# OCR A Level Chemistry Transition Booklet

BRISTOL
FREE SCHOOL


| Name: |
|---|

## Information

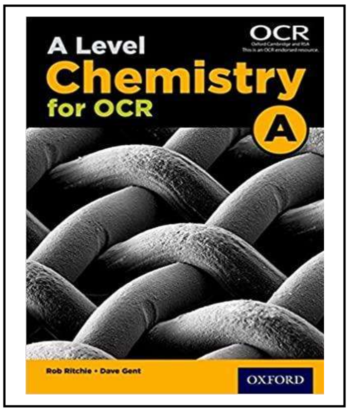
**Key Topics to Revisit:**

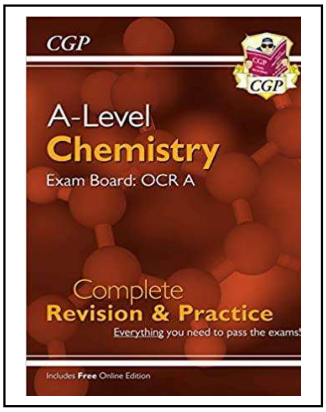
- Atomic Structure (structure of atoms, atomic number, mass number, isotopes)
- Periodic Table (arrangement of elements, atomic number and electron configuration)
- Ionic and Covalent Bonding (including the formation of lattice and molecular structures and how physical properties are linked to bonding and structure)
- Calculations involving Masses (empirical formulae, conservation of mass, moles)
- Qualitative Analysis (includes yields, atom economy, concentrations, titrations, molar volumes of gases)
- Heat energy changes in chemical reactions (endothermic and exothermic reactions, activation energy)
- Reaction Rates (including factors affecting reaction rates, use of catalysts, dynamic equilibrium)
- Fuels (Hydrocarbons: alkanes and alkenes)

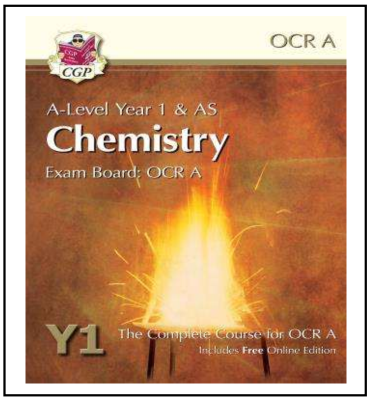
**Support materials and Further reading;**

- Chemguide has been used by a lot of our students for help in independent study http://www.chemguide.co.uk
- There are many different topics explained on You tube(Machemguy) and Khan academy is very good.
- A very useful website for revision and past paper questions is : https://www.physicsandmathstutor.com/ which not only covers chemistry, but maths, physics, biology, economics, geography and psychology too.
- Chemistry Review is a full colour magazine for post-16 chemists. The aim is to make chemistry exciting and understandable. It is an ideal resource for students taking AS/A2 and Higher chemistry. Each issue features short, accessible articles, on topics related to the exam specifications.
- The Royal Society of Chemistry's website https://www.rsc.org/ is well worth exploring and has a student section.
- Take a look at this website - http://www.rsc.org/careers/future/- it helps you to explore chemistry careers and what jobs you can do.

## Useful Text Books




## Transition Tasks

1. To ensure you are ready to fully access the A Level Syllabus

2. There are “Transition Skills” tasks below, which we have provided to enable further study and challenge with a focus on revisiting some of the key areas from GCSE which underpin new learning.

## Task 1: The Mole

### What is a mole?

The mole is a counting unit for atoms, molecules and ions (particles). Just as you might buy socks by the pair (2), eggs by the dozen (12), or paper by the ream (500), chemists use particles by the mole ($6.02 \times 10^{23}$).

### Why such a strange number?

Follow this logic… Magnesium (Mg) atoms are twice as heavy as carbon (C) atoms. So one Mg atom weighs twice as much as a carbon atom, 2Mg atoms are twice as heavy as 2C atoms, 12Mg atoms weigh double the amount of 12C atoms, 500Mg atoms weigh twice as much as 500C atoms. So the same number of atoms always weighs twice as much.

