

Markscheme

November 2016

Chemistry

On-screen examination

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- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the “Total” column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word “**max**” in the Answer column. Further guidance may be given in the Notes column.
- 8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.
- 9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 10 Alternative answers are indicated in the Answer column by “**or**”. Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 11 If two related points are required to award a mark, this is indicated by “**and**” in the answer column.
- 12 Words in brackets () in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.
- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA* (*or reverse argument*) in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE* (*or words to that effect*) in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.
- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. Candidate’s work should be marked using a best fit approach. A candidate’s response should be reviewed to determine holistically the band in which the response falls. Once this has been determined, each bullet point within that band should be assessed to see if the candidate has met the requirements of the statement. Where those requirements are met, marks should be awarded, starting from the lowest available mark for that band.

Once this process has been completed if the highest (or lowest) mark available for that band has been determined, the examiner must check the band above (or below) to ensure that the initially correct determination of the band was correctly allocated. For example, there may be sufficient detail in the candidate's response to award the lowest mark of the band above.

NB. Marks are distributed unevenly across the mark bands as candidates have to include much more detail in their responses to access the highest mark bands.

Question	Answers	Notes	Marks	Criterion
1 a	<p>The image shows two Lewis structures side-by-side. The top structure, labeled 'Butane', consists of four carbon atoms in a horizontal chain, each bonded to the appropriate number of hydrogen atoms to satisfy its valency. The bottom structure, labeled 'Ethanol', consists of two carbon atoms bonded together; the first carbon is also bonded to three hydrogen atoms, and the second carbon is bonded to one hydrogen atom and to an oxygen atom, which is further bonded to a hydrogen atom.</p>		2	A
b	(butane:) alkane/hydrocarbon (ethanol:) alcohol / alkanol		2	A
c	attempt to substitute into equation (energy released =) 147.488 kJ or 147 488 J (mass of ethanol = $147.488/30.0 =$) 4.91626... answer given correctly to 3 sig figs 4.92 (g) unit of g/gram	<i>Seen or implied</i> <i>Accept incorrect use of kJ for 3rd marking point</i> <i>Unit required</i> <i>Award unit mark separately</i>	5	A
d	so 1 g releases 49.6 kJ or ethanol releases 1380 kJ mol^{-1} and butane release 2877 kJ mol^{-1} butane is a better fuel for portable heaters because it releases more energy per gram or butane is a better fuel as it releases more energy per mole	<i>ECF from 1c</i> <i>WTTE</i>	2	A

2	a	<table border="1"> <thead> <tr> <th></th><th>Property 1</th><th>Property 2</th></tr> </thead> <tbody> <tr> <td>Aluminium</td><td>malleable</td><td>corrosion resistant</td></tr> <tr> <td>Carbon</td><td>high strength to weight ratio</td><td>does not react easily or rigid</td></tr> </tbody> </table>		Property 1	Property 2	Aluminium	malleable	corrosion resistant	Carbon	high strength to weight ratio	does not react easily or rigid	Accept the properties listed in any order for the correct element	4	C
	Property 1	Property 2												
Aluminium	malleable	corrosion resistant												
Carbon	high strength to weight ratio	does not react easily or rigid												
	b	Sc reacts with air or water				1	C							
	c	(adding scandium) increases the <u>yield strength</u>				2	C							
3	a	orange-red and bright red and green			All correct	1	A							
	b	energy/heat is released or release (much) more energy/heat than they absorb (so) the reaction is exothermic			WTTE Only award second mark if first is awarded	2	A							
	c	Cu (copper) or Fe (iron)				1	A							
	d	isotopes are atoms of the same element and have different number of neutrons/mass numbers or isotopes are atoms that have the same number of protons and have different number of neutrons/mass numbers				1	A							
	e	12 (neutrons)			Do not accept 12.31	1	A							
4	a	air is mostly a combination of N ₂ and O ₂ or air is a mixture of gases and mostly N ₂ (and N ₂ and O ₂ /molecules in air) are bigger or have a greater mass than He atoms or (and N ₂ and O ₂ /molecules in air) move at a slower speed (so) He molecules will diffuse through the balloon's membrane faster at the same temperature				3	A							

	<p>b</p> <p>hot air rises <i>or</i> the density of warm air is less than the density of colder air (because) the kinetic energy of the molecules is greater in warm air (so) the same mass of gas has a bigger volume it is the lower density of the warm air inside the balloon that will make it float up in the sky</p>		4	A
	<p>c</p> <p>the size of the bag increases/inflates (because) the external pressure decreases and the internal pressure is unchanged</p>		2	A

5	a	<ul style="list-style-type: none">• plans to test metal but incomplete details given• one relevant piece of equipment suggested	1-2		18	B
		<ul style="list-style-type: none">• a dependent variable is suggested but measurement is qualitative only• metal identified as independent variable• two relevant pieces of equipment• attempt at a method but detail is insufficient for another student to follow	3-6			
		<ul style="list-style-type: none">• a correct dependent variable identified and measurement is quantitative• metal identified as independent variable• a control variables identified with details of how it is controlled• at least two relevant pieces of equipment likely to generate quantitative data• method is described and could easily be followed by another student• care is needed with acids	7-12			
		<ul style="list-style-type: none">• a correct dependent variable identified and measurement is quantitative• metal identified as independent variable• at least two control variables identified• control variables justified with details• complete details of equipment likely to generate quantitative data• complete method is described, fully explained and could easily be followed by another student• plans to repeat experiment and calculate average• care is needed with acids	13-18			

	b	<p>needs to include all metals</p> <p>dependent variable – eg mass lost after set time, rate of production of gas</p> <p>unit for dependent variable included</p> <p>columns for repeats</p> <p>column for average calculation</p>		5	C						
6	a	ion(s)	<i>Do not accept positive ions</i>	1	A						
	b	<p>ions cannot move through the salt bridge or electrons cannot flow</p> <p>circuit is now broken / incomplete</p> <p>or</p> <p>no more charge exchange possible</p> <p>(so) the circuit is broken / incomplete</p>	<i>ECF from part a Accept "no electricity can flow"</i>	2	B						
7	a	<table border="1"> <tr><td>Voltage / V</td></tr> <tr><td>1.607</td></tr> <tr><td>3.155</td></tr> <tr><td>2.227</td></tr> <tr><td>2.707</td></tr> <tr><td>0.000</td></tr> </table> <p>one value correctly recorded</p>	Voltage / V	1.607	3.155	2.227	2.707	0.000		1	B
Voltage / V											
1.607											
3.155											
2.227											
2.707											
0.000											
<p>the bigger the difference in reactivity and the higher the cell potential</p>	<i>Accept "further apart in the reactivity series" Accept "the elements become more reactive"</i>	1	B								
c	<p>independent variable – metal in the positive half cell</p> <p>dependent variable – cell potential</p> <p>any two controlled variables, for example</p> <p>size of electrodes, surface area of the electrodes, volume of the electrolyte, concentration of the electrolyte, temperature, pressure, <u>magnesium</u> in the negative/left half cell</p>		4	B							

	d	Any four reasonable points, for example <ul style="list-style-type: none">• non-standard conditions might have been used• different concentrations• the electrodes may not have been clean• the temperature might not have been constant• heat may have been lost		4	C
	e	Any reasonable precaution, for example <ul style="list-style-type: none">• eye protection should be worn• wash hands after experiment		1	B
	f	Anode oxidation or electrons are lost electrons are lost and oxidation Cathode electrons are gained or reduction electrons are gained and reduction	1 mark for correct identification of reduction and oxidation in terms of electron gain or loss wherever seen	2	A
	g	metal atoms deposited at the cathode (so) mass of the cathode increases anode dissolves in the solution (so) mass of anode decreases	no ECF	4	C
8	a	(diluting the copper ions solutions) increases the cell voltage		1	C
	b	colour becomes paler fewer Cu ²⁺ / copper ions are present Cu ²⁺ / copper ions give the blue colour	Do not accept copper/Cu	3	C
	c	(diluting the silver ions solutions) decreases the cell voltage		1	C
	d	Cu (s) + 2Ag⁺ (aq) → 2Ag (s) + Cu²⁺ (aq) reactants and products all correct no electrons shown correct balancing correct use of arrow rather than equilibrium sign and correct state symbols		4	D

9	a	the <u>lower the temperature</u> , the longer the time the charge is maintained	<i>WTTE</i>	1	B
	b	xy scatter graph selected		1	C
	c	70±5%	<i>Accept a range of % as long as the full range falls within 70±5 %</i>	1	C
	d	30±5 %	<i>Accept a range of % as long as the full range falls within 30±5 %</i>	1	C
	e	for the value at 50°C the estimate is <u>valid</u> because it falls within the data set/interpolation for the value at 80°C the estimate may be <u>invalid</u> because it falls outside the data set/extrapolation	<i>WTTE</i>	2	C

10	a	<p>Any reasonable answer, for example</p> <ul style="list-style-type: none"> countries not chosen are politically unstable majority of countries not chosen are in the Southern hemisphere poorer economic conditions / LEDC (less economically developed country) identification of the fact that Olympic Games are hosted by rich/developed countries only link between economics and (un)equal opportunities 		1	D
	b	<p>hydrogen ion concentration decreases</p> <p>iron oxide is a basic oxide/alkaline</p> <p>hydroxide ions react/neutralize with (some of) hydrogen ions in the water</p>		3	A
	c	<p>a change in pH, for example living organisms in the water can survive only within a certain range of pH</p> <p>an effect of changing pH, for example change in pH / hydrogen ion concentration of water will cause many organisms to die</p> <p>a change in colour, for example the soil that gets washed into the water changes the clarity/colour of water causing less sunlight to penetrate</p> <p>an effect of change in clarity/colour, for example (this) affects the photosynthesis of aquatic plants poor visibility for aquatic animals reduced oxygen for fish</p>	WTTE	4	D

11		<ul style="list-style-type: none"> • brief account of an impact on either environment or community • a comment about industrial process eg roads/noise/power demand/dust/technology 	1–2		17	D
		<ul style="list-style-type: none"> • brief account of an impact on environment • brief account of an impact on community • an account of the impact of an industrial process eg about roads/noise/power demand/dust/technology 	3–5			
		<ul style="list-style-type: none"> • account of more than one impact on environment • account of more than one impact on community • more than one impact of an industrial process • a detailed account of the impact of at least one industrial process eg about roads/noise/power demand/dust/technology supported with specific examples • suggestion for the future unsupported by science 	6–10			
		<ul style="list-style-type: none"> • account of more than one impact on environment • account of one positive impact on community • account of one negative impact on community • a detailed account of the impact of more than one industrial process eg about roads/noise/power demand/dust/technology supported with specific examples • consideration of tech that could be used to counter industrial impacts • more than one suggestion for the future supported by science • a concluding appraisal linking all the issues discussed previously 	11–17			
		Any reasonable points, for example max 4				
12		<ul style="list-style-type: none"> • conserving finite raw materials • conserving natural resources • (conserving natural resources) for other uses • reduction in CO₂ emissions/reduction in climate change • reduction in waste as products are recycled/waste management • reduction in waste material associated with mining • reduced destruction of environment/habitats 			4	D

MARKSCHEME

MAY 2016

MYP CHEMISTRY

ON-SCREEN EXAMINATION

16 pages

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Question		Answers	Notes	Total	Crit
1	a	exothermic		1	A
	b	1 (mole) of iron reacts with 0.75 (mole) of oxygen or mole ratio of 4:3 and iron:oxygen 5.6g of iron=0.1 (mole) 0.075 (moles) of oxygen needed	award 2 marks only for 0.075 (moles) of oxygen if no working, incomplete or incorrect working is shown	3	A
	c	ionic (bonding) / electrovalent		1	A
	d	3+	accept +3	1	A
	e	aluminium (only) aluminium can lose three electrons /has three electrons in its outer shell / valency of three/forms an ion with a charge of 3+	ecf from part 1d accept answer in terms of Na/Ca/C not having 3 outer electrons do not accept group 3/13 alone for ecf to apply in second marking point, the justification should agree with the element selected in the first marking point	2	A

2	a	<p>physical (process)</p> <p>no new bonds are formed between atoms in the substance <i>or</i> no new substance is formed <i>or</i> physical processes are reversible changes</p>		2	A
	b	<p>substance/solid/solute is added</p> <p>until no more dissolves (at a certain temperature) <i>or</i> until undissolved substance/solid/solute/deposit remains (at a certain temperature)</p>	<i>WTTE</i> <i>accept references greater than the solubility product constant</i>	2	A
	c	<p>heat the heat pack</p> <p>energy increases (so) the crystals dissolve</p>	<i>WTTE</i>	2	A
	d	$\text{CH}_3\text{COOH} + \text{NaOH} \longrightarrow \text{CH}_3\text{COONa} + \text{H}_2\text{O}$ <p>sodium hydroxide/NaOH</p> <p>correct reactants</p> <p>correct products</p> <p>correctly balanced</p>	<i>Ignore one error in subscripts if all others are correct</i> <i>Award 4 marks for a correct chemical equation</i> <i>Award 1 mark only for a correct word equation</i> <i>Accept condensed formula $\text{C}_2\text{H}_4\text{O}_2$</i> <i>Accept \rightleftharpoons or =</i>	4	A

3	a	<p>A problem associated with acid rain, for example</p> <p>water ecosystem deterioration, changes in the solubility of soil minerals erosion by dissolution of monuments or building containing CaCO₃</p> <table border="1"> <tr> <td>• simple or incomplete statement</td><td>1</td></tr> <tr> <td>• complete statement</td><td>2-3</td></tr> <tr> <td>• chemistry mentioned but not in the context of the question</td><td></td></tr> <tr> <td>• detailed statement</td><td>4-5</td></tr> <tr> <td>• explicitly linked to relevant chemistry</td><td></td></tr> <tr> <td>• detailed statement</td><td>6-8</td></tr> <tr> <td>• fully explained using chemistry</td><td></td></tr> <tr> <td>• causes and effects explained in the context of acid rain</td><td></td></tr> </table>	• simple or incomplete statement	1	• complete statement	2-3	• chemistry mentioned but not in the context of the question		• detailed statement	4-5	• explicitly linked to relevant chemistry		• detailed statement	6-8	• fully explained using chemistry		• causes and effects explained in the context of acid rain			8	B
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b	a substance that speeds up a chemical reaction (is not used up/consumed in the reaction)	WTTE accept “hastens the reaction”																			
c	<p>a catalyst gives a lower energy path for the reaction</p> <p>because the Ea/energy barrier (is lower) <i>or</i> (by) providing an alternative reaction pathway <i>or</i> (by) altering the mechanism of the reaction</p>	WTTE accept more molecules have enough energy to react																			
4	a	ester	do not accept organic compounds	1	A																
	b	pentanol / pentan-1-ol	do not accept pentan-2-ol, pentan-3-ol	1	A																
	c	water	Do not accept H ₂ O because this is not the name	1	A																

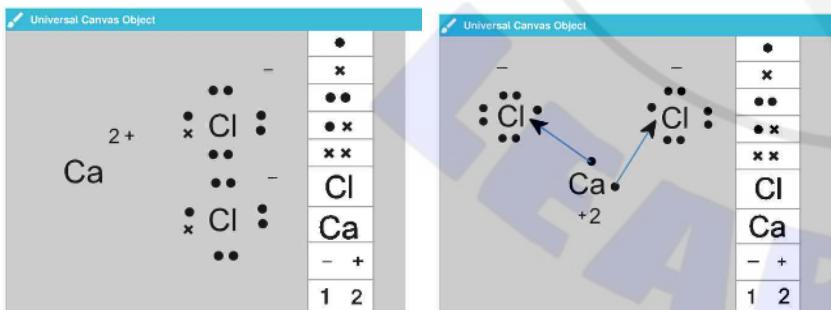
5	a	<i>liquid – gas - solid</i> all correct		1	A
	b	melting the particles gain (kinetic) energy / particle movement increases (the particles) move further apart (than in the solid) or intermolecular forces weaken or intermolecular bonds break or entropy / disorder /S increases		3	C
	c	condensation the particles lose energy / particle movement decreases the particles get closer together compared to gas or intermolecular forces increase or intermolecular bonds form or entropy / disorder /S decreases		3	C
	d	no change in state the particles lose (kinetic) energy / movement of the particles decreases the particles get closer together compared to gas or intermolecular forces increase or intermolecular bonds form or entropy / disorder /S decreases		3	C

6	a	hydrogen/H and oxygen/O	<i>not H₂ /O₂ / H₂O</i>	1	A																														
	b	Any two of the following [2 max] <ul style="list-style-type: none"> • the point at which molecules escape from the surface • increased molecular motion (compared to lower temperatures) • because they have enough (kinetic) energy (to escape) • bubbles of gas/vapour are produced 		2	A																														
	c	three marks for four correct values, two marks for three correct values, one mark for two correct values <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="text-align: left;">Location</th> <th style="text-align: left;">Altitude / m</th> <th style="text-align: left;">Boiling temperature of water / °C</th> </tr> </thead> <tbody> <tr><td>Bangkok</td><td>1</td><td>100.0</td></tr> <tr><td>Belgrade</td><td>210</td><td>99.8</td></tr> <tr><td>Bogota</td><td>2625</td><td>97.2</td></tr> <tr><td>Canberra</td><td>605</td><td>99.4</td></tr> <tr><td>Kathmandu</td><td>1400</td><td>98.6</td></tr> <tr><td>La Paz</td><td>3640</td><td>96.1</td></tr> <tr><td>Nairobi</td><td>1800</td><td>98.0</td></tr> <tr><td>New Delhi</td><td>210</td><td>99.8</td></tr> <tr><td>Tehran</td><td>1138</td><td>98.7</td></tr> </tbody> </table>	Location	Altitude / m	Boiling temperature of water / °C	Bangkok	1	100.0	Belgrade	210	99.8	Bogota	2625	97.2	Canberra	605	99.4	Kathmandu	1400	98.6	La Paz	3640	96.1	Nairobi	1800	98.0	New Delhi	210	99.8	Tehran	1138	98.7	<i>accept ± 25 (m) for altitude</i> <i>accept ±0.2 (°C) for temperature</i>	3	C
Location	Altitude / m	Boiling temperature of water / °C																																	
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	d	a hypothesis linking the independent and dependent variables in the table in part c	<i>accept an incorrect hypothesis for this mark</i>	1	B																														
	e	Variables: independent: altitude/height/(atmospheric pressure) Dependent: (boiling) temperature Any reasonable control variables [2 max], for example <ul style="list-style-type: none"> • volume • mass of water • type of water • container 		4	B																														

f	<ul style="list-style-type: none"> includes equipment for measuring temperature or altitude attempts a method <hr/> <ul style="list-style-type: none"> includes equipment for measuring temperature or altitude method includes details of one control variable diagram includes incomplete equipment care is needed with hot objects <hr/> <ul style="list-style-type: none"> includes equipment for measuring temperature and altitude method includes details of more than one control variable diagram includes complete equipment not assembled correctly plans to repeat experiment care is needed with hot objects <hr/> <ul style="list-style-type: none"> includes equipment for measuring temperature and altitude includes a statement of when a measurement should be made (boiling or steady temperature) and includes care is needed with hot objects method includes details of more than one control variable with justification for at least one diagram includes complete equipment assembled correctly plans to repeat experiment a minimum of three times and calculate average and a reference to range of data 	<p>1-2</p> <p>3-6</p> <p>7-11</p> <p>12-16</p>	<p><i>complete equipment list:</i></p> <p><i>water</i></p> <p><i>thermometer/temperature probe</i></p> <p><i>heat source</i></p> <p><i>container</i></p> <p><i>GPS/altimeter/barometer</i></p> <p><i>measuring cylinder or balance</i></p> <p><i>tripod or clamp stand</i></p> <p><i>accept measurement of pressure when this is correctly linked to altitude either in part d, part e or part f</i></p>	<p>16</p>	<p>B</p>
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7	a	<p>x axis: altitude (km) and y axis: O₂ (% / percent(age))</p> <p>units included in both axis labels</p> <p><u>all</u> numbers (in boxes) given in even increments on both axes</p> <p>plotting points</p> <p>four points plotted correctly ($x \pm 10$, $y \pm 0.5$)</p> <p>all points plotted correctly ($x \pm 10$, $y \pm 0.5$)</p>	<p>accept incorrect use of brackets eg altitude (km)</p> <p>that is one mark for four correct, two mark for eight correct, points plotted correctly on inverted axes can score both marks</p>	5	C
	b	<p>all data should not be included because of the trend</p> <p>reference to a correctly plotted graph in part a or the data in the table (because) the point at <u>500</u> (km) is an outlier or because %O₂ at <u>500</u> (km) is higher than expected or (it is possible that) the data at <u>500</u> (km) was measured incorrectly</p>	<p>WTTE do not accept "the data should be included" without relating it correctly to the trend</p>	2	C
	c	<p>a hypothesis linking the percentage of oxygen with time for the flame to extinguish or a hypothesis linking the percentage of oxygen with time for the flame to extinguish change in water level</p>	<p>do not accept altitude in place of oxygen</p> <p>accept an incorrect hypothesis for this mark</p>	1	B
	d	<p>independent variable: percentage of oxygen</p> <p>dependent variable: water level or time to extinguish the flame</p>	<p>must be correctly linked to answer from part c</p>	2	B

	e	<p>accept any reasonable improvement, for example</p> <ul style="list-style-type: none">• use burette/ measuring cylinder• support the test tube• increase the volume of water		1	C
	f	<p>test: bubble gas through lime water/calcium hydroxide solution</p> <p>observation: calcium hydroxide solution turns milky/cloudy/white suspension</p> <p>conclusion: (so) CO₂ must be present</p>	<p>WTTE</p> <p><i>award this mark independently</i></p>	3	C

8	a	<p>correct reactants and products: $2\text{CO}_2(\text{g}) \rightarrow \text{O}_2(\text{g}) + 2\text{CO}(\text{g})$</p> <p>correct balancing</p> <p>correct states</p>	<p><i>No credit for restating word equation all subscripts must be correct Accept \rightleftharpoons or =</i></p>	3	A
	b	<p>oxygen is needed for life/breathing/respiration</p> <p>any additional point, for example [1 max]</p> <ul style="list-style-type: none"> • processes using combustion • manufacturing • fuel 		2	D
9	a	<p>hypothesis is not supported by the data (because) not all of the salts contain a group one ion</p> <p>Ca/Mg are in group two (not in group one)</p> <p>or</p> <p>NH_4^+ ion is not in group one/it is a polyatomic/compound ion</p> <p>all the salts contain a chloride ion</p> <p>(so) the salty taste is caused by the chloride ion (present in each of the five salts)</p>		4	C
	b	<p>either diagram 1 or diagram 2</p>  <p><i>Accept x • in any order on correct location.</i></p>		1	D

	c	evidence of a correct method e.g. number of neutrons for all isotopes seen in response (20, 22, 23, 24, 26) average = 23	award 2 marks for correct answer if no working	2	A
--	----------	--	--	----------	---

