

QUESTION 2

2.1 The acid HF ionises according to the following equation:



When a 0, 10 mol.dm⁻³ solution of HF is prepared, it is found that the concentration of the F⁻ ions is 0, 018 mol.dm⁻³ at 25 °C.

2.1.1 Define a *strong acid*.

(2)

2.1.2 Is HF a strong acid? Choose from YES or NO.

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Give a reason for the answer.

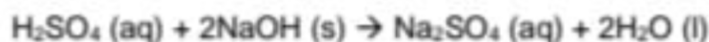
(2)

2.1.3 Calculate the concentration of hydroxide ions (OH⁻) in this solution.

(3)

2.2 Sodium hydroxide (NaOH) pellets of mass **X** grams are added to sufficient distilled water to prepare a solution of volume 25 cm³ in a flask.

12 cm³ of sulphuric acid, H₂SO₄, of concentration 0, 10 mol.dm⁻³ is added to the flask containing the sodium hydroxide. The total volume of the mixture formed is 37 cm³ and its pH is 12, 56.



2.2.1 Explain the term *dilute acid*.

(2)

2.2.2 How does the concentration of the hydronium ions compare to the concentration of the hydroxide ions in the mixture?

Choose from LARGER THAN, SMALLER THAN, or EQUAL TO.

(1)

2.2.3 Calculate the value of **X**.

(8)

[18]

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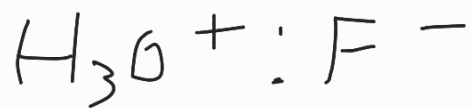
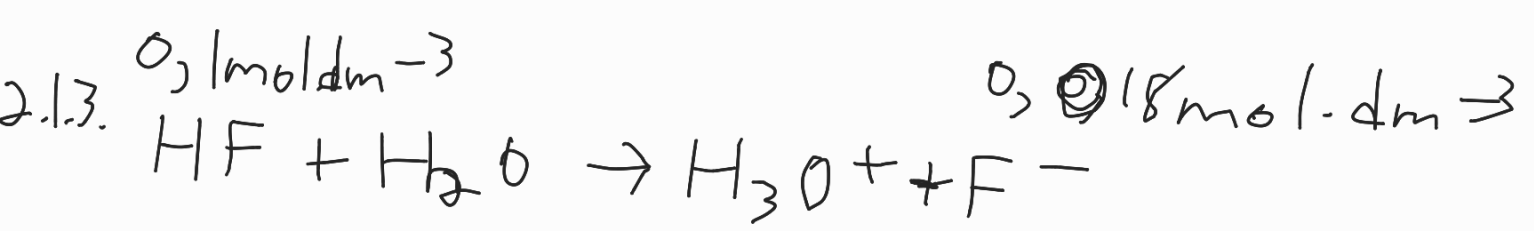
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[18]

QUESTION 3



$$1 : 1$$

$$[\text{H}_3\text{O}^+] = [\text{F}^-] = 0,018 \text{ mol dm}^{-3}$$

2.1.2. No, HF partially ionises in water to form a lower concentration of H_3O^+ ions

$$K_w = [\text{H}_3\text{O}^+] \times [\text{OH}^-] = 1 \times 10^{-14}$$

$$0,018 \times [\text{OH}^-] = 1 \times 10^{-14}$$

$$[\text{OH}^-] = \frac{1 \times 10^{-14}}{0,018}$$

$$\approx 5,56 \times 10^{-13} \text{ mol dm}^{-3}$$

2.2.1. Dilute acid - substance containing less amount of acid relative to the volume of water.

2.2.2. Smaller than ($[\text{H}_3\text{O}^+] < [\text{OH}^-]$)
 ($\text{pH} > 7$)

$$\begin{aligned} 2.2.3. \quad n_{\text{H}_2\text{SO}_4} &= C \times V \\ &= 0,1 \times \frac{12}{1000} \\ &= 0,0012 \text{ mol} \end{aligned}$$

$$\text{pH} = -\log [\text{H}_3\text{O}^+]$$

$$pH = -\log [H_3O^+] \quad 12,56 = -\log [H_3O^+]$$

$$[H_3O^+] = 10^0$$

$$= 10^{-12,56}$$

$$= 2,7542 \times 10^{-13}$$

$$[H_3O^+] \times [OH^-] = 1 \times 10^{-14}$$

$$[OH^-] = 0,0363 \text{ mol/dm}^3$$

$$n_{OH^-} = C \times V$$

$$= 0,0363 \times 0,037$$

$$= 0,001343 \text{ mol}$$

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

pH of solution
at the end (products
and
excess
substance)



