

Question	Answers	Notes	Total	Crit	
1	a	exothermic	1	A	
	b	1 (mole) of iron reacts with 0.75 (mole) of oxygen <b>or</b> mole ratio of 4:3 <b>and</b> iron:oxygen  5.6g of iron=0.1 (mole)  0.075 (moles) of oxygen needed	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+	<i>ecf from part 1d</i>  <i>accept answer in terms of Na/Ca/C not having 3 outer electrons</i>  <i>do not accept group 3/13 alone</i>  <i>for ecf to apply in second marking point, the justification should agree with the element selected in the first marking point</i>	2	A

2	a	<p>physical (process)</p> <p>no new bonds are formed between atoms in the substance  <b>or</b>  no new substance is formed  <b>or</b>  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)  <b>or</b>  until undissolved substance/solid/solute/deposit remains (at a certain temperature)</p>	<p>WTTE</p> <p><i>accept references greater than the solubility product constant</i></p>	2	A
	c	<p>heat the heat pack</p> <p>energy increases (so) the crystals dissolve</p>	WTTE	2	A
	d	<p><math>CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O</math></p> <p>sodium hydroxide/NaOH</p> <p>correct reactants</p> <p>correct products</p> <p>correctly balanced</p>	<p><i>Ignore one error in subscripts if all others are correct</i></p> <p><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 C<sub>2</sub>H<sub>4</sub>O<sub>2</sub></i></p> <p><i>Accept ⇌ or =</i></p>	4	A

3	a	<p><b>A problem associated with acid rain, for example</b>  water ecosystem deterioration,  changes in the solubility of soil minerals  erosion by dissolution of monuments or building containing <math>\text{CaCO}_3</math></p> <table border="1"> <tr> <td>• simple or incomplete statement</td> <td>1</td> </tr> <tr> <td>• complete statement • chemistry mentioned but not in the context of the question</td> <td>2-3</td> </tr> <tr> <td>• detailed statement • explicitly linked to relevant chemistry</td> <td>4-5</td> </tr> <tr> <td>• detailed statement • fully explained using chemistry • causes and effects explained in the context of acid rain</td> <td>6-8</td> </tr> </table>	• simple or incomplete statement	1	• complete statement • chemistry mentioned but not in the context of the question	2-3	• detailed statement • explicitly linked to relevant chemistry	4-5	• detailed statement • fully explained using chemistry • causes and effects explained in the context of acid rain	6-8		8	B
	• simple or incomplete statement	1											
	• complete statement • chemistry mentioned but not in the context of the question	2-3											
• detailed statement • explicitly linked to relevant chemistry	4-5												
• detailed statement • fully explained using chemistry • causes and effects explained in the context of acid rain	6-8												
b	a substance that speeds up a chemical reaction (is not used up/consumed in the reaction)	WTTE accept "hastens the reaction"	1	A									
c	a catalyst gives a lower energy path for the reaction  because the $E_a$ /energy barrier (is lower) <b>or</b> (by) providing an alternative reaction pathway <b>or</b> (by) altering the mechanism of the reaction	WTTE  accept more molecules have enough energy to react	2	A									
4	a	ester	do <b>not</b> accept organic compounds	1	A								
	b	pentanol / pentan-1-ol	do <b>not</b> accept pentan-2-ol, pentan-3-ol	1	A								
	c	water	<b>Do not</b> accept $\text{H}_2\text{O}$ because this is not the name	1	A								

