



OCR A H432

Haloalkanes I

Original exam questions | TEST IT → EXAM STYLE → HARDER MIXED → STRETCH

SPECIFICATION-LED. PROGRESSIVE. MECHANISM-PRECISE.

OCR A SPECIFICATION		4.2.2(a-d) hydrolysis, nucleophiles, mechanisms and rates	
TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
8	10	5	1
24 QUESTIONS ORIGINAL		156 MARKS TOTAL	

FINAL NOTES-ALIGNED EDITION | HYDROLYSIS • AgX • BOND ENTHALPY • MECHANISMS

Independent practice material. Every question is original and mapped to OCR A Chemistry A H432 specification version 3.1 (May 2026).

START HERE

How to use this pack

Attempt independently, then compare the first lost mark with the model answer

- 1 Attempt TEST IT first, then work through the sections in order without using the notes.
- 2 For mechanisms, audit the lone pair, dipole, both arrow tails, both arrowheads and every product.
- 3 For practical questions, separate what is observed from what is inferred and control every rate variable.
- 4 Redraw any incorrect mechanism from memory after marking; do not only read the model.

OCR A BOUNDARY	This pack assesses OCR A 4.2.2(a-d): hydrolysis with aqueous alkali; water/ethanol/AgNO ₃ rate comparisons; nucleophiles; primary-haloalkane substitution mechanisms; and the C-X bond-enthalpy trend.
HELD BACK	Elimination, ethanolic hydroxide, CN ⁻ /NH ₃ substitution, SN1/SN2 labels, carbocations, CFC/ozone chemistry and later synthesis are not assessed.
QUESTION PAGES	There are no method grids, route strips or mechanism scaffolds. Written responses have one clear grey dotted line per mark; mechanisms use blank drawing areas.
MECHANISM STANDARD	Arrows must start at the O lone pair and the C-X bond. Show Cδ ⁺ -Xδ ⁻ , a neutral alcohol, X ⁻ and an unchanged carbon skeleton.

SECTION A

TEST IT

Eight direct checks of the finished-notes mastery outcomes

QUESTION 1

TEST IT

(a) Define the term nucleophile.

[1 mark]

(b) State what a full curly arrow represents.

[1 mark]

(c) Define heterolytic fission in terms of the two electrons in a covalent bond and the products formed.

[2 marks]

QUESTION 2

TEST IT

Consider the haloalkanes A, B and C.

COMPOUND	STRUCTURAL FORMULA
A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{Cl}$
B	$\text{CH}_3\text{CHBrCH}_3$
C	$(\text{CH}_3)_3\text{CBr}$

(a) Classify A, B and C as primary, secondary or tertiary haloalkanes.

[3 marks]

(b) Explain why A is a primary haloalkane.

[1 mark]

(c) Name compound A.

[1 mark]

QUESTION 3

TEST IT

1-Iodopropane has the structural formula $\text{CH}_3\text{CH}_2\text{CH}_2\text{I}$.

(a) Add the correct partial charges to the C–I bond.

[1 mark]

(b) Explain why the C–I bond is polar.

[2 marks]

(c) Identify the atom attacked by OH^- and explain why it is attacked.

[1 mark]

QUESTION 4

TEST IT

1-Chlorobutane is hydrolysed using potassium hydroxide.

(a) State the reagent, solvent and heating condition.

[2 marks]

(b) Name the organic product.

[1 mark]

(c) Write the ionic equation for the reaction.

[1 mark]

(d) Write the full equation using KOH.

[1 mark]

(e) State the type of organic reaction.

[1 mark]

QUESTION 5

TEST IT

1-Bromopropane reacts with aqueous hydroxide ions.

- (a) Draw the complete nucleophilic-substitution mechanism. Show the O lone pair, the C–Br dipole, both full curly arrows and both products. [5 marks]

MECHANISM DRAWING AREA

QUESTION 6

TEST IT

Consider matched primary 1-fluoro-, 1-chloro-, 1-bromo- and 1-iodobutane molecules.

- (a) Place the four haloalkanes in order of increasing hydrolysis rate. [1 mark]

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- (b) Explain why the bromoalkane hydrolyses faster than the chloroalkane. [2 marks]

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- (c) Explain why the greater polarity of C–F does not make the fluoroalkane the fastest to hydrolyse. [2 marks]

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QUESTION 7

TEST IT

Water, ethanol and aqueous silver nitrate are used to compare haloalkane hydrolysis rates.

