

# Markscheme

May 2019

Chemistry

Standard level

Paper 2

12 pages

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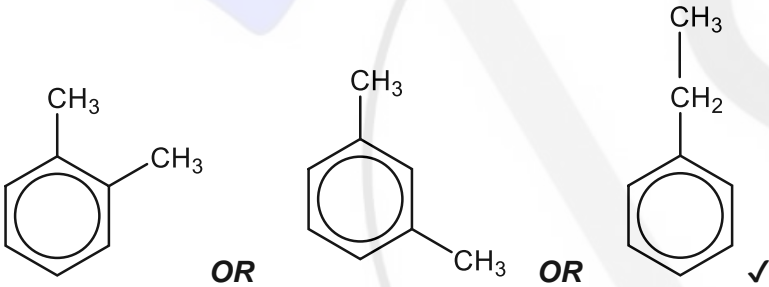
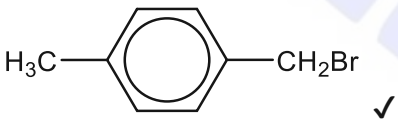
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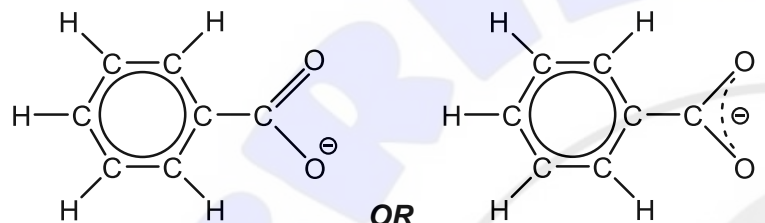
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Question			Answers	Notes	Total
1.	a		<p>Number of signals: 2 ✓</p> <p>Ratio: 3:2 <b>OR</b> 6:4 ✓</p>	<p>Accept any correct integer or fractional ratio. Accept ratios in reverse order.</p>	2
1.	b				1
1.	c	i	<p><math>\text{Br}_2 \rightarrow 2\text{Br}\cdot</math> ✓</p> <p>«sun»light/UV/hv <b>OR</b> high temperature ✓</p>	<p>Do <b>not</b> penalize missing radical symbol on Br. Accept "homolytic fission of bromine" for M1.</p>	2
1.	c	ii	 <p>HBr ✓</p>	<p>Accept condensed formulae, such as <math>\text{CH}_3\text{C}_6\text{H}_4\text{CH}_2\text{Br}</math>. Accept skeletal structures.</p>	2

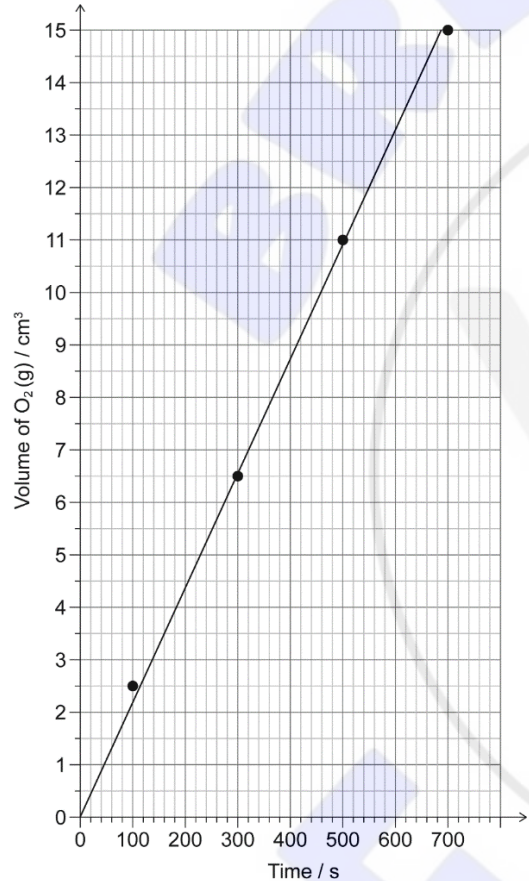
Question			Answers	Notes	Total
2.	a		 <p style="text-align: center;">OR</p>	<p>Accept Kekulé structures.</p> <p>Negative sign must be shown in correct position- on the O or delocalised over the carboxylate.</p>	1
2.	b	i	<p><b>ALTERNATIVE 1:</b>  <math>[H^+] \llcorner 10^{-2.95} \llcorner = 1.122 \times 10^{-3} \llcorner \text{mol dm}^{-3} \llcorner \checkmark</math>  <math>\llcorner [OH^-] = \frac{1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{1.22 \times 10^{-3} \text{ mol dm}^{-3}} \Rightarrow 8.91 \times 10^{-12} \llcorner \text{mol dm}^{-3} \llcorner \checkmark</math></p> <p><b>ALTERNATIVE 2:</b>  <math>\text{pOH} = \llcorner 14 - 2.95 \Rightarrow \llcorner 11.05 \checkmark</math>  <math>\llcorner [OH^-] = 10^{-11.05} \Rightarrow 8.91 \times 10^{-12} \llcorner \text{mol dm}^{-3} \llcorner \checkmark</math></p>	<p>Award [2] for correct final answer.</p> <p>Accept other methods.</p>	2
2.	b	ii	$2C_6H_5COOH(s) + 15O_2(g) \rightarrow 14CO_2(g) + 6H_2O(l)$ correct products $\checkmark$ correct balancing $\checkmark$		2
2.	c		$\llcorner \text{intermolecular} \llcorner$ hydrogen bonding $\checkmark$	<p>Accept diagram showing hydrogen bonding.</p>	1

