

3(b)(iii)	increases (%) decomposition (of HBr)	1
	(increasing T) shifts equilibrium to the right / in the forward direction / endothermic direction / towards $H_2 + Br_2$	1
	to oppose the change or oppose the increase in temperature OR to absorb (additional) energy / heat OR to decrease the temperature	1
3(c)(ii)	$HCl = 9/10$ AND $x_{H_2} = 1/20$ AND $C_{l_2} = 1/20$ OR $HCl = 0.9(0)$ AND $H_2 = 0.05$ AND $C_{l_2} = 0.05$	1
3(d)(i)	$(K_p =) \frac{p_{H_2} \times p_{Cl_2}}{p_{HCl}^2}$	1
3(d)(iii)	4.649×10^{-3}	1
Total:		18

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Question	Answer	Marks
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May/June 2017 9701/22 · Q3 (b)(iii), (c)(ii), (d)(i), (d)(iii)

3(d)(i)	$(K_p =) \frac{p_{SO_3}^2}{p_{O_2} \times p_{SO_2}^2}$	1
3(d)(ii)	0.1946737305	1
	Pa^{-1}	1
Total:		17

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Question	Answer	Marks
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May/June 2017 9701/23 · Q3 (d)(i), (d)(ii)

1(f)(ii)	fully ionises/dissociates	1
	(Brønsted-Lowry acid is a) proton / H^+ donor	1

May/June 2018 9701/21 · Q1 (f)(ii)

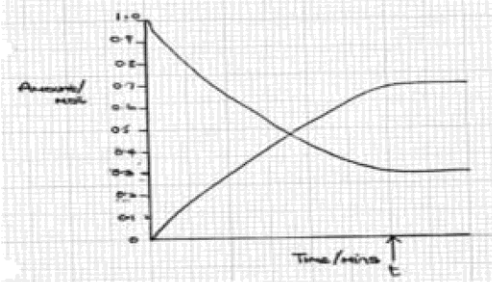
1(d)(i)	$K_c = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2 \times [\text{O}_2]}$		1
1(d)(iii)	$K_c = \frac{(1.98 / 40)^2}{(0.02 / 40)^2 (1.01 / 40)}$ $= 3.88 / 3.882 \times 10^5$ Units = $\text{dm}^3 \text{mol}^{-1} / \text{mol}^{-1} \text{dm}^3$	M1 M2 M3	3

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Question	Answer	Marks
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May/June 2018 9701/23 · Q1 (d)(i), (d)(iii)

1(c)(i)	t shown on graph which corresponds to start of the horizontal part of both curves. 	1
1(c)(iv)	M1 value for K_c $K_c = \frac{\text{value of methylpropane in (ii)}}{\text{value of butane in (ii)}} = 0.7 / 0.3 = 2.3 \text{ (3)}$	1
	M2 units consistent with expression used in M1 no units / dimensionless / none	1

Question	Answer	Marks
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May/June 2019 9701/22 · Q1 (c)(i), (c)(iv)

2(c)(i)	proton / H^+ donor	1
2(c)(ii)	acid HCl AND conjugate base Cl^-	1

May/June 2019 9701/22 · Q2 (c)(i), (c)(ii)

1(f)(i)	M1 equal rates of forward and backward reactions M2 closed system OR macroscopic properties unchanging	2																
1(f)(ii)	M1 <table><tr><td></td><td>Cl_2</td><td>O_2</td><td></td></tr><tr><td>initial</td><td>x</td><td>0</td><td>mol</td></tr><tr><td>equilibrium</td><td>$0.3x$</td><td>$0.35x$</td><td>mol</td></tr><tr><td>mol fraction</td><td>$\frac{6}{13}$</td><td>$\frac{7}{13}$</td><td></td></tr></table> M2 $K_p = \frac{100\,000 \times \frac{7}{13}}{(100\,000 \times \frac{6}{13})^2} = 2.53 \times 10^{-5}$ M3 Pa^{-1}		Cl_2	O_2		initial	x	0	mol	equilibrium	$0.3x$	$0.35x$	mol	mol fraction	$\frac{6}{13}$	$\frac{7}{13}$		3
	Cl_2	O_2																
initial	x	0	mol															
equilibrium	$0.3x$	$0.35x$	mol															
mol fraction	$\frac{6}{13}$	$\frac{7}{13}$																

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Question	Answer	Marks
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March 2020 9701/22 · Q1 (f)(i), (f)(ii)

4(a)	Accepts a proton / H^+ (ion)	1
4(b)	<i>Two reasons why product mixture is added to soil – allow in any order</i> M1 Acts as a fertiliser / adds nutrients (for plants) M2 Neutralise acid soils / increases the pH of acid soil	2

May/June 2020 9701/21 · Q4 (a), (b)

3(d)(ii)	M1: proton / H^+ donor	2
	M2: partially dissociates (in solution)	

