2 Sodium hydroxide solution reacts with carbon dioxide in the air and should be standardised before use. Ethanedioic acid may be used for this standardisation.

(a) A standard solution of ethanedioic acid, $(COOH)_2$, is prepared.

- 2.40 g of solid ethanedioic acid is dissolved in approximately 100 cm^3 of deionised water in a beaker.

- The solution is transferred into a 250.0 cm^3 volumetric flask and made up to the mark with deionised water.

(i) Give a possible reason why any solution remaining in the beaker is washed into the volumetric flask before making up to the mark.

(1)

so no   solution is left

behind .

(ii) Calculate the concentration of this standard solution of ethanedioic acid in mol dm^{-3}.

Give your answer to an appropriate number of significant figures.

[Molar mass of ethanedioic acid = 90.0 g mol^{-1}]

(2)

$$n = \frac{2.4}{40} = 0.027 \text{ moles}$$

$$M = \frac{0.027}{0.25} = 0.108 \text{ mol} \cdot dm^{-3}$$

(b) A **different** standard solution of ethanedioic acid is used to determine the concentration of a sodium hydroxide solution **J**.

Procedure

Step **1** A burette is rinsed with deionised water.

Step **2** The burette is then rinsed with 0.0900 mol dm⁻³ ethanedioic acid and filled with this acid solution.

Step **3** A pipette is used to transfer 25.0 cm³ portions of solution **J** to conical flasks.

Step **4** The portions are titrated with the ethanedioic acid solution using phenolphthalein indicator.
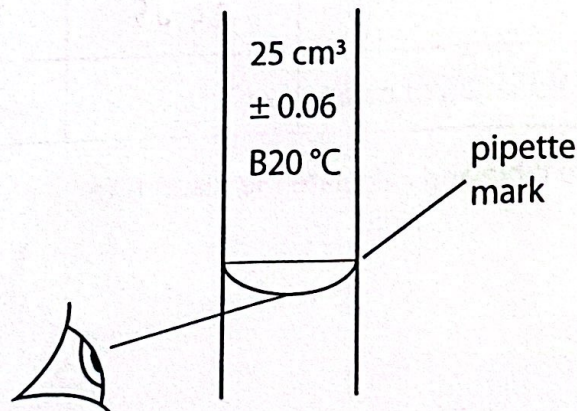
(i) Explain why the burette is rinsed with ethanedioic acid solution in Step **2**.

(1)

To remove the water, so it doesn't change the concentration of the acid.

(ii) The diagram shows how the student read the filled pipette in Step **3**.

Identify the **two** mistakes the student made.

(2)

25 cm³
± 0.06
B20 °C

pipette mark

The reading should be taken parallel to the bottom of the miniscus. The ~~bottom~~ to bottom of the miniscus should be at the mark

(iii) The student completely emptied the pipette for each transfer in Step **3**.

Explain the effect **on the titre** of completely emptying the pipette rather than leaving a small amount of solution in the tip.

(2)

_____

_____

_____

(iv) State the colour **change** in the conical flask at the end-point.

(2)

From .... pink .... to .... colorless ....

(c) The titration results are shown.

Titration	1	2	3
Final reading / cm³	25.05	26.60	25.50
Initial reading / cm³	✓ 0.00	2.00	1.00
Titre / cm³	25.05	24.60	24.50
Titres used in calculation of mean		✓	✓

(i) Complete the table and calculate the mean titre.

(2)

$$\frac{24.6 + 24.5}{2}$$

$$= 24.55 \, cm^3$$

alculate the concentration of the sodium hydroxide solution in mol dm⁻³.

he equation for the titration is

$$(COOH)_2 + 2NaOH \rightarrow (COONa)_2 + 2H_2O$$

(3)
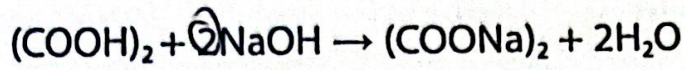
$$M = \frac{n}{v} \qquad n = M \times V$$

$$n_{(COOH)_2} = 0.09 \times 0.02455$$

$$= 2.21 \times 10^{-3} \text{ moles}$$

n NaOH

$$\frac{1}{2}$$

$$2.21 \times 10^{-3} : x$$

$$x = 4.419 \times 10^{-3}$$

$$M = \frac{4.419 \times 10^{-3}}{0.025} = 0.17676$$

$$= 0.177 \text{ mol/dm}^{-3}$$

(Total for Question 2 = 15 marks)