PEARSON EDEXCEL IAL CHEMISTRY · YCH11

CHEMISTRY



EXAM QUESTION PACK

UNIT 2: GENERAL PRINCIPLES

SCORE	PERCENTAGE
/72	%

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Q1.

1-bromopropane is used for spot removal when 'dry cleaning' clothes.

(a) 1-bromopropane does not occur naturally but can be made from propan-1-ol.

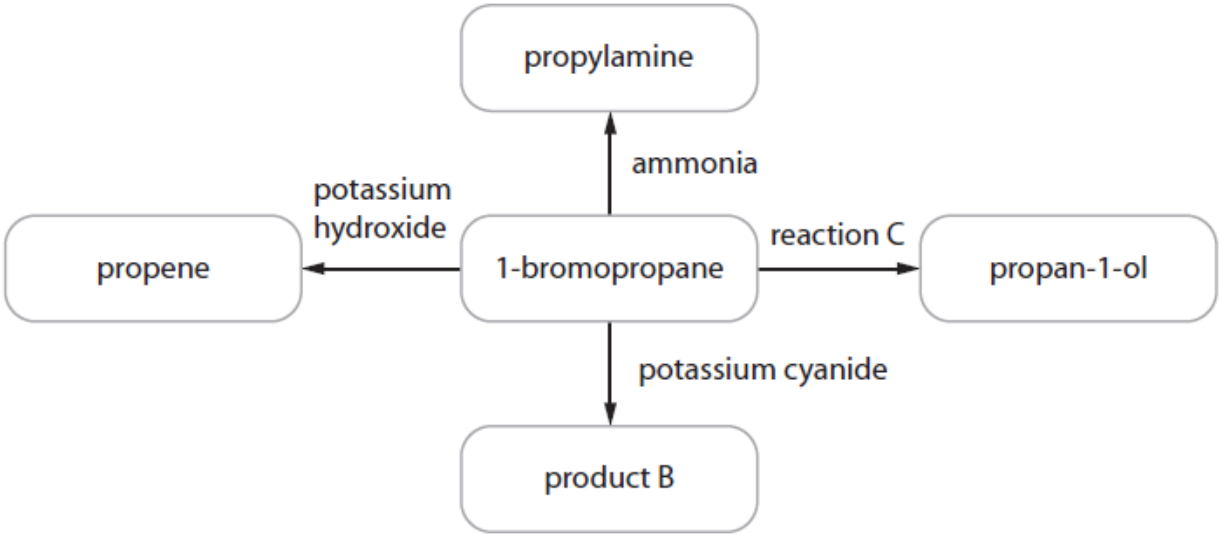
Identify the reagent or reagents you would use to make 1-bromopropane from propan-1-ol.

(1)

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(b) Some reactions of 1-bromopropane are shown.



(i) Give the conditions for the formation of propene.

(1)

.....

(ii) Give the **molecular** formula of product B.

(1)

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(iii) Name the type and mechanism of the reaction taking place in reaction C.

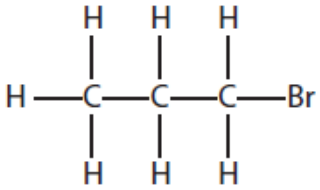
(2)

.....

(iv) Complete the mechanism for the reaction that occurs between ammonia and 1-bromopropane to form propylamine,
$CH_3CH_2CH_2NH_2$.

Include curly arrows, and relevant lone pairs and dipoles.

(4)



(Total for question = 9 marks)

Q2.

This question is about bicycles.

Bicycle frames have been made from steel and aluminium for many years but more recently titanium has been used.

Titanium is a metal that is extracted from its ore, impure titanium oxide (TiO_2), in a two-step process.

Step **1**

The titanium oxide reacts with chlorine in the presence of carbon to form titanium(IV) chloride ($TiCl_4$) and carbon monoxide.

Step **2**

The titanium(IV) chloride reacts with magnesium.

$$TiCl_4 + 2Mg \rightarrow Ti + 2MgCl_2$$

(a) (i) Write the equation for Step **1**.

State symbols are not required.

(1)

(ii) Explain why Step **2** is a redox reaction.

Refer to relevant oxidation numbers in your answer.

(2)

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.....

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(b) Titanium(IV) chloride is a liquid that reacts violently with water, producing white smoke. This reaction has been used to produce naval smoke screens to hide ships.

Suggest the type of reaction taking place **and** the compound producing the white smoke.

(2)

Type of reaction

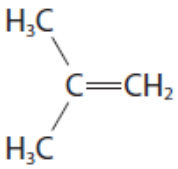
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Compound

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(c) Many bicycles use an inner tube inside the tyre.

A common material used for inner tubes is the addition polymer formed from 2-methylpropene.