10	a	prevents the oxygen from reaching the fire or removes the oxygen. Any three further points [3 max] from <ul style="list-style-type: none"> • water has a lower boiling point than oil or grease • water is immiscible with oil or grease so the fire would float • the water would boil to produce steam which is a hazard • water conducts electricity so would be hazardous to use on an electrical fire 	accept any other reasonable and equally valid point to a maximum of 3	4	D
	b	(the NaHCO_3) behaves as a base or removes H^+ ions or neutralizes the acid		1	D
	c	acid/ H^+ /hydronium ion reacts with OH^- /hydroxide/hydroxyl ions (which causes the) position of equilibrium shifts to the right or towards the products or the forward reaction is favoured amount/concentration of HCO_3^- decreases or OH^- decreases (so) amount/concentration of H_2CO_3 increases	WTTE do not accept water decreases	4	D

11	a	<p>the gelatine / network is broken or melts</p> <p>above 15°C there is a large enough increase in (kinetic) energy to break the network or above 15°C there is enough molecular movement to break the network</p>	<p>WTTE accept gelatine molecule/particle ignore references to water</p>	2	D
	b	<p>needed: citric acid and flavour and water</p> <p>not needed: adipic acid and colouring and gelatine</p>	<p>ignore sugar regardless of which column it appears in</p>	2	D

c	<ul style="list-style-type: none">• a statement about additives in food• an attempt to link the use of additives with a limitation or benefit	1-2		12	D
	<ul style="list-style-type: none">• a statement about a specified additive• an attempt to link the use of additives with a limitation and a benefit• an attempt at a social or ethical implication for an individual or a community	3-5			
	<ul style="list-style-type: none">• a statement about a specified additive linked to either a social or an ethical implication• a relevant social or ethical implication for an individual or a community• a correct link to the limitations or benefits of the use of additives	6-8			
	<ul style="list-style-type: none">• a statement about a specified additive linked to either a social or an ethical implication with scientific justification• a correct social or ethical impact on an individual and a community• a correct link to the limitations and benefits of the use of additives• a concluding appraisal linking all the issues discussed previously	9-12			

