Mark Scheme

Q1.

Question Number	Correct Answer	Reject	Mark
	B		1

Q2.

Question Number	Acceptable Answers	Reject	Mark
(a)(i)	**Mark the two points independently, subject to the constraint in Reject column** **Effect:** (Equilibrium) shifts to the right **(1)** *ALLOW*: "favours forward reaction" / "increase the amount of product" / "increase the yield (of product)" **Reason:** Exothermic (in forward direction) **(1)** *NOTE:* **Just** "(equilibrium) shifts in the exothermic direction" scores **(1)**	**"Equilibrium shifts to left" will score (0) for (a)(i)**	2

Question Number	Acceptable Answers	Reject	Mark
(a)(ii)	**First mark:** Activation energy for the reaction is too high / (if cooled) molecules would not have enough energy to react / few(er) molecules have the required E_a/more molecules have energy $\geq E_a$ at higher temperatures **OR** not (technologically) feasible to cool the gases before they enter the converter/costly to cool the gases **(1)** **Second mark:** (cooling the gases would make) the rate (too) slow /rate is faster if the temperature is high (so the gases are not cooled) **(1)**	Cooling the gases decreases the yield (of products) /an incorrect Le Chatelier argument	2

Question Number	Acceptable Answers	Reject	Mark
(a)(iii)	**Mark the two points independently, subject to the constraint in Reject column** **Effect:** (Equilibrium) shifts to the right *ALLOW*: "favours forward reaction" / "increase the amount of product" / "increase the yield of product" **(1)** **Reason:** Shifts / moves in the direction of fewer (moles of gas) molecules *ALLOW* "shifts in direction of fewer moles (of gas molecules)" **(1)** *IGNORE* effect on the rate	**"Equilibrium shifts to left" will score (0) for (a)(iii)** "…. fewer atoms"	2

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	(In NO): +2 / 2+ (1) (In NO_3^-): +5 / 5+ (1) *NOTE*: (In NO): Just "2" **AND** (In NO_3^-): Just "5" scores (1)		2

Question Number	Acceptable Answers	Reject	Mark
(b)(ii)	$NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O$ *ACCEPT* multiples		1

Question Number	Acceptable Answers	Reject	Mark
(b)(iii)	$Ag \rightarrow Ag^+ + e^{(-)}$ / $Ag - e^{(-)} \rightarrow Ag^+$ *ACCEPT* multiples *IGNORE* state symbols, even if incorrect	"$Ag + e^- \rightarrow Ag^+$"	1

Question Number	Acceptable Answers	Reject	Mark
(b)(iv)	$3Ag + NO_3^- + 4H^+ \rightarrow 3Ag^+ + NO + 2H_2O$ (2) (1) for multiplication of the silver half-equation by three or cq multiple from (b)(ii) (1) for rest of equation correct *NOTE*: Equation must be completely correct for the second mark. *IGNORE* state symbols, even if incorrect	if any e^- are left in the final equation, second mark cannot be scored	2

Q3.

Question Number	Correct Answer	Reject	Mark
	A		**1**

Q4.

Question Number	Correct Answer	Mark
	B	1

Q5.

Question Number	Correct Answer	Reject	Mark
(a)	C		**1**
(b)	D		**1**

Q6.

Question Number	Correct Answer	Reject	Mark
(a)	D		1

Question Number	Correct Answer	Reject	Mark
(b)	D		1

Q7.

Question Number	Correct Answer	Reject	Mark
(a)	A		**1**

Question Number	Correct Answer	Reject	Mark
(b)	C		**1**

Q8.

