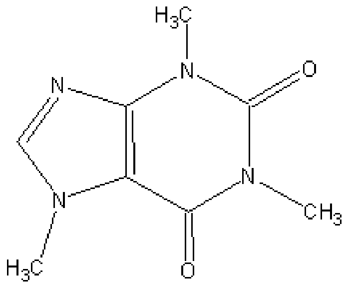
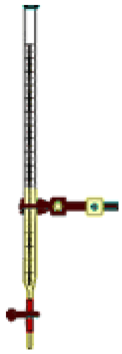
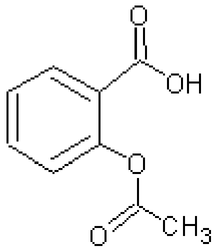
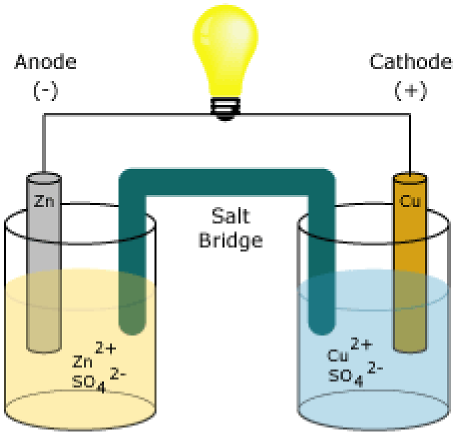
Bridging the Gap





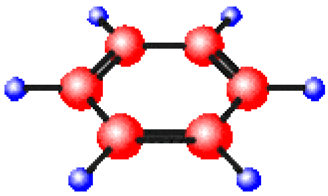


GCSE to A level Chemistry



Daniell Cell

On the following pages you will find key chemical concepts that you will need to know and be familiar with. There are also several problems for you to work through and you should complete them before your return to Malmesbury 6th Form in September



Key:

element name atomic number symbol atomic weight (mean relative mass)

hydrogen 1 H 1.0079																		helium 2 He 4.0026
lithium 3 Li 6.941	beryllium 4 Be 9.0122												boron 5 B 10.811	carbon 6 C 12.011	nitrogen 7 N 14.007	oxygen 8 O 15.999	fluorine 9 F 18.998	neon 10 Ne 20.180
sodium 11 Na 22.990	magnesium 12 Mg 24.305												aluminium 13 Al 26.982	silicon 14 Si 28.086	phosphorus 15 P 30.974	sulfur 16 S 32.065	chlorine 17 Cl 35.453	argon 18 Ar 39.948
potassium 19 K 39.098	calcium 20 Ca 40.078		scandium 21 Sc 44.956	titanium 22 Ti 47.867	vanadium 23 V 50.942	chromium 24 Cr 51.996	manganese 25 Mn 54.938	iron 26 Fe 55.845	cobalt 27 Co 58.933	nickel 28 Ni 58.693	copper 29 Cu 63.546	zinc 30 Zn 65.39	gallium 31 Ga 69.723	germanium 32 Ge 72.61	arsenic 33 As 74.922	selenium 34 Se 78.96	bromine 35 Br 79.904	krypton 36 Kr 83.80
rubidium 37 Rb 85.468	strontium 38 Sr 87.62		yttrium 39 Y 88.906	zirconium 40 Zr 91.224	niobium 41 Nb 92.906	molybdenum 42 Mo 95.94	technetium 43 Tc [98]	ruthenium 44 Ru 101.07	rhodium 45 Rh 102.91	palladium 46 Pd 106.42	silver 47 Ag 107.87	cadmium 48 Cd 112.41	indium 49 In 114.82	tin 50 Sn 118.71	antimony 51 Sb 121.76	tellurium 52 Te 127.60	iodine 53 I 126.90	xenon 54 Xe 131.29
caesium 55 Cs 132.91	barium 56 Ba 137.33	57-70 *	lutetium 71 Lu 174.97	hafnium 72 Hf 178.49	tantalum 73 Ta 180.95	tungsten 74 W 183.84	rhenium 75 Re 186.21	osmium 76 Os 190.23	iridium 77 Ir 192.22	platinum 78 Pt 195.08	gold 79 Au 196.97	mercury 80 Hg 200.59	thallium 81 Tl 204.38	lead 82 Pb 207.2	bismuth 83 Bi 208.98	polonium 84 Po [209]	astatine 85 At [210]	radon 86 Rn [222]
francium 87 Fr [223]	radium 88 Ra [226]	89-102 **	lawrencium 103 Lr [262]	rutherfordium 104 Rf [261]	dubnium 105 Db [262]	seaborgium 106 Sg [266]	bohrium 107 Bh [264]	hassium 108 Hs [269]	meitnerium 109 Mt [268]	ununnilium 110 Uun [271]	unununium 111 Uuu [272]	ununbium 112 Uub [277]		ununquadium 114 Uuq [289]				

