Question	Answer	Marks	Guidance
1 a	The rate of the forward reaction is faster than the rate of the backward reaction ☐ The position of equilibrium will not change if more product is added ☐ The concentration of the reactants does not change ✓ The rate of the forward reaction is the same as the rate of the backward reaction ✓ The concentration of the reactants is the same as the concentration of the products ☐ The position of equilibrium moves to the left when product is removed from the equilibrium ☐ **one** correct answer (1) **but** **two** correct answers (2)	2	
b	(yes) it is exothermic because the percentage yield goes down as **temperature** increases (1) (no) there are less moles on right hand side because the percentage yield goes up as **pressure** increases (1)	2	**Answers must refer to yield, or amount of product reference to only position of equilibrium is not sufficient** **ignore** references to bond making and bond breaking **allow** ora if specified
	Total	**4**	

Question	Answer	Marks	Guidance
2 a	**[Level 3]** **Deduces how increasing temperature and pressure affects the percentage yield** **AND** **Explains how addition of carbon dioxide will shift the position of equilibrium** Quality of written communication does not impede communication of the science at this level (5 – 6 marks) **[Level 2]** **Deduces how changing temperature and pressure affects the percentage yield** **AND** **Describes how adding carbon dioxide shifts the position of equilibrium** Quality of written communication partly impedes communication of the science at this level (3 – 4 marks) **[Level 1]** **Deduces how changing temperature affects the percentage yield and how changing pressure affects the percentage yield** **OR** **Describes how adding carbon dioxide shifts the position of equilibrium** Quality of written communication impedes communication of the science at this level (1 – 2 marks) **[Level 0]** Insufficient or irrelevant science. Answer not worthy of credit. (0 marks)	6	**This question is targeted at grades up to A.** **Indicative scientific points at level 3 must include:** • To minimise addition of carbon dioxide reaction uses up carbon dioxide i.e. shifts to the right **Relevant points at all levels could include explanations** • as temperature increases percentage yield decreases / as temperature increases position of equilibrium shifts to the left / ora • as pressure increases percentage yield increases / as pressure increases position of equilibrium shifts to the right / ora • Addition of carbon dioxide shifts position of equilibrium to the right / ora **Use the L1, L2, L3 annotations in scoris. Do not use ticks.**

Question	Answer	Marks	Guidance
b	**any two from:** can share ideas / have different views (1) can evaluate ideas / check results / can compare results (1) can collect more evidence (in a shorter time) / more productive / can do more approaches / can work faster / more ideas can be tested (1) can share cost of research (1)	2	**allow** small discoveries can be combined into a large one **allow** help to make new predictions **allow** results would be more reliable **ignore** results are more accurate
	Total	**8**	

Question	Answer	Marks	Guidance
3	**Level 3** **Applies knowledge to identify with reasons the type of hardness in all of the samples** **AND** **explains in detail how washing soda softens hard water** Quality of written communication does not impede communication of the science at this level. (5 – 6 marks) **Level 2** **Applies knowledge to identify, with reasons, the type of hardness in two of the samples** **OR** **Applies knowledge to identify, with a reason, the type of hardness in one of the samples and attempts to explain how washing soda softens hard water** Quality of written communication partly impedes communication of the science at this level. (3 – 4 marks) **Level 1** **Applies knowledge to identify, with a reason, the type of hardness in one of the samples** **OR** **attempts to explain how washing soda softens hard water** Quality of written communication impedes communication of the science at this level. (1 – 2 marks) **Level 0** Insufficient or irrelevant science. Answer not worthy of credit. (0marks)	6	**This question is targeted at grades up to A/A*.** **Indicative scientific points may include:** Types of hardness and explanation • sample **A** contains permanent hardness • as not softened by boiling • sample **B** contains both temporary and permanent hardness • as some (but not all) of the hardness is removed by boiling • sample **C** contains only temporary hardness • as it completely softened by boiling How washing soda softens hard water • hard water contains dissolved calcium ions and /or magnesium ions • calcium ions and magnesium ions removed from water • calcium and magnesium ions removed by precipitation as insoluble carbonates **Use the L1, L2, L3 annotations in Scoris; do not use ticks.**
		6	

Question			Answer	Marks	Guidance
4	(a)		**B** (1)	1	**allow** correct answer ticked, circled or underlined in list if the answer line is blank
	(b)		**any two from:** the temperature or pressure chosen is a compromise (1) the high temperature gives a high rate of reaction (1) high pressure increases the percentage yield of ethanol (1) at higher temperatures the percentage yield is lower (1) higher pressures are expensive to maintain or generate (1)	2	**allow** answer relating to the risks associated with high pressure (1)
			Total	**3**	

Question			Answer	Marks	Guidance
5			**Level 3 (5–6 marks)** **Manipulates the data to describe and explain how the position of equilibrium changes with pressure** **AND** **Manipulates the data to describe and explain how the position of equilibrium changes with temperature** Quality of written communication does not impede communication of the science at this level. **Level 2 (3–4 marks)** **Manipulates the data to describe and explain how the position of equilibrium changes with pressure** **OR** **Manipulates the data to describe and explain how the position of equilibrium changes with temperature** Quality of written communication partly impedes communication of the science at this level. **Level 1 (1–2 marks)** **Manipulates the data to describe how the position of equilibrium changes with pressure AND with temperature** Quality of written communication impedes communication of the science at this level. **Level 0 (0 marks)** Insufficient or irrelevant science. Answer not worthy of credit.	6	**This question is targeted at grades up to A*.** **Relevant points at levels 2 and 3 include:** • increasing the pressure moves the equilibrium to the right because there are fewer molecules (or number of moles)on the rhs • increasing the temperature moves the equilibrium to the left because the forward reaction is exothermic or the backward reaction is endothermic. **Relevant points at level 1 include:** • as the pressure increases the position of equilibrium moves to the right or vice versa • as pressure increases percentage of ammonia increases • as the temperature increases the position of equilibrium moves to the left or vice versa • as temperature increases the percentage of ammonia decreases **ignore** references to rate
			Total	**6**	

Question			Answer	Marks	Guidance
6	(a)		**Any two from:** Contains both temporary **and** permanent hardness (1) temporary because volume of soap goes down on boiling (1) permanent because boiled water needs more soap than distilled water (1)	2	
	(b)		Mg^{2+} removed / Ca^{2+} removed (1) are replaced by Na^{+} ions (1)	2	**not** magnesium removed / calcium removed **allow** Ca^{+} ions **not** are replaced by sodium **allow** magnesium or calcium ions swapped for sodium ions (2) **allow** calcium ions displace sodium ions / ora
			Total	**4**	

Question			Answer	Marks	Guidance
7	(a)	(i)	increases / gets bigger / AW (1)	1	
		(ii)	decreases / gets less / AW (1)	1	
	(b)		idea of catalyst used to speed up the reaction or increase the rate of reaction (1) 70 atm used as is cheaper to generate than higher pressures (1) 300 ^{o}C is used to increase the rate of reaction but sacrifice percentage yield / it is a compromise or optimum temperature (1)	3	**allow** catalyst does not affect percentage yield (1) **allow** answer relating to the risks associated with high pressure (1)
	(c)		idea of **reduction** of wage bill / idea of **reduction** of number of workers (1)	1	**ignore** rule out human error **ignore** to make the process work faster **ignore** references to safety **ignore** it is a continuous process **not** no labour costs
			Total	**6**	