Question			Answers	Notes	Total
3.	a	i	<p>«3-D/giant» regularly repeating arrangement «of ions»  <b>OR</b>            lattice «of ions» ✓</p> <p>electrostatic attraction between oppositely charged ions  <b>OR</b>            electrostatic attraction between Na<sup>+</sup> and O<sup>2-</sup> ions ✓</p>	<p>Do <b>not</b> accept “ionic” without description.</p>	2
3.	a	ii	<p><i>Sodium oxide:</i>  <math>\text{Na}_2\text{O}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow 2\text{NaOH}(\text{aq})</math> ✓</p> <p><i>Phosphorus(V) oxide:</i>  <math>\text{P}_4\text{O}_{10}(\text{s}) + 6\text{H}_2\text{O}(\text{l}) \rightarrow 4\text{H}_3\text{PO}_4(\text{aq})</math> ✓</p> <p><i>Differentiation:</i>            NaOH / product of Na<sub>2</sub>O is alkaline/basic/pH &gt; 7 <b>AND</b> H<sub>3</sub>PO<sub>4</sub> / product of P<sub>4</sub>O<sub>10</sub> is acidic/pH &lt; 7 ✓</p>		3

(continued...)

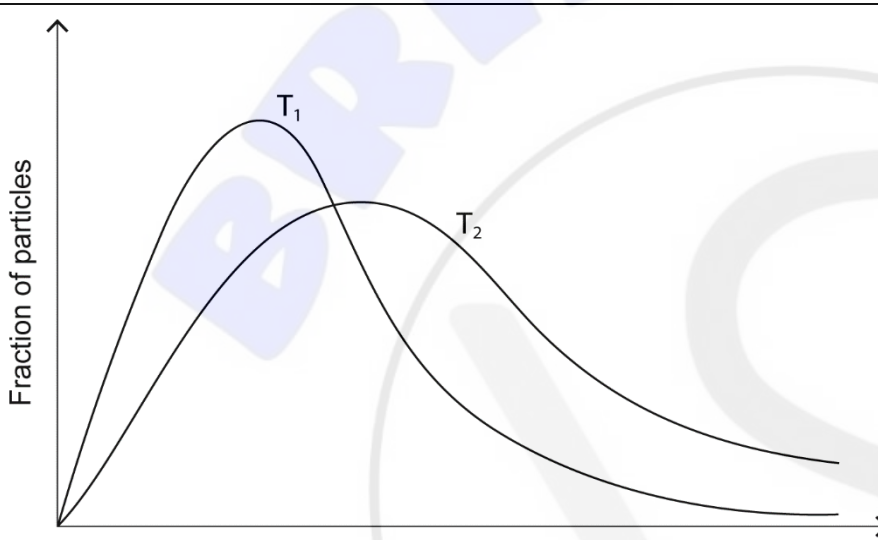
(Question 3 continued)

Question			Answers	Notes	Total
3.	b		$n(\text{Na}_2\text{O}_2)$ theoretical yield $\llcorner = \frac{5.00 \text{ g}}{61.98 \text{ g mol}^{-1}} \llcorner = 0.0807/8.07 \times 10^{-2} \llcorner \llcorner \text{ «mol»}$ <b>OR</b> mass $\text{Na}_2\text{O}_2$ theoretical yield $\llcorner = \frac{5.00 \text{ g}}{61.98 \text{ g mol}^{-1}} \times 77.98 \text{ g mol}^{-1} \llcorner = 6.291 \llcorner \llcorner \text{ «g»} \checkmark$ % yield $\llcorner = \frac{5.50 \text{ g}}{6.291 \text{ g}} \times 100 \llcorner \llcorner \text{ OR } \llcorner = \frac{0.0705}{0.0807} \times 100 \llcorner \llcorner = 87.4 \llcorner \llcorner \text{ «%»} \checkmark$	Award <b>[2]</b> for correct final answer.	2
3.	c	i	$\Sigma \Delta H_f$ products = $2 \times (-1130.7) / -2261.4 \llcorner \llcorner \text{ «kJ»} \checkmark$ $\Sigma \Delta H_f$ reactants = $2 \times (-510.9) + 2 \times (-393.5) / -1808.8 \llcorner \llcorner \text{ «kJ»} \checkmark$ $\Delta H = \llcorner \Sigma \Delta H_f$ products $- \Sigma \Delta H_f$ reactants = $-2261.4 - (-1808.8) = \llcorner -452.6 \llcorner \llcorner \text{ «kJ»} \checkmark$	Award <b>[3]</b> for correct final answer. Award <b>[2 max]</b> for “+452.6 «kJ»”.	3
3.	c	ii	only valid for covalent bonds <b>OR</b> only valid in gaseous state $\checkmark$		1
3.	d		NaOH $\checkmark$	Accept correct equation showing NaOH as a product.	1
3.	e		IV $\checkmark$		1

