

CIE A-Level Biology 9700 Paper 5 Practice

Paper (Planning, Analysis and Evaluation) -

ANSWERS

Total: 30 marks · 1 h 15 min · 2 questions · 11 parts

Q	Part	Answer	Mark points	marks
1	(a)	Independent variable: temperature (10, 20, 30, 40 and 50 °C). Dependent variable: the rate of oxygen release (cm ³ s ⁻¹). Controls: the concentration and volume of hydrogen peroxide (20 cm ³ of 2.0% w/v), the number and total surface area of the potato discs (5 discs, 2 mm thick, cut with the same cork borer), the pH (same buffer) and the length of time over which gas is collected.	1 mark: temperature independent, rate of oxygen release dependent 1 mark: two controls (hydrogen peroxide concentration / volume, disc number and size, pH, collection time)	2
1	(b)	Set up five water baths at 10, 20, 30, 40 and 50 °C and check each with a thermometer until the reading is steady. Stand the tube containing 20 cm ³ of 2.0% hydrogen peroxide in the bath for 5 minutes, and pre-warm the potato discs in the same bath for 5 minutes, so that both reach the bath temperature. Just before mixing, read the temperature of the liquid in the tube with a thermometer and record it instead of assuming it equals the bath setting; it should be within ±0.5 °C of the target.	1 mark: five water baths set at 10-50 °C 1 mark: peroxide and discs pre-warmed in the bath for 5 minutes 1 mark: temperature of the liquid measured, not assumed to equal the bath setting	3
1	(c)	Add the discs, immediately fit a gas-tight syringe (or an inverted gas measuring tube over water) and start the stopwatch at the same moment. Record the gas volume every 10 s for 120 s. Take the initial rate (cm ³ s ⁻¹) from the steepest tangent to the volume-time graph over the first 30 s, because the substrate concentration falls and the rate slows later. Repeat each temperature three times and average, using fresh discs and fresh hydrogen peroxide each time, and blot the discs dry with filter paper.	1 mark: gas-tight apparatus (syringe / inverted tube) with no leak 1 mark: volume read every 10 s for 120 s 1 mark: initial rate from the steepest tangent over the first 30 s, not a whole-run average 1 mark: three repeats averaged / fresh discs and fresh reagent	4

1	(d)	Plot the initial rate ($\text{cm}^3 \text{ s}^{-1}$) on the y-axis against temperature ($^{\circ}\text{C}$) on the x-axis. The rate should rise steadily from 10°C to about 40°C , roughly doubling for each 10°C rise, reach a maximum near 40°C and then fall sharply because the enzyme denatures and the active site loses its shape. Q_{10} equals the rate at $(T + 10)^{\circ}\text{C}$ divided by the rate at $T^{\circ}\text{C}$, for example the rate at 30°C divided by the rate at 20°C .	1 mark: rate plotted against temperature, both axes labelled with units 1 mark: expected rise to a maximum near 40°C then a sharp fall due to denaturation 1 mark: $Q_{10} = \text{rate at } (T + 10) \text{ divided by rate at } T$	3
1	(e)	(1) Repeat every temperature three times and average, which reduces random error. (2) Cut all discs with the same cork borer, keep the thickness the same and blot them dry, so that surface area and the amount of enzyme are controlled. (3) Hydrogen peroxide irritates skin and eyes, so wear goggles and gloves and work in a well-ventilated place; use tongs for tubes in the 50°C bath because of the risk of scalding.	1 mark: three repeats averaged (reduces random error) 1 mark: same cork borer / equal thickness / blotted dry (controls surface area and enzyme amount) 1 mark: goggles and gloves, ventilation, tongs for hot tubes (safety reason)	3
2	(a)	Rate = volume in 5 min $\div$ 5: d = 10 cm gives $20.0 \div 5 = 4.00$; 20 cm gives $5.00 \div 5 = 1.00$; 30 cm gives $2.22 \div 5 = 0.44$; 40 cm gives $1.25 \div 5 = 0.25$; and 50 cm gives $0.80 \div 5 = 0.16 \text{ cm}^3 \text{ min}^{-1}$.	1 mark: all five values divided by 5 minutes (4.00, 1.00, 0.44, 0.25, 0.16) 1 mark: unit $\text{cm}^3 \text{ min}^{-1}$ 1 mark: all values given consistently to 2 decimal places	3
2	(b)	The five points lie close to a straight line through the origin: 1.00×10^{-2} gives 4.00; 2.50×10^{-3} gives 1.00; 1.11×10^{-3} gives 0.44; 6.25×10^{-4} gives 0.25; 4.00×10^{-4} gives 0.16. The least-squares gradient is about $4.0 \times 10^2 \text{ cm}^3 \text{ min}^{-1} \text{ cm}^2$. A straight line through the origin shows that the rate is directly proportional to light intensity, so light is the limiting factor over this range, and the gradient is the increase in rate per unit increase in $1/d^2$.	1 mark: both axes labelled with variable and unit 1 mark: all five points plotted correctly 1 mark: straight line through the origin 1 mark: gradient about $4.0 \times 10^2 \text{ cm}^3 \text{ min}^{-1} \text{ cm}^2$, with rate proportional to intensity / light limiting	4
2	(c)	At d = 25 cm, $1/d^2 = 1 \div 625 = 1.60 \times 10^{-3} \text{ cm}^{-2}$, so the rate is $4.0 \times 10^2 \times 1.60 \times 10^{-3} = 0.64 \text{ cm}^3 \text{ min}^{-1}$. From the raw data the volume in 5 minutes is $2000 \div 625 = 3.20 \text{ cm}^3$, giving $3.20 \div 5 = 0.64 \text{ cm}^3 \text{ min}^{-1}$. The two values agree to within 1%, which supports the conclusion that the rate is proportional to light intensity.	1 mark: $1/d^2 = 1.60 \times 10^{-3} \text{ cm}^{-2}$ 1 mark: gradient used to obtain $0.64 \text{ cm}^3 \text{ min}^{-1}$ 1 mark: compared with the	3

			value from the data and a conclusion drawn	
2	(d)	Volume: $0.05 \div 0.80 \times 100\% = 6.25\%$; time: $1 \div 300 \times 100\% = 0.33\%$; total 6.58%, which is about 6.6% (or 7% to one significant figure). The volume is smallest at 50 cm, so the relative uncertainty is largest there and that point is the least reliable on the graph.	1 mark: $6.25\% + 0.33\% = 6.6\%$ 1 mark: notes that the smallest volume at 50 cm gives the largest percentage uncertainty	2
2	(e)	(1) The distance is measured with a ruler between the lamp and the weed, but the position of the filament is not well defined, and the lamp heats up and raises the water temperature, changing enzyme activity. Use a light box or LED, fix the lamp-weed distance, and keep the water at 25 °C in a water bath. (2) Some oxygen dissolves in the water or clings to the weed and never enters the tube. Let the weed acclimatise for 5 minutes, tap the tube so bubbles rise, or measure with a dissolved-oxygen electrode. (3) Only the carbon dioxide already dissolved in the water is available and it may run out within 5 minutes and become the limiting factor. Supply carbon dioxide using a solution of sodium hydrogencarbonate of fixed concentration.	1 mark: first limitation (distance / filament position, lamp heating) with an improvement (light box, fixed distance, water bath) 1 mark: second limitation (oxygen dissolving / clinging, CO ₂ running out) with an improvement (acclimatise, tap the tube, hydrogencarbonate solution) 1 mark: each improvement must actually address the stated error	3