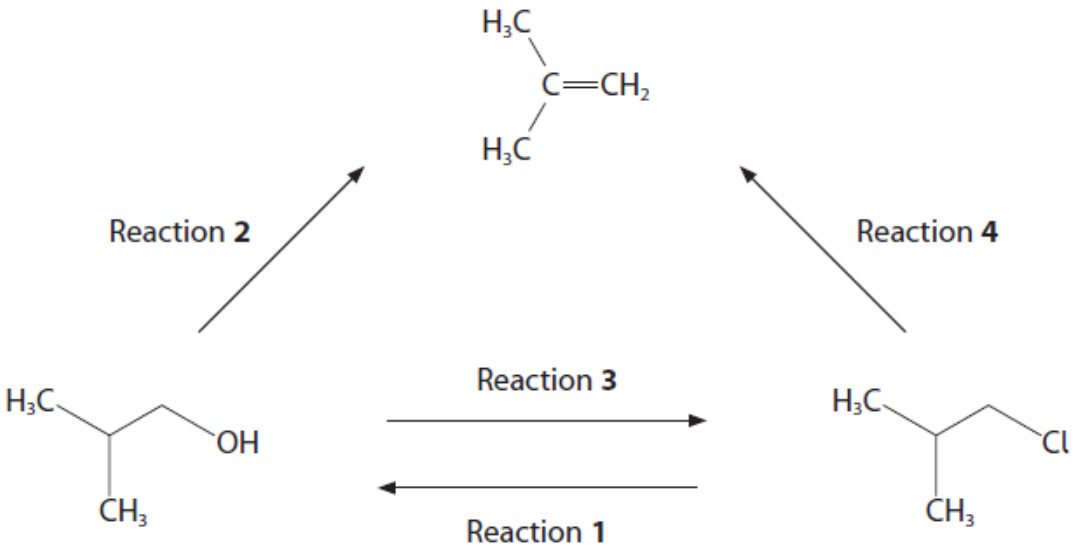


2-methylpropene

Draw a section of the polymer showing two repeat units.

(2)

(d) A reaction scheme involving 2-methylpropene is shown.



(i) For Reaction **1**, give the name or formula of a suitable reagent, stating the conditions for the reaction.

(2)

Reagent

.....

Conditions

.....

(ii) For Reaction **2**, give the name or formula of a suitable reagent, stating the type of reaction taking place.

(2)

Reagent

.....

Type of reaction

.....

(iii) For Reaction **3**, give the name or formula of a suitable reagent, writing an equation for the reaction taking place.

(2)

Reagent

.....

Equation

(iv) For Reaction **4**, the reagent used is potassium hydroxide (KOH).

Give the conditions required for this reaction, stating the role of the hydroxide ions in this reaction.

(2)

Conditions

.....

Role of hydroxide ions

.....

(e) Many cyclists carry a small cylinder of carbon dioxide to inflate their inner tube if it is punctured. The carbon dioxide is stored under pressure.



(Source: © Douglas Sacha/Getty Images)

A gas cylinder contains 16.0 g of carbon dioxide (CO_2).
The cylinder has a volume of 20 cm^3 .

Calculate the pressure in the cylinder at 25 °C. Include units in your answer.
Assume that all the CO_2 in the cylinder is a gas.

[$pV = nRT$ $R = 8.31$ J mol^{-1} K^{-1}]

(5)

(Total for question = 20 marks)

Q3.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Organic reactions can be classified in different ways.

(a) How should the reaction shown be classified?

(1)



☒ **A** addition

☒ **B** oxidation

☒ **C** polymerisation

☒ **D** substitution

(b) How should the reaction shown be classified?

(1)



☒ **A** addition

☒ **B** oxidation

☒ **C** reduction

☒ **D** substitution

(Total for question = 2 marks)

Q4.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Hydrogen peroxide decomposes in the presence of a catalyst.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) What type of reaction occurs?

(1)

☒ **A** displacement

☒ **B** disproportionation

☒ **C** elimination

☒ **D** hydrolysis

(b) In an experiment, the volume of oxygen produced by the decomposition of hydrogen peroxide was measured at various times as the reaction progressed and a graph was plotted.

The initial gradient of the graph was 0.50 $cm^3\ s^{-1}$.

What is the initial rate of decomposition of hydrogen peroxide in mol s^{-1}?

[Molar volume of a gas at r.t.p. = 24 $dm^3\ mol^{-1}$]

(1)

☒ **A** 2.1×10^{-2} mol s^{-1}

☒ **B** 4.2×10^{-5} mol s^{-1}

☒ **C** 2.1×10^{-5} mol s^{-1}

☒ **D** 1.0×10^{-5} mol s^{-1}

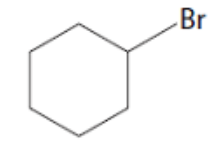
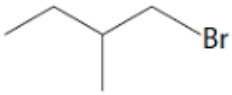
(Total for question = 2 marks)

Q5.

This question is about some halogenoalkanes.

(a) Give the classification of each halogenoalkane shown in the table as primary, secondary or tertiary.

