1. Alcohols can be prepared by the hydrolysis of haloalkanes with aqueous alkali.

i. Write an equation for the hydrolysis of 2- bromo- 2- methylpropane.

Show organic compounds as structures.

[2]

ii. A student hydrolyses a chloroalkane, RC*l*, a bromoalkane, RBr, and an iodoalkane, RI.

For a fair comparison, the student has chosen the same R group for each haloalkane.

Predict, with a reason, the relative rates of hydrolysis of these three haloalkanes.

[2]

2. This question is about the analysis of organic compounds.

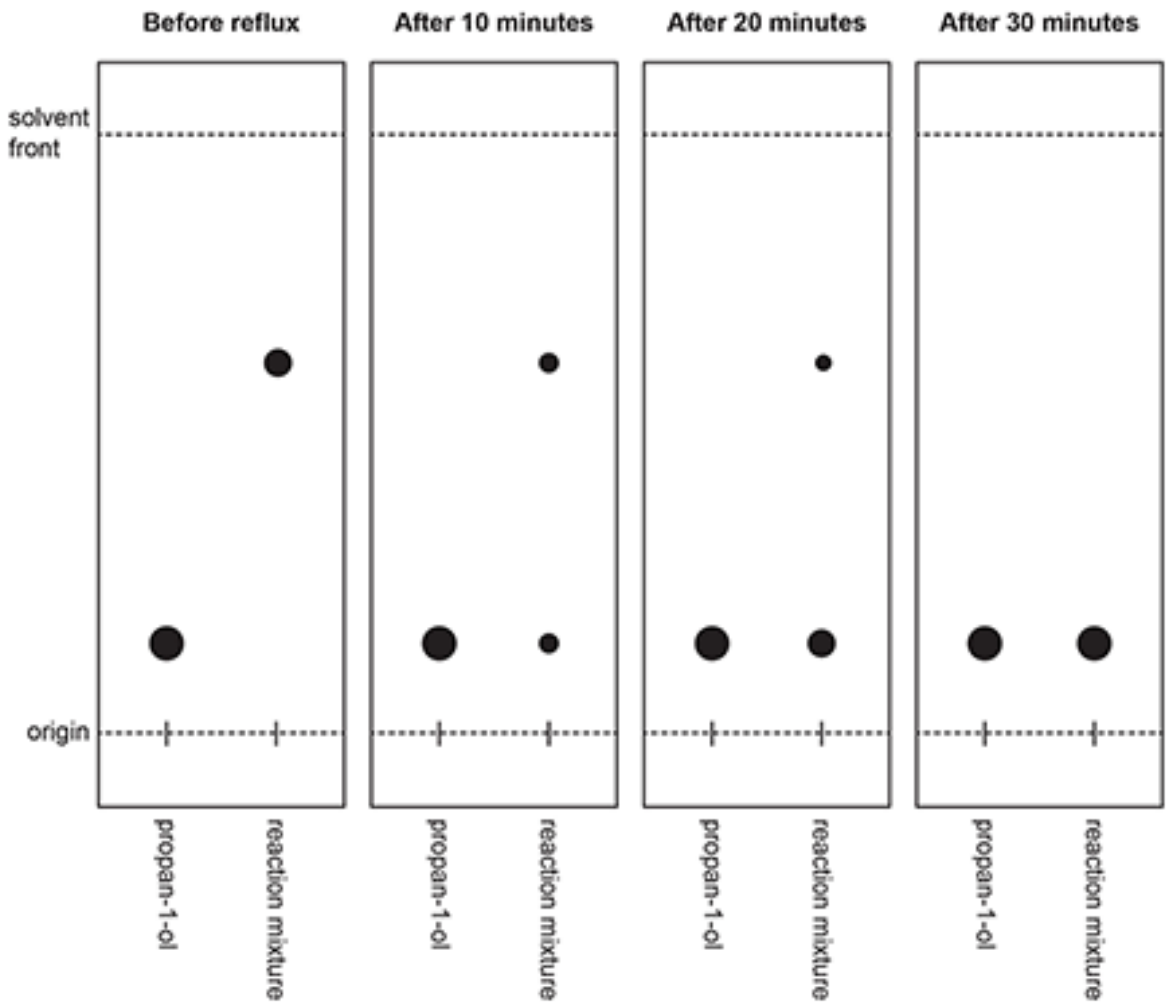
A student investigates the alkaline hydrolysis of 1-bromopropane as outlined below.

Step 1 The student adds 1-bromopropane to an excess of aqueous potassium hydroxide, KOH(aq), in a pear-shaped flask.

Step 2 A TLC chromatogram is run using propan-1-ol and the reaction mixture.

Step 3 The reaction mixture is refluxed.
A TLC chromatogram of the reaction mixture is run every 10 minutes.

The TLC chromatograms are shown below



i. Determine the R_f value of propan−1−ol.

