Ratio and proportion

Using ratios is an important maths skill in chemistry. Ratios are used every day in industry:

- **Environmental chemists** measure the ratios of chemicals in rivers and lakes to check whether the water is clean enough for fish and other wildlife to survive.
- **Food scientists** use precise ratios of ingredients so that foods have the same taste, texture and quality every time they are produced.
- **Pharmaceutical chemists** use ratios to make sure that medicines contain the correct amount of active ingredient each time they are made. For example, paracetamol must contain the same amount of painkiller in each tablet so that it is effective but also safe to use.
- **Agricultural chemists** create fertilisers with the correct ratio of nutrients. You may have heard of NPK fertilisers which contain nitrogen, phosphorus and potassium compounds in the correct ratio. Too much of one compound can cause damage to the growing crops or soil.
- **Industrial chemists** must scale up chemical reactions from successful small laboratory experiments to factory size production. They use ratios to calculate the amounts of raw materials required to make sure the product stays the same.

In this worksheet, you will focus on the key skills to help you use ratios in chemistry. You can use the key terms list or glossary to look up any definitions.

Ratios

- A ratio is used to **compare the relative sizes** of two or more values.
- Ratios are written in the format **a:b.**
- Check the question or sentence to determine which value comes first.
- The ratio 3:1 means there are 3 parts of something to every one part of something else. The ratio 3:1 tells us that there are 4 parts in total.
- 6:2 has the **same relationship** between the values as 3:1.
- To **simplify** a ratio, **divide** both sides of the ratio by the highest common factor. For example: 6:2 is simplified to 3:1 by dividing both sides of the ratio by 2.
- Ratios are **whole numbers** in science.

Worked example

An artist wanted to mix a particular shade of purple paint by mixing 8 cm^3 of red paint with 12 cm^3 of blue paint.

(a) Write the ratio of red paint to blue paint.
As the question mentions red paint first, this is the initial number in the ratio.

Red:blue = 8:12

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This means for every 8 cm^3 of red paint there are 12 cm^3 of blue paint to make the correct shade of purple. A ratio does not need units.

(b) Simplify this ratio
Simplify means to write the ratio in its simplest form while keeping the same relationship between the values. Identify the highest common factor (HCF) which both numbers in the ratio can be divided by. The common factors are 1, 2 and 4. The HCF is 4 so divide both sides of the ratio by 4 to simplify.

$8 \div 4 = 2$ and $12 \div 4 = 3$. So, the simplified ratio = 2:3.

(c) How much blue paint does the artist need to mix with 20 cm^3 of red paint?
The ratio is 2:3 so if we have 20 cm^3 of red paint this represents 2 parts.

One part must be $20 \div 2 = 10$.

Blue paint is 3 parts of the whole amount. $3 \times 10 = 30\ \text{cm}^3$ of blue paint.

Questions

1. A solution is made using 6 g of salt and 18 g of water. Write the **ratio** of salt to water in its **simplest** form.

2. In a compound, the ratio of hydrogen atoms to oxygen atoms is 2:1.

(a) Which element has more atoms?

(b) How many hydrogen atoms are present if there are 3 oxygen atoms?

3. Glucose has the formula $C_6H_{12}O_6$.

(a) Write the simplest ratio of carbon atoms to hydrogen atoms to oxygen atoms.

(b) If a sample contains 18 oxygen atoms, how many carbon atoms and how many hydrogen atoms are present?

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