

Markscheme

May 2019

Chemistry

Standard level

Paper 2

12 pages

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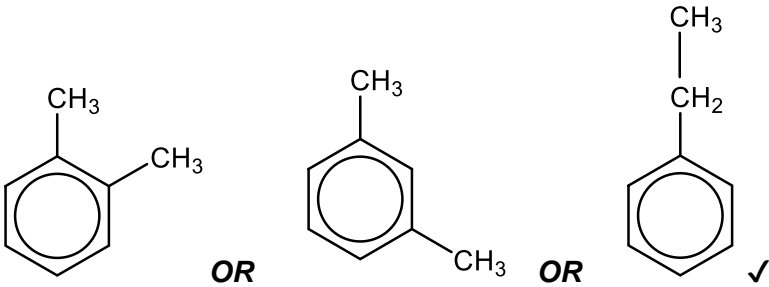
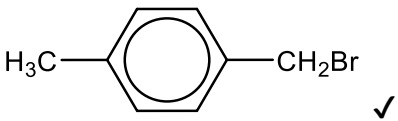
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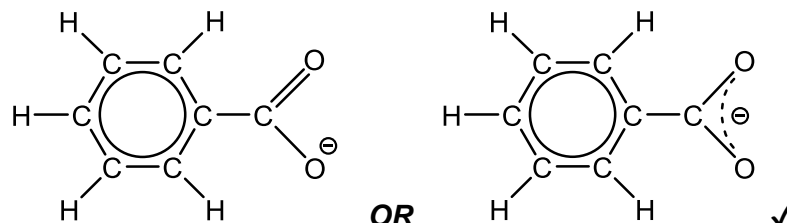
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| Question | | | Answers | Notes | Total |
|----------|---|----|--|---|-------|
| 1. | a | | <p>Number of signals: 2 ✓</p> <p>Ratio: 3:2 OR 6:4 ✓</p> | <p>Accept any correct integer or fractional ratio. Accept ratios in reverse order.</p> | 2 |
| 1. | b | |  | | 1 |
| 1. | c | i | <p>$\text{Br}_2 \rightarrow 2\text{Br}\cdot$ ✓</p> <p>«sun»light/UV/hv OR high temperature ✓</p> | <p>Do not 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 $\text{CH}_3\text{C}_6\text{H}_4\text{CH}_2\text{Br}$. Accept skeletal structures.</p> | 2 |