Markscheme

November 2017

Chemistry

On-screen examination

12 pages

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○	Dynamic annotation, it can be expanded to surround work		SEEN	Seen; must be stamped on all blank response areas	Alt+9
~~~~	Horizontal wavy line that can be expanded			Vertical wavy line that can be expanded	
■	Highlight tool that can be expanded to mark an area of a response		WTE	Words to that effect	
NAQ	Not answered the question		✓ 1 ✓ 2 ✓ 3 ✓ 4	Award 1, 2, 3, 4 marks. For use in holistically marked questions only	

## Markscheme instructions

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- 2 Follow the markscheme provided and award only whole marks.
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- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question	Answers						Notes	Total	Criterion																		
1	a	group 4 period 6						Accept group 14	2	A																	
	b	$2PbS + 3O_2 \rightarrow 2PbO + 2SO_2$ Reactants correct Products correct  $2PbO + C \rightarrow 2Pb + CO_2$ Reactants correct Products correct						Do <b>not</b> accept ? in place of a blank coefficient	4	A																	
	c	SO ₂ is formed  (which) contributes to the formation of acid rain  <i>or</i>  CO ₂ is formed  (which) contributes to climate change						Do <b>not</b> accept "toxic" fumes as this is not specific enough	2	A																	
	d	<b>Any two from,</b> <ul style="list-style-type: none"><li>• electrical conductivity</li><li>• thermal conductivity</li><li>• malleability</li><li>• appearance</li></ul>						Any two  Do <b>not</b> accept high melting point for lead	2	A																	
	e	(arsenic is a metalloid/semi-metal so) it would have different structure  different structure gives rise to different properties							2	A																	
	f	<table border="1"> <thead> <tr> <th>Isotope</th> <th>Atomic Number</th> <th>Atomic Mass</th> <th>Protons</th> <th>Electrons</th> <th>Neutrons</th> </tr> </thead> <tbody> <tr> <td>⁶⁵As</td> <td>33</td> <td>65</td> <td>33</td> <td>33</td> <td>32</td> </tr> <tr> <td>⁷⁰As</td> <td>33</td> <td>70</td> <td>33</td> <td>33</td> <td>37</td> </tr> </tbody> </table>						Isotope	Atomic Number	Atomic Mass	Protons	Electrons	Neutrons	⁶⁵ As	33	65	33	33	32	⁷⁰ As	33	70	33	33	37		2
Isotope	Atomic Number	Atomic Mass	Protons	Electrons	Neutrons																						
⁶⁵ As	33	65	33	33	32																						
⁷⁰ As	33	70	33	33	37																						
g	Same electron configuration  (So) the different isotopes will react in the same way						WTTE only award the second mark if the first is given	2	A																		

<b>2</b>	<b>a</b>	How does the volatility of esters depend on the length of their hydrocarbon chain?	WTTE – must relate to volatility of esters	<b>1</b>	B
	<b>b</b>	If the length of the carbon chain increases  (then) the volatility of the ester will reduce  (because) the intermolecular forces are stronger	WTTE ECF from part (a), accept a link between chain length and volatility Accept "bonds are stronger"	<b>3</b>	B
	<b>c</b>	<b>Independent variable:</b> ester <b>or</b> length of the carbon chain  <b>Dependent variable:</b> time  <b>Control variables, any three reasonable variables (2 max) for example,</b> • temperature • surface area • container size <b>or</b> shape • volume <b>or</b> mass • wind		<b>4</b>	B
	<b>d</b>	<b>low temperature:</b> no heat added  so avoids breakdown of the ester <b>or</b> position of equilibrium remains towards the right-hand side/shifts right  <b>dry:</b> avoids adding water to the equilibrium mixture /no change in the concentration of water  so avoids breakdown of the ester <b>or</b> so position of equilibrium remains towards the right hand side/shifts right (ORA)	ORA Accept correct answers relating to intermolecular forces for the first two marking points	<b>4</b>	A
	<b>e</b>	<b>A</b>  ethanoic acid  butanol		<b>3</b>	A

<b>3</b>	<b>a</b>	C		<b>1</b>	C
	<b>b</b>	Thermometer <b>or</b> temperature probe		<b>1</b>	B
	<b>c</b>				
		<b>1</b>	<b>2</b>	<b>3</b>	
	<b>Equipment</b>	some equipment is listed	some equipment including a thermometer is listed	appropriate and complete equipment is listed: suitable solutions, thermometer or temperature probe, test tube, measuring cylinder	
	<b>Variables</b>	one control variable is stated	two control variables are stated		
	<b>Method</b>	attempt at a method	temperature is measured	some fine details of technique are included eg recording temperature only when stable, description of how to minimise heat loss	<b>15</b> B
	<b>Measurements</b>	one metal is investigated	more than two metals are investigated	all five metals are investigated	
	<b>Sufficient data</b>	appropriate number of trials	appropriate number of trials and plans to calculate averages		
	<b>Safety</b>	a safety precaution is stated	a safety precaution is stated and linked to hazard		
	<b>d</b>	<b>Order:</b> Lead – Iron – Zinc – Aluminium – Magnesium		<i>all correct</i>	<b>1</b> C

	e the order of reactivity is based on the temperature rise  the larger the <u>temperature change/rise</u> the more reactive the metal is	WTTE	2	C												
f	bar graph		1	C												
g	<table border="1"> <thead> <tr> <th>Metal added</th> <th>Temperature change for the reaction / °C</th> </tr> </thead> <tbody> <tr> <td>Aluminium</td> <td>39</td> </tr> <tr> <td>Iron</td> <td>16</td> </tr> <tr> <td>Lead</td> <td>12</td> </tr> <tr> <td>Magnesium</td> <td>46</td> </tr> <tr> <td>Zinc</td> <td>32</td> </tr> </tbody> </table> <p>labels for metal on the x axis title linking temperature change to different metals data for one metal correctly plotted data for all metals plotted correctly °C</p>	Metal added	Temperature change for the reaction / °C	Aluminium	39	Iron	16	Lead	12	Magnesium	46	Zinc	32		5	C
Metal added	Temperature change for the reaction / °C															
Aluminium	39															
Iron	16															
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Zinc	32															
h	limited validity as results that produced once only are not reliable as errors may occur more than one trial should be carried out to produce an average	WTTE	2	C												

4	A	test with <u>Lit</u> splint/spill/stick gas burns with a (squeaky) pop (so it is hydrogen)	Accept any reasonable alternative of splint	2	A
	b	if the coin is 100 % copper  (then) it will react the slowest  (because) copper is the least reactive of these metals	Accept “newer coins will react the fastest”	3	B
	c	<b>Independent variable:</b> the composition of the coin <b>or</b> date of coin  <b>Dependent variable:</b> the volume of gas produced in a fixed time <b>or</b> the time taken to produce a fixed volume of gas  <b>Any two reasonable control variables (max 2), for example</b> <ul style="list-style-type: none"> <li>• temperature</li> <li>• concentration of acid</li> <li>• type of acid</li> </ul>	<i>Do not award this mark for volume or time alone</i>  <i>Do not accept pressure</i>	4	B
	d	<b>80s:</b> date 1857-1864  <b>100s:</b> date 1857-1864  <b>70s:</b> date 1962-1982		3	C
	e	<b>Any three reasonable points, for example</b> <ul style="list-style-type: none"> <li>• the coins may not be the exact percentages as indicated in the chart</li> <li>• the results in the calibration graph were for averages and not specific coins</li> <li>• no repeats were possible so there may have been experimental errors</li> <li>• the collection of the gas was inaccurate</li> </ul>		3	C
	f	destructive method  so cannot keep the coin <b>or</b> cannot repeat results	WTTE	2	C

<b>5</b>	<b>a</b>	2.32183 x 10 ⁴ g	accept 2.32 x 10 ⁴ , 2.322 x 10 ⁴ , 2.3218 x 10 ⁴	<b>2</b>	D
	<b>b</b>	<b>Any three comments about the method, for example</b> <ul style="list-style-type: none"><li>• method is destructive</li><li>• the method is able to prove the metal is gold</li><li>• no details of how the solution was measured</li><li>• no safety precaution given</li><li>• no repeats possible, method is not reproducible</li></ul> <b>Comment about the validity of the result</b> result is inconclusive <b>or</b> gold could be less than 24 k	WTTE	<b>4</b>	C
	<b>c</b>	<b>Any two evaluative points from the list below</b> <ul style="list-style-type: none"><li>• react should be used rather than dissolve <b>and</b> concentrated should be used rather than strong</li><li>• the hypothesis is invalid because gold is slow to react/unreactive</li><li>• the relationship between the independent variable / purity of gold / number of Karat and dependent variable (concentration) is correct</li></ul>	Allow use of concentration or strength for this last marking point	<b>2</b>	C
	<b>d</b>	7.32 g		<b>2</b>	D
	<b>e</b>	7.32/7.89 X100 = 92.8% (to 3 significant figures)		<b>1</b>	C

6	a	<p><b>Grey arrow = fuel + oxygen → carbon dioxide + water</b>  <b>Red arrow = glucose + oxygen → carbon dioxide + water</b>  <b>Green arrow = carbon dioxide + water → glucose + oxygen</b></p> <p>one correct label all labels correct</p>		2	A																			
	b	<p>correct answer 0.44 correct unit °C</p>		2	C																			
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7		1	2	3	4		
	<b>Environmental impact</b>	an environmental impact	an environmental impact for both cars	an environmental impact for both cars with supporting data			
	<b>Running costs/ economic impact</b>	an economic impact	an economic impact for both cars	an economic impact for both cars with explicit supporting data			
	<b>Fuel sustainability</b>	a relevant comment about sustainability for a fuel	a relevant comment about sustainability one fuel with justification <b>or</b> a relevant comment about sustainability for both fuels	a relevant comment about sustainability for both fuels with justification for one	a relevant comment about sustainability for both fuels with justification for both		
	<b>Usefulness of cars - range and refuelling</b>	a relevant comment about usefulness	a relevant comment about usefulness for both cars referring to data	more than one relevant comment about usefulness for both cars with supporting data	more than one relevant comment about usefulness for both cars with explicit supporting data		
	<b>Appraisal</b>	a concluding appraisal linked to previous arguments	a concluding appraisal with some scientific justification	a concluding appraisal with complete and detailed scientific justification			

17

D

# Markscheme

May 2017

Chemistry

On-screen examination

15 pages

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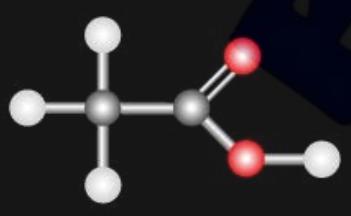
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Once this process has been completed if the highest (or lowest) mark available for that band has been determined, the examiner must check the band above (or below) to ensure that the initially correct determination of the band was correctly allocated. For example, there may be sufficient detail in the candidate's response to award the lowest mark of the band above.

NB. Marks are distributed unevenly across the mark bands as candidates have to include much more detail in their responses to access the highest mark bands.

Question	Answers	Notes	Marks	Criterion
1 a	Fe ₂ O ₃ MnO ₂	Accept MnO ₂ if subscripts are seen somewhere	2	A
b	Any transition metal identified by name or symbol other than Mn or Fe Any two of the following: <ul style="list-style-type: none"> • This is also a transition metal or d block element or group B • variable oxidation states or variable valency • electrons in the d orbital • form coloured compounds or solutions • a named typical metallic property eg malleable, ductile, shiny, sonorous, conductor 		3	A
c	Emulsion it is a mixture of powder/pigments/crushed minerals and in water or oil or heterogenous mixture or immiscible mixture or colloid		2	A
d	A watercolour paint is very soluble in water Oil paint is not soluble in water so the watercolour paint will be washed away		3	A
e	A statement about the effect of one type of paint on the environment with a valid reason Any three relevant, further points, for example (3 max) <ul style="list-style-type: none"> • water soluble paints can enter rivers (and cause pollution) • solvents are not soluble in water so remain in environment • oil-based paints can cause pollution • Solvents are needed to clean oil-based paints 		4	D
f	Correct balancing: $2 \text{CrO}_4^{2-} + 10 \text{H}^+ + 6\text{e}^- \rightarrow \text{Cr}_2\text{O}_3 + 5 \text{H}_2\text{O}$ Correct coefficients on one side of the equation All coefficients are correct	Accept 10 H	2	A

	g	<p>Reduction because Cr⁶⁺/Cr (VI) gains electrons or because Cr⁶⁺ / Cr (VI) becomes Cr³⁺ / Cr (III) or CrO₄²⁻ loses oxygen or gains electrons or the oxidation state/number of chromium decreases</p>	<p>Accept chromium oxide on left hand side</p>	2	A
--	----------	--	--	----------	---

2	a	 <p>methyl group or carboxyl group correctly displayed correct structure for ethanoic acid carboxyl group correctly named</p>	<p>Remember to scroll down to see the response box for the name of the functional group</p> <p>Only award this mark if there is a reasonable attempt at a correct structure</p> <p>Correct structure scores 2 marks accept carboxylic acid</p>	3	A
	b	Neutralization		1	A
	c	110 (g/mol or amu)	Units not required	1	A
	d	<p>Molar mass of silver = 108 Molar mass of AgBr = 188 Final mass needed 3481(g)/ 3.48(kg) Any calculated answer to 2 sig figs (3500 (g) 3.5 x 10³ (g) or 3.5 (kg))</p>	<p>ECF from points 1 and 2</p> <p>Award the sig fig mark independently</p>	4	D

3	a	Evaporation		1	A
	b	Water loses heat/energy Condensation Or Changes from gas/vapour to liquid		2	A
	c	Two essential items from: filter paper, funnel and container All items selected labelled correctly Arranged correctly for filtration	<i>If all equipment is selected, award maximum 2 marks</i> <i>Items can be incorrect for this mark</i>	3	B
	d	high decreases ions		3	C
	e	between 20–25 cm ³ of NaCl added there is a sharp drop in conductivity because the silver ions are reacting or removed or a precipitate is forming	<i>Accept drop in mV</i>	2	C
	f	Conductivity or water purity or number of microbes or amount of microbes Temperature or same water sample or same equipment	<i>Do not accept references to filter or volume of water as these are given in the question</i>	2	B

g	<ul style="list-style-type: none">an attempt at a research questionattempts to plan a method	1-2		14	B
	<ul style="list-style-type: none">research question attempts to link most effective filter with lowest conductivityplans to measure the conductivity using one purification methodattempt at a method but detail is insufficient for another student to follow	3-5			
	<ul style="list-style-type: none">research question correctly links most effective filter with lowest conductivityplans to measure the conductivity using two purification methodsequipment to measure volume or temperature is listedmethod is described and could easily be followed by another student	6-9			
	<ul style="list-style-type: none">research question correctly links most effective filter with lowest conductivity and justifies thisplans to measure the conductivity using all three purification methodsequipment to measure volume and temperature is listedcomplete method is described, fully explained and could easily be followed by another studentplans to repeat process and calculate mean values	10-14			

4	a	Type of fuel	Percentage of different types of fuel use in an urban area / %	Percentage of different types of fuel use in a rural area / %		
		Wood	36.2	81.4		
		Dung (animal waste)	2.5	9.4		
		LPG	41.5	3.9		
		Biogas	3.2	2.4		
		Crop waste	0.2	1.8		
		Kerosene	15.8	1.0		
		Charcoal	0.2	0.1		
		Electricity	0.4	0		
		LPG – 41.5				
		Dung – 9.4				
	b	Calcium hydroxide solution / $\text{Ca}(\text{OH})_2$ (aq) / Limewater Bubbling through (limewater) or passing through (limewater) (Limewater) will turn white or cloudy or a precipitate or CaCO_3 is formed if CO_2 is present	Ignore incorrect formula (eg CaOH) if calcium hydroxide or limewater are mentioned WTTE			3 B
	c	<i>Fuels:</i> either wood or dung identified both fuels identified <i>variables:</i> volume of CO_2 or gas is measured/dependent variable mass of fuel should be controlled (could be seen as part of method) <i>Sufficient data:</i> repeat for both fuels minimum three trials <i>method:</i> burn or set on fire or combust fuel collect gas in syringe leave until all fuel is burnt measure volume or amount or quantity of gas produced <i>Safety:</i> a safety concern is mentioned	Accept “amount” “Syringe” can be implied			11 B
	d	All the CO_2 is collected Or No CO_2 is lost				1 C

	e	(smoke indicates) incomplete combustion Less CO ₂ or unwanted products or smoke (produced) Results are not valid because all of the fuel did not burn	Accept "accurate" WTTE	3	C
	f	Increase air flow or more oxygen or more air		1	C

5	a	<table border="1"> <thead> <tr> <th></th><th>Volume of chemical X added</th></tr> </thead> <tbody> <tr> <td>First titration ml</td><td>(22.75)</td></tr> <tr> <td>Second titration ml</td><td>(27.25)</td></tr> <tr> <td>Average amount of chemical X added ml</td><td>25.00</td></tr> </tbody> </table> <p>Average correctly calculated Correct number of significant figures: 25.00</p>		Volume of chemical X added	First titration ml	(22.75)	Second titration ml	(27.25)	Average amount of chemical X added ml	25.00		2	C
	Volume of chemical X added												
First titration ml	(22.75)												
Second titration ml	(27.25)												
Average amount of chemical X added ml	25.00												
	b	1.65 (g) Carbon dioxide g	<i>Unit needed for second mark, award this mark independently</i>	2	C								
	c	1.65 x 10 = 16.5 g carbon dioxide $16.5/44 = 0.375$ moles $0.375 \times 22.7 = 8.51$ dm ³ or l	<i>ECF</i> <i>seen or implied</i> <i>award 3 for correct mass</i> <i>unit mark awarded independently</i>	4	C								

6	a	<p>data values given in numerical order all volumes converted into cm³</p> <table border="1"> <thead> <tr> <th>Time / s</th><th>Volume CO₂ / cm³</th></tr> </thead> <tbody> <tr><td>10</td><td>13.0</td></tr> <tr><td>20</td><td>17.3</td></tr> <tr><td>30</td><td>18.4</td></tr> <tr><td>40</td><td>19.2</td></tr> <tr><td>60</td><td>19.8</td></tr> <tr><td>70</td><td>20.1</td></tr> <tr><td>80</td><td>20.4</td></tr> <tr><td>90</td><td>20.5</td></tr> <tr><td>100</td><td>20.9</td></tr> <tr><td>110</td><td>20.1</td></tr> <tr><td>120</td><td>21.1</td></tr> <tr><td>130</td><td>21.2</td></tr> <tr><td>140</td><td>21.3</td></tr> <tr><td>150</td><td>21.3</td></tr> </tbody> </table>	Time / s	Volume CO ₂ / cm ³	10	13.0	20	17.3	30	18.4	40	19.2	60	19.8	70	20.1	80	20.4	90	20.5	100	20.9	110	20.1	120	21.1	130	21.2	140	21.3	150	21.3	2	C
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110	20.1																																	
120	21.1																																	
130	21.2																																	
140	21.3																																	
150	21.3																																	
b	<p>Graph 1 volume of CO₂ against time</p>																																	
	c	<p>data value at 110s identified 21 (cm³)</p>	<i>WTTE but in this order only</i>	2	C																													
	d	<p>repeat measurement and calculate average value</p>	<i>Units required</i>	1	C																													
7	a	<p>Group 4 period 6</p>	<i>accept group 14</i> <i>check group and number are correctly paired</i>	2	A																													
	b	<p>good conductivity</p>		1	A																													
	c	<p>low reactivity (with air/water) or high chemical stability</p>		1	A																													
	d	<p>82 (protons) 126 (neutrons)</p>	<i>Accept 126n, 82p</i> <i>Do not accept 126, 82</i>	2	A																													

8	<ul style="list-style-type: none">• lead adversely affects the body• lead levels have changed• lead adversely affects the body and link to learning difficulties status graph• lead is accumulated in the body• lead levels have decreased over time• suggests an impact on society	1-2			
	<ul style="list-style-type: none">• lead adversely affects the body correctly linked to learning difficulties• lead levels have decreased over time since lead was banned• level of lead generally increases with age as it is accumulated in the body• links year of birth with lead levels• reference to the second graph• a suggestion of why children are more sensitive• a wider impact on society• a final appraisal	3-6			
		7-14			

14

D

9	<ul style="list-style-type: none">• identify their chosen type of battery with a supporting statement• identify their chosen type of battery with a valid supporting statement• comparison with at least one other battery implied	1
	<ul style="list-style-type: none">• identify their chosen type of battery with more than one valid supporting statement• comparison with at least two other batteries implied• an environmental or economic factor is mentioned	2-3
	<ul style="list-style-type: none">• identify their chosen type of battery with more than two valid supporting statements• comparison of all battery types implied• environmental and economic factors are discussed• a concluding appraisal referring to all factors considered	4-6
		7-10

10 D

Markscheme

November 2018

Chemistry

On-screen examination

12 pages

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The following are the annotations available to use when marking responses.

Annotation	Explanation
	Correct point, place at the point in the response where it is clear that the candidate deserves the mark. For use in analytically marked questions only.
	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Horizontal wavy line that can be expanded
	Highlight tool that can be expanded to mark an area of a response

Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Markscheme instructions

- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the “Total” column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word “**max**” in the Answer column. Further guidance may be given in the Notes column.
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- 11 If two related points are required to award a mark, this is indicated by “**and**” in the answer column.
- 12 Words in brackets () in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.
- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation **ORA** (or reverse argument) in the Notes column. Candidates should not be rewarded for reverse arguments unless **ORA** is given in the Notes column.
- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation **WTTE** (words to that effect) in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add **ECF** (error carried forward) to the candidate response.

- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question	Answers		Notes	Total	Criterion
1	a	Period 4		1	A
	b	transition metals		1	A
	c	Accept any reasonable response (max 2), for example: <ul style="list-style-type: none"> • variable oxidation state/number • form coloured compounds • any named metallic property 	Accept: "they have colour" Do not accept "hard"	2	A
	d	Protons: 27 Neutrons: 32 Electrons: 25		3	A
	e	CoCl ₂ Ionic (bonding)		2	A
	f	cobalt oxide or cobalt (II) oxide cobalt carbonate or cobalt (II) carbonate	Roman numeral must be correct if present ECF from part e "cobalt monoxide"	2	A

2	a	plastic – dissolves in organic solvent steel – magnetic glass – sinks in water		3	A
	b	Fe_2O_3		1	C
	c	mass Fe = 56 and O = 16 seen or implied 160 g or g mol^{-1}	<i>ECF from part b for all marking points</i>	3	A D
	d	$n=m/M$ or $0.5/160$ seen or implied 3.125×10^{-3} (moles) seen or implied 3.13×10^{-3} or 0.00313	<i>Award 1 mark only for an answer of 320</i> <i>no ECF from 2nd marking point</i>	3	A Di
	e	Covalent electrons shared between silicon and oxygen atoms		2	C
	f	(silicon oxide is) insoluble in water <u>giant covalent structure will not dissolve in water</u>	<i>Accept reference to glass or sand not being soluble for the second marking point</i>	2	A
	g	Accept any three reasonable points (max 3), for example <ul style="list-style-type: none">• save beaches• preserve biodiversity• conserve raw materials• improves sustainability		3	D

3	a	<p>Independent variable: type of fruit</p> <p>Dependent variable: pH</p> <p>Control variables: mass of fruit, time of mixing fruit same volume of water added, same volume of mixture tested, same equipment used</p>	accept “acidity” Do not accept “amount”	4	B
	b	a research question linking pH with type of fruit	Accept “acidic”	1	B
