Diploma Programme
Programme du diplôme
Programa del Diploma

Markscheme

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Chemistry

Standard level

Paper 2

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Question			Answers	Notes	Total
1.	a	i	«K_c =» $\frac{[HOCH_2CH_2OH]}{[CO]^2 \times [H_2]^3}$ ✓		1
1.	a	ii	*Position of equilibrium*: moves to right ***OR*** favours product ✓ K_c: no change ***OR*** is a constant at constant temperature ✓		2
1.	a	iii	*Bonds broken*: 2C≡O + 3(H–H) / 2(1077 kJ mol^{-1}) + 3(436 kJ mol^{-1}) / 3462 «kJ» ✓ *Bonds formed*: 2(C–O) + 2(O–H) + 4(C–H) + (C–C) / 2(358 kJ mol^{-1}) + 2(463 kJ mol^{-1}) + 4(414 kJ mol^{-1}) + 346 kJ mol^{-1} / 3644 «kJ» ✓ «Enthalpy change = bonds broken − bonds formed = 3462 kJ − 3644 kJ =» −182 «kJ» ✓	*Award **[3]** for correct final answer.* *Award **[2 max]** for «+»182 «kJ».*	3
1.	a	iv	in (a)(iii) gas is formed and in (a)(iv) liquid is formed ***OR*** products are in different states ***OR*** conversion of gas to liquid is exothermic ***OR*** conversion of liquid to gas is endothermic ***OR*** enthalpy of vapourisation needs to be taken into account ✓	*Accept product is «now» a liquid.* *Accept answers referring to bond enthalpies being means/averages.*	1

(continued)

(Question 1 continued)

Question			Answers	Notes	Total
1.	**b**		*Ethene*: −2 ✓ *Ethane-1,2-diol*: −1 ✓	*Do **not** accept 2–, 1– respectively.*	**2**
1.	**c**		ethane-1,2-diol can hydrogen bond to other molecules **«**and ethene cannot**»** ***OR*** ethane-1,2-diol has **«**significantly**»** greater van der Waals forces ✓ hydrogen bonding is **«**significantly**»** stronger than other intermolecular forces ✓	*Accept converse arguments.* *Award **[0]** if answer implies covalent bonds are broken.*	**2**
1.	**d**		acidified **«**potassium**»** dichromate**«**(VI)**»** / H^+ ***AND*** $K_2Cr_2O_7$ / H^+ ***AND*** $Cr_2O_7^{2-}$ ***OR*** **«**acidified potassium**»** manganate(VII) / **«**H^+**»** $KMnO_4$ / **«**H^+**»** MnO_4^- ✓	*Accept H_2SO_4 or H_3PO_4 for H^+.* *Accept "permanganate" for "manganate(VII)".*	**1**

(continued)

Question			Answers	Notes	Total
2.	a		*Weak acid*: partially dissociated/ionized **«**in solution/water**»** ***AND*** *Strong acid*: **«**assumed to be almost**»** completely/100 % dissociated/ionized **«**in solution/water**»** ✓	*Accept answers relating to pH, conductivity, reactivity if solutions of equal concentrations stated.*	**1**
2.	b		**«**log scale**»** reduces a wide range of numbers to a small range ***OR*** simple/easy to use ***OR*** converts exponential expressions into linear scale/simple numbers ✓	*Do **not** accept "easy for calculations".*	**1**
2.	c	i	**«**$n(NaOH) = \left(\frac{14.0}{1000}\right) dm^3 \times 0.100\,mol\,dm^{-3}$ **=»** 1.40×10^{-3} **«**mol**»** ✓		**1**
2.	c	ii	**«**$\frac{1}{2} \times 1.40 \times 10^{-3}$ **=»** 7.00×10^{-4} **«**mol**»** ✓		**1**

(continued)

(Question 2 continued)