- (a) State the role of water and explain how a neutral water molecule can act as a nucleophile. [2 marks]

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- (b) State the role of ethanol. [1 mark]

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- (c) State the role of Ag^+ ions. [1 mark]

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- (d) Name one variable that must be controlled and explain why it must be controlled. [2 marks]

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QUESTION 8

TEST IT

Matched primary haloalkanes give the following observations under identical conditions.

SAMPLE	OBSERVATION	TIME / s
A	white cloudiness	132
B	cream cloudiness	48
C	yellow cloudiness	14

- (a) Identify the halide ion released by A, B and C. [3 marks]

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- (b) Write the ionic equation, with state symbols, for the precipitate formed by B. [1 mark]

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- (c) Identify the fastest-hydrolysing sample and explain your choice using its C–X bond. [2 marks]

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SECTION B

EXAM STYLE

Ten original structured questions using OCR A command words and marking logic

QUESTION 9

EXAM STYLE

Compound D has the structural formula $\text{ClCH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$.

(a) Name compound D.

[1 mark]

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(b) Explain why D is a primary haloalkane.

[1 mark]

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(c) Draw the structural formula of the organic product formed when D is hydrolysed by aqueous hydroxide ions.

[1 mark]

STRUCTURE DRAWING AREA

(d) Name the organic product.

[1 mark]

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(e) Write the ionic equation for the hydrolysis.

[2 marks]

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QUESTION 10

EXAM STYLE

1-Iodo-2-methylpropane, $(\text{CH}_3)_2\text{CHCH}_2\text{I}$, reacts with aqueous hydroxide ions.

(a) Draw the complete nucleophilic-substitution mechanism.

[5 marks]

MECHANISM DRAWING AREA

(b) Name the organic product.

[1 mark]

QUESTION 11

EXAM STYLE

A student writes: 'OH• attacks the δ^- iodine atom. The C–I bond splits so that each atom takes one electron.'

(a) Correct the attacking species and state its role.

[2 marks]

(b) State the atom attacked and explain why it is attacked.

[2 marks]

(c) Describe the movement of the C–I bonding pair and name the ion formed.

[2 marks]

QUESTION 12

EXAM STYLE

Plan an experiment to compare the hydrolysis rates of 1-chloropropane and 1-bromopropane using water, ethanol and aqueous silver nitrate.

- (a) Describe a fair, safe and reliable method. Include quantities, temperature control, the timed endpoint and treatment of repeat results. [8 marks]

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QUESTION 13

EXAM STYLE

Times to first persistent cloudiness were measured under identical conditions.

HALOALKANE	REPEAT 1 / s	REPEAT 2 / s	REPEAT 3 / s
1-chloropropane	144	141	143
1-bromopropane	52	50	91
1-iodopropane	16	15	16

- (a) Identify and justify the anomalous result. [2 marks]

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- (b) Calculate the corrected mean time for 1-bromopropane. [1 mark]

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- (c) Calculate the rate proxy $1/t$ for 1-bromopropane. Give its unit. [2 marks]

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- (d) State the hydrolysis-rate order and link it to C–X bond enthalpy. [2 marks]

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QUESTION 14**EXAM STYLE**

Three haloalkanes are tested separately. P gives a cream precipitate after 35 s, Q gives a white precipitate after 88 s and R gives a yellow precipitate after 12 s.

(a) Identify the halide ion released by P, Q and R.

[3 marks]

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(b) State whether this test can distinguish 1-bromopropane from 1-bromobutane.

[1 mark]

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(c) Explain your answer to part (b).

[2 marks]

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QUESTION 15**EXAM STYLE**

Matched 1-fluoro- and 1-iodoalkanes are compared.

(a) State which C–X bond is more polar.

[1 mark]

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(b) Predict which haloalkane hydrolyses faster.

[1 mark]

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(c) Explain the apparent contradiction between the answers to parts (a) and (b).

[3 marks]

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QUESTION 16

EXAM STYLE

- (a) Write the ionic equation, with state symbols, for the formation of AgCl. [2 marks]

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- (b) Write the ionic equation, with state symbols, for the formation of AgI. [2 marks]

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- (c) Explain why a silver halide precipitate does not form until hydrolysis has begun. [2 marks]

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QUESTION 17

EXAM STYLE

A student compares 0.20 mol dm^{-3} 1-chlorobutane at 60°C with 0.10 mol dm^{-3} 1-bromobutane at 40°C . The chloride sample becomes cloudy first, so the student concludes that C–Cl is weaker.

