

Solutions

2.1 Potassium sulfate.

2.2 $\text{H}^+ + \text{OH}^- \rightarrow \text{H}_2\text{O}$.

2.3 Strong – hydrochloric/nitric/sulfuric acid; weak – ethanoic/citric/carbonic acid.

2.4 A acidic, B neutral, C alkaline. Add universal indicator to a small sample and compare its colour with the indicator's chart. A suitable calibrated pH probe gives a numerical reading; a colour band does not justify invented decimal precision.

3.1 Copper oxide + nitric acid $\rightarrow$ copper nitrate + water. Warm the dilute nitric acid; add copper oxide until no more dissolves – excess proves all the acid has reacted; filter off the excess black solid; evaporate the filtrate to the crystallisation point and allow it to cool/crystallise; dry the crystals between filter paper/in a warm oven.

3.2 Dilution lowers the concentration of H^+ ions – the same amount of acid in more water; pH measures H^+ concentration, not presence; so pH rises toward 7 as the solution is diluted.

3.3 Ethanoic acid is a weak acid – only partially ionised in water; so its H^+ concentration is lower than hydrochloric's at the same 0.1 mol/dm^3 ; hydrochloric acid ionises completely, so it has the higher $[\text{H}^+]$ and the lower pH.

3.4 $\text{Ca}(\text{NO}_3)_2$, since two singly negative nitrate ions balance one Ca^{2+} . $\text{CaCO}_3 + 2\text{HNO}_3 \rightarrow \text{Ca}(\text{NO}_3)_2 + \text{CO}_2 + \text{H}_2\text{O}$. Carbonate produces CO_2 , whereas magnesium with hydrochloric acid produces H_2 . HT: magnesium loses electrons and is oxidised; H^+ ions gain electrons to form H_2 and are reduced.

3.5 Too little oxide leaves acid: add oxide until some remains unreacted. Dissolved acid passes through filter paper; filtering removes the excess insoluble oxide. Boiling dry is not the crystallisation method: gently concentrate without drying out, then cool to crystallise. Filter and wash crystals with a little cold distilled water; dry between filter papers.

3.6 A suitable indicator changes colour close to the endpoint; a white tile makes the change easier to see. Swirling mixes the added acid with the alkali; dropwise addition limits overshooting. Distilled water adds no alkali, so the reacting amount and required acid titre stay the same.

3.7 Exclude the rough result. The three accurate titres span the permitted 0.20 cm^3 .

$$\bar{V} = \frac{V_1 + V_2 + V_3}{3} = \frac{25.00 + 24.90 + 25.10}{3} \text{ cm}^3 = 25.00 \text{ cm}^3$$

Mean 25.00 cm^3 .

$$n(\text{NaOH}) = cV = (0.100 \text{ mol/dm}^3)(0.0200 \text{ dm}^3) = 0.00200 \text{ mol}$$

Known amount.

$$n(\text{H}_2\text{SO}_4) = \frac{n(\text{NaOH})}{2} = \frac{0.00200 \text{ mol}}{2} = 0.00100 \text{ mol}$$

Equation ratio.

$$c = \frac{n}{V} = \frac{0.00100 \text{ mol}}{0.02500 \text{ dm}^3} = 0.0400 \text{ mol/dm}^3$$

Acid concentration.

$$c_m = cM = (0.0400 \text{ mol/dm}^3)(98 \text{ g/mol}) = 3.92 \text{ g/dm}^3$$

Mass concentration. The 1:2 mole ratio is essential; equal volumes would not imply equal concentrations.

3.8 No: concentration and degree of ionisation both affect H^+ concentration; the labels do not give enough numerical information. Strong/weak describes degree of ionisation, whereas dilute/concentrated describes amount per volume. R has $10^{5-2} = 1000$ times S's H^+ concentration. Neutrality means a balance of H^+ and OH^- , not no ions.