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Question	Answer	Marks
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Oct/Nov 2020 9701/22 · Q3 (d)(ii)

2(c)(i)	M1 rates of forward and reverse / backward reactions are equal	1
	M2 closed / sealed system / container OR no change in measurable properties / no change in macroscopic properties	1
2(c)(ii)	M1 mol fraction = $0.97 / (0.030 + 0.060 + 0.97) = 0.97 / 1.06 = (0.9151)$	1
	M2 $M1 \times 1.0 \times 10^7 = 9.2 \times 10^6 \text{ (Pa)}$ ✓✓	1
2(c)(iii)	<i>expression for K_p</i> M1 $K_p = p(\text{CH}_3\text{OH}) / p(\text{CO}) \times p(\text{H}_2)^2$	1
	M2 units = Pa^{-2}	1

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Question	Answer	Marks
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May/June 2021 9701/23 · Q2 (c)(i), (c)(ii), (c)(iii)

1(c)(ii)	HS^-	1
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Question	Answer	Marks
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Oct/Nov 2021 9701/21 · Q1 (c)(ii)

1(c)(i)	$K_p = \frac{p_{HI}^2}{p_{H_2} p_{I_2}}$	1
1(c)(ii)	28.76 OR 28.8 OR 29	1

Oct/Nov 2021 9701/22 · Q1 (c)(i), (c)(ii)

3(a)(i)	M1 rate(s) of forward and reverse / backward reactions are equal / are the same M2 no change in measurable properties OR concentration of reactants and products remain constant	2
3(a)(ii)	(colourless gas) becomes purple (gas)	1
3(a)(iii)	$K_p = \frac{(p_{H_2})(p_{I_2})}{(p_{HI})^2}$	1
3(a)(iv)	M1 use correct expression for finding amount of HI used up in reaction $86.4 = 100 \times (0.025 - x) / (0.025 - x + x/2 + x/2)$ where $x = HI$ mol used up OR $86.4 = 100 \times (0.025 - 2x) / (0.025 - 2x + x + x)$ where $2x = HI$ mol used up M2 correct calculation to find amount of HI(mol) at equilibrium based on HI(mol) at eq'm = $0.025 - HI(mol)$ used = $0.025 - 0.0034 = 0.0216$ OR 0.022 (mol) alternative method M1 use the pp H_2 and pp I_2 at equilibrium (= 13.6) to calculate no mol H_2 & I_2 at equilibrium (either 0.0034 in total OR 0.0017 each) M2 use value for no mol $H_2 + I_2$ in expression to find no mol HI $0.025 - (\text{no mol } H_2 + I_2) = 0.0216$	2
3(c)	none / no change	1
3(d)(i)	acid-base	1

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Question	Answer	Marks
3(d)(ii)	$8HI + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$ OR $8H^+ + 8I^- + H_2SO_4 \rightarrow 4I_2 + H_2S + 4H_2O$	1
3(d)(iii)	explanation in terms of comparison of reducing nature of HI to HCl i.e. HI / I^- is stronger reducing agent compared to Cl^- / HCl OR explanation in terms of additional behaviour of HI (compared to HCl) i.e. HI / I^- reduces S (in sulfuric acid) / (concentrated) sulfuric acid	1

Question	Answer	Marks
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May/June 2022 9701/22 · Q3 (a)(i), (a)(ii), (a)(iii), (a)(iv), (c), (d)(i), (d)(ii), (d)(iii)

3(a)(iii)	M1 $K_c = \frac{[C_2H_6][CO][CH_4]}{[C_4H_{10}O]}$ M2 $\text{mol}^2 \text{dm}^{-6}$	2
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May/June 2022 9701/23 · Q3 (a)(iii)

1(c)(i)	proton / H^+ donor	1
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Oct/Nov 2022 9701/22 · Q1 (c)(i)

4(b)	M1 amount ethanol increases M2 equilibrium moves to right AND to produce fewer moles gas OR smaller amount of gas (to reduce the pressure)	2
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May/June 2023 9701/22 · Q4 (b)

4(b)(i)	(from colourless) to purple	1
4(b)(ii)	$K_c = \frac{[H_2][I_2]}{[HI]^2}$ OR $0.0217 = \frac{[H_2][I_2]}{[HI]^2}$	1
4(c)(ii)	endothermic AND decrease in temperature causes position of equilibrium to shift in exothermic direction	1

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Question	Answer	Marks
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May/June 2023 9701/23 · Q4 (b)(i), (b)(ii), (c)(ii)

