

Additional Science B

General Certificate of Secondary Education

Unit **B721/02**: Modules B3, C3, P3 (Higher Tier)

Mark Scheme for June 2013

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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For answers marked by levels of response:

- a. **Read through the whole answer from start to finish**
- b. **Decide the level that best fits** the answer – match the quality of the answer to the closest level descriptor
- c. **To determine the mark within the level**, consider the following:

Descriptor	Award mark
A good match to the level descriptor	The higher mark in the level
Just matches the level descriptor	The lower mark in the level

- d. Use the **L1**, **L2**, **L3** annotations in Scoris to show your decision; do not use ticks.

Quality of Written Communication skills assessed in 6-mark extended writing questions include:

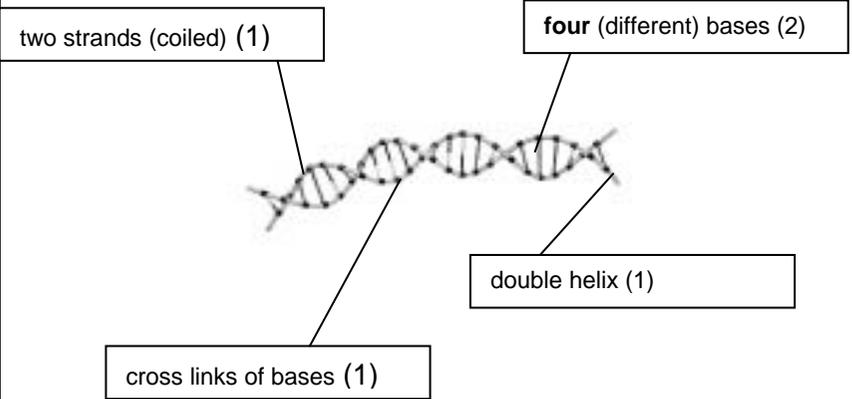
- appropriate use of correct scientific terms
- spelling, punctuation and grammar
- developing a structured, persuasive argument
- selecting and using evidence to support an argument
- considering different sides of a debate in a balanced way
- logical sequencing.

Annotations

Annotation	Meaning
	correct response
	incorrect response
	benefit of the doubt
	benefit of the doubt not given
	error carried forward
	information omitted
	ignore
	reject
	contradiction
	Level 1
	Level 2
	Level 3

Abbreviations, annotations and conventions used in the detailed Mark Scheme.

/	=	alternative and acceptable answers for the same marking point
(1)	=	separates marking points
allow	=	answers that can be accepted
not	=	answers which are not worthy of credit
reject	=	answers which are not worthy of credit
ignore	=	statements which are irrelevant
()	=	words which are not essential to gain credit
—	=	underlined words must be present in answer to score a mark (although not correctly spelt unless otherwise stated)
ecf	=	error carried forward
AW	=	alternative wording
ora	=	or reverse argument

Question		Answer	Marks	Guidance
1	(a)	37 (1)	1	not 37 pairs
	(b)	<p>any two from: two strands (coiled) (1) (strands coiled to form a) double helix (1) (with cross links of) bases (1) but four (different) bases (2)</p>	2	<p>allow diagram drawn with one mark for each correct label</p>  <p>allow high level answers eg (bases are) A, T, C, G (1) but has bases A, T, C, G (2) allow idea of complementary bases (2) or A-T and C-G (2) ignore incorrect pairing of bases ignore spiral</p>

Question		Answer	Marks	Guidance
	(c)	<p>any three from:</p> <p>both (proteins) coded for by sequence of bases (1)</p> <p>both (proteins) require 3 bases to code for each amino acid (1)</p> <p>sequence of bases will be different for each protein (1)</p> <p>because they have different amino acid sequence (1)</p>	3	<p>answer must include comparison. A simple description of protein synthesis scores maximum of two marks.</p> <p>eg DNA contains a sequence of bases, which codes for the amino acids in the proteins, the bases are copied onto mRNA to make the protein, each amino acid is coded for by three bases = 2</p> <p>eg DNA contains a sequence of bases, which codes for the amino acids in the proteins. The bases are copied onto mRNA to make the protein, the sequence of bases for collagen is different to that of insulin = 3</p> <p>allow production of both proteins requires making mRNA (1)</p> <p>if no other marks scored then reference to coding scores (1)</p>
		Total	6	

