit the 9 : 3 : 3 : 1 ratio.

- 450, 150, 150, 50 from 800/16 (1)
- counts close, so they fit (1)