Question Number	Acceptable Answers	Reject	Mark
(a)	1 Reaction 1: C goes from −4 to +2, (1) 2 H from +1 to 0 (redox reaction) (1) 3 Reaction 2: C goes from +2 to +4 (1) 4 H from +1 to 0 (redox reaction) (1) Allow from 2(+1) to 0 For each mark **both** correct oxidation states are needed Additional incorrect oxidation numbers of oxygen lose 1 mark per reaction Allow number followed by charge Penalise missing plus signs only once Penalise wrong use of the terms reduced and oxidized only once Penalise correct oxidation states and **not** a redox reaction only once 5 Reaction 3 **no** (elements) **change** (oxidation number)/**details for carbon / hydrogen calculated** **AND** so this is **not a redox reaction** **OR** Redox mentioned in reactions 1 and 2 but 'not redox' omitted in reaction 3 (1)	 H from +2 to 0 H from +2 to 0	5

Question Number	Acceptable Answers	Reject	Mark
* (b) (i)	Any seven from: **1** A higher temperature would increase the yield /favour the forward reaction /produce more hydrogen... **(1)** **2** ...(as) the reaction is endothermic **(1)** **3** Increased temperature would increase the rate/speed of reaction /make the reaction go faster... **(1)** **4** ...(as) a greater proportion of /more molecules have sufficient /higher/activation energy (to react) **(1)** **5** Decreased pressure increases the yield /favour the forward reaction /produce more hydrogen... **(1)** **6**...(as) the forward reaction is favoured with more (gaseous) molecules /mole **(1)** **7** Decreased pressure would decrease the rate of reaction... **(1)** **8** ...(as) collision frequency decreases/less collisions **(1)** Points may muddle into one another **Reverse statements allowed** e.g. 'lower temperature decreases yield because reaction is endothermic'. **Contradictory statements** in each pair lose both marks e.g. 'lower temperature increases yield because reaction is endothermic'.	'More (successful) collisions' alone	**7**

Question Number	Acceptable Answers	Reject	Mark
(b) (ii)	An excess is used to drive the equilibrium to the right / to ensure all the methane reacts (as the reaction responds to remove steam by Le Chatelier's principle) **(1)** Methane is more expensive (so it is better to increase the amount of steam) / steam is cheaper /readily available /renewable OR Methane is not renewable **(1)**	...to get a better yield of hydrogen /to allow reaction to happen fully / so all the reactants react / to make the reaction go to completion Methane is a greenhouse gas / dangers associated with methane e.g. flammable	**2**

Question Number	Acceptable Answers	Reject	Mark
(c)	The catalyst provides an alternative route for the reaction **(1)** (with) a lower activation energy **(1)** Allow 'catalyst lowers activation energy' alone for one mark		**2**

Question Number	Acceptable Answers	Reject	Mark
(d) (i)	It regenerates /reforms potassium carbonate /reactant(s) (which reduces the cost of the process) OR potassium carbonate can be re-used Allow recycles potassium carbonate	Regenerates some of the other reactants. Chemicals are regenerated	**1**

Question Number	Acceptable Answers	Reject	Mark
* (d) (ii)	1 Carbon dioxide / CO_2 Allow both water and carbon dioxide (1) 2 Traps longer wavelength radiation / traps radiation / IR emitted (from the earth) OR Absorbs/traps heat /IR OR Prevents loss of IR / heat (1) 3,4 Any two from: Rising sea levels / flooding Polar ice / ice caps /glacier(s) / glacial / habitat ice melting Changing (sea /air) currents Changing weather patterns /more extreme weather / climate change (2) Other acceptable alternatives only if well justified e.g. more malaria because more breeding areas for mosquitoes But more malaria /desertification /forest fires alone is insufficient Three or more correct answers get 2 marks Three or more answers, where some are wrong, are marked 1 mark for each correct answer and -1 mark for each incorrect answer e.g. Two correct and one wrong award 1 mark Three correct and two wrong award 1 mark etc One on list and one wrong award 1. Ignore neutral statements	Water alone Mark is lost if any mention of UV / ozone layer depletion Absorbs IR / heat from the sun Increased UV Increased skin cancer/melanoma	4

Q9.