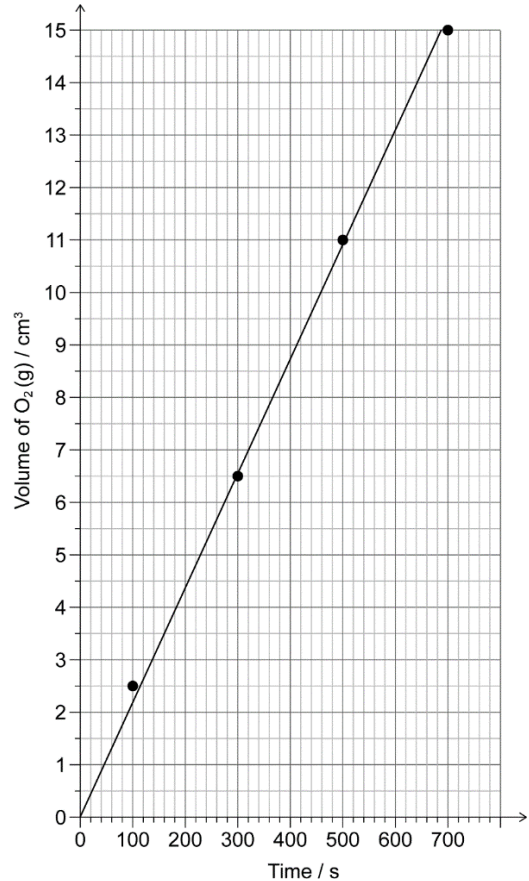
| Question | | | Answers | Notes | Total |
|----------|---|----|--|--|-------|
| 2. | a | |  <p style="text-align: center;">OR</p> | <p>Accept Kekulé structures.</p> <p>Negative sign must be shown in correct position- on the O or delocalised over the carboxylate.</p> | 1 |
| 2. | b | i | <p>ALTERNATIVE 1: $[H^+] \llcorner 10^{-2.95} \llcorner = 1.122 \times 10^{-3} \llcorner \text{mol dm}^{-3} \llcorner \checkmark$ $\llcorner [OH^-] = \frac{1.00 \times 10^{-14} \text{ mol}^2 \text{ dm}^{-6}}{1.22 \times 10^{-3} \text{ mol dm}^{-3}} \llcorner \Rightarrow 8.91 \times 10^{-12} \llcorner \text{mol dm}^{-3} \llcorner \checkmark$</p> <p>ALTERNATIVE 2: $\text{pOH} = \llcorner 14 - 2.95 \llcorner \Rightarrow 11.05 \checkmark$ $\llcorner [OH^-] = 10^{-11.05} \llcorner \Rightarrow 8.91 \times 10^{-12} \llcorner \text{mol dm}^{-3} \llcorner \checkmark$</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» OR lattice «of ions» ✓</p> <p>electrostatic attraction between oppositely charged ions OR electrostatic attraction between Na⁺ and O²⁻ ions ✓</p> | <p><i>Do not accept "ionic" without description.</i></p> | 2 |
| 3. | a | ii | <p><i>Sodium oxide:</i> $\text{Na}_2\text{O (s)} + \text{H}_2\text{O (l)} \rightarrow 2\text{NaOH (aq)}$ ✓</p> <p><i>Phosphorus(V) oxide:</i> $\text{P}_4\text{O}_{10} \text{ (s)} + 6\text{H}_2\text{O (l)} \rightarrow 4\text{H}_3\text{PO}_4 \text{ (aq)}$ ✓</p> <p><i>Differentiation:</i> NaOH / product of Na₂O is alkaline/basic/pH > 7 AND H₃PO₄ / product of P₄O₁₀ is acidic/pH < 7 ✓</p> | | 3 |

(continued...)

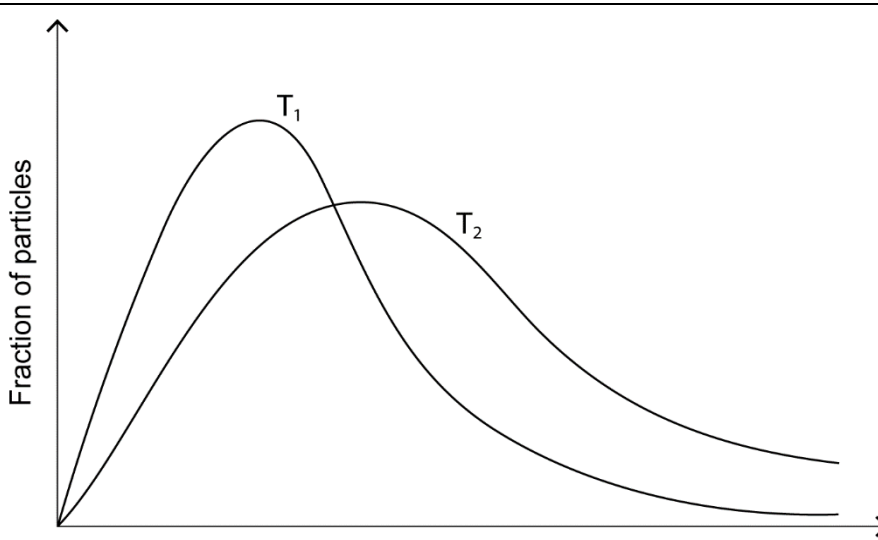
(Question 3 continued)

