

Question	Answer	Marks	Guidance
1 a i	<p>as the temperature increases, the rate of photosynthesis increases and decreases (1) but as the temperature increases, the rate of photosynthesis increases, levels off, and then decreases (2) plus correct uses of data, e.g.: rises to max rate of 20 (arbitrary units) / rises to max rate at 30 (°C) / decreases after 40 (°C) / rate is zero at 55 (°C) / constant / optimum 28 – 40 (°C)</p>	3	<p>(it) increases and goes down = 0</p> <p>(it) increases, levels off, then decreases (1)</p> <p>allow answer in range 28-30 (°C)</p> <p>allow answer in range 28-40 (°C)</p>
ii	<p>(as the temperature increases, the rate of photosynthesis) increases because particles/enzymes have more (kinetic) energy / collide more (frequently) / ORA (1)</p> <p>levels off because of some other limiting factor / not enough CO₂ / not enough light / temperature is not a limiting factor (1)</p> <p>decreases because enzymes denature (1)</p>	3	<p>ignore optimum temperature</p> <p>allow at start, temperature is the limiting factor (1)</p>
iii	<p>answer in range 28-30 (°C) (1) idea that max rate of photosynthesis and heating any more would be wasteful (1)</p>	2	<p>if give temperature above 30 (°C) then no marks at all</p> <p>allow value less than 28 (°C) if explains that reduced rate of photosynthesis / yield is balanced by reduced heating costs = 2 answer below 28 (°C) with no justification = 0</p>

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b	cost of heaters / cost of heating / payback time for heaters (1) idea of pollution / environmental damage / carbon footprint (1)	2	ignore simply 'cost' allow idea that gas/oil heaters also release carbon dioxide for photosynthesis (1) allow idea that transpiration might increase / may need more water (1)
Total		10	

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2 a	from carbon dioxide (from the air / through leaves) (1)	1	allow from glucose allow correct formula ignore from food ignore photosynthesis / respiration / breathing
b	from water (from the soil / through roots) (1)	1	allow from glucose allow correct formula ignore from food ignore photosynthesis / respiration / breathing
c	from carbon dioxide (from the air / through leaves) (1)	1	not from water allow from glucose allow correct formula ignore from food ignore photosynthesis / respiration / breathing
d	from nitrates (from the soil / through roots) (1)	1	allow correct formula
Total		4	

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3	(a)	$C_6H_{12}O_6$ and $6O_2$ (1)	1	any order must use subscripts
	(b)	idea that not enough mass/materials/substances/nutrients lost from soil to supply the mass/material/substances/nutrients gained by the tree (1) correct calculation : soil lost 1kg but tree gained 78kg (1)	2	allow the tree gained (much) more mass than the soil lost allow total weight changed from 102kg → 179kg allow soil would have been 22kg (if scientists were correct) allow the tree gained 77kg from somewhere else (not soil) = 2 marks allow tree gains 78kg but soil only lost 1kg = 2 bod
	(c) (i)	(water lost in) transpiration (1) idea that only a small proportion is used in photosynthesis (1)	2	allow evaporation from plant
	(ii)	more transpiration (1) idea that wind moves away water vapour (1)	2	allow more water lost through stomata allow more evaporation / more diffusion (out of leaf) ignore simply 'more water lost'
Total			7	

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4	(a)	<p>(Level 3) Answer includes more than one correct assumption and a correct calculation and a sensible interpretation of the result. Quality of written communication does not impede communication of the science at this level. (5–6 marks)</p> <p>(Level 2) Answer includes a correct assumption and a correct calculation OR Answer includes a correct calculation and a sensible interpretation of the result. Quality of written communication partly impedes communication of the science at this level. (3–4 marks)</p> <p>(Level 1) Answer includes either a correct assumption or a correct calculation or a sensible interpretation. Quality of written communication impedes communication of the science at this level. (1–2 marks)</p> <p>(Level 0) Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)</p>	6	<p>This question is targeted from grades D to A</p> <p>Indicative scientific points may include:</p> <p>assumptions:</p> <ul style="list-style-type: none"> • no immigration / emigration between release and recapture • no death / reproduction between release and recapture • identical sampling methods • the marking does not affect the survival rate • marked slugs have mixed with non-marked slugs • marks don't get removed <p>calculations:</p> <ul style="list-style-type: none"> ▪ calculation is $\frac{50 \times 45}{5} = 450$ ▪ estimate of population is 450 ▪ the population is halved <p>interpretations:</p> <ul style="list-style-type: none"> ▪ method of control is working / is successful as population has gone down/halved ▪ an appreciation that these are only estimates. <p>If mostly matches level 3 but only has one assumption, give 5 marks</p> <p>If give formula only i.e. $50 \times 45 / 5$ then award 1 mark if level 1, 3 marks if level 2, 5 marks if level 3</p> <p>If incorrect calculation, then can give sensible interpretation ecf for L1</p> <p>Use L1, L2, L3 annotations in scoris. Do not use ticks</p>

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	(b)	(i)	C (1)	1	
		(ii)	(cells with) most chloroplasts / palisade layer is near the top of the leaf (1)	1	allow upper epidermis is transparent / one cell thick ignore cuticle ignore large surface area / thin
		(iii)	they (carotene / xanthophyll) absorb different wavelengths (to chlorophyll) (1) a wider range of wavelengths can be absorbed / more of the spectrum is absorbed (1)	2	allow absorb different colours (of light) allow correct reference to just one pigment ignore absorb wrong wavelengths ignore just 'absorb more light'
			Total	10	