Stage 1

Ratio and proportion

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Introduction

Chemists work with data which tells them how much of each element is present in compounds. Understanding ratios can help them to interpret this data and be able to carry out calculations.

Learning objectives

1. Understand how to write ratios correctly and simplify them.
2. Know how and when to simplify ratios.
3. Work out the ratios of atoms in chemical formulas.
4. Use ratios to calculate required quantities.

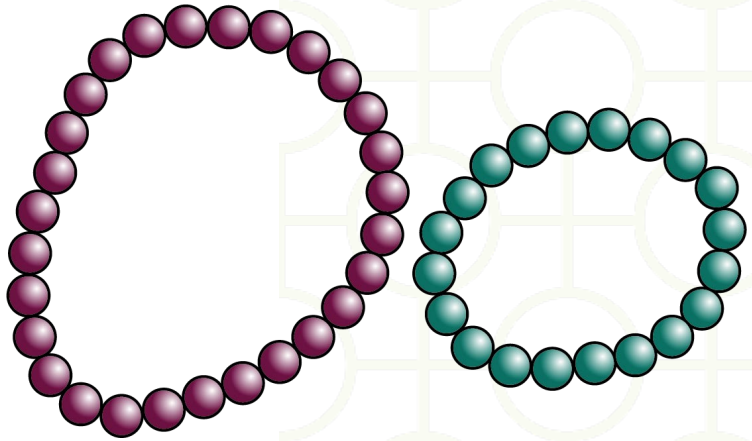
Simplifying and using ratios

Activity

A bracelet is made using yellow and green beads. There are **28 purple beads** and **20 green beads**.

a) Write the ratio of purple to green beads in its simplest form.

b) If you made the bracelet larger using 42 purple beads, how many more green beads would be needed to keep the same ratio?



Simplifying and using ratios – answers

Answers

a) The ratio is 28:20 which is simplified by dividing by the highest common factor of 4. $28 \div 4 = 7$ and $20 \div 4 = 5$. **The simplest ratio is 7:5.**

b) A bigger bracelet can be made with 42 purple beads. The ratio must stay as 7:5. Find out what we need to multiply 7 by to get 42 ($42 \div 7 = 6$). Therefore, we multiply 5 from the ratio by 6 which gives **30 green beads**.

Writing ratios

Activity

A salt solution is made by mixing 2 g of salt with 8 g of water.

a) Write the ratio of salt to water in its simplest form.

b) Write this ratio out using words instead of numbers.

Writing ratios – answers

a) 2:8 can be simplified by dividing by 2, so the simplest form is **1:4**.

b) For every 1 g of salt there is 4 g of water.

Answers

Writing, simplifying and using ratios 1

Activity

A recipe for a fruit smoothie instructs you to mix 45 cm^3 of orange juice with 30 cm^3 mango juice and shake.

a) Write down the simplest ratio for orange juice to mango juice.

b) How much orange juice would be needed for 40 cm^3 of mango juice?

Writing, simplifying and using ratios 1 – answers

Answers

a) The ratio is 45:30. This can be simplified by dividing by the highest common factor which is 15. $45 \div 15 = 3$ and $30 \div 15 = 2$.

The simplified ratio for orange juice to mango juice is **3:2.**

b) The ratio must remain as 3(orange):2(mango).

What do we need to multiply 2 by to get 40? $2 \times ? = 40$.

Rearranged this is to $40 \div 2 = ?$. $40 \div 2 = 20$.

Multiply $3 \times 20 = 60\ \text{cm}^3$ of orange juice.

Writing, simplifying and using ratios 2

Activity

Water has the chemical formula H_2O.

a) Write the ratio of hydrogen atoms to oxygen atoms in one water molecule.

b) If there are 10 water molecules, calculate the total number of hydrogen atoms and oxygen atoms present.

c) Write the ratio of hydrogen to oxygen atoms for 10 molecules. What do you notice?

Writing, simplifying and using ratios 2 – answers

Answers

a) Hydrogen:oxygen is 2:1

b) Hydrogen $10 \times 2 = 20$ atoms

c) 20:10 which simplifies to 2:1 (the ratio stays the same)

Identifying ratios in chemical formulas

Activity

The formula for ammonium nitrate is NH_4NO_3.

a) What is the ratio of hydrogen to oxygen in the formula for ammonium nitrate?

b) What is the ratio of nitrogen to oxygen?

c) What is the ratio of nitrogen to hydrogen?

