Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

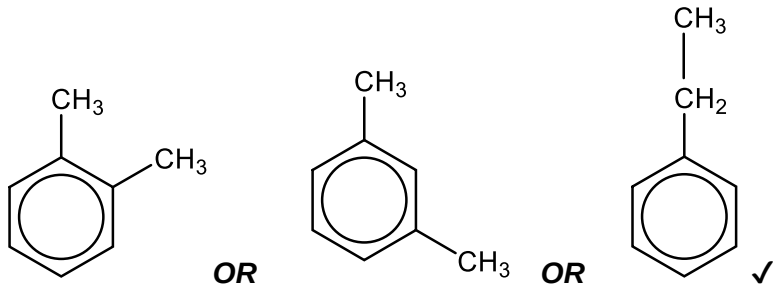
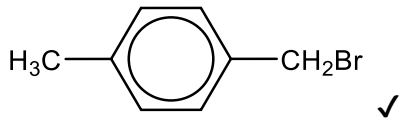
May 2019

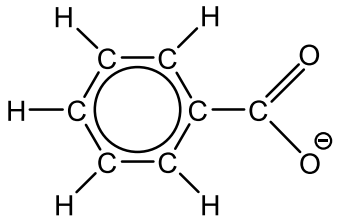
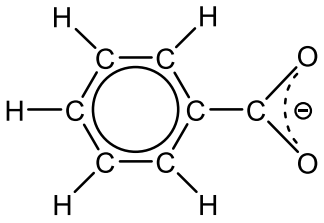
Chemistry

Standard level

Paper 2

12 pages

Question			Answers	Notes	Total
1.	a		*Number of signals:* 2 ✓ *Ratio:* 3 : 2 ***OR*** 6 : 4 ✓	*Accept any correct integer or fractional ratio.* *Accept ratios in reverse order.*	**2**
1.	b		 ✓		**1**
1.	c	i	$Br_2 \rightarrow 2Br\bullet$ ✓ «sun»light/UV/*hv* ***OR*** high temperature ✓	*Do **not** penalize missing radical symbol on Br.* *Accept "homolytic fission of bromine" for M1.*	**2**
1.	c	ii	 ✓ HBr ✓	*Accept condensed formulae, such as $CH_3C_6H_4CH_2Br$.* *Accept skeletal structures.*	**2**

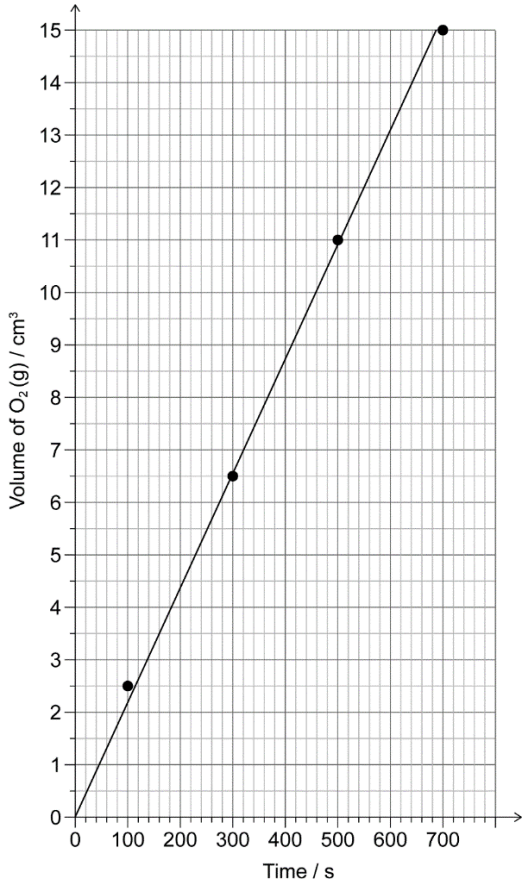
Question			Answers	Notes	Total
2.	a		 ***OR***  ✓	*Accept Kekulé structures.* *Negative sign must be shown in correct position- on the O or delocalised over the carboxylate.*	**1**
2.	b	i	***ALTERNATIVE 1:*** $[H^+]$ **«**$= 10^{-2.95}$**»** $= 1.122 \times 10^{-3}$ **«**mol dm^{-3}**»** ✓ **«**$[OH^-]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

Question			Answers	Notes	Total
3.	**a**	**i**	«3-D/giant» regularly repeating arrangement «of ions» ***OR*** lattice «of ions» ✓ electrostatic attraction between oppositely charged ions ***OR*** electrostatic attraction between Na^+ and O^{2-} ions ✓	*Do **not** accept "ionic" without description.*	**2**
3.	**a**	**ii**	*Sodium oxide:* $Na_2O\,(s) + H_2O\,(l) \rightarrow 2NaOH\,(aq)$ ✓ *Phosphorus(V) oxide:* $P_4O_{10}\,(s) + 6H_2O\,(l) \rightarrow 4H_3PO_4\,(aq)$ ✓ *Differentiation:* NaOH / product of Na_2O is alkaline/basic/pH $>$ 7 ***AND*** H_3PO_4 / product of P_4O_{10} is acidic/pH $<$ 7 ✓		**3**

(continued…)