Question			Answers	Notes	Total
2.	c	iii	***ALTERNATIVE 1:*** «mass of pure hydrated ethanedioic acid in each titration = 7.00×10^{-4} mol × 126.08 g mol^{-1} =» 0.0883 / 8.83×10^{-2} «g» ✓ mass of sample in each titration = « $\frac{25}{1000} \times 5.00\,g$ =» 0.125 «g» ✓ «% purity = $\frac{0.0883\,g}{0.125\,g} \times 100$ =» 70.6 «%» ✓ ***ALTERNATIVE 2:*** «mol of pure hydrated ethanedioic acid in 1 dm^3 solution = $7.00 \times 10^{-4} \times \frac{1000}{25}$ =» 2.80×10^{-2} «mol» ✓ «mass of pure hydrated ethanedioic acid in sample = 2.80×10^{-2} mol × 126.08 g mol^{-1} =» 3.53 «g» ✓ «% purity = $\frac{3.53\,g}{5.00\,g} \times 100$ =» 70.6 «%» ✓ ***ALTERNATIVE 3:*** mol of hydrated ethanedioic acid (assuming sample to be pure) = $\frac{5.00\,g}{126.08\,g\,mol^{-1}} = 0.03966$ «mol» ✓ actual amount of hydrated ethanedioic acid = «$7.00 \times 10^{-4} \times \frac{1000}{25}$ =» 2.80×10^{-2} «mol» ✓ «% purity = $\frac{2.80 \times 10^{-2}}{0.03966} \times 100$ =» 70.6 «%» ✓	*Award suitable part marks for alternative methods.* *Award **[3]** for correct final answer.* *Award **[2 max]** for 50.4 % if anhydrous ethanedioic acid assumed.*	**3**

(continued)

(Question 2 continued)

Question			Answers	Notes	Total
2.	**d**		electrons delocalized «across the O–C–O system» ***OR*** resonance occurs ✓ 122 «pm» < C–O < 143 «pm» ✓	*Accept delocalized π-bond(s).* *Accept any answer in the range 123 «pm» to 142 «pm».* *Accept "bond intermediate between single and double bond" or "bond order 1.5".*	**2**

3.	**a**		H_2O ***AND*** (l) ✓	*Do **not** accept H_2O (aq).*	**1**
	b		SO_2 (g) is an irritant/causes breathing problems ***OR*** SO_2 (g) is poisonous/toxic ✓	*Accept SO_2 (g) is acidic, but do not accept "causes acid rain".* *Accept SO_2 (g) is harmful.* *Accept SO_2 (g) has a foul/pungent smell.*	**1**
	c		$n(HCl) = \text{«} \frac{10.0}{1000} dm^3 \times 2.00 \, mol \, dm^{-3} = \text{»} 0.0200 / 2.00 \times 10^{-2}$ «mol» ***AND*** $n(Na_2S_2O_3) = \text{«} \frac{50}{1000} dm^3 \times 0.150 \, mol \times dm^{-3} = \text{»} 0.00750 / 7.50 \times 10^{-3}$ «mol» ✓ 0.0200 «mol» > 0.0150 «mol» ***OR*** 2.00×10^{-2} «mol» > $2 \times 7.50 \times 10^{-3}$ «mol» ***OR*** $\frac{1}{2} \times 2.00 \times 10^{-2}$ «mol» > 7.50×10^{-3} «mol» ✓	*Accept answers based on volume of solutions required for complete reaction.* *Award **[2]** for second marking point.* *Do **not** award M2 unless factor of 2 (or half) is used.*	**2**

