**The mole and Chemical Equations**

**1** Zinc and iodine react to form zinc iodide, according to the equation

Zn(*s*) + I2(*s*) ZnI2(*s*)

*M*(Zn) = 65·4 g mol−1; *M*(ZnI2) = 319·4 g mol−1

A student weights out exactly 1·65 g of zinc and allows it to react with excess iodine. Calculate the amount (mol) of zinc used.

What mass of zinc iodide will form?

**2** The reaction between magnesium carbonate and dilute hydrochloric acid is represented by the equation

MgCO3(*s*) + 2HCl(*aq*) MgCl2(*aq*) + H2O(*l*) + CO2(*g*)

*M*(MgCO3) = 84·3 g mol−1; *M*(MgO) = 40·3 g mol−1

1. Calculate the molar mass of carbon dioxide.

(b) Calculate the mass of magnesium carbonate that will be needed to produce 8·80 g of CO2.

**3** A student weighed out 2·40 g of magnesium and burned it in air. Magnesium burns in air to form magnesium oxide. The equation for the reaction is

2Mg(*s*) + O2(*g*) 2MgO(*s*)

Calculate the mass of magnesium oxide produced in the reaction.

**4** When copper carbonate is heated, it decomposes. The reaction occurring is

CuCO3(*s*) CuO(*s*) + CO2(*g*)

(a) Calculate the mass of copper carbonate that must be decomposed to provide 110 g of carbon dioxide.

(b) Calculate the mass of copper oxide that forms when 247 g of copper carbonate is completely decomposed.

(c) If 318 g of copper oxide is produced, what mass of carbon dioxide is produced?

**5** The reaction for the decomposition of calcium carbonate is

CaCO3(*s*) CaO(*s*) + CO2(*g*)

If 100 kg of calcium carbonate is heated what mass of calcium oxide will form?

**6** Calcium burns in the air according to the equation

2Ca(*s*) + O2(*g*) 2CaO(*s*)

How much calcium is needed when 8·00 kg of oxygen is used up?

**7** When sulfur trioxide dissolves in water, the reaction occurring is

SO3(*g*) + H2O(*l*) H2SO4(*l*)

Find the mass of H2SO4 formed when 8·0 tonnes of SO3 dissolves in water.

**8** Iron oxide is converted into iron by carbon monoxide according to the equation:

Fe2O3(*s*) + 3CO(*g*) 2Fe(*s*) + 3CO2(*g*)

Calculate the mass of iron which would be obtained from 1·60 tonnes of iron oxide.

**9** CH4(*g*) + 2O2(*g*) 2H2O(*g*) + CO2(*g*)

How many moles of water vapour form when 32 g of methane burns?

**10** Calculate the mass of water that will react completely with 4·00 g of pure calcium metal according to the following equation:

Ca(*s*) + 2H2O(*l*) Ca(OH)2(*s*) + H2(*g*)

**11** A substance X reacts with oxygen as shown by the equation

4***X***(*s*) + O2(*g*) 2***X***2O(*s*)

(a) How many moles of oxygen molecules react with one mol of ***X***?

(b) 4·6 g of ***X*** burns completely to produce 6·2 g of ***X***2O. How much oxygen (in mol) has reacted in this experiment?

**12** Calculate the mass of ammonia that is required to produce 182 kg of urea, CO(NH2)2, according to the equation

CO2(*g*) + 2NH3(*g*) CO(NH2)2(*s*) + H2O(*l*)

**13** Calculate the mass of HF that can be prepared from 15·6 g of CaF2 when treated with excess H2SO4, according to the equation:

CaF2(*s*) + H2SO4(*aq*) 2HF(*g*) + CaSO4(*s*)

**14** Calculate the mass of CO2 produced in the complete combustion of 21·2 g of butene, C4H8, according to the equation:

C4H8(*g*) + 6O2(*g*) 4CO2(*g*) + 4H2O(*g*)

**15** Calculate the mass of H2O produced in the complete combustion of 9·90 g of cyclohexene, C6H10, according to the equation:

2C6H10(*g*) + 17O2(*g*) 12CO2(*g*) + 10H2O(*g*)

**16** Calculate the mass of sulfur trioxide, SO3, produced from 100 kg of sulfur dioxide, SO2, according to the equation:

