4.2 Reactions of acids and making salts

Name: _____ Class: _____ Date: _____ **Total: 48 marks**

KEY WORDS neutralisation • titration • strong acid

Objective

Predict salt products, describe salt preparation and titration, and use strong/weak acid ideas. Original questions for spec statements 4.4.2.1–4.4.2.6.

1 Key knowledge and worked examples

Neutralisation products: acid + alkali/base → **salt + water**; acid + carbonate → **salt + water + CO_2**. The acid sets the salt's negative ion – HCl → **chloride**, HNO_3 → **nitrate**, H_2SO_4 → **sulfate**; the base supplies the positive ion. magnesium + hydrochloric acid → magnesium chloride + hydrogen.

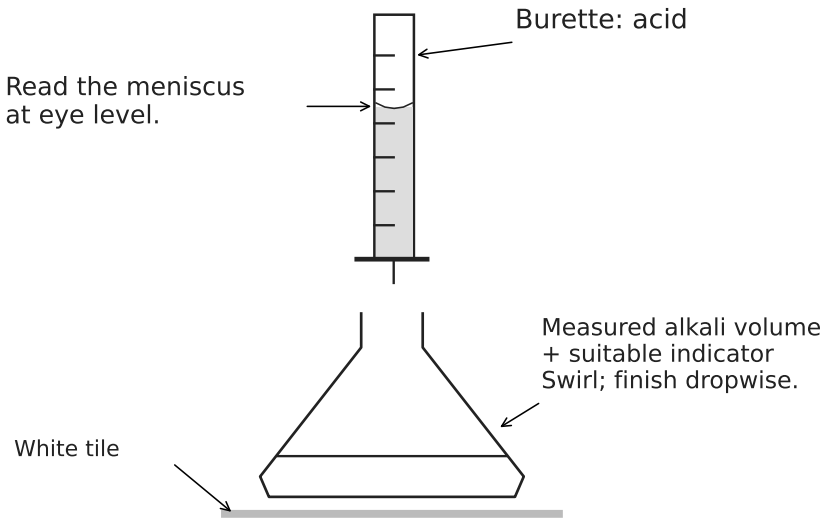
RP1 – pure dry salt from an insoluble base: warm dilute acid; add the insoluble oxide/carbonate **until no more reacts**; **filter** off excess; **evaporate** until crystals form on cooling; **dry** the crystals.

pH: acids < 7 give $\mathbf{H^+(aq)}$; alkalis > 7 give $\mathbf{OH^-(aq)}$; neutralisation is $\mathbf{H^+ + OH^- \rightarrow H_2O}$.

(Chem) RP2 titration: rinse and fill the burette with acid; pipette a fixed alkali volume using a filler; add suitable indicator; swirl and add dropwise near the endpoint. Read at eye level; titre = final − initial. Exclude the rough trial; average concordant accurate titres. (HT) compute concentrations (moles = C × V).

(HT) Strong vs weak: strong acids (HCl, HNO_3, H_2SO_4) **completely ionised**; weak (ethanoic, citric, carbonic) **partially**. Same concentration – stronger acid, lower pH. **pH down 1 unit = $[H^+] \times 10$.** Dilute/concentrated is about amount per volume – independent of strength.

Titre = final burette reading − initial burette reading



Worked example (3 marks, HT). pH 2 HCl has $[H^+] = 0.01$ mol/dm^3. What is $[H^+]$ at pH 4, and how does that compare for a weak acid of the same concentration?

pH 4 $\rightarrow$ $[H^+] = 0.0001$ mol/dm^3; each pH unit is a factor of 10, so 2 units = $\div 100$; a weak acid at the same concentration as a strong one is only partially ionised, so its $[H^+]$ is lower and its pH higher.

2 Practice

2.1 Name the salt formed from sulfuric acid and potassium hydroxide. [1]

2.2 Write the ionic equation for neutralisation. [1]

2.3 *(HT)* Give one example each of a strong acid and a weak acid. [2]

2.4 Solutions A, B and C have measured pH values 3, 7 and 11. Classify each as acidic, neutral or alkaline. Describe how universal indicator gives an approximate pH, and name an instrument that gives a numerical pH reading. [5]

3 Exam-style questions

3.1 Copper oxide reacts with dilute nitric acid. Write the word equation and describe how pure dry crystals of the salt are separated. [6]

3.2 A student claims both an acid and the water added to dilute it contain H^+ ions, so dilution does not change the pH. Explain the mistake. [3]

3.3 *(HT)* Explain why 0.1 mol/dm^3 ethanoic acid has a higher pH than 0.1 mol/dm^3 hydrochloric acid. [3]

3.4 Calcium carbonate reacts with nitric acid. Given Ca^{2+} and NO_3^-, deduce the salt formula and write a balanced equation. Explain why the gas here differs from the gas formed when magnesium reacts with dilute hydrochloric acid. *(HT)* For the magnesium reaction, identify the species oxidised and reduced in terms of electrons. [6]

3.5 A student wants pure dry copper(II) sulfate crystals from dilute sulfuric acid and copper(II) oxide. They add too little oxide, then try to filter out the remaining acid and boil the filtrate dry. Explain three errors and give the correct separation and drying stages. [6]

3.6 A pipette delivers 20.0 cm^3 NaOH to a flask. A burette contains sulfuric acid. Explain why a suitable indicator, a white tile, swirling and dropwise addition near the endpoint are used. Explain why rinsing the flask walls with distilled water does not change the titre needed. [5]

3.7 *(Chemistry HT)* Sulfuric acid reacts with 20.0 cm^3 of 0.100 mol/dm^3 NaOH. Accurate acid titres are 25.00, 24.90 and 25.10 cm^3; a rough titre is 26.20 cm^3. The stated concordance tolerance is 0.20 cm^3. Calculate the mean accurate titre and the acid concentration in mol/dm^3 and g/dm^3. Use $M(H_2SO_4) = 98$ g/mol and $H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$. [6]

3.8 *(HT)* Solution P is dilute strong hydrochloric acid; solution Q is concentrated weak ethanoic acid. Can their names alone decide which has the lower pH? Explain. A measured solution R has pH 2 and S has pH 5. Compare their H^+ concentrations and explain why a neutral solution still contains ions. [4]