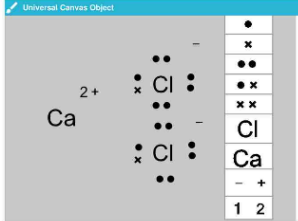
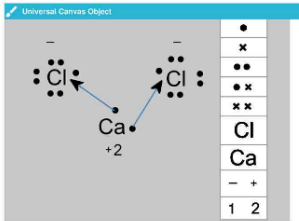
5	a	<b>liquid – gas - solid</b> all correct		1	A
	b	melting  the particles gain (kinetic) energy / particle movement increases  (the particles) move further apart (than in the solid) <b>or</b> intermolecular forces weaken <b>or</b> intermolecular bonds break <b>or</b> entropy / disorder /S increases		3	C
	c	condensation  the particles lose energy / particle movement decreases  the particles get closer together compared to gas <b>or</b> intermolecular forces increase <b>or</b> intermolecular bonds form <b>or</b> 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 <b>or</b> intermolecular forces increase <b>or</b> intermolecular bonds form <b>or</b> entropy / disorder /S decreases		3	C

6	a	hydrogen/H <b>and</b> oxygen/O	not H <sub>2</sub> /O <sub>2</sub> / H <sub>2</sub> O	1	A																													
	b	<p><b>Any two of the following [2 max]</b></p> <ul style="list-style-type: none"> <li>the point at which molecules escape from the surface</li> <li>increased molecular motion (compared to lower temperatures)</li> <li>because they have enough (kinetic) energy (to escape)</li> <li>bubbles of gas/vapour are produced</li> </ul>		2	A																													
	c	<p>three marks for four correct values, two marks for three correct values, one mark for two correct values</p> <table border="1"> <thead> <tr> <th>Location</th> <th>Altitude / m</th> <th>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	<p>accept ± 25 (m) for altitude</p> <p>accept ±0.2 (°C) for temperature</p>	3
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																																
d	a hypothesis linking the independent and dependent variables in the table in part c	accept an incorrect hypothesis for this mark	1	B																														
e	<p><b>Variables:</b></p> <p><b>independent:</b> altitude/height/(atmospheric pressure)</p> <p><b>Dependent:</b> (boiling) temperature</p> <p><b>Any reasonable control variables [2 max], for example</b></p> <ul style="list-style-type: none"> <li>volume</li> <li>mass of water</li> <li>type of water</li> <li>container</li> </ul>		4	B																														

<b>f</b>	<ul style="list-style-type: none"> <li>• includes equipment for measuring temperature <b>or</b> altitude</li> <li>• attempts a method</li> </ul>	1-2	<p><i>complete equipment list:</i>  <i>water</i>  <i>thermometer/temperature probe</i>  <i>heat source</i>  <i>container</i>  <i>GPS/altimeter/barometer</i>  <i>measuring cylinder or balance</i>  <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>	<b>16</b>	<b>B</b>
	<ul style="list-style-type: none"> <li>• includes equipment for measuring temperature <b>or</b> altitude</li> <li>• method includes details of one control variable</li> <li>• diagram includes incomplete equipment</li> <li>• care is needed with hot objects</li> </ul>	3-6			
	<ul style="list-style-type: none"> <li>• includes equipment for measuring temperature <b>and</b> altitude</li> <li>• method includes details of more than one control variable</li> <li>• diagram includes complete equipment not assembled correctly</li> <li>• plans to repeat experiment</li> <li>• care is needed with hot objects</li> </ul>	7-11			
	<ul style="list-style-type: none"> <li>• includes equipment for measuring temperature <b>and</b> altitude</li> <li>• includes a statement of when a measurement should be made (boiling or steady temperature) and includes care is needed with hot objects</li> <li>• method includes details of more than one control variable with justification for at least one</li> <li>• diagram includes complete equipment assembled correctly</li> <li>• plans to repeat experiment a minimum of three times and calculate average and a reference to range of data</li> </ul>	12-16			

