



GCSE

Chemistry B

Unit **B741/02**: Modules C1, C2, C3 (Higher Tier)

General Certificate of Secondary Education

Mark Scheme for June 2017

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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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Annotations used in scoris

Annotation	Meaning
	correct response
	incorrect response
BOD	benefit of the doubt
NBOD	benefit of the doubt not given
ECF	error carried forward
	information omitted
I	ignore
R	reject
CON	contradiction

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 i	D (1) idea that absorbs then gives off light (1)	2	award 0 marks for the question with incorrect choice but second mark can be awarded if no choice given allow blue for D (1) ignore reference to any temperature change
ii	C (1) idea of changes colour with temperature (1)	2	award 0 marks for the question with incorrect choice but second mark can be awarded if no choice given allow pink or thermochromic for C (1) allow eg it changes to yellow if the food is too hot (1) ignore shows the temperature of the baby's food
b	solvent evaporates (1) oil is oxidised (by atmospheric oxygen) (1)	2	allow solvent becomes a gas or vapour (1) ignore just 'evaporation' ignore solvent dries ignore liquid evaporates not solvent reacts with oxygen not water evaporates allow oil reacts with oxygen (1) allow binding medium is oxidised (1) ignore paint is oxidised or reacts with oxygen (1)

Question	Answer	Marks	Guidance
c	<p>any two from:</p> <p>idea that may harm or hurt the animal / testing is cruel (1)</p> <p>idea that results on animals not (necessarily) same with humans (1)</p> <p>idea that animals do not have a choice of being tested / animals have no control over what happens to them (1)</p> <p>idea that there are other ways of testing products (that are less damaging to living things) (1)</p>	2	<p>assume unqualified answer refers to testing on animals</p> <p>allow idea that animals have rights / morally wrong / unethical (1)</p>
	Total	8	

Question	Answer	Marks	Guidance
2 a	acid + alcohol → ester + water (1)	1	allow a named alcohol eg ethanol (1) allow phonetic spelling
b	<div> Water <input type="checkbox"/> The force <input checked="" type="checkbox"/> There is <input type="checkbox"/> The force <input checked="" type="checkbox"/> Water will <input type="checkbox"/> (2) </div>	2	one mark for each tick in the correct box if one incorrect box ticked maximum of one mark if two or more incorrect boxes ticked no marks for the question
c	volatile or easily evaporates – so perfume particles can easily reach the nose (1) insoluble – so cannot be washed off easily (1)	2	allow volatile – so you can smell it (1) allow idea that sweat will not remove the perfume (1)
	Total	5	

Question	Answer	Marks	Guidance
3 a	B (1)	1	allow ethene / C_2H_4 , but letter takes precedence(1)
b	A (1)	1	allow methane / CH_4 , but letter takes precedence (1)
c	B (1)	1	allow ethene / C_2H_4 , but letter takes precedence (1)
d	C (1)	1	allow poly(bromoethene) / $(C_2H_3Br)_n$, but letter takes precedence (1)
e	<p>waterproof – (because holes in PTFE are too small) so do not allow (liquid) water to pass through (1)</p> <p>breathable – (holes are big enough to) allows (water) vapour through (1)</p>	2	<p>allow rain for (liquid) water</p> <p>allow water droplets</p> <p>BUT ignore water molecules or water particles</p> <p>allow big enough to let sweat or water evaporate (1)</p> <p>BUT ignore 'sweat' without reference to evaporation</p> <p>not water for water vapour</p> <p>allow the (liquid) water does not pass through but (water) vapour does (2)</p>
	Total	6	