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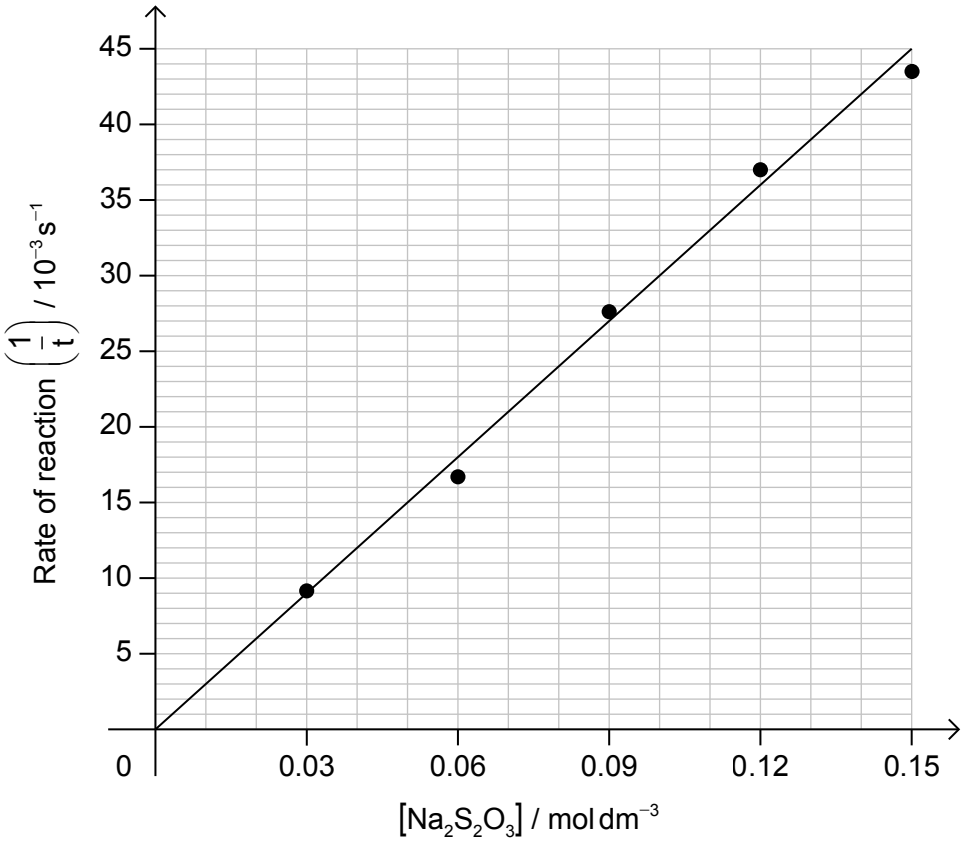
(Question 3 continued)

Question			Answers	Notes	Total
3.	d		 five points plotted correctly ✓ best fit line drawn with ruler, going through the origin ✓		**2**

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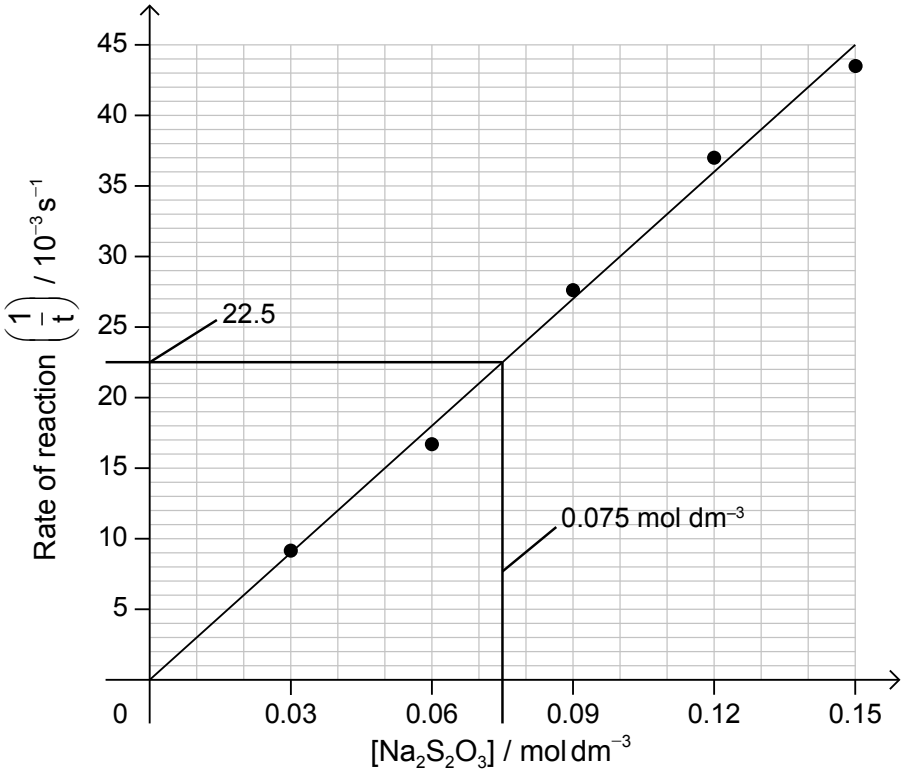
(Question 3 continued)

