

# De Lisle College Chemistry A-level Transition work 2024-25

Please complete this work over the summer.

Hand it in during your first week studying A-level chemistry at De Lisle.

Name: .....

#### Atoms, ions and compounds



Atoms are made of smaller particles called 'subatomic particles.' These are the proton, neutron & electron. Protons and neutrons are found in the nucleus of an atom which has an overall positive charge. Electrons orbit the nucleus at set distances in energy levels (electron shells)

Subatomic particles have charges and masses. The actual charges and masses are very small so we use relative charges and masses instead. These are given below:

Subatomic particle	Relative charge	Relative mass
Proton	1+	1
Neutron	0	1
Electron	1-	Very small



Atoms of different elements contain different amounts of subatomic particles. The numbers for each atom can be deduced by looking at the atomic symbol of the element on the periodic table.

The atomic number tells us the number of protons in an atom of an

element. It also tells us the number of electrons as number of protons = number of electrons in a neutral atom. The atom is neutral overall as the positive charges from the protons is cancelled out by the negative charges of the electron. different numbers of subatomic particles.

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The number of neutrons can be calculated using the formula:

number of neutrons = mass number – atomic number.

#### Isotopes

The number of protons in the nucleus of an atom is what determines the element that atom is. An isotope is an atom of an element that has the same number of protons but a different number of neutrons. As the nuclei of isotopes have different numbers of neutrons they will also have different mass numbers. The mass of an isotope is known as the isotopic mass. The average of these masses that takes account of the abundance of the isotopes is known as the relative atomic mass of an element.

#### **Representing isotopes**

Isotopes can be represented in a way similar to what we have seen with atoms previously. We can calculate the different numbers of neutrons in isotopes using the formula:



## number of neutrons = mass number – atomic number

Besides using element symbols we can also represent isotopes like this:  ${}^{12}_{6}C$ ,  ${}^{13}_{6}C$ .

#### Abundantly clear

The abundance of an isotope is the percentage of the element that is that isotope. For example carbon-12 has an abundance of 98.9% whereas carbon-13 has an abundance of 1.1%. If we know the abundances of all the isotopes of an element then we can calculate the relative atomic mass of the element.

Relative atomic mass =  $\frac{(isotopic mass 1 x \% abundance) + (isotopic mass 2 x \% abundance) ...}{100}$ 

For example the relative atomic mass of carbon is worked out like this:

Relative atomic mass =  $\frac{(12 \times 98.9) + (13 \times 1.1)}{100}$ 

= 12.011

#### Electrons

The electrons in an atom are arranged in energy levels. These energy levels are set orbits around the nucleus of an atom. Electrons fill the lowest energy level first and when that is full they begin to fill the second energy level and so on. The energy level closest to the nucleus is energy level 1.

#### Drawing ions

lons form when atoms of elements gain or lose electrons. An atom will gain or lose electrons so that its outermost shell is full. This is energetically favourable as having a full outer shell makes an atom more stable. If you can draw the electronic structure of an atom you can draw the electronic structure of an ion and deduce its charge. To form an ion only the number of electrons changes. Gaining electrons will make an ion negatively charged whereas losing electrons will make an ion positively charged.

#### Checkpoint 1

Use your periodic table to:

- a. Find the relative atomic mass of atoms of each of the following elements.
- b. Find the number of protons in atoms of each of the following elements.
- c. Now deduce the number of electrons in an atom of each of the elements given.
- d. Use **number of neutrons = mass number atomic number** to calculate the neutrons.

Element	Relative atomic mass (Mass number)	No. protons (atomic number)	No. electrons	No. neutrons
н				
С				
Li				
Mn				

For each of the elements below calculate the relative atomic mass from the abundances of the isotopes:

Oxygen-16, 99.76% Oxygen-17, 0.0373% Oxygen-18, 0.20%

Hydrogen-1, 99.972% Hydrogen-2, 0.038%

<sup>63</sup><sub>29</sub>Cu – 69% <sup>65</sup><sub>29</sub>Cu – 31%

 ${}^{79}_{35}Br - 50.7\%$  ${}^{81}_{35}Br - 49.3\%$ 

#### lons

Draw the electron configurations for atoms of:

Hydrogen:	Helium:
nydrogen.	
Benyllium	Lithium
Derymort	
Oxygen	Fluorine

Complete the table to represent ions of the elements provided. Don't forget brackets and charges!

Name of element	Sodium	Magnesium	Chlorine	oxygen
Number of electrons in an atom	11	12	17	8
Number of electrons in an ion				

#### Quantitative chemistry

### Conservation of mass

In a chemical reaction that goes to completion the total mass of products must be equal to the total mass of the reactants.

This is explained by the law of conservation of mass which states:

## "No atoms are lost or gained during a chemical reaction."

Sometimes it can appear that the mass involved in a reaction has changed. This is because a gas is involved either as a reactant or a product. If one of the reactants is a gas, then it can seem that the products have gained mass. If a gas is a product it can seem that mass has been lost.