*lanthanoids	lanthanum 57 La 138.91	cerium 58 Ce 140.12	praseodymium 59 Pr 140.91	neodymium 60 Nd 144.24	promethium 61 Pm [145]	samarium 62 Sm 150.36	europium 63 Eu 151.96	gadolinium 64 Gd 157.25	terbium 65 Tb 158.93	dysprosium 66 Dy 162.50	holmium 67 Ho 164.93	erbium 68 Er 167.26	thulium 69 Tm 168.93	ytterbium 70 Yb 173.04
**actinoids	actinium 89 Ac [227]	thorium 90 Th 232.04	protactinium 91 Pa 231.04	uranium 92 U 238.03	neptunium 93 Np [237]	plutonium 94 Pu [244]	americium 95 Am [243]	curium 96 Cm [247]	berkelium 97 Bk [247]	californium 98 Cf [251]	einsteinium 99 Es [252]	fermium 100 Fm [257]	mendelevium 101 Md [258]	nobelium 102 No [259]

Relative atomic number, Relative mass number and Isotopes

Subatomic particles

You should be able to:

- List the three main subatomic particles of an atom.
- Discuss the positions of these particles within the atom and what electric charge they carry, if any.

Review:

1. **Subatomic particles** are particles that are smaller than the atom.
2. **Protons**, **neutrons**, and **electrons** are the three main subatomic particles found in an atom.
3. Protons have a positive (+) charge. An easy way to remember this is to remember that both **p**roton and **p**ositive start with the letter "**P**."
4. Neutrons have no electrical charge. An easy way to remember this is to remember that both **n**eutron and **n**o electrical charge start with the letter "**N**."
5. Electrons have a negative (-) charge.

Atomic number and Mass number

You should be able to:

- Define and determine the atomic number of an atom.
- Define and determine the mass number of an atom.

What is an atom's atomic number?

The number of protons in the nucleus of an atom determines an element's atomic number. In other words, each element has a unique number that identifies how many protons are in one atom of that element. For example, all hydrogen atoms, and only hydrogen atoms, contain one proton and have an atomic number of 1. All carbon atoms, and only carbon atoms, contain six protons and have an atomic number of 6. Oxygen atoms contain 8 protons and have an atomic number of 8. The atomic number of an element never changes, meaning that the number of protons in the nucleus of every atom in an element is always the same.

What is an atom's mass number?

All atoms have a mass number which is derived as follows

Number of neutrons + Number of protons = Mass number

Review:

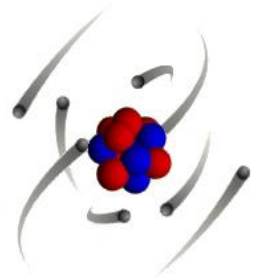
1. An element's or isotope's **atomic number** tells how many protons are in its atoms.
2. An element's or isotope's **mass number** tells how many protons and neutrons in its atoms.

Electrons

You should be able to:

- Describe the behaviour of electrons in an atom.
- Explain how electrons allow atoms to gain or lose energy.