Question		Answer	Marks	Guidance
2	(a)	(resistant) gene isolated or extracted (1) gene is inserted into DNA (of soya bean) (1)	2	allow second marking point in first box so long as answer is not contradicted in second box (1)
	(b)	any two from: they may have ethical reasons (1) because they may harm the environment/harm biodiversity/disrupt food chains (1) resistance or resistant gene to pesticides or herbicides could get into other plants or could lead to increase in pesticide or herbicide use (1)	2	allow some farmers cannot compete (1) as they cannot afford the GM seeds (1) allow morally or religiously wrong (1) ignore you can't fiddle with nature ignore people don't like the idea of playing God allow reduce biodiversity (1) because everyone grows the same crop (1) allow some harmful effects may not yet have been discovered (1) allow the idea that it would enable use of high levels of pesticides (1) that could lead to build up in the food chain (1) ignore people will not eat it unless qualified eg people will not eat it because it is not natural or organic (1) but ignore they object because 'it's not natural or organic ' on its own ignore may not taste as good ignore idea of all susceptible to the same disease ignore references to (genetic) variation or reduction of gene pool
		Total	4	

Question		Answer	Marks	Guidance
3	(a)	40 (2) but $\frac{1.8}{4.5} \times 100$ (1)	2	
	(b)	any three from: rate of growth in warm room or plant A is greater/ora(1) enzymes work at a faster rate in warmth/ora(1) enzymes needed for photosynthesis (1) enzymes needed for mitosis (1) mitosis needed for growth (1) can photosynthesise faster/cells divide faster so more growth (1)	3	allow plant A grows faster or grows bigger (1) allow enzymes work best or at optimum in warm room or at any temperature in the range 15 – 40°C (1) ignore enzymes grow or more enzymes allow an implication that enzymes control the rate of photosynthesis eg the warmer the room the faster the rate of photosynthesis. Enzymes act as a biological catalyst speeding up the rate (2) allow enzymes control growth rate (1) allow temperature is a limiting factor (1) allow higher level answers eg enzymes required for respiration (1) eg can respire faster (in the warm room) (1)
		Total	5	

Question		Answer	Marks	Guidance
4	(a)	<p>[Level 3] Applies understanding of oxygen debt to give a detailed explanation of the complete pattern to explain the gradual decrease in the graph. Quality of written communication does not impede communication of the science at this level. (5–6 marks)</p> <p>[Level 2] Candidate applies understanding of TWO from oxygen debt, anaerobic respiration or lactic acid build up to explain why heart rate is higher after exercise. Quality of written communication partly impedes communication of the science at this level. (3–4 marks)</p> <p>[Level 1] Candidate describes a pattern from the graph between 4 and 20 minutes AND attempts an explanation. 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 at grades up to A</p> <p>Relevant scientific points at level 3 include:</p> <ul style="list-style-type: none"> oxygen needed to break down lactic acid higher pulse rate needed to remove lactic acid from muscle lactic acid taken to liver pulse rate levels off when lactic acid is broken down gradual decrease due to the fact that lactic acid is broken down gradually not all at once <p>Relevant scientific points at level 2 include:</p> <ul style="list-style-type: none"> idea of oxygen debt higher pulse rate needed to take extra oxygen to muscle after 14 min oxygen debt repaid takes 10 minutes to recover from anaerobic respiration idea that anaerobic respiration took place lactic acid built up during exercise <p>Relevant scientific points at level 1 include:</p> <ul style="list-style-type: none"> idea that pulse rate (gradually) falls because they have stopped exercising eventually reaches normal (after 14 minutes) body needs oxygen (for recovery) <p>Check graph for any labels</p> <p>Use L1, L2, L3 annotations in scoris; do not use ticks.</p>

Question	Answer	Marks	Guidance
(b)	14 (minutes) (because it has levelled off) (1) levels off because the maximum oxygen debt is reached (1) or 18 minutes because the 10 minute reading is an error (1) 18 would give a linear pattern (1)	2	not 13-14 or 14-15 (minutes) allow idea that maximum amount of lactic acid made (1) allow at higher temperatures enzymes activity may decrease/enzymes may denature (1)
(c)	any two from: idea that blood to body would not contain as much oxygen or would flow at lower rate or be under less pressure (1) idea that this decreases the flow of blood to muscle or tissue which would mean that less oxygen will be delivered (1) which would result in less oxygen available for aerobic respiration (1)	2	
	Total	10	

