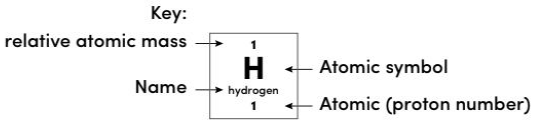
Triple - Chemistry - Key stage 4

Practical application of Quantitative Chemistry

Mrs Begum

Periodic Table of Elements



1 H hydrogen 1																4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	63.5 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	[97] Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La* lanthanum 57	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	[209] Po polonium 84	[210] At astatine 85	[222] Rn radon 86
[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[267] Rf rutherfordium 104	[270] Db dubnium 105	[269] Sg seaborgium 106	[270] Bh bohrium 107	[270] Hs hassium 108	[278] Mt meitnerium 109	[281] Ds darmstadtium 110	[281] Rg roentgenium 87	[285] Cn copernicium 112	[286] Nh nihonium 113	[289] Fl flerovium 114	[289] Mc moscovium 115	[293] Lv livermorium 116	[293] Ts tennessine 117	[294] Og organesson 118

* The lanthanides (atomic numbers 58 - 71) and the Actinides (atomic numbers 90 - 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

Warm up

1. Calculate the number of moles in 4.9 g of H_2SO_4.
2. Calculate the number of moles of potassium nitrate dissolved in 10 cm^3 of a 0.2 mol/dm^3 solution.
3. What mass of oxygen will react exactly with 6 g of magnesium?

   $2Mg + O_2 \longrightarrow 2MgO$
4. If you have 4.8 g of Mg reacting with 7.3 g of HCl, which reactant is the limiting reactant?

   $Mg + 2HCl \longrightarrow MgCl_2 + H_2$
5. How do you calculate yield?
6. Calculate the atom economy of this reaction, PbO is the desired product.

   A_r Pb = 207; S = 32; O = 16

   $2PbS + 3O_2 \longrightarrow 2PbO + 2SO_2$

Independent practice 1

Your task is to produce 6.5g of copper sulfate. Using 1.5M H_2SO_4.

Work out the volume of acid you will need to make sure it is not the limiting reactant and write a method to produce the salts.

Calculate your yield

Your task was to produce 6.5 g of copper sulfate.

You identified the volume of acid you would need.

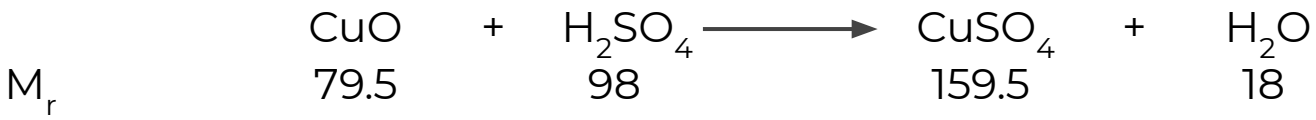
A student carried out your experiment and produced 4.9 g of copper sulfate.

1. What is the percentage yield?
2. Suggest reasons why the yield is less than 100%.

Atom economy

$$\text{Atom economy} = \frac{\text{relative formula mass of the desired product}}{\text{total formula mass of } \textbf{\textit{all}} \text{ the reactants}} \times 100\%$$

Calculate the atom economy of your reaction.
Relative atomic mass of Cu = 63.5; O = 16; H = 1; S = 32



Warm up

1. Calculate the number of moles in 4.9 g of H_2SO_4. **4.9/98 = 0.05 mol**
2. Calculate the number of moles of potassium nitrate dissolved in 10 cm^3 of a 0.2 mol/dm^3 solution. **Moles = 0.2 x (10/1000) = 0.002 mol**
3. What mass of oxygen will react exactly with 6 g of magnesium? **4g of O_2**

   $2Mg + O_2 \longrightarrow 2MgO$
4. If you have 4.8 g of Mg reacting with 7.3 g of HCl, which reactant is the limiting reactant?

   $Mg + 2HCl \longrightarrow MgCl_2 + H_2$

   You need 2.4g of Mg to react with 7.3g of HCl and you added 4.8 g so Mg is in excess. HCl is the limiting reactant.
5. How do you calculate yield? **(actual yield/theoretical yield) x 100**
6. Calculate the atom economy of this reaction, PbO is the desired product.

   A_r Pb = 207; S = 32; O = 16

   $2PbS + 3O_2 \longrightarrow 2PbO + 2SO_2$ **(2 x (207 +16) / 478 + 96) x 100% = 77.7%**

Independent practice 1 answers

Your task is to produce 6.5g of copper sulfate, using 1.5M H_2SO_4.

$$CuO + H_2SO_4 \longrightarrow CuSO_4 + H_2O$$

Work out the volume of acid you will need and write a method to produce the salts.

1.5 M H_2SO_4

How many moles in 6.5 g $CuSO_4$?

Moles = 6.5/159.5 = 0.041 moles

Balanced equation shows a ratio 1 : 1. So 0.041 moles is needed of H_2SO_4

Independent practice 1 answers

We need 0.041 moles of 1.5 M H_2SO_4.

Volume (dm^3) = moles / concentration (mol/dm^3)

= 0.041 / 1.5

= 0.027 dm^3

Convert 0.027 dm^3 into cm^3 = 0.027 x 1000 = 27 cm^3

Method

1. Measure 27 cm^3 of 1.5M H_2SO_4 and pour it into the conical flask.
2. Gently heat the acid.
3. Add copper oxide, a spatula at a time, until no more will dissolve (excess).
4. Filter to get rid of the excess insoluble CuO.
5. Evaporate the water from the copper sulfate solution and you will be left with copper sulfate crystals.

Yield answers

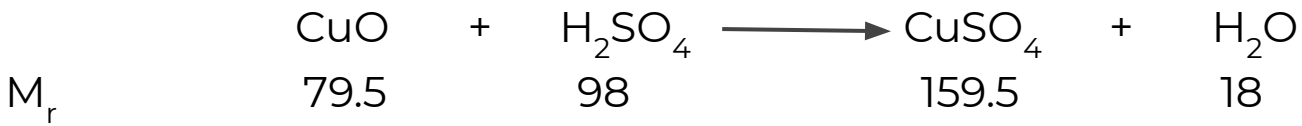
1. What is the percentage yield?
   (4.9 / 6.5) x 100 = 75.4%

2. Suggest reasons why the yield is less than 100%.
   - **Some copper sulphate remains on the filter paper.**
   - **Some of the copper sulphate may have been spilled or lost during the transfer from conical flask to evaporating dish.**

Atom economy answer

$$\text{Atom economy} = \frac{\text{relative formula mass of the desired product}}{\text{total formula mass of } \textbf{\textit{all}} \text{ the reactants}} \times 100\%$$

Calculate the atom economy of your reaction. Relative atomic mass of Cu = 63.5; O = 16; H = 1; S = 32



Atom economy = (159.5 / 177.5) x 100% = 89.9%