- (a) Explain why the conclusion is invalid. [2 marks]

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- (b) Redesign the comparison so that it is valid. [3 marks]

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- (c) Predict the result of the controlled comparison. [1 mark]

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QUESTION 18

EXAM STYLE

A chemist needs to make 2-methylpropan-1-ol. Three possible haloalkanes are shown.

COMPOUND	STRUCTURAL FORMULA
A	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl}$
B	$(\text{CH}_3)_2\text{CHCH}_2\text{Cl}$
C	$(\text{CH}_3)_3\text{CCl}$

(a) Select and name the correct haloalkane.

[2 marks]

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(b) Explain the carbon-skeleton and substitution logic behind your choice.

[1 mark]

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(c) State the reagent and heating condition.

[2 marks]

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(d) Write the ionic equation.

[1 mark]

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SECTION C

HARDER MIXED

Five less-scaffolded applications requiring careful chemical and practical reasoning

QUESTION 19

HARDER MIXED

A compound with molecular formula C_4H_9X gives 2-methylpropan-1-ol when heated with aqueous alkali. A separate sample gives a cream precipitate in the OCR hydrolysis-rate test.

(a) Identify X and the silver halide precipitate.

[2 marks]

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(b) Name the haloalkane and give its structural formula.

[2 marks]

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(c) Write the ionic precipitation equation, with state symbols.

[1 mark]

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(d) Explain why the haloalkane is primary.

[1 mark]

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(e) Compare its hydrolysis rate with the chloro analogue and explain your answer.

[2 marks]

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QUESTION 20

HARDER MIXED

Iodoethane reacts with $^{18}\text{OH}^-(\text{aq})$, in which the oxygen atom is the isotope ^{18}O .

- (a) Draw the complete primary-haloalkane nucleophilic-substitution mechanism. Keep the isotope label on the oxygen atom throughout. [5 marks]

MECHANISM DRAWING AREA

- (b) Identify which product contains ^{18}O and explain why. [2 marks]

QUESTION 21

HARDER MIXED

A light sensor records the time until transmission first falls to 80.0%.

HALOALKANE	REPEAT 1 / s	REPEAT 2 / s	REPEAT 3 / s
1-chlorobutane	118	120	119
1-bromobutane	43	42	44
1-iodobutane	15	16	14

- (a) State one advantage of using the fixed transmission threshold. [1 mark]

- (b) Calculate the mean time for each haloalkane. [3 marks]

- (c) Calculate the rate proxy $1/t$ for 1-bromobutane. [2 marks]

- (d) Calculate how many times larger the bromoalkane rate proxy is than the chloroalkane rate proxy. [1 mark]

- (e) Explain the overall rate order. [1 mark]

QUESTION 22

HARDER MIXED

Two hypotheses are proposed for matched primary haloalkanes.

C-X BOND	MEAN BOND ENTHALPY / kJ mol^{-1}	OBSERVED HYDROLYSIS
C-F	484	slowest
C-Cl	338	faster
C-Br	276	faster again
C-I	238	fastest

Hypothesis 1: greater bond polarity gives faster hydrolysis. Hypothesis 2: lower C-X bond enthalpy gives faster hydrolysis.

(a) Identify the most polar bond. [1 mark]

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(b) Identify the strongest and weakest C-X bonds. [2 marks]

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(c) State the prediction from hypothesis 1 and show why the observations contradict it. [2 marks]

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(d) Explain why hypothesis 2 fits all four observations. [3 marks]

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QUESTION 23

HARDER MIXED

A technician wants both to prepare butan-1-ol from 1-bromobutane and to compare the hydrolysis rate of 1-bromobutane with 1-chlorobutane.

(a) Describe the preparative aqueous-alkali reaction, including reagent, condition and products.

[3 marks]

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(b) Describe the water/ethanol/ AgNO_3 comparison, including the roles of all three substances and the rate measurement.

[4 marks]

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(c) State one essential chemical distinction between the two experiments.

[1 mark]

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SECTION D

STRETCH / SYNOPTIC

One final problem connecting identification, data processing, bond enthalpy and mechanism

QUESTION 24

STRETCH

P and Q are matched primary haloalkanes with the same carbon skeleton. Hydrolysis by aqueous KOH gives 3-methylbutan-1-ol. In the OCR rate test P gives a white precipitate at 149, 151 and 150 s; Q gives a yellow precipitate at 18.2, 17.8 and 18.0 s.