### This is where the relative atomic mass comes in

The relative atomic mass (Ar) of Mg is 24. For C its 12. Any number of atoms of Mg always weighs twice as much as the same number of C atoms, so if we have 24g of Mg and 12g of carbon they must contain the same number of atoms. Amedeo Avogadro worked out how many – its $6.02 \times 10^{23}$ and is known as Avogadro’s constant. This idea extends to every element on the periodic table. If we take a number of grams of any element equivalent to it’s Ar it will always contain $6.02 \times 10^{23}$ atoms. We call this a mole of atoms.

### Questions: (you will need a periodic table to find some Ar values)

1. Calculate the number of moles and the number of atoms in: a) 7g of Lithium (Li), b) 8g of oxygen (O), c) 28g nitrogen (N), d) 560g Iron (Fe), e) 10g Sulfur (S)

2. How many grams are there in: a) 1 mole of Calcium (Ca), b) 2 moles of phosphorus (P), c) 0.5 moles of Aluminium (Al), d) $6.02 \times 10^{23}$ atoms of Nickel (Ni), e) $3.01 \times 10^{23}$ atoms of Titanium (Ti)?

**A mole is a counting unit, so we can also count molecules**. For example one mole of methane ($CH_4$) contains $6.02 \times 10^{23}$ methane molecules. But how much does a mole weigh (or more correctly, what is its mass)? For this we need to know its relative molecular mass (Mr) which we find by adding up the Ar values of all the atoms in the molecule (12+1+1+1+1 = 16). So one mole of methane has a mass of 16g and contains $6.02 \times 10^{23}$ molecules.

3. **Calculate the Mr** of the following molecules:

a) ethane ($C_2H_6$), b) carbon dioxide ($CO_2$), c) ammonia ($NH_3$), d) water ($H_2O$).

4. Calculate the number of moles **and** the number of molecules in: a) 17g ammonia, b) 22g carbon dioxide, c) 60g ethane, d) 72g water, e) 20g nitrogen dioxide

5. **How many grams** are there in a) 1 mole of ammonia, b) 2 moles of water, c) half a mole of ethane, d) $6.02 \times 10^{23}$ molecules of carbon dioxide, e) $12.04 \times 10^{23}$ molecules of nitrogen dioxide?

### Transition task 2: Transition Skills 1-3.

We would like you to print off and complete the following sheets on these core skills Skill

1: Basic Chemistry Competencies

- Balancing Equations
- Constructing ionic formulae
- Writing Equations from texts

Skill 2: Basic Mathematical Competencies

- Rearranging equations
- BODMAS (order of operations)
- Quantity Calculus (unit determination)
- Expressing Large and small numbers
- Significant figures, decimal places and rounding
- Unit conversions – length, mass and time and Unit conversions – volume
- Moles and Mass
- Moles and concentration

Skill 3: Basic Practical Competencies:

- Laboratory equipment
- Recording Results · Drawing Scatter graphs

# Transition Task 2 1. Transition skills

### 0.1.1 Balancing equations

Balance the equations below.

1. …..C + …..$O_2$ …..CO $\longrightarrow$

2. …..Ba + …..$H_2O$ …..$Ba(OH)_2$ + $\longrightarrow$ …..$H_2$

3. …..$C_2H_6$ + …..$O_2$ …..$CO_2$ + $\longrightarrow$ …..$H_2O$

4. …..HCl + …..$Mg(OH)_2$ …..$MgCl_2$ $\longrightarrow$ + $H_2O$

5. …..$N_2$ + …..$O_2$ …..NO $\longrightarrow$

6. …..$Fe_2O_3$ + …..C …..Fe + $\longrightarrow$ …..$CO_2$

7. …..$CH_3CH_2OH$ + …..[O] $\longrightarrow$ …..$CH_3COOH$ + …..$H_2O$

8. …..$HNO_3$ + …..CuO $\longrightarrow$ …..$Cu(NO_3)_2$ + $H_2O$

9. …..$Al^{3+}$ + …..$e^-$ …..Al $\longrightarrow$

10. …..$[Fe(H_2O)_6]^{3+}$ + …..$CO_3^{2-}$ …..$Fe(OH)_3(H_2O)_3$ + …..$CO_2$ + …..$H_2O$

(10 marks)