(1)

Halogenoalkane	Classification
	
	

(b) Samples of 1-iodobutane and 2-chloro-2-methylpropane were hydrolysed using aqueous silver nitrate in ethanol.

Explain whether or not it is possible to predict the relative rate of hydrolysis of these two compounds.

(3)

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(c) Butylamine is formed when 1-bromobutane reacts with excess concentrated alcoholic ammonia.

$$CH_3CH_2CH_2CH_2Br + 2NH_3 \rightarrow CH_3CH_2CH_2CH_2NH_2 + NH_4Br$$

(i) Give a reason why this reaction should be carried out by heating the reactants in a sealed tube rather than heating under reflux.

(1)

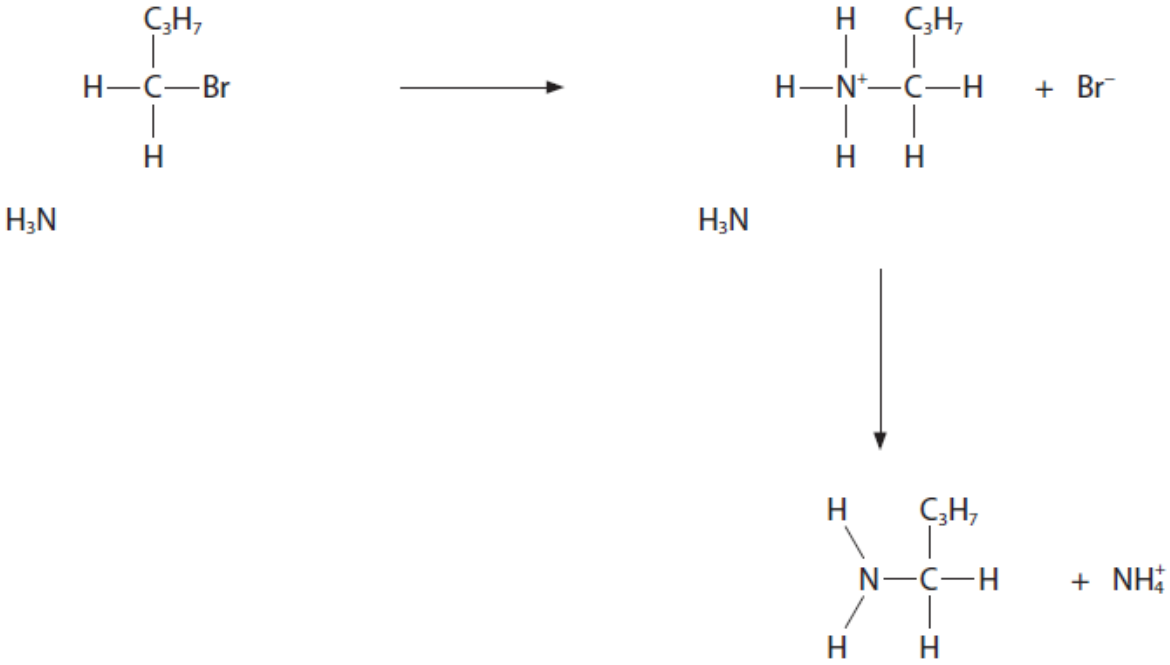
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(ii) Complete the mechanism for this reaction by adding curly arrows, and any relevant lone pairs and dipoles.

(4)



(d) Bromoethane is prepared by reacting ethanol with potassium bromide and concentrated sulfuric acid.

$$C_2H_5OH + KBr + H_2SO_4 \rightarrow C_2H_5Br + KHSO_4 + H_2O$$

Calculate the maximum mass of bromoethane that could be prepared from 4.65 g of ethanol, 14.90 g of potassium bromide and a solution containing 16.35 g of H_2SO_4.

[Ar values: H = 1.0 C = 12.0 O = 16.0 S = 32.1 K = 39.1 Br = 79.9]

(3)

*(e) The reaction between 2-bromopropane and potassium hydroxide takes place under two different conditions:

- in aqueous solution
- in ethanolic solution.

Compare and contrast these two reactions.

Include equations for the reactions.
Detailed mechanisms of these reactions are **not** required.

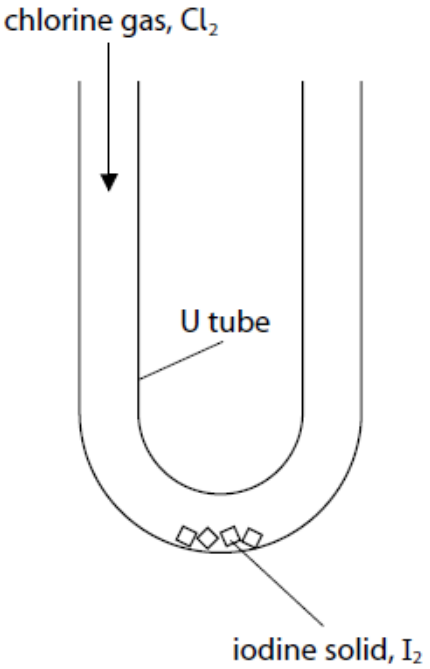
(6)

(Total for question = 18 marks)

Q6.