3(a)	M1 (if a change in conditions occurs) the equilibrium shifts M2 to minimise the change in conditions	2
3(b)	M1 change in appearance paler red / more yellow / less orange M2 change in relative concentration of $FeSCN^{2+}(aq)$ lower M3 change in value of the equilibrium constant, K_c lower	3
3(c)(i)	M1 deduce the concentration of SCN^- present in initial mixture $[SCN^- \text{ eq'm}] = [Fe^{3+} \text{ eq'm}] = [\text{original } SCN^-] - [FeSCN^{2+} \text{ produced}]$ $1.30 \times 10^{-3} + 0.300 \times 10^{-3} = 1.60 \times 10^{-3} \text{ mol dm}^{-3}$ M2 find initial amount of Fe^{3+} initially $M1 \times 25 / 1000 = \text{amount of } Fe^{3+} \text{ added initially} = 4.00 \times 10^{-5} \text{ (mol)}$	2
3(c)(ii)	M1 value for $K_c = 178$ M2 units = $\text{mol}^{-1} \text{ dm}^3$	2

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Question	Answer	Marks
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May/June 2024 9701/21 · Q3 (a), (b), (c)(i), (c)(ii)

3(a)	M1 rates of forward and reverse / backward reactions are equal M2 no change in measurable properties OR concentration of reactants AND products remain constant	2
3(b)(i)	M1 change to appearance of the mixture: (goes) darker red / more red M2 change to relative concentration of $\text{Fe}^{3+}(\text{aq})$: decreases M3 change to the value of equilibrium constant, K_c : constant / none	3

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Question	Answer	Marks
3(b)(ii)	Method 1 M1 conc of initial conc of Fe^{3+} and $\text{SCN}^- = 0.0020 \text{ (mol dm}^{-3}\text{)}$ M2 at equilibrium the conc of Fe^{3+} and SCN^- are $(\text{M1} - 0.000423)$ M3 use $0.000423 \div (\text{M1} - 0.000423)^2$ to calculate $K_c = 170(.089)$ M4 units = $\text{mol}^{-1} \text{ dm}^3$ OR $\text{dm}^3 \text{ mol}^{-1}$ Method 2 M1 no mol $\text{FeSCN}^{2+} = 4.23 \times 10^{-4} \times 25 / 1000 = 1.0575 \times 10^{-5}$ M2 no mol Fe^{3+} and SCN^- are $(5 \times 10^{-5} - \text{M1}) = 3.9425 \times 10^{-5}$ M3 $0.000423 \div (\text{M2} \times 1000 / 25)^2 = 170(.089)$ M4 units = $\text{mol}^{-1} \text{ dm}^3$ OR $\text{dm}^3 \text{ mol}^{-1}$	4

May/June 2024 9701/22 · Q3 (a), (b)(i), (b)(ii)

2(c)(ii)	M1 correct amount N_2 at equilibrium = $1 - 1.16 / 2 = 0.42$ AND correct amount H_2 at equilibrium = $3.0 - (1.16 \times 3 / 2) = 1.26$ M2 express amount of ammonia as a mol fraction in terms of total amount of $\text{N}_2 + \text{H}_2 + \text{NH}_3$ at equilibrium = $1.16 / (\text{N}_2 + \text{H}_2 + 1.16) = 0.408$ OR 0.41	2
2(c)(iii)	$0.625 \times 1000 = 625 \text{ (atm)}$	1

May/June 2024 9701/23 · Q2 (c)(ii), (c)(iii)

3(c)(ii)	sodium chloride / NaCl	1
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March 2025 9701/22 · Q3 (c)(ii)

3(b)	M1 (if a change is made at a system is dynamic equilibrium) the equilibrium moves M2 to minimise the change in conditions	2
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May/June 2025 9701/21 · Q3 (b)

2(d)	it / ZnO accepts protons	1
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May/June 2025 9701/23 · Q2 (d)

3(c)	2.46	1
3(d)(i)	(electrostatic) attraction between the nuclei (of two atoms) and a shared pair of electrons	1

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Question	Answer	Marks
3(d)(iii)	any value or range of values for K_c between $5.50 \times 10^{-34} < K_c < 1.26 \times 10^{-3}$	1

Question	Answer	Marks
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May/June 2025 9701/24 · Q3 (c), (d)(i), (d)(iii)

1(d)(i)	rate of forward and backward (reaction) are the same / equal OR concentrations of reactants and products are constant	1
1(d)(ii)	closed system	1

Oct/Nov 2025 9701/21 · Q1 (d)(i), (d)(ii)

2(e)(i)	rate of forward and backward (reaction) are the same / equal OR (ratio of) concentrations of reactants and products are constant	1
2(e)(ii)	closed system	1

Oct/Nov 2025 9701/22 · Q2 (e)(i), (e)(ii)

2(b)(i)	$\text{mol}^{-2} \text{dm}^6$	1
2(b)(ii)	M1 at equilibrium: moles of CO = 0.120 AND moles of H ₂ = 0.240 M2 [CH ₃ OH] = 0.056 AND [CO] = 0.024 AND [H ₂] = 0.048 M3 use of K_c with correct evaluation = 1.01×10^3	3

Oct/Nov 2025 9701/24 · Q2 (b)(i), (b)(ii)