7	a	<p><b>x axis:</b> altitude (km) <b>and y axis:</b> O<sub>2</sub> (% / 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><b>plotting points</b> four points plotted correctly (x±10, y ±0.5)</p> <p>all points plotted correctly (x±10, y ±0.5)</p>	<p><i>accept incorrect use of brackets eg altitude (km)</i></p> <p><i>that is</i> <i>one mark for four correct,</i> <i>two mark for eight correct,</i> <i>points plotted correctly on inverted axes</i> <i>can score both marks</i></p>	5	C
	b	<p>all data should not be included because of the trend</p> <p><b>reference to a correctly plotted graph in part a or the data in the table</b> (because) the point at <u>500 (km)</u> is an outlier <b>or</b> because %O<sub>2</sub> at <u>500 (km)</u> is higher than expected <b>or</b> (it is possible that) the data at <u>500 (km)</u> was measured incorrectly</p>	<p><i>WTTE</i> <i>do not accept "the data should be included" without relating it correctly to the trend</i></p>	2	C
	c	<p>a hypothesis linking the percentage of oxygen with time for the flame to extinguish <b>or</b> a hypothesis linking the percentage of oxygen with time for the flame to extinguish change in water level</p>	<p><i>do not accept altitude in place of oxygen</i></p> <p><i>accept an incorrect hypothesis for this mark</i></p>	1	B
	d	<p><b>independent variable:</b> percentage of oxygen</p> <p><b>dependent variable:</b> water level <b>or</b> time to extinguish the flame</p>	<p><i>must be correctly linked to answer from part c</i></p>	2	B

	<b>e</b> <b>accept any reasonable improvement, for example</b> <ul style="list-style-type: none"> <li>• use burette/ measuring cylinder</li> <li>• support the test tube</li> <li>• increase the volume of water</li> </ul>		<b>1</b>	<b>C</b>
	<b>f</b> <b>test:</b> bubble gas through lime water/calcium hydroxide solution  <b>observation:</b> calcium hydroxide solution turns milky/cloudy/white suspension  <b>conclusion:</b> (so) CO <sub>2</sub> must be present	<i>WTTE</i>   <i>award this mark independently</i>	<b>3</b>	<b>C</b>

8	a	<p>correct reactants <b>and</b> products: <math>2\text{CO}_2(\text{g}) \rightarrow \text{O}_2(\text{g}) + 2\text{CO}(\text{g})</math></p> <p>correct balancing</p> <p>correct states</p>	<p><i>No credit for restating word equation</i></p> <p><i>all subscripts must be correct</i></p> <p><i>Accept <math>\rightleftharpoons</math> or <math>=</math></i></p>	3	A
	b	<p>oxygen is needed for life/breathing/respiration</p> <p><b>any additional point, for example [1 max]</b></p> <ul style="list-style-type: none"> <li>• processes using combustion</li> <li>• manufacturing</li> <li>• fuel</li> </ul>		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><b>or</b></p> <p><math>\text{NH}_4^+</math> 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 <b>or</b> diagram 2</p> <div style="display: flex; justify-content: space-around;">   </div> <p><i>Accept x • in any order on correct location.</i></p>		1	D

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

<b>10</b>	<b>a</b>	prevents the oxygen from reaching the fire <b>or</b> removes the oxygen.  <b>Any three further points [3 max] from</b> <ul style="list-style-type: none"> <li>• water has a lower boiling point than oil or grease</li> <li>• water is immiscible with oil or grease so the fire would float</li> <li>• the water would boil to produce steam which is a hazard</li> <li>• water conducts electricity so would be hazardous to use on an electrical fire</li> </ul>	<i>accept any other reasonable and equally valid point to a maximum of 3</i>	<b>4</b>	D
	<b>b</b>	(the $\text{NaHCO}_3$ ) behaves as a base <b>or</b> removes $\text{H}^+$ ions <b>or</b> neutralizes the acid		<b>1</b>	D
	<b>c</b>	acid/ $\text{H}^+$ /hydronium ion reacts with $\text{OH}^-$ /hydroxide/hydroxyl ions  (which causes the) position of equilibrium shifts to the right <b>or</b> towards the products <b>or</b> the forward reaction is favoured  amount/concentration of $\text{HCO}_3^-$ decreases <b>or</b> $\text{OH}^-$ decreases  (so) amount/concentration of $\text{H}_2\text{CO}_3$ increases	<i>WTTE</i>  <i>do not accept water decreases</i>	<b>4</b>	D

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

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