Chemistry:
Transition from GCSE to AS level

Part 2 - Calculating M_r of a compound

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Recap writing a formula!

RELATIVE ATOMIC MASSES (1 decimal place at A level !)

How heavy are atoms?

(Definition: the atom is the smallest part of an element that can exist)

The mass of a hydrogen atom is found to be 1.66×10^{-24} g and the masses of different atoms all involve large negative powers of ten such as 10^{-24} These are inconvenient to use, so instead, we use a different scale in which the masses are compared to a standard mass.

This is called the **Relative Atomic Masses,** A_r.

Originally the standard used was the mass of one hydrogen atom, however since 1961 the standard used has been carbon as it can be more accurately measured,
i.e. the ^{12}C isotope has been defined as having a mass of exactly 12.000 000 units.

$$\text{hence Relative Atomic Mass} = \frac{\text{mass of one atom}}{\frac{1}{12}\text{ mass of one atom of carbon-12}}$$

Note: relative atomic mass is a ratio so has no units
e.g.
A_r of magnesium = 24.3, so a magnesium atom is twice as heavy as an atom of carbon-12.

Molecules and compounds

The mass of a molecule is the sum of all the masses of the atoms in it.

The **Relative Molecular Mass**, $\mathbf{M_r}$ is the sum of all the relative atomic masses,
e.g. $H_2SO_4 = (2 \times 1.0) + 32.1 + (4 \times 16.0) = 2.0 + 32.1 + 64.0 = \underline{98.1}$ (**1 dp**)

Many compounds consist of ions and not atoms or molecules, e.g.

$Mg(OH)_2 = 24.3 + 2(16.0 + 1.0) = 24.3 + 2(17.0) = 24.3 + 34.0 = \underline{58.3}$

(Note: when brackets are involved, always work out the inside of the bracket first, then multiply by the number outside.)

Either of the terms **Relative Molecular Mass**, $\boldsymbol{M_r}$ or **Relative Molar Mass**, $\boldsymbol{M_r}$ can be used

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*	*(9)*	*(10)*	*(11)*	*(12)*	*(13)*	*(14)*	*(15)*	*(16)*	*(17)*	*(18)*
							1.0 **H** hydrogen 1										4.0 **He** helium 2
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5	12.0 **C** carbon 6	14.0 **N** nitrogen 7	16.0 **O** oxygen 8	19.0 **F** fluorine 9	20.2 **Ne** neon 10
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13	28.1 **Si** silicon 14	31.0 **P** phosphorus 15	32.1 **S** sulfur 16	35.5 **Cl** chlorine 17	39.9 **Ar** argon 18
39.1 **K** potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31	72.6 **Ge** germanium 32	74.9 **As** arsenic 33	79.0 **Se** selenium 34	79.9 **Br** bromine 35	83.8 **Kr** krypton 36
85.5 **Rb** rubidium 37	87.6 **Sr** strontium 38	88.9 **Y** yttrium 39	91.2 **Zr** zirconium 40	92.9 **Nb** niobium 41	96.0 **Mo** molybdenum 42	[97] **Tc** technetium 43	101.1 **Ru** ruthenium 44	102.9 **Rh** rhodium 45	106.4 **Pd** palladium 46	107.9 **Ag** silver 47	112.4 **Cd** cadmium 48	114.8 **In** indium 49	118.7 **Sn** tin 50	121.8 **Sb** antimony 51	127.6 **Te** tellurium 52	126.9 **I** iodine 53	131.3 **Xe** xenon 54
132.9 **Cs** caesium 55	137.3 **Ba** barium 56	138.9 **La** * lanthanum 57	178.5 **Hf** hafnium 72	180.9 **Ta** tantalum 73	183.8 **W** tungsten 74	186.2 **Re** rhenium 75	190.2 **Os** osmium 76	192.2 **Ir** iridium 77	195.1 **Pt** platinum 78	197.0 **Au** gold 79	200.6 **Hg** mercury 80	204.4 **Tl** thallium 81	207.2 **Pb** lead 82	209.0 **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	[294] **Ts** tennessine 117	[294] **Og** oganesson 118

Key

relative atomic mass
symbol
name
atomic (proton) number

140.1 **Ce** cerium 58	140.9 **Pr** praseodymium 59	144.2 **Nd** neodymium 60	[145] **Pm** promethium 61	150.4 **Sm** samarium 62	152.0 **Eu** europium 63	157.3 **Gd** gadolinium 64	158.9 **Tb** terbium 65	162.5 **Dy** dysprosium 66	164.9 **Ho** holmium 67	167.3 **Er** erbium 68	168.9 **Tm** thulium 69	173.0 **Yb** ytterbium 70	175.0 **Lu** lutetium 71
232.0 **Th** thorium 90	231.0 **Pa** protactinium 91	238.0 **U** uranium 92	[237] **Np** neptunium 93	[244] **Pu** plutonium 94	[243] **Am** americium 95	[247] **Cm** curium 96	[247] **Bk** berkelium 97	[251] **Cf** californium 98	[252] **Es** einsteinium 99	[257] **Fm** fermium 100	[258] **Md** mendelevium 101	[259] **No** nobelium 102	[262] **Lr** lawrencium 103

* **58 – 71** Lanthanides

† **90 – 103** Actinides

Use this for the task on the next page

Using an A level Periodic Table, calculate the Relative Molecular Mass of:

Show your working.

(a) calcium carbonate .....

(b) fluorine gas .....

(c) copper (II) oxide .....

(d) magnesium hydrogen carbonate .....

(e) aluminium hydroxide.....

(f) ammonium sulphate.....

(g) nitric acid .....

(h) potassium carbonate .....

(i) calcium nitrate .....

(j) iron(III) sulphate.....

Pause this presentation while you complete the exercise on the previous page.

When complete move to the next page where you can check your answers.

Answers (all to 1 decimal place !)

(a) calcium carbonate $CaCO_3 = 40.1 + 12.0 + (3\times16.0) = 100.1$

(b) fluorine gas $F_2 = 2\times19.0 = 38.0$

(c) copper (II) oxide $CuO = 63.5 + 16.0 = 79.5$

(d) magnesium hydrogen carbonate

$Mg(HCO_3)_2 = 24.3 + 2(1.0 + 12.0 + 3\times16.0) = 146.3$

(e) aluminium hydroxide $Al(OH)_3 = 27.0 + 3(16.0+1.0) = 78.0$

(f) ammonium sulphate

$(NH_4)_2SO_4 = 2(14.0+4\times1.0) + (32.1+ 4\times16.0) = 132.1$

(g) nitric acid $HNO_3 = 1.0 + 14.0 + (3\times16.0) = 63.0$

(h) potassium carbonate $K_2CO_3 = (2\times39.1) + 12.0 + (3\times16.0) = 138.2$

(i) calcium nitrate $Ca(NO_3)_2 = 40.1 + 2(14.0 + 3\times16.0) = 164.1$

(j) iron(III) sulphate

$Fe_2(SO_4)_3 = (2\times55.8) + 3(32.1 + 4\times16.0) = 399.9$

Having checked your work you will have either:

1. Completed the task correctly - well done :)

2. Made some mistakes - which you now understand (having seen the correct answer) - that's OK as you have 'learned from your mistakes'

3. Do not understand the answer - if this is the case you **must** seek assistance from your teacher (if you do not then you will ***never*** understand this and this may be a building block for later work!)

When you’re confident with this topic move onto part 3:

Calculating Amount of Substance