Iodine monochloride, ICl, is a covalent compound produced by the reaction of iodine with chlorine. Iodine monochloride is a dark brown liquid at room temperature.

The equipment shown can be used to pass chlorine over solid iodine to produce iodine monochloride.



When excess chlorine is passed through the U tube, the iodine monochloride reacts to produce iodine trichloride in an equilibrium reaction.

(a) Write a chemical equation for the reaction of iodine with chlorine to produce iodine monochloride. Include state symbols.

(2)

(b) The iodine monochloride molecule has a permanent dipole. Complete the following table using the electronegativity data from your Data Booklet and hence show the dipole on the diagram of the iodine monochloride molecule.

(1)

Element	Electronegativity
Cl	
I	

I — Cl

(c) Iodine monochloride reacts with propene to form two isomeric products. This is an addition reaction that is similar to the reaction of propene with hydrogen halides.

(i) Draw the skeletal formulae of both isomers.

(2)

(ii) Explain which of these isomers is the major product.

(3)

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(d) The equation for the reaction between iodine monochloride and chlorine is:

$$\underset{\text{brown liquid}}{ICl(l)} + Cl_2(g) \rightleftharpoons \underset{\text{yellow solid}}{ICl_3(s)}$$

(i) State and justify **one** precaution that must be taken when preparing iodine trichloride.

(2)

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(ii) Give the oxidation number of iodine in both iodine-containing compounds in the equilibrium.

(1)

I in ICl

.....

I in ICl_3

.....

(iii) Iodine trichloride can also be made by reacting potassium chlorate(V) with iodine in hydrochloric acid. The equation for the reaction is

$$KClO_3 + I_2 + 6HCl \rightarrow KCl + 2ICl_3 + 3H_2O$$

By considering oxidation numbers for chlorine, explain whether or not this reaction is a disproportionation.

(2)

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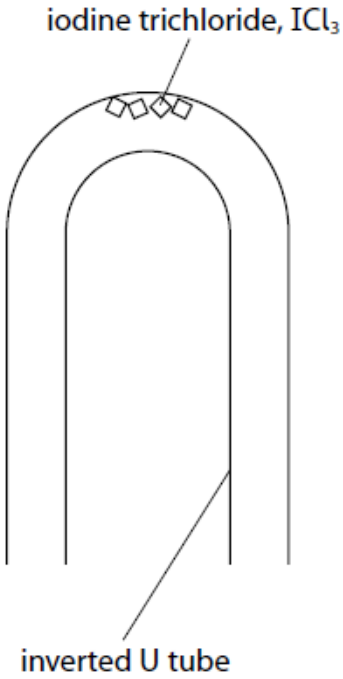
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(e) Chlorine gas has a molar volume of 24 000 cm^3 mol^{-1} under the conditions used in this reaction.

(i) Show that the density of chlorine gas is approximately 3 g dm^{-3}.

(2)

(ii) Air has an average density of 1.25 g dm^{-3}. If the U-tube used in part (d) is inverted, as shown in the diagram, the solid yellow iodine trichloride produced in the equilibrium reaction turns to a brown liquid.



Explain this observation.

(3)

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(f) A mass of 0.64 g of iodine reacted with fluorine to form 1.31 g of a fluoride of iodine.

Calculate the empirical formula of this compound of iodine and fluorine.

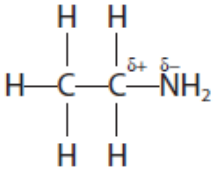
(2)

(Total for question = 20 marks)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The structure of ethylamine is shown.



What type of reagent will attack the Cδ+ atom?

☒ **A** electrophile

☒ **B** free radical

☒ **C** nucleophile

☒ **D** oxidising agent

Use this space for any rough working. Anything you write in this space will gain no credit.

(Total for question = 1 mark)

Mark Scheme

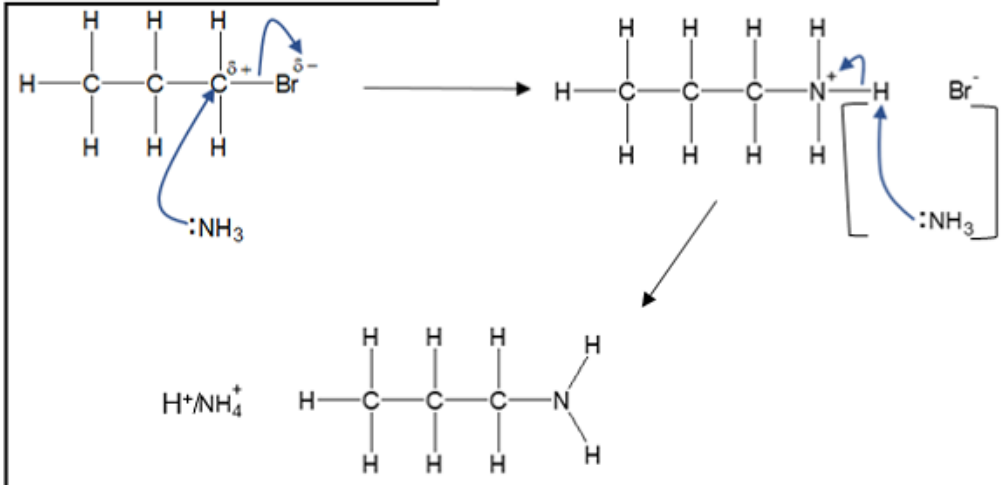
Q1.