Question		Answer	Marks	Guidance
5	(a)	200 (seconds) (1)	1	allow any answer in range 190–200 seconds (1) ignore units
	(b)	reactant not in excess/reactant that is all used up (at the end of the reaction)/reactant that is used up first (1)	1	ignore only lasts a limited time
	(c)	gradient of new curve less steep than original curve, but still passes through origin (1) levels out at 0.47g (1)	2	the line must not go above 0.47g

Question	Answer	Marks	Guidance
(d)	<p>[Level 3] Applies knowledge and understanding of reacting particle model to explain <u>both</u> factors in detail although the reference to more collisions may only be made for one of the factors. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>[Level 2] Applies knowledge and understanding of reacting particle model to explain one of the factors in detail <u>or</u> partially explain both factors Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>[Level 1] Appreciation that the rate of any reaction depends on the number of collisions in whatever context it is used 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.</p>	6	<p>This question is targeted at grades up to C</p> <p>At all levels ignore reference to faster collisions and to more particles and ignore particles vibrate more allow answers that give ora but it must be very clear that this is what candidate has done</p> <p>Indicative scientific points at levels 2 and 3 may include: <u>rate increases with temperature because</u></p> <ul style="list-style-type: none"> • acid particles move faster/acid particles have more energy • more collisions between particles of acid and marble – this does not have to be qualified eg more (successful) collisions or more collisions (per second) <p>allow – higher level answers for temperature that refer to more acid particles having sufficient energy to react or more acid particles having energy above that of the activation energy</p> <p>concentration of hydrochloric acid:</p> <ul style="list-style-type: none"> • idea of more crowded acid particles/more acid particles in same volume • more collisions between particles of acid and marble – this does not have to be qualified eg more (successful) collisions or more collisions (per second) <p>ignore references to ‘more particles’</p> <p>Indicative scientific points at level 1 may include:</p> <ul style="list-style-type: none"> • more collisions gives a faster reaction even if referring to particle size or pressure • link between number of collisions and rate of reaction <p>Use L1, L2, L3 annotations in scoris; do not use ticks.</p>
	Total	10	

Question		Answer	Marks	Guidance
6	(a)	50(g) scores (2) but mass = $\frac{4200}{4.2 \times 20}$ or mass = $\frac{4200}{84}$ scores (1) or mass = $\frac{\text{energy}}{\text{specific heat capacity} \times \text{temp change}}$ (1)	2	look for correct answer first , 50(g) on own scores (2) but also check for correct working if included not 50.4 (g) unit not needed
	(b)	idea that bond breaking is endothermic (1) idea that bond making is exothermic (1) more energy is given out (in bond making) than is taken in (in bond breaking) (1)	3	allow bond breaking absorbs energy (1) allow bond making releases energy (1) allow more energy released than absorbed (1) ignore references to different numbers of bonds, eg more bonds made than broken not references to intermolecular bonds allow exothermic reactions give out energy or heat (1) if no other mark awarded
	(c)	$\text{C}_2\text{H}_6\text{O} + 3\text{O}_2 \rightarrow 2\text{CO}_2 + 3\text{H}_2\text{O}$ formulae (1) balancing (1)	2	allow $\text{C}_2\text{H}_5\text{OH}$ as formula for ethanol allow any correct multiple, including fractions eg $2\text{C}_2\text{H}_6\text{O} + 6\text{O}_2 \rightarrow 4\text{CO}_2 + 6\text{H}_2\text{O}$ (2) allow = or = instead of \rightarrow not and or & balancing mark is dependent on the correct formulae but allow 1 mark for a balanced equation with a minor error in subscripts or case eg $\text{C}_2\text{H}_6\text{O} + 3\text{O}_2 \rightarrow 2\text{Co}_2 + 3\text{H}_2\text{O}$ (1)
Total			7	