# 1. Transition skills

### 0.1.2 Constructing ionic formulae

1. For each of the following ionic salts, determine the cation and anion present and use these to construct the formula of the salt. (5 marks)

   a. Magnesium oxide

   a. Sodium sulfate

   b. Calcium hydroxide

   c. Aluminium oxide

   d. Copper(I) oxide

2. When an acid is added to water it dissociates to form $H^+$ ions (which make it acidic) and an anion. These acidic hydrogen atoms can be used to determine the charge on the anion. Deduce the charge on the anions in the following acids. The acidic H atoms, $H^+$, have been underlined for you. (5 marks)

   - $\underline{H_2}SO_3$
   - $\underline{H}NO_3$
   - $\underline{H_3}PO_4$
   - $HCOO\underline{H}$
   - $\underline{H_2}CO_3$

# 1 Transition skills

### 0.1.3 Writing equations from text

The following questions contain a written description of a reaction. In some cases the products may be missing as you will be expected to predict the product using your prior knowledge.

For more advanced equations you may be given some of the formulae you need.

For each one, write a balanced symbol equation for the process. (10 marks)

**1.** The reaction between silicon and nitrogen to form silicon nitride $Si_3N_4$.

........................................................................................................................................

**2.** The neutralisation of sulfuric acid with sodium hydroxide.

........................................................................................................................................

**3.** The preparation of boron trichloride from its elements.

........................................................................................................................................

**4.** The reaction of nitrogen and oxygen to form nitrogen monoxide.

........................................................................................................................................

**5.** The combustion of ethanol ($C_2H_5OH$) to form carbon dioxide and water only.

........................................................................................................................................

**6.** The formation of silicon tetrachloride ($SiCl_4$) from $SiO_2$ using chlorine gas and carbon.

........................................................................................................................................

**7.** The extraction of iron from iron(III) oxide ($Fe_2O_3$) using carbon monoxide.

........................................................................................................................................

**8.** The complete combustion of methane.

........................................................................................................................................

**9.** The formation of one molecule of $ClF_3$ from chlorine and fluorine molecules.

........................................................................................................................................

**10.** The reaction of nitrogen dioxide with water and oxygen to form nitric acid.

........................................................................................................................................

# 2. Transition skills

## 0.2.1 Rearranging equations

**1.** The amount of substance in moles (n) in a solution can be calculated when the concentration given in mol/dm$^3$ (c) and volume (v) in cm$^3$ are known by using the equation:

$$n = \frac{cv}{1000}$$

a. Rearrange this equation making c the subject of the equation. (1 mark)

b. Rearrange this equation making v the subject of the equation. (1 mark)

**2.** The density of a substance can be calculated from its mass (m) and volume (v) using the equation:

$$d = \frac{m}{v}$$

a. Rearrange this equation so that the mass of a substance can be calculated given its density and volume. (1 mark)

Chemists most commonly work with masses expressed in grams and volumes in $cm^3$.

However, the SI unit for density is $kg/m^3$.

b. Write an expression for the calculation of density in the SI unit of $kg/m^3$ when the mass (m) of the substance is given in g and the volume (v) of the substance is given in $cm^3$. (2 marks)

**3.** The de Broglie relationship relates the wavelength of a moving particle (λ) with its momentum (p) through Planck's constant (h):

$$\lambda = \frac{h}{p}$$

a. Rearrange this equation to make momentum (p) the subject of the formula. (1 mark)

Momentum can be calculated from mass and velocity using the following equation.

$$p = mv$$

b. Using this equation and the de Broglie relationship, deduce the equation for the velocity of the particle. (2 marks)

**4.** The kinetic energy (KE) of a particle in a time of flight mass spectrometer can be calculated using the following equation.

$$KE = \frac{1}{2}mv^2$$

Rearrange this equation to make v the subject of the equation. (2 marks)

# 2. Transition skills

### 0.2.2 BODMAS (order of operations)

The order of operations for a calculation is very important. If operations are carried out in the wrong order then this could lead to the wrong answer. Most modern calculators will anticipate BODMAS issues when operations are entered but human beings can override the calculator's instincts.