(a) Identify the halogen in P and Q.

[2 marks]

(b) Name P and Q.

[2 marks]

(c) Calculate both mean times and the ratio of the rate proxies Q : P.

[3 marks]

(d) Explain why Q hydrolyses faster.

[2 marks]

(e) Draw the complete nucleophilic-substitution mechanism for Q with $\text{OH}^-(\text{aq})$.

[5 marks]

MECHANISM DRAWING AREA



CrackingCHEM

GCSE | A-LEVEL

UNDERSTAND • APPLY • SUCCEED

OCR A H432

Haloalkanes I

Fully worked answers | OCR A-style marking guidance

SPECIFICATION-LED. PROGRESSIVE. MECHANISM-PRECISE.

OCR A SPECIFICATION	4.2.2(a-d) hydrolysis, nucleophiles, mechanisms and rates		
TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
8	10	5	1
24 QUESTIONS MARKED		156 MARKS EXPLAINED	

FINAL NOTES-ALIGNED EDITION | HYDROLYSIS • AgX • BOND ENTHALPY • MECHANISMS

Independent practice material. Every question is original and mapped to OCR A Chemistry A H432 specification version 3.1 (May 2026).

OCR A MAP

How this pack matches the specification

The completed notes and OCR A H432 version 3.1 define the boundary

OCR A REF	WHAT IS ASSESSED	FREQUENT TRAP	QUESTIONS
4.2.2(a)(i)	Hydrolysis by aqueous NaOH/KOH, heat under reflux; alcohol and halide products.	Using ethanolic OH ⁻ or describing elimination.	4, 9, 18, 23
4.2.2(a)(ii)	Hydrolysis by water; ethanol aids mixing; Ag ⁺ detects released X ⁻ as AgX(s).	Saying ethanol hydrolyses or Ag ⁺ attacks the haloalkane.	7-8, 12-14, 16-17, 19, 21, 23-24
4.2.2(b)-(c)	Nucleophile definition and one-step primary-haloalkane substitution with aqueous OH ⁻ .	Arrow from H/empty space, carbocation, or missing X ⁻ .	1-5, 9-11, 18, 20, 24
4.2.2(d)	Hydrolysis-rate trend from C-F, C-Cl, C-Br and C-I bond enthalpies.	Explaining the trend by polarity alone or writing AgF(s).	6, 8, 13-15, 17, 19, 21-22, 24

BOUNDARY

CFC/ozone chemistry, elimination, CN⁻/NH₃ substitution, SN1/SN2 labels, carbocations, secondary/tertiary mechanisms and later synthesis are not assessed.

MARKING LOGIC

A mechanism mark depends on the exact electron source and destination. Rate explanations must use C-X bond enthalpy: lower enthalpy means easier bond breaking and faster hydrolysis.

SECTION A

TEST IT ANSWERS

Exact terminology, equations, observations and mechanism conventions

QUESTION 1 | TEST IT ANSWER

4 MARKS

- A nucleophile is an electron-pair donor [1]
- A full curly arrow represents movement of an electron pair [1]
- In heterolytic fission, both electrons in the covalent bond move to one of the bonded atoms/species, forming ions [2]

QUESTION 2 | TEST IT ANSWER

5 MARKS

- A is primary; B is secondary; C is tertiary [3]
- In A, the carbon bonded to Cl is directly attached to only one other carbon atom [1]
- A is 1-chloropropane [1]

QUESTION 3 | TEST IT ANSWER

4 MARKS

**1-iodopropane: the carbon bonded to I is electron-deficient**

- The bond is Cδ⁺-Iδ⁻; both partial charges must be on the correct atoms [1]
- Iodine is more electronegative than carbon [1]
- Iodine attracts the C-I bonding pair towards itself [1]
- OH⁻ attacks the electron-deficient δ⁺ carbon bonded to iodine [1]