2SO2(*g*) + O2(*g*) 2SO3(*g*)

Activity 7D: **The Mole and Chemical Equations Answers**

**1** *n*(Zn) =  =  = 0·0252 mol

*n*(ZnI2) = *n*(Zn) = 0·0252 mol *m*(ZnI2) = *n*(ZnI2)*M*(ZnI2) = 0·0252 × 319·4 = 8·06 g

**2** (a) *M*(CO2) = *M*(MgCO3) – *M*(MgO) = 84·3 − 40·3 = 44·0 g mol−1

(b) *n*(MgCO3) = *n*(CO2) =  =  = 0·200 mol

*m*(MgCO3) = *n*(MgCO3)*M*(MgCO3) = 0·200 × 84·3 = 16·9 g

**3** *n*(MgO) = *n*(Mg) =  =  = 0·0988 mol

*m*(MgO) = *n*(MgO)*M*(MgO) = 0·0988 × (24·3 + 16·0) = 3·98 g

**4** (a) *n*(CuCO3) = *n*(CO2) =  =  = 2·50 mol

*m*(CuCO3) = *n*(CuCO3)*M*(CuCO3) = 2·50 × (63·5 + 12·0 + 48·0) = 309 g

(b) *n*(CuO) = *n*(CuCO3) =  =  = 2·00 mol

*m*(CuO) = *n*(CuO)*M*(CuO) = 2·00 × 79·5 = 159 g

(c) *n*(CO2) = *n*(CuO) =  =  = 4·00 mol

*m*(CO2) = *n*(CO2)*M*(CO2) = 3·99 × 44·0 = 176 g

**5** *n*(CaO) = *n*(CaCO3) =  =  = 999 mol

*m*(CaO) = *n*(CaO)*M*(CaO) = 999 × 56·1 = 56044 g = 56·0 kg

**6** *n*(Ca) = 2*n*(O2) =  =  = 2 × 250 = 500 mol

*m*(Ca) = *n*(Ca)*M*(Ca) = 500 × 40·1 = 20050 g = 20·1 kg

**7** *n*(H2SO4) = *n*(SO3) =  =  = 99900 mol

*m*(H2SO4) = *n*(H2SO4)*M*(H2SO4) = 99900 × 98·1 = 9797752 g = 9·8 tonnes

**8** *n*(Fe) = 2*n*(Fe2O3) =  =  = 2 × 10012·5 = 20025 mol

*m*(Fe) = *n*(Fe)*M*(Fe) = 20025 × 55·9 = 1119399 g = 1·12 tonnes

**9** *n*(H2O) = 2*n*(CH4) =  =  = 2 × 2·00 = 4·00 mol

**10** *n*(H2O) = 2*n*(Ca) =  =  = 2 × 0·09975 = 0·1995 mol

*m*(H2O) = *n*(H2O)*M*(H2O) = 0·1995 × 18·0 = 3·59 g

**11** (a) *n*(O2) = ¼*n*(***X***) = 0·25 mol of ***X***

(b) *m*(O2) = *m*(X2O) – *m*(X) = 6·2 − 4·6 = 1·6 g

*n*(O2) =  =  = 0·050 mol

**12** *n*(NH3) = 2*n*(CO(NH2)2) =  =  = 6067 mol

*M*(NH3) = *n*(NH3)*M*(NH3) = 6067 × 17·0 = 103133 g = 103 kg

**13** *n*(HF) = 2*n*(CaF2) =  =  = 2 × 0·1997 = 0·3995 mol

*m*(HF) = *n*(HF)*M*(HF) = 0·3995 × 20·0 = 7·99 g

**14***n*(CO2) = 4*n*(C4H8) =  =  = 4 × 0·379 = 1·51 mol

*m*(CO2) = *n*(CO2)*M*(CO2) = 1·51 × 44·0 = 66·6 g

**15** *n*(H2O) = 5*n*(C6H10) =  =  = 5 × 0·121 = 0·604 mol

*m*(H2O) = *n*(H2O)*M*(H2O) = 0·604 × 18·0 = 10·9 g

**16** *n*(SO3) = *n*(SO2) =  =  = 1560 mol

*m*(SO3) = *n*(SO3)*M*(SO3) = 1560 × 80·1 = 124961 g = 125 kg