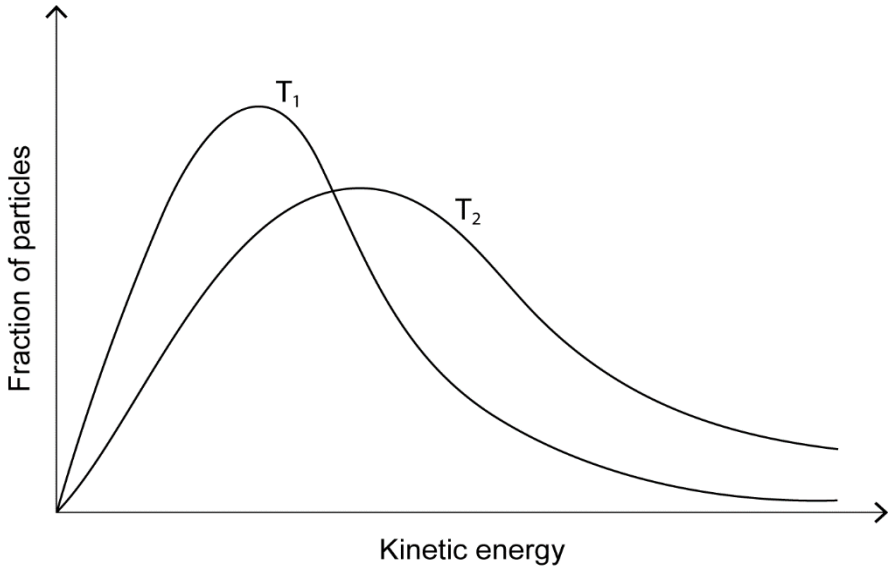
(Question 3 continued)

Question			Answers	Notes	Total
3.	**b**		$n(Na_2O_2)$ theoretical yield **«**$= \frac{5.00\,g}{61.98\,g\,mol^{-1}}$**»** $= 0.0807/8.07 \times 10^{-2}$ **«mol»** ***OR*** mass Na_2O_2 theoretical yield **«**$= \frac{5.00\,g}{61.98\,g\,mol^{-1}} \times 77.98\,g\,mol^{-1}$**»** $= 6.291$ **«g»** ✓ % yield **«**$= \frac{5.50\,g}{6.291\,g} \times 100$**»** ***OR*** **«**$\frac{0.0705}{0.0807} \times 100$**»** $= 87.4$ **«%»** ✓	*Award **[2]** for correct final answer.*	**2**
3.	**c**	**i**	$\Sigma\Delta H_f$ products $= 2 \times (-1130.7) / -2261.4$ **«kJ»** ✓ $\Sigma\Delta H_f$ reactants $= 2 \times (-510.9) + 2 \times (-393.5) / -1808.8$ **«kJ»** ✓ $\Delta H =$ **«**$\Sigma\Delta H_f$ products $- \Sigma\Delta H_f$ reactants $= -2261.4 - (-1808.8) =$**»** -452.6 **«kJ»** ✓	*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 ✓		**1**
3.	**d**		NaOH ✓	*Accept correct equation showing NaOH as a product.*	**1**
3.	**e**		IV ✓		**1**

Question			Answers	Notes	Total
4.	a		decomposes in light ✓	*Accept "sensitive to light".*	1
4.	b	i	 points correctly plotted ✓ best fit line ***AND*** extended through (to) the origin ✓ *Average rate of reaction:* **«**slope (gradient) of line =**»** 0.022 **«**cm^3 O_2 (g) s^{-1}**»** ✓	*Accept range 0.020–0.024 cm^3 O_2 (g) s^{-1}.*	3

(continued…)

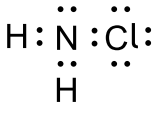
(Question 4 continued)

Question			Answers	Notes	Total
4.	**b**	**ii**	 peak of T_2 to right of ***AND*** lower than T_1 ✓ lines begin at origin ***AND*** T_2 must finish above T_1 ✓		**2**
4.	**b**	**iii**	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 T_2 ✓		**2**
4.	**b**	**iv**	manganese(IV) oxide ***OR*** manganese dioxide ✓	*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 (H_2O_2) **«**$= 2 \times 1.01 + 2 \times 16.00$**»** $= 34.02$ **«**g**»** ✓ **«**% $H_2O_2 = 3 \times \frac{34.02}{314.04} \times 100 =$**»** 32.50 **«**%**»** ✓	*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 gas ***OR*** Cl_2 (g)/chlorine gas is toxic ✓	*Accept "ethanoic acid produces H^+ ions".* *Accept "ethanoic acid/vinegar reacts with NaOCl".* *Do **not** accept "$2CH_3COOH + NaOCl + NaCl \rightarrow 2CH_3COONa + Cl_2 + H_2O$" as it does not refer to equilibrium.* *Accept suitable molecular or ionic equations for M1 and M3.*	**3**
5.	**c**	**i**	 ✓	*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**		$^{54}_{26}Fe$ ✓		**1**
6.	**b**		«A_r =» $54 \times 0.0584 + 56 \times 0.9168 + 57 \times 0.0217 + 58 \times 0.0031$ ***OR*** «A_r =» 55.9111 ✓ «A_r =» 55.91 ✓	*Award **[2]** for correct final answer.* *Do **not** accept data booklet value (55.85).*	**2**

(continued…)

(Question 6 continued)

Question			Answers	Notes	Total
6.	**c**		lemon juice is the electrolyte ***OR*** lemon juice allows flow of ions ***OR*** each nail/metal forms a half-cell with the lemon juice ✓ *Any one of:* iron is higher than copper in the activity series ***OR*** each half-cell/metal has a different redox/electrode potential ✓ iron is oxidized ***OR*** $Fe \rightarrow Fe^{2+} + 2e^-$ ***OR*** $Fe \rightarrow Fe^{3+} + 3e^-$ ***OR*** iron is anode/negative electrode of cell ✓ copper is cathode/positive electrode of cell ***OR*** reduction occurs at the cathode ***OR*** $2H^+ + 2e^- \rightarrow H_2$ ✓ electrons flow from iron to copper ✓	*Accept "lemon juice acts as a salt bridge".* *Accept "iron is more reactive than copper".*	**2**