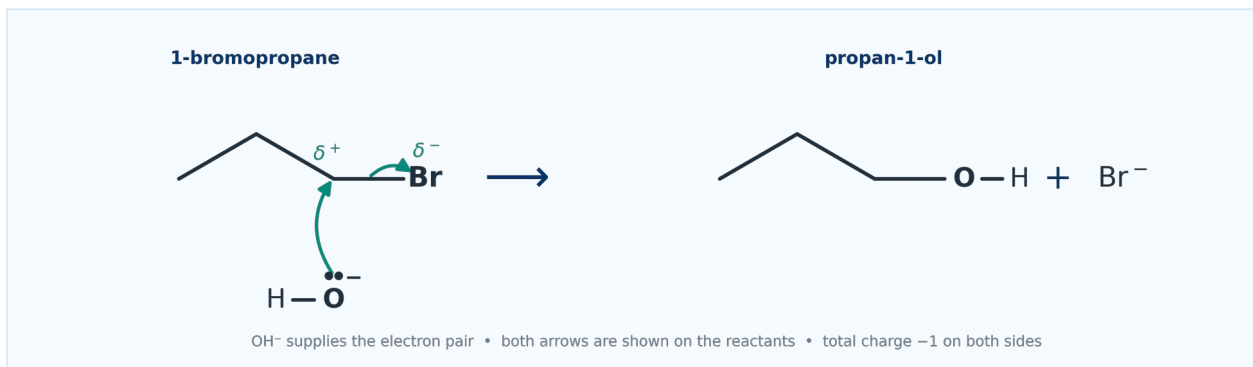
QUESTION 4 | TEST IT ANSWER

6 MARKS

- Use aqueous KOH and heat under reflux [2]
- Organic product: butan-1-ol [1]
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} + \text{OH}^- \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{Cl}^-$ [1]
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{Cl} + \text{KOH} \rightarrow \text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH} + \text{KCl}$ [1]
- Hydrolysis / nucleophilic substitution [1]

QUESTION 5 | TEST IT ANSWER

5 MARKS



- $\text{C}\delta^+ - \text{Br}\delta^-$ is shown with the partial charges close to the correct atoms [1]
- OH^- is shown with a visible lone pair on O [1]
- The first full curly arrow starts at that O lone pair and ends at the carbon bonded to Br [1]
- The second full curly arrow starts on the C-Br bond and ends at Br [1]
- Products are neutral propan-1-ol and Br^- ; the carbon skeleton is unchanged [1]

EXAMINER
GUIDANCE

Do not insert a carbocation. Both arrows belong on the reactants in this one-step primary-haloalkane mechanism.

QUESTION 6 | TEST IT ANSWER

5 MARKS

- Increasing rate: $\text{R-F} < \text{R-Cl} < \text{R-Br} < \text{R-I}$ [1]
- C-Br has a lower bond enthalpy / is weaker than C-Cl [1]
- C-Br therefore needs less energy to break, so the bromoalkane hydrolyses faster [1]
- C-F has the greatest bond enthalpy / is the strongest C-X bond [1]
- It is difficult to break, so high polarity does not make the fluoroalkane hydrolyse fastest [1]

QUESTION 7 | TEST IT ANSWER

6 MARKS

- Water hydrolyses the haloalkane / acts as the nucleophile [1]
- Oxygen in water has a lone pair that it can donate [1]
- Ethanol helps the organic haloalkane mix with the aqueous components [1]
- Ag^+ detects the X^- released by hydrolysis by forming visible AgX(s) [1]
- Any valid control, such as temperature, haloalkane concentration/volume, AgNO_3 concentration/volume or solvent proportions [1]
- It must be controlled so that the C-X bond / halogen is the only factor causing any rate difference [1]

QUESTION 8 | TEST IT ANSWER

6 MARKS

- A releases Cl^- ; B releases Br^- ; C releases I^- [3]
- $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr(s)}$ [1]
- C hydrolyses fastest [1]
- Its C-I bond has the lowest bond enthalpy / is easiest to break [1]

SECTION B

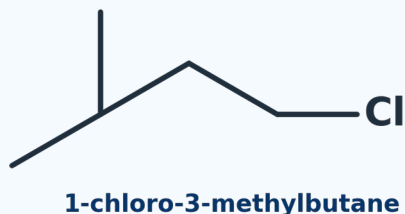
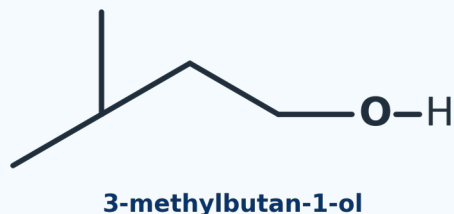
EXAM STYLE ANSWERS

