# AS Level Chemistry B

**H033/02** Chemistry in depth

## Question Set 7

**7** Bromomethane is a gas that is used as a fumigant to protect young plants against insects androdents.

**(a)** It is possible to make bromomethane by reacting methane with bromine in the presence of light. This takes place by a radical chain reaction.

**(i)** Write an equation to show the effect of light on bromine in the initiation stage of this reaction.

**[1]**

**(ii)** The initiation stage is followed by the propagation stage which involves two steps.

The equation for the **first** propagation step is shown below.

$$CH_4 + Br^{\bullet} \rightarrow {}^{\bullet}CH_3 + HBr$$

Write the mechanism for the **second** propagation step using 'half curly arrows'. Indicate radicals with dots as above.

**[2]**

**(iii)** Bromomethane can also be made by treating methanol with hydrogen bromide.

Is this method or the reaction of methane and bromine

preferable?

Give a reason for your answer. **[1]**

**(b)** A student predicts incorrectly that chloromethane will have a higher boiling point than bromomethane. The student's reason is that chlorine is more electronegative than bromine and thus the carbon to chlorine bond is more polar than the carbon to bromine bond. This will cause stronger permanent dipole-permanent dipole bonds.

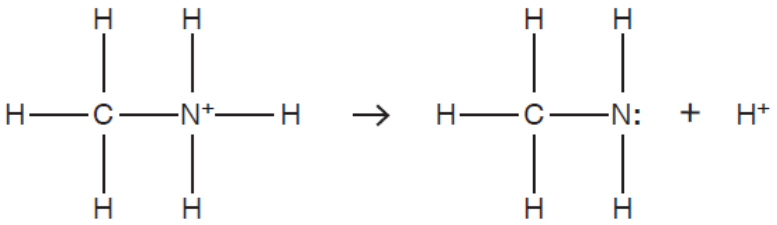
Discuss the student's reasoning and give the correct chemistry where necessary. **[4]**

**(c)** Haloalkanes react with ammonia under suitable conditions.

**(i)** The first step in the mechanism of the reaction of bromomethane with ammonia involves the following reaction.

$$CH_3Br + NH_3 \rightarrow CH_3NH_3^+ + Br^-$$

Draw a 'curly arrow' to show the electron movement in the second step in the mechanism below.



**[1]**

**(ii)** Name the mechanism for the reaction of bromomethane with ammonia.

**[1]**

**(iii)** Name the functional group in the organic product of the reaction.

**[1]**

**(d)** A student investigates the rate of hydrolysis of haloalkanes.

Two test tubes, each containing aqueous silver nitrate and ethanol, are placed in a water bath at 60 °C. Five drops of each of chlorobutane and iodobutane are added separately to each of the two test tubes.

**(i)** Describe what the student would see as the reactions progress that would show that iodobutane reacts faster. **[1]**

**(ii)** Suggest why ethanol is used in the mixture. **[1]**

**(iii)** Use the following data to explain whether bond enthalpy or bond polarity is the more important in determining the order of the rate of hydrolysis of haloalkanes.

| | | | |
|---|---|---|---|
| Electronegativity | C*l* = 3.2 | I = 2.7 | C = 2.6 |
| Bond enthalpy/kJ mol$^{-1}$ | C–C*l* = +346 | C–I = +228 | |

.....

**[3]**

**(e)** When bromomethane, $CH_3Br$, gets into the Earth's atmosphere, a C–Br bond may be broken by ultraviolet radiation from the Sun. However, the ultraviolet radiation may not have high enough energy to break the bond.

Suggest what other effect it may have on the molecule. **[1]**

**(f)** The minimum frequency of radiation needed to break one C–Br bond is $7.14 \times 10^{14}$ Hz.

Calculate the bond enthalpy of the C–Br bond, in kJ mol$^{-1}$.

Give your answer to an **appropriate** number of significant figures.

bond enthalpy =..... kJ mol$^{-1}$ **[3]**

**(g)** Ozone is present in both the troposphere (lower atmosphere) and the stratosphere (upper atmosphere).

**(i)** The ozone percentage concentration in the stratosphere is 0.000021% by volume.

Calculate the concentration of ozone in ppm (parts per million).

ozone concentration =..... ppm **[1]**

**(ii)** The process by which Br reacts with ozone in the stratosphere is represented in the following equations.

$Br + O_3 \rightarrow BrO + O_2$ **Equation 3.1**

$BrO + O \rightarrow Br + O_2$ **Equation 3.2**

Combine **equations 3.1** and **3.2** to produce the overall equation for the process.

**[1]**

**(iii)** Explain how **equations 3.1** and **3.2** show that Br could be a catalyst for the breakdown of ozone.

..... **[1]**

**(iv)** Give **one** disadvantage of a build-up of **tropospheric** ozone.

..... **[1]**

## Total Marks for Question Set 7: 24