$$n_{NaOH_{\text{excess}}} = n_{OH^-} = 0,001343 \text{ mol}$$

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

$$3,7 \times 10^{-3} = \frac{x}{40}$$

$$x = 0,148$$



$$n_{NaOH} = 2 \times n_{H_2SO_4} = 2 \times 0,0012$$

$$= 2,4 \times 10^{-3} \text{ mol (reacted)}$$

$$n_{NaOH} = 0,001343 + 2,4 \times 10^{-3}$$

$$= 3,7 \times 10^{-3} \text{ mol (Total)}$$

QUESTION 4

- 4.1 Nitric acid (HNO_3), an important industrial acid, is a strong acid.
- 4.1.1 Give a reason why nitric acid is classified as a strong acid. (1)
- 4.1.2 Write down the NAME or FORMULA of the conjugate base of nitric acid. (1)
- 4.1.3 Calculate the pH of a $0,3 \text{ mol} \cdot \text{dm}^{-3}$ nitric acid solution. (3)

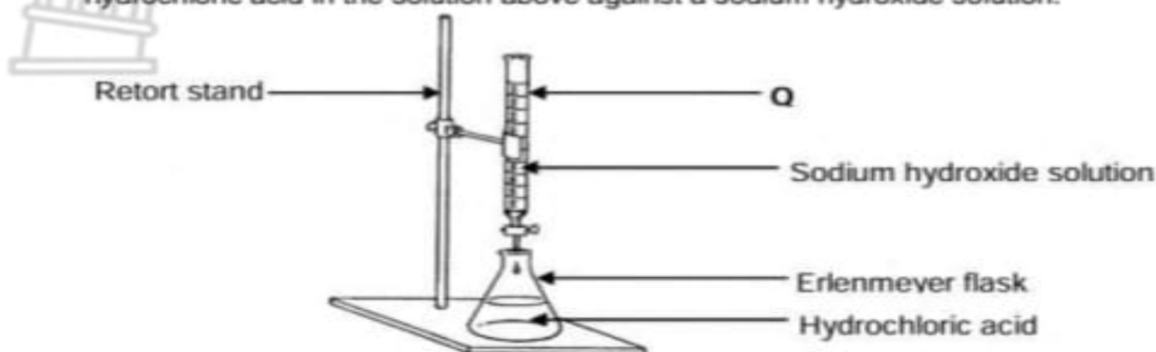
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- 4.2 A laboratory technician wants to determine the percentage purity of magnesium oxide. He dissolves a $4,5 \text{ g}$ sample of magnesium oxide in 100 cm^3 hydrochloric acid of concentration $2 \text{ mol} \cdot \text{dm}^{-3}$.

- 4.2.1 Calculate the number of moles of hydrochloric acid added to the magnesium oxide. (3)

The technician then uses the apparatus shown below to titrate the EXCESS hydrochloric acid in the solution above against a sodium hydroxide solution.



- 4.2.2 Write down the name of apparatus Q in the above diagram. (1)

- 4.2.3 The following indicators are available for the titration:

INDICATOR	pH RANGE
A	3,1 – 4,4
B	6,0 – 7,6
C	8,3 – 10,0

- Which ONE of the above indicators (A, B or C) is most suitable to indicate the exact endpoint in this titration? Give a reason for the answer. (3)

- 4.2.4 During the titration, the technician uses distilled water to wash any sodium hydroxide that spills onto the sides of the Erlenmeyer flask into the solution. Give a reason why the addition of distilled water to the Erlenmeyer flask will not influence the results. (1)

- 4.2.5 At the endpoint of the titration, he finds that 21 cm^3 of a $0,2 \text{ mol} \cdot \text{dm}^{-3}$ sodium hydroxide solution has neutralised the EXCESS hydrochloric acid. Calculate the number of moles of hydrochloric acid in excess. (3)

- 4.2.6 The balanced equation for the reaction between hydrochloric acid and magnesium oxide is:



Calculate the percentage purity of the magnesium oxide. Assume that only the magnesium oxide in the $4,5 \text{ g}$ sample reacted with the acid.

(5)
[21]

QUESTION 5