Q	Answer	Additional Guidance	Mark
(a)	• identification of suitable reagent(s)	50% / concentrated **and** sulfuric acid / H_2SO_4 **and** potassium bromide / KBr Allow Other named bromides Phosphorus **and** bromine Phosphorus(V) bromide / PBr_5 Phosphorus(III) bromide / PBr_3 Thionyl bromide / $SOBr_2$ If the name and the formula are given, then both must be correct Do not award dilute sulfuric acid	**1**

Q	Answer	Additional Guidance	Mark
(b)(i)	• conditions	Ethanolic / alcoholic (solution) Allow ethanol / alcohol Ignore heat / solid / reflux Do not award aqueous solution	**1**

Q	Answer	Additional Guidance	Mark
(b)(ii)	• C_4H_7N	Allow elements in any order Ignore C_3H_7CN	**1**

Q	Answer	Additional Guidance	Mark
(b)(iii)	• nucleophilic **(1)** • substitution **(1)**	Allow nucleophile for nucleophilic Mark independently List principle applies (further incorrect answers will each lose a mark) Allow phonetic spelling	**2**

Q	Answer	Additional Guidance	Mark
(b)(iv)	• dipole and arrow from C–Br bond to $Br^{\delta-}$ or just beyond **(1)** • arrow from ammonia to $C^{\delta+}$ **and** 1 or 2 correct curly arrows on intermediate (each from bond or lone pair to atom) **(1)** **(1)**  • intermediate with charge **(1)** • ammonium / H^+ **and** bromide ion **OR** HBr **OR** NH_4Br	Accept bromide and H^+/ammonium ions shown anywhere on answer (i.e. they don't have to be with intermediate and final product respectively) Allow 3rd arrow for M2 to be from bromide lone pair to the hydrogen atom Negative charge on ammonia should be penalised once only Accept correct SN2 mechanism for 4 marks	4
		Total for Question = 9 marks)	

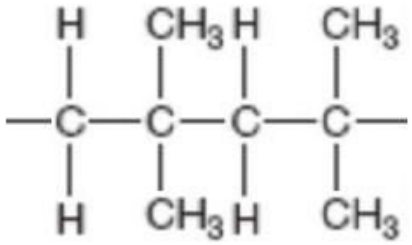
Q2.

Question Number	Answer	Additional Guidance	Mark
(a)(i)	$TiO_2 + 2Cl_2 + 2C \rightarrow TiCl_4 + 2CO$	Ignore state symbols even if incorrect Allow multiples	1

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Question Number	Answer	Additional Guidance	Mark
(a)(ii)	• Ti is reduced **and** from +4 to 0 **(1)** • Mg is oxidised **and** from 0 to +2 **(1)**	Four correct oxidation numbers with no or incorrect mention of reduced or oxidised scores (1) Ti is reduced as it gains electrons and Mg is oxidised as it loses electrons with no or incorrect oxidation numbers scores (1)	**2**

Question Number	Answer	Additional Guidance	Mark
(b)	• hydrolysis **(1)** • titanium((IV)) oxide/TiO_2 **(1)**	Do not award hydration Ignore hydrogen chloride/HCl Allow titanium((IV))hydroxide/$Ti(OH)_4$	**2**

Question Number	Answer	Additional Guidance	Mark
(c)	 • correct repeating unit **(1)** • two repeating units and extension **(1)** Note M2 depends on M1 or near miss eg missing a H	Allow adjacent pairs of methyl groups Ignore square brackets and subscript n/2 Ignore connectivity of CH_3	**2**

Question Number	Answer	Additional Guidance	Mark
(d)(i)	An answer that makes reference to the following points: • reagent: potassium hydroxide / KOH (1) • conditions: aqueous/water (1) M2 dependent on M1or near miss e.g. OH^- will not score M1 but will allow access to M2.	Allow sodium hydroxide / NaOH Ignore any reference to concentration or heat Allow dilute	2

Question Number	Answer	Additional Guidance	Mark
(d)(ii)	An answer that makes reference to the following points: • reagent: (concentrated) phosphoric((V)) acid / H_3PO_4 (1) • reaction type: elimination/dehydration (1) Independent marks	Allow (concentrated) sulfuric acid Ignore heat Do not award H_3PO_3 Allow passing vapour over porous pot / alumina or any surface catalyst **and** heat	2