Question	Answer	Marks	Guidance																		
4	<p>Level 3 Evaluates one advantage and one disadvantage of all three of the fuels AND chooses B with at least two correct reasons Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 Evaluates one advantage and one disadvantage of two of the fuels AND chooses fuel B with a correct reason Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 Evaluates one advantage and one disadvantage of one of the fuels OR chooses fuel B with a correct reason 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. (0marks)</p>	6	<p>This question is targeted at grades up to grade A/A* Indicative scientific points may include: Evaluations</p> <table><tr><th colspan="2">Fuel A</th></tr><tr><th>Advantages</th><th>Disadvantages</th></tr><tr><td><ul style="list-style-type: none">• high(est) energy content• reasonable projected supply• does not produce SO₂ / only produces CO₂• liquid can be stored in tanks and pipeline used</td><td><ul style="list-style-type: none">• limited availability• medium cost• makes carbon dioxide</td></tr><tr><th colspan="2">Fuel B</th></tr><tr><th>Advantages</th><th>Disadvantages</th></tr><tr><td><ul style="list-style-type: none">• good availability• cheap(est)• solid is easy to store• many / most years of supply</td><td><ul style="list-style-type: none">• low(est) energy value• makes the most pollution</td></tr><tr><th colspan="2">Fuel C</th></tr><tr><th>Advantages</th><th>Disadvantages</th></tr><tr><td><ul style="list-style-type: none">• does not produce SO₂ / only produces CO₂• good availability</td><td><ul style="list-style-type: none">• (most) expensive• gas is more difficult to store• insufficient years of supply• makes carbon dioxide</td></tr></table> <p>Choices</p> <ul style="list-style-type: none">• B because it is eg cheap and has more than 25 years supply <p>Use the L1, L2, L3 annotations in RM Assessor; do not use ticks.</p>	Fuel A		Advantages	Disadvantages	<ul style="list-style-type: none">• high(est) energy content• reasonable projected supply• does not produce SO₂ / only produces CO₂• liquid can be stored in tanks and pipeline used	<ul style="list-style-type: none">• limited availability• medium cost• makes carbon dioxide	Fuel B		Advantages	Disadvantages	<ul style="list-style-type: none">• good availability• cheap(est)• solid is easy to store• many / most years of supply	<ul style="list-style-type: none">• low(est) energy value• makes the most pollution	Fuel C		Advantages	Disadvantages	<ul style="list-style-type: none">• does not produce SO₂ / only produces CO₂• good availability	<ul style="list-style-type: none">• (most) expensive• gas is more difficult to store• insufficient years of supply• makes carbon dioxide
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		6	
Question	Answer	Marks	Guidance
5 a	crust and upper or outer part of the mantle (1)	1	allow cold, rigid outer part of the Earth (1) ignore between crust and mantle
b	any two from: to predict future eruptions (1) to minimise danger to life or keep people safe (1) to reveal information about the structure of the Earth (1) to understand how volcanoes are formed (1) idea of gathering (extra) data / get samples (1)	2	ignore to predict earthquakes allow to understand about the Earth or tectonic plates (1)
c	any two from: can evaluate ideas / check results / can compare results (1) can share ideas / have different views (1) can collect more evidence (in a shorter time) / more productive / can do more approaches / can work faster / more ideas can be tested (1) can share cost of research (1) to see if work can be replicated / so work does not need to be duplicated (1) so that further evidence can be collected (1) to provide information to other scientists or public or other organisations / AW (1)	2	allow peer-review (1) allow results would be more reliable (1) ignore results are more accurate allow small discoveries can be combined into a large one (1) allow help to make new predictions (1) allow work can be developed further (1)

	so they can get recognition for their work (1)		allow so other scientists cannot take credit (1)
	Total	5	

Question	Answer	Marks	Guidance
6 a	$2\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{NH}_4)_2\text{SO}_4$ formulae (1) balancing - dependent on the correct formulae (1)	2	allow any correct multiple, including fractions allow = / \rightleftharpoons instead of \rightarrow not and / & instead of '+' allow 1 mark for a balanced equation with a minor error in subscripts, superscripts and case e.g. $\text{NH}_3 + \text{H}_2\text{SO}_4 \rightarrow (\text{Nh}_4)_2\text{SO}_4$
b	potassium nitrate (1)	1	allow KNO_3 but name takes precedence (1)
c	H^+ (1)	1	allow correct answer ticked, circled or underlined in list if answer line is blank
	Total	4	

