Grade 9 Optional Science Model Paper 1

ANSWER KEY

Full marks 75 · 2.25 hours

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

A practice paper by Science Playground, made to CDC's Specification Grid 2076, Science (Optional); not an official CDC or exam board paper.

Section A

16 × 1 = 16

a. The lysosome. If the cell is damaged, its lysosomes burst and their enzymes digest the cell itself (autolysis).

Marking scheme

- Lysosome.

b. A bacteriophage (phage) is a virus that infects bacteria, such as phage T4, which infects *E. coli*.

Marking scheme

- A virus that infects bacteria.

c. 44 autosomes (22 pairs); with the two sex chromosomes they make 46.

Marking scheme

- 44 (22 pairs).

d. An ecosystem is a community of living things together with the abiotic (non-living) environment of the area, working as one system.

Marking scheme

- A community of living things together with its abiotic environment.

e. A vaccine is a dead or weakened germ, a part of a germ, or an inactivated toxin, given to make the body produce antibodies and memory cells without causing the disease.

Marking scheme

- A dead or weakened germ (or its part, or a toxoid) that makes the body produce antibodies and memory cells without causing the disease.

f. James Chadwick, in 1932.

Marking scheme

- James Chadwick.

g. The volume of a fixed mass of a gas is inversely proportional to its pressure, provided its temperature stays the same.

Marking scheme

- The volume of a fixed mass of gas is inversely proportional to its pressure at constant temperature.

h. An electrolyte is a substance that conducts electricity when molten or in solution, by means of its ions, and is decomposed by the current. Examples: sodium chloride, copper sulphate.

Marking scheme

- A substance that conducts electricity in the molten state or in solution (by ions) and is decomposed by it.

i. Catenation is the property of carbon atoms of joining with one another by covalent bonds to form long chains, branches and rings.

Marking scheme

- Carbon atoms bonding with each other to form chains, branches or rings.

j. An alloy is a homogeneous mixture of a metal with other metals or with a non-metal, made by melting them together. Example: brass (copper and zinc).

Marking scheme

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- A homogeneous mixture of a metal with another metal or a non-metal, made by melting them together.

k. Newton meter (N m).

Marking scheme

- N m (newton meter).

l. A radioisotope is an isotope whose nuclei are unstable and break down by themselves, giving out radiation; for example carbon-14 or cobalt-60.

Marking scheme

- An isotope with unstable nuclei that gives out radiation (carbon-14, cobalt-60).

m. The critical angle is the angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.

Marking scheme

- The angle of incidence in the denser medium for which the angle of refraction in the rarer medium is 90°.

n. The force of attraction or repulsion between two point charges is directly proportional to the product of the charges and inversely proportional to the square of the distance between them, and it acts along the line joining them.

Marking scheme

- Force $\propto$ product of the charges and $\propto 1/(\text{distance})^2$, along the line joining them.

o. The farad (F).

Marking scheme

- Farad (F).

p. The epicenter is the point on the Earth's surface directly above the focus, the place underground where the rock first slips.

Marking scheme

- The point on the surface directly above the focus.

Section B

13 × 2 = 26

2. Any two: **[2]**

Prokaryotic cell	Eukaryotic cell
No true nucleus: the DNA lies in a nucleoid with no membrane round it.	A true nucleus with a double nuclear envelope.
No membrane-bound organelles (no mitochondria, ER, Golgi body).	Membrane-bound organelles such as mitochondria, ER, Golgi body.
70S ribosomes.	80S ribosomes in the cytoplasm.
Usually one circular chromosome, not wound on histones.	Several linear chromosomes on histones.
Small, mostly 1–5 µm.	Larger, mostly 10–100 µm.

Marking scheme

- One correct difference, both sides given.
- A second correct difference.

3. Any two: **[2]**

Sporangiospore	Zygospore
Formed asexually, inside a sporangium.	Formed sexually, when two gametangia fuse.
Haploid (n).	Diploid (2n).
Small, thin-walled, thousands in a sporangium.	Large, single, with a thick black warty wall.

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Sporangiospore	Zygospore
Spreads the mold by wind.	Survives bad times, resting for months.

Marking scheme

- One correct difference.
- A second correct difference.

4. With few frogs left to eat them, the grasshoppers multiply. More grasshoppers eat more rice plants, so the rice crop falls. (The snakes, losing their food, also decrease.) **[2]**

Marking scheme

- Grasshoppers increase, because their predator (the frog) is gone.
- The rice crop decreases, because more grasshoppers eat it.

5. Any two: **[2]**

Active immunity	Passive immunity
The body's own B cells make the antibodies.	Ready-made antibodies are given (antivenom, through the placenta or milk).
Takes 1–2 weeks to develop.	Works at once.
Memory cells are formed; lasts years or for life.	No memory cells; fades in weeks or months.
Used to prevent disease (vaccines).	Used for immediate protection.

Marking scheme

- One correct difference.
- A second correct difference.