Question			Answers	Notes	Total
4.	a		decomposes in light ✓	Accept "sensitive to light".	1
4.	b	i	 <p>points correctly plotted ✓                      best fit line <b>AND</b> extended through (to) the origin ✓</p> <p>Average rate of reaction:                      «slope (gradient) of line =&gt; 0.022 «cm<sup>3</sup> O<sub>2</sub> (g) s<sup>-1</sup>» ✓</p>	Accept range 0.020–0.024 cm <sup>3</sup> O <sub>2</sub> (g) s <sup>-1</sup> .	3

(continued...)

(Question 4 continued)

Question			Answers	Notes	Total
4.	b	ii	 <p>peak of <math>T_2</math> to right of <b>AND</b> lower than <math>T_1</math> ✓ lines begin at origin <b>AND</b> <math>T_2</math> must finish above <math>T_1</math> ✓</p>		2
4.	b	iii	<p><math>E_a</math> marked on graph ✓ explanation in terms of more “particles” with <math>E \geq E_a</math> <b>OR</b> greater area under curve to the right of <math>E_a</math> in <math>T_2</math> ✓</p>		2
4.	b	iv	<p>manganese(IV) oxide <b>OR</b> manganese dioxide ✓</p>	Accept “manganese(IV) dioxide”.	1

(continued...)

(Question 4 continued)

Question		Answers	Notes	Total
4.	c	move «position of» equilibrium to right/products ✓	Accept "reactants are always present as the reaction is in equilibrium".	1
4.	d	$M(\text{H}_2\text{O}_2) = 2 \times 1.01 + 2 \times 16.00 = 34.02 \text{ «g» } \checkmark$ $\text{«% H}_2\text{O}_2 = 3 \times \frac{34.02}{314.04} \times 100 = \text{» } 32.50 \text{ «%» } \checkmark$	Award [2] for correct final answer.	2

Question			Answers	Notes	Total
5.	a		partial dissociation «in aqueous solution» ✓		1
5.	b		ethanoic acid/vinegar reacts with NaOH ✓  moves equilibrium to left/reactant side ✓  releases Cl <sub>2</sub> (g)/chlorine <u>gas</u> <b>OR</b> Cl <sub>2</sub> (g)/chlorine <u>gas</u> is toxic ✓	Accept "ethanoic acid produces H <sup>+</sup> ions". Accept "ethanoic acid/vinegar reacts with NaOCl".  Do <b>not</b> accept "2CH <sub>3</sub> COOH + NaOCl + NaCl → 2CH <sub>3</sub> COONa + Cl <sub>2</sub> + H <sub>2</sub> O" as it does not refer to equilibrium. Accept suitable molecular or ionic equations for M1 and M3.	3
5.	c	i	$\begin{array}{c} \text{H} : \ddot{\text{N}} : \ddot{\text{Cl}} : \\   \quad \quad \quad \cdot \\ \text{H} \end{array} \quad \checkmark$	Accept any combination of dots/crosses or lines to represent electron pairs.	1
5.	c	ii	Molecular geometry: «trigonal» pyramidal ✓  H–N–H bond angle: 107° ✓	Accept angles in the range of 100–109.	2

Question		Answers	Notes	Total
6.	a	${}^{54}_{26}\text{Fe}$ ✓		1
6.	b	« $A_r$ =» $54 \times 0.0584 + 56 \times 0.9168 + 57 \times 0.0217 + 58 \times 0.0031$ <b>OR</b> « $A_r$ =» 55.9111 ✓  « $A_r$ =» 55.91 ✓	Award <b>[2]</b> for correct final answer. Do <b>not</b> accept data booklet value (55.85).	2

(continued...)

(Question 6 continued)

Question		Answers	Notes	Total
6.	c	<p>lemon juice is the electrolyte  <b>OR</b>  lemon juice allows flow of ions  <b>OR</b>  each nail/metal forms a half-cell with the lemon juice ✓</p> <p><i>Any one of:</i>  iron is higher than copper in the activity series  <b>OR</b>  each half-cell/metal has a different redox/electrode potential ✓</p> <p>iron is oxidized  <b>OR</b>  <math>\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^{-}</math>  <b>OR</b>  <math>\text{Fe} \rightarrow \text{Fe}^{3+} + 3\text{e}^{-}</math>  <b>OR</b>  iron is anode/negative electrode of cell ✓</p> <p>copper is cathode/positive electrode of cell  <b>OR</b>  reduction occurs at the cathode  <b>OR</b>  <math>2\text{H}^{+} + 2\text{e}^{-} \rightarrow \text{H}_2</math> ✓</p> <p>electrons flow from iron to copper ✓</p>	<p><i>Accept "lemon juice acts as a salt bridge".</i></p> <p><i>Accept "iron is more reactive than copper".</i></p>	2