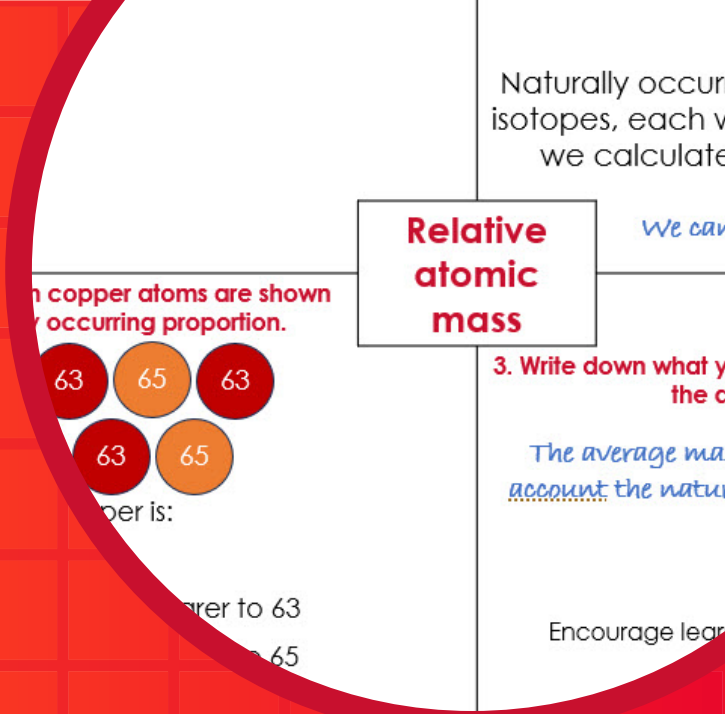
14–16 years

Quantitative chemistry: Frayer models



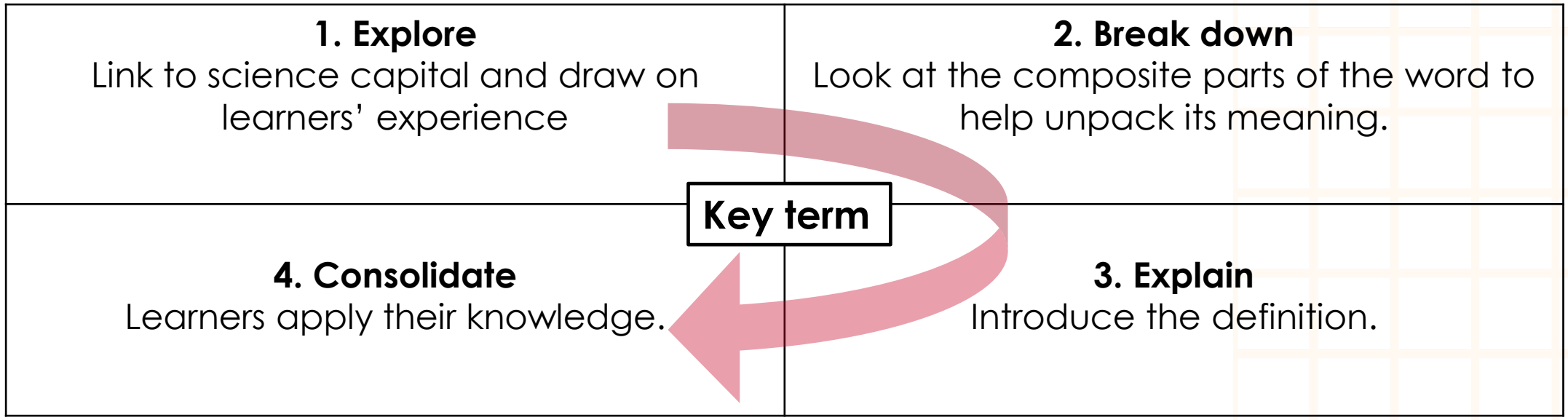
ROYAL SOCIETY OF CHEMISTRY

Education
Inspiring your teaching and learning

Frayer models

Frayer models are a simple but effective way to develop learners' understanding of a new piece of vocabulary. You will see what your learners already know and identify any misconceptions they have.

There are four stages learners can work through, but you can adapt this model to best suit your learners. You can guide learners through all quadrants, but particularly quadrant 2 works best as a teacher-led discussion. Quadrant 3 might also need/benefit from some discussion.

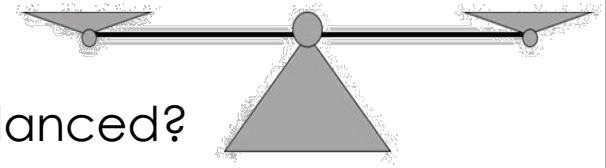


Find more guidance including tips, adaptations and further reading, in the teacher notes: rsc.li/3Gi9HHN

Balanced symbol equation

1. What does the term 'balanced symbol equation' mean to you? Where have you come across this term (or parts of this term) before?