Question	Answer	Marks	Guidance
7 a	$\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ <p>formulae (1)</p> <p>balancing - dependent on the correct formulae (1)</p>	2	<p>allow any correct multiple, including fractions</p> <p>allow = / \rightarrow instead of \rightleftharpoons</p> <p>not and / & instead of '+'</p> <p>allow one mark for a balanced equation with a minor error in subscripts, superscripts and case</p> <p>e.g. $\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{N}_2\text{H}_3$</p>
b i	idea of increases / ora (1)	1	allow percentage yield decreases when pressure decreases (1)
ii	idea of decreases / ora (1)	1	allow percentage yield increases when temperature decreases (1)
iii	<p>any three from:</p> <p>idea that high(er) pressures are expensive (to generate or maintain) / ora (1)</p> <p>idea that higher pressures are (more) dangerous (1)</p> <p>high(er) pressures give a high(er) yield / ora (1)</p> <p>high(er) pressures give a high(er) rate / ora (1)</p> <p>idea that reaction is too slow at low(er) temperatures or rate is fast(er) at 450°C (1)</p> <p>but low(er) temperatures give high(er) yield / ora (1)</p> <p>catalyst increases rate of reaction (1)</p> <p>catalyst does not affect (percentage) yield (1)</p>	3	<p>note 450°C is a high temperature and 200 atmospheres is a low pressure in the context of this question</p> <p>allow high(er) atmospheres for high(er) pressures</p> <p>allow correct higher level answers in terms of moving the position of equilibrium</p> <p>allow correct higher level answers in terms of moving the position of equilibrium</p>

	Total	7	

Question	Answer	Marks	Guidance
8 a	<p>(yes because)</p> <p>idea that this alloy is a good conductor (of electricity) (1)</p> <p>and has good ductility / can easily be pulled into wires (1)</p>	2	<p>marks are for explanation BUT just quoting numbers is insufficient</p> <p>ignore no</p> <p>just 'conducts (electricity)' is not sufficient not it has the highest (electrical) conductivity</p> <p>just 'it is ductile' / 'it is quite ductile' / 'it is fairly ductile' is not sufficient</p> <p>ignore comments about strength</p> <p>ignore comments about other brasses BUT allow no use A because it is the best conductor (of electricity) (1)</p>
b	<p>oxidation occurs at the anode because electrons are lost / copper loses electrons AND reduction occurs at the cathode because electrons are gained / copper ions gain electrons (1)</p>	1	<p>just oxidation is loss of electrons and reduction is gain is not sufficient</p> <p>not incorrect particle eg oxidation occurs at the anode because copper ions lose electrons</p> <p>not incorrect particle eg reduction occurs at the cathode because copper gains electrons</p>

