2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Section I – Part B (continued)

Marks

Question 22 (6 marks)

Justify the procedure you used to prepare an ester in a school laboratory. Include relevant chemical equations in your answer. **6**

Ester is produced by reacting an alcohol with alkanoic acid. In school, we used 1-butanol and ethanoic acid with concentrated sulfuric acid as a catalyst. We added an excess of ~~butanol~~ ethanoic acid in the reaction flask along with other reagents. We took care to not spill the sulfuric acid and wore gloves during handling as it burns the skin. We heat the mixture in water bath as the reactants are highly flammable. We use a inverted condenser to set up a reflux so we can heat mixture at high temperature without losing the volatile substance. The ester is formed

$C_4H_9OH_{(aq)} + CH_3COOH_{(aq)} \rightarrow C_6H_{12}COO_{(aq)} + H_2O_{(l)}$

The ester is 1-butylethanoate. We then cooled mixture and poured into separating funnel adding water and then shake up the mixture. Then using the separating funnel to discard the bottom aqueous layer as it contains the excess ethanoic acid and the sulfuric acid which are not reacted. We add ~~sodium~~ calcium carbonate to mixture and add water again and separate and discard bottom layer as well. This changes

$CH_3COOH \rightarrow CH_3COO^-$ ~~$+ H_2O + CO_{2(g)}$~~ and water and carbon dioxide to get the acid that is dissolved in ester to be dissolved in water. We then ~~add~~ ~~Anhydrous~~ dry the ester by adding anhydrous $Na_2CO_{3(s)}$ and distill it to obtain pure ester.

as acid + carbonate → water + carbon dioxide + salt

~~$CO_3^{2-}{}_{(aq)} + CH_3COOH_{(aq)} \rightarrow 2CH_3COO^-{}_{(aq)} + CO_{2(g)} + H_2O_{(l)}$~~

Marks

Question 23 (4 marks)

A household cleaning agent contains a weak base of general formula NaX. 1.00 g of this compound was dissolved in 100.0 mL of water. A 20.0 mL sample of the solution was titrated with 0.1000 mol L^{-1} hydrochloric acid and required 24.4 mL of the acid for neutralisation.

(a) What is the Brönsted–Lowry definition of a base? **1**

A Brönsted-Lowry base is one which accept hydrogen ions $[H^+]$ or protons from another species in solution.

(b) What is the molar mass of this base? **3**

$NaX + HCl \rightleftharpoons NaCl + HX \quad [H_2O]$

$n(HCl) = CV$

$= 0.1 \times \frac{24.4}{1000}$

$= 0.00244$

Ratio of $NaX : HCl = 1:1$

$\therefore n(NaX) = 0.00244$

$\therefore C(NaX) = \frac{n}{V}$

$= \frac{0.00244}{\frac{20}{1000}}$

$= 0.122$

$n(NaX) = 0.00244$

$\therefore MM(NaX) = \frac{m}{n}$

$= \frac{1}{0.00244}$

* mass of NaX in 100ml = 1g

$\therefore$ mass of NaX in 20ml = 0.2g

$\therefore MM(NaX) = \frac{0.2}{0.00244}$

$= 81.97 \text{ g/mol}$

Marks

Question 24 (6 marks)

In the early twentieth century, Fritz Haber developed a method for producing ammonia, as shown by the equation:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) \qquad -\Delta H$$

(a) Ammonia is used as a cleaning agent. State ONE other use of ammonia. **1**

Used to make ~~HNO3~~ fertilizers.

(b) Explain the effect of liquefying the ammonia on the yield of the reaction. **2**

To liquefy the ammonia you must cool it. By cooling the ammonia (since the reaction is exothermic) you increase the yield of ammonia.

(c) Explain why it is essential to monitor the temperature and pressure inside the reaction vessel. **3**

Temperature and pressure have an effect on yield and rate of reaction. A lower temp. (since reaction is exothermic. Using Le Chatelier's Principal) will increase the yield of ammonia but the rate of reaction will be slower. A higher pressure will force the reaction to the right i.e increase yield of ammonia (using Le Chateleirs principal) but to maintain a very high ~~ten~~ pressure would be expensive. Therefore an optimum combination must be found between the two. typically 400°C and 250 atm.

A high temperature will allow the reaction to go faster but, a smaller yield would be obtained