So far, we have talked mainly about what is inside the nucleus of an atom. Protons and neutrons are found in the nucleus. Circling around outside the nucleus are tiny little particles called electrons. Electrons have a negative charge. Electrons spin as they circle the nucleus billions of times every second. They are moving so fast and the path that they travel is not the same each time, so that if we could see these electrons, they might appear to look like a cloud around the nucleus.



According to current theory, electrons are arranged in energy levels around the nucleus. When electrons gain or lose energy, they jump between energy levels as they are rotating around the nucleus. For example, as electrons gain energy, they might move from the second to the third level. Then, as they lose energy, they might move back to the second level or even to the first energy level. Only a certain number of electrons can be in an energy level at the same time.

Review:

1. Electrons spin and rotate around the outside of the nucleus.
2. As the electrons circle the nucleus they travel at certain energy levels but can "jump" between different energy levels if they gain or lose energy.

Isotopes

You should be able to:

- Define an isotope and explain how it is different than an element.

The other particle in the nucleus of an atom is the neutron. The **neutron** has no electrical charge and is said to be neutral. Like protons, all neutrons are identical.

Do all atoms of an element have the same number of neutrons?

The answer to this question is no. The number of protons in the nucleus of every atom of an element is always the same, but this is not the case with the number of neutrons. **Atoms of the same element can have a different number of neutrons.** Atoms want to have the same number of neutrons and protons but the number of neutrons can change

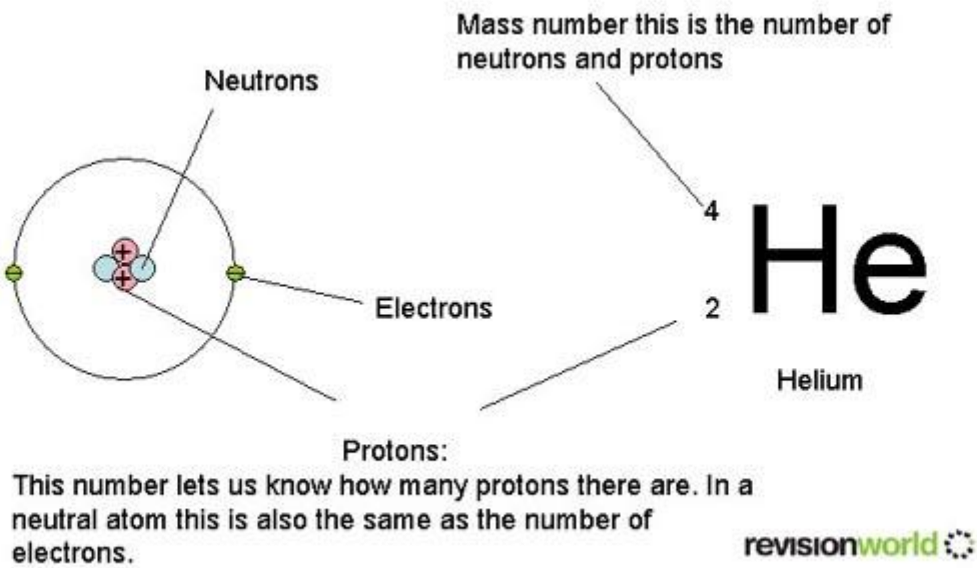
$$^{1}_{1}H \qquad ^{2}_{1}H \qquad ^{3}_{1}H$$

Notice that the three hydrogen atoms have the same number of protons, but a different number of neutrons. These atoms are called **isotopes**, which are atoms of the same element that have a different number of neutrons.