Question	Answer	Marks	Guidance																																										
c	<p>Level 3 Applies knowledge and understanding to <u>evaluate</u> an advantage and disadvantage for each of aluminium and steel</p> <p>AND</p> <p>explains which metal (aluminium, steel or both) is suitable to make a helicopter body. 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 to give an advantage and disadvantage for each of aluminium and steel</p> <p>OR</p> <p>Applies knowledge and understanding to give two advantages, two disadvantages or an advantage and a disadvantage for either metal</p> <p>AND chooses a metal (aluminium, steel or both) with a reason. Quality of written communication partly impedes communication of the science at this level. (3–4 marks)</p> <p>Level 1 Applies knowledge and understanding to give two advantages, two disadvantages or an advantage and a disadvantage for either metal</p> <p>OR</p> <p>chooses a metal (aluminium, steel or both) with a reason. Quality of written communication impedes communication of the science at this level. (1–2 marks)</p> <p>Level 0 Insufficient or irrelevant science such as repeating the question. Answer not worthy of credit. (0 mark)</p>	6	<p>This question is targeted at grades up to A / A*</p> <p>Relevant scientific points may include:</p> <p>Comments for aluminium:</p> <table><tr><th>Advantage</th><th>Disadvantage</th><th>Evaluation</th></tr><tr><td>low density / lightweight</td><td></td><td>so better fuel economy / so can travel faster</td></tr><tr><td>does not corrode / does not rust</td><td></td><td>so will last longer</td></tr><tr><td>malleable</td><td></td><td>can be made into correct shape</td></tr><tr><td></td><td>not very strong</td><td>might get damaged (in a crash)</td></tr><tr><td></td><td>not very hard</td><td>scratched easily</td></tr><tr><td></td><td>(more) expensive</td><td>cost more to make</td></tr></table> <p>Comments for steel:</p> <table><tr><th>Advantage</th><th>Disadvantage</th><th>Evaluation</th></tr><tr><td>strong</td><td></td><td>so less damage (in a crash)</td></tr><tr><td>malleable</td><td></td><td>can be made into correct shape</td></tr><tr><td>hard</td><td></td><td>will not scratch easily</td></tr><tr><td>cheap(er)</td><td></td><td>cost less to make</td></tr><tr><td></td><td>high density</td><td>poor fuel economy / would travel slower</td></tr><tr><td></td><td>corrodes (slowly)</td><td>so will not last longer / have to spend money on rust protection</td></tr></table> <p>Use the L1, L2, L3 annotations in RM Assessor. Do not use ticks.</p>	Advantage	Disadvantage	Evaluation	low density / lightweight		so better fuel economy / so can travel faster	does not corrode / does not rust		so will last longer	malleable		can be made into correct shape		not very strong	might get damaged (in a crash)		not very hard	scratched easily		(more) expensive	cost more to make	Advantage	Disadvantage	Evaluation	strong		so less damage (in a crash)	malleable		can be made into correct shape	hard		will not scratch easily	cheap(er)		cost less to make		high density	poor fuel economy / would travel slower		corrodes (slowly)	so will not last longer / have to spend money on rust protection
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	Total	9	
Question	Answer	Marks	Guidance
9 a	60% (2) BUT if answer is incorrect then atom economy = $\frac{M_r \text{ of desired products}}{\text{sum of } M_r \text{ of all products}} \times 100$ or atom economy = $\frac{48}{80} \times 100$ scores (1)	2	allow full marks for correct answer even if equation for atom economy not stated
b	84 (%) (2) BUT if answer is incorrect then $\frac{\text{actual yield}}{\text{predicted yield}} \times 100$ or $\frac{81}{96} \times 100$ scores (1)	2	note final answer must be two significant figures look for correct answer first, 84(%) on own scores (2) unit not needed - ignore incorrect units allow $\frac{am}{pm} \times 100$ (1) allow 84.4 / 84.38 / 84.375 / 84.3 (%) on their own scores one mark i.e. the mark for the substitution into the equation.
c	high atom economy: to make the process more sustainable or 'greener' / (to make the process more efficient) by reducing the amount of waste product (made) / to reduce the processing of unwanted products (1) high percentage yield: to reduce cost / reducing the reactants wasted / reducing the need to recycle unreacted reactants (1)	2	ignore just 'less waste' allow idea of making the process more profitable (1) ignore conserve reactants / conserve raw materials

			ignore just 'less waste'
	Total	6	
Question	Answer	Marks	Guidance
10 a	<p>75 (g) (2)</p> <p>BUT if answer is incorrect then</p> <p>mass = $\frac{6300}{4.2 \times 20}$ or mass = $\frac{6300}{84}$</p> <p>or mass = $\frac{\text{energy}}{\text{specific heat capacity} \times \text{temp change}}$ (1)</p>	2	<p>look for correct answer first, 75 (g) on own scores (2) despite any other working out</p> <p>allow ecf from incorrect temperature change for the final mass (1)</p>
b	<p>no because fuel A uses the most fuel or more fuel / no because all the other fuels use less fuel (1)</p> <p>BUT</p> <p>no because fuel A does not transfer the most energy per gram / does not have the highest temperature change per gram / evidence of correct calculation of energy per gram for each fuel / evidence of calculation of temperature change per gram for each fuel (2)</p>	2	<p>'yes' = 0 for question</p> <p>ignore no because fuel A transfers the lowest energy per gram (as this is incorrect)</p> <p>allow answer that refers to fuel D i.e. no, fuel D is best choice (1) ignore fuel D is the most efficient</p> <p>because fuel D transfers more energy per gram / fuel D has a higher temperature change per gram / evidence of calculation of energy per gram for each fuel (1)</p> <p>NB Energy per gram values are:</p>

