Grade 9 Optional Science Model Paper 2

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. Cristae are the folds of the inner membrane of a mitochondrion, which carry the particles that make ATP.

Marking scheme

- The folds of the inner membrane of a mitochondrion.

b. The generation time is the time between one division and the next, in which the number of bacteria doubles (about 20 minutes for *E. coli* at 37 °C).

Marking scheme

- The time between two divisions, in which the number doubles.

c. A gene is a stretch of DNA on a chromosome that carries the instruction for one protein (or RNA), and so for a character.

Marking scheme

- A segment of DNA on a chromosome that codes for one protein (a character).

d. A keystone species is one whose loss changes the whole ecosystem, far more than its numbers would suggest, such as the tiger, a top predator.

Marking scheme

- A species whose loss changes the whole ecosystem, far beyond its numbers.

e. Edward Jenner, in 1796, using cowpox to protect against smallpox.

Marking scheme

- Edward Jenner.

f. Isobars are atoms of different elements that have the same mass number but different atomic numbers, such as argon-40 and calcium-40.

Marking scheme

- Atoms with the same mass number but different atomic numbers (different elements).

g. 0 °C (273 K) and 1 atm (760 mmHg).

Marking scheme

- 273 K (0 °C) and 760 mmHg (1 atm).

h. Electroplating is coating an object with a thin layer of another metal by electrolysis.

Marking scheme

- Coating an object with a thin layer of a metal by electrolysis.

i. Ethanol.

Marking scheme

- Ethanol.

j. Brass (about 2 parts of copper to 1 of zinc).

Marking scheme

- Brass.

k. A couple is a pair of equal, opposite and parallel forces whose lines of action are not the same.

Marking scheme

- A pair of equal, opposite, parallel forces not acting along the same line.

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l. When no external force acts on a system of bodies, the total momentum of the system stays the same.

Marking scheme

- With no external force, the total momentum of a system remains constant.

m. The sievert (Sv).

Marking scheme

- Sievert (Sv).

n. It is the ratio of the speed of light in a vacuum to the speed of light in the medium, $\mu = c/v$ (also equal to sin *i* ÷ sin *r* for light from a vacuum or air).

Marking scheme

- Speed of light in vacuum ÷ speed of light in the medium.

o. The angle of dip is the angle that the Earth's magnetic field makes with the horizontal, in the magnetic meridian.

Marking scheme

- The angle between the Earth's magnetic field and the horizontal (in the magnetic meridian).

p. A syncline is a downfold in rock layers, with a trough.

Marking scheme

- A downfold in rock layers.

Section B

13 × 2 = 26

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

- They are about the size of bacteria and have two membranes.
- They have their own circular DNA, like bacteria.
- They have 70S ribosomes, like bacteria, not the 80S ribosomes of the cytoplasm.
- They divide by splitting; a cell cannot make one from scratch.
- Their DNA is like that of purple bacteria (mitochondria) and cyanobacteria (chloroplasts).

Marking scheme

- One correct piece of evidence.
- A second correct piece of evidence.

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

Autosomes	Sex chromosomes
Control the body's characters.	Decide the sex.
22 pairs (44) in a human body cell.	1 pair (2).
The two of a pair are alike.	May differ (X and Y).
The same in both sexes.	XX in a female, XY in a male.

Marking scheme

- One correct difference.
- A second correct difference.

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

Aerobic decomposition	Anaerobic decomposition
Needs oxygen.	Takes place without oxygen.
Fast and complete.	Slow and often incomplete.
Gives carbon dioxide, water, minerals, humus and heat.	Gives methane, carbon dioxide, hydrogen sulphide, ammonia and organic acids.
In leaf litter and turned compost.	In flooded paddy, swamps, biogas plants.

Marking scheme

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- One correct difference.
- A second correct difference.

5. A cold is caused by viruses. Antibiotics act only on bacteria, on parts such as the cell wall or 70S ribosomes that viruses don't have, so they do nothing against a cold. Taking them anyway kills friendly bacteria and helps antibiotic-resistant bacteria to spread. **[2]**

Marking scheme

- A cold is caused by viruses, which antibiotics cannot harm (they act only on bacteria).
- Misuse kills friendly bacteria or helps antibiotic resistance spread.

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

Rutherford's model	Bohr's model
Electrons can move in orbits of any size.	Electrons move only in certain fixed orbits with fixed energies.
A circling electron should radiate energy and fall into the nucleus.	An electron gives out no energy while in an orbit; energy is given out or taken in only in jumps.
Cannot explain why atoms are stable or hydrogen's line spectrum.	Explains the stability of atoms and hydrogen's line spectrum.

Marking scheme

- One correct difference.
- A second correct difference.