Review:

1. Neutrons are all identical to each other, just as protons are.
2. Atoms of a particular element must have the same number of protons but can have different numbers of neutrons.
3. When an atom does not have the same number of protons and neutrons, it is called an **isotope.**

Overview



Isotope Practice Worksheet

1. Here are three isotopes of an element: $_{6}^{12}C$ $_{6}^{13}C$ $_{6}^{14}C$
    a. The element is: ___________________
    b. The number 6 refers to the ___________________________
    c. The numbers 12, 13, and 14 refer to the __________________________
    d. How many protons and neutrons are in the first isotope? __________________
    e. How many protons and neutrons are in the second isotope? __________________
    f. How many protons and neutrons are in the third isotope? __________________

2. Complete the following table:

Isotope name	atomic no	mass no	No of protons	No of neutrons	No of electrons
uranium-235					
uranium-238					
boron-10					
boron-11					

3. Chlorine consists of two isotopes with masses of 35 (abundance 75%) and 37 (abundance of 25%). Calculate the relative atomic mass of chlorine.

4. Naturally occurring boron (B) consists of two isotopes with a mass of 10 and 11. Boron-10 has an abundance of 18.7% and boron-11 has an abundance of 81.3%. What is the relative atomic mass of Boron?

Deducing Ionic Formula

You need to learn or be able to deduce the formula of the following ions. This list is not comprehensive but covers most of the common ions that you will come across in A Level chemistry.

H^+ hydrogen	**Li^+** lithium	**K^+** potassium	**Na^+** sodium
Cu^+ copper(I)	**Ag^+** silver	**NH_4^+** ammonium	**Ca^{2+}** calcium
Fe^{2+} iron(II)	**Cu^{2+}** copper(II)	**Mg^{2+}** magnesium	**Ni^{2+}** nickel(II)
Sr^{2+} strontium	**Zn^{2+}** zinc	**Sn^{2+}** tin(II)	**Pb^{2+}** lead(II)
Ba^{2+} barium	**Fe^{3+}** iron(III)	**Al^{3+}** aluminium	**Cr^{3+}** Chromium(III)
F^- fluoride	**Cl^-** chloride	**Br^-** bromide	**I^-** iodide
HO^- hydroxide	**NO_2^-** nitrite	**NO_3^-** nitrate	**HCO_3^-** hydrogencarbonate
O^{2-} oxide	**CO_3^{2-}** carbonate	**SO_4^{2-}** sulfate	**HSO_4^-** hydrogensulfate
S^{2-} sulphide	**N^{3-}** nitride	**PO_4^{3-}** phosphate	

Use the ions given above to work out the formulae of the following ionic compounds. Remember, the compound must have a net neutral charge, i.e. it must have as many positive charges as negative.

Sodium nitrate	Iron (III) chloride	Magnesium sulphate
Aluminium oxide	Calcium nitrate	Potassium hydroxide
Copper (II) chloride	Sodium oxide	Aluminium phosphate
Potassium sulphate	Calcium hydroxide	Magnesium carbonate
Sodium hydrogen carbonate	Barium hydroxide	Chromium (III) oxide

Balancing Chemical Equations

You need to be comfortable with balancing equations so practice by balancing the equations below:

