CHAPTER 1 LAB ACTIVITIES

LAB EXERCISE 1.3.1 PREPARATION OF ETHYNE

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Prediction

(a) (Sample answer) From the balanced equation,

$CaC_{2(s)} + 2\ H_2O_{(l)} \rightarrow C_2H_{2(g)} + Ca(OH)_{2(aq)}$

m_{CaC_2} reacted = 6.78 g

M_{CaC_2} = 64.10

therefore, n_{CaC_2} reacted = $6.78\ g \times \frac{1\ mol}{64.10\ g}$

n_{CaC_2} = 0.106 mol CaC_2

$n_{C_2H_2} = n_{Ca(OH)_2} = n_{CaC_2}$ = 0.106 mol

$M_{C_2H_2}$ = 26.04

therefore, $m_{C_2H_2}$ = 0.106 mol × 26.04 g/mol

$m_{C_2H_2}$ = 2.76 g

$M_{Ca(OH)_2}$ = 74.10

therefore, $m_{Ca(OH)_2}$ = 0.106 mol × 74.10 g/mol

$m_{Ca(OH)_2}$ = 7.85 g

The predicted mass of ethyne produced is 2.76 g; the predicted mass of calcium hydroxide produced is 7.85 g.

Analysis

(b) $2\ HCl_{(aq)} + Ca(OH)_{2(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$

(c) n_{HCl} in titration = 0.100 L × 1.00 mol/L HCl

n_{HCl} = 0.100 mol HCl

From the balanced equation,

$2\ HCl_{(aq)} + Ca(OH)_{2(aq)} \rightarrow CaCl_{2(aq)} + 2\ H_2O_{(l)}$

$n_{Ca(OH)_2} = 0.100\ mol\ HCl \times \frac{1\ mol\ Ca(OH)_2}{2\ mol\ HCl}$

$n_{Ca(OH)_2}$ = 0.0500 mol $Ca(OH)_2$

Therefore, the amount of $Ca(OH)_2$ produced is 0.0500 mol.

(d) From the balanced equation,

$CaC_{2(s)} + 2\ H_2O_{(l)} \rightarrow C_2H_{2(g)} + Ca(OH)_{2(aq)}$

$n_{C_2H_2} = n_{Ca(OH)_2}$ = 0.0500 mol

$M_{C_2H_2}$ = 26.04

therefore, $m_{C_2H_2}$ = 0.0500 mol × 26.04 g/mol

$m_{C_2H_2}$ = 1.30 g

The yield of ethyne is 1.30 g.

(e) As shown in the prediction, answer (a), the theoretical yield of C_2H_2 = 0.106 mol

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

$$= \frac{1.30\text{ g}}{2.76\text{ g}} \times 100\%$$

percentage yield = 47.2%

Therefore, the CaC_2 is 47.2% pure.

Evaluation

(f) We assume that the reactants are pure, that $H_2O_{(l)}$ is in excess, and that we obtained a 100% yield.

INVESTIGATION 1.5.1 COMPARISON OF THREE ISOMERS OF BUTANOL

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Prediction

(a) All three alcohols will produce alkyl halides, because they can all undergo substitution reactions where the OH group is substituted by a halogen atom.

The primary alcohol will oxidize to an aldehyde; the secondary alcohol will oxidize to a ketone; and the tertiary alcohol will not readily undergo oxidization.

Evidence

(b)

Alcohol	Reaction with $HCl_{(aq)}$	Reaction with $KMnO_{4(aq)}$
1-butanol	cloudy layer formed after more than 1 min	colour change
2-butanol	cloudy layer formed in about a minute	colour change
2-methyl-2-propanol	cloudy layer formed immediately	no reaction

Analysis

(c) Each alcohol undergoes halogenation. Only the primary and secondary alcohols undergo controlled oxidation.

Evaluation

(d) The theory is correct (although the cloudy layer may be difficult to see in the primary alcohol).

Synthesis

(e) All three alcohols form chlorides. The primary and secondary alcohols undergo controlled oxidation; the tertiary alcohol does not. The chlorides do not contain groups capable of hydrogen bonding and thus are not as soluble as the alcohols in water.

(f) $CH_3CH_2CH_2CH_2OH + HCl \rightarrow CH_3CH_2CH_2CH_2Cl + H_2O$

$$CH_3CH_2\underset{\displaystyle OH}{\underset{|}{C}}HCH_3 + HCl \rightarrow CH_3CH_2\underset{\displaystyle Cl}{\underset{|}{C}}HCH_3 + H_2O$$

$$CH_3\underset{\displaystyle OH}{\underset{|}{C}}(CH_3)CH_3 + HCl \rightarrow CH_3\underset{\displaystyle Cl}{\underset{|}{C}}(CH_3)CH_3 + H_2O$$