6. Isotopes have the same number of protons, so in a neutral atom the same number of electrons arranged in the same way. Chemical properties depend on the electrons (especially the outermost ones), not on the neutrons, so isotopes react alike. Only their masses, and properties that depend on mass, differ. **[2]**

Marking scheme

- Isotopes have the same atomic number, so the same number and arrangement of electrons.
- Chemical properties depend on the electrons, not on the number of neutrons (mass).

7. The air inside the ball is heated. By Charles's law, the volume of a fixed mass of gas is directly proportional to its absolute temperature (at constant pressure), so the warmed air expands and pushes the soft dent back out. **[2]**

Marking scheme

- The air inside is heated and expands.
- Charles's law: volume $\propto$ absolute temperature, so the expanding air pushes the dent out.

8. Solid sodium chloride is made of Na^+ and Cl^- ions, but they are locked in the crystal and can only vibrate, so they cannot carry a current. When it dissolves (or melts), the ions are set free and move to the electrodes, so the solution conducts. **[2]**

Marking scheme

- In the solid the ions are held fixed in the crystal and cannot move.
- In solution the ions are free to move, so they carry the current.

9. Any two: **[2]**

- All members have the same functional group and similar chemical properties.
- They can be shown by one general formula (alkanes C_nH_{2n+2}).
- Neighboring members differ by $-CH_2-$, a mass of 14.
- Physical properties such as boiling point change gradually along the series.
- They can be made by similar methods.

Marking scheme

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- One correct characteristic.
- A second correct characteristic.

10. The moment of a force = force × perpendicular distance from the pivot (the hinges). A handle far from the hinges gives a large perpendicular distance, so a small force produces a large enough moment to turn the door. **[2]**

Marking scheme

- Moment = force × perpendicular distance from the hinge (pivot).
- A larger distance gives the needed moment with a smaller force, so the door opens easily.

11. An alpha particle is heavy, slow and has a charge of +2, so it pulls electrons off a great many atoms along its path (tens of thousands of ion pairs per cm). Every ion it makes costs it energy, so it uses up its energy quickly and is stopped within a few cm of air or by a sheet of paper. **[2]**

Marking scheme

- It is heavy, slow and doubly charged, so it makes very many ions along its path.
- Each ion costs energy, so it loses its energy quickly and is stopped soon (paper, a few cm of air).

12. Light from the bottom passes from water (denser) into air (rarer) and bends away from the normal. The eye traces the bent rays straight back, so they seem to come from a point higher than the bottom. The bottom's image is raised, and the pool looks shallower (about ¾ of its real depth). **[2]**

Marking scheme

- Light from the bottom refracts away from the normal as it passes from water into air.
- The eye sees the image where the rays seem to come from, above the real bottom, so the apparent depth is less.

13. Any two: **[2]**

Electric lines of force	Magnetic lines of force
Start on a positive charge and end on a negative charge: not closed.	Form closed loops: N to S outside the magnet, S to N inside.
The path a small free positive charge would tend to follow.	The path a free north pole would tend to follow.
Meet a conductor's surface at right angles.	Pass through magnetic materials, crowding into them.

Marking scheme

- One correct difference.
- A second correct difference.

14. Any two: **[2]**

Magnitude	Intensity
Measures the energy released at the source.	Measures the shaking and damage at a place.
One value for an earthquake.	Different at different places.
Measured on the Richter or moment magnitude scale (7.8).	Measured on the Modified Mercalli scale (I–XII).

Marking scheme

- One correct difference.
- A second correct difference.

Section C

7 × 3 = 21

15. Number of generations: $n = \dfrac{\text{time passed}}{\text{generation time}} = \dfrac{120\ \text{min}}{20\ \text{min}} = 6$ **[3]**

$N = N_0 \times 2^n = 50 \times 2^6 = 50 \times 64 = 3{,}200$

There will be 3,200 bacteria.

Marking scheme

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- Number of generations n = 120 ÷ 20 = 6.
- Uses N = $N_0 \times 2^n = 50 \times 2^6$.
- N = 3,200 bacteria.

16. i. Mass lost = 40.0 − 18.0 = 22.0 g **[3]**

$$\%\ \text{lost} = \frac{22.0}{40.0} \times 100 = 55\%$$

ii. Less. Decomposers (bacteria and fungi) work fastest where it is warm and moist; cold and dryness slow them down.

Marking scheme

- Mass lost = 22.0 g.
- Percentage lost = 22.0 ÷ 40.0 × 100 = 55%.
- Less, because cold, dry conditions slow the decomposers.

17. $P_1 = 750$ mmHg, $V_1 = 500$ cm³, $T_1 = 27 + 273 = 300$ K; at STP $P_2 = 760$ mmHg, $T_2 = 273$ K. **[3]**

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{750 \times 500 \times 273}{300 \times 760} \approx 449\ \text{cm}^3$$

Marking scheme

- Temperatures in kelvin: T_1 = 300 K, T_2 = 273 K (and P_2 = 760 mmHg).
- Uses the combined gas equation, $V_2 = P_1V_1T_2 \div (T_1P_2)$.
- $V_2 \approx 449$ cm³.

