Calculations Booklet

For GCSE Chemistry



**FOUNDATION TIER**

Name:

Class:

Teacher:

Relative Atomic Mass (Ar)

1. Find the atomic mass of these element using a periodic table

|  |  |  |
| --- | --- | --- |
| **Element** | **Symbol** | **Relative atomic mass**1. What do we mean by relative atomic mass?

First let’s look at the atomic structure of some atoms:Lithium : p=\_\_ n=\_\_ e=\_\_Nitrogen : p=\_\_ n=\_\_ e=\_\_Chlorine : p=\_\_ n=\_\_ e=\_\_How can we have half a neutron?? |
| Sodium | Na | 23 |
| Oxygen |  |  |
| Magnesium |  |  |
| Sulphur |  |  |
| Calcium |  |  |
| Chlorine |  |  |
| Aluminium |  |  |
| Hydrogen |  |  |
| Potassium |  |  |
| Nitrogen |  |  |

# Isotopes

**This is a rhetorical question!!**

1. Describe the atomic structure of these atoms:

Cl

**37**

**17**

Cl

**35**

**17**

p=\_\_ n=\_\_ e=\_\_ p=\_\_ n=\_\_ e=\_\_

These are both atoms of chlorine. There are called **isotopes**.

1. What is different about them? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. What is the same? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Chlorine is made of a mixture of both these isotopes.

1. What would the mean atomic mass of chlorine be? \_\_\_\_

**That’s still not 35.5. Can you think of why we still don’t have the correct value?**

**The relative atomic mass (shortened to Ar) is a w\_\_\_\_\_\_\_\_\_\_\_ average of the mass of all the atoms of an element compared to carbon -12.**

1. If there are 3 atoms of chlorine-35 and 1 of chlorine-37.

What would the mean atomic mass of chlorine be then? \_\_\_\_

**Carbon - 12 – all atomic masses are compared to the mass of carbon-12 as this can be measured extremely accurately. It has a mass of 12, so a hydrogen atom weighs 1/12 the mass of carbon-12, its mass is said to be 1.**

1. What would the mass of an atom that is double the mass of carbon -12? \_\_\_\_\_

Relative formula mass (Mr)

1. Write the formula of this molecule:
2. What is the relative atomic mass of one oxygen atom? \_\_\_\_
3. What would the mass of two oxygen atoms be? \_\_\_\_
4. What is the mass of the carbon atom? \_\_\_\_
5. Calculate the total mass of one carbon atom and two oxygen atoms: \_\_\_\_

This is called the **relative formula mass** (or Mr for short)

1. Write the formula of this molecule:
2. What is the mass of one oxygen atom? \_\_\_\_
3. What is the mass of three oxygen atoms? \_\_\_\_
4. What is the mass of the sulfur atom? \_\_\_\_
5. Calculate the total mass of one sulfur and three oxygen atoms \_\_\_\_
6. Now calculate the **relative formula masses** (called **Mr** for short) of these molecules:

**HF \_\_\_\_ NH3 \_\_\_\_**

**CH4 \_\_\_\_ CH2O \_\_\_\_**

**N2H4 \_\_\_\_ C2H5OH \_\_\_\_**

**Mg(OH)2 \_\_\_\_ C6H12O6 \_\_\_\_**

Mr and Equations

1. This equation shows the reaction between methanol and hydrogen fluoride:

 **CH4O + HF****→ CH3F + H2O**

1. Count the **number** of each type of atom in the reactants:

**C \_\_**

**H \_\_**

**O \_\_**

**F \_\_**

1. Count the **number** of each type of atom in the products:

**C \_\_**

**H \_\_**

**O \_\_**

**F \_\_**

In a balanced equation, the number of each type of atom is **the same** in the reactants and the products.