Question Number	Acceptable Answers	Reject	Mark
(a)(i)	2.2 g in 1000 g = 2200 g per 1 000 000 g / 2200 (ppm) (greater than 60) OR 60ppm = 0.060 (g dm^{-3}) (less than 2.2) OR 2.2g dm^{-3} = 0.22% which is more than 60ppm = 0.006% (Both values needed as neither is given in question) OR $2.2 \div 1000 = 2.2 \times 10^{-3}$ and $60 \div 1000000 = 6 \times 10^{-5}$		**1**

Question Number	Acceptable Answers	Reject	Mark
(a)(ii)	Cl_2 (g/aq) + $2Br^-$ (aq) → $2Cl^-$ (aq) + Br_2 (aq) Correct species **(1)** Balancing and state symbols **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(iii)	(Colourless to) yellow / orange / brown / red-brown colour (or any combination of these colours) appears	'Effervescence'	**1**

Question Number	Acceptable Answers	Reject	Mark
(a)(iv)	Addition of hydrochloric acid increases the concentration of H^+ **(1)** Equilibrium shifts to the left/ favours the backwards reaction / H^+ combines with Br^- **and** BrO^- to make H_2O and Br_2 **(1)** OR The equilibrium will not produce H^+ **(1)** So forward reaction will not occur **(1)** Standalone marks		**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(v)	The equilibrium shifts to the right / favours the forward reaction **(1)** To absorb added heat (energy) / in the endothermic / positive ΔH direction **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
(a)(vi)	Greater proportion of / more molecules with energy more than (or equal to) activation energy / sufficient energy to react (at higher temperature) ALLOW particles. ALLOW 'overcome' for 'more than'.	Atoms Lowers activation energy Just 'more successful collisions'	**1**

Question Number	Acceptable Answers	Reject	Mark
(a)(vii)	Bromine (atoms) are (simultaneously) oxidized from 0 to +1 in BrO^- **(1)** And reduced to -1 in Br^- **(1)**		**2**

Question Number	Acceptable Answers	Reject	Mark
(b)(i)	The forward and backward reactions occur at the same **rate** **(1)** The concentrations or amounts or moles of reactants and products remain constant / intensive or macroscopic properties (e.g. colour) are constant **(1)** IGNORE reference to 'closed system'	Concentrations of products and reactants are the same	**2**

Question Number	Acceptable Answers	Reject	Mark
(b)(ii)	Equilibrium shifts to the right so more $CO_2(g)$ dissolves / equilibrium shifts to the right so reducing the concentration of $CO_2(aq)$ **(1)** So amount of CO_2 in atmosphere / gaseous decreases **(1)** Second mark depends on first unless qualified by a near miss		**2**

Question Number	Acceptable Answers	Reject	Mark
(b)(iii)	(Bonds) bend / stretch / vibrate (more)/ bonds change polarity or dipole (moment)	Molecules vibrate Bonds break.	**1**

Question Number	Acceptable Answers	Reject	Mark
(b)(iv)	Infrared radiation / heat is absorbed by greenhouse gases / by carbon dioxide and water **(1)** And one of the following: When energy from the sun is (re-)emitted from the earth's surface (allow 'reflected') OR IR / heat cannot escape from earth's atmosphere OR IR / heat is (re-)emitted back to the earth **(1)**	IR absorbed from the sun UV radiation	**2**

Question Number	Acceptable Answers	Reject	Mark
(b)(v)	• Anthropogenic climate change is caused by human activity **(1)** • Natural climate change is caused by volcanic eruptions etc **(1)** Up to any three of the following to a max of (4) • Water vapour levels always relatively constant / water levels fluctuate normally / water levels vary only to a small extent • CO_2 levels increasing due to (fossil) fuel combustion/deforestation / industrial revolution • CO_2 **molecules** absorb more IR radiation than H_2O **molecules** OR CO_2 **molecules** have a greater 'greenhouse effect' than H_2O **molecules** • Increase in CO_2 levels has accompanied rise in global temperatures • Concern due to melting of ice packs / rising sea levels / flooding / change in sea pH etc	 Reference to UV Reference to ozone depletion negates this mark	**4**