Question Number	Answer	Additional Guidance	Mark
(d)(iii)	An answer that makes reference to the following points: • reagent: phosphorus(V) chloride/ phosphorus pentachloride/PCl_5 (1) • equation: $C_4H_9OH + PCl_5 \rightarrow C_4H_9Cl + HCl + POCl_3$ (1)	Allow thionyl chloride / $SOCl_2$ Allow phosphorus (III) chloride / phosphorus trichloride / PCl_3 Allow $C_4H_9OH + SOCl_2 \rightarrow C_4H_9Cl + HCl + SO_2$ $3C_4H_9OH + PCl_3 \rightarrow 3C_4H_9Cl + H_3PO_3$ Allow skeletal, structural, displayed or molecular formulae	2

Question Number	Answer	Additional Guidance	Mark
(d)(iv)	An answer that makes reference to the following points: • conditions: alcoholic (1) • role of the hydroxide ions: base (1) Note answers may be given on either line	Allow ethanol/ethanolic Ignore heat and concentration Allow proton acceptor/reacts with H^+	2

Question Number	Answer	Additional Guidance	Mark
(e)	An answer that makes reference to the following points: • moles of carbon dioxide (1) • conversion of cm^3 to m^3 (1) • conversion of °C to K (1) • rearrangement of the ideal gas equation (1) • calculation of pressure and correct units given (1)	Examples of calculation 16 ÷ 44 = 0.36364 (mol)/ 4÷11(mol) 20 ÷ 1000000 = 2×10^{-5} / 0.00002 (m^3) 273 + 25 = 298 (K) $p = \frac{nRT}{V}$ $\frac{0.3636 \times 8.31 \times 298}{2 \times 10^{-5}}$ = 45025000 Pa / 45025 kPa 4.5×10^7 Pa / 45MPa Ignore SF except 1 Allow TE for answers to M1, M2 and M3 But no TE on wrong rearrangement of gas equation Correct answer, including units with or without working scores (5)	5

Q3.

Question Number	Answer	Mark
(a)	**The only correct answer is A** (addition) *B is not correct because it is not an oxidation reaction* *C is not correct because it is not a polymerisation reaction* *D is not correct because it is not a substitution reaction*	(1)

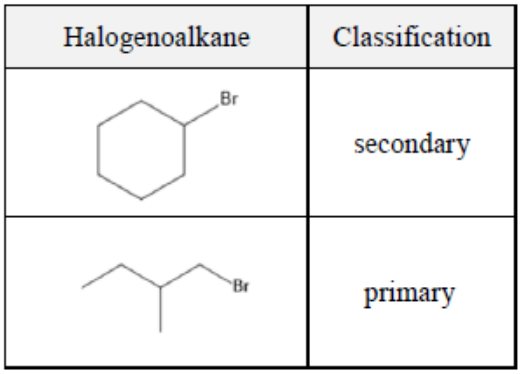
Question Number	Answer	Mark
(b)	**The only correct answer is B** (oxidation) *A is not correct because it is not an addition reaction* *C is not correct because it is not a reduction reaction* *D is not correct because it is not a substitution reaction*	(1)

Q4.

Question Number	Answer	Mark
(a)	**The only correct answer is B** (disproportionation) *A is incorrect because no species has been replaced/displaced* *C is incorrect because no species has been eliminated* *D is incorrect because water is produced and no species is hydrolysed*	(1)

Question Number	Answer	Mark
(b)	**The only correct answer is B** (4.2×10^{-5} mol s^{-1}) *A is incorrect because incorrect units for the Molar Volume of a gas has been used* *C is incorrect because the stoichiometry has not been taken into account* *D is incorrect because the stoichiometry is incorrect*	(1)

Q5.

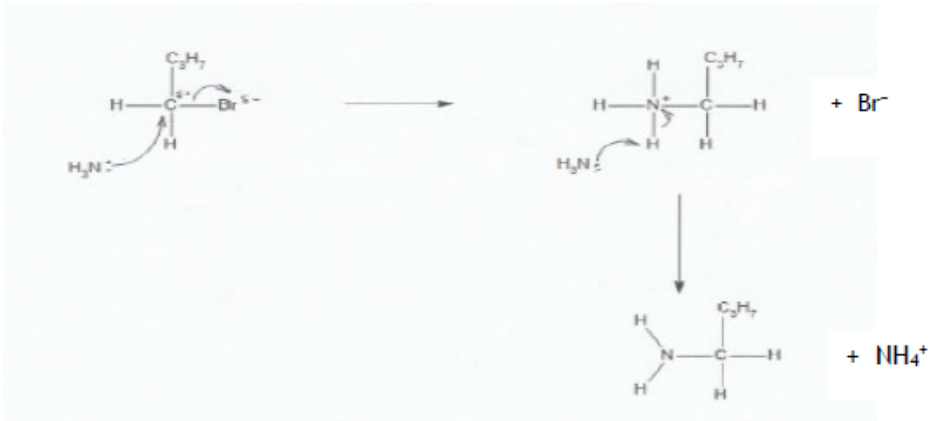
Question Number	Answer	Additional Guidance	Mark
(a)	• both classifications correct	Example of table:  Allow 2° for secondary Allow 1° for primary Ignore halogenoalkane	(1)