1. This equation shows the thermal decomposition of calcium carbonate:

 **CaCO3****→ CaO + CO2**

**Formula masses of products:**

Mr of **CaO \_\_\_**

Mr of  **CO2 \_\_\_**

**Total of the formula masses \_\_\_\_\_\_\_\_**

**Formula masses of reactants:**

Mr of **CaCO3 \_\_\_**

**Total of the formula masses \_\_\_\_\_\_\_\_**

**Formula masses of products:**

Mr of **CH3F \_\_\_**

Mr of  **H2O \_\_\_**

**Total of the formula masses \_\_\_\_\_\_\_\_**

**Formula masses of reactants:**

Mr of **CH4O \_\_\_**

Mr of H**F \_\_\_**

**Total of the formula masses \_\_\_\_\_\_\_\_**

 Equations

# Balancing Equations

Mg + HCl → MgCl2 + H2

H2 + O2 → H2O

NaOH + H2SO4 → Na2SO4 + H2O

# What do balanced equations show us?

 **H2 + Cl2 → 2HCl**

This equation means:

* \_\_\_ hydrogen molecule reacts with \_\_\_ chlorine molecule to produce \_\_\_ molecules of hydrogen chloride, or
* Describe what this equation tells you:

**N2 + 3H2 → 2NH3**

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Draw molecules represented by the equation above:**

**Draw molecules represented by this equation:**

**2H2 + O2 → 2H2O**

# Mass and Equations

**H2 + Cl2 → 2HCl**

What is the mass of: H2  \_\_\_g and Cl2  \_\_\_g ?

What is the mass of 2HCl? \_\_\_ g

What do you notice about the mass of the reactants compared to the products? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mass change and uncertainty

# Mass change demos

**Burning Mg ribbon**

Mass of Mg ribbon at start \_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of oxide at end \_\_\_\_\_\_\_\_\_\_\_\_\_

Change in mass \_\_\_\_\_\_\_\_\_\_\_\_\_

**Reaction of HCl and carbonate**

Mass of acid, flask and carbonate at start \_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of acid, flask and carbonate after 2 min\_\_\_\_\_\_\_\_\_\_\_\_\_

Change in mass \_\_\_\_\_\_\_\_\_\_\_\_\_

**Burning Iron Wool**

Which end of the ruler fell?

Has the iron wool increased or decreased in mass?

**Combustion of paper**

Mass of paper and beaker at start \_\_\_\_\_\_\_\_\_\_\_\_\_

Mass of paper and beaker end \_\_\_\_\_\_\_\_\_\_\_\_\_

Change in mass \_\_\_\_\_\_\_\_\_\_\_\_\_

## Explaining Mass Change and Conservation in Mass

Explain how the mass measured has changed, but the Conservation of Mass is still true.

# Uncertainty

**Put your results here**

|  |  |  |  |
| --- | --- | --- | --- |
| Repeat | Time when the solution went cloudy. | Time when the cross disappeared. | Time when the light sensor dropped below 50 lux. |
| 1 | 42s |  | 56s |
| 2 | 88s |  | 58s |
| 3 | 28s |  | 55s |



Which method has the most uncertainty?

How can you tell?

Do any of these methods have no uncertainty?

Concentration of Solutions

c=m/v

We can calculate the concentration of a solution by using this equation:

**Concentration** (g/dm3) **= mass** (g) **÷ volume** (dm3)

1. If 20g of sodium chloride is dissolved in 1 dm3 of solution, what is the concentration in g/dm3?
2. If 25g of glucose is dissolved in 5 dm3 of solution, what is the concentration in g/dm3?
3. If 1g of zinc chloride is dissolved in 0.1 dm3 of solution, what is the concentration in g/dm3?
4. If 0.05g of copper sulfate is dissolved in 0.125 dm3 of solution, what is the concentration in g/dm3?

# Converting cm3 to dm3

To use the equation above we need to convert any volumes given in cm3 to dm3.

We do this by dividing by 1000.