Worked structures, data processing and OCR-style marking guidance

QUESTION 9 | EXAM STYLE ANSWER

6 MARKS

Hydrolysis replaces Cl by OH without changing the carbon skeleton

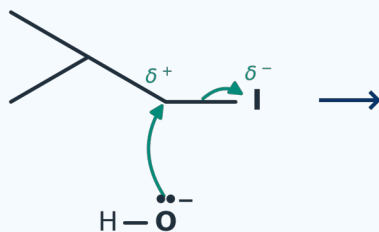


- D is 1-chloro-3-methylbutane [1]
- The carbon bonded to Cl is directly attached to only one other carbon [1]
- Correct product structure: $\text{HOCH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3$ [1]
- Product name: 3-methylbutan-1-ol [1]
- $\text{ClCH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3 + \text{OH}^- \rightarrow \text{HOCH}_2\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_3 + \text{Cl}^-$; correct species and unchanged skeleton [1]
- Equation is balanced for atoms and total charge [1]

QUESTION 10 | EXAM STYLE ANSWER

6 MARKS

1-iodo-2-methylpropane



2-methylpropan-1-ol



OH^- supplies the electron pair • both arrows are shown on the reactants • total charge -1 on both sides

- $\text{C}\delta^+ - \text{I}\delta^-$ shown correctly [1]
- Visible O lone pair on OH^- [1]
- Full curly arrow from the O lone pair to the carbon bonded to I [1]
- Full curly arrow from the C-I bond to I [1]
- Neutral $(\text{CH}_3)_2\text{CHCH}_2\text{OH}$ and I^- formed with the skeleton unchanged [1]
- The organic product is 2-methylpropan-1-ol [1]

QUESTION 11 | EXAM STYLE ANSWER

6 MARKS

- The attacking species is OH^- , not $\text{OH}\cdot$ [1]
- OH^- is the nucleophile / electron-pair donor [1]
- OH^- attacks the carbon bonded to iodine [1]
- That carbon is δ^+ / electron-deficient [1]
- Both electrons in the C-I bond move to iodine: heterolytic fission [1]
- I^- is formed [1]

QUESTION 12 | EXAM STYLE ANSWER

8 MARKS

- Use equal measured volumes of equally concentrated ethanolic 1-chloropropane and 1-bromopropane [1]
- Use the same measured volume and concentration of AgNO_3 and the same ethanol/water proportions [1]
- Pre-warm all reagents to the same fixed temperature in a thermostatically controlled water bath [1]
- Use a water bath / electric heater, not a naked flame, because ethanol is flammable [1]
- Add, mix and start timing in the same way for each sample [1]
- Time to the same endpoint: first persistent cloudiness [1]
- Repeat each measurement [1]
- Calculate and compare means after checking for justified anomalies [1]

QUESTION 13 | EXAM STYLE ANSWER

7 MARKS

- 91 s is anomalous [1]
- It is not concordant with 50 s and 52 s [1]
- Corrected bromo mean = $(52 + 50) / 2 = 51.0$ s [1]
- Rate proxy = $1 / 51.0$ [1]
- Rate proxy = 0.0196 s^{-1} [1]
- Hydrolysis rate: iodo > bromo > chloro [1]
- $\text{C-I} < \text{C-Br} < \text{C-Cl}$ in bond enthalpy; a lower-enthalpy bond breaks more readily [1]

QUESTION 14 | EXAM STYLE ANSWER

6 MARKS

- P releases Br^- ; Q releases Cl^- ; R releases I^- [3]
- No: the test cannot distinguish the two bromoalkanes [1]
- Both hydrolyse to release Br^- and therefore give cream AgBr [1]
- The precipitate colour identifies the halide ion, not the carbon skeleton; timing alone is not a structural identification [1]

QUESTION 15 | EXAM STYLE ANSWER

5 MARKS

- C-F is more polar [1]
- The iodoalkane hydrolyses faster [1]
- C-I has a much lower bond enthalpy / is weaker than C-F [1]
- C-I therefore requires less energy and breaks more readily [1]
- The C-F bond is strongest, so polarity alone gives the wrong rate prediction [1]

QUESTION 16 | EXAM STYLE ANSWER

6 MARKS

- $\text{Ag}^+(\text{aq}) + \text{Cl}^-(\text{aq}) \rightarrow \text{AgCl}(\text{s})$: correct ions and formula [1]
- All state symbols correct [1]
- $\text{Ag}^+(\text{aq}) + \text{I}^-(\text{aq}) \rightarrow \text{AgI}(\text{s})$: correct ions and formula [1]
- All state symbols correct [1]
- The starting C-X bond is covalent, so no free X^- is initially available [1]
- Hydrolysis must release X^- before Ag^+ can form $\text{AgX}(\text{s})$ [1]