	c	cranberry and (pH =) 2.4 this has the lowest pH or this has the highest acidity the higher the acidity in the stomach, the more severe the heartburn	<i>This mark is awarding for linking stomach acidity with heartburn so it can be awarded for an incorrect juice</i>	3	C
	d	bar chart data for all juices presented correctly title linking DV with IV x axis: type of fruit juice y axis: pH		5	C
	e	Any reasonable extension, for example <ul style="list-style-type: none"> • different (varieties of) fruits • length of time the fruit is blended • different ripeness of fruit 		1	C
	f	(with more than one trial you are able to) calculate the mean reduces experimental errors or increases accuracy		2	C

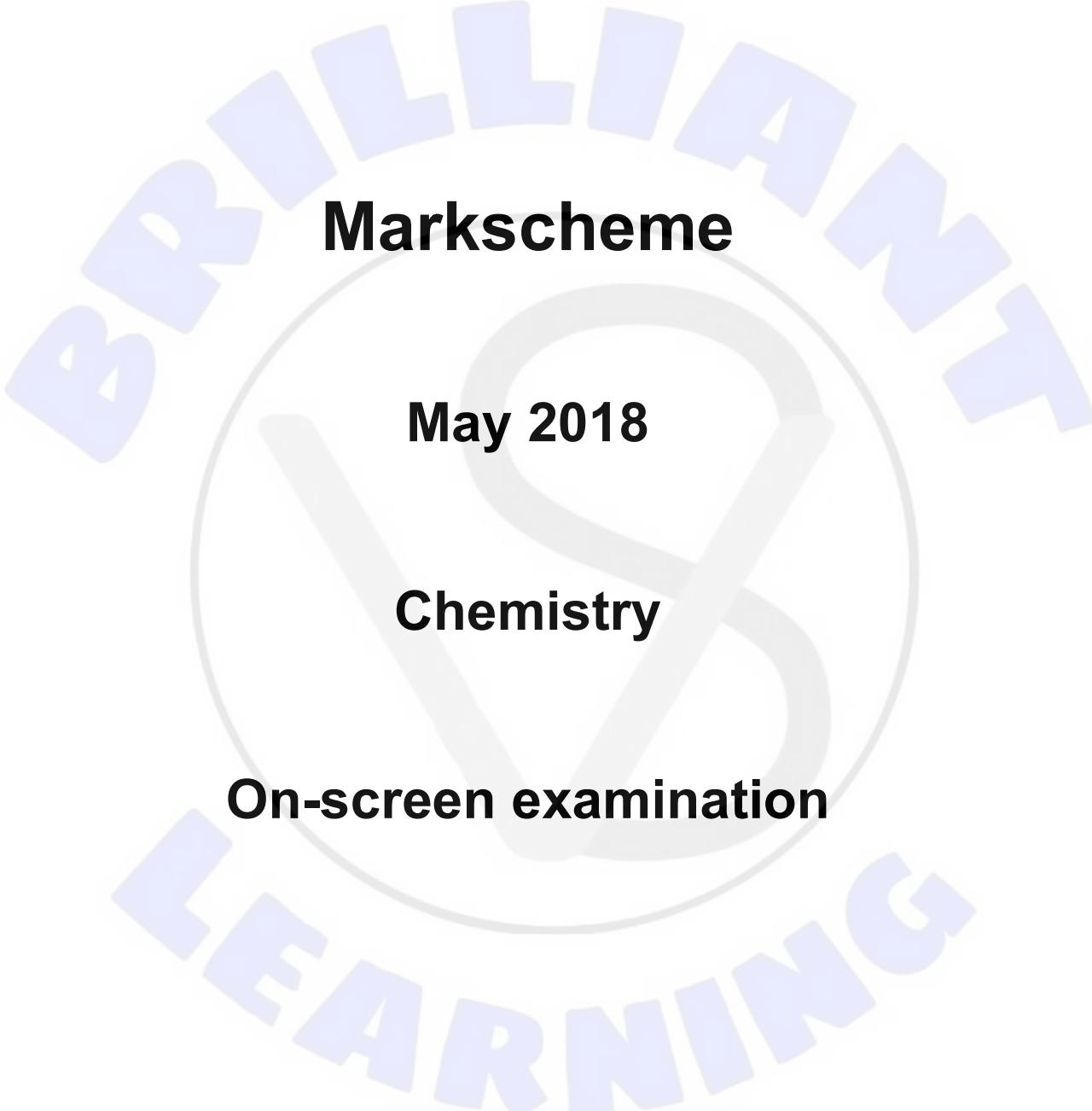
	g	red green purple red		4	C
	h	the indicator gives a range of pH <i>or</i> the colour change would not be visible		1	C

4	a	<p>Cayenne – jalapeño – red chilli – habanero</p> <p>any two in the correct location</p> <p>all correct</p>		2	C
	b	<p>the data show that habanero peppers contain the most capsaicin</p> <p>(so) the prediction is not valid</p>	<i>Only award 2nd mark if the 1st mark is awarded</i>	2	C
	c	<p>compound 1 contains a (C=C) double bond or alkene (group)</p> <p>compound 1 has a longer (carbon) chain or it has an extra carbon</p>	ORA	2	C
	d	<p>if the temperature of the method is low or the pepper is raw</p> <p>then the spiciness will increase or the spiciness will be the highest</p> <p>because the capsaicin will not melt or boil or evaporate or be destroyed</p>		3	B

5		1	2	3	4		
	Variables	A variable is identified	Independent variable and dependent variable identified	Independent variable and dependent variable identified and one control variable is stated	Independent variable and dependent variable identified and more than one control variable is stated		
	Additional equipment	One piece of additional equipment is listed	Stopwatch and one piece of additional equipment	Stopwatch and mortar and pestle or balance and one piece of additional equipment	Complete equipment is listed: balance, measuring cylinder or 25 cm ³ pipette/burette, stopwatch, mortar and pestle		
	Method	Attempt at a method	Time for neutralization is measured	Time for neutralization is measured and mass is measured or powder is used	Time for neutralization is measured and mass is measured and powder is used		
	Data	One treatment is investigated	All treatments are investigated	All treatments are investigated with repeats	All treatments are investigated with repeats and plans to calculate means		
	Assumptions	All of the acid has reacted					
	Safety	A safety precaution is stated	A safety precaution is stated and linked to hazard				

19 B

6	a	<p>value of 2.9 ± 0.2 from graph</p> <p>value for carbon footprint for the potato in the range $0.65 - 0.74$</p> <p>value 11.32 ± 0.04 for total carbon footprint (accept any sig figs)</p> <p>final value given to two sig figs</p>	<p><i>ECF from first marking point</i></p> <p><i>ECF from second marking point</i></p>	4	C D																													
	b	<p>energy values are similar for both</p> <p>(but) environmental impact is higher for meat-based than for vegetable</p> <p>correct use of 11.32 (kgCO_2e) for meat-based or 1.91 (kgCO_2e) for vegetable-based</p>	<p><i>Do not award this mark if no data is given, ECF from part a for meat-based meal</i></p>																															
7	a	$\text{CH}_4(g) + 2\text{O}_2(g) \rightarrow \text{CO}_2(g) + 2\text{H}_2\text{O}(g)$ reactants correct products correct		2	A																													
	b	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr> </thead> <tbody> <tr> <td>Advantages and disadvantages of cattle farming</td><td>An attempt at an advantage or disadvantage</td><td>An advantage or disadvantage</td><td>An advantage and disadvantage</td><td>An advantage and disadvantage with at least one justified</td></tr> <tr> <td>Economic impacts of cattle farming</td><td>An attempt at an economic impact</td><td>An economic impact</td><td>More than one economic impact</td><td></td></tr> <tr> <td>Environmental impact of CH_4 capture</td><td>An attempt at an environmental impact</td><td>An environmental impact</td><td>More than one environmental impact</td><td></td></tr> <tr> <td>Ethical aspects of CH_4 capture</td><td>A statement about the impact on a cow or a statement about the methane hazard</td><td>A statement about the impact on a cow with justification or a statement about the methane hazard with justification</td><td>A statement about the impact on a cow with justification and linked to a statement about the methane hazard</td><td></td></tr> <tr> <td>Concluding appraisal</td><td>A conclusion is given</td><td></td><td></td><td></td></tr> </tbody> </table>		1	2	3	4	Advantages and disadvantages of cattle farming	An attempt at an advantage or disadvantage	An advantage or disadvantage	An advantage and disadvantage	An advantage and disadvantage with at least one justified	Economic impacts of cattle farming	An attempt at an economic impact	An economic impact	More than one economic impact		Environmental impact of CH_4 capture	An attempt at an environmental impact	An environmental impact	More than one environmental impact		Ethical aspects of CH_4 capture	A statement about the impact on a cow or a statement about the methane hazard	A statement about the impact on a cow with justification or a statement about the methane hazard with justification	A statement about the impact on a cow with justification and linked to a statement about the methane hazard		Concluding appraisal	A conclusion is given				14	D
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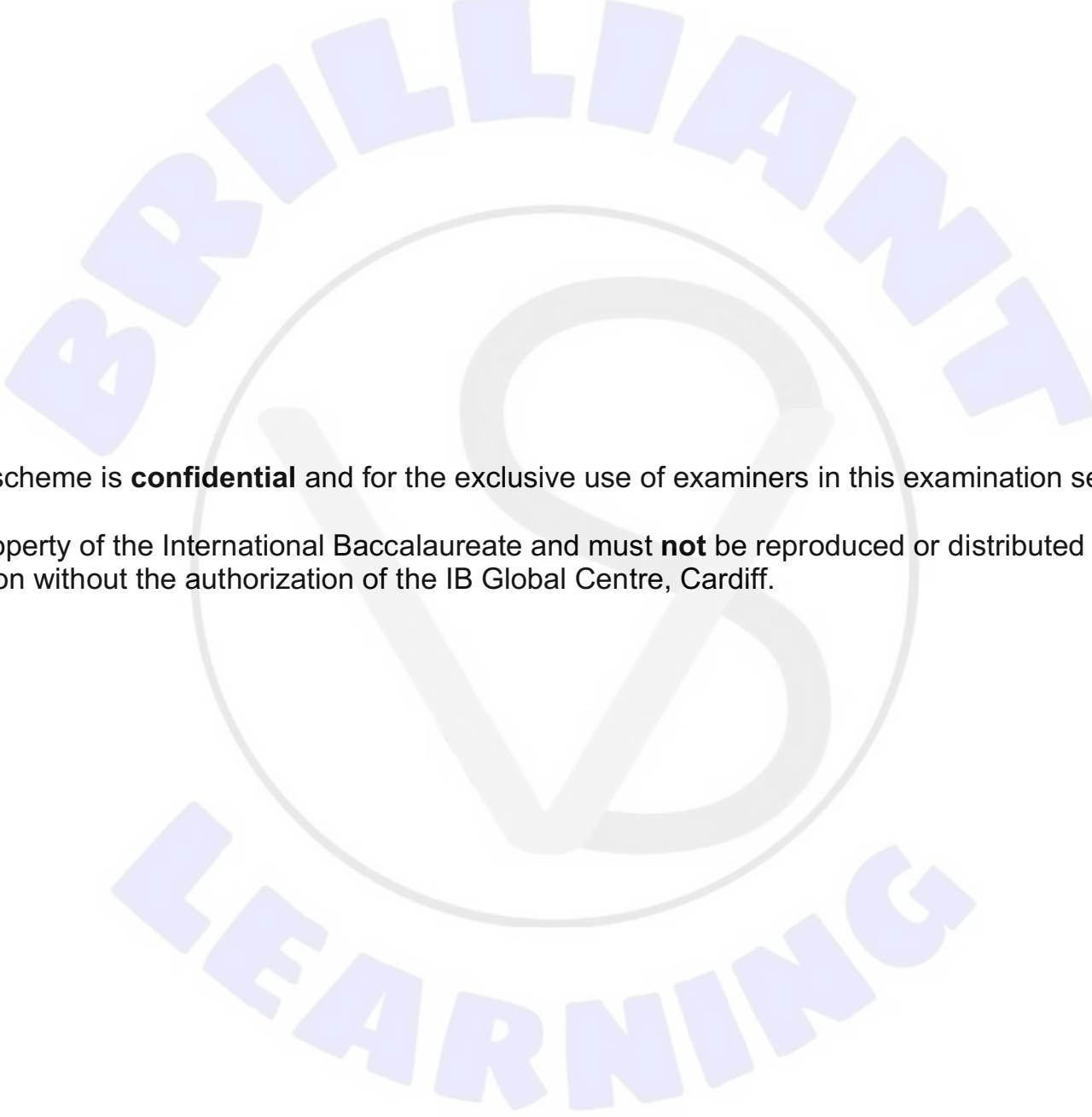
Markscheme

May 2018

Chemistry

On-screen examination

11 pages



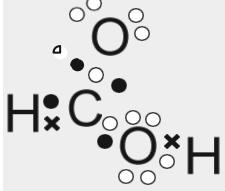
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	Correct point, place at the point in the response where it is clear that the candidate deserves the mark	Alt+1		No benefit of the doubt	Alt+4
	Arithmetic error			No explanation given	
	Benefit of the doubt	Alt+3		Not good enough	
	Omission, incomplete	Alt+7		Not worthy of any marks	
	Contradiction	Alt+6		No working shown	
	Valid part (to be used when more than one element is required to gain the mark)			Test box used for additional marking comments	
	Error carried forward	Alt+8		Unclear	Alt+2
	Dynamic annotation, it can be expanded to surround work			Seen; must be stamped on all blank response areas	Alt+9
	Horizontal wavy line that can be expanded			Vertical wavy line that can be expanded	
	Highlight tool that can be expanded to mark an area of a response			Words to that effect	
	Not answered the question			Award 1, 2, 3, 4 marks. For use in holistically marked questions only	

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Question	Answers	Notes	Total	Criterion								
1 a	<table style="margin-left: auto; margin-right: auto;"> <tr> <th style="text-align: center;">Group</th> <th style="text-align: center;">Period</th> </tr> <tr> <td style="text-align: center;">Carbon:</td> <td style="text-align: center;"><input type="button" value="4"/> <input type="button" value="2"/></td> </tr> <tr> <td style="text-align: center;">Hydrogen:</td> <td style="text-align: center;"><input type="button" value="1"/> <input type="button" value="1"/></td> </tr> <tr> <td style="text-align: center;">Oxygen:</td> <td style="text-align: center;"><input type="button" value="6"/> <input type="button" value="2"/></td> </tr> </table>	Group	Period	Carbon:	<input type="button" value="4"/> <input type="button" value="2"/>	Hydrogen:	<input type="button" value="1"/> <input type="button" value="1"/>	Oxygen:	<input type="button" value="6"/> <input type="button" value="2"/>	<p>Award only 1 mark if groups and periods are interchanged</p> <p>Award 1 mark only if all groups are correct</p> <p>Award 1 mark only if all periods are correct</p>	3	A
Group	Period											
Carbon:	<input type="button" value="4"/> <input type="button" value="2"/>											
Hydrogen:	<input type="button" value="1"/> <input type="button" value="1"/>											
Oxygen:	<input type="button" value="6"/> <input type="button" value="2"/>											
b	methanoic (acid)		1	A								
c	 correct bonds shown or all lone pairs correct structure fully correct	Accept dots or crosses or any combination	2	A								
d	$HCOOH \text{ (aq)} + H_2O(l) \rightleftharpoons H_3O^+(aq) + HCOO^-(aq)$ reactant(s) correct products correct states all correct correct use of equilibrium arrow	Allow $HCOOH(aq) \rightleftharpoons H^+(aq) + HCOO^-(aq)$ Accept incorrect order for example, H_2CO_2 , $CHOOH$ Accept <i>l</i> for $HCOOH$ Allow any double-headed arrow	4	A								
e	add/react with a base/alkali		1	A								

2	a	protons = 12 neutrons = 12		2	A
	b	$Mg_3(PO_4)_2$	<i>Brackets must be present</i>	1	A
	c	for any relevant property, for example: state, metal or non-metal, malleable etc property 1 identified statement of how Mg and Cl or Cl_2 are distinguished property 2 identified statement of how Mg and Cl or Cl_2 are distinguished	<i>Do not accept reference to valence electrons, solubility or type of element</i> <i>Accept linked answers in switched response boxes</i>	4	A
	d	ionic bond	<i>Accept electrovalent</i>	1	A
	e	sulphate ion identified calcium sulphate is insoluble magnesium sulphate is soluble or Mg^{2+} (ions) remain in solution filter (calcium sulphate from the solution) or remove precipitate or solid	<i>Accept sulphuric acid</i> <i>Accept Ca ions</i> <i>Accept Mg ions</i>	4	A
	f	2.5 (moles)		1	A
3	a	$CaCl_2$		1	A
	b	Independent variable: <u>Percentage of calcium carbonate</u> or type of bone/tooth Dependent variable: (Volume or amount) of carbon dioxide produced Accept any two reasonable control variables, for example <ul style="list-style-type: none"> • mass of bone/tooth • volume or amount of acid used • concentration of acid used • temperature • surface area or size of bone 	<i>Do not accept calcium</i> <i>Do not accept amount of bone</i> <i>Do not accept type of acid</i>	4	B

C		Table Object			4	C		
		Animal Part	Volume of carbon dioxide produced (ml) when reacting to hydrochloric acid	Trial 1	Trial 2	Trial 3		
		Elephant tooth						
		Elephant bone						
		Horse tooth						
		Horse bone						
		Human tooth						
		Human bone						
		Monkey tooth						
		Monkey bone						
		Dolphin tooth						
		Dolphin Bone						
		indication of more than one trial			ECF from part (b)			
		column for independent variable: type of bone			Accept dm^3 or cm^3 or mL or ml or l or L for units			
		column for dependent variable: volume of CO_2						
		unit for volume						

	d	Allow ECF from part (b)						
			1	2	3	4		
		Additional equipment (E)	Equipment suggested but is not relevant	Equipment to measure mass or volume or one control variable	Equipment to measure mass and volume and one control variable	Equipment to measure mass and volume and two control variables		
		Method (M)	Attempt at a method but may not be relevant	Attempt at a method but detail is insufficient for another student to follow and is not likely to give relevant data	Method is described, could be followed by another student producing relevant data	Complete method is described, fully explained and could be repeated by another student		
		Data (D)	Plans to test one type of tooth/bone	Plans to test each type of tooth/bone	Plans to use at least three samples of each type of tooth/bone	Plans to use at least three samples of each type of tooth/bone and calculates a mean		
		Assumptions (A)	Assumptions that all bone/teeth/CaCO ₃ has reacted or temperature or pressure remain constant	Assumptions that all bone/teeth/CaCO ₃ has reacted and temperature or pressure remain constant	Assumptions that all bone/teeth/CaCO ₃ has reacted and temperature and pressure remain constant			
		Safety (S)	Use of relevant safety equipment	Use of relevant safety equipment linked to corrosive hazard from acid				
4	a	these points are outliers/anomalies or reason why an outlier was obtained repeat				eg <i>incorrect amount of CaCO₃ was used, amount of CaCO₃ was too high and too low</i> <i>Do not accept interpolation</i>		2 C
	b	use of graph to give mass of 2.40 g evidence of calculation of % by mass correct value of 24.7 correct identification of horse bone				<i>seen or implied</i> <i>ECF marking point 2</i> <i>ECF marking point 3 – do not award this mark alone</i>		4 C

5	a	Image 1: Corrosive Image 2: Flammable Image 3: Toxic	Award 1 mark for each	3	B
	b	Image 1		1	B
	c	appropriate average = 56 (cm ³) it is not appropriate to include an outlier in the average	Award 1 mark only for inappropriate average of 60. <i>Do not award 2nd marking point even if justification is correct.</i>	2	C
	d	Limestone = 1.33 ± 0.03 (cm ³ s ⁻¹) Crushed oyster shell = 0.28 ± 0.03 (cm ³ s ⁻¹)		2	C
	e	limestone particles are smaller than crushed oyster shell (so) rate of reaction is greater for limestone correct use of terms <u>surface area</u> and <u>rate of reaction</u>	ORA ORA	3	C D
	f	the crushed oyster shell takes longer to be broken down allowing more time for the hen to absorb or use the calcium carbonate for eggshell production	Accept “digest”	2	C
	g	limestone <u>data</u> is less reliable (because) greater variability in data between trials or poor consistency crushed oyster shell <u>data</u> is more reliable (because) data have good agreement or low variability or good consistency		4	C
	h	increase number of trials or use same size particles of limestone and oyster shell		1	C

6	a	A				1	A																		
	b	more than two compounds or mixtures of compounds can be separated boiling point (depends on size of molecules) or change in state from liquid to gas molecules with smallest mass or length will have the lowest boiling point			WTTE ORA	3	D																		
	c	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr> </thead> <tbody> <tr> <td>Method (M)</td><td>Comment about removal</td><td>Comment about more than one method of removal</td><td>Describes removal using all three methods</td><td>Describes removal using all three methods linked to science Skimmer – oil and water are immiscible Burning – fumes, smoke Dispersion – components remain in water, affect aquatic life</td></tr> <tr> <td>Advantages/disadvantages (AD)</td><td>One advantage or disadvantage implied</td><td>One advantage and one disadvantage for one method implied or One advantage or one disadvantage for more than one method implied</td><td>Advantages and disadvantages identified for all three methods</td><td></td></tr> <tr> <td>Appraisal (A)</td><td>“Best method identified” and supported by scientific evaluation</td><td></td><td></td><td></td></tr> </tbody> </table>						1	2	3	4	Method (M)	Comment about removal	Comment about more than one method of removal	Describes removal using all three methods	Describes removal using all three methods linked to science Skimmer – oil and water are immiscible Burning – fumes, smoke Dispersion – components remain in water, affect aquatic life	Advantages/disadvantages (AD)	One advantage or disadvantage implied	One advantage and one disadvantage for one method implied or One advantage or one disadvantage for more than one method implied	Advantages and disadvantages identified for all three methods		Appraisal (A)	“Best method identified” and supported by scientific evaluation		
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Appraisal (A)	“Best method identified” and supported by scientific evaluation																								
					8	D																			

7		1	2	3	4	14	D
Pipeline (distribution of oil) (P)	A comment about a pipeline	One advantage or one disadvantage of a pipeline implied	One advantage and one disadvantage of a pipeline implied	More than one advantage and more than one disadvantage of a pipeline			
Alternative methods (AM)	A comment about an alternative method	One advantage or one disadvantage of one alternative method	One advantage or one disadvantage of both alternative methods or More than one advantage and more than one disadvantage of a both alternative methods	More than one advantage and more than one disadvantage of a both alternative methods			
Environmental considerations (E)	An environmental impact	More than one environmental impact	More than one environmental impact with at least one supported by science				
Social considerations (S)	A social impact of transporting oil	More than one social impact of transporting oil					
Appraisal (A)	A concluding appraisal linking the issues discussed						

Markscheme

November 2019

Chemistry

On-screen examination

12 pages

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Annotation	Explanation
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	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Question	Answers		Notes	Total	Criterion
1	a	9		1	A
	b	Aluminium: <input type="text" value="3"/> <input type="text" value="3"/> Silicon: <input type="text" value="4"/> <input type="text" value="3"/>		2	A
		Aluminium: group 3 and period 3			
		Silicon: group 4 and period 3			
2	c	A. $\begin{array}{c} \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \\ \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \end{array}$ B. $\begin{array}{c} \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \\ \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \end{array}$ C. $\begin{array}{c} \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \\ \times\ddot{\text{O}}\times\text{C}\ddot{\text{O}}\times \end{array}$ D. $\begin{array}{c} \text{O}\ddot{\text{C}}\ddot{\text{O}} \\ \text{O}\ddot{\text{C}}\ddot{\text{O}} \end{array}$ <input type="button" value="B"/>		1	A
	a	alloy		1	A
2	b	Low carbon steel: Would not be strong or too malleable or would not hold its shape Very high carbon steel: Brittle or not malleable or not easy to shape	WTTE	2	A
	c	kg converted to g $n = \text{m}/\text{ram}$ or $n = 405/56$ 7.23 (moles) 7.2 (moles)	Seen or implied. Accept correct answers using 98.15% high carbon steel Award 3 marks if only this answer is seen Correct answer expressed to 2 sig figs	4	A D
	d	Solid		1	A

	e	<p>Point A (liquid) Irregular arrangement of at least 6 particles with at least 4 in contact arranged towards the base of the container</p> <p>Point B (solid) Regular arrangement of at least 6 particles at the base of the container</p>	<p><i>Do not accept completely dispersed particles or pairs of particles implying gas molecules</i></p>	2	A
	f	327 ± 1 (°C)		1	A

3	a	Strontium carbonate + nitric acid → strontium nitrate + Carbon dioxide Water	<i>Accept correct formulae</i>	2	A
	b	$\text{SrCO}_3 + 2\text{HNO}_3 \rightarrow \text{Sr}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$ Correct reactants with correct coefficients Correct formula for $\text{Sr}(\text{NO}_3)_2$ Equation correctly balanced	<i>Ignore one subscript error, accept = sign no ECF</i>	3	A
	c	Radium is <u>radioactive</u> or zinc sulphide is not <u>radioactive</u> Radioactivity causes damage to the body	<i>WTTE accept negative effect on health</i>	2	A

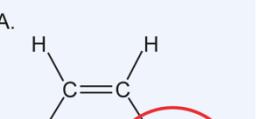
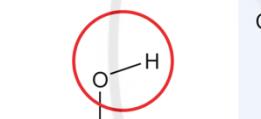
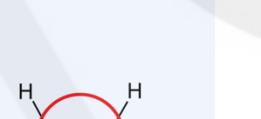
	d	<p>Text Object</p> <p>$^{210}_{\text{Po}}$ $^{210}_{\text{Pb}}$</p> <p>Text/MCQ/Mini-Cloze Object</p> <p>Protons: 84 82</p> <p>Neutrons: 126 128</p> <p>Electrons: 84 82</p> <p>One mark for each correct column</p> <p>$^{210}_{\text{Po}}$: $p = 84$ and $n = 126$ and $e = 84$</p> <p>$^{210}_{\text{Pb}}$: $p = 82$ and $n = 128$ and $e = 82$</p>		2	A
	e	C		1	A

4	a	<p>IV: (type of) hydrogel DV: volume of water (not absorbed)</p> <p>Any two reasonable CV, for example [max 2]</p> <ul style="list-style-type: none"> • mass of hydrogel • temperature • <u>initial</u> volume of water or 400 cm^3 • time (for absorption) • number of times mixed 		4	B
	b	<p>Two columns or rows for IV and DV</p> <p>Labels: hydrogel and volume (of water) (volume of water) not absorbed</p> <p>Unit of cm^3 in label only</p>	<p><i>Ignore order of hydrogels</i> <i>Accept "sample"</i></p>	4	C
	c	<p>Title correctly linking hydrogels with water (not) absorbed</p> <p>y axis scale starts at zero with even intervals</p> <p>Axis labelling: $x =$ type of hydrogel or sample and $y =$ volume/cm^3</p> <p>Data for at least three hydrogels correctly plotted as a bar chart</p>	<p><i>Accept labels from part b, ECF</i> <i>Accept volume of water absorbed if processed data is plotted</i></p>	4	C
	d	<p>Any justification from the list [max 1]</p> <ul style="list-style-type: none"> • no and the raw data measured water not absorbed • yes and need to process raw data to calculate water absorbed • no and there were not sufficient trials 		1	C
	e	<p>Hydrogel 1</p> <p>(experimental data shows water absorbed) $400 - 340 = 60 \text{ cm}^3$ or $400 - 60 = 340 \text{ cm}^3$</p> <p>An explanation that only hydrogel 1 can absorb this volume of water or more than this volume</p>	<p><i>Accept 400 – 350 or 400 - 50</i></p>	3	C

5	a	<p>Any two environmental impacts correctly linked to a specific nappy type, for example [max 2]</p> <ul style="list-style-type: none"> • waste water • pesticides • energy use • detergent use <p>Advantages and disadvantages correctly linked to a specific nappy type, for example [max 2]</p> <ul style="list-style-type: none"> • time needed to wash • need to buy new nappies each time • hygiene considerations about washing nappies • cost of energy to wash <p>A concluding appraisal linked to earlier arguments</p>	<p>Do not credit the same idea in both categories</p>	5	D																								
	b	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr> </thead> <tbody> <tr> <td>Variables</td><td>some variables implied</td><td>IV (type of nappy) or DV (volume of water) and one CV identified</td><td>IV and DV and one CV identified</td><td>IV and DV and two CV identified</td></tr> <tr> <td>Equipment</td><td>equipment suggested but not relevant</td><td>equipment to measure DV or to control one CV</td><td>equipment to measure DV and to control two CV</td><td></td></tr> <tr> <td>Sufficient data</td><td>reference to different brands or trials</td><td>all five brands or three trials</td><td>all five brands and three trials</td><td>all five brands, three trials and calculates mean</td></tr> <tr> <td>Method</td><td>attempt at method but may be not relevant</td><td>attempt at method, insufficient detail and not likely to give relevant data</td><td>method described, could be followed, will produce relevant data</td><td>complete method fully explained and could be replicated</td></tr> </tbody> </table>		1	2	3	4	Variables	some variables implied	IV (type of nappy) or DV (volume of water) and one CV identified	IV and DV and one CV identified	IV and DV and two CV identified	Equipment	equipment suggested but not relevant	equipment to measure DV or to control one CV	equipment to measure DV and to control two CV		Sufficient data	reference to different brands or trials	all five brands or three trials	all five brands and three trials	all five brands, three trials and calculates mean	Method	attempt at method but may be not relevant	attempt at method, insufficient detail and not likely to give relevant data	method described, could be followed, will produce relevant data	complete method fully explained and could be replicated	15	B
	1	2	3	4																									
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6	a	<p>Any three reasonable statements correctly linked to the <u>data</u>, for example [max 3]</p> <ul style="list-style-type: none"> • not supported and the most absorbent nappy is Pugs • not supported and Pugs has the least amount of hydrogel • the fluff pulp also affects volume of water absorbed • volume absorbed depends on the composition of fluff pulp and hydrogel 		3	C
	b	<p>If: the total mass of absorbent material increases then: the mass of water absorbed increases because: fluff pulp and hydrogel both absorb water or hydrogel absorbs more than fluff pulp</p> <p>or</p> <p>If: the mass of hydrogel increases then: the mass of water <u>absorbed by the hydrogel</u> increases because: hydrogel absorbs a larger proportion of the total water absorbed (compared to FP)</p> <p>or</p> <p>If: the mass of fluff pulp is greater then: the mass of water <u>absorbed by the fluff pulp</u> increases because: fluff pulp absorbs water</p>		3	B
	c	<p>Fluff pulp removes ions or impurities or minerals from the urine (so) the hydrogel absorbs the water</p>		WTTE	2

7	a	Dye C Because it has the same spot pattern or it is an irritant	WTTE	2	C
	b	The other dyes do not have the same components <u>Dye B</u> only has two pigments in common <u>Dye D</u> has an additional pigment which is not present in the sample	WTTE	3	C