1) ____ N_2 + ____ H_2 → ____ NH_3

2) ____ $KClO_3$ → ____ KCl + ____ O_2

3) ____ NaCl + ____ F_2 → ____ NaF + ____ Cl_2

4) ____ H_2 + ____ O_2 → ____ H_2O

5) ____ $Pb(OH)_2$ + ____ HCl → ____ H_2O + ____ $PbCl_2$

6) ____ $AlBr_3$ + ____ K_2SO_4 → ____ KBr + ____ $Al_2(SO_4)_3$

7) ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

8) ____ C_3H_8 + ____ O_2 → ____ CO_2 + ____ H_2O

9) ____ C_8H_{18} + ____ O_2 → ____ CO_2 + ____ H_2O

10) ____ $FeCl_3$ + ____ NaOH → ____ $Fe(OH)_3$ + ____NaCl

11) ____ P + ____O_2 → ____P_2O_5

12) ____ Na + ____ H_2O → ____ NaOH + ____H_2

13) ____ Ag_2O → ____ Ag + ____O_2

14) ____ S_8 + ____O_2 → ____ SO_3

15) ____ CO_2 + ____ H_2O → ____ $C_6H_{12}O_6$ + ____O_2

16) ____ K + ____ MgBr → ____ KBr + ____ Mg

17) ____ HCl + ____ $CaCO_3$ → ____ $CaCl_2$ + ____H_2O + ____ CO_2

18) ____ HNO_3 + ____ $NaHCO_3$ → ____ $NaNO_3$ + ____ H_2O + ____ CO_2

19) ____ H_2O + ____ O_2 → ____ H_2O_2

20) ____ NaBr + ____ CaF_2 → ____ NaF + ____ $CaBr_2$

21) ____ H_2SO_4 + ____ $NaNO_2$ → ____ HNO_2 + ____ Na_2SO_4

Worksheet: Writing Equations

You also need to be happy to write equations given reactants or products or both. Write the balanced chemical equations for the following reactions:

1) The reaction of ammonia with iodine to form nitrogen triiodide (NI_3) and hydrogen gas.

2) The combustion of propane (C_3H_8).

3) The incomplete combustion of propane to form CO and water.

4) The reaction of nitric acid with potassium hydroxide.

5) The reaction of copper (II) oxide with hydrogen to form copper metal and water.

6) The reaction of iron metal with oxygen to form iron (III) oxide.

7) The complete combustion of 2,2-dimethylpropane (C_4H_{10}) in oxygen.

8) The reaction of $AlBr_3$ with $Mg(OH)_2$

9) The decomposition of hydrogen peroxide to form water and oxygen.

10) The reaction of ammonia with sulfuric acid.

Intro to the Mole Worksheet

Background:

In everyday life, we can use a "shorthand" for certain quantities, i.e., a dozen = 12, a pair = 2, and a ton = 2000 pounds.

In chemistry, we deal with things that are so small (atoms and molecules), that they cannot be seen with the naked eye. Therefore, we usually have to deal with a huge number of them so that the amount will be both visible and a reasonable quantity with which to work. In order to handle this problem, chemists have invented a "shorthand" for a certain quantity of atoms or molecules called the "mole".

Consider the following: **1 dozen C atoms = 12 C atoms**
1 pair of C atoms = 2 C atoms
1 mole of C atoms = 602,000,000,000,000,000,000,000 C atoms

Since the *mole* is such a huge number, this value is written using scientific notation:

1 mole = 6.02 x 10^{23} things (atoms or molecules or whatever!)

Typing this value correctly into your calculator is important. For most calculators:

a. Type "6.02"
b. Press the "EXP" button. (This stands for "exponent" and is the same as typing "multiply by 10 raised to the power of…" It may also be "E" or "EE".)
c. Type "23".

Practice entering this number. Try multiplying it by 2, 3, 4, etc, and see how these values are displayed by your calculator. Be sure you can interpret them correctly as well!

Why would chemists ever make the *mole* have such a strange value?
Chemists wanted to show the relationship between the number of atoms and the atomic mass (or molecular mass). To come up with the value of a mole, chemists did the following:

1. Measured out exactly 12.000 grams of Carbon-12.
2. Calculated how many C atoms would be in that sample.

It is calculated to be 6.02 x 10^{23} C atoms. Check out C on your periodic table; the atomic mass of carbon is about 12 grams (as noted in step #1 above!)

Now look at nitrogen. The atomic mass of nitrogen is 14.00 grams; this means that:

1 mole of N atoms = 6.02 x 10^{23} N atoms = 14.00 grams of N atoms

Now look at helium. Notice that:

1 mole He atoms = 6.02 x 10^{23} He atoms = 4.00 grams of He atoms

The atomic mass (in grams, as recorded on the periodic table) equals the mass of ONE MOLE of atoms of that element.

This value is also called the **MOLAR MASS** (the mass of 1 mole of that element or substance).