Show your working.

R_f = ... **[1]**

ii. Write an equation for the alkaline hydrolysis of 1−bromopropane.

Show structures of organic compounds.

[1]

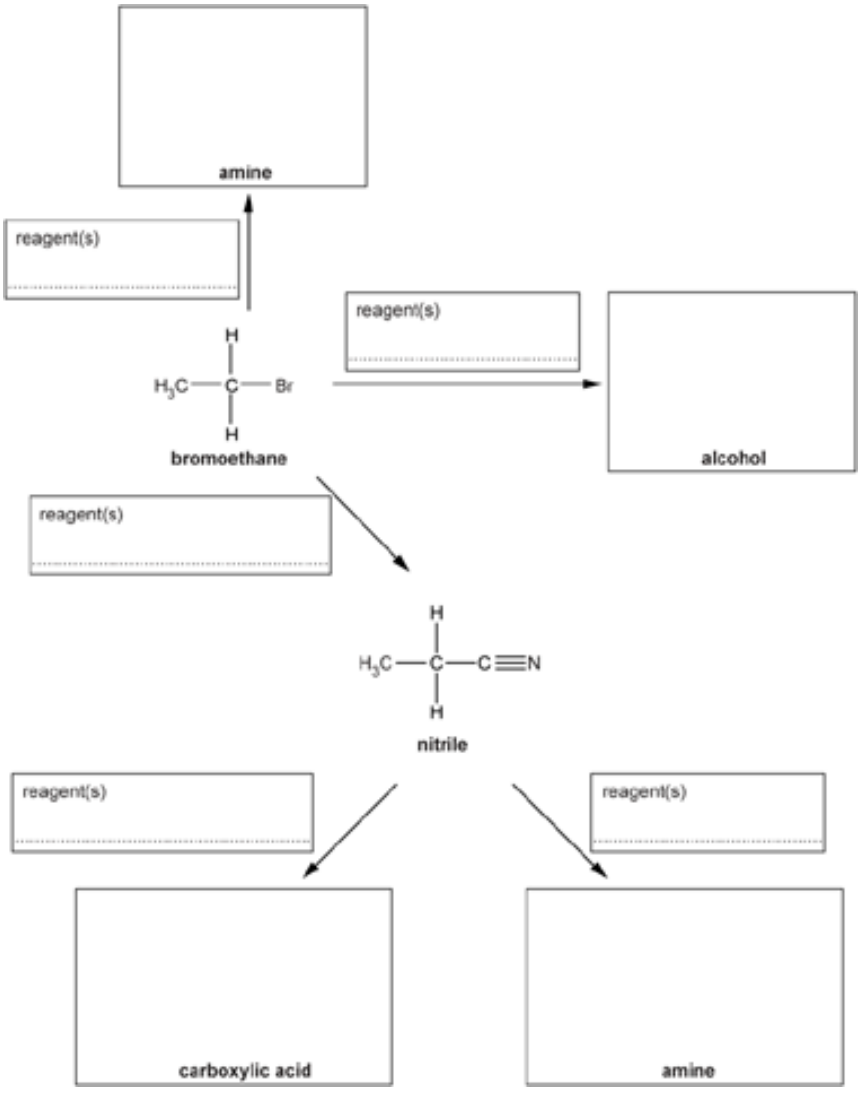
iii. A student investigates the alkaline hydrolysis of 1−chloropropane using the same method as for 1−bromopropane.

Predict, with reasons, how the appearance of the reaction mixture in the chromatogram produced after 20 minutes would be different when 1−chloropropane is used instead of 1−bromopropane.

Suggest why propan−1−ol is run alongside the reaction mixture.

[3]

3. Complete the flowchart by filling in each box.



[9]

4. A student investigates the rate of hydrolysis of different iodoalkanes using aqueous silver nitrate in ethanol.

What colour of precipitate is seen?

A Brown
B Cream
C White
D Yellow

Your answer ☐ **[1]**

5. Which statement gives a valid scientific reason for global warming?

A Infrared radiation causes bonds in CH_4 molecules to vibrate more.
B Infrared radiation causes O_2 molecules to vibrate more.
C Ultraviolet radiation causes bonds in CO_2 to vibrate more.
D Ultraviolet radiation causes bonds in CFC molecules to break.

Your answer ☐ **[1]**

6. The CFC CCl_2F_2 can cause the breakdown of ozone in the upper atmosphere.

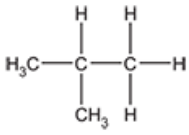
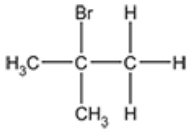
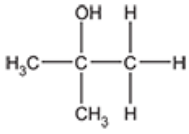
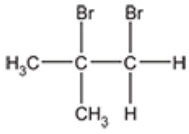
Which initiation step could occur with ultraviolet radiation to catalyse this breakdown?