	c	Appropriate measurements: Yellow spot 1.5-1.9 (cm) and solvent front 3.7 (cm) Any Rf value calculated correctly Rf value links to yellow spot in Dye C 0.48 ± 0.05	Accept correct measurements for other spots for this first mark. Examiners will need to measure incorrect spots Can award first two marks for any spot	3	C

8	a	A.  <chem>CH3COOR</chem> <input type="checkbox"/> Ester	B.  <chem>CH3CHO</chem> <input type="checkbox"/> Alcohol	C.  <chem>CH2=CH2</chem> <input type="checkbox"/> Alkene		
					3	A

	b	<p>Any two properties, for example [max 2]</p> <ul style="list-style-type: none">• heat resistant or appropriate melting temperature• cheap• waterproof• strong• rigid <p>Any advantage, for example [max 1]</p> <ul style="list-style-type: none">• PLA can biodegrade• made from renewable material• does not release harmful toxins• saves greenhouse gases during production• higher heat capacity• can be reused• uses less oil during production <p>Any disadvantage, for example [max 1]</p> <ul style="list-style-type: none">• limited production capacity• more expensive <p>Any two further advantages or disadvantages [max 2]</p> <p>A conclusion linking all arguments</p>	7	D
--	---	---	---	---

9		1	2	3	4	13 D
	Sustainability (including costs of a one- use product)	oil-based plastics are unsustainable or algae- based plastics are sustainable is implied	a clear statement that oil-based plastics are unsustainable or algae is sustainable	a clear statement that oil-based plastics are unsustainable and algae-based are sustainable	a clear statement that oil-based plastics are unsustainable and algae-based are sustainable supported with scientific reasoning	
	Environmental	an environmental impact of oil-based plastics or algae-based plastics is implied	a clear statement of an environmental impact of oil-based plastics or algae-based plastics	a clear statement of an environmental impact of oil-based plastics and algae-based plastics	a clear statement of an environmental impact of oil-based plastics and algae-based plastics and an additional environmental impact of either plastic (at any stage)	
	Social impacts (jobs and production time, social or health effects of environmental damage)	one social impact is implied	a clear statement of one social impact	clear statements of two social impacts (at any stage)	clear statements of social impact of production and use and end of use	
	Appraisal	a concluding statement				

Markscheme

May 2019

Chemistry

On-screen examination

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	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Markscheme instructions

- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the “Total” column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word “**max**” in the Answer column. Further guidance may be given in the Notes column.
- 8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.
- 9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 10 Alternative answers are indicated in the Answer column by “**or**”. Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 11 If two related points are required to award a mark, this is indicated by “**and**” in the answer column.
- 12 Words in brackets () in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.
- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA* (*or reverse argument*) in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE* (*or words to that effect*) in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.
- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate’s work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

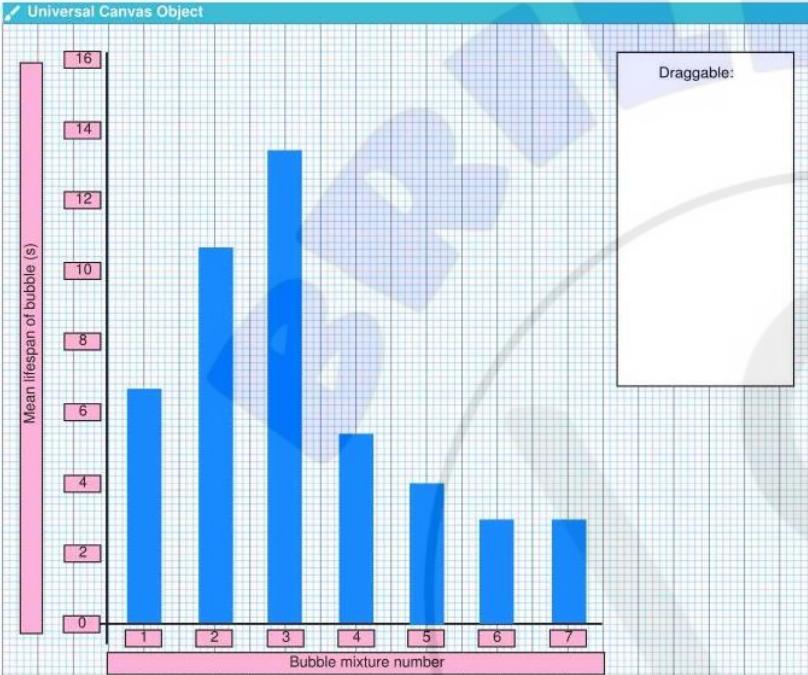
Question	Answers		Notes	Total	Criterion
1	a	<p>Accept any of the following [1 max]:</p> <ul style="list-style-type: none">• any noble gas• any element from 209 to 280• any actinide or lanthanide except Th or U• Sc or Ga or Ge or Hf		1	A
	b	<p>lanthanides or actinides very small quantities of these elements exist or many are not naturally occurring or noble / inert gases / group 0 / group 18 / group VIII unreactive or not found in compounds or technology not available to isolate them</p>	<i>Reason should be correctly linked to named group</i>	2	A
	c	<p>Number of protons = 26 Number of neutrons = 32</p>		2	A
	d	Iron / Fe	<i>ecf from part (c)</i>	1	A

2	a	<p>Image Object</p> <p>Text/MCQ/Mini-Cloze Object</p> <p>○ ○ •</p>	<i>Check the position of the dot carefully, it is not always aligned directly under the correct structure</i>	1	A
	b	$[4] \text{NO}_2 \text{(g)} + \text{O}_2 \text{(g)} + [2] \text{H}_2\text{O(l)} \rightarrow [4] \text{HNO}_3 \text{(aq)}$ <p>First mark: any two coefficients are correct Second mark: all coefficients are correct</p>		2	A
	c	acidic or contains an acid or low pH		1	A
	d	Group 6 Period 3	<i>Do not award any marks if the group and period are switched</i>	2	A
	e	98 or 0.098 g or kg	<i>Accept g mol⁻¹ Award unit mark separately unit and value must agree</i>	2	A
	f	<p>Text/MCQ/Mini-Cloze Object</p> <p>Class: Ester</p> <p>Text/MCQ/Mini-Cloze Object</p> <p>Name: Ethyl ethanoate</p> <p>Text/MCQ/Mini-Cloze Object</p> <p>Class: Alcohol</p> <p>Text/MCQ/Mini-Cloze Object</p> <p>Name: Propan-1-ol</p>		4	A

3	a	<p>Any two from the list [2 max]:</p> <ul style="list-style-type: none">• good thermal / heat conductivity• malleable• high melting point• rigid / solid	<p><i>Do not accept conductivity alone, high boiling point, long lasting</i></p>	2	A
	b	<p>+3 or 3+</p> <p><u>Oxidized</u></p> <p>(because) electrons are lost from the Al atom or (because) oxidation state or number increases</p>	<p><i>Award marks independently</i></p> <p><i>Accept half equation showing oxidation but the word oxidized must also be seen</i></p>	3	A
	c	<p>covalent and metallic</p> <p>Teflon™ forms a protective coating</p> <p>(metals can produce) ions which are soluble or Teflon™ is not soluble</p> <p>coating prevents ions from forming or avoids health issues from ions</p>	<p><i>Ignore polar</i></p>	4	A

4	a	<p>Any one of the following [1 max]:</p> <ul style="list-style-type: none"> • constant colour (of solution) • volume or amount of water • type of glass or cup 		1	B
	b	<p>the time taken for diffusion to be complete <input type="text" value="decreases"/> <input type="button" value="▼"/></p> <p>the kinetic energy increases with increasing temperature so the tea “particles” mix with the water molecules more quickly or diffusion occurs more quickly</p>	<i>WTTE</i> <i>Award marks independently</i>	3	B
	c	<p>400 ± 10 (seconds) seconds / s</p>	<i>Award separately</i>	2	C
	d	<p>record data points at intermediate temperatures carry out more than one trial calculate an average</p>		3	C

5	a	1 cm ³ pipette		1	B
	b	<p>10.666666 (s) 10.7 (s)</p>	<i>Award two marks if only 10.7 is seen Please check table for 10.7 in addition to response box</i>	2	C

C	 <p>scale: evenly spaced increments that start at zero</p> <p>x axis: bubble mixture</p> <p>y axis: lifespan</p> <p>y axis unit: s</p> <p>Plotting: additional mark for all points plotted correctly</p> <p>Title: correctly links dependent and independent variable</p>	6	C
d	<p>Independent variable: volume of glycerine</p> <p>Dependent variable: lifespan of bubble</p>	2	B

e	bubbles are different sizes in method 2/ wand or bubbles are moving in method 2/wand and are static in method 1,straw or bubbles are affected differently by gravitational field in method 2/wand bubbles in method 2/wand are not reproducible bubbles in method 1,straw will give the most reliable data	<i>Method 1 uses a straw to form the bubble on a bench</i> <i>Method 2 uses a wand</i>	3	C
f	convert 1 min 10 seconds to 70 and 1¼ min to 75 seconds method of calculation of mean is seen final answer 74 (s)	<i>Award 2nd mark independently (mean can be incorrect)</i> <i>no ecf award full marks if correct answer is seen</i> <i>accept 1 min 14 s</i>	3	C
g	not valid because the two additives show different trends sugar causes a decrease in the lifespan of the bubble	<i>WTTE</i>	2	C

6	a		1	2	3	4		
1.V (Variables)	either independent or dependent variable is identified	independent and dependent variables are identified						
2.CV (Control variables)	one control variable is stated	two control variables are stated						
3.E (Equipment)	straw or wand and bubble mix are listed	straw or wand and bubble mix and timer or measuring equipment are listed	straw or wand and bubble mix and timer and measuring equipment are listed					
4. Meth (Method)	<ul style="list-style-type: none"> make bubbles 	<ul style="list-style-type: none"> make bubbles add at least one additive mentioned time (until they burst) 	<ul style="list-style-type: none"> make bubbles all additives are mentioned time until they burst 	<ul style="list-style-type: none"> make and measure a bubble solution all additives are measured and added time until bubble bursts 				
5. Meas (Measurements)	time for one additive is measured	time for one additive is measured and size of bubble controlled	time for all additives is measured and the size of the bubble is controlled					
6. D (Sufficient data)	at least three trials for an additive	at least three trials for all additives	at least three trials for all additives and plans to calculate average					
b	Graph C				Accept Graph A		1	C

7	a		1	2	3	8	D
			1.L (Impact of landfills) mention of landfills	with recycling only 10 % of waste goes to landfills or there is a 90% reduction in waste going to landfill with recycling			
			2.P (Effects of pollution) if plastics are recycled or re-used there will be less plastic polluting the environment or when plastics are used to generate electricity they are removed and will not pollute the environment	if plastics are not recycled there will be more plastic polluting the environment and when plastics are used to generate electricity they are removed and will not pollute the environment			
			3.B (use of by-products) if plastics are re-used or recycled useful by-products are produced or plastics can be recycled and used to generate electricity	if plastics are re-used or recycled useful by-products are produced and plastics can be recycled and used to generate electricity	if plastics are re-used or recycled useful by-products are produced and plastics can be recycled and used to generate electricity and plastics which are not recycled produce no useful by-products		
			4.R (Re-use of raw materials) same amount of raw material is consumed or lost whether or not the plastic is recycled				
	b		Any two reasonable responses, for example [2 max]:		WTTE	2	D
			<ul style="list-style-type: none"> • can be reused • can be recycled at the end of life • less material is processed • product can put back into washed bottles • fewer chemicals are released to the environment • economic benefits or decrease in production costs 				

8		1	2	3	4	17	D
		efficiency of one method	efficiency of both methods	efficiency of both methods compared to each other	efficiency of both methods with comparison compared to each other and scientific justification		
1. Eff (Efficiency - to what extent are ions removed can be positive or negative)							
2. Env (Environmental impact)	environmental impact of one method	environmental impact of both methods	environmental impact of both methods with scientific reasoning for both				
3.Eco (Economic impact)	economic impact of one method	economic impact of both methods					
4.G (Green chemistry)	one aspect of green chemistry is mentioned eg preventing waste, being energy efficient, using renewable raw materials	two aspects of green chemistry are mentioned eg preventing waste, being energy efficient, using renewable raw materials					
5.C (Complexity)	complexity of one method	complexity of both methods	complexity of both methods with comparison	complexity of both methods with comparison and scientific justification			
6. F (Final choice)	final choice stated	final choice with justification					

Markscheme

November 2020

Chemistry

On-screen examination

13 pages

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	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Horizontal wavy line that can be expanded
	Highlight tool that can be expanded to mark an area of a response

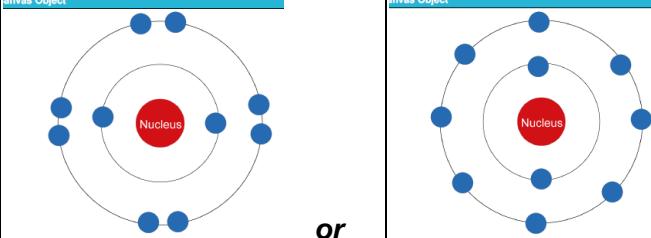
Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Markscheme instructions

- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
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- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
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- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE* (words to that effect) in the Notes column.

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- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
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- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question		Answers	Notes	Total	Crit					
1	a	solidification		1	A					
	b	<p>Table Object</p> <table border="1"> <tr> <td>Oxide</td> <td>Formula</td> </tr> <tr> <td>silicon dioxide</td> <td>SiO₂</td> </tr> <tr> <td>magnesium oxide</td> <td>MgO</td> </tr> </table>	Oxide	Formula	silicon dioxide	SiO ₂	magnesium oxide	MgO	Do not accept silicon oxide	2
Oxide	Formula									
silicon dioxide	SiO ₂									
magnesium oxide	MgO									
c	basaltic		1	A						
d	$m\text{SiO}_2 = 1.16 \times 100 / 2.00 \text{ g} = 58.0 \%$ 58.0 % SiO ₂		2	C						
e	andesitic	ECF from part d	1	C						
2	a	the gases dissolve in water to form acids (SO ₂ or HCl) with pH approx. 0.1		2	A					
	b	<p>Lewis structures for sulfur hydrides:</p> <ul style="list-style-type: none"> H₂S₂: Two sulfur atoms connected by two single bonds, each with two lone pairs. H₂S₄: Two sulfur atoms connected by four single bonds, each with one lone pair. H₂S₆: Two sulfur atoms connected by six single bonds, no lone pairs. H₂S₈: Two sulfur atoms connected by eight single bonds, no lone pairs. 		1	A					
	c	(Period) 3		1	A					
	d	P-10 N-12 E-10		3	A					

	e	 <p>Only 2 electrons in the inner shell Only 8 electrons in the outer shell</p>		2	A
3	a	Alkene		1	A
	b	Ethene Propene		2	A
	c	C_5H_{12}	do not accept pentane, $CH_3(CH_2)_3CH_3$	1	A
	d	neutralize acidic gases	Accept remove toxic gases	1	A
	e	boiling	Accept water turning into steam Do not accept evaporation	1	A
	f	Accept any two reasonable responses, for example [max 2] <ul style="list-style-type: none"> waste should not contain any materials that could produce hazardous/toxic/explosive substances during incineration atmospheric emissions should be controlled with the proper equipment 		1	A
	g	A — C — B (increasing size) A had the fastest rate of biodegradability / breakdown rate of reaction increases with decreasing particle size or the smaller the particles, the higher the surface area and the faster the reaction	Accept correct decreasing order only if explained in words	3	A

4	a	a chemical which speeds up the rate of a reaction or lowers the activation energy without itself being used up	WTTE	2	A
	b	Ester		1	A
	c			1	C
	d	temperature time taken for the glow stick to stop glowing Any two reasonable control variables [max 2] <ul style="list-style-type: none"> • <u>type</u> or <u>colour</u> of glow stick • volume of water • time to equilibrate 	WTTE <i>Do not accept amount of water</i>	4	B
	e	if the temperature increases then the length of time the glow stick will glow will decrease because the rate of the reaction increases		3	B
	f	330 ± 10 Minutes or min(s)		2	C

	g	rate = molecules/time $= 6.58 \times 10^5 / 260$ $= 2530(. 0769 \dots)$ molecules min ⁻¹ or 42.2 molecules s ⁻¹	<i>Seen or implied</i> <i>Award the unit mark separately</i>	4	C D
5	a	Aurum		1	C
	b	sunlight consists of all the different wavelengths/colours/frequencies of light UV lamp only emits a narrow band of light / UVA only	<i>WTTE</i>	2	C

5	c		1	2	3	4	17	B
		V (Variables)	some variables implied	IV or DV and one CV identified	IV and DV and one CV identified	IV and DV and two CV identified		
		E (Equipment)	equipment suggested but not relevant	equipment to monitor one CV	equipment to monitor two CVs			
		M (Method)	attempt at a method but may not be relevant	attempt at a method but detail is insufficient for another student to follow and is not likely to give relevant data	method is described, could be followed by another student producing relevant data	complete method is described, fully explained and could be repeated by another student		
		D (Data)	plans to test one type of chemical	plans to test each type of chemical	plans to use at least three samples of each type of chemical	plans to use at least three samples of each type of chemical and calculates a mean		
		S (Safety)	a safety consideration is given	a safety consideration is given related to a specific hazard				
6	a	compare the number of beads that have changed colour after exposure for each chemical if titanium dioxide has the lowest number of beads that have changed, then the RQ is supported					2	C
	b	Accept any reasonable response, for example [max 1]: <ul style="list-style-type: none">• combinations of chemicals/ingredients/compounds• different length of time• exposure to sunlight/ light source• different concentration of chemical				<i>Do not accept repeat the experiment</i>		1

	c	<p>Title – A title that links Absorbance and concentration (of chemical X)</p> <p>two data points plotted correctly</p> <p>all data points plotted correctly</p> <p>line of best fit to start at (0,0) and go through all points except 70$\mu\text{mol dm}^{-3}$</p> <p>axis labels: concentration on x axis and absorbance on y axis</p> <p>unit of concentration $\mu\text{mol dm}^{-3}$</p>		6	C
	d	<p>anomalous data point at 70 ($\mu\text{mol dm}^{-3}$)</p> <p><i>or</i></p> <p>there is only one trial <i>or</i> averages are not plotted</p>	<i>Ignore any units of absorbance</i>	WTTE No ecf from incorrect plotting in part (c)	1 C
7	a	<p>Accept any reasonable suggestion, for example:</p> <ul style="list-style-type: none"> lack of fruit for food/diet lack of medical products loss of species destruction of habitat an impact on respiratory health <p>Justification (because) fewer plants, so less photosynthesis is taking place</p> <p><i>or</i></p> <p>less glucose is synthesized</p> <p><i>or</i></p> <p>an increase in the level of carbon dioxide</p>		2	D
	b	$\text{Fe(s)} + \text{CO}_2(\text{g}) + \text{H}_2\text{O(l)} \rightarrow \text{FeCO}_3(\text{s}) + \text{H}_2(\text{g})$ <p>one correct</p> <p>all correct</p>		<i>Do not accept H₂O(aq)</i>	2 D

c	Iron (II) carbonate		1	D
d	oxidation number of iron has increased or has lost electrons (from 0 to) +2 (so) iron has been <u>oxidised</u>		3	D
e	All reactants correct: $2\text{H}_2 + \text{O}_2$ Product correct: $2\text{H}_2\text{O}$	Do not accept ? O_2	2	D
f	Only product is water or no CO_2 or no NO_x or no SO_x is produced product is non-toxic or pollutant	<i>Do not accept reference to energy density</i> <i>ORA accept combustion of petrol produces a pollutant gas for this mark only</i>	2	D

8		1	2	3	4		
Carb (Why there is a need for carbon sinks)	attempt at need for carbon dioxide sink	a statement about need for carbon dioxide sink	a statement about need for carbon dioxide sink supported by science				
Eco (Economic impact)	an economic impact for one system is implied	an economic impact for one system is stated	an economic impact for both systems is stated				
Soc (Social impact)	a social impact for one system is implied	a social impact for one system is stated	a social impact for both systems is stated				
Sci (Scientific link to advantages and disadvantages)	attempt at advantage or disadvantage of one system	advantage or disadvantage of one system	advantage and disadvantage of one system or an advantage or disadvantage of both systems	advantage and disadvantage of both systems			
Con (Concluding appraisal)	a concluding statement	a concluding choice with justification					

15

D

Markscheme

November 2021

Chemistry

On-screen examination

15 pages

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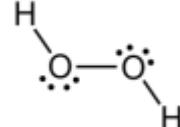
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	Vertical wavy line that can be expanded
	Words to that effect
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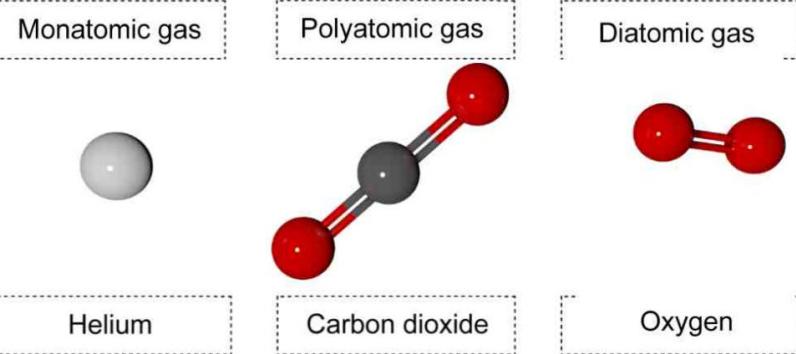
Markscheme instructions

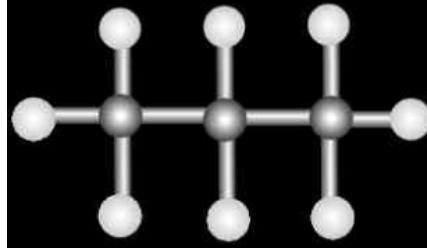
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Question		Answers	Notes	Total	Crit
1	a	CaCO ₃		1	A
	b	Group 1 Period 3		2	A
	c	2.7 or 1s ² 2s ² 2p ⁵ or K ² L ⁷		1	A
	d	less energy to remove the electron or the electron is easier to remove (because) outermost electron is further away from nucleus or (because there is) less attraction from the nucleus (because there are) more electron shells/levels in sodium	ORA <i>WTTE accept larger size</i>	3	A

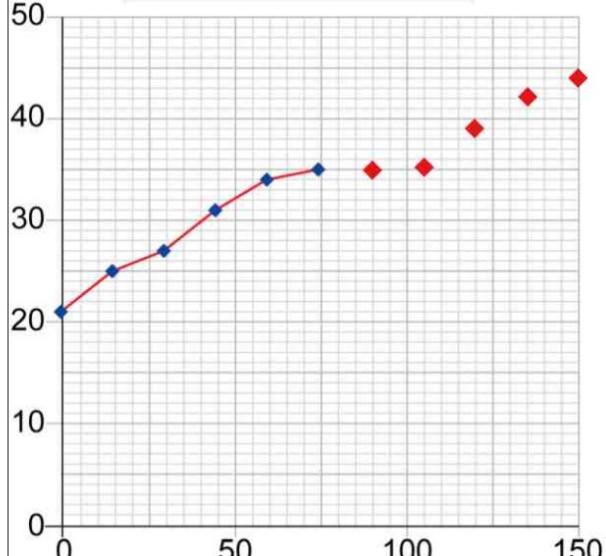
2	a	covalent		1	A
	b	 C		1 A	
	c	$2\text{H}_2\text{O}_2 \text{ (aq)} \rightarrow 2\text{H}_2\text{O} \text{ (l)} + \text{O}_2\text{(g)}$ formulae of products correct with superscripts correct correctly balanced state symbols correct	<i>Accept any correctly balanced equivalent</i> <i>Accept aqueous or liquid for H₂O₂</i>	3	D
	d	 D		1	A
	e	more (hydrogen peroxide) particles are present at higher concentrations (hence) there are more successful collisions with stain particles (so) the teeth are being whitened more quickly or rate of reaction is faster	WTTE ORA	3	A

3	a	<p>nitrogen and 78%</p> <p>oxygen and 20.9%</p>	Accept in either order	2	C
	b	<p>Monatomic gas</p> <p>Polyatomic gas</p> <p>Diatomeric gas</p>  <p>Correct row above or below the model</p> <p>Correct pairing and correct structure</p> <p>All correct</p>		3	A
	c	(noble gases are) unreactive or inert or have full outer shells (of electrons) or they don't share electrons with other atoms		1	A
	d	<p>12 and 35.5 and 19 seen or correct method for calculation of RMM correctly calculated 187.5</p>	<i>Ignore mass units if present, answer alone scores 2 marks</i>	2	A

	e	scent or deodorant (particles) move diffuse or move until equally spread out more quickly higher temperatures mean that the <u>particles</u> move faster or higher temperatures mean that the kinetic energy of the <u>particles</u> is greater	ORA	3	A
	f			1	A

4	a	28.1 (°C)		1	C
	b	29.7 (°C)		1	C
	c	Student B and measured T when all of gallium had melted or Student B and the change of state had occurred (and) the temperature was steady	<i>Do not accept ref to equipment, do not accept ref to more than one measurement</i>	2	C
	d	(as the % of zinc increases, the melting point) decreases	ORA	1	C
	e	(if) the percentage of zinc increases in an alloy (then) the density of that alloy will decrease (because) zinc has a lower density than copper		3	B
	f	1000 ± 10 °C		2	C
	g	Type A the melting point is 1066 (°C) so it will not melt or has a melting point that is above 1050 (°C)		2	C

5	a	Carbon dioxide or CO ₂		1	A
	b	Independent variable: (type of) solute Dependent variable: freezing point or freezing temperature	WTTE <i>Do not accept melting point</i>	2	B
	c	Any two reasonable control variables, for example [max 2]: <ul style="list-style-type: none">• volume / size of ice cube• amount/mass/concentration of solute• temperature of freezer• (shape /material of) container• starting temperature (of solution)• time		2	B
	d	how does the (IV from 5b) of solute affect the freezing point / temperature of the solution	<i>ECF from incorrect IV in 5b</i>	2	B

6	a		5	C
	b	<p>two data points plotted correctly</p> <p>all data point plotted correctly</p> <p>title links temperature change with time</p> <p>X axis label: time and s</p> <p>Y axis label: temperature and °C</p>		
	b	<p>B because the graph shows a steady plateau at 35 °C</p> <p>this is the melting point/temperature of Form V</p>	2	C

c	evidence of a calculation of an average 36.6(6666...) 36.7	<i>Does not have to be correct answer for this first mark</i> <i>Award two marks if only 36.6 is shown</i> <i>Award three marks if only 36.7 is shown</i>	3	C
d	43 ± 0.5 °C		2	C
e	Any reasonable suggestion, for example [max 1]: <ul style="list-style-type: none">• melting point not measured correctly• incorrect % of cocoa used• not all of the sample was melted• water bath was at incorrect temperature•		1	C
f	investigate samples with intermediate % between 30 and 60		1	C

7	a	1	2	3	4		
		1.V (Variables) either independent or dependent variable is identified	independent and dependent variables are identified				
		2.CV (Control variables) one control variable is stated	two control variables are stated				
