**b** $2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(l) + 3CO_2(g)$ (reactants; products)

**c** Iron is a liquid.

**d** Carbon is more reactive than iron.

**e** Any metal above iron in the reactivity series; Too expensive/metals above carbon extracted by electrolysis so require more energy.

### The reactions of acids

**1** Both neutralise acid; Bases are insoluble/alkalis are soluble bases/alkalis form hydroxide/$OH^-$ ions ins solution.

**2 a** Sodium chloride – sodium hydroxide and hydrochloric acid.

**b** Potassium nitrate – potassium carbonate and nitric acid.

**c** Copper sulfate – copper oxide and sulfuric acid.

**3 a** Solid dissolves/colourless solution forms.

**b** Fizzing occurs with magnesium carbonate.

**c** Magnesium oxide + hydrochloric acid → magnesium chloride + water

**d** $MgCO_3$

**4 a** $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$

**b** $Li_2O(s) + H_2SO_4(aq) \rightarrow Li_2SO_4(aq) + H_2O(l)$

**c** $CuO(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + H_2O(l)$

**5 a** $Ca(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2(g)$ (reactants; products; state symbols)

**b** Ca oxidised; $H^+$/hydrogen reduced.

### The preparation of soluble salts

**1 a** Copper carbonate + sulfuric acid → copper sulfate + water + carbon dioxide

**b** Any two from: Copper carbonate dissolves; Fizzing/bubbles/effervescence; Blue/green solution forms.

**c** To ensure all the acid reacts.

**d** Filtration

**e** Copper oxide/copper hydroxide.

**f** Any one from: Salt lost from spitting during evaporation; Solution left in container; Not all the solution crystallises.

**2 a** $Ca(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2(g)$ (reactants; products; state symbols)

**b** % yield = 2.6/3.0 x 100; 86.7%

**3 Possible steps to include:** Reactants (zinc/zinc hydroxide/zinc oxide/zinc carbonate) and hydrochloric acid; Correct equation for chosen reactants; Heat acid; Add base until no more reacts/dissolves so the base is in excess; Filter unreacted base; Heat solution on a steam bath until half the water has evaporated; Leave remaining solution to cool so crystals form.

**Equipment list:** Bunsen burner; Heatproof mat; Tripod; Gauze; Beaker; Evaporating dish; Funnel; Filter paper; Conical flask; Spatula; Measuring cylinder; Safety glasses.

### Oxidation and reduction in terms of electrons

**1 a** $Mg(s) + Cu^{2+}(aq) \rightarrow Mg^{2+}(aq) + Cu(s)$

**b** Mg is oxidised and Cu is reduced.

**2 a** $Mg(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$; Mg oxidised, Zn reduced.

**b** $2Na(s) + Zn^{2+}(aq) \rightarrow 2Na^+(aq) + Zn(s)$; Na oxidised, Zn reduced.

**c** $Cu(s) + 2Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2Ag(s)$; Cu oxidised, Zn reduced.

**d** $3Ca(s) + 2Fe^{3+}(aq) \rightarrow 3Ca^{2+}(aq) + 2Fe(s)$; Ca oxidised, Fe reduced.

### pH scale and neutralisation

**1** Strong acid — pH 2 — Red, Weak acid — pH 5 — Yellow, Strong alkali — pH 13 — Purple, Weak alkali - pH 9 — Blue, Neutral — pH 7 — Green.

**2** Hydroxide ion

**3** $H^+$

**4** pH 1

**5** pH 12

**6 a** Potassium hydroxide.

**b** $2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

**c** $H^+ + OH^- \rightarrow H_2O$ ***or*** $2H^+ + 2OH^- \rightarrow 2H_2O$

**7** $OH^-$ and $NH_4^+$

### Strong and weak acids

**1 a** $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

**b** $HCOOH(aq) \rightarrow H^+(aq) + COO^-(aq)$

**c** $H_2SO_4(aq) \rightarrow 2H^+(aq) + SO_4^{2-}(aq)$ ***or*** $H_2SO_4(aq) \rightarrow H^+(aq) + HSO_4^-(aq)$

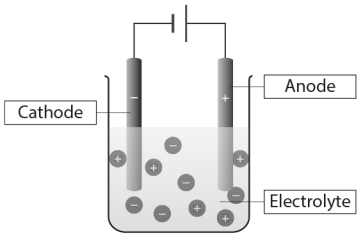
**2** Weak acid only partially ionises in solution; Dilute acid has fewer moles of solute dissolved.

**3 a** $1 \times 10^{-3}$

**b** Answer is 100 times greater as if pH decreases by 1, $H^+$ concentration increases by 10; 0.1 (overrides previous mark); $1 \times 10^{-1}$

### Electrolysis

**1**




**2** Ions are free to move when molten/aqueous; Ions in fixed positions/ions can't move in solid lattice.

**3 a** Zinc and chlorine.

**b** Silver and iodine.

**c** Copper and oxygen.

**4 a** $Pb^{2+} + \mathbf{2e^-} \rightarrow Pb$ ; $2Br^- \rightarrow Br_2 + \mathbf{2e^-}$

**b** Lead/lead ions reduced and bromine/bromide ions oxidised.

### The electrolysis of aqueous solutions

**1 a** Copper chloride – copper and chlorine.

**b** Potassium bromide – hydrogen and bromine.

**c** Zinc sulfate – zinc and oxygen.

**d** Sodium carbonate – hydrogen and oxygen.

**2 a** $\mathbf{2}H^+ + \mathbf{2e^-} \rightarrow H_2$

**b** Chlorine; $2Cl^- \rightarrow Cl_2 + 2e^-$ (correct; balanced)

**3 a** $H^+$/hydrogen; $Li^+$/lithium; $OH^-$/hydroxide.

**b** $I^-$/iodide ions attracted to anode/positive electrode; Lose electron/an electron; Form iodine; $2I^- \rightarrow I_2 + 2e^-$.

**c** Lithium hydroxide/LiOH.

**4 a** Anode

**b** $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ ; $OH^-$ and $H_2O$ (correct; balanced)

### The extraction of metals using electrolysis

**1 a** Strong ionic bonds/strong electrostatic attraction between oppositely charged ions; Requires lots of energy to overcome.

**b** So the ions are free to move.

**c** Reduce the operating temperature; Saves energy/reduces energy costs.

**d** Electrons are lost.

**e** $Al^{3+} + 3e^- \rightarrow Al$ (correct; balanced electrons)

**f** They react with the oxygen produced; Carbon + oxygen → carbon dioxide/$C + O_2 \rightarrow CO_2$

**g** Electricity wasn't discovered/electricity not needed to extract iron.

### Practical investigation into the electrolysis of aqueous solutions

**1 a** Independent – Metal/metal ion in salt; Dependent variable – Product formed at cathode; Control variables – Volume of solution, Concentration of solution, Negative ion in salt, Voltages.

**b** Only 1 variable is changed.

**2** Place a lighted splint into the gas; Positive test – burns with a squeaky pop.

**3 a** $CuCl_2$ – Copper; all others – Hydrogen.

**b** Solutions containing metals above hydrogen in the reactivity series