**1000cm3 = 1 dm3**

Convert the following volumes to dm3:

1. 2000cm3 = \_\_\_\_\_\_\_\_ dm3  b. 500cm3 = \_\_\_\_\_\_\_\_ dm3
2. 100cm3 = \_\_\_\_\_\_\_\_ dm3  d. 1500cm3 = \_\_\_\_\_\_\_\_ dm3
3. If 2g of lithium chloride is dissolved in 100 cm3 of solution, what is the concentration in g/dm3?
4. If 2.5g of tin nitrate is dissolved in 5000 cm3 of solution, what is the concentration in g/dm3?
5. If 6.5g of zinc chloride is dissolved in 250 cm3 of solution, what is the concentration in g/dm3?
6. If 0.01g of copper sulfate is dissolved in 1 cm3 of solution, what is the concentration in g/dm3?
7. If 12g of silver nitrate is dissolved in 600 cm3 of solution, what is the concentration in g/dm3?

Percentage Yield

# Mirror words:

 stnatcaer \_\_\_\_\_\_\_\_ stcudorp \_\_\_\_\_\_\_\_ noitaluclac \_\_\_\_\_\_\_\_\_

 dleiy \_\_\_\_\_\_\_\_ egatnecrep \_\_\_\_\_\_\_\_

# Percentage yield

This is the amount of product produced compared to the maximum that can be made from the reactants.

To calculate it, you use this equation:

 **Percentage yield = Amount of product actually produced x 100%**

 **Maximum amount of product possible**

1. A reaction produces a theoretical yield of 100g but only makes 50g. What is the percentage yield?

**Percentage yield = 50 x 100 =**

 **100**

1. A reaction produces 60g of product but in theory makes 80g. What is the percentage yield?
2. A reaction produces a theoretical yield of 200g but only makes 150g. What is the percentage yield?
3. A reaction produces a theoretical yield of 20g but only makes 12g. What is the percentage yield?
4. A reaction produces 15g of product but in theory makes 75g. What is the percentage yield?
5. How much of reactant is needed to make 30g of product if the percentage yield is 75%?

**Very few chemical reactions have a yield of 100%.**

* Try a list some reasons why.
	+

* +

* +

Atom Economy

The atom economy is the percentage of starting materials that end up as useful products.

**Atom economy = Relative formula mass of desired product from equation × 100**

**Sum of relative formula masses of all reactants from equation**

1. In a reaction to produce H2 gas, what is the atom economy of the following reaction?

 **CO2 + CH4 → CO + 2H2**

* 1. Add up the Mr of all the reactants \_\_\_\_\_\_\_
	2. Calculate the Mr of the **useful** product (multiplying by 2 as there is a **2** in front) \_\_\_\_\_\_\_
	3. Calculate the percentage atom economy \_\_\_\_\_\_\_%
1. In a reaction to produce Cu metal, what is the atom economy of the following reaction?

 **CuCl2 + Zn → ZnCl2 + Cu**

* 1. Add up the Mr of all the reactants \_\_\_\_\_\_\_
	2. Calculate the Mr of the **useful** product \_\_\_\_\_\_\_
	3. Calculate the percentage atom economy \_\_\_\_\_\_\_%
1. In a reaction to produce SO3 gas, what is the atom economy of the following reaction?

 **2SO2 + O2 → 2SO3**

* 1. Add up the Mr of all the reactants \_\_\_\_\_\_\_
	2. Calculate the Mr of the **useful** product \_\_\_\_\_\_\_
	3. Calculate the percentage atom economy \_\_\_\_\_\_\_%
	4. How could you have spotted the answer to this without working it out?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. In a reaction to produce NaOH, what is the atom economy of the following reaction?

 **2Na + 2H2O → 2NaOH + H2**

* 1. Add up the Mr of all the reactants \_\_\_\_\_\_\_
	2. Calculate the Mr of the **useful** product \_\_\_\_\_\_\_
	3. Calculate the percentage atom economy \_\_\_\_\_\_\_%
	4. How could you have spotted the answer to this without working it out?

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

It is important for sustainable development and for economic reasons to use reactions with high atom economy.

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