Identifying ratios in chemical formulas – answers

Answers

a) There are 4 hydrogen atoms for every 3 oxygen atoms. The ratio is 4:3.

b) There are 2 nitrogen atoms per 3 oxygen atoms. The ratio is 2:3.

c) There are 2 nitrogen atoms for every 4 hydrogen atoms. The ratio is 2:4 which is simplified to 1:2.

Using ratios 1

Activity

A student mixes chemicals A and B in the ratio 5:2.

If 15 g of chemical A is used, how much chemical B is needed?

Using ratios 1 – answer

Answer

The ratio of A:B is 5:2.

This means 5 parts of A correspond to 2 parts of B so if 15 g is 5 parts for A then 1 part is $15 \div 5 = 3$ g.

B is 2 parts of 3 g. $2 \times 3 = 6$ so, **6 g** is needed.

Using ratios 2

Activity

A reaction requires magnesium and oxygen in the ratio 3:2 by mass.

a) How much oxygen is needed for 9 g of magnesium?

b) What is the total mass of the reactants?

Using ratios 2 – answers

a) Magnesium and oxygen are in the ratio of 3:2. 9 g of magnesium is used, compared to 3 parts. 1 part is $9 \div 3 = 3$ g.

If oxygen is 2 parts, then $2 \times 3 = 6$ g of oxygen is needed.

b) $9 + 6 = 15$ g total mass.

Answers

Discussing ratios

Activity

Three learners are discussing how to simplify the ratio **18:12.**

Learner A

Subtract 12 from both sides of the ratio as this is a common factor.

The simplified ratio is **6:0**.

Learner B

Divide both sides by 6 which is the highest common factor to give a ratio of **3:2**.

Learner C

As both numbers are in the ratio are even, we divide by 2 to give a ratio of **9:6**. As 9 is odd this is as simple as the ratio can get.

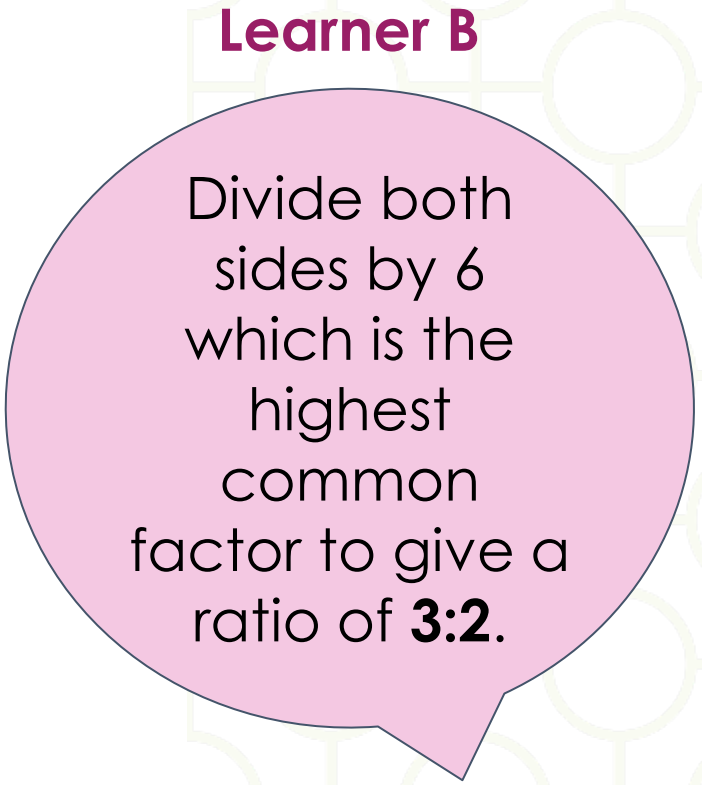
Which learner has simplified the ratio correctly? Explain why you think the other two learners are wrong.

Discussing ratios – answer

Learner B is correct. They have found the highest common factor and divided both sides of the ratio correctly.

Learner A is incorrect because they are subtracting numbers. A ratio is also comparing relative values – there cannot be 6 parts of something to every 0 of another.

Learner C is incorrect because they think that odd numbers cannot be simplified further. 9 can be simplified to 3 and 6 can be simplified to 2 by dividing by 3.



Answer