Stage 1

Algebra and equations

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Introduction

These activities use the same estimation and checking skills you have already practised in maths, but you will apply them to chemical situations.

You will learn to predict the missing results of reactions, write those reactions using words and symbols, and understand that mass never simply disappears, even when substances change completely (which might seem surprising at first).

Learning objectives

1. Make estimates of the results of simple calculations.
2. Recognise that mass is conserved during a chemical reaction.
3. Understand some of the common symbols used in word and symbol equations.

Round to 1 significant figure and estimate

Activity

To calculate the relative formula mass of a compound, we add the relative atomic masses of each atom present.

The symbol formula for sulfuric acid is H_2SO_4.
Relative atomic masses: $H = 1, S = 32, O = 16$

a) How many atoms of hydrogen are present in sulfuric acid?

b) How many atoms of sulfur are present in sulfuric acid?

c) How many atoms of oxygen are present in sulfuric acid?

d) Without using a calculator, **estimate** the relative formula mass for sulfuric acid. Show your working.

e) Calculate the exact relative formula mass.

Round to 1 significant figure and estimate – answers

a) 2

b) 1

c) 4

d) $(2 \times 1) + 30 + (4 \times 20) = 112$

e) $2 + 32 + 64 = 98$

Answers

Reactants and products

Activity

Hydrochloric acid reacts with sodium hydroxide to produce sodium chloride and water.

a) Write a word equation for this reaction.
b) A learner measured the masses of the reactants and products. Here are the results:

Substance	Mass (g)
hydrochloric acid (reactant)	36.5
sodium hydroxide (reactant)	40.0
sodium chloride (product)	58.5
water (product)	?

Calculate the mass of water produced. Show your working.

c) Which law did you use to find the missing mass of water?

Reactants and products - answers

Answers

a) $\text{hydrochloric acid} + \text{sodium hydroxide} \rightarrow \text{sodium chloride} + \text{water}$

b) $\text{Total reactant mass} = 36.5 + 40.0 = 76.5$

$\text{Mass of water} = \text{mass of reactants} - \text{mass of sodium chloride}$

$\text{Mass of water} = 76.5 - 58.5$

$\text{Mass of water} = 18.0\ \text{g}$

c) The law of conservation of mass: the total mass of reactants must equal the total mass of products.

Where did the extra mass come from?

Activity

A learner heats magnesium ribbon in an open container. The magnesium reacts with oxygen from the air.

Substance	Mass (g)
Magnesium ribbon	3.6
Magnesium oxide	6.0

a) Write a word equation for this reaction

The learner thinks that they have made a mistake in their experiment because the mass of the product is greater than the mass of the reactants.

b) Explain to the learner why this is **not** a mistake.

Where did the extra mass come from? Answers

a) $\text{magnesium} + \text{oxygen} \rightarrow \text{magnesium oxide}$

b) The magnesium reacted with oxygen gas from the surrounding air. Oxygen has mass, so when it combines with magnesium the product is heavier than the magnesium alone. Mass is still conserved; the extra mass came from the oxygen in the air.

Using a table to count atoms

Activity

When methane gas burns in oxygen, it produces carbon dioxide and water.

a) Write a word equation for this chemical reaction

A learner writes the symbol equation for this reaction:

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

b) Count the atoms on each side of the equation and complete the table below:

Element	Number of atoms on the left side	Number of atoms on the right side
C		
H		
O		

c) Is the symbol equation balanced?

Using a table to count atoms – answers

Answers

a) methane + oxygen → carbon dioxide + water

b)

Element	Number of atoms on the left side	Number of atoms on the right side
C	1	1
H	4	4
O	4	4

c) Yes, the symbol equation is balanced.

Estimating density

Activity

A forensic scientist wants to identify the density of an unknown solid powder. The mass is 127 g and the volume 47 cm^3.

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

a) Estimate the density of the powder. Show your working.
b) Calculate the actual density of the powder. Show your working.
c) Why do scientists and mathematicians estimate answers before they calculate the actual value?

Estimating density – answers

a) 127 rounds to 100.
47 rounds to 50.
Estimate $= 100 \div 50 = 2\ \mathrm{g/cm^3}$

b) $127 \div 27 = 2.7\ \mathrm{g/cm^3}$

c) Estimation is used to give an approximate answer to compare with the calculated value to see if they are similar.

Answers

Symbols in chemistry 1

Activity

Complete the table by selecting the correct symbol from the box.

Not all these symbols will be used.

Fe Pb Na Ag Cu C Co S Si I

Element	Symbol
Sodium	
Iron	
Copper	
Lead	
Silver	
Carbon	
Cobalt	

Symbols in chemistry 1 - answers

Activity

Element	Symbol
Sodium	Na
Iron	Fe
Copper	Cu
Lead	Pb
Silver	Ag
Carbon	C
Cobalt	Co

Symbols in chemistry 2

Activity

a) Which is the correct symbol for magnesium?

A. MG
B. mg
C. Mg
D. M

b) A learner writes CL to represent chlorine. Explain why this is **incorrect** and write the correct symbol.

Symbols in chemistry 2 – answers

a) Option C, Mg.
b) Chlorine has the symbol Cl. When a symbol has two letters then only the first is a capital.

Answers

Discussing conservation of mass

Activity

Three learners carried out a reaction in an open beaker.

The word equation for this reaction is:

$$\text{calcium carbonate} + \text{hydrochloric acid} \rightarrow \text{calcium chloride} + \text{water} + \text{carbon dioxide}$$

Their results were:

$$\text{mass of beaker} + \text{contents at start} = 85.0\ \text{g}$$
$$\text{mass of beaker} + \text{contents at end} = 82.3\ \text{g}$$

Discussing conservation of mass

Activity

Their teacher asked the learners to explain their results using the law of conservation of mass.

Learner A

The law has been broken. The mass decreased by 2.7 g, so some atoms have been destroyed in the reaction.

Learner B

The law has not been broken. The missing 2.7 g left the beaker as carbon dioxide gas.

Learner C

The law has not been broken. The missing mass has turned into energy when the chemicals reacted.

Which learner gave the best explanation? Explain why the other two learners were wrong.

Discussing conservation of mass – answer

Answer

Learner B is correct.

Learner A is wrong because atoms are never destroyed in a chemical reaction, they are rearranged. The mass did not disappear as it left the beaker as carbon dioxide gas.

Learner C is wrong because the missing mass did not turn into energy. Mass is always conserved in chemical reactions. The 2.7 g left the beaker as carbon dioxide gas.

Learner B