QUESTION 17 | EXAM STYLE ANSWER

6 MARKS

- The haloalkane concentrations are different [1]
- The temperatures are different, so the comparison cannot isolate the C-X bond [1]
- Use equal concentrations and equal measured volumes of the two ethanolic haloalkanes [1]
- Use identical AgNO_3 concentration/volume and solvent proportions [1]
- Use the same controlled temperature and the same mixing/timing endpoint [1]
- The bromoalkane should be faster because C-Br has lower bond enthalpy than C-Cl [1]

QUESTION 18 | EXAM STYLE ANSWER

6 MARKS

- Select B [1]
- B is 1-chloro-2-methylpropane [1]
- Hydrolysis replaces Cl by OH without changing the carbon skeleton [1]
- Use aqueous NaOH or aqueous KOH [1]
- Heat under reflux [1]
- $(\text{CH}_3)_2\text{CHCH}_2\text{Cl} + \text{OH}^- \rightarrow (\text{CH}_3)_2\text{CHCH}_2\text{OH} + \text{Cl}^-$ [1]

SECTION C

HARDER MIXED ANSWERS

Less-scaffolded deductions with explicit chemical and practical checks

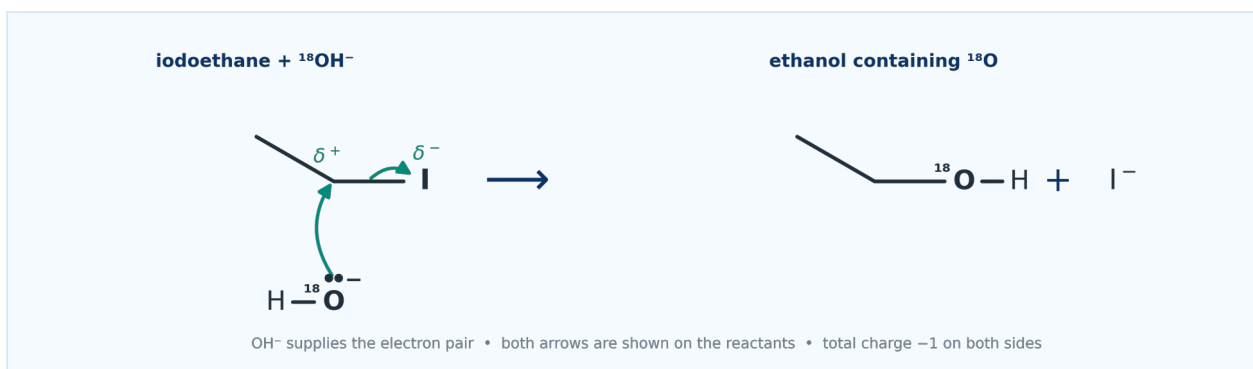
QUESTION 19 | HARDER MIXED ANSWER

8 MARKS

- X is Br and the precipitate is AgBr [2]
- The haloalkane is 1-bromo-2-methylpropane, $(\text{CH}_3)_2\text{CHCH}_2\text{Br}$ [2]
- $\text{Ag}^+(\text{aq}) + \text{Br}^-(\text{aq}) \rightarrow \text{AgBr}(\text{s})$ [1]
- The carbon bonded to Br is directly attached to one other carbon [1]
- The bromoalkane hydrolyses faster than the chloro analogue [1]
- C-Br has lower bond enthalpy / is easier to break than C-Cl [1]

QUESTION 20 | HARDER MIXED ANSWER

7 MARKS



- $\text{C}\delta^+ - \text{I}\delta^-$ shown correctly [1]
- $^{18}\text{OH}^-$ shown with a visible O lone pair [1]
- Full curly arrow from the ^{18}O lone pair to the carbon bonded to I [1]
- Full curly arrow from the C-I bond to I [1]
- Products are $\text{CH}_3\text{CH}_2^{18}\text{OH}$ and I^- [1]
- The alcohol contains ^{18}O [1]
- The attacking oxygen forms the new C-O bond, so the isotope enters the alcohol rather than I^- [1]