7. Brine contains H^+ ions from the water as well as Na^+ ions from the salt, and both go to the cathode. Sodium is far above hydrogen in the activity series, so H^+ ions take electrons much more easily and are discharged instead: $2H^+ + 2e^- \rightarrow H_2$. The Na^+ ions stay in the solution. (Sodium can be obtained only by electrolysing molten sodium chloride, where there are no H^+ ions.) **[2]**

Marking scheme

- Both Na^+ and H^+ (from water) ions reach the cathode.
- H^+ ions are discharged in preference, because sodium is above hydrogen in the activity series (sodium stays as Na^+).

8. The molecules of ethanol have an –OH group, which holds neighboring molecules together strongly, so much energy is needed to separate them. Propane's molecules have no –OH and attract each other only weakly, so propane boils at a very low temperature, although its molecules are nearly as heavy. **[2]**

Marking scheme

- The –OH group holds ethanol's molecules together strongly.
- Propane has no –OH; its molecules attract weakly, so it boils at a low temperature.

9. Stainless steel is iron with at least 10.5% chromium (the common 18/8 kind: 18% chromium, 8% nickel). The chromium forms a thin film of oxide on the surface which keeps air and water away from the iron, and if the film is scratched it forms again (heals), so the steel does not rust. **[2]**

Marking scheme

- Iron with chromium (at least 10.5%) and nickel (18/8: 18% Cr, 8% Ni).
- Chromium forms a protective oxide film that heals when scratched, so it doesn't rust.

10. The ball's momentum must be brought to zero, a fixed change. By Newton's second law, force = change in momentum ÷ time. Drawing the hands back makes the stop take longer, so the force on the hands is smaller and they are not hurt. **[2]**

Marking scheme

- The change in momentum is fixed; force = change in momentum ÷ time.
- Drawing the hands back increases the time, so the force on the hands is smaller.

11. Gamma rays have the greatest penetrating power, so they pass through the sealed packet and reach the syringe; alpha and beta would be stopped. They kill the germs without heating, so the **[2]**

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plastic syringe isn't damaged and stays sterile inside its packet.

Marking scheme

- Gamma rays penetrate the sealed packet (alpha and beta can't).
- They kill germs without heat, so the plastic isn't harmed and the packet stays sealed.

12. The critical angle of diamond is very small, about 24.4°, against glass's 41.8°. So most light that enters a cut diamond meets its back faces at more than the critical angle and is totally internally reflected again and again, leaving through the top. Much of the light in the glass leaks out at the back. **[2]**

Marking scheme

- Diamond has a very small critical angle (24.4°, glass 41.8°).
- So light is totally internally reflected many times inside and leaves by the top.

13. A television has capacitors, which store electric charge on their plates. The charge stays on the plates after the set is unplugged, until it is discharged through something. A person who touches the terminals becomes the path, and the stored charge flows through the body. **[2]**

Marking scheme

- Capacitors inside store charge on their plates.
- The charge remains after unplugging and can discharge through the body.

14. Under Nepal one continental plate (the Indian plate) is colliding with another (the Eurasian plate). No wet oceanic plate sinks into the mantle here, and there is no spreading ridge or hot spot, so no magma forms. The rocks are squeezed, folded and broken instead, which gives earthquakes. (Nepal's hot springs are water warmed deep along faults.) **[2]**

Marking scheme

- Continent meets continent: no oceanic plate sinks (no ridge or hot spot), so no magma forms.
- The squeezed rocks break and slip, causing earthquakes.

Section C

7 × 3 = 21

15. Total magnification = eyepiece × objective = 10 × 40 = 400 **[3]**

Real size = $\dfrac{\text{image size}}{\text{magnification}} = \dfrac{24\ \text{mm}}{400} = 0.06\ \text{mm}$

0.06 mm × 1,000 = 60 µm

Marking scheme

- Total magnification = 10 × 40 = 400.
- Real size = 24 mm ÷ 400 = 0.06 mm.
- 0.06 mm = 60 µm.

16. Share immune $= 1 - \dfrac{1}{R_0} = 1 - \dfrac{1}{12} = \dfrac{11}{12} \approx 0.917$ (about 92%) **[3]**

Students = $\dfrac{11}{12} \times 600 = 550$

Marking scheme

- Uses share immune = 1 − 1/R_0.
- 1 − 1/12 = 11/12 (about 92%).
- 11/12 × 600 = 550 students.

17. i. Cathode: $4H^+ + 4e^- \rightarrow 2H_2$. Anode: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$. **[3]**

ii. Hydrogen and oxygen form in the ratio 2 : 1 by volume, so oxygen = 24 ÷ 2 = 12 cm³.

Marking scheme

- Cathode: $4H^+ + 4e^- \rightarrow 2H_2$ (or $2H^+ + 2e^- \rightarrow H_2$).
- Anode: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$.
- Oxygen = 12 cm³ (2 : 1 by volume).