Use the following examples to help answer the questions below:

Example 1:	How many atoms in 3 moles of sulfur? (Given: 1 mole sulfur = 6.02 x 10^{23} S atoms)
Answer:	$\frac{3\text{ moles S}}{1} \times \frac{6.02 \times 10^{23}\text{ S atoms}}{1\text{ mole S}} = 1.81 \times 10^{24}\text{ S atoms}$
Example 2:	How many grams in 3 moles of sulfur? (Given: 1 mole sulfur = 32.00 g S)
Answer:	$\frac{3\text{ moles S}}{1} \times \frac{32\text{ grams S}}{1\text{ mole S}} = 96\text{ grams S}$
Example 3:	How many moles in 5.98 x 10^{25} S atoms? (Given: 1 mole S = 6.02 x 10^{23} S atoms)
Answer:	$\frac{5.98 \times 10^{25}\text{ S atoms}}{1} \times \frac{1\text{ mole S}}{6.02 \times 10^{23}\text{ S atoms}} = 99.3\text{ moles S}$

Practise Questions:

Complete the following problems. Show your work, and be sure to use proper significant figures and standard form in your answers.

1. How many atoms are in 5 moles sulfur?

2. How many atoms are in 8 moles carbon?

3. What is the mass of 5 moles of sulphur?

4. What is the mass of 8 moles of carbon?

5. How many moles of sulfur are in 2.45 x 10^{19} S atoms?

6. How many moles of carbon are in 5.22 x 10^{26} C atoms?

Moles Worksheet

1) Define the term "mole".

2) How many moles are present in 34 grams of $Cu(OH)_2$?

3) How many moles are present in 2.45×10^{23} molecules of CH_4?

4) How many grams are there in 3.4×10^{24} molecules of NH_3?

5) How much does 4.2 moles of $Ca(NO_3)_2$ weigh?

6) What is the molar mass of MgO?

7) How are the terms "molar mass" and "atomic mass" different from one another?

8) Which is a better unit for expressing molar mass, "amu" or "grams/mole"?

9) What is the difference between molecular mass and formula mass?

Grams/Moles Calculations

Given the following, find the number of moles:

1) 30 grams of H_3PO_4

2) 25 grams of HF

3) 110 grams of $NaHCO_3$

4) 1.1 grams of $FeCl_3$

5) 987 grams of $Ra(OH)_2$

6) 564 grams of copper

7) 12.3 grams of CO_2

8) 89 grams of $Pb(CH_3COO)_4$

Given the following, find the number of grams:

9) 4 moles of $Cu(CN)_2$

10) 5.6 moles of C_6H_6

11) 21.3 moles of $BaCO_3$

12) 1.2 moles of $(NH_4)_3PO_3$

13) 9.3×10^{-3} moles of SmO

14) 6.6 moles of ZnO

15) 5.4 moles of K_2SO_4

16) 88.4 moles of NI_3

Mole Calculation Worksheet

1) How many moles are in 15 grams of lithium?

2) How many grams are in 2.4 moles of sulfur?

3) How many moles are in 22 grams of argon?

4) How many grams are in 88.1 moles of magnesium?

5) How many moles are in 2.3 grams of phosphorus?

6) How many grams are in 11.9 moles of chromium?

7) How many moles are in 9.8 grams of calcium?

8) How many grams are in 238 moles of arsenic?

What are the molecular weights of the following compounds?

9) NaOH

10) H_2O

11) $MgCl_2$

12) H_3PO_4

13) Mn_2Se_7

14) $(NH_4)_2SO_4$

Percentage Composition

From the formula of a compound, we can work out the percentage by mass of each element present in the compound.

$$\% A = \frac{A_r(A) \times \text{No. of atoms of A in formula}}{M_r(\text{compound})} \times 100\%$$

Example:
Calculate the percentage of silicon and oxygen in silicon dioxide (SiO_2).

First calculate the relative formula mass of SiO_2.

1 x Si + 2 x O = 1 x 28 + 2 x 16 = 60

So the relative formula mass of SiO_2 is 60.