| Question | | | Answers | Notes | Total |
|----------|---|----|---|---|-------|
| 3. | b | | $n(\text{Na}_2\text{O}_2)$ theoretical yield $\llcorner = \frac{5.00 \text{ g}}{61.98 \text{ g mol}^{-1}} \llcorner = 0.0807/8.07 \times 10^{-2} \llcorner \llcorner \text{ «mol»}$ OR mass Na_2O_2 theoretical yield $\llcorner = \frac{5.00 \text{ g}}{61.98 \text{ g mol}^{-1}} \times 77.98 \text{ g mol}^{-1} \llcorner = 6.291 \llcorner \llcorner \text{ «g»} \llcorner \llcorner \checkmark$ % yield $\llcorner = \frac{5.50 \text{ g}}{6.291 \text{ g}} \times 100 \llcorner \llcorner \text{ OR } \llcorner = \frac{0.0705}{0.0807} \times 100 \llcorner \llcorner = 87.4 \llcorner \llcorner \text{ «%»} \llcorner \llcorner \checkmark$ | Award [2] for correct final answer. | 2 |
| 3. | c | i | $\Sigma \Delta H_f$ products = $2 \times (-1130.7) / -2261.4 \llcorner \llcorner \text{ «kJ»} \llcorner \llcorner \checkmark$ $\Sigma \Delta H_f$ reactants = $2 \times (-510.9) + 2 \times (-393.5) / -1808.8 \llcorner \llcorner \text{ «kJ»} \llcorner \llcorner \checkmark$ $\Delta H = \llcorner \llcorner \Sigma \Delta H_f$ products - $\Sigma \Delta H_f$ reactants = $-2261.4 - (-1808.8) = \llcorner \llcorner -452.6 \llcorner \llcorner \text{ «kJ»} \llcorner \llcorner \checkmark$ | Award [3] for correct final answer. Award [2 max] for "+452.6 «kJ»". | 3 |
| 3. | c | ii | only valid for covalent bonds OR 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 AND extended through (to) the origin ✓</p> <p>Average rate of reaction: «slope (gradient) of line => 0.022 «cm³ O₂ (g) s⁻¹» ✓</p> | Accept range 0.020–0.024 cm ³ O ₂ (g) s ⁻¹ . | 3 |

(continued...)

(Question 4 continued)

| Question | | | Answers | Notes | Total |
|----------|---|-----|--|---------------------------------|-------|
| 4. | b | ii |  <p>peak of T₂ to right of AND lower than T₁ ✓ lines begin at origin AND T₂ must finish above T₁ ✓</p> | | 2 |
| 4. | b | iii | <p>E_a marked on graph ✓ explanation in terms of more “particles” with $E \geq E_a$ OR greater area under curve to the right of E_a in T₂ ✓</p> | | 2 |
| 4. | b | iv | <p>manganese(IV) oxide OR 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 ₂ (g)/chlorine <u>gas</u> OR Cl ₂ (g)/chlorine <u>gas</u> is toxic ✓ | Accept “ethanoic acid produces H ⁺ ions”. Accept “ethanoic acid/vinegar reacts with NaOCl”. Do not accept “2CH ₃ COOH + NaOCl + NaCl → 2CH ₃ COONa + Cl ₂ + H ₂ 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 | | ${}_{26}^{54}\text{Fe}$ ✓ | | 1 |
| 6. | b | | <p>«A_r =» $54 \times 0.0584 + 56 \times 0.9168 + 57 \times 0.0217 + 58 \times 0.0031$</p> <p>OR</p> <p>«A_r =» 55.9111 ✓</p> <p>«A_r =» 55.91 ✓</p> | <p>Award [2] for correct final answer.</p> <p>Do not accept data booklet value (55.85).</p> | 2 |

(continued...)

(Question 6 continued)

| Question | | Answers | Notes | Total |
|----------|---|---|---|-------|
| 6. | c | <p>lemon juice is the electrolyte OR lemon juice allows flow of ions OR 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 OR each half-cell/metal has a different redox/electrode potential ✓</p> <p>iron is oxidized OR $\text{Fe} \rightarrow \text{Fe}^{2+} + 2\text{e}^{-}$ OR $\text{Fe} \rightarrow \text{Fe}^{3+} + 3\text{e}^{-}$ OR iron is anode/negative electrode of cell ✓</p> <p>copper is cathode/positive electrode of cell OR reduction occurs at the cathode OR $2\text{H}^{+} + 2\text{e}^{-} \rightarrow \text{H}_2$ ✓</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 |