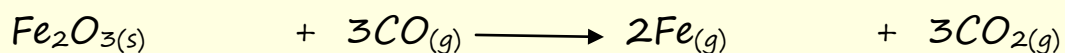


# Mole Calculations

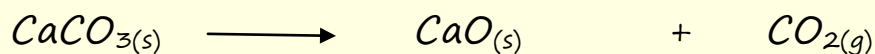
Answer all the questions below. Check your answers when you are done.

1. Iron (III) oxide ( $\text{Fe}_2\text{O}_3$ ) can be reduced by carbon monoxide inside the blast furnace according to the equation below:

Relative atomic masses,  $A_r$  Fe = 56 C=12 O=16



- Calculate the relative formula mass of iron(III) oxide.
  - What does the word reduce mean?
  - Calculate the mass of iron that can be obtained from 80 tonnes of iron (III) oxide.
2. Calcium carbonate ( $\text{CaCO}_3$ ) undergoes thermal decomposition when heated to a high temperature. The equation for this reaction is given below:



Relative atomic masses,  $A_r$  Ca = 40 C=12 O=16

- Calculate the relative formula mass of calcium carbonate and the mass of 1 mole of calcium carbonate.
- Explain why this reaction can be described as a deposition reaction.

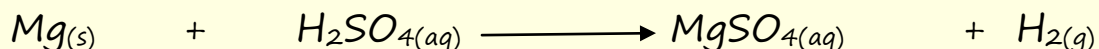
c. Calculate the mass of calcium oxide (lime) that can be obtained from 200 tonnes of calcium carbonate.

3. Epsom salts can be taken as a pain reliever. One of the main ingredients in Epsom salts is magnesium sulfate. Magnesium sulfate has the formula  $MgSO_4$ .

Relative atomic masses,  $A_r$  Mg = 24 S=32 O=16

a. Calculate the relative formula mass of magnesium sulfate.

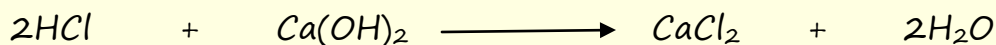
b. Magnesium sulfate can be prepared by reacting magnesium ribbon with sulfuric acid according to the equation below:



c. Calculate the maximum mass of magnesium sulfate that can be obtained from 20g of magnesium ribbon.

4. Hydrochloric acid (HCl) can be neutralise by calcium hydroxide ( $Ca(OH)_2$ ) according to the equation below.

Relative atomic masses,  $A_r$  Ca = 40 Cl=35.5 O=16 H=1

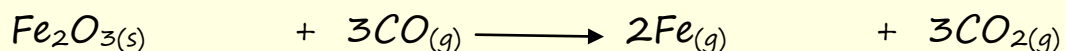


a. Calculate how much hydrochloric acid is needed to neutralise 500 tonnes of calcium hydroxide

# Answers

1. Iron (III) oxide can be reduced by carbon monoxide inside the blast furnace according to the equation below:

Relative atomic masses,  $A_r$  Fe = 56 C=12 O=16

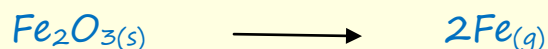


a. Calculate the relative formula mass of iron(III) oxide. = 160

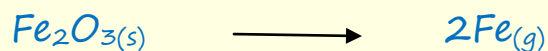
b. What does the word reduce mean? Remove oxygen

c. Calculate the mass of iron that can be obtained from 100 tonnes of iron (III) oxide.

Remove carbon monoxide and carbon dioxide from equation as we are not asked about these. This leaves



1 mole of iron oxide gives 2 moles of iron, so:

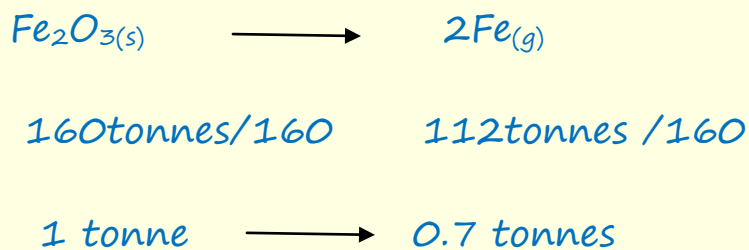


160g  $\longrightarrow$  112g scale up to give Kg x1000

160kg  $\longrightarrow$  112kg scale up to give tonnes x1000

160tonnes  $\longrightarrow$  112tonnes

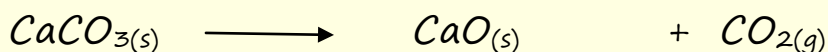
Calculate for 1 tonne by  $\div 160$



So 100 tonnes of iron oxide will give 70 tonnes of iron. Note you could also have worked this out from % composition calculations.