The percentage of SiO_2 that is silicon = mass silicon / rel. formula mass of silicon dioxide x 100
= 28 / 60 x 100
= 47%

The percentage of SiO_2 that is oxygen= mass oxygen / rel. formula mass of silicon dioxide x 100
= 32 / 60 x 100
= 53%

Find the percentage of the named substances in each of the following examples:

a) carbon in propane, C_3H_6

b) water in magnesium sulphate crystals, $MgSO_4.7H_2O$

c) nitrogen, hydrogen and oxygen in ammonium nitrate, NH_4NO_3

Now try these. They are a little tougher, but not impossible!

1) Haemoglobin contains 0.33% by mass of iron. There are 2 Fe atoms in 1 molecule of haemoglobin. What is the relative molecular mass of haemoglobin?

2) An adult's bones weigh about 11kg, and 50% of this mass is calcium phosphate, $Ca_3(PO_4)_2$. What is the mass of phosphorus in the bones of an average adult?

Percent, Actual, and Theoretical Yield

1) $LiOH + KCl \rightarrow LiCl + KOH$

a) I began this reaction with 20 grams of lithium hydroxide. What is my theoretical yield of lithium chloride?

b) I actually produced 6 grams of lithium chloride. What is my percent yield?

2) $C_3H_8 + 5\ O_2 \rightarrow 3\ CO_2 + 4\ H_2O$

a) If I start with 5 grams of C_3H_8, what is my theoretical yield of water?

b) I got a percent yield of 75% How many grams of water did I make?

3) $Be + 2\ HCl \rightarrow BeCl_2 + H_2$

My theoretical yield of beryllium chloride was 10.7 grams. If my actual yield was 4.5 grams, what was my percent yield?

4) $2\ NaCl + CaO \rightarrow CaCl_2 + Na_2O$

What is my theoretical yield of sodium oxide if I start with 20 grams of calcium oxide?

5) $FeBr_2 + 2\ KCl \rightarrow FeCl_2 + 2\ KBr$

a) What is my theoretical yield of iron (II) chloride if I start with 34 grams of iron (II) bromide?

b) What is my percent yield of iron (II) chloride if my actual yield is 4 grams?

6) $TiS + H_2O \rightarrow H_2S + TiO$

What is my percent yield of titanium (II) oxide if I start with 20 grams of titanium (II) sulfide and my actual yield of titanium (II) oxide is 22 grams?

7) A student had to produce some magnesium sulphate crystals, $MgSO_4.7H_2O$. He reacted 1.20g magnesium with a slight excess of sulphuric acid to give magnesium sulphate solution, and then evaporated off about ¾ of the liquid before leaving it to crystallise. He separated the crystals from the remaining liquid, dried them and weighed them. 9.84g of crystals had been produced. Calculate the percentage yield.

Making the solution: $Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$
Crystallising the solution: $MgSO_4 + 7H_2O \rightarrow MgSO_4.7H_2O$

8) A teacher demonstrated the formation of silicon tetrachloride, $SiCl_4$, by passing dry chlorine over 1.0g of heated silicon powder until all of the silicon had reacted. She collected the liquid chloride produced and then purified it by distillation. At the end of the preparation she had 3.5cm^3 of silicon tetrachloride. Calculate her percentage yield. Density of $SiCl_{4(l)}$ = 1.48 g cm^{-3}

$$Si_{(s)} + 2Cl_{2(g)} \rightarrow SiCl_{4(l)}$$

Empirical Formula and Molecular Formula

Empirical and molecular formulae by mass

The formula of a compound is determined by finding the mass of each element present in a certain mass of the compound. Remember this formula:

$$\text{Amount (in moles) of substance} = \frac{\text{Mass of substance}}{\text{Molar mass of the substance}}$$

Suppose you did an experiment to find out how much magnesium and oxygen reacted together to form magnesium oxide, and 2.4g of magnesium combined with 1.6g of oxygen. You can use these figures to find the formula of magnesium oxide.

