

A Level OCR Chemistry

Chapter 12 – answers

Question	Answers	Extra information	Mark	AO Spec reference
1(a)	from C—Cl to C—I the bond gets less polar This means that the carbon (in the C—X bond) is less electron deficient The nucleophile feels less attraction to the electron-deficient carbon and the reaction is slower.		1 1 1	AO3 4.2.2a 4.2.2d
1(b)(i)	Choose haloalkanes with similar structures. For example, 1-chlorobutane, 1-bromobutane, etc. Mix silver nitrate solution with ethanol/alcohol in separate test tubes. The ethanol acts as a solvent for the silver nitrate and the haloalkane. The silver ions will react with any halide ions formed in the reaction to give a precipitate (of the silver halide). Warm the mixtures in a beaker of warm water. Add equal number of drops of haloalkane to each tube and time how long it takes for a precipitate to appear.	This is for a fair test. Avoid selection of primary and secondary/tertiary haloalkanes. Molar volumes very similar.	1 1 1 1 1	AO1 PAG7 4.2.2a
1(b)(ii)	The precipitate will be formed most quickly with the iodoalkane. This shows that the factor determining the reactivity is the bond-enthalpy because the C—I bond is the weakest.	Allow the iodoalkane gives the densest precipitate	1 1	AO1 4.2.2d
2(a)	Electron-pair donor		1	AO1 4.2.2d
2(b)	Lone-pair of electrons on oxygen and negative charge on the 'OH'. To C ^{δ+} on C—Cl bond Curly arrow from either lone-pair or negative charge on 'OH'. Dipole on C-Cl bond i.e. C ^{δ+} —Cl ^{δ-} Curly arrow from C-Cl bond onto Cl One product is CH ₃ CH(OH)CH ₃ (or displayed formula) Cl: ⁻ other product	Both electron pair and charge on Cl: ⁻ are necessary to 'balance' the mechanism.	1 1 1 1 1 1	AO1 4.2.2c

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2(c)	$\text{CH}_2\text{BrCH}_2\text{Br} + 2\text{NaOH} \rightarrow \text{HOCH}_2\text{CH}_2\text{OH} + 2\text{NaBr}$	1 mark for correct products and 1 mark for balancing.	1 + 1	AO2/AO3 4.2.2a
	$\text{CH}_3\text{CHBrCH}_2\text{Br} + 2\text{NH}_3 \rightarrow \text{CH}_3\text{CH}(\text{NH}_2)\text{CH}_2\text{NH}_2 + 2\text{HBr}$	1 mark for correct products and 1 mark for balancing. For second equation accept 4NH_3 on LHS and $2\text{NH}_4\text{Br}$ on RHS i.e. $\text{CH}_3\text{CHBrCH}_2\text{Br} + 4\text{NH}_3 \rightarrow$ $\text{CH}_3\text{CH}(\text{NH}_2)\text{CH}_2\text{NH}_2 + 2\text{NH}_4\text{Br}$ Same mark allocation as above.	1 + 1	
3(a)	Butan-1-ol		1 1	AO2 4.2.1e
3(b)(i)	Sulfuric acid $\text{H}_2\text{SO}_4 + \text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O} + \text{CO}_2$	Accept	1	AO2
		$2\text{H}^+ + \text{CO}_3^{2-} \rightarrow \text{H}_2\text{O} + \text{CO}_2$	1	1.2.2d
3(b)(ii)	Continuous evaporation and condensation		1	AO1 4.2.3a
3(b)(iii)	The bromobutane and the aqueous mixture are immiscible. The bromobutane is denser than the aqueous layer so sinks to the bottom and can be run off.	Allow any words that means the same as immiscible	1 1	AO2 4.2.3a; 1.2.2g
3(c)	Indication that have correctly calculated the M_r of butan-1-ol (74) and 1-bromobutane (136.9) No. of moles of butan-1-ol = $4.8/74 = 0.0649$ No. of moles of 1-bromobutane = $5.75/136.9 = 0.0420$ mol Percentage yield = $(0.0420/0.0649) \times 100\% = 64.7\%$	Error carried forward throughout	1	AO2 2.1.3g
			1	
			1	
			1	