Question Number	Answer	Additional Guidance	Mark
(b)	An explanation that makes reference to the following points:		(3)
	• 2-chloro-2-methylpropane should react faster than 1-iodobutane because it is tertiary (1)	Stand alone mark Allow tertiary / branched chain / more branched halogenoalkanes have a higher rate of hydrolysis than primary halogenoalkanes Do not award secondary for 2-chlor-2-methylpropane Do not award tertiary carbocation	
	• 1-iodobutane should react faster than 2-chloro-2-methylpropane because the C–I bond enthalpy is lower enthalpy is lower than C–Cl (1)	Stand alone mark Allow just 'the C–I bond is weaker / has a lower bond enthalpy than C–Cl' Ignore just 'bonds in 1-iodobutane are weaker' Do not award H–I / H–Cl bonds	
	• it is not possible to predict the relative effects of these two opposing factors / structure and bond enthalpies (1)	Conditional on two opposing factors If M1 and M2 scored, allow 'so it is not possible to predict the relative rate of hydrolysis'	

Question Number	Answer	Additional Guidance	Mark
(c)(i)	• **ammonia** (gas) would escape (from the condenser when heated under reflux) **or** to prevent **ammonia** (gas) escaping (from the condenser when heated under reflux)	Ignore just 'ammonia will evaporate' Ignore concentrated alcoholic Ignore references to safety Ignore just 'gas / reactant escapes' Do not award any other substance escaping	(1)

Question Number	Answer	Additional Guidance	Mark
(c)(ii)	• lone pair on N of NH_3 **and** curly arrow from lone pair on N to, or towards C (1) • dipole on C-Br **and** curly arrow from C-Br bond to, or just beyond, Br (1) • lone pair on N of NH_3 **and** curly arrow from lone pair on N to, or towards H (1) • curly arrow from N-H bond to, or towards N (1)	Penalise missing lone pair on N once only Penalise negative charge on NH_3 once only Penalise half-arrow heads once only Do not award any charge / dipole on H Ignore any changes to final products	(4)

Example of mechanism:



Question Number	Answer	Additional Guidance	Mark
(d)	• calculation of amounts of KBr and H_2SO_4 (1)	Example of calculation: amount KBr = $\frac{14.90}{119}$ = 0.12521 (mol) amount H_2SO_4 = $\frac{16.35}{98.1}$ = 0.16667 (mol) Allow use of 98 for M_r of H_2SO_4 giving 0.16684 (mol)	(3)
	• calculation of amount of C_2H_5OH **and** statement or implication that this is the limiting quantity (1)	amount C_2H_5OH = $\frac{4.65}{46}$ = 0.10109 / 0.10 / 0.1 (mol) **and** any indication that the limiting reagent is C_2H_5OH e.g. by use of mol of ethanol in M3	
	• calculation of maximum mass of C_2H_5Br formed (1)	(maximum amount C_2H_5Br formed = 0.10109 (mol) maximum mass C_2H_5Br formed = 0.10109 x 108.9 = 11.008 / 11.01 / 11.0 / 11 (g) Allow use of 109 for M_r of C_2H_5Br giving 11.018 (g) Ignore SF except 1 SF, but allow 0.1 for mol C_2H_5OH	

Question Number	Acceptable Answers	Additional Guidance	Mark
(e)*	This question assesses a student's ability to show a coherent and logically structured answer with linkages and fully-sustained reasoning. Marks are awarded for indicative content and for how the answer is structured and shows lines of reasoning. The following table shows how the marks should be awarded for indicative content. Number of indicative marking points seen in answer / Number of marks awarded for indicative marking points 6 / 4 5–4 / 3 3–2 / 2 1 / 1 0 / 0 The following table shows how the marks should be awarded for structure and lines of reasoning.	Guidance on how the mark scheme should be applied: The mark for indicative content should be added to the mark for lines of reasoning. For example, an answer with five indicative marking points that is partially structured with some linkages and lines of reasoning scores 4 marks (3 marks for indicative content and 1 mark for partial structure and some linkages and lines of reasoning). If there are no linkages between points, the same five indicative marking points would yield an overall score of 3 marks (3 marks for indicative content and no marks for linkages).	(6)

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	Number of marks awarded for structure of answer and sustained line of reasoning
Answer shows a coherent and logical structure with linkages and fully sustained lines of reasoning demonstrated throughout.	2
Answer is partially structured with some linkages and lines of reasoning.	1
Answer has no linkages between points and is unstructured.	0

Comment:
Look for the indicative marking points first, then consider the mark for structure of answer and sustained line of reasoning

In general it would be expected that 5 or 6 indicative points would get
2 reasoning marks, and
3 or 4 indicative points would get 1 mark for reasoning, and 0, 1 or 2 indicative points would score zero marks for reasoning.

