HALOGENALKANES

TIME – 15min **M.M - 26**

NOTE THE EXACT NUMBERS AS IN QUESTIONS

DON'T DO YOUR OWN NUMBERING

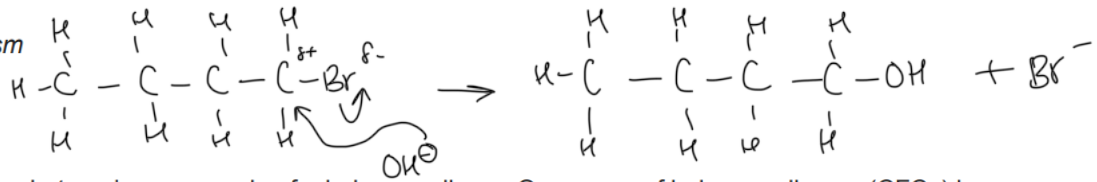
(b) Butan-1-ol can be prepared by warming 1-chlorobutane with aqueous sodium hydroxide

(i) Classify the type of reaction occurring and give the mechanism for the reaction

[4]

Reaction type nucleophilic substitution

Mechanism



(d) 1-Chlorobutane is an example of a halogenoalkane. One group of halogenoalkanes (CFCs) has been shown to play a role in ozone depletion. Most of these ozone-depleting substances contain chlorine. Halogenoalkanes containing only fluorine do not harm the ozone layer.

Due to the Montreal Protocol of 1987, CFCs have been largely banned and have been replaced in many applications by HFCs, which contain fluorine as the only halogen.

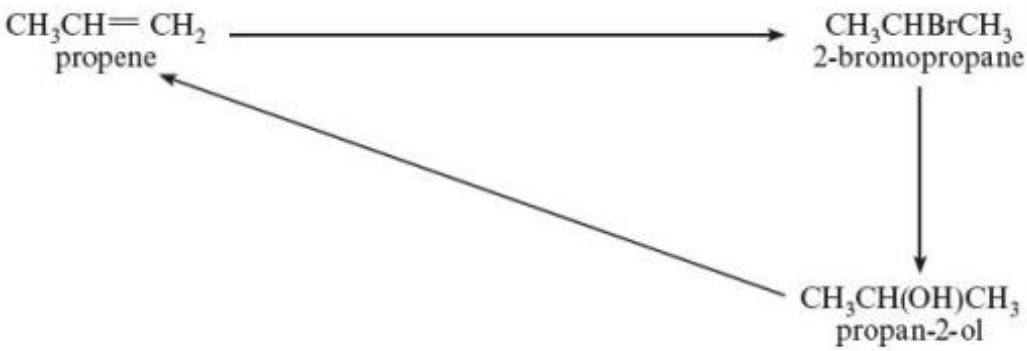
(i) Explain why CFCs deplete the ozone layer, but HFCs do not.

[2]

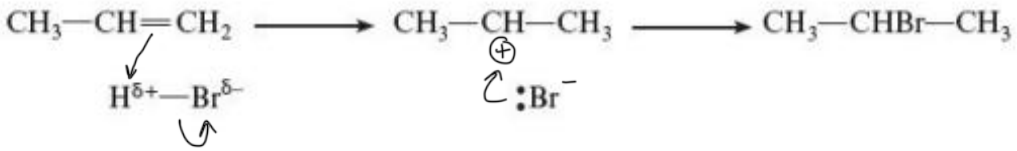
(ii) Suggest a reason why there is still concern about ozone depletion.

[1]

3. *(a)* This question is about the compounds and reactions shown in the diagram below.



(i) The addition of hydrogen bromide to propene gives 2-bromopropane as the main product. Complete the outline mechansim below, inserting curly arrows and charges where appropriate. [2]



(ii) The reaction of 2-bromopropane to give propan-2-ol is an example of a nucleophilic substitution reaction. Suggest a nucleophile that can be used for this reaction and give a reason why this is classed as a substitution reaction. [2]

Nucleophile NaOH (aq) → OH^-

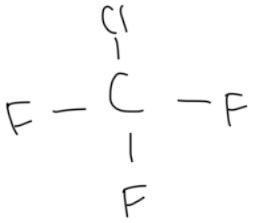
Reason OH^- replaces the Br^-

(iii) The production of propene from propan-2-ol is an example of an elimination reaction. Another elimination reaction is the reaction of bromoethane with sodium hydroxide.

$$CH_3CH_2Br + NaOH \longrightarrow CH_2{=}CH_2 + HBr$$

Complete the equation by giving the formulae of the other products. [1]

(Total 5)



4. Trifluorochloromethane, CF_3Cl, is an example of a chlorofluorocarbon, CFC, that was commonly used as a propellant in aerosols. Nowadays, CFCs have limited use because of the damage caused to the ozone layer.

(i) Draw a diagram to show the shape of a molecule of CF_3Cl.

[1]

(ii) Predict an approximate value for the bond angles in a molecule of CF_3Cl.

bond angle 109.5°

[1]

(iii) Suggest a property that made CF_3Cl suitable as a propellant in an aerosol.

.....

[1]

(iv) When CFCs are exposed to strong ultraviolet radiation in the upper atmosphere, homolytic fission takes place to produce free radicals.

Explain what is meant by the term *homolytic fission*.

covalent bonds break down into non-polar molecules generating free radicals.

[2]

(v) Suggest which bond is most likely to be broken when CF_3Cl is exposed to ultraviolet radiation. Explain your answer.

bond C-Cl

reason C-Cl bond is weaker than C-F bond, requires less energy to break.

[1]

(vi) Identify the **two** free radicals most likely to be formed when CF_3Cl is exposed to ultraviolet radiation.

$CF_3^{\bullet}$ and $Cl^{\bullet}$

[2]

[Total 8 marks]

6. In this question, one mark is available for the quality of spelling, punctuation and grammar.

The rates of hydrolysis of chloroethane, bromoethane and iodoethane are different.

- Describe how you would monitor the reaction rates.
- Explain why chloroethane, bromoethane and iodoethane react at different rates.

Use suitable equations in your answer.

[Total 6 marks]

Add $AgNO_3$ to chloroethane, bromoethane & iodoethane

Chloroethane gives AgCl which has a white ppt.
ppt. appears the slowest.

$$CH_3CH_2Cl + H_2O + AgNO_3 \longrightarrow CH_3CH_2OH + AgCl + HNO_3$$

bromoethane gives AgBr which has a cream ppt.
ppt. appears quicker than AgCl, but slower than AgI

$$CH_3CH_2Br + AgNO_3 + H_2O \longrightarrow CH_3CH_2OH + AgBr + HNO_3$$

iodoethane gives AgI which has a yellow ppt.
ppt. appears fastest.

$$CH_3CH_2I + AgNO_3 + H_2O \longrightarrow CH_3CH_2OH + AgI + HNO_3$$

- iodoethane reacts the fastest as C-I bond is the weakest
- chloroethane reacts the slowest as C-Cl bond is the strongest