Yield

Introduction

These questions are designed to help you to develop mental models (pictures in your head) of the theoretical mass of product that should be formed based on the balanced chemical equation and the actual mass obtained. Use the icon in the margin to find out which level of understanding the question is developing.

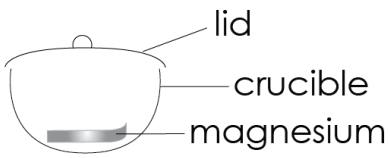
Macroscopic: what we can see. Think about the properties that we can observe, measure and record.

Sub-microscopic: smaller than we can see. Think about the particle or atomic level.

Symbolic: representations. Think about how we represent chemical ideas including symbols and diagrams.

Questions

1. Grey magnesium metal burns in oxygen to form magnesium oxide.
It is difficult to find out the mass of magnesium oxide that is produced because some of the magnesium oxide escapes as white smoke.
In order to try to collect as much magnesium oxide as possible, magnesium can be burnt in a ceramic crucible with a lid.



(a) Complete the table to give the name of the substance described by each observation.

Observation	Substance
grey solid	
colourless gas	
white solid	
white smoke	

(b) A student (**A**) measures the mass of the crucible and the mass of the crucible and the magnesium ribbon.

- mass of crucible = 50 g
- mass of crucible + magnesium = 51.2 g

Calculate the mass of magnesium at the start.

_____

_____

(c) The student heats the crucible with a Bunsen burner and puts the lid on once the magnesium starts burning.

Explain why the student has to occasionally slightly lift the lid until the magnesium has completely reacted.

_____

_____

(d) The student measures the mass of the crucible and white magnesium oxide product as 51.7 g.

Calculate the actual mass of product collected (actual yield).

_____

_____

(e) Three other students complete the same experiment using the same mass of magnesium. Complete the table to calculate the mass of magnesium oxide each student collects in the crucible.

Student	mass of crucible + magnesium oxide /g	Mass of magnesium oxide/g (actual yield)/g
B	51.8	
C	51.5	
D	51.6	

(f) Give the letter of the student who has achieved the greatest actual yield. ☐

(g) The teacher tells the students that, theoretically based on calculations, the yield could have been 2 g.

Complete the table by calculating the percentage yield of each student.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \text{x} 100$$

Student	Actual yield (g)	Theoretical yield (g)	Percentage yield (%)
A		2	
B		2	
C		2	
D		2	

(h) Suggest why no student obtained 100% yield.

_____

_____

2. The balanced chemical equation for the reaction between magnesium and oxygen is:

$$2\text{Mg(s)} + \text{O}_2\text{(g)} \rightarrow 2\text{MgO(s)}$$

(a) Complete the sentences to describe what the equation shows.

Every two moles of _____ react with one mole of oxygen to form _____ moles of magnesium oxide. This means that every mole of magnesium produces _____ mole of magnesium oxide.

(b) The relative atomic mass of magnesium is 24 and oxygen is 16.

Give the mass of one mole of magnesium. _____g

(c) Calculate the mass of one mole of magnesium oxide.

_____

_____

(d) Complete the table to calculate the mass of magnesium that could theoretically be produced (theoretical yield) from each mass of magnesium.

mass of magnesium/g	number of moles of magnesium	Number of moles of magnesium oxide	Theoretical yield of magnesium oxide /g
24	1	1	40
2.4			
0.24			

(e) A student places 1.8 g of magnesium into a crucible.
Calculate the number of moles of magnesium that the student has added.

$$\text{number of moles} = \frac{\text{mass}}{\text{mass of one mole}}$$

(f) Give the number of moles of magnesium oxide that could be theoretically produced. _____ moles

(g) Calculate the theoretical yield of magnesium oxide.

$$\text{mass} = \text{number of moles x mass of one mole}$$

(h) The student manages to collect 2.6 g of magnesium oxide as their actual yield.
Calculate the percentage yield that the student achieved.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \text{ x } 100$$

3. Silver nitrate solution reacts with sodium chloride solution to form silver chloride (white solid), as well as sodium nitrate solution. The silver chloride can be separated from the sodium nitrate solution using filter paper. The silver chloride can then be rinsed before being transferred to a dish to dry in an oven.

(a) Describe what will be observed when the two colourless solutions are mixed.

_____

_____

(b) Complete the table to show which ions make up each reactant and product.

Choose from the following ions:

Ag^+ Na^+ NO_3^- Cl^-

reactant or product	Ion 1	Ion 2
silver nitrate		
sodium chloride		
silver chloride		
sodium nitrate		

(c) State whether each ion is found in filtrate or the residue.

i. Ag^+ _____

ii. Na^+ _____

(d) Suggest where the Ag^+ ions are located at the very end of the experiment.

_____

(e) The balanced chemical equation for the reaction is:

$$AgNO_3\,(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$$

Complete the sentence to show what the balanced chemical equation represents.

Each mole of silver nitrate that is dissolved in the water reacts with _____ mole of sodium chloride that is also dissolved in water. This forms _____ mole of silver chloride and _____ mole of sodium nitrate dissolved in water.

(f) The relative atomic mass of silver is 108, nitrogen is 14, oxygen is 16 and chlorine is 35.5.

Calculate the mass of one mole of $AgNO_3$

(g) Calculate the mass of one mole of $AgCl$

(h) A solution of silver nitrate contains 1.7 g of silver nitrate.

Calculate the theoretical yield of silver chloride product.

(i) A final sample of silver chloride product can be obtained by drying in an oven. The actual yield of silver chloride is 1.3 g.

Calculate the percentage yield of silver chloride.

(j) Suggest why 100% yield was not obtained.