		3.E (Equipment) equipment to measure temperature or equipment to monitor one CV	equipment to measure temperature and equipment to monitor one CV				
		4. Meth (Method) <ul style="list-style-type: none">• put chocolate in boiling tube and measure melting temperature	<ul style="list-style-type: none">• put chocolate in boiling tube and measure melting temperature• all samples are measured	<ul style="list-style-type: none">• put chocolate in boiling tube and measure melting temperature• all samples are measured• all samples are same size/mass	<ul style="list-style-type: none">• put chocolate in boiling tube and measure melting temperature• all samples are measured• all samples are same size/mass• heat until temperature is stable		
		5. D (Sufficient data) at least three trials for one chocolate	at least three trials for all chocolates	at least three trials for all chocolates and plans to calculate average			
		6. S (Safety) a safety precaution is mentioned	a safety precaution is mentioned linked to a specific named hazard				

15

B

8	a	Li ⁺			Accept no superscript Do not accept Li ¹⁺ or Li ⁺¹	1	A																		
	b	1714.28 (moles) 1714.3 (to 1 dp)			Award 1 mark for 1.7		2																		
	c	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr> </thead> <tbody> <tr> <td>Env (Environmental)</td><td>comment about lithium-ion batteries or crude oil</td><td>comment about lithium-ion batteries and crude oil</td><td>statement of advantage and disadvantage for lithium-ion or petrol or statement of advantage or disadvantage for lithium-ion and petrol</td><td>statement of advantage and disadvantage of lithium-ion and crude oil</td></tr> <tr> <td>Soc (Social impacts)</td><td>a social impact of lithium-ion batteries or crude oil</td><td>a social impact of lithium-ion batteries and crude oil</td><td>a social impact of lithium-ion batteries and crude oil and an additional impact of either</td><td></td></tr> <tr> <td>App (Appraisal)</td><td>a choice is stated</td><td>a choice is stated with further justification</td><td></td><td></td></tr> </tbody> </table>					1	2	3	4	Env (Environmental)	comment about lithium-ion batteries or crude oil	comment about lithium-ion batteries and crude oil	statement of advantage and disadvantage for lithium-ion or petrol or statement of advantage or disadvantage for lithium-ion and petrol	statement of advantage and disadvantage of lithium-ion and crude oil	Soc (Social impacts)	a social impact of lithium-ion batteries or crude oil	a social impact of lithium-ion batteries and crude oil	a social impact of lithium-ion batteries and crude oil and an additional impact of either		App (Appraisal)	a choice is stated	a choice is stated with further justification		
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9			1	2	3	4		
		Economic aspects	a comment about an economic impact	a statement about an economic impact linked to the linear economy or the circular economy	a statement about an economic impact linked to the linear economy or the circular economy with justification	a statement about an economic impact linked to the linear economy and the circular economy with justification		
		Use of resources	a comment about use of resources	a statement about use of resources linked to the linear economy or the circular economy	a statement about use of resources linked to the linear economy or the circular economy with justification	a statement about use of resources linked to the linear economy and the circular economy with justification		
		Social impacts	a comment about a social impact	a statement about social impacts linked to the linear economy or the circular economy	a statement about social impacts linked to the linear economy and the circular economy			
		A concluding appraisal	a concluding appraisal is given					
							12	D

Markscheme

May 2021

Chemistry

On-screen examination

14 pages

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	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Horizontal wavy line that can be expanded
	Highlight tool that can be expanded to mark an area of a response

Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

Markscheme instructions

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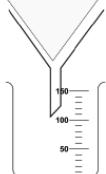
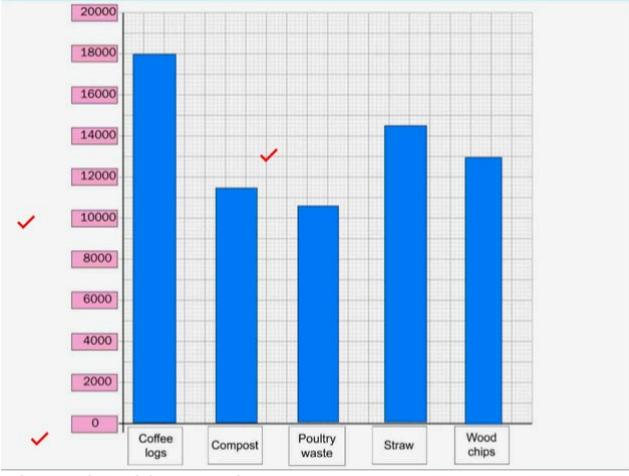
Question	Answers	Notes	Total	Criterion
1	a Magnesium <input type="button" value="2 electrons ▾"/>		1	A
	b Group 4 Period 3	Allow 14, IVA	2	A
	c <input type="button" value="Transition metals ▾"/>		1	A
	d H atom has one electron (in outer shell so is electronically unstable) H atoms need to share electrons in order to gain stability or to obtain the electron configuration of a noble gas He (already) has a full outer shell of electrons or complete outer shell (so) there is no need for He to share electrons or does not react or does not bond or is already stable	Accept "stable electron shell", "noble gas configuration", "complete duplet" Do not accept "balanced". Ignore "octet"	4	A
	e <input type="button" value="c ▾"/>		1	A
2	a Mass number: number of protons + number of neutrons or $A = p^+ + n^0$ Mass number = 17	Seen or implied <i>No ECF from first marking point, award two marks for 17 alone</i> Max 1 if g added	2	A
	b Accept any reasonable response related to oxygen, for example [max 1] <ul style="list-style-type: none"> • oxygen can be produced from decomposition of CO_2 • depends on the amount of water that decomposes • oxygen formed may not be enough for any kind of biological process to occur • reference to O_2 being in organic molecules 	<i>Do not accept that oxygen is in water as this is in the question</i>	1	A

	c	46	<i>Ignore units if present</i>	1	A
	d	Top of the range = 7 Range expressed precisely between 4.3-4.5 to 7	<i>Award two marks for correct answer</i>	2	A
	e	The temperature is higher or there is more heat or more energy on the surface of exoplanets that are closer to the star they orbit (so) at higher temperatures the rate of the reaction increases		2	A
	f	Catalysts increase the rate of a reaction or speed up a reaction Any further additional point from the list [max 1] <ul style="list-style-type: none"> • reaction using a catalyst has a lower (activation) energy • reaction using a catalyst reduces (activation) energy • reaction using a catalyst takes place by an alternative path • the catalyst is not used up or consumed 		2	A
	g	Accept any two reasonable suggestions, for example [max 2] <ul style="list-style-type: none"> • collect materials that may be useful on the Earth • collect materials that may give information about the origin of the structure or the atmosphere of the Moon or the universe • search for water • enable possible human settlement in the future • collect materials to look for signs of life • political control of the moon • the Moon could be used as a base for exploring other planets 		2	D

3	a	A: Solid B: Liquid		2	A
	b	Pentane Alkane	ECF for alkene if pentene was stated as the name of the hydrocarbon	2	A
	c	$\text{C}_5\text{H}_{12}(\text{l}) + 8 \text{O}_2(\text{g}) \rightarrow 5 \text{CO}_2(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$ Reactants correctly balanced Products correctly balanced	Do not accept ? for pentane	2	A
	d	Increase The wax or fuel will not move away from the wick (and so) will remain to allow the candle to burn for a longer time or Increase The metal will remove the heat (and so) the wax will not melt and be available to burn or Decrease The wax is contained (and so) it is available to burn	Do not award the first marking point alone WTTE Or reference to wick will burn longer	3	B

e	1.06×10^{-1} (g min ⁻¹)	Ignore unit	1	D
f	<p>Accept any two points from the list [max 2]</p> <ul style="list-style-type: none"> • data plotted incorrectly • should show rate decreasing with height or a negative correlation • should be a scatter graph • it is continuous data • IV (altitude) should be on x axis or DV should be on y axis • number of decimal places • order of rates on the x axis • increments on the x axis 	<p><i>Accept linear or line graph</i></p>	2	C
g	<p>Accept any two reasons from the list [max 2]</p> <ul style="list-style-type: none"> • different weather or location • different equipment • available oxygen or air composition <p>Correctly linked suggestion of how the result would be affected [max 2]</p> <ul style="list-style-type: none"> • effect of specific weather type or location correctly linked to rate • effect of different equipment correctly linked to rate • rate of combustion 	<p>WTTE <i>Different aspects of equipment can be credited twice</i> <i>Do not accept different type of wax</i></p>	4	C

4	a	Independent variable: fragrance Dependent variable: burn time	Accept “flavour”, “ingredient”	2	B
	b	30(.0 hours) 30.0 correctly expressed to 3 sig figs	Ignore any units ECF from first marking point for transcription error	2	C
	c	The second student did not include the outlier at 24.3 hours in their average calculation	WTTE	1	C
	d	Not valid because the strawberry has a longer time to burn Accept two any additional points from the list below [max 2] <ul style="list-style-type: none"> • different containers • different masses so no direct comparison • insufficient data to test the hypothesis • in first data set would need to repeat investigation due to the 24.3 hours • different wick sizes 	Ignore references to surface area	3	C
	e	Use the same style or mass of container or candle This would give identical heat transfer characteristics or Additional trials and calculate averages Reduce random error or Use the same mass of wax Time how long the candles took to burn	<i>Do not accept trials with different fragrances as this will not improve validity</i> WTTE WTTE	2	C

5	a	 Correct arrangement visible Only filter paper and beaker selected	<p>The funnel is already provided to candidates so should not be counted as additional equipment</p> <p>Award second mark only if no other equipment is seen</p>	2	B
	b	<input type="button" value="C"/>		1	B
	c	 y axis scale with even increments y axis scale starting at zero All data correctly plotted A title linking IV with DV x axis: Type of fuel or biomass y axis: Energy / MJ Tonne ⁻¹	6	C	

	d	Exothermic		1	A
	e	<p>Reduces waste</p> <p>Reduced reliance on landfill</p> <p>or</p> <p>As a new fuel source</p> <p>Reduced reliance on fossil fuels or reduces waste</p> <p>or</p> <p>Used as fertiliser</p> <p>Reduced need for artificial fertilisers or reduces waste</p>	WTTE	2	D

		1	2	3	4		
6	Variables	some variables implied	fuel type as IV or DV as mass or one CV identified	fuel type as IV and DV as mass and one CV identified	fuel type as IV and DV as mass and temperature change identified as a CV and one additional CV identified	16	B
	Justification	set up one selected and justification that the temp change can be measured or set up two selected with no justification	set up two selected and justification that the temp change can be measured and heat losses are minimized				
	Sufficient data	reference to different fuels	all five fuels or three trials	all five fuels and three trials	all five fuels and three trials and calculates mean		
	Method	attempt at method but may be not relevant	attempt at method, insufficient detail and temperature change is mentioned but method is not likely to give relevant data	method for measuring mass of fuel burned for fixed temp change or fixed time (<5 mins) is described, could be followed, will produce relevant data	complete method for measuring mass of fuel burned for fixed temp change or fixed time (<5 mins) for all fuels is fully explained and could be replicated		
	Safety	a safety concern is mentioned	a safety concern is mentioned and linked to a specific hazard				

7	a	Australia (and Oceania)			1	C
	b	2150 +/-100 Billion and m ³ or cubic metres			2	C
	c	Population increase		<i>Do not accept increasing industrialization alone</i>	1	C
	d	<p>Pore size ▾</p> <p>The pores of the filter need to be smaller than the material that is being separated out</p>		<i>WTTE</i>	2	D
e	Advantages and disadvantages	1 an advantage or disadvantage of CCU (ORA)	2 an advantage and disadvantage of CCU (ORA)	3 an advantage and disadvantage of CCU (ORA) with either supported by scientific reasoning	4 an advantage and disadvantage of CCU (ORA) with both supported by scientific reasoning	6 D
	Justification	a simple justification	a simple justification with supporting evidence			

8		1	2	3	4		
	Economic comparison	a statement comparing two technologies	a statement comparing all three technologies or a statement comparing two technologies with supporting evidence	a statement comparing all three technologies with supporting evidence using data			
	Environmental	one impact on the environment is implied	a statement of one impact on the environment for one technology	a statement of one impact on the environment of at least two technologies	a statement of one impact on the environment of all three technologies		
	Not suitable	one technology is supported with a reason (may be incorrect)	micro and ultrafiltration are not suitable as heavy metals are not removed				
	Social considerations	a statement of a social impact	a statement of a social impact with supporting evidence				
	Appraisal	a concluding appraisal	a concluding appraisal linking the issues discussed				

13

D

Markscheme

November 2022

Chemistry

On-screen examination

15 pages

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Annotation	Explanation
NGE	Not good enough
0	The candidate has given a response but it is not worthy of any marks
T	Test box used for additional marking comments
SEEN	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
WTE	Words to that effect
✓ 1 ✓ 2 ✓ 3 ✓ 4	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

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Question	Answers	Notes	Total	Crit
1	a Transition metals		1	A
	b Period 4		1	A
	c An isotope is an atom with same number of protons and electrons  (but) different number of neutrons.	<i>Award 1 mark for same atomic number but different mass number</i>	2	A
	d Neutrons = 36  Electrons = 29		2	A
	e Alloy		1	A
	f Greater resistance to corrosion (so) it won't deteriorate  <i>or</i>  High enough melting point so (so)that it can be made into moulds  <i>or</i>  Makes a hard substance (so) it can be made into objects that won't be easily destroyed  <i>or</i> Is malleable (so) it can be made into statues	<i>Accept due to weather affects</i>	2	A

<b>2</b>	a	Oxidation		<b>1</b>	A															
	b	A ▾		<b>1</b>	A															
	c	$4Fe$ $3O_2$ $2Fe_2O_3$		<b>3</b>	A															
	d	$n(Fe) = m / MM = 0.60 / 56$  $n(Fe) = 0.011 \text{ mol}$  $0.011/4$  $(0.00275) \times 3 = 0.00825 \text{ mol}$	<i>ECF from part c</i>  Award mp 3 for 0.023/4 (if 26 is used)  Award mp 4 for 0.1725 (if 26 is used)  Award 1 mark if ratio 4/3 stated	<b>4</b>	A															
	e	<p>Table Object</p> <table border="1"> <thead> <tr> <th>Substance</th> <th>State at room temperature</th> <th>Soluble in water</th> <th>Conductivity at room temperature</th> </tr> </thead> <tbody> <tr> <td>Chlorine</td> <td>Gas</td> <td>Slightly</td> <td>No</td> </tr> <tr> <td>Iron</td> <td>Solid</td> <td>No</td> <td>Yes</td> </tr> <tr> <td>Iron (III) chloride</td> <td>Solid</td> <td>Yes</td> <td>No</td> </tr> </tbody> </table> <p>One substance correctly identified All substances correctly identified</p>	Substance	State at room temperature	Soluble in water	Conductivity at room temperature	Chlorine	Gas	Slightly	No	Iron	Solid	No	Yes	Iron (III) chloride	Solid	Yes	No		<b>2</b>
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Chlorine	Gas	Slightly	No																	
Iron	Solid	No	Yes																	
Iron (III) chloride	Solid	Yes	No																	
f	2, 8, 7 <b>or</b> $1s^2 2s^2 2p^6 3s^2 3p^5$		<b>1</b>	A																

	g	Iron loses electrons <b>or</b> forms positive ions/cations  Chlorine gains electrons <b>or</b> forms negative ions/anions  Forming an ionic bond  (because of the) electrostatic attraction <b>or</b> attraction between the <u>opposite</u> charged ions		4	A
	h	Corrosive ▼		1	D

3	a	evidence of an average calculation  Correctly rounded to 2.93	<i>Do not award this mark for an incorrect value even if correctly stated to 3 sig figs</i>	2	C D
	b	pH probe gives numerical/quantitative data or data to 3 sig figs  Indicator paper gives a range of colours or a range of pH <b>or</b> qualitative data  Measured pH is dependent on interpretation of a scale  (so) pH probe gives more valid data	<i>Only award the third mark if the first two marks are awarded</i>	3	C
	c	Lemon juice  The largest increase in pH		2	C

d	<table border="1"> <thead> <tr> <th></th><th>1</th><th>2</th><th>3</th><th>4</th></tr> </thead> <tbody> <tr> <td><b>Variables</b></td><td>some variables implied</td><td>size as IV <b>or</b> final mass or pH or volume of gas as DV <b>or</b> one CV identified</td><td>size as IV <b>and</b> final mass or pH or volume of gas as DV <b>and</b> one CV identified</td><td>size as IV <b>and</b> final mass or pH or volume of gas as DV <b>and</b> at least two CV identified</td></tr> <tr> <td><b>Equipment</b></td><td>correct equipment to measure IV <b>or</b> DV <b>or</b> CV</td><td>two pieces of correct equipment to measure IV <b>or</b> DV <b>or</b> CV</td><td>correct equipment to measure IV <b>and</b> DV <b>and</b> CV</td><td></td></tr> <tr> <td><b>Sufficient data</b></td><td>reference to different sizes</td><td>at least five sizes <b>or</b> three trials</td><td>at least five sizes <b>and</b> three trials</td><td>at least five sizes <b>and</b> three trials <b>and</b> calculates mean</td></tr> <tr> <td><b>Method</b></td><td>attempt at method but may be not relevant</td><td>attempt at method, insufficient detail about IV, DV or CVs so method is not likely to give relevant data</td><td>method is described, could be followed for IV, DV and CVs and will produce relevant data</td><td>complete method for IV, DV and CVs is fully explained and could be replicated</td></tr> <tr> <td><b>Safety</b></td><td>a safety concern is mentioned</td><td>a safety concern is mentioned and linked to acidity</td><td></td><td></td></tr> </tbody> </table>		1	2	3	4	<b>Variables</b>	some variables implied	size as IV <b>or</b> final mass or pH or volume of gas as DV <b>or</b> one CV identified	size as IV <b>and</b> final mass or pH or volume of gas as DV <b>and</b> one CV identified	size as IV <b>and</b> final mass or pH or volume of gas as DV <b>and</b> at least two CV identified	<b>Equipment</b>	correct equipment to measure IV <b>or</b> DV <b>or</b> CV	two pieces of correct equipment to measure IV <b>or</b> DV <b>or</b> CV	correct equipment to measure IV <b>and</b> DV <b>and</b> CV		<b>Sufficient data</b>	reference to different sizes	at least five sizes <b>or</b> three trials	at least five sizes <b>and</b> three trials	at least five sizes <b>and</b> three trials <b>and</b> calculates mean	<b>Method</b>	attempt at method but may be not relevant	attempt at method, insufficient detail about IV, DV or CVs so method is not likely to give relevant data	method is described, could be followed for IV, DV and CVs and will produce relevant data	complete method for IV, DV and CVs is fully explained and could be replicated	<b>Safety</b>	a safety concern is mentioned	a safety concern is mentioned and linked to acidity			17 B
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e	<p><b>Research question to include IV:</b> Thickness of coating</p> <p><b>DV: accept any relevant DV for example [max 1]</b></p> <ul style="list-style-type: none"> <li>• change in mass of marble (chips)</li> <li>• volume of gas produced</li> <li>• detail or colour of sculpture</li> <li>• pH change</li> </ul>																															

4	a	<p><b>IV:</b> Number of teaspoons <b>or</b> amount of baking soda</p> <p><b>DV:</b> Number of candles extinguished</p> <p><b>Accept any reasonable CV, for example [max 1]</b></p> <ul style="list-style-type: none"> <li>• volume of vinegar</li> <li>• type or size of teapot</li> <li>• distance between the spout and the top of the flame</li> </ul>	<p><i>Accept quantity for volume</i></p>	3	B
	b	<p>If the mass of baking soda increases</p> <p>Then more candles will be extinguished</p> <p>Because more carbon dioxide is produced</p>		3	B
	c	<p><b>Accept any two reasonable limitations, for example [max 2]</b></p> <ul style="list-style-type: none"> <li>• Mass of baking soda was not measured</li> <li>• Need to replace the lid of the teapot quickly</li> <li>• Distance between spout and candle is not specified</li> <li>• Only one trial for each mass or no calculation of average</li> </ul>		2	C
	d	<p><b>Accept any reasonable suggestion, for example [ max 1]</b></p> <ul style="list-style-type: none"> <li>• Concentration of acid</li> <li>• Type of acid</li> <li>• Volume of acid</li> <li>• Surface area of carbonate</li> <li>• Temperature of solution</li> </ul>	<p><i>Accept quantity of acid</i></p>	1	C

	e	<p><b>Table Object</b></p> <table border="1"> <thead> <tr> <th>Mass of baking soda / g</th><th>Number of candles extinguished</th></tr> </thead> <tbody> <tr><td>1</td><td>2</td></tr> <tr><td>2</td><td>4</td></tr> <tr><td>3</td><td>6</td></tr> <tr><td>4</td><td>8</td></tr> <tr><td>5</td><td>9</td></tr> </tbody> </table> <p>Table with two columns Headers: Mass (of baking soda) <b>and</b> g <b>and</b> number of candles Data in order and units in the header only</p>	Mass of baking soda / g	Number of candles extinguished	1	2	2	4	3	6	4	8	5	9	Accept % candles extinguished	3	C
Mass of baking soda / g	Number of candles extinguished																
1	2																
2	4																
3	6																
4	8																
5	9																
	f	<p>y axis scale with even increments <b>and</b> y axis scale starting at zero All data correctly plotted A line of best fit with approximately the same number of points above and below the line <b>x axis:</b> Mass (of baking soda) <b>and</b> <b>y axis:</b> number of candles (extinguished) Unit included with baking soda label</p>	<i>Mp3 can be awarded for incorrectly plotted data</i> <i>ECF for Y axis from 4e</i>	5	C												

<b>5</b>	<b>a</b>	<p>The hanging extinguisher is the heaviest <b>and</b> can extinguish an area of $3\text{ m}^2$</p> <p>The largest area that can be extinguished is $35\text{m}^2$ by the ball (which is not the heaviest)</p> <p>(so) the research statement is not valid</p>	<i>ORA. Must include data in the response</i>  <i>do not award the third mark unless the first two marks are awarded</i>	<b>3</b>	C
	<b>b</b>	<p>Fire extinguisher ball</p> <p><b>Accept any two reasonable justifications, for example [ max 2]</b></p> <ul style="list-style-type: none"> <li>• Dropped from a high</li> <li>• Does not need to be in a fixed space or manually operated</li> <li>• Extinguishes over a large area</li> <li>• Lightweight to store and transport</li> <li>• Less maintenance than the other dry powders, types or low maintenance</li> </ul>		<b>3</b>	C
	<b>c</b>	Exothermic		<b>1</b>	A

<b>6</b>	<b>a</b>	Adenosine: Alcohol ▼ Caffeine: Alkene ▼					<b>2</b>	<b>A</b>		
	<b>b</b>									
		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>					
	<b>Importance of sleep</b>	a general statement about the importance of sleep	a statement about the importance of sleep <b>and</b> one specific example relevant to driving a bus				<b>13</b>	<b>D</b>		
	<b>Sleep quality</b>	one impact of one spray on sleep quality implied	one impact of one spray on sleep quality explicitly stated	comparison of impact of more than one spray on sleep quality explicitly stated	comparison of impact of more than one spray on sleep quality explicitly stated <b>and</b> linked to data					
	<b>Economic</b>	a general statement of an economic consideration	a statement of an economic consideration of one spray	comparison of economic considerations of more than one spray <b>or</b> economic consideration of one spray with supporting evidence	comparison of economic considerations of more than one spray with complete supporting evidence					
	<b>Final choice</b>	a final choice is stated	a final choice is evaluated	a final choice is evaluated by linking impact of spray with economic considerations						

7		1	2	3	4		
	<b>Social impact</b>	A social impact for one extract is identified	A social impact is identified for both extracts	A social impact is identified for both extracts with supporting evidence			
	<b>Environmental impact</b>	An environmental impact is implied	An environmental impact for one extract is stated	An environmental impact for both extracts is stated	An environmental impact for both extracts is stated with supporting evidence		