Question			Answers	Notes	Total
3.	e		 22.5×10^{-3} «s^{-1}» ✓ «Time = $\frac{1}{22.5 \times 10^{-3}}$ =» 44.4 «s» ✓	*Award **[2]** for correct final answer.* *Accept value based on candidate's graph.* *Award M2 as ECF from M1.* *Award **[1 max]** for methods involving taking mean of appropriate pairs of $\frac{1}{t}$ values.* *Award **[0]** for taking mean of pairs of time values.* *Award **[2]** for answers between 42.4 and 46.4 **«s»**.*	**2**

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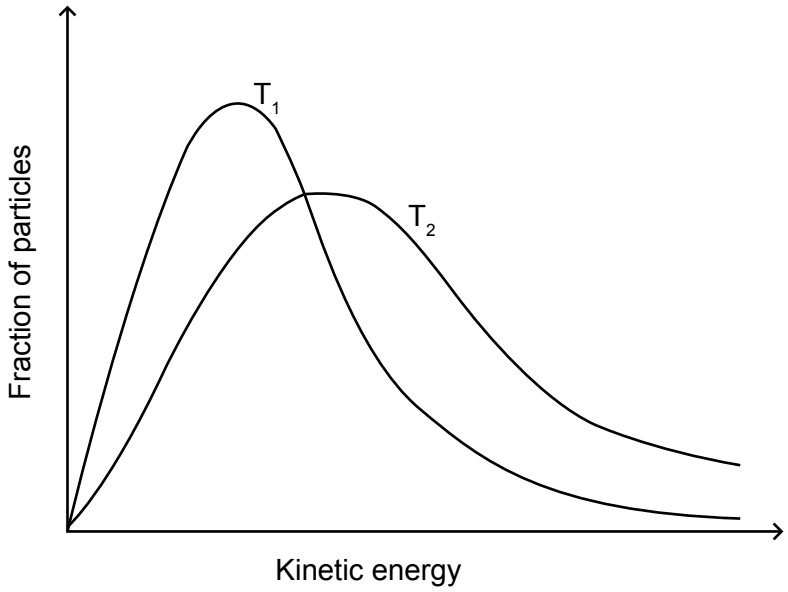
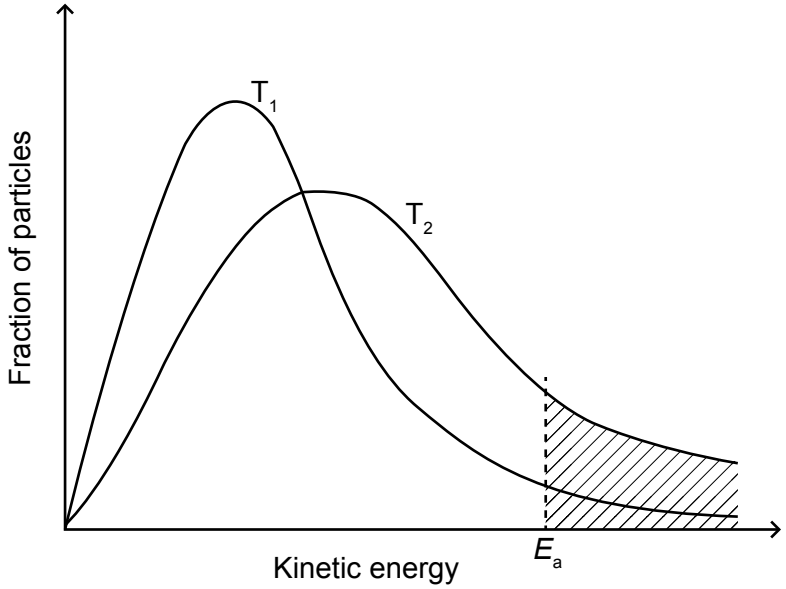
(Question 3 continued)