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18. i. 2-methylbutane (the longest chain has four carbons; the methyl is on carbon 2, counted from the nearer end). **[3]**

ii. Propanone (a ketone of three carbons).

iii. But-2-ene (four carbons, the double bond starting at carbon 2).

Marking scheme

- 2-methylbutane.
- Propanone.
- But-2-ene (2-butene).

19. i. $a = \dfrac{v-u}{t} = \dfrac{10-0}{5} = 2\ \mathrm{m/s^2}$ (the slope of the first line). **[3]**

ii. Distance = area under the graph:

- first 5 s (triangle): $\frac{1}{2} \times 5 \times 10 = 25$ m
- next 15 s (rectangle): $15 \times 10 = 150$ m
- last 4 s (triangle): $\frac{1}{2} \times 4 \times 10 = 20$ m

Total = 25 + 150 + 20 = 195 m.

Marking scheme

- a = 10 ÷ 5 = 2 m/s².
- Areas of the three parts: 25 m, 150 m, 20 m.
- Total distance = 195 m.

20. $q_1 = 2 \times 10^{-6}$ C, $q_2 = 3 \times 10^{-6}$ C (size), $r = 0.30$ m **[3]**

$$F = \frac{kq_1q_2}{r^2} = \frac{9 \times 10^9 \times 2 \times 10^{-6} \times 3 \times 10^{-6}}{0.09} = \frac{0.054}{0.09} = 0.6\ \mathrm{N}$$

The charges are unlike, so the force is attraction.

Marking scheme

- Units changed: 2 × 10⁻⁶ C, 3 × 10⁻⁶ C, 0.30 m.
- F = kq₁q₂/r² = 0.6 N.
- Attraction (unlike charges).

21. i. $d = v \times t = 5 \times 10{,}000{,}000 = 50{,}000{,}000$ cm. Since 1 km = 100,000 cm, $d = 500$ km. **[3]**

ii. Shortening = 80 − 60 = 20 km; $\dfrac{20}{80} \times 100\% = 25\%$.

Marking scheme

- d = 5 cm × 10⁷ = 5 × 10⁷ cm.
- = 500 km.
- Shortening = 20 ÷ 80 × 100% = 25%.

Section D

3 × 4 = 12

22. i. *Mucor mucedo* is heterothallic: a mycelium can mate only with one of the other strain (+ with −). The two patches came from different strains, and their gametangia fuse only where the two meet. **[4]**

ii. When the zygospore germinates, its diploid nucleus divides by meiosis, so the spores of the germ sporangium are haploid and grow into haploid + and − mycelia.

iii. Its thick wall lets it survive bad times such as drying or a lack of food, and it germinates when conditions are good again.

iv. No. The mold's hyphae run deep into the bread, out of sight, and its spores can cause allergies; moldy bread should be thrown away.

Marking scheme

- Heterothallic: only + and − strains can conjugate, which happens where they meet.
- The zygospore's nucleus undergoes meiosis on germination, giving haploid spores.
- The thick-walled zygospore survives unfavorable conditions.
- Not safe: the hyphae run deep into the bread (throw it away).

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23. i. $NH_3 + HCl \rightarrow NH_4Cl$ (white solid). **[4]**

ii. Nearer the hydrochloric acid end. By Graham's law, the rate of diffusion is inversely proportional to the square root of the density (molar mass); HCl is heavier, so it diffuses more slowly and the gases meet nearer its end.

iii. $\frac{r\mathrm{NH_3}}{r\mathrm{HCl}} = \sqrt{\frac{M\mathrm{HCl}}{M\mathrm{NH_3}}} = \sqrt{\frac{36.5}{17}} = 1.465$

In the same time the distances are in this ratio: $x : (120 - x) = 1.465 : 1$, so $x = \frac{1.465}{2.465} \times 120 \approx 71.3$ cm from the ammonia end.

Marking scheme

- $NH_3 + HCl \rightarrow NH_4Cl$.
- Nearer the HCl end, because HCl is heavier and diffuses more slowly (Graham's law).
- Rate ratio = √(36.5/17) = 1.465.
- Distance ≈ 71.3 cm from the ammonia end.

24. i. Below the fish he sees. Light from the fish bends away from the normal as it leaves the water, so the image he sees is higher than the real fish. **[4]**

ii. $\mathrm{apparent\ depth} = \frac{\mathrm{real\ depth}}{\mu} = \frac{2.0}{4/3} = 1.5$ m.

iii. Apparent shift = real depth − apparent depth = 2.0 − 1.5 = 0.5 m.

iv. Shallower still: at a slant the rays bend more and the bottom seems raised even more.

Marking scheme

- Below, because refraction makes the image appear higher than the fish.
- Apparent depth = 2.0 ÷ (4/3) = 1.5 m.
- Shift = 0.5 m.
- Shallower.

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