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4(a)(i)	A 2-methylpropan-2-ol 3° B 2, 2-dimethylpropan-1-ol 1° C 2-methylpropan-1-ol 1°	Both name and classification required for each mark	1 1 1	AO1/AO2 4.2.1a
4(a)(ii)	A and C $(\text{CH}_3)_2\text{C}=\text{CH}_2$		1	AO2 4.2.1d
4(a)(iii)	B It has no hydrogen atoms on the carbon adjacent to the C attached to the -OH group.	owtte	1 1	AO2 4.2.1d
4(a)(iv)	Either $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$ Butan-2-ol OR $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$ Butan-1-ol		1 1	AO2 4.2.1a
4(b)	<p>1 mark for dipoles 1 mark for lone-pair on oxygen 1 for dashed line for hydrogen bond</p>	Each component is a separate mark.	1 1 1	AO1 4.2.1a
5(a)	Warm both alcohols (separately) With acidified potassium dichromate solution With E the solution changes from orange to green	Owtte Allow $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$	1 1 1	AO1 4.2.1c
5(b)(i)	Acidified potassium dichromate solution	Reject $\text{H}^+/\text{Cr}_2\text{O}_7^{2-}$ as this is not a reagent but an ion	1	AO1 4.2.1c
5(b)(ii)	Refluxing will return the products the reaction flask. Oxidising the aldehyde to the carboxylic acid		1 1	AO3 4.2.1c; 4.2.3a; 6.1.2a

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5(b)(iii)	Distillation will remove the products from the reaction vessel Any aldehyde formed cannot be oxidised further to the carboxylic acid		1 1	AO3 4.2.1c; 4.2.3a; 6.1.2a
5(c)	Group I $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + [\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CHO} + \text{H}_2\text{O}$ Group II $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + 2[\text{O}] \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{COOH} + \text{H}_2\text{O}$		1 1	AO2 4.2.1c
6(a)(i)	G $\text{CH}_3\text{CH}_2\text{COOH}$ and $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH}$	Both structural formulae needed for mark. Do not accept other types of formulae.	1	AO2 6.1.3c
6(a)(ii)	H CH_3COOH and $(\text{CH}_3)_2\text{CHCH}_2\text{CH}_2\text{OH}$	Both structural formulae needed for mark. Do not accept other types of formulae.	1	AO2 6.1.3c
6(b)(i)	Concentrated sulfuric acid	Allow concentrated phosphoric or hydrochloric acid	1	AO1 6.1.3c
6(b)(ii)	Number of moles of $\text{CH}_3\text{COOH} = 9/60 \text{ mol} = 0.15 \text{ mol}$ Number of moles of $(\text{CH}_3)_2\text{CHCH}_2\text{OH} = 14.8/74 = 0.2 \text{ mol}$ Therefore, CH_3COOH is limiting reagent because lower amount is used.		1 1 1	AO2 2.1.3h
6(b)(iii)	Number of moles of product = $14.5/116 = 0.125 \text{ mol}$ Yield = $(0.125/0.15) \times 100\% = 83.3\%$	Alternative is calculating the expected mass of the ester. i.e $0.15 \times 116 = 17.4 \text{ g}$ Yield = $(14.5/17.4) \times 100\% = 83.3\%$	1 1	AO2 2.1.3

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6(b)(iv)	Any two from: The reaction is reversible Will not get to completion Product is lost in transfer or purification There are side reactions		1 1	AO3 3.2.3

Skills box answers:

$$\text{a) } [\text{H}^+] = \sqrt{K_a[\text{HA}]} = \sqrt{1.75 \times 10^{-5} \times 0.5} = 0.00296 \text{ mol dm}^{-3}$$

$$\text{b) } [\text{H}^+] = \sqrt{K_a[\text{HA}]} = \sqrt{1.51 \times 10^{-5} \times 0.2} = 0.00174 \text{ mol dm}^{-3}$$

$$\text{c) } [\text{H}^+] = \frac{\text{rate}}{k[\text{Br}^-]} = \frac{0.4 \times 10^{-4}}{1.6 \times 10^{-4} \times 0.6} = 0.417 \text{ mol dm}^{-3}$$

$$\text{d) } [\text{H}^+] = \frac{\text{rate}}{k[\text{CH}_3\text{COOCH}_3]} = \frac{8.2 \times 10^{-6}}{1.5 \times 10^{-3} \times 0.02} = 0.273 \text{ mol dm}^{-3}$$