Question			Answers	Notes	Total
3.	**f**	**i**	 correctly labelled axes ✓ peak of T_2 curve lower ***AND*** to the right of T_1 curve ✓	*Accept "probability «density» / number of particles / N / fraction" on y-axis.* *Accept "kinetic E/KE/E_K" but **not** just "Energy/E" on x-axis.*	**2**

(continued)

(Question 3 continued)

Question			Answers	Notes	Total
3.	**f**	**ii**	greater proportion of molecules have $E \geq E_a$ or $E > E_a$ ***OR*** greater area under curve to the right of the E_a ✓ greater frequency of collisions «between molecules» ***OR*** more collisions per unit time/second ✓  	*Accept more molecules have energy greater than E_a.* *Do **not** accept just "particles have greater kinetic energy".* *Accept "rate/chance/probability/likelihood/" instead of "frequency".* *Accept suitably shaded/annotated diagram.* *Do **not** accept just "more collisions".*	**2**
3.	**g**		shorter reaction time so larger «%» error in timing/seeing when mark disappears ✓	*Accept cooling of reaction mixture during course of reaction.*	**1**

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Question			Answers	Notes	Total
4.	a		$^{26}_{12}Mg$ ✓		1
4.	b		«A_r =» $\frac{24 \times 78.60 + 25 \times 10.11 + 26 \times 11.29}{100}$ ✓ «= 24.3269 =» 24.33 ✓	*Award **[2]** for correct final answer.* *Do **not** accept data booklet value (24.31).*	2
4.	c		$MgO(s) + H_2O(l) \rightarrow Mg(OH)_2(s)$ ***OR*** $MgO(s) + H_2O(l) \rightarrow Mg^{2+}(aq) + 2OH^-(aq)$ ✓	*Accept* ⇌.	1
4.	d		from basic to acidic ✓ through amphoteric ✓	*Accept "alkali/alkaline" for "basic".* *Accept "oxides of Na and Mg: basic **AND** oxide of Al: amphoteric" for M1.* *Accept "oxides of non-metals/Si to Cl acidic" for M2.* *Do **not** accept just "become more acidic".*	2
4.	e		Mg_3N_2 ✓	*Accept MgO_2, $Mg(OH)_2$, $Mg(NOx)_2$, $MgCO_3$.*	1
4.	f		«3-D/giant» regularly repeating arrangement «of ions» ***OR*** lattice «of ions» ✓ electrostatic attraction between oppositely charged ions ***OR*** electrostatic attraction between Mg^{2+} and O^{2-} ions ✓	*Accept "giant" for M1, unless "giant covalent" stated.* *Do **not** accept "ionic" without description.*	2
4.	g		*Anode (positive electrode)*: $2Cl^- \rightarrow Cl_2(g) + 2e^-$ ✓ *Cathode (negative electrode)*: $Mg^{2+} + 2e^- \rightarrow Mg(l)$ ✓	*Penalize missing/incorrect state symbols at Cl_2 and Mg once only.* *Award **[1 max]** if equations are at wrong electrodes.* *Accept Mg(g).*	2

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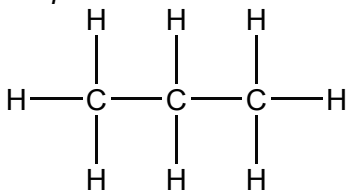
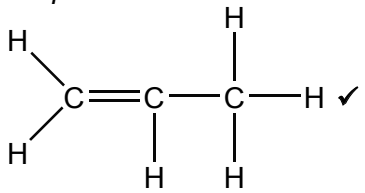
Question			Answers	Notes	Total
5.	**a**		*Propane*:  ***AND*** *Propene*:  ✓		**1**
5.	**b**	**i**	$C_3H_8 + Br_2 \rightarrow C_3H_7Br + HBr$ ✓ **«**sun**»**light/UV/$h\nu$ ***OR*** high temperature ✓	*Do **not** accept "reflux" for M2.*	**2**
5.	**b**	**ii**	$C_3H_6 + Br_2 \rightarrow C_3H_6Br_2$ ✓		**1**
5.	**b**	**iii**	*Propane*: **«**free radical**»** substitution / S_R ***AND*** *Propene*: **«**electrophilic**»** addition / A_E ✓	*Award mark even if incorrect type of substitution/ addition given.*	**1**