	Mg		O
Masses of elements reacting	2.4 g		1.6 g
Number of moles of atoms	2.4 / 24 = 0.1		1.6 / 16 = 0.1
Ratio of moles	1	:	1
Simplest formula	MgO		

This simplest formula is called the empirical formula. The empirical formula just tells you the ratio of the various atoms. For ionic substances the formula quoted is **always** the empirical formula but this is not always so for organic compounds.

It isn't possible without more information to work out the 'true' or 'molecular' formula for an organic compound e.g. CH_2 is the empirical formula but this cannot be the molecular formula as the carbon would have unbonded electrons so the molecular formula must be a multiple of this such as C_2H_4 or C_3H_6. You need to know the relative formula mass (or the mass of one mole).

So, if you had calculated that the empirical formula was CH_2 and you were told that the substance had a relative formula mass of 56, you need to know how many multiples of the empirical formula you have:

CH_2 = 14 RFM = 56

so 56 / 14 = 4 and so you need 4 lots of CH_2 – in other words your molecular formula is C_4H_8.

Empirical and molecular formulae by percentage

If you are given the percentage of elements in a compound you need to convert the percentage into a mass of that element first. The easiest way to do this is to assume that you are dealing with the percentage of 100g. So if an oxide of iron contains 72.4% iron and 27.6% oxygen, then you can say that for every 100g there is 72.6g iron and 27.6g oxygen. You then just work out the empirical and molecular formulas in the same way as above, so for this example:

	Fe		O
Masses of elements reacting	72.6 g		27.6 g
Number of moles of atoms	72.6 / 56 = 1.29		27.6 / 16 = 1.725
Ratio of moles	1.29 / 1.29 = 1	:	1.725 / 1.29 = 1.334
Ratio in whole numbers of atoms	3	:	4
Empirical formula	Fe_3O_4		

Problems on Empirical Formulae

1). Given that 127g of copper combine with 32g oxygen, what is the formula of copper oxide?

2). The percentage by mass composition of X is: C 54.5%, H 9.10%, O 36.4%. Find the empirical formula of X.

3). Calculate the empirical formula when 0.72g magnesium combine with 0.28g of nitrogen.

4). Calculate the empirical formula when 1.68g of iron combine with 0.64g oxygen.

5). Calculate the empirical formula of the compound formed when 2.70g of aluminium form 5.10g of its oxide.

6). An organic compound contains C 66.7%, H 11.1%, Cl 22.2% by mass. Its relative formula mass is 72. Calculate the empirical formula and the molecular formula of the compound.

7). Tin reacts with iodine in an organic solvent to form a covalent compound SnI_x. When 0.4650g of tin (an excess) was used all the iodine reacted. A mass 0.1230g of unreacted tin and 1.8020g of SnI_x were obtained. Find the value of x.

8). A student took 2 exactly equal volumes of calcium iodide solution. To one, she added an excess of silver nitrate solution which precipitated all the iodine out as 9.40g of silver iodide, AgI. To the second volume she added an excess of sodium carbonate which precipitated all the calcium out as 2.00g of calcium carbonate, $CaCO_3$. Confirm that the formula of calcium iodide is CaI_2.

Try as many of the problems in this booklet as you can. Do not be disheartened if you find them difficult – you won't be the only one and we will using lots of these types of calculations throughout A level so you will have plenty of opportunity to practise and to ask questions.

I have listed a few websites below that you might find helpful when answering these questions. They also give a good background to the topics in the course.

https://www.creative-chemistry.org.uk/alevel

https://www.s-cool.co.uk/a-level/chemistry

http://www.docbrown.info/page06/page06.htm

http://www.4college.co.uk/as/index.php

If you have any questions, please do not hesitate to contact us:

gpeersdent@malmesbury.wilts.sch.uk
bwakeford@malmesbury.wilts.sch.uk
lmackenzie@malmesbury.wilts.sch.uk
sacton@malmesbury.wilts.sch.uk
charrell@malmesbury.wilts.sch.uk

Have a great holiday and we look forward to welcoming you to the A level chemistry course in September.