3 a 83.3 moles b 0.083 moles

c 3.66 g

### Percentage yield and atom economy

1 a

$$\frac{\text{Relative formula mass of desired product}}{\text{Sum of relative formula masses of reactants}} \times 100$$

b They would understand how much of the desired product is made from the reactants and how much is wasted; it can inform decisions about the sustainability of different methods/percentage yield gives no information about the quantity of wasted atoms.

c 1 $\frac{48}{128} \times 100 = 38\%$

2 $\frac{48}{80} \times 100 = 60\%$

d It would increase the atom economy of method to 100%; making method even more favourable.

2 a $CaCO_3$ = 100; CaO = 56

b 56%

c 7g

d $\frac{6.5}{7} \times 100 = 92.9\%$

## Chemical changes

### Metal oxides and the reactivity series

1 a Magnesium + oxygen → magnesium oxide

b $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ (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 ore.

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

3 a Tin(IV) oxide + carbon → carbon oxide/dioxide + tin

b Carbon

4 a $2CuO\ (s) + C\ (s) \rightarrow CO_2\ (g) + 2Cu\ (s)$ or (l)

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

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 blast furnace

1 a Carbon + oxygen → carbon dioxide (1)

b $C(s) + CO_2(g) \rightarrow 2CO(g)$ – 1 mark for correct formulae and balancing, 1 mark for state symbols

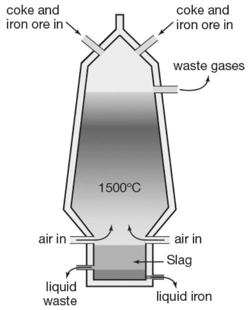
c Reduction/redox (1)

d $2Fe_2O_3\ (s) + 3C\ (s) \rightarrow 4Fe\ (l) + 3CO_2\ (g)$

e Iron is a liquid

f $CaSiO_3$

g




### 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 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 $1 \times 10^{-3}$

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