As conservation of mass tells us that no atoms are gained or lost during a reaction we can represent reactions using balanced symbol equations. In a balanced symbol equation, the number of atoms of each element present are the same in both the reactants and the products.

Look at the example below:

$$2Mg + O_2 \rightarrow 2MgO$$

In this balanced symbol equation, a two has been written in front of the magnesium, this means that there are two atoms of magnesium present, the small two after the O tells us that a molecule of oxygen contains two oxygen atoms. A two has also been written in front of the magnesium oxide, MgO, in this case the two doubles everything that follows it. This would mean that there are two magnesium atoms and two oxygen atoms in the products.

## What is relative formula mass (M<sub>r</sub>)?

Relative formula mass has the symbol  $M_r$ . The relative formula mass of a substance is the sum of the relative atomic masses of the atoms that make it up. Look at the example below to see how to work it out:

 $C_2H_6$  contains two carbon atoms and six hydrogen atoms. To calculate its relative formula mass you need to know the relative atomic mass of carbon, which is 12, and hydrogen, which is 1.

 $M_{r} C_{2}H_{6} = (2 \times 12) + (6 \times 1)$ = 24 + 6= 30

## What is the mole?

In chemistry we measure amounts in moles, a mole of any substance contains an Avogadro's number of particles; be they atoms, molecules or ions. An Avogadro's

number is 6.02 x 10<sup>23</sup> per mole. The mass of a mole is a substance's relative formula mass expressed in grams.

- A mole contains 6.02 x 10<sup>23</sup> atoms (or molecules or ions)
- A mole is the formula mass in grams

What does this mean practically?

If we consider methane gas,  $CH_4$ , we could calculate its relative formula mass from the sum of the relative atomic masses of its atoms as  $12 + (4 \times 1) = 16$ . As the mass of a mole of a substance is the substance's relative formula mass in grams a mole of methane will have a mass of 16g. We also know that a mole of methane contains  $6.02 \times 10^{23}$  molecules of methane. So a mole of methane contains an Avogadro's number of methane molecules and has a mass of 16g.

We can calculate the amount of moles of a substance using the following equation:

#### $n = m/M_r$

Where n = moles in mol, m = mass in grams & M<sub>r</sub> = relative formula mass

If we know the amount of a substance in moles and the substance's relative formula mass we can also calculate the mass of the substance. To do this we need to rearrange the equation above to make m the subject.

#### $m = n \ge M_r$

Where n = moles in mol, m = mass in grams & M<sub>r</sub> = relative formula mass

## Checkpoint 2

Add nu 1	umbers <b>in front of</b> H <sub>2</sub> O <sub>2</sub>	reactan →	ts/products to bo H2O	alance the equations +O2
2Na	+Cl <sub>2</sub>	÷	NaCl	
3 _Mg	+HC/	÷	MgCl <sub>2</sub>	+H2
4 _CaCl <sub>2</sub>	+Na2SO4	÷	CaSO4	+ _NaCl
5К	+H2O	÷	_КОН	+H2
6MgCl <sub>2</sub>	+NaOH	÷	Mg(OH) <sub>2</sub>	+ _NaCl
7 _CaCl <sub>2</sub>	+KOH	$\rightarrow$	_Ca(OH)₂	+KC/

Calculate the relative formula masses of:

HBr	H <sub>2</sub> O	Ca(OH) <sub>2</sub>
NaCl	CO <sub>2</sub>	H <sub>2</sub> SO <sub>4</sub>
KI	PF <sub>3</sub>	(NH4)2SO4
LiF	SO <sub>2</sub>	HNO3
СО	NH <sub>3</sub>	CaCO <sub>3</sub>
NaBr	SF6	Ba <sub>2</sub> F <sub>6</sub>
Csl	NaC/O	Mgl <sub>2</sub>

Calculate the amount, in moles, of each substance for the stated mass:

6g of H <sub>2</sub>
Mr =
Moles =
72g of C
Mr =
Moles =
36g of H <sub>2</sub> O
Mr =
Moles =
9g of H <sub>2</sub> O
Mr =
Moles =
450g of CaCO <sub>3</sub>
Mr =
Moles =

Calculate the mass, in g, of the following amounts of substance:

4 moles of carbon monoxide, CO			
10 moles of ethane, C <sub>2</sub> H <sub>6</sub>			
2 moles of hydrogen chloride, HC/			

A sample of water contains 1.505 x 10<sup>24</sup> molecules. Calculate how many moles of water this is:

Calculate the mass of the sample of water:

Assuming water has a density of 1g/cm<sup>3</sup> what volume of water is the sample composed of?

How many molecules of sulfur dioxide,  $SO_2$ , are in 96g of sulfur dioxide gas? Take Avogadro's constant to be 6.02 x  $10^{23}$ .

hydrogen 1.0 2 3 4 Li Ber Inhum beryflur 500 K 11 12 12 0 11 12 12 0 13 2 19 20 19 20 137 38 85.5 87.6 55 56 55 56 55 56 87.6 87 88 87 88 88	<b>≖</b> → 3	(1)
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