KS3 Science Independent Learning Booklets

Quantitative Chemistry

If you have internet at home, you can use bitesize to help you with some of the activities.

Try your hardest to work through the booklets

Year 8 - Quantitative Chemistry

Relative formula mass

Atoms have very little **mass** so their **relative atomic masses** are used. The relative atomic mass of an **element**, symbol A_r, is the relative mass of its atoms compared to the mass of a carbon-12 atom. The A_r values for elements are given in the periodic table. Since A_r is a measure of relative mass, it has no units.

See the **Atomic structure** study guide for more on calculating relative atomic mass.

Calculating relative formula mass

The relative formula mass of a substance made up of **molecules** is the sum of the relative atomic masses of the atoms in the numbers shown in the **formula**.

Relative formula mass has the symbol, M_r. To calculate the M_r for a substance:

1. Work out how many atoms of each element there are in the chemical formula.
2. Add together the A_r values for all the atoms of each element present.

For example, the formula for carbon dioxide is CO_2. It consists of one carbon atom (A_r = 12) and two oxygen atoms (A_r = 16):

M_r of CO_2 = 12 + 16 + 16 = 44

It could also be calculated this way:

M_r of CO_2 = (1 × 12) + (2 × 16) = 12 + 32 = 44

Like A_r values, M_r values are just numbers. They have no units because they are **relative** masses.

Quick Quiz: Find their Relative Atomic Mass (RAM)

	Element	***RAM***
1	Aluminium	
2	Gold	
3	Iodine	
4	Sodium	
5	Radium	
6	Iron	
7	Magnesium	
8	Sulphur	
9	Manganese	
10	Copper	
11	Molybdenum	
12	Silver	
13	Francium	
14	Tin	
15	Hassium	
16	Radon	
17	Titanium	

Calculate the Relative Formula Masses (RFM)

	Molecule	Workings	M_r
1	H_2		
2	N_2		
3	O_2		
4	Cl_2		
5	I_2		
6	F_2		
7	Br_2		
8	H_2O		
9	CO_2		
10	HCl		

11	$CaCl_2$		
12	C_4H_{10}		
13	$TiCl_4$		
14	NH_4NO_3		
15	$Mo(CO)_6$	1 x Mo = 6 x C + O	
16	$Ba(OH)_2$		
17	$Cu(NO_3)$		
18	$Mg(OH)_2$		
19	$2LiOH$		
20	$2KOH$		
21	$3H_2O$		
22	$5CO_2$		

Identify the elements

Challenge: Calculate the RFM (M_r)

Compound	M_r	Name the element
CO	12 + 16 = 28	C = carbon (RAM 12) O= oxygen (RAM 16)
LiF		Li = F =
KNO_3		K = N = O (x3) =
$NaHCO_3$		Na = H = C = O (x3)=
$Zn(CN)_2$		Zn = C (x2) = N (x2)=
$CaCl_2$		Ca = Cl (x2) =

$$\% \text{ by mass} = \frac{A_{r\,(Total)}}{M_r} \times 100$$

Compound	M_r	Calculate
CO	28	% by mass of carbon
CO	28	% by mass of oxygen
LiF	26	% by mass of fluorine
LiF	26	% by mass of lithium
HCl	36.5	% by mass of hydrogen
HCl	36.5	% by mass of chlorine

CO_2	44	% by mass of carbon
CO_2	44	% by mass of oxygen
NH_3		% by mass of nitrogen
NH_3		% by mass of hydrogen
Al_2O_3		% by mass of aluminium
KNO_3		% by mass of oxygen

Al_2O_3	102	% by mass of oxygen
$CaCl_2$		% by mass of chlorine
H_2SO_4	80	% by mass of oxygen
NH_4NO_3		% by mass of hydrogen
$Zn(CN)_2$		% by mass of carbon % by mass of nitrogen % by mass of zinc

Challenge

Counting atoms and moles

Visit this link and read all the pages to understand moles.
https://www.bbc.co.uk/bitesize/guides/z84wfrd/revision/2

Aims

This worksheet will introduce the concept of moles and gives you the opportunity to carry out some mole calculations.

Information

If you are running a chemical company it is important not to waste raw materials. You cannot just weigh out the same amount of each substance because some atoms are heavier than others.

The best way to do it is to work out exactly how many atoms of one substance you need to react with another. Then all you have to do is count the atoms.

The only trouble with counting atoms is that they are incredibly small. In just one teaspoon of water, there are about this many atoms:

500 000 000 000 000 000 000 000 = 5×10^{23}

That is a total of 23 zeros. Put another way, that teaspoon contains more atoms than there have been seconds since the Earth was formed – about a million times more. In this activity you will find out how we can 'count' atoms more efficiently.

In a bank, they often count money by weighing it. If the cashier knows what coins she has and how heavy each one is, she can quickly calculate how much the money is worth. It is the same with atoms.

The number of atoms in 12 g of carbon is called a *mole*. This is about:

600 000 000 000 000 000 000 000 = 6×10^{23} atoms.

Questions

Carbon has an atomic mass is 12. You would need 12 g of carbon to have one mole of carbon atoms. How many grams of each of these elements would you need to have one mole of atoms?

Helium: ……

Oxygen: ……

Iron: ……

1 g of hydrogen has 6×10^{23} atoms. How many atoms would you have if you had the following?

a 2 g of helium ……

b 32 g of oxygen atoms ……

c 8 g of carbon ……

How many *moles* of atoms would you have if you had these amounts of substance?

a 160 g of oxygen atoms ……

b 1 g of helium ……

c 207 g of lead ……

You can have moles of molecules too. To work these out you need to calculate the mass of a molecule first by adding up all the relative atomic masses. What is the mass of each of the following?

a 1 mole of hydrogen *molecules*, H_2 ……

b 1 mole of water, H_2O ……

c 0.5 moles of carbon dioxide, CO_2 ……

How many moles of the formula unit are there if you have each of the following?

a 100 g of calcium carbonate, $CaCO_3$

Answer: ……

b 320 g of copper oxide, CuO

Answer: ……

c 0.98 g of sulfuric acid, H_2SO_4

Answer: ……

AQA

The Periodic Table of Elements

1	2											3	4	5	6	7	0
							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 111	[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** oganesson 118

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

* 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.