A $CCl_2F_2 \rightarrow \bullet C + \bullet Cl_2F_2$
B $CCl_2F_2 \rightarrow \bullet F + \bullet CCl_2F$
C $CCl_2F_2 \rightarrow \bullet Cl + \bullet CClF_2$
D $CCl_2F_2 \rightarrow \bullet Cl_2 + \bullet CF_2$

Your answer ☐ **[1]**

7. A student has planned the two-stage synthesis shown below.

Which compound could be the intermediate for this synthesis?

A	
B	
C	
D	

Your answer ☐ **[1]**

8(a). This question is about halogens and halogen compounds.

A student is studying the hydrolysis of haloalkanes.

The equation for the alkaline hydrolysis of 2-bromopropane, $CH_3CHBrCH_3$, is shown below.

$CH_3CHBrCH_3 + OH^- \rightarrow CH_3\ CHOHCH_3 + Br^-$

Use the curly arrow model to outline the mechanism for the alkaline hydrolysis of 2-bromopropane.

Show relevant dipoles and lone pairs, and name the mechanism.

name of mechanism ..... **[3]**

(b). The student sets up an experiment to compare the rates of hydrolysis of 2-bromopropane and 2-iodopropane.

The student uses the method below.

Step 1 Place two test tubes, both containing aqueous silver nitrate and ethanol, in a water bath at 60 °C.

Step 2 Add five drops of 2-bromopropane to one test tube and five drops of 2-iodopropane to the other test tube.

Step 3 Record the time taken for a precipitate to appear in each test tube.

i. Complete the table below to show the formula and colour of each precipitate formed.

Haloalkane	Formula of precipitate	Colour of precipitate
2-bromopropane		
2-iodopropane		

[2]

ii. Predict which precipitate would form first and explain the difference in the rates of hydrolysis of 2-bromopropane and 2-iodopropane.

---

[1]

9. Butan-1-ol reacts with sodium bromide and sulfuric acid to form 1-bromobutane by nucleophilic substitution.

The mechanism for this reaction takes place by two steps.

Step 1 The oxygen atom of the alcohol group accepts a proton to form a positively- charged intermediate.

Step 2 Bromide ions react with the intermediate from **Step 1** by nucleophilic substitution to form 1-bromobutane.

Show both steps in this mechanism.

[4]

10. * Carbon-carbon bond formation is used in synthesis to increase the length of a carbon chain.

Describe the formation of carbon−carbon bonds in aliphatic compounds by **two** different mechanisms.

Your answer should include mechanisms for each aliphatic compound.

Additional answer space if required.

[6]

11. Which species could react as a nucleophile?

1 NH_3
2 OH^-
3 CH_3NH_2

A 1, 2 and 3
B Only 1 and 2
C Only 2 and 3
D Only 1

Your answer ☐ **[1]**

12. Which statement is correct for the different rates of hydrolysis of RC*l* and RBr?

A RBr is hydrolysed faster because C*l* is more electronegative than Br.
B RBr is hydrolysed faster because the C–C*l* bond enthalpy is greater than C–Br.
C RC*l* is hydrolysed faster because C*l* is more electronegative than Br.
D RC*l* is hydrolysed faster because the C–Br bond enthalpy is greater than C–C*l*.

Your answer ☐ **[1]**

13. Which statement about absorption of radiation is correct?

A Infrared radiation can result in the breakdown of the ozone layer.
B Ultraviolet radiation can cause some polymers to photodegrade to benefit the environment.
C Ultraviolet radiation is linked to global warming.
D Ultraviolet radiation is used in modern breathalysers to measure ethanol in the breath.

Your answer ☐ **[1]**

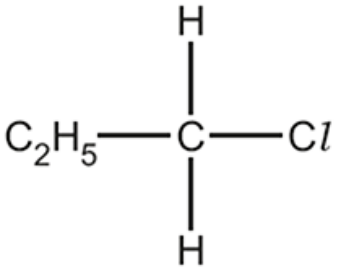
14. When heated with NaOH(aq), 1-chlorobutane is hydrolysed at a slower rate than 1-bromobutane. Which statement explains the different rates?

A The C–Br bond enthalpy is greater than the C–C*l* bond enthalpy.
B The C–Br bond enthalpy is less than the C–C*l* bond enthalpy.
C The C–Br bond is less polar than the C–C*l* bond.
D The C–Br bond is more polar than the C–C*l* bond

Your answer ☐ **[1]**

15. This question is about haloalkanes.

1-Chloropropane, $C_2H_5CH_2Cl$, can be hydrolysed with aqueous sodium hydroxide, NaOH.
Outline the mechanism for this reaction.
The structure of 1-chloropropane has been provided.
Show curly arrows, relevant dipoles and product(s).



[3]

END OF QUESTION PAPER