Here are some ideas.



- How do you keep a set of weighing scales balanced?
- Which of these four mathematical symbols would you **not** usually see in a chemical equation?

$+$ $-$ $\mathbf{x}$ $=$

2. Break down the term 'balanced symbol equation'.

'Balanced' suggests that something is the same on both sides – what is the same?

How is the word 'equation' used differently in maths and chemistry?

3. Complete the word fill to define the term 'balanced symbol equation'.

For a chemical reaction this shows the chemical _____ of the reactants and _____ separated by an _____. Whole numbers may be written _____ the formulas to balance the equation.

4. Here is a word equation for the complete combustion of methane. Arrange the chemical formulas given below to construct a balanced symbol equation for the reaction.

methane + oxygen → carbon dioxide + water

CO_2 H_2O CH_4 O_2

(There is no need to include state symbols.)

Compare what you wrote with the definition (slide 7).

Relative atomic mass

1. What does the the term ‘relative atomic mass’ mean to you? Where have you come across this word (or parts of this word) before?

Here are some ideas.

- Think of a sentence using the word ‘relative’ to describe how good you are at playing a sport.
- The term ‘related to’ is used when something is connected to something else.

2. Break down the term ‘relative atomic mass’.

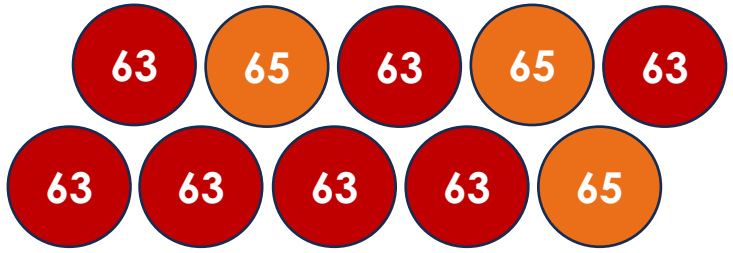
What does the adjective ‘relative’ mean?

Naturally occurring elements usually contain several isotopes, each with a slightly different mass. How can we calculate just one mass to represent all the isotopes?

3. Complete the word fill to define ‘relative atomic mass’.

The _____ mass of an atom of an element taking into account the naturally occurring _____ of its _____.

4. The relative masses of ten copper atoms are shown below in their naturally occurring proportion.



The relative atomic mass of copper is:

A less than 65.

B in between 63 and 65, but nearer to 63.

C in between 63 and 65, but nearer to 65.

D more than 65.

Compare what you wrote with the definition (slide 8).

Amount of substance

1. What does the term 'amount of substance' mean to you? Where have you come across this term (or parts of this term) before?

Here are some ideas.

- Amount is a word we use when we are thinking about how much of something we have. For example, 'that's a large amount of money'.
- The word 'substance' has several meanings, such as an important quality that something or someone has, or a particular type of material.

2. Break down 'amount of substance'.

amount

substance

3. Complete the word fill to define 'amount of substance'.

How many _____,

_____ or

_____ _____

are present in a sample of the substance, measured in

_____.

4. Circle the description that could describe the amount of helium in the balloon.

A It contains 0.4 g of helium.

B It has a volume of 2.4 dm^3.

C It contains 0.1 mol of helium.

D All three descriptions above.

Compare what you wrote with the definition (slide 9).

Percentage yield

1. What does the term 'percentage yield' mean to you? Where have you come across this term (or parts of this term) before?

Here are some ideas.

- Examples of using percentage to compare a number with a whole amount are:
  - 'the inflation rate went up to 5%'
  - 'his exam result was 64%'
  - 'I am 99% sure that I am right'.
- Farmers try to get a high yield of crops.

2. Break down 'percentage yield'.

percentage

yield

3. Complete the word fill to define 'percentage yield'.

The _____ mass or amount of product, given as a percentage of the _____ mass or amount of product you could make in a chemical reaction.

4. Use the words to fill in the blanks to show the type of yield being described at each stage.

percentage actual theoretical

A student made some crystals of hydrated copper(II) sulfate by neutralising 0.016 mol of dilute sulfuric acid. From this amount of acid, her _____ yield was 4.0 g of crystals, but when she weighed her crystals, she found that her _____ yield was only 2.8 g. From this, she calculated that her _____ yield was 70%.

Compare what you wrote with the definition (slide 10).