General points to note
If there is any incorrect chemistry, deduct mark(s) from the reasoning. If no reasoning mark(s) awarded do not deduct mark(s).

Indicative content	Penalise use of incorrect halogenoalkane once only
• **IP1 –Similarity** Both reactions involve hydroxide ions / OH^-	Allow OH^- shown with both reactions anywhere in the answer e.g. in the equations Allow both reactions need heat (under reflux)
• **IP2 – Type of reaction** Reaction with aqueous solution is substitution **and** reaction with ethanolic solution is elimination	Ignore displacement for substitution Ignore dehydration for elimination Do not award dehydrogenation for elimination
• **IP3 – Type of reagent** (OH^- is a) nucleophile in aqueous solution **and** a base in ethanolic solution	If IP2 and IP3 not awarded, allow 1 IP for just 'nucleophilic substitution' or 'elimination by a base'
• **IP4 – Products** In aqueous solution propan-2-ol / an alcohol forms **and** in ethanolic solution propene / an alkene forms	This can be scored from the equations
• **IP5 – Equation in aqueous solution** $CH_3CHBrCH_3 + OH^- \rightarrow CH_3CHOHCH_3 + Br^-$	In IP5 and IP6, allow displayed formulae / any combination of displayed and structural formulae / skeletal formula Allow KOH / KBr / $K^+ + OH^-$ / $K^+ + Br^-$ The equations must be balanced Ignore state symbols even if incorrect Ignore mechanisms even if incorrect
• **IP6 – Equation in ethanolic solution** $CH_3CHBrCH_3 + OH^- \rightarrow CH_3CH{=}CH_2 + H_2O + Br^-$	

Q6.

Question number	Answer		Additional guidance	Mark
(a)	• balanced equation	(1)	$I_2(s) + Cl_2(g) \rightarrow 2ICl(l)$	2
	• all states correct	(1)	Accept multiples	

Question number	Answer	Additional guidance	Mark
(b)	• correct electronegativity values and correct dipole diagram	Cl = 3.0 **and** I = 2.5 δ+ I — Cl δ- Do not award full charges	1

Question number	Answer	Additional guidance	Mark
(c)(i)	• 1 mark each correct formula	 Allow 1 mark for 2 correct non-skeletal formulae	2

Question number	Answer		Additional guidance	Mark
(c)(ii)	An explantion that makes reference to the following points:			3
	• identification of correct isomer	(1)	2-chloro-1-iodopropane	
	• iodine is δ+ and is attacked by the π electrons	(1)		
	• more stable secondary carbocation formed.	(1)		

Question number	Answer		Additional guidance	Mark
(d)(i)	An answer that makes reference to the following points:			2
	• carry out in fume cupboard	(1)	Allow fume hood or similar description	
	• chlorine is toxic.	(1)	Do not allow 'harmful'	

Question number	Answer	Additional guidance	Mark
(d)(ii)	• I in ICl = +1 I in ICl_3 = +3	Both needed for the mark	1

Question number	Answer		Additional guidance	Mark
(d)(iii)	• +5 **and** -1 to -1 (and -1)	(1)		2
	• not disproportionation because the chlorine has not undergone both oxidation and reduction	(1)		

Question number	Answer		Additional guidance	Mark
(e)(i)	• correct method	(1)	$Cl_2 = 2 \times 35.5 = 71$ $71 \div 24000$	2
	• answer with units	(1)	$= 0.0029583$ g cm^{-3} $= 3$ g dm^{-3}	

Question number	Answer		Additional guidance	Mark
(e)(ii)	An explanation that makes reference to the following points: • chlorine (gas) is more dense than air	(1)		3
	• chlorine (gas) removed (from the equilibrium)	(1)		
	• position of equilibrium moves to the LHS (more brown liquid/ICl).	(1)		

Question number	Answer		Additional guidance	Mark
(f)	• calculation of mols of iodine and fluorine	(1)	Mols of iodine = $0.64 \div 126.9 = 5.04 \times 10^{-3}$ Mols of fluorine = $(1.31–0.64) \div 19 = 3.53 \times 10^{-2}$	2
	• calculation of whole number ratio and formula	(1)	Ratio 1:7 therefore formula IF_7	

Q7.

Question number	Answer	Mark
	The only correct answer is C (nucleophile) ***A*** *is incorrect because electrophiles attack atoms with a slight negative charge* ***B*** *is incorrect because free radicals attack neutral atoms* ***D*** *is incorrect because oxidising agents remove electrons from a species*	**(1)**