

Starters for 10 – Transition skills

0.2.7 Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m³**. However as volumes in chemistry are often smaller than 1 m³, fractions of this unit are used as an alternative.

centimetre cubed, cm³	decimetre cubed, dm³
centi- prefix one hundredth	deci- prefix one tenth
1 cm = $\frac{1}{100}$ m so,	1 dm = $\frac{1}{10}$ m so,
1 cm ³ = $\left(\frac{1}{100}\right)^3$ m ³ = $\left(\frac{1}{1\,000\,000}\right)$ m ³	1 dm ³ = $\left(\frac{1}{10}\right)^3$ m ³ = $\left(\frac{1}{1\,000}\right)$ m ³

1. Complete the table by choosing the approximate volume from the options in bold for each of the everyday items (images not drawn to scale). (1 mark)

	1 cm³	1 dm³	1 m³
			
	drinks bottle	sugar cube	washing machine
Approx. volume			




2. Complete the following sentences; (1 mark)

To convert a volume in **cm³** into a volume in **dm³**, divide by.....

To convert a volume in **cm³** into a volume in **m³**, divide by.....

3. a. A balloon of helium has a volume of 1600 cm³. What is its volume in units of dm³?
 b. The technician has prepared 550 cm³ of HCl(aq). What is its volume in units of m³?
 c. An experimental method requires 1.35 dm³ of NaOH(aq). What volume is this in cm³?
 d. A swimming pool has a volume of 375 m³. What volume is this in cm³?
 e. A 12 g cylinder of CO₂ contains 6.54 dm³ of gas. What volume of gas is this in units of m³? (5 marks)

4. Which cylinder of propane gas is the best value for money? (3 marks)

a.		b.		c.	
	<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">2.13 × 10⁶ cm³ of propane for £15.49</div>		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">2700 dm³ of propane for £21.25</div>		<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: auto;">7 m³ of propane for £28.75</div>

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Starters for 10 – Transition skills

0.2.8 Moles and mass

One mole of a substance is equal to 6.02×10^{23} atoms, ions or particles of that substance. This number is called the **Avogadro constant**.

The value of the Avogadro constant was chosen so that the relative formula mass of a substance weighed out in grams is known to contain exactly 6.02×10^{23} particles. We call this mass its **molar mass**.

We can use the equation below when calculating an amount in moles:

$$\text{amount of substance (mol)} = \frac{\text{mass (g)}}{\text{molar mass (g mol}^{-1}\text{)}}$$

How is a mole similar to a dozen?



Stating the amount of substance in moles is just the same as describing a quantity of eggs in dozens. You could say you had 24 or 2 dozen eggs.

Use the equation above to help you answer the following questions.

- Calculate the amount of substance, in moles, in: (3 marks)
 - 32 g of methane, CH_4 (molar mass, 16.0 g mol^{-1})
 - 175 g of calcium carbonate, CaCO_3
 - 200 mg of aspirin, $\text{C}_9\text{H}_8\text{O}_4$
- Calculate the mass in grams of: (3 marks)
 - 20 moles of glucose molecules (molar mass, 180 g mol^{-1})
 - 5.00×10^{-3} moles of copper ions, Cu^{2+}
 - 42.0 moles of hydrated copper sulfate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$
- 3.09 g of a transition metal carbonate was known to contain 0.0250 mol.
 - Determine the molar mass of the transition metal carbonate. (1 mark)
 - Choose the most likely identity for the transition metal carbonate from the list below:

CoCO₃	CuCO₃	ZnCO₃	(1 mark)
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 - 4.26 g of a sample of chromium carbonate was known to contain 0.015 mol.
Which of the following is the correct formula for the chromium carbonate? (2 marks)

CrCO₃	Cr₂(CO₃)₃	Cr(CO₃)₃
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BONUS QUESTION

If you had 1 mole of pennies which you could share with every person on earth how much could you give each person?
Approximate world population = 7 500 000 000.

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0.2.9 Moles and concentration



To calculate the concentration of a solution we use the equation:

$$\text{concentration (mol dm}^{-3}\text{)} = \frac{\text{amount of substance (mol)}}{\text{volume (dm}^3\text{)}}$$

Use the equation to help you complete each of the statements in the questions below.

1. a. 1.5 mol of NaCl dissolved in 0.25 dm³ of water produces a solution with a concentration ofmol dm⁻³. (1 mark)
- b. 250 cm³ of a solution of HCl(aq) with a concentration of 0.0150 mol dm⁻³ containsmoles. (1 mark)
- c. A solution with a concentration of 0.85 mol dm⁻³ that contains 0.125 mol has a volume ofdm³. (1 mark)

2. In this question you will need to convert between an amount in moles and a mass as well as using the equation above.

Space for working is given beneath each question.

- a. 5.0 g of NaHCO₃ dissolved in 100 cm³ of water produces a solution with a concentration of mol dm⁻³. (2 marks)

- b. 25.0 cm³ of a solution of NaOH(aq) with a concentration of 3.8 mol dm⁻³ contains g of NaOH. (2 marks)

- c. The volume of a solution of cobalt(II) chloride, CoCl₂, with a concentration of 1.3 mol dm⁻³ that contains 2.5 g of CoCl₂ iscm³. (3 marks)

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