18. Chlorine reacts with the water on the wet petal to form hypochlorous acid: **[3]**

$Cl_2 + H_2O \rightleftharpoons HCl + HOCl$

Hypochlorous acid breaks down, giving nascent oxygen:

$HOCl \rightarrow HCl + [O]$

The nascent oxygen oxidizes the colored dye into a colorless substance (colored matter + [O] → colorless matter). The dry petal has no water, so no HOCl forms and it is not bleached.

Marking scheme

- $Cl_2 + H_2O \rightleftharpoons HCl + HOCl$.
- $HOCl \rightarrow HCl + [O]$.
- The nascent oxygen oxidizes the dye to a colorless substance; with no water (dry petal) there is no HOCl, so no bleaching.

19. Before firing both are at rest, so the total momentum is zero. By the conservation of linear momentum: **[3]**

$$m_g v_g + m_b v_b = 0 \Rightarrow v_g = -\frac{m_b v_b}{m_g} = -\frac{0.020 \times 300}{5} = -1.2\ \text{m/s}$$

The rifle recoils at 1.2 m/s, opposite to the bullet.

Marking scheme

- Total momentum before firing is zero (conservation of momentum), with 20 g = 0.020 kg.
- 0 = 5 × v + 0.020 × 300.
- v = −1.2 m/s: 1.2 m/s backward.

20. **[3]**

$$\mu = \frac{\sin i}{\sin r} \Rightarrow \sin r = \frac{\sin 45^\circ}{1.5} = \frac{0.707}{1.5} = 0.471 \Rightarrow r \approx 28.1^\circ$$

$$\mu = \frac{c}{v} \Rightarrow v = \frac{3 \times 10^8}{1.5} = 2 \times 10^8\ \text{m/s}$$

Marking scheme

- sin r = sin 45° ÷ 1.5 = 0.471.
- r ≈ 28°.
- v = c ÷ μ = 2×10^8 m/s.

21. If the distance is d, the P waves take $d/6$ s and the S waves $d/3.5$ s. **[3]**

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$$\frac{d}{3.5} - \frac{d}{6} = 25 \Rightarrow d\left(\frac{6 - 3.5}{21}\right) = 25 \Rightarrow d = \frac{25 \times 21}{2.5} = 210 \text{ km}$$

Marking scheme

- Travel times d/3.5 and d/6.
- d/3.5 − d/6 = 25.
- d = 210 km.

Section D

3 × 4 = 12

22. i. The nucleus sends the instructions (mRNA) out → the protein is made on the ribosomes of the rough endoplasmic reticulum → it travels in a vesicle to the Golgi body, enters at the cis face and is packed at the trans face → a vesicle carries it to the cell membrane, which releases it outside (exocytosis). **[4]**

ii. Making proteins and moving vesicles needs much energy (ATP), which mitochondria release by aerobic respiration.

iii. The lysosomes' digestive enzymes would be set free inside the cell and digest the cell itself (autolysis), killing it.

Marking scheme

- Made on ribosomes of the rough ER.
- Then Golgi body → vesicle → cell membrane (exocytosis), in that order.
- Mitochondria supply the energy (ATP) needed to make and move the proteins.
- The enzymes digest the cell itself (autolysis).

23. i. Cathode: the clean iron key. Anode: a plate of pure copper. Electrolyte: copper sulphate solution (with a little dilute sulphuric acid). **[4]**

ii. Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$ (copper is deposited on the key). Anode: $Cu \rightarrow Cu^{2+} + 2e^-$ (the copper plate dissolves).

iii. For every copper ion deposited on the key, the anode puts one copper ion back into the solution, so the concentration of Cu^{2+} ions, which give the blue color, stays the same.

iv. Use a small, steady direct current (and a clean key). A large current deposits copper too fast, so the coat is rough and loose.

Marking scheme

- Key as cathode, copper plate as anode, copper sulphate solution as electrolyte.
- Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$; anode: $Cu \rightarrow Cu^{2+} + 2e^-$.
- The anode replaces the Cu^{2+} ions deposited, so their concentration stays the same.
- A small, steady current, because a large one gives a rough, loose deposit.

24. i. On the east and west of the magnet, on the line through its middle (its equatorial line). **[4]**

ii. At a neutral point the magnet's field is equal and opposite to the Earth's horizontal field, so the resultant field is zero and nothing turns the needle.

iii. Beyond the N pole the magnet's field points north, the same way as the Earth's horizontal field, so the two add and can never cancel.

iv. On the magnet's axis, beyond both ends (beyond its N pole and beyond its S pole).

Marking scheme

- East and west of the magnet, on its equatorial line.
- The magnet's field cancels the Earth's horizontal field: resultant zero.
- There the magnet's field points north, along the Earth's, so they add.
- On the axis, beyond both poles.

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