Question		Answer	Marks	Guidance
7	(a)	<p>33(%) (2)</p> <p>but if correct answer not given, atom economy = $\frac{M_r \text{ of desired products}}{\text{sum of } M_r \text{ of all products}} \times 100$</p> <p>or atom economy = $\frac{M_r \text{ of desired products}}{\text{sum of } M_r \text{ of all reactants}} \times 100$</p> <p>or atom economy = $\frac{58}{175} \times 100$ scores (1)</p>	2	<p>allow full marks for correct answer even if equation for atom economy not stated allow 33.1% / 33.14%</p> <p>allow $\frac{58}{58 + 117}$ or $\frac{58}{58 + (2 \times 58.5)}$ (1)</p>
	(b)	<p>60(%) scores (2)</p> <p>but $\frac{\text{actual yield}}{\text{predicted yield}} \times 100$ (1)</p> <p>or $\frac{21}{35} \times 100$ scores (1)</p>	2	<p>look for correct answer first, 60(%) on own scores (2) unit not needed – ignore incorrect units</p> <p>allow $\frac{am}{pm} \times 100$ (1)</p>

Question	Answer	Marks	Guidance
(c)	<p>high percentage yield: to reduce cost/make more profit/ idea of increased efficiency eg by not wasting starting materials or idea of producing more useful product/idea of producing less waste products/ reducing the need to recycle unreacted reactants (1)</p> <p>high atom economy: to make the process more sustainable or 'greener'/ idea of increased efficiency or idea of producing more useful product/idea of producing less waste products/ to reduce the processing of unwanted products/ to conserve raw materials (1)</p>	2	<p>the answer must be linked to the correct term (i.e. % yield or atom economy)</p> <p>If answer is not clearly linked then max 1 for increased efficiency or idea of producing more useful or desired product or less waste products (1)</p> <p>reduce amount of waste is not sufficient but allow to reduce the amount of waste product</p>

Question		Answer	Marks	Guidance
	(d)	batch process is flexible/can easily change the type of vaccine made (1) batch process allows the amount of product made to be varied (according to demand for vaccine) (1)	2	
		Total	8	

Question		Answer	Marks	Guidance
8	(a)	C and D (1)	1	both needed in either order allow B for one of the answers if candidate makes it clear that B lies between 3 and 5.7 minutes or allow A if candidate makes it clear that A extends beyond 3 minutes or below 1 minute Check the graph to see if this has been done.
	(b)	8.3 (m/s) (3) but if answer is incorrect $1000 \div (2.0 \times 60)$ or $1 \times 1000 \div (2.0 \times 60)$ (2)	3	allow 8.33.m/s (3) any more d.p. beyond 2 (2) but if conversions are incorrect allow $\frac{2}{4}$ or $\frac{1.5}{3}$ or $\frac{1}{2}$ or $\frac{0.5}{1}$ or 0.5 (m/s) (1)
	(c)	(i) 5 (m/s) (1)	1	if answer line is blank allow correct answer ticked circled or underlined
		(ii) velocities are subtracted (1) (This mark is conditional on correct answer to 8(c)(i)) idea of both cars moving in same direction (1)	2	allow $15 \text{ (m/s)} - 10 \text{ (m/s)} (= 5 \text{ m/s})$ (1) allow both velocities positive (1) allow Ravi is moving away from Lewis at a speed of 15 m/s so difference is 5 m/s (2)
Total			7	

Question	Answer	Marks	Guidance
9 (a)	<p>[Level 3] Calculates rate of momentum change OR force for both with and without an airbag and comments correctly upon it. Quality of written communication does not impede communication of the science at this level. (5–6 marks)</p> <p>[Level 2] Candidate makes 3 points which must be drawn from both sections A and B. Quality of written communication partly impedes communication of the science at this level. (3–4 marks)</p> <p>[Level 1] Candidate makes any two points from sections A and B. 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 at grades up to C Indicative scientific points may include:</p> <p>A: fundamental ideas:</p> <ul style="list-style-type: none"> • airbag changes shape • airbag absorbs energy (ignore absorbs force) • reduced or no injuries in a collision or crash • deflates after stopping to stop suffocation • increase stopping or collision distance • less force (exerted on driver) • collision lasts for a longer time with airbag/ora • driver takes longer to stop <p>ignore any mention of impact or slowing down time for impact</p> <p>B: use of table data:</p> <ul style="list-style-type: none"> • collision time longer with airbag • longer time to absorb energy <p>C: calculations and comments needed for level 3:</p> <ul style="list-style-type: none"> • momentum change to work out force without airbag = $\frac{15 \times 50}{0.02}$ (N) • momentum change to work out force with airbag = $\frac{15 \times 50}{0.05}$ (N) • Use $F=ma$ to calculate force for each $\frac{15 \times 50}{0.02}$ (N) <ul style="list-style-type: none"> ▪ 0.02 • and $\frac{15 \times 50}{0.05}$ (N) • clear implication of calculations in qualitative form eg same momentum change in shorter time. • less force on driver with airbag or rate of change of momentum is less • less force over longer time with airbag/ora