Balanced symbol equation

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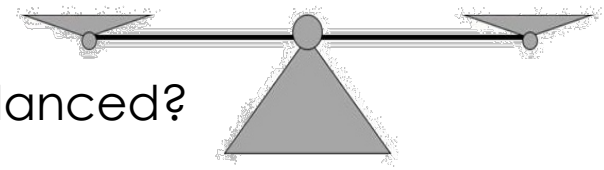


- How do you keep a set of weighing scales balanced?
- Which of these four mathematical symbols would you **not** usually see in a chemical equation?

+ **−** **x** **=**

2. Break down the term 'balanced symbol equation'.

'Balanced' suggests that something is the same on both sides – what is the same?

The total number of atoms of each element and also the total mass.

How is the word 'equation' used differently in maths and chemistry? *In maths, it is an expression or formula with an '=' sign showing how different quantities are related. In chemistry it shows the chemical formulas for the reactants and products separated by an arrow.*

3. Complete the word fill to define the term 'balanced symbol equation'.

For a chemical reaction this shows the chemical formulas of the reactants and products separated by an arrow. Whole numbers may be written before the formulas to balance the equation.

4. Here is a word equation for the complete combustion of methane. Arrange the chemical formulas given below to construct a balanced symbol equation for the reaction.

methane + oxygen → carbon dioxide + water

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

CO_2 H_2O CH_4 O_2

(There is no need to include state symbols.)

Relative atomic mass

1. What does the the term 'relative atomic mass' mean to you? Where have you come across this word (or parts of this word) before?

Here are some ideas.

- Think of a sentence using the word 'relative' to describe how good you are at playing a sport.
- The term 'related to' is used when something is connected to something else.

2. Break down the term 'relative atomic mass'.

What does the word 'relative' mean?

One thing compared to something else. In this case atomic masses are compared to the approximate mass of a proton or neutron.

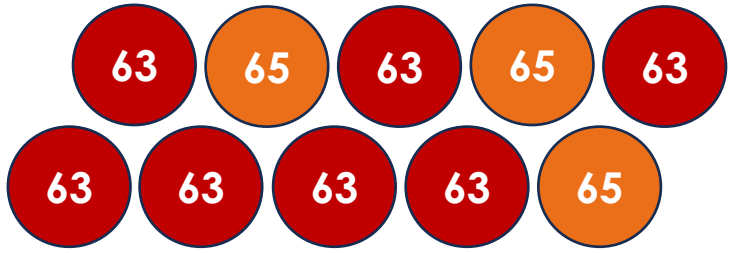
Naturally occurring elements usually contain several isotopes, each with a slightly different mass. How can we calculate just one mass to represent all the isotopes?

We can work out the average mass of an atom.

3. Complete the word fill to define the term 'relative atomic mass'.

The *average* mass of an atom of an element taking into account the naturally occurring *percentages* of its *isotopes*.

4. The relative masses of ten copper atoms are shown below in their naturally occurring proportion.



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- The word 'substance' has several meanings, such as an important quality that something or someone has, or a particular type of material.

2. Break down 'amount of substance'.

amount

From the Middle English verb amounten meaning to increase or add up to.

Today it generally refers to the quantity of something.

substance

From Middle English it was first used to describe the essence of something.

In chemistry it is used to refer to a particular solid, liquid or gas.

3. Complete the word fill to define 'amount of substance'.

How many atoms, molecules or formula units are present in a sample of the substance, measured in moles (mol).

4. Circle the description that could describe the amount of helium in the balloon.

A It contains 0.4 g of helium.

B It has a volume of 2.4 dm^3.

C It contains 0.1 mol of helium.

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Percentage yield

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  - 'I am 99% sure that I am right'.
- Farmers try to get a high yield of crops.

2. Break down 'percentage yield'.

percentage

From the Latin 'percentum' meaning 'by the hundred'. It is a way of expressing the proportion of a whole in terms of hundredths.

yield

From the Anglo-Saxon 'geldan' meaning the idea of a reward or pay that is given. Today, the noun 'yield' refers to what you produce.

3. Complete the word fill to define 'percentage yield'.

The __actual__ mass or amount of product, given as a percentage of the __theoretical__ mass or amount of product you could make in a chemical reaction.

4. Use the words to fill in the blanks to show the type of yield being described at each stage.

percentage **actual** **theoretical**

A student made some crystals of hydrated copper(II) sulfate by neutralising 0.016 mol of dilute sulfuric acid. From this amount of acid, her _theoretical_ yield was 4.0 g of crystals, but when she weighed her crystals, she found that her _actual_ yield was only 2.8 g. From this, she calculated that her__percentage_ yield was 70%.

Example layout

1. Explore

Link to science capital and draw on learners' experience.

2. Break down/'what do we know about X'?

Look at composite parts of the word to help unpack its meaning.

Or invite learners to suggest what, as a class, they already know about the key term (with the help of a few bullet points).

Select your key term

3. Explain

Introduce the definition.

4. Consolidate

Learners apply their knowledge.