	<b>Final choice</b>	final choice is stated	final choice is stated with justification				

# Markscheme

May 2022

Chemistry

On-screen examination

15 pages

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	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Horizontal wavy line that can be expanded
	Highlight tool that can be expanded to mark an area of a response

<b>Annotation</b>	<b>Explanation</b>
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Test box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

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- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA* (*or reverse argument*) in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE* (*or words to that effect*) in the Notes column.

- 16** When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.
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- 20** Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question	Answers	Notes	Total	Crit
1	a Unreactive		1	A
	b Aluminium oxide or Aluminium (III) oxide $\text{Fe}_2\text{O}_3$	Subscripts must be present	2	A
	c Chlorine <b>or</b> Cl		1	A
	d Mass number = number of protons + number of neutrons  Mass number is 37	<i>Evidence of this calculation ECF from part c</i>  <i>Award 2 marks for correct answer with no additional working required. Ignore units if present.</i>	2	A
	e Molar mass of water = 18 (g mol ⁻¹ )  (so) 5 mole CaSO ₄ .2H ₂ O contains 10 moles H ₂ O  (so) 180 g water	  <i>Unit required for third mark. Award 3 marks for correct answer and unit if no working is seen.</i>	3	A
2	a Copper <b>and</b> Cu <b>or</b> Tungsten <b>and</b> W <b>or</b> Gold <b>and</b> Au		1	A
	b Calcium <b>or</b> Ca		1	A

	<b>c</b>	Mass of Na ₂ O=5.3 (g)  Molar mass of Na ₂ O = 62  (Moles of Na ₂ O in sample =) 0.0854838...  0.085	<i>ECF if molar mass is incorrect</i>	<b>4</b>	A  D
	<b>d</b>	B		<b>1</b>	A
	<b>e</b>	pH=2.1		<b>1</b>	A
	<b>f</b>	39 <b>and</b> °C  (+) 14 (°C)	<i>Do not accept just degrees, C alone can be accepted</i>  <i>Award 1 mark for 15 (ECF from incorrect reading of meniscus in first marking point)</i>	<b>2</b>	A
	<b>g</b>	Exothermic		<b>1</b>	A
	<b>h</b>	$2 \text{HF} + \text{Ca(OH)}_2 \rightarrow \text{CaF}_2 + 2\text{H}_2\text{O}$  <b>Reactant coefficient:</b> 2HF  <b>Product coefficient:</b> CaF ₂  <b>Product:</b> CaF ₂  <b>Product coefficient:</b> 2H ₂ O	<i>Do not award mark if ? is present</i>	<b>4</b>	A

3	a	C		1	D
	b	A		1	A
	c	4-6 (%)		1	C
	d	6 (hours) <b>or</b> more than 6 hours		1	C
	e	(Two-step process) because it removes more or more efficient at removing bacteria during this time  4 hours and over		Ref to two-step process can be implied  Only award the second mark if the first mark is awarded	2 C
4	a	Collect gas in a test tube  It relights a glowing splint	<i>Do not accept a lit split Accept use of Oxygen probe</i>	2	A
	b	If the catalyst is a solution  Then the rate of decomposition will be higher  <b>Third marking point from the list [max 1]</b> <ul style="list-style-type: none"><li>• because the number of collisions is higher</li><li>• greater chance of collision</li><li>• higher frequency of collision</li><li>• particles can move more freely</li></ul>	<i>ORA for solid catalyst  Do not award the first marking point without correct link to the second marking point</i>	3	B
	c	IV: (type of) catalyst used  DV: time for flame to burn <b>or</b> stop burning  <b>Accept any two reasonable CV, for example [max 2]</b> <ul style="list-style-type: none"><li>• mass <b>or</b> volume of catalyst</li><li>• volume of H₂O₂ used</li><li>• type of fuel used</li><li>• mass of fuel used</li><li>• how the fuel is lit</li></ul>	<i>WTTE. Do not accept rate  Do not accept amount or quantity or equipment</i>	4	B

d	<p><b>First explanation linked to rate of production, for example [max 1]</b></p> <ul style="list-style-type: none"> <li>as the rate of decomposition would be faster for the best catalyst</li> <li>(so) the burn time would be shorter for the best catalyst</li> <li>a longer burn would come from a smaller rate of reaction</li> </ul> <p><b>Second explanation linked to oxygen, for example [max 1]</b></p> <ul style="list-style-type: none"> <li>total volume of oxygen would be the same for all catalysts</li> <li>steady burning does not necessarily mean it is the fastest rate of oxygen production</li> <li>a good catalyst might produce oxygen too quickly for it to be burnt</li> </ul> <p><b>Final mark:</b> (so) the hypothesis is invalid</p>	WTTE	3	C
e	<p>Average volume = 44 (cm³)</p> <p>Value of rate: 44/30=1.47 (accept 1.5)</p> <p>Unit of rate: cm³s⁻¹</p>	<p><i>ECF from first marking point</i></p> <p>Accept cm³/s or ml/s, 88.2 cm³min⁻¹</p>	3	C
f	<p><b>Accept any two errors, for example [max 2]</b></p> <ul style="list-style-type: none"> <li>the stopper is not inserted into the test tube</li> <li>the tubing is not in the eudiometer</li> <li>the eudiometer was not filled up completely with water</li> <li>the timing was longer than 30 seconds</li> </ul> <p><b>Correctly linked justification [max 1]</b></p> <ul style="list-style-type: none"> <li>the volume of gas collected will be too low as not enough water displaced</li> <li>(Not filled with water) the volume of the gas will be too high</li> <li>(the length of the trial was too long) so more gas was collected</li> </ul>		3	C

5		1	2	3	4		
	Variables	A variable is identified	Independent variable <b>and</b> dependent variable identified	Independent variable <b>and</b> dependent variable identified <b>and</b> one control variable is stated			
	Additional equipment	One piece of additional equipment (not stopwatch, eudiometer, test tube) is listed	One piece of equipment to measure the catalyst <b>and</b> one piece of additional equipment	Balance to measure mass of catalyst <b>and</b> equipment to measure the volume of H ₂ O ₂			
	Method	Attempt at a method	States how one CV will be controlled	States how one CV will be controlled <b>and</b> their method can be repeated but the data will not be valid	States how their CV will be controlled <b>and</b> can be replicated to give valid data <b>and</b> clearly states how rate will be calculated from measured data		
	Data	One catalyst is investigated	All catalysts are investigated	All catalysts are investigated with at least 3 repeats	All catalysts are investigated with repeats <b>and</b> plans to calculate means		
	Safety	A safety precaution is stated	A safety precaution is stated <b>and</b> linked to oxidizing hazard or flammability				

16

B

6	a	<p>as the length of time increases hydrogen peroxide reacts with the hair more <b>or</b> the hair becomes lighter as it is in contact for more time <b>or</b> more collisions <b>or</b> If the hair is darker it will take longer to become lighter More pigment removed The hair changes colour more</p>		WTTE	3 C												
	b	<table border="1"> <caption>Data points estimated from the scatter plot</caption> <thead> <tr> <th>Concentration (x)</th> <th>Signal Strength (y)</th> </tr> </thead> <tbody> <tr><td>1</td><td>500</td></tr> <tr><td>2</td><td>1500</td></tr> <tr><td>3</td><td>2000</td></tr> <tr><td>4</td><td>3000</td></tr> <tr><td>6</td><td>4000</td></tr> </tbody> </table> <p>At least five data points plotted correctly Title linking x and y Concentration on x axis and signal strength on y axis Scale with even increments Concentration <b>and</b> %</p>	Concentration (x)	Signal Strength (y)	1	500	2	1500	3	2000	4	3000	6	4000		<p>Y axis does not need to start at 0 <i>Ignore any line of best fit if present</i></p>	5 C
Concentration (x)	Signal Strength (y)																
1	500																
2	1500																
3	2000																
4	3000																
6	4000																

c	3500 +/- 200	ECF from part b	1	C
d	<p><b>First marking point</b> Average does not give the value of an individual bottle <b>or</b> The average is not a reliable measure of concentration (of each bottle) <b>or</b> The average gives no info about range of concentrations</p> <p><b>Second marking point</b> (so) the concentration in each bottle could be higher or lower than the average</p>		2	C

7	<b>a</b>	<b>Accept any reasonable response, for example [max 1]</b> <ul style="list-style-type: none"> <li>• malleable</li> <li>• easy to fold</li> <li>• strong</li> <li>• keeps its shape</li> <li>• can be coloured</li> </ul>		1	A
	<b>b</b>	<b>Accept any reasonable response, for example [max 1]</b> <ul style="list-style-type: none"> <li>• waterproofing</li> <li>• wo give a glossy appearance</li> <li>• to protect (from air, heat)</li> </ul>	<i>Ignore “stronger”</i>	1	D
	<b>c</b>	(When using hydrogen peroxide the) Oxygen produced is not toxic <b>or</b> (Use of chlorine) a toxic gas is produced	<i>Do not accept chlorine is toxic</i>	1	D
	<b>d</b>	An advantage of papyrus  A disadvantage of papyrus  An advantage of acid-free paper  A disadvantage of acid-free paper  A conclusion is stated  Further justification of the conclusion		6	D

8		<b>1 mark</b>	<b>2 marks</b>	<b>3 marks</b>	<b>4 marks</b>	
	Env (Environment)	one impact on the environment is implied	one impact on the environment is stated and linked to one type of paper production <b>or</b> same impact on the environment is stated for both types of paper production	comparison of one impact on the environment for both types of paper production is stated <b>or</b> two impacts on the environment for one type of paper production are stated	comparison of more than one impact on the environment is stated for both types of paper production	
	Eco (Economy)	one impact on the economy is implied	one impact on the economy is stated and linked to one type of paper production <b>or</b> one impact on the economy for both types of paper production is stated	comparison of one impact on the economy for both types of paper production is stated <b>or</b> two impacts on the economy for one type of paper production is stated	comparison of more than one impact on the economy is stated for both types of paper production	10 D
	Con (Conclusion)	a conclusion is stated	conclusion is stated with justification			

9	<p><b>Accept any reasonable advantage of paper, for example [max 1]</b></p> <ul style="list-style-type: none"><li>• preservation of cultural knowledge and memory</li><li>• accessible without technology</li></ul> <p><b>Accept any reasonable advantage of electronic information storage, for example [max 1]</b></p> <ul style="list-style-type: none"><li>• easily accessible</li><li>• interactive</li><li>• safe storage</li></ul> <p><b>Accept any reasonable disadvantage of paper, for example [max 1]</b></p> <ul style="list-style-type: none"><li>• paper degrades</li><li>• can be destroyed or lost or stolen</li><li>• it can be hard to find or search information</li></ul> <p><b>Disadvantage of electronic information storage, for example [max 1]</b></p> <ul style="list-style-type: none"><li>• technology may advance so information may not be accessible</li><li>• it can be deleted or manipulated</li><li>• it is not healthy to use technology all the time</li></ul> <p>Conclusion stated</p> <p>Justification of conclusion linked to culture</p>		6	D
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# Markscheme

**May 2023**

**Chemistry**

**On-screen examination**

12 pages

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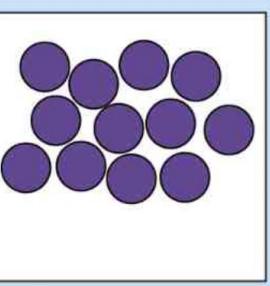
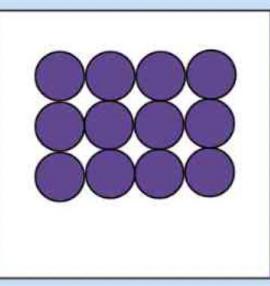
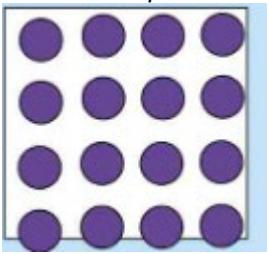
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Question		Answers	Notes	Total	Crit.									
1	a	Exothermic		1	A									
	b	$\text{C}_3\text{H}_8 + 5 \text{ O}_2 \rightarrow 3 \text{ CO}_2 + 4 \text{ H}_2\text{O}$  Reactants correct Products correct		2	A									
	c	(Molecule) A: Alcohol <b>or</b> alkanol  (Molecule) B: Carboxylic acid <b>or</b> organic acid	Correctly named molecules: ethanol and methanoic acid  Both alcohols= CON award 0	2	A									
	d	Particles of powdered coal have a greater surface area (than when using lumps)  Rate of reaction is faster  Energy is released more quickly (than when using lumps)	ORA  WTTE	3	A									
2	a	<table border="1"> <tr> <td></td><td>Ga</td><td>As</td></tr> <tr> <td>Group</td><td>3</td><td>5</td></tr> <tr> <td>Period</td><td>4</td><td>4</td></tr> </table>		Ga	As	Group	3	5	Period	4	4		2	A
	Ga	As												
Group	3	5												
Period	4	4												
b	No emissions from solar (compared with fossil fuels)  <b>Accept any additional reasonable point, for example [max 1]</b> <ul style="list-style-type: none"> <li>• solar is renewable <b>and</b> fossil fuels are finite</li> <li>• no mining is needed for solar (unlike fossil fuels)</li> <li>• solar panels are available worldwide (and fossil fuels are not)</li> <li>• local legislation promotes use of renewable fuel source</li> </ul>		2	A										
c	A		1	A										
d	Both have same number of electrons in the outer/valence shell/energy level or are in the same group  (Valence) electrons pair up or share electrons  to form 4 <u>covalent</u> bonds		3	A										

3	a	More reactive metals will produce hydrogen more quickly <b>or</b> higher rates  The metals react differently because they have different reactivities	ORA	2	A
	b	Speeds up the rate of reaction  By lowering the activation energy <b>or</b> providing an alternative pathway  Without being used up		3	A
	c	Molar mass of methane = 16 seen anywhere  8kg methane = 500 moles  1 mole methane reacts to produce 3 moles of H ₂  Moles of hydrogen produced= 1500 (mol)	ECF  <i>Marking point 3 can be implied</i>	4	A
	d	<b>Accept any reasonable suggestion, for example [max 1]</b> <ul style="list-style-type: none"> <li>• Ammonia is not flammable</li> <li>• Ammonia is less reactive</li> <li>• Ammonia has a distinct smell so leaks can be detected</li> <li>• No more carbon dioxide is used in the (transportation) process/ carbon neutral</li> </ul>	ORA for answers correctly referencing hydrogen	1	D
	e	<b>Accept any reasonable benefit</b> <ul style="list-style-type: none"> <li>• reduction in environmental damage from mining</li> <li>• reduction in effects of climate change</li> <li>• reduced risk of leaks of carbon dioxide</li> </ul> <b>Accept any linked justification</b> <ul style="list-style-type: none"> <li>• the calcium carbonate – non-renewable material – is produced instead of quarried.</li> <li>• carbon dioxide is not released into the atmosphere</li> <li>• the CO₂ from the production of H₂ is being used instead of stored underground</li> </ul>		2	D

4	a	<p><b>Liquid:</b> irregular arrangement of at least 9 molecules fairly close together with at least two in contact</p>  <p>Before freezing</p> <p><b>Solid:</b> Regular arrangement of at least 9 molecules in contact</p>  <p>After freezing</p>		2	A
b		<p>Measurement 55 ($\mu\text{m}$) $\pm$ 5</p> <p>Conversion $5.5 \times 10^{-5}$ (m)</p>	<p><b>Do not accept the following for a solid</b></p> 	2	C
	c	<p>X axis label: Temperature <b>and</b> $^{\circ}\text{C}$</p> <p>Y axis label: Percentage of ice cream frozen</p> <p>Two points plotted correctly</p> <p>All data plotted correctly</p>		4	C

	<b>d</b>	-6 ±0.5 °C	<i>Minus sign must be included to award the mark</i>	<b>2</b>	<b>C</b>
	<b>e</b>	If the temperature is lower  Then the texture will be smoother  Because the ice crystals are smaller <b>or</b> because the ice crystals have formed more quickly	WTTE, ORA  <i>Marking points 2 and 3 must be correctly linked to temperature</i>	<b>3</b>	<b>B</b>
	<b>f</b>	<b>Accept any reasonable suggestion, for example [max 1]</b> <ul style="list-style-type: none"><li>• use same units are used (for different liquids)</li><li>• all data should have a consistent precision</li><li>• include the units in the heading</li><li>• include mean value</li></ul>		<b>1</b>	<b>C</b>
	<b>g</b>	Milk does not melt the quickest <b>or</b> water is the quickest  So the hypothesis is invalid	<i>Do not award the second mark unless the first is awarded, ORA</i>	<b>2</b>	<b>C</b>

5	a	RQ linking surface area of the ice <b>and</b> time taken for the ice to melt (with salt)	<i>Do not accept form of ice for surface area</i>	1	B
	b	IV: The surface area of the ice  DV: The time taken for the ice to melt  <b>Accept any two reasonable control variables, for example [max 2]</b> <ul style="list-style-type: none"><li>• mass of salt</li><li>• type of salt used</li><li>• mass of ice</li><li>• size of test tube</li><li>• room temperature</li></ul>	<i>Do not accept amount</i>	4	B
	c	<b>Accept any reasonable suggestion, for example [max 1]</b> <ul style="list-style-type: none"><li>• the student could use the same mass of ice</li><li>• the student should use the same surface area</li><li>• use more values of IV</li><li>• carry out more trials</li></ul>		1	C
	d	Percentage of ice remaining 53(.33%)  Percentage of ice melted 31(.03%)  Both values correctly rounded to 31.03(%) <b>and</b> 53.33(%)		3	C
	e	This was the control <b>or</b> reference to which all the other substances could be compared	WTTE	1	C
	f	<b>Any substance above -45°C on the scale:</b> <ul style="list-style-type: none"><li>• urea</li><li>• sodium chloride</li><li>• calcium magnesium acetate</li><li>• magnesium chloride</li></ul> Because if temperatures reach -45°C the ice would not melt and so remain on the runway.		2	C
	g	Potassium acetate  Only substance which does not include chloride <b>and</b> works below -45°C		2	C

	<b>h</b>	<p><b>Accept any two relevant points, for example [ max 2]</b></p> <ul style="list-style-type: none"> <li>surface area differences</li> <li>airports use natural snow</li> <li>structures are different</li> </ul> <p><b>Accept any reasonable, linked justification [ max 1]</b></p> <ul style="list-style-type: none"> <li>machine-made snow is more compact compared to natural</li> <li>de-icers might pass through natural snow but act on the surface of machine-made snow</li> </ul>	<b>3</b>	<b>C</b>
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<b>6</b>	<b>a</b>	Toxic		<b>1</b>	<b>D</b>																													
	<b>b</b>	<table border="1"> <thead> <tr> <th></th> <th><b>1</b></th> <th><b>2</b></th> <th><b>3</b></th> <th><b>4</b></th> </tr> </thead> <tbody> <tr> <td><b>Variables</b></td> <td>some variables implied</td> <td>salt as IV <b>or</b> DV as time to melt <b>or</b> mass of ice melted <b>or</b> one CV identified</td> <td>salt as IV <b>and</b> DV as time to melt <b>or</b> mass of ice melted <b>and</b> one CV identified</td> <td>salt as IV <b>and</b> DV as time to melt <b>or</b> mass of ice melted <b>and</b> mass of salt or ice as CV <b>and</b> one additional CV identified</td> </tr> <tr> <td><b>Equipment</b></td> <td>equipment to measure DV <b>or</b> monitor one CV</td> <td>equipment to measure DV <b>and</b> monitor one CV</td> <td></td> <td></td> </tr> <tr> <td><b>Sufficient data</b></td> <td>reference to different salts</td> <td>all five salts <b>or</b> three trials</td> <td>all five salts <b>and</b> three trials</td> <td>all five salts <b>and</b> three trials <b>and</b> calculates mean</td> </tr> <tr> <td><b>Method</b></td> <td>attempt at method but may be not relevant</td> <td>attempt at method but time of melting <b>or</b> mass of ice melted is not measured so is not likely to give relevant data</td> <td>method for measuring time of melting <b>or</b> mass of ice melted is described, could be followed, will produce relevant data</td> <td>complete method for measuring time of melting <b>or</b> mass of ice melted is fully explained and could be replicated</td> </tr> <tr> <td><b>Safety</b></td> <td>a safety concern is mentioned</td> <td>a safety concern is mentioned and linked to a specific hazard</td> <td></td> <td></td> </tr> </tbody> </table>		<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>Variables</b>	some variables implied	salt as IV <b>or</b> DV as time to melt <b>or</b> mass of ice melted <b>or</b> one CV identified	salt as IV <b>and</b> DV as time to melt <b>or</b> mass of ice melted <b>and</b> one CV identified	salt as IV <b>and</b> DV as time to melt <b>or</b> mass of ice melted <b>and</b> mass of salt or ice as CV <b>and</b> one additional CV identified	<b>Equipment</b>	equipment to measure DV <b>or</b> monitor one CV	equipment to measure DV <b>and</b> monitor one CV			<b>Sufficient data</b>	reference to different salts	all five salts <b>or</b> three trials	all five salts <b>and</b> three trials	all five salts <b>and</b> three trials <b>and</b> calculates mean	<b>Method</b>	attempt at method but may be not relevant	attempt at method but time of melting <b>or</b> mass of ice melted is not measured so is not likely to give relevant data	method for measuring time of melting <b>or</b> mass of ice melted is described, could be followed, will produce relevant data	complete method for measuring time of melting <b>or</b> mass of ice melted is fully explained and could be replicated	<b>Safety</b>	a safety concern is mentioned	a safety concern is mentioned and linked to a specific hazard			<b>16</b>	<b>B</b>
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8	a	1 mark	2 marks	3 marks	4 marks	12	D	
		Environment	A statement of an advantage of reclaiming  <b>or</b> A statement of two advantages of reclaiming	A statement of an advantage of reclaiming with justification  <b>or</b> A statement of two advantages of reclaiming	A statement of two advantages of reclaiming, <b>both</b> with justification			
		Economy	A statement of one impact	A statement of two impacts  <b>or</b> A statement of one impact with justification	A statement of two impacts with further justification for one			
		Individual	A statement of one impact	A statement of two impacts  <b>or</b> A statement of one impact with justification	A statement of two impacts with further justification for one			
		Appraisal	Appraisal	Appraisal with evidence				
	b	<b>Accept any reasonable suggestions, for example [max 2]</b> <ul style="list-style-type: none"><li>• extending the lifetime</li><li>• can make new clothing to suit personal preference</li><li>• less likely to discard clothing</li></ul>				Do <b>not</b> accept clothing can be repaired	2	D

# Markscheme

November 2023

Chemistry

On-screen examination

12 pages

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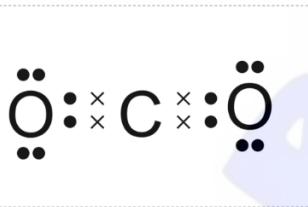
The following are the annotations available to use when marking responses.

Annotation	Explanation
	Correct point, place at the point in the response where it is clear that the candidate deserves the mark. For use in analytically marked questions only.
	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Underline tool that can be expanded
	Highlight tool that can be expanded to mark an area of a response

Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

## Markscheme instructions

- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses. Do not deduct marks for spelling errors.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the “Total” column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word “**max**” in the Answer column. Further guidance may be given in the Notes column.
- 8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.
- 9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 10 Alternative answers are indicated in the Answer column by “**or**”. Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 11 If two related points are required to award a mark, this is indicated by “**and**” in the answer column.
- 12 Words in brackets ( ) in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.
- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA (or reverse argument)* in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate’s response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE (or words to that effect)* in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.
- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate’s work should be reviewed to determine holistically the mark for each row of the holistic grid and a mark awarded for each row.

Question	Answers	Notes	Total	Crit
1 a	(The molecule) contains two atoms of oxygen		1	A
b	CO ₂	2 must be a subscript	1	A
c	 Carbon in the centre with oxygen either side Both double bonds correct (dots and crosses) Correct arrangement of lone pairs (dots) around each oxygen atom		3	A
d	$\text{CO}_2(\text{aq}) \rightleftharpoons \text{CO}_2(\text{g})$ both states correct correct equilibrium arrow	Accept either direction for equilibrium	2	D