Question		Answer	Marks	Guidance
				<ul style="list-style-type: none"> leads to less force on driver/ora allow incorrect calculation of force as 750 (N) and 300 (N) with correct comment scores 5 marks. allow idea of reduced acceleration with airbag. Use L1, L2, L3 annotations in scoris; do not use ticks.
	(b)	<p>any two from:</p> <p>legislation passed to make seat belt wearing compulsory (1)</p> <p>advertising campaigns in papers/TV/radio etc (1)</p> <p>idea of scientists obtain more evidence/provide further evidence (1)</p> <p>used actual crash data (to reinforce test data) (1)</p> <p>closer monitoring by police/CCTV to enforce the law (1)</p> <p>make manufacturers add to safety warning features in car (1)</p>	2	<p>allow it is legal or it is the law (1)</p> <p>allow taught in schools (1)</p> <p>eg use of crash dummies (1)</p> <p>eg warning noise or info for belts not engaged or car not able to start unless belts in use (1)</p>
		Total	8	

Question		Answer	Marks	Guidance
10	(a)	<p>536.25 (W) (3)</p> <p>but if answer is incorrect</p> <p>$\frac{(550 \times 7.8)}{8}$ (2)</p> <p>or</p> <p>$\frac{(500 \times 7.8)}{8} / 487.5$ (W) (1)</p> <p>or</p> <p>$\frac{(550 \times 9.7)}{8} / 666.875$ (W) (1)</p>	3	<p>allow 536 or 536.2 or 536.3 (W) (3)</p> <p>if rounding of answer is incorrect eg 535 or 537 then scores 2</p> <p>allow 487 or 488 (W) (1)</p> <p>allow 667 or 666.87 or 666.88 or 666.9 or 666.8 or 660 (W) (1)</p>
	(b)	<p>lower/half power/numerical value is less than or half of answer to 10(a)/AW (no mark)</p> <p>explanation (less power) because of greater time or lower speed (1)</p> <p>but</p> <p>half the power due to doubling the time/halving the speed (2)</p>	2	if increase or stays the same then scores 0
Total			5	

Question		Answer	Marks	Guidance
11	(a)	<p>any two from: idea of drivers having different driving styles (produces different consumptions) (1)</p> <p>idea that Tanya travelled more slowly or accelerated less or braked less OR Sarah travelled more quickly or accelerated more or braked more (1)</p> <p>idea that drivers could have travelled in different traffic or road conditions or weather conditions (1)</p> <p>(idea that) Sarah has a heavier load/more weight (1)</p> <p>then for the third mark</p> <p>Sarah's lower km per litre/AW indicates higher speeds or higher acceleration or heavier resulting in higher (CO₂) emissions (1)</p>	3	<p>ignore references to high or low fuel consumption allow the faster they go the more fuel they will use/ora (1)</p> <p>allow examples eg Sarah could have been stuck in traffic/Sarah stopped more at traffic lights/ora (1) eg Tanya could have travelled at a steady speed on the motorway longer/Sarah could have travelled up more hills in town (1)</p> <p>allow correct link between fuel consumption or the amount of petrol used and (CO₂) emissions (1) eg the higher the fuel consumption the lower the emissions/ora (1)</p>
	(b) (i)	<p>(thinking distance) (on day 2 is greater due to) driver having taken drugs or drunk alcohol/distractions or named distraction/(lack of) concentration/tiredness (1)</p>	1	<p>allow ora for day 1 allow stress or mental state of the driver (1) not greater speed</p>
	(ii)	<p>(braking distance) on (day 2 is greater because of) less grip on the road (1)</p>	1	<p>allow ora for day 1 allow examples such as wet road/ice or snow on road/leaves on road (1) allow greater load (1) ignore poor or worn brakes or poor or worn tyres not greater speed</p>
Total			5	

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