H 3 **a** $4Cu + O_2 \rightarrow 2Cu_2O$

b Cu → 1.26 moles; O_2 → 1.56 moles

c Copper; because in the equation, the ratio of moles is Cu:O_2 4:1, however in the experiment there was only 1.26:1.56 moles.

Concentrations in solutions

H 1 **a** 1 **b** 2

2 a Test 1 – 250 g/dm^3
Test 2 – 400 g/dm^3
Test 3 – 571 g/dm^3

b Test 1 – 0.09 moles
Test 2 – 0.17 moles
Test 3 – 0.34 moles

H 3 **a** 143

b 0.01 moles/143 g/mol = 1.43 g = 1.43 g/dm^3

c 3575000 g; 3.575×10^6 g

Chemical changes

Metal oxides and the reactivity series

1 a Magnesium + oxygen → magnesium oxide

b 2Mg(s) + O2(g) → 2MgO(s) (correct; balanced)

c Oxygen is gained/electrons are lost.

2 a Aluminium + lead chloride → aluminium chloride + lead

b Silver + copper oxide → no reaction

c Calcium + zinc nitrate → calcium nitrate + zinc

d Iron chloride + copper → no reaction

3 a 1-Sodium, 2-X, 3-Magnesium, 4-Copper.

b Copper

Extraction of metals and reduction

1 Carbon is less reactive than magnesium.

2 It's unreactive/doesn't easily form compounds.

3 a Copper oxide + carbon → carbon oxide/dioxide + copper (reactants; products)

b Carbon

4 a Reduction/redox

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 – pH2 – Red, Weak acid – pH5 – Yellow, Strong alkali – pH13 – Purple, Weak alkali - pH9 – Blue, Neutral – pH7 – Green.

2 Hydroxide ion

3 H^+

4 pH1

5 pH12

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*** $H_2SO_4(aq) \rightarrow H^+(aq) + HSO_4^-(aq)$

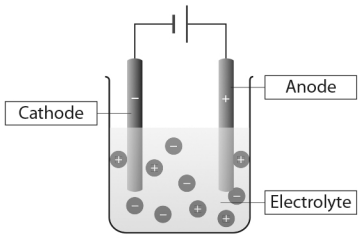
2 Weak acid only partially ionises in solution; Dilute acid has fewer moles of solute dissolved.

3 a 1×10^{-3}

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