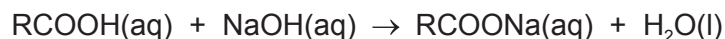


## EXPERIMENT NO. 12

- 2 When an organic acid, RCOOH, is neutralised by an alkali an exothermic reaction takes place. You will determine the enthalpy change of neutralisation,  $\Delta H$ , for the following reaction.



In this equation R is an alkyl group.

**FA 3** is a solution containing  $120.1 \text{ g dm}^{-3}$  of RCOOH.

**FA 4** is aqueous sodium hydroxide, NaOH.

### (a) Method

#### Experiment 1

- Support the cup in the  $250 \text{ cm}^3$  beaker.
- Use the  $25 \text{ cm}^3$  measuring cylinder to transfer  $25.0 \text{ cm}^3$  of **FA 3** into the cup.
- Measure and record the temperature of this **FA 3**. Rinse the thermometer.
- Place  $25.0 \text{ cm}^3$  of **FA 4** into the  $50 \text{ cm}^3$  measuring cylinder.
- Measure and record the temperature of the **FA 4** in the measuring cylinder. Rinse the thermometer.
- Tip the **FA 4** from the measuring cylinder into the cup. Stir, then measure and record the highest temperature reached.
- Calculate and record the average initial temperature of **FA 3** and **FA 4**.
- Calculate and record the difference between the average initial temperature and the highest temperature reached.
- Rinse and dry the cup for use in **Experiment 2**.

#### Experiment 2

- Repeat **Experiment 1** using  $50.0 \text{ cm}^3$  of **FA 3** and **FA 4**. You will need to use the  $25 \text{ cm}^3$  measuring cylinder twice to measure the **FA 3**.
- Calculate and record the average initial temperature of **FA 3** and **FA 4**.
- Calculate and record the difference between the average initial temperature and the highest temperature reached.

Experiment number	01	02
Temperature of FA3 / °C	22.0	22.5
Temperature of FA4 / °C	22.0	22.5
Average initial temperature / °C	22.0	22.5
Final temperature / °C	28.0	28.5
Change in temperature / °C	6.0	6.0

[4]

**(b) Calculations**

(i) Calculate the energy released in **Experiment 1**.

(Assume that 4.2 J of energy changes the temperature of 1.0 cm<sup>3</sup> of solution by 1.0 °C.)

$$= m C \Delta T \text{ or } V C \Delta T$$

$$= 50 \times 4.2 \times 6.0$$

energy released = ..... 1260 ..... J [1]

(ii) Calculate the number of moles of RCOOH used in **Experiment 1**. Assume that the relative molecular mass,  $M_r$ , of RCOOH is 122.

Show your working.

$$n = \frac{m}{M_r}$$

$$= \frac{120.1}{122}$$

$$0.984 \text{ mol dm}^{-3}$$

$$n = CV$$

$$= 0.984 \times \frac{25.0}{1000}$$

$$0.0246 \text{ mol}$$

moles of RCOOH = ..... 0.0246 ..... mol [2]

(iii) Calculate the enthalpy change of neutralisation,  $\Delta H$ , of RCOOH. Assume that the sodium hydroxide is in excess.

$$\frac{0.0246 \text{ mol}}{1 \text{ mol}} \times \frac{1260 \text{ J}}{x}$$

$$\frac{51219.5 \text{ J mol}^{-1}}{1000}$$

enthalpy change of neutralisation of RCOOH = ..... 51.2 ..... kJ mol<sup>-1</sup>  
sign value [1]

(c) Each measuring cylinder can be read to an accuracy of  $\pm 0.5 \text{ cm}^3$ .

Calculate the total maximum percentage error in the volumes of solution measured in each of **Experiments 1** and **2**.

**Experiment 1**

% error in the vol. of FA3 =  $\frac{\pm 0.5 \text{ cm}^3}{25.0 \text{ cm}^3} \times 100$   
2%

% error in the vol. of FA4 =  $\frac{\pm 0.5 \text{ cm}^3}{25.0 \text{ cm}^3} \times 100$   
2% = 2 + 2

total maximum percentage error = ..... 4 ..... %

**Experiment 2**

% error in the vol. of FA3 =  $\frac{\pm 0.5 \text{ cm}^3}{25.0 \text{ cm}^3} \times 100$   
 2% x 2 = 4%

% error in the vol. of FA4 =  $\frac{\pm 0.5 \text{ cm}^3}{50.0 \text{ cm}^3} \times 100$   
1% = 4 + 1

total maximum percentage error = ..... 5 ..... %

[2]

(d) A student repeated both experiments in (a) using hydrochloric acid in place of RCOOH.

Suggest how the temperature rise when using HCl would compare to the temperature rise recorded in (a). Assume all volumes and concentrations of solutions, in  $\text{mol dm}^{-3}$ , are the same.

Explain your answer by considering the chemical bonds involved.

With HCl temperature change would be more  
because in organic acid some energy needed  
to release  $\text{H}^+$  ions. [2]

[Total: 12]