QUESTION 21 | HARDER MIXED ANSWER

8 MARKS

- A fixed transmission threshold gives a more objective / reproducible endpoint [1]
- Mean chloro time = 119 s; mean bromo time = 43.0 s; mean iodo time = 15.0 s [3]
- Bromo rate proxy = $1 / 43.0$ [1]
- Bromo rate proxy = 0.0233 s^{-1} [1]
- Ratio bromo : chloro = $(1/43) / (1/119) = 119/43 = 2.77$ [1]
- Rate rises $\text{Cl} \rightarrow \text{Br} \rightarrow \text{I}$ because C-X bond enthalpy falls and the bond breaks more readily [1]

QUESTION 22 | HARDER MIXED ANSWER

8 MARKS

- C-F is the most polar bond [1]
- C-F is strongest and C-I is weakest [2]
- Hypothesis 1 predicts the fluoroalkane should be fastest, but it is observed to be slowest [2]
- Bond enthalpy decreases in the order C-F > C-Cl > C-Br > C-I [1]
- Lower bond enthalpy means less energy is required / the bond is easier to break [1]
- The predicted rate therefore increases $F < Cl < Br < I$, matching all four observations [1]

EXAMINER
GUIDANCE

No visible AgF precipitate should be predicted: AgF is soluble. The rate trend is theoretical for C-F and is explained by bond enthalpy.

QUESTION 23 | HARDER MIXED ANSWER

8 MARKS

- Prepare butan-1-ol using aqueous NaOH/KOH [1]
- Heat 1-bromobutane under reflux [1]
- Products are butan-1-ol and Br^- / NaBr / KBr [1]
- In the rate experiment, water hydrolyses the haloalkane [1]
- Ethanol helps the organic and aqueous components mix [1]
- Ag^+ detects released halide ions as $AgX(s)$ [1]
- Compare equal samples at the same temperature by timing to the same persistent-cloudiness endpoint [1]
- OH^- is the nucleophile in the preparative reaction, whereas water is the nucleophile and Ag^+ is only the reporter in the rate experiment [1]

SECTION D

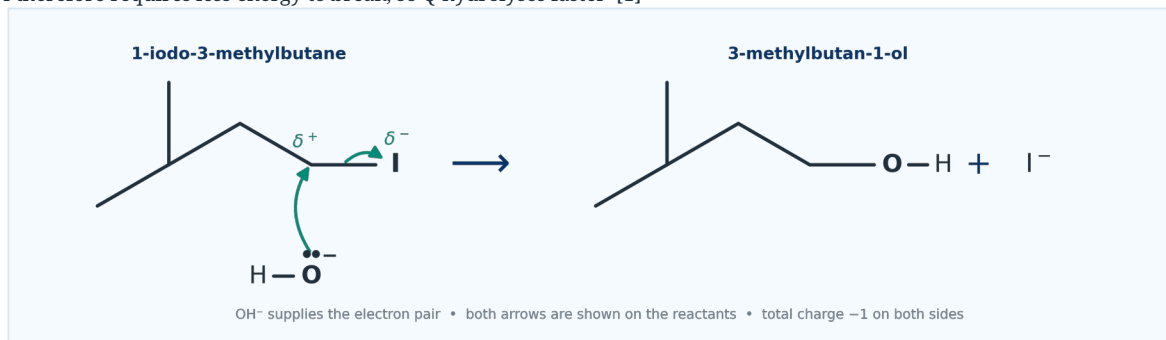
STRETCH / SYNOPTIC ANSWER

A complete model connecting identification, calculation, rate theory and mechanism

QUESTION 24 | STRETCH ANSWER

14 MARKS

- P contains Cl; Q contains I [2]
- P is 1-chloro-3-methylbutane; Q is 1-iodo-3-methylbutane [2]
- Mean P time = 150 s and mean Q time = 18.0 s [2]
- Rate-proxy ratio $Q : P = (1/18.0) / (1/150) = 150/18.0 = 8.33$ [1]
- C-I has lower bond enthalpy / is weaker than C-Cl [1]
- C-I therefore requires less energy to break, so Q hydrolyses faster [1]



- $C\delta^+-I\delta^-$ shown correctly [1]
- OH^- has a visible O lone pair and the first arrow runs from that pair to the carbon bonded to I [1]
- The second arrow starts on the C-I bond and ends at I [1]
- Neutral 3-methylbutan-1-ol and I^- are formed [1]
- The carbon skeleton is unchanged and total charge is -1 on both sides [1]