e	The cola is less fizzy Is no longer at equilibrium or (because) some of the CO ₂ escapes The solubility of CO ₂ decreases with the temperature <i>or</i> Diffusion increases <i>or</i> The concentration of dissolved CO ₂ decreases <i>or</i> is lower		3	A

2	a	98 g mol ⁻¹	Accept g/mol	2	A
	b	0.113(93514) (moles)  0.114 (moles)	Award 2 marks if only 0.114 is seen	2	A
	c	(C ₅ H ₁₂ O ₅ )  Correct number of each type of atoms  Correct formula  Correctly expressed	Elements must be in the correct order for 3 marks	3	A
	d	<input type="button" value="Text/MCQ/Mini-Cl"/>  <input type="button" value="Carboxylic acid"/>  <input type="button" value="Text/MCQ/Mini-Cl"/>  <input type="button" value="Ester"/>		2	A

3	a	2.8.3 or $1s^2 2s^2 2p^6 3s^2 3p^1$		1	A
	b	<p><b>Accept any two properties, for example, [max 2]</b></p> <ul style="list-style-type: none"><li>• Aluminium can is less reactive</li><li>• Aluminium can is less dense or lighter</li><li>• Aluminium is more readily available</li></ul> <p><b>Accept any two correctly linked explanations, for example [max 2]</b></p> <ul style="list-style-type: none"><li>• Less likely to react with food</li><li>• Cheaper to transport</li><li>• (as) it can be recycled</li></ul>		4	A

4	a	<p>Table Object</p> <table border="1"><thead><tr><th>Temperature of water (°C)</th><th>Mass of sugar (g)</th></tr></thead><tbody><tr><td>0</td><td>200</td></tr><tr><td>20</td><td>210</td></tr><tr><td>40</td><td>250</td></tr><tr><td>60</td><td>365</td></tr><tr><td>80</td><td>370</td></tr><tr><td>100</td><td>480</td></tr></tbody></table> <p>Columns labelled as Temperature and mass Units in column header Data arranged in increasing order</p>	Temperature of water (°C)	Mass of sugar (g)	0	200	20	210	40	250	60	365	80	370	100	480	<p><i>Do not accept units with data</i></p>	3	C
Temperature of water (°C)	Mass of sugar (g)																		
0	200																		
20	210																		
40	250																		
60	365																		
80	370																		
100	480																		
	b	<p>X Axis labelled Temperature Y axis labelled mass of sugar Units included with both axis labels Three data points plotted correctly All data points plotted correctly <b>and</b> using the majority of the graph grid</p>		5	C														

<b>c</b>	C	1	C
<b>d</b>	Correct point identified 60 °C  Mass = 290±10 (g)	2	C
<b>e</b>	<p> Text Object</p> <p>Sugar inside the spinning container</p> <p> Text/MCQ/Mini-Cloze Object</p> <p>State of sugar: liquid ▾</p> <p> Text Object</p> <p>Sugar in the collection bowl</p> <p> Text/MCQ/Mini-Cloze Object</p> <p>State of sugar: solid ▾</p> <p> Text/MCQ/Mini-Cloze Object</p> <p>Sugar inside the spinning container:</p> <p>Takes the shape of the container ▾</p> <p>Sugar in the collection bowl:</p> <p>No change of shape when changing container ▾</p>	4	<i>Award ECF from first marking point for second mark for each pair</i>

5	a	<p><b>IV:</b> Time <b>or</b> duration  <b>DV:</b> How cooked or solid or white</p> <p><b>Accept any two reasonable CV, for example [max 2]</b></p> <ul style="list-style-type: none"> <li>• Size of egg</li> <li>• Type of egg</li> <li>• Temperature of water</li> <li>• Volume of water</li> <li>• Colour of shell</li> </ul>	<p>Accept ref to any change in appearance</p>	4	B
	b	<p><b>If:</b> the egg is heated <b>or</b> cooked for a longer time</p> <p><b>Then:</b> The more solid <b>or</b> white the egg will become</p> <p><b>Because:</b> there is a greater amount of chemical change</p>	WTTE	3	B
	c	<p>Sugar and protein react</p> <p>With heat</p> <p>Maillard reaction causes brown colour</p>		3	A
	d	<p>The colour would be less brown</p> <p>(as) lower temperature gives fewer changes due to Maillard reaction</p>	WTTE, accept rate is slower	2	B

6	a	The force needed to break cooked meat is higher  (so) the hypothesis is not supported	ORA  <i>Do not award the second mark unless the first is awarded</i>	2	C
	b	Lime <b>and</b> lemon <b>and</b> lime and lime (could be eaten)  The samples had breaking forces of greater than 280 N		2	C
	c	As a control <b>or</b> for direct comparison <b>or</b> as a baseline		1	C
	d	Repeat the experiment  Calculate an average		2	C
	e	What is the effect of pH on (breaking force)?	WTTE	1	B
f					
		1	2	3	4
	Variables	Either IV (pH) <b>or</b> DV (force) is identified	IV (pH) <b>and</b> DV (force) is identified		
	CV	One CV is stated	Two CV are stated		
	Equipment	Equipment to measure DV (Force meter) <b>or</b> equipment to monitor one CV	Equipment to measure DV (Force meter) <b>and</b> one CV	Equipment to measure DV (Force meter) <b>and</b> stopwatch <b>and</b> equipment to monitor one further CV	
	Method	A method is attempted	Force measured <b>and</b> at least 15 mins <b>or</b> same size of sample <b>or</b> sample is submerged in acid	Force measured <b>and</b> at least 15 mins <b>and</b> Same size of sample <b>or</b> sample is submerged in acid	Force measured <b>and</b> at least 15 mins <b>and</b> Same size samples <b>and</b> sample is submerged in acid
	Data	Measurement for one pH	3 trials for one pH <b>or</b> One trial for at least five pH	3 trials for at least 5 pH	3 trials for at least 5 pH <b>and</b> plans to calculate average
	Safety	A safety precaution is mentioned	A safety precaution explicitly linked to acidity of solutions <b>or</b> use of force meter		

7	a	2000-950 <i>or</i> 2000-900  Accept answers in the range 1050 to 1100				Award 2 marks for correct answer with no working	2	C																													
	b	<table border="1"> <tr> <td></td><td>1</td><td>2</td><td>3</td></tr> <tr> <td><b>Advantages/disadvantages (AD)</b></td><td>One production advantage or disadvantage of plant-based protein is implied</td><td>More than one production advantage or disadvantage of plant-based protein is stated</td><td>More than one production advantage or disadvantage of plant-based protein is stated with further supporting evidence for at least one</td></tr> <tr> <td><b>Nutritional Data (D)</b></td><td>One category of nutritional data is stated for both burgers</td><td>More than one category of nutritional data is compared for both burgers</td><td></td></tr> <tr> <td><b>Conclusion (C)</b></td><td>A concluding appraisal</td><td>A concluding appraisal with justification</td><td></td></tr> </table>					1	2	3	<b>Advantages/disadvantages (AD)</b>	One production advantage or disadvantage of plant-based protein is implied	More than one production advantage or disadvantage of plant-based protein is stated	More than one production advantage or disadvantage of plant-based protein is stated with further supporting evidence for at least one	<b>Nutritional Data (D)</b>	One category of nutritional data is stated for both burgers	More than one category of nutritional data is compared for both burgers		<b>Conclusion (C)</b>	A concluding appraisal	A concluding appraisal with justification		7	D														
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# Markscheme

May 2024

Chemistry

On-screen examination

17 pages

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The following are the annotations available to use when marking responses.

Annotation	Explanation
	Correct point, place at the point in the response where it is clear that the candidate deserves the mark. For use in analytically marked questions only.
	Omission, incomplete
CON	Contradiction
	Valid part (to be used when more than one element is required to gain the mark)
	Error carried forward
	Dynamic annotation, it can be expanded to surround work
	Underline tool that can be expanded
	Highlight tool that can be expanded to mark an area of a response

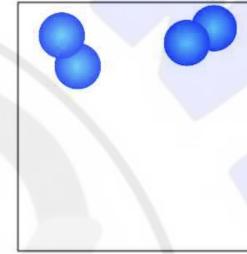
Annotation	Explanation
	Not good enough
	The candidate has given a response but it is not worthy of any marks
	Text box used for additional marking comments
	Seen; must be stamped on all blank response areas and on duplicate pages of concatenated responses
	Vertical wavy line that can be expanded
	Words to that effect
	Award 1, 2, 3, 4 marks. For use in holistically marked questions only

## Markscheme instructions

- 1 Mark positively. Give candidates credit for what they have achieved and what is correct. Do not deduct marks for incorrect responses. Do not deduct marks for spelling errors.
- 2 Follow the markscheme provided and award only whole marks.
- 3 Each marking point appears on a separate line.
- 4 The maximum mark for each subpart is indicated in the "Total" column.
- 5 Where a mark is awarded a tick should be placed in the text at the precise point where it is clear the candidate deserves the mark.
- 6 Each marking point in a question part should be awarded separately unless there is an instruction to the contrary in the Notes column.
- 7 A question subpart may have more marking points than the total allows. This will be indicated by the word "**max**" in the Answer column. Further guidance may be given in the Notes column.
- 8 Additional instructions on how to interpret the markscheme are in bold italic text in the Answer column.
- 9 Alternative wording may be indicated in the Answer column by a slash (/). Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 10 Alternative answers are indicated in the Answer column by "**or**". Either alternative is equally acceptable but the candidate cannot be rewarded for both as they are associated with the same marking point.
- 11 If two related points are required to award a mark, this is indicated by "**and**" in the answer column.
- 12 Words in brackets ( ) in the Answer column are not necessary to gain the mark.
- 13 Words that are underlined are essential for the mark.
- 14 In some questions a reverse argument is also acceptable. This is indicated by the abbreviation *ORA (or reverse argument)* in the Notes column. Candidates should not be rewarded for reverse arguments unless *ORA* is given in the Notes column.
- 15 If the candidate's response has the same meaning or is clearly equivalent to the expected answer the mark should be awarded. In some questions this is emphasized by the abbreviation *WTTE (or words to that effect)* in the Notes column.
- 16 When incorrect answers are used correctly in subsequent question parts the follow through rule applies. Award the mark and add ECF (error carried forward) to the candidate response.
- 17 The order of marking points does not have to be the same as in the Answer column unless stated otherwise.
- 18 Marks should not be awarded where there is a contradiction in an answer. Add CON to the candidate response at the point where the contradiction is made.
- 19 Do not penalize candidates for errors in units or significant figures unless there is specific guidance in the Notes column.
- 20 Questions with higher mark allocations will generally be assessed using a level response method using task specific clarifications developed with reference to the criteria level descriptors. A candidate's work should be reviewed holistically to determine the mark awarded for each aspect.

Question	Answers		Total	
1	a  $6\checkmark\text{H}_2\text{O} + 6\checkmark\text{CO}_2 \rightarrow \boxed{\text{C}_6\text{H}_{12}\text{O}_6} + 6\checkmark\text{O}_2$ Reactants correct Products correct	Do not accept ? in front of glucose	2	A
	b Alcohol	Accept hydroxyl, do not accept hydroxide	1	A
	c  $\text{C} \checkmark$  A.                    B.                    C.                    D. 		1	A
d	Mixture		1	A
e	<b>Band 1: pigment C</b> <b>Band 2: pigment B</b> <b>Band 3: pigment A</b>  One correct  All correct		2	A
f	Measurement of solvent front from application point: 10.0  Measurement of band from the application point: 9.8  Calculation of $R_f = 0.98 \pm 0.01$		3	A

2	a	7		1	A
	b	Increase the acidity of the soil <b>or</b> decrease the pH  By adding sulfuric acid / $\text{H}_2\text{SO}_4$	Award second mark only if first is awarded, accept any acid.	2	A
	c	100 $\text{g mol}^{-1}$ <b>or</b> g/mol	Accept g	2	A
	d	$\text{H}_2\text{O}$ $\text{CO}_2$	Accept in either order	2	A
	e	$\text{CaSO}_4$	Correct subscripts required	1	A
	f	7		1	A

3	a	Reactants correct: $\text{N}_2 + \text{O}_2$ Products correct: 2NO		2	A
	b	Two or more particles randomly placed and not touching	<i>Do not accept if particles are touching such as below</i> 	1	A
	c	Random (motion ) High (kinetic) energy	WTTE, Accept high speed	2	A
	d	Nitrogen monoxide or emission is a gas or a gas is produced Gas (particles) spread <b>or</b> move <b>or</b> travel out From an area of high concentration to an area of low concentration A correct use of the word “diffusion”	<i>Movement can be implied</i> WTTE	4	D

4	a	<p>Colorimeter <b>and</b> because it gives quantitative data <b>or</b> more accurate/precise data <b>or</b> removes human error</p>	ORA	1	C
	b	<p><b>If:</b> The concentration of red pigment <b>or</b> yellow pigment is increased</p> <p><b>Then:</b> The yolk colour will become darker/deeper or more orange or closer to 16 on the YolkFan scale</p> <p><b>Because:</b> The pigment changes the colour of the yolk</p>	Accept response in any box or in a single box	3	B
	c	62		1	C
	d	<p>Method B <b>and</b> The thermometer is measuring where the egg white or proteins are <b>or</b> In the other method the thermometer is measuring the temperature of the water (not the egg white)</p>	Correct method must be selected	1	C
	e	<p>Accept any single value in the range <b>or</b> a range 62 – 70</p> <p>°C</p> <p>Because that was the maximum temperature that the individual components of the egg denatured</p>		3	D C

5	a	<p><b>IV:</b> Type of vinegar</p> <p><b>DV:</b> pH of egg white <b>or</b> tenderness of the egg <b>or</b> taste</p> <p><b>Accept any reasonable CV, for example [max 2]</b></p> <ul style="list-style-type: none"> <li>• Volume of solution</li> <li>• Temperature</li> <li>• Size of egg</li> <li>• Initial concentration of solution</li> <li>• % of salt</li> <li>• Time</li> <li>• Type of egg</li> </ul>	<i>Do not accept amount</i>	4	B
	b	<p>How does the type of vinegar affect</p> <p>The final pH of the egg whites <b>or</b> The tenderness of the egg</p>	<i>ECF IV from 5a</i>	2	B
	c	The pH decreases	<i>Accept values that imply a decrease in pH</i>	1	C
	d	<p>Repeat the investigation with a new pH meter <b>or</b> method to determine the pH such as universal indicator</p>	<i>WTTE</i>	1	C

6	a	<p><b>Title:</b> correctly linking Vitamin C concentration with juice type</p> <p><b>x axis:</b> juice type <b>and</b> y axis: vitamin C concentration</p> <p><b>y axis scale:</b> evenly spaced increments that start at zero</p> <p><b>y axis unit:</b> mg 100cm⁻³ (juice)</p> <p><b>Plotting:</b> all values plotted correctly</p>	<table border="1"> <thead> <tr> <th>Juice Type</th> <th>Vitamin C Concentration (mg 100cm⁻³)</th> </tr> </thead> <tbody> <tr> <td>Apple</td> <td>~20</td> </tr> <tr> <td>Pink Grapefruit</td> <td>~80</td> </tr> <tr> <td>Beetroot</td> <td>~70</td> </tr> <tr> <td>Red cabbage</td> <td>~60</td> </tr> <tr> <td>Tomato</td> <td>~20</td> </tr> </tbody> </table>	Juice Type	Vitamin C Concentration (mg 100cm ⁻³ )	Apple	~20	Pink Grapefruit	~80	Beetroot	~70	Red cabbage	~60	Tomato	~20	5	C
Juice Type	Vitamin C Concentration (mg 100cm ⁻³ )																
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b		<p>Heat treated juice (pasteurized)</p> <p>Vitamin C is broken down at high temperatures</p> <p>Reference to oxidized or denatured</p>	<p><i>Loss of vit C must be linked with high temperature</i></p> <p><i>Do not accept evaporate or killed</i></p>	3	C												

	c	Change in vitamin C concentration: $375-350=25\pm5$ ( $\mu\text{g cm}^{-3}$ ) Rate of change of vit C concentration: $25/21=1.19$ ( $\mu\text{g cm}^{-3}\text{ day}^{-1}$ )	<i>Decrease can be implied i.e. 375-350 Accept values in the range 0.95-1.43</i>	2	C
	d	The vitamin C will not be oxidized <b>or</b> oxidized as much  Because the pulp <b>or</b> juice is not exposed to oxygen <b>or</b> lower exposure to oxygen  Due to protective layer of the peel  Therefore invalid	    <i>Award the 4th mark only if marking point 2 or 3 is scored</i>	4	C

7				16	
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	1 mark	2 marks	3 marks	4 marks	Notes
1.V	Explicitly states metals as IV <b>or</b> appropriate DV	Explicitly states metals as IV <b>and</b> appropriate DV	Explicitly states metals as IV <b>and</b> appropriate DV <b>and</b> one CV	Explicitly states metals as IV <b>and</b> appropriate DV <b>and</b> two CVs	<p><b>Only requirement is to state using the terminology of IV, DV and CV. No need to explain further.</b></p> <p><b>DV</b> This should be what is measured and can come from the whole response. Could be mass change/amount of bubbles produced/change in pH.</p> <p><b>Do not accept</b> calculated values as DV unless explicitly shown how calculated from measured values.</p> <p><b>CV</b> Volumes of liquids/mass of metal/time for reaction</p> <p><b>Do not accept</b> “keeping equipment the same” as a CV.</p>
2.E	Specified equipment considers IV <b>or</b> DV <b>or</b> CV	Specified equipment considers IV <b>and</b> DV <b>or</b> IV <b>and</b> CV <b>or</b> DV <b>and</b> CV	Specified equipment considers IV <b>and</b> DV <b>and</b> one CV	Specified equipment considers IV <b>and</b> DV <b>and</b> two CVs	<p><b>Equipment needs to be correct for the given situation and stated CVs.</b></p> <p><b>There are several investigations that could be carried out here so equipment should be linked.</b></p> <p><b>Balance to measure mass changes over time ( so balance and stopwatch/timer)</b></p> <p><b>pH change of solution added to the metal so pH meter</b></p> <p><b>Gas production due to reactivity and so measuring cylinder/gas syringe or other acceptable way to measure gas - eudiometer</b></p> <p><b>Accept whole cans as equipment for IV, ruler/balance to measure size/mass of sample of metal</b></p> <p><b>Do not accept</b> equipment that is mentioned in the question / instructions.</p>

<b>3.M</b>	Method is linked to IV <b>or</b> DV	Method is linked to IV <b>and</b> DV but is incomplete	Method linked to IV <b>and</b> DV and can be followed to give results	Method linked to IV <b>and</b> DV and can be followed and include details on how to control main CVs	<p><i>A method that does not include how to vary the IV is incomplete.</i></p> <p><i>Limited information about CVs mean that data is unlikely to be relevant for example salt production – as different metals mass of salt produced not same.</i></p> <p><i>If metals are not same mass/size then this would produce an incomplete method.</i></p>
<b>4.D</b>	Any reference made to different variations of the IV	At least five variations of the IV <b>or</b> at least three trials	At least five values of the IV <b>and</b> at least three trials	At least five values of the IV <b>and</b> at least three trials <b>and</b> takes an average	<p><i>The values of the five or more variations should be explicitly stated for 3 or 4 marks.</i></p> <p><i>The information could be in a table.</i></p>

8	a	$\text{Na}^{+}_{(\text{aq})}$ and $\text{Cl}^{-}_{(\text{aq})}$ are charged particles Ions are mobile when dissolved in water <b>or</b> ions can conduct electricity	Accept explanations of the idea using other ionic salts and ions	2	D
	b	Pacific (ocean) water  Highest electrical conductivity or highest dissolved salts		2	C
	c	$1.4 +/ - 0.2 \text{ (mmol dm}^{-3}\text{)}$	<i>Unit not required</i>	1	D
	d	A correct statement about crop A and crop B  <b>A correct use of data for crop A, for example [max 1]</b> <ul style="list-style-type: none"><li>• crop A decreases rapidly to 20% (at low salinity of $0.5 \text{ mmol dm}^{-3}$)</li><li>• decrease in % yield starts at $0.15 \text{ mmol dm}^{-3}$ for crop A</li></ul> <b>A correct use of data for crop B, for example [max 1]</b> <ul style="list-style-type: none"><li>• crop B yield starts decreasing at a higher concentration of salt and at a lower rate</li><li>• decrease in % yield starts at $0.8 \text{ mmol dm}^{-3}$ for crop B</li></ul>		3	D
9	a	Latin America <b>and</b> Caribbean  Surrounded by saline water <b>or</b> Little surface water suitable for drinking or irrigation  Freshwater required for high populations		3	D

<b>9</b>	b		<b>14</b>	<b>D</b>
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<b>A comparison of the efficiencies of the three systems</b>				
<b>Mark</b>	<b>Descriptor</b>	<b>Notes</b>		
1	The efficiency of two systems stated	<p>The three systems are thermal, membrane and solar</p> <p><b>Examples of statements</b></p> <ul style="list-style-type: none"> <li>• operates at high temperatures -so inefficient with respect to energy requirements</li> <li>• clogging of tubes would make the process inefficient</li> <li>• high maintenance required</li> <li>• low energy – implies good use of energy so efficient</li> <li>• comparison: Solar based system is inferior to heat based system based on overall efficiency (based on energy usage)</li> </ul>		
2	The efficiency of all three systems stated <i>or</i> The efficiency of two systems compared to each other			
3	The efficiency of all three systems compared to each other			
4	The efficiency of all three systems compared to each other <b>and</b> scientific justification	<p><b>Examples of justifications</b></p> <ul style="list-style-type: none"> <li>• the highest and most efficient system is the thermal based set-up [...] suitable for large scale industrial use, [...] water in a larger amount and in a short time.</li> <li>• do <b>not</b> accept reference to CO₂ as a scientific justification for efficiency</li> </ul>		

The economic impacts of the three systems		
Mark	Descriptor	Notes
1	A statement about an economic impact of one system	<p><b>Examples of statements</b></p> <ul style="list-style-type: none"> <li>• membrane based high cost for maintenance due to clogging</li> <li>• expensive to build</li> <li>• energy use = cost implied</li> <li>• due to the high operating temperatures, some salts [...] deposit on the tubes and can cause clogging. This may require financial aid in order to be maintained [...]</li> </ul>
2	A statement about an economic impact of two systems	
3	A statement about an economic impact of all three systems <i>or</i> A comparison of any two systems	<p><b>Examples of comparisons</b></p> <ul style="list-style-type: none"> <li>• The thermal based system is not that expensive .. the membrane based system is the most expensive to build and it costs a lot to maintain...Solar based which is the easiest to construct and the cheapest as well...</li> </ul>
4	A comparison of the economic impacts of all three systems	<ul style="list-style-type: none"> <li>• the membrane based system has a much bigger economic impact, as it is expensive to build and to maintain [due to membrane change] while both the thermal-based one and solar based one are easy to construct and have a low maintenance cost</li> </ul>

The environmental impacts of the three systems		
Mark	Descriptor	Notes
1	A statement about an environmental impact of one system	<p><b>Examples of statements</b></p> <ul style="list-style-type: none"> <li>• Emissions of CO₂</li> <li>• The thermal based system generate high level of CO₂ and can cause increased greenhouse gases which can lead to increase in the global temperature</li> </ul>
2	A statement about an environmental impact of two systems	<p><b>Example of comparisons</b></p> <ul style="list-style-type: none"> <li>• The thermal based system has a large CO₂ emissions (24 kg). The membrane based system has large but lesser emissions than the thermal based system (5,3 kg)</li> <li>• The thermal based method uses a lot of energy to heat up and produce steam. The method produces 24 kg of carbon dioxide. This is extremely harmful for the environment. The membrane system is lesser energy but still requires energy...producing 5.3 kg of carbon dioxide. Solar is cleaner and produces 0 kg carbon dioxide.</li> </ul>
3	A statement about an environmental impact of all three systems <b>or</b> A comparison of any two systems	
4	A comparison of the environmental impacts of all three systems	

An appraisal of the three systems		
Mark	Descriptor	Notes
1	A simple concluding statement	<p><b>Example of a simple conclusion</b></p> <ul style="list-style-type: none"> <li>• The three systems are a great way to increase the amount of fresh water</li> </ul>
2	A concluding appraisal with a choice that is justified	<p><b>Example of an appraisal</b></p> <ul style="list-style-type: none"> <li>• Out of all 3 systems the thermal based system is the most efficient due to...but is the worst on the environment, while the solar based system is the cleanest form...therefore the thermal based system should be used.</li> </ul>