$\text{Fe}_2\text{O}_{3(s)}$  is 70% iron. So 100 tonnes will give 70 tonnes of iron from % compositions.

2. Calcium carbonate ( $\text{CaCO}_3$ ) undergoes thermal decomposition when heated to a high temperature. The equation for this reaction is given below:



Relative atomic masses,  $A_r$  Ca = 40 C=12 O=16

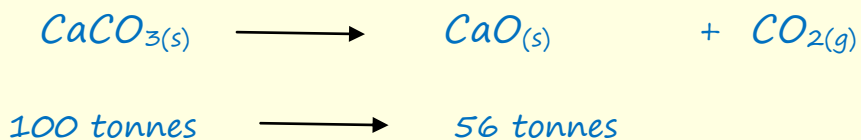
- a. Calculate the relative formula mass of calcium carbonate and the mass of 1 mole of calcium carbonate

$$40 + 12 + (16 \times 3) = 100. \quad 1 \text{ mole} = 100\text{g}$$

- b. Explain why this reaction can be described as a decomposition reaction.

Single substance is split up or broken down into simpler substances

c. Calculate the mass of calcium oxide (lime) that can be obtained from 200 tonnes of calcium carbonate.



So 100 tonnes will produce  $56 \times 2 = 112$  tonnes of calcium oxide.

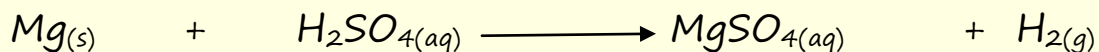
3. Epsom salts can be taken as a pain reliever. One of the main ingredients in Epsom salts is magnesium sulfate. Magnesium sulfate has the formula  $\text{MgSO}_4$ .

Relative atomic masses,  $A_r$  Mg = 24 S=32 O=16

a. Calculate the relative formula mass of magnesium sulfate.

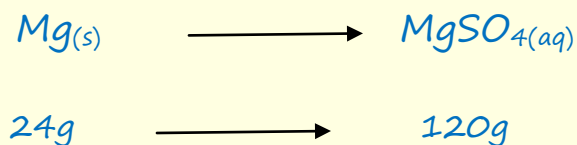
$$24 + 32 + (16 \times 4) = 120$$

b. Magnesium sulfate can be prepared by reacting magnesium ribbon with sulfuric acid according to the equation below:



c. Calculate the maximum mass of magnesium sulfate that can be obtained from 20g of magnesium ribbon.

Remove anything from equation that question does not ask us about. This leaves



Calculate for 1g by  $\div 24$ .

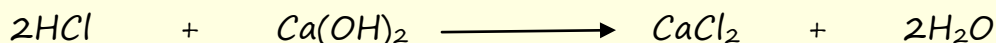
$$24\text{g}/24 \longrightarrow 120\text{g}/24$$

$$1\text{g} \longrightarrow 5\text{g}$$

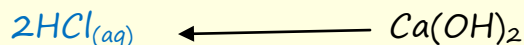
So 20g of magnesium will produce 100g of magnesium sulfate.

4. Hydrochloric acid (HCl) can be neutralise by calcium hydroxide  $\text{Ca}(\text{OH})_2$  according to the equation below.

Relative atomic masses,  $A_r$  Ca = 40 Cl=35.5 O=16 H=1



a. Calculate how much hydrochloric acid is needed to neutralise 500 tonnes of calcium hydroxide

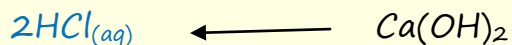


$$73\text{g} \longleftarrow 74\text{g}$$

$$73\text{kg} \longleftarrow 74\text{kg}$$

$$73\text{tonnes} \longleftarrow 74\text{tonnes}$$

Work out for 1 tonne by  $\div 74$



$$73\text{tonnes}/74 \longleftarrow 74\text{tonnes}/74\text{tonnes}$$

$$0.987\text{tonnes} \longleftarrow 1\text{tonne}$$

So 500 tonnes will need  $0.987 \times 500 = 493$  tonnes.