			A – 5775 J/g B – 7875 J/g C – 5250 J/g D – 9000 J/g
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Question	Answer	Marks	Guidance
c	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 or heat (1) allow bond making releases energy or heat (1) allow more energy or heat released than absorbed (1) ignore references to different numbers of bonds, e.g. more bonds made than broken not references to intermolecular bonds allow exothermic reactions give out energy or heat (1) if no other mark awarded
d	$2\text{C}_3\text{H}_8\text{O} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 8\text{H}_2\text{O}$ formulae (1) balancing dependent on the correct formulae (1)	2	allow any correct multiple, including fractions eg $\text{C}_3\text{H}_8\text{O} + 4\frac{1}{2}\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O}$ allow = / \rightleftharpoons instead of \rightarrow not and / & instead of '+' allow 1 mark for a balanced equation with a minor error in subscripts, superscripts or case e.g. $2\text{C}_3\text{H}_8\text{O} + 9\text{O}_2 \rightarrow 6\text{CO}_2 + 8\text{H}_2\text{O}$ allow $\text{C}_3\text{H}_7\text{OH}$ for $\text{C}_3\text{H}_8\text{O}$
	Total	9	

Question	Answer	Marks	Guidance
11 a	calcium carbonate + hydrochloric acid → calcium chloride + carbon dioxide + water (1)	1	order of substances on either side of arrow is unimportant allow marble for calcium carbonate allow mixture of correct formulae and names but names take precedence allow correct formulae, i.e. $\text{CaCO}_3 + \text{HCl} \rightarrow \text{CaCl}_2 + \text{CO}_2 + \text{H}_2\text{O}$ balancing is not required allow = or \Rightarrow for arrow not 'and' or & for +
b i	2.9 / 3.0 (minutes) (1)	1	allow just '3' (minutes) (1)
ii	curve for small chips is steeper / ora (1)	1	assume unqualified answer refers to small marble chips allow for a given time more gas with smaller chips (1) allow reaction finishes in shorter time / reaction finishes before the large chips / curve ends first / reaction stops sooner (1) ignore references to reaction finishes in a faster / quicker time allow numbers quoted from the graph but they must be correct to within $\pm\frac{1}{2}$ square eg the curve for small chips finishes at 3 minutes but the curve for large chips finishes at 5 minutes
c	the number of (successful) collisions is doubled (1)	1	ignore frequency or chance of collisions is doubled

Question	Answer	Marks	Guidance
d	<p>Level 3 Applies reacting particle model, including mention of collisions, to explain the effect of concentration</p> <p>AND</p> <p>temperature on the rate of reaction. Quality of written communication does not impede communication of the science at this level. (5 – 6 marks)</p> <p>Level 2 Applies reacting particle model, including mention of collisions, to explain the effect of concentration</p> <p>OR</p> <p>temperature on the rate of reaction Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks)</p> <p>Level 1 Applies reacting particle model (without collisions) to explain the effect of concentration</p> <p>OR</p> <p>temperature on the rate of reaction. 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</p> <p>Indicative scientific points may include:</p> <ul style="list-style-type: none"> more collisions between marble chips and hydrochloric acid particles result in faster reaction <p>concentration of hydrochloric acid increasing the concentration of the acid increases the rate of reaction because</p> <ul style="list-style-type: none"> idea of more crowded acid particles / more acid particles in same volume idea of increased collisions (frequency) <p>ignore references to 'more particles'</p> <p>temperature of hydrochloric acid: increasing the temperature of the acid increases the rate of reaction because</p> <ul style="list-style-type: none"> idea that acid particles move faster / particles have more energy / more (successful) collisions between acid and marble chips / collisions between marble chips and acid are more energetic idea of increased collisions (frequency) between acid particles and marble chips <p>allow reference to ions / atoms / molecules instead of particles</p> <p>Use the L1, L2, L3 annotations in RM Assessor. Do not use ticks.</p>
Total		11	

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