**1.** Do the following calculations in your head.

(a) 3 + 5 × 5 = (d) 48 – 12 ÷ 4 =

(b) $6 \times 6 + 4 =$ (e) $4 + 4 \div 2 =$

(c) $20 - 6 \times 2 =$ (f) $100 - (20 \times 3) =$

(6 marks)

**2.** The molecular formula of glucose is $C_6H_{12}O_6$. Three students entered the following into their calculators to calculate the relative formula mass of glucose. Repeat their calculations as shown.

(a)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | × | 6 | + | 1 | × | 12 | + | 16 | × | 6 | = |

(b)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12 | × | 6 | = | + | 1 | = | × | 12 | = | + | 16 |
| = | × | 6 | = | | | | | | | | |

(c)

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ( | 12 | × | 6 | ) | + | ( | 12 | × | 1 | ) | + |
| ( | 16 | × | 6 | ) | = | | | | | | |

(d) Write a sentence summing up why the answers differ.

(4 marks)

# 2. Transition skills

## 0.2.3 Quantity calculus (unit determination)

**1.** Determine the units of density given that

$$density = \frac{mass(g)}{volume\ (cm^3)}$$

(1 mark)

**2.** Determine the units of concentration given that

$$concentration = \frac{number\ of\ moles\ (mol)}{volume\ (dm^3)}$$

(1 mark)

**3.** Pharmacists often calculate the concentration of substances for dosages. In this case the volumes are smaller, measured in $cm^3$, and the amount is given as a mass in grams. Determine the units of concentration when

$$concentration = \frac{mass\ (g)}{volume\ (cm^3)}$$

(1 mark)

**4.** Rate of reaction is defined as the *'change in concentration per unit time'*. Determine the units for rate when concentration is measured in mol $dm^{-3}$ and time in seconds.

(1 mark)

**5.** Pressure is commonly quoted in pascals (Pa) and can be calculated using the formula below. The SI unit of force is newtons (N) and area is $m^2$.

$$pressure = \frac{force}{area}$$

Use this formula to determine the SI unit of pressure that is equivalent to the Pascal.

(1 mark)

**6.** Determine the units for each of the following constants (K) by substituting the units for each part of the formula into the expression and cancelling when appropriate. For this exercise you will need the following units [ ] = mol $dm^{-3}$, rate = mol $dm^{-3}$ $s^{-1}$, p = kPa.

a. $K_c = \frac{[A][B]^2}{[C]}$

b. $K = \frac{rate}{[A][B]}$

c. $K_p \frac{(pA)^{0.5}}{(pB)}$

d. $K_w = [H^+][OH^-]$

e. $K_a = \frac{[H^+]\,[X^-]}{[HX]}$

# 2. Transition skills

## 0.2.4 Expressing large and small numbers

### Standard form and scientific form

Large and small numbers are often expressed using powers of ten to show their magnitude. This saves us from writing lots of zeros, expresses the numbers more concisely and helps us to compare them.

In standard form a number is expressed as;

$$\boldsymbol{a \times 10^n}$$

where ***a*** is a number between 1 and 10 and ***n*** is an integer.

Eg, 160 000 would be expressed as $1.6 \times 10^5$

Sometimes scientists want to express numbers using the same power of ten. This is especially useful when putting results onto a graph axis. This isn't true standard form as the number could be smaller than 1 or larger than 10. This is more correctly called **scientific form.**

Eg, $0.9 \times 10^{-2}$, $2.6 \times 10^{-2}$, $25.1 \times 10^{-2}$ and $101.6 \times 10^{-2}$ are all in the same scientific form.

**1.** Express the following numbers using standard form.

a. 1 060 000
b. 0.001 06
c. 222.2

(3 marks)

**2.** The following numbers were obtained in rate experiments and the students would like to express them all on the same graph axes. Adjust the numbers to a suitable scientific form.

0.1000 0.0943 0.03984 0.00163

(3 marks)

**3.** Calculate the following without using a calculator. Express all values in standard form.

a. $\frac{10^9}{10^5}$

b. $\frac{10^7}{10^{-7}}$

c. $\frac{1.2 \times 10^6}{2.4 \times 10^{17}}$

d. $(2.0 \times 10^7) \times (1.2 \times 10^{-5})$

(3 marks)

# 2.Transition skills

## 0.2.5 Significant figures, decimal places and rounding

For each of the numbers in questions 1–6, state the number of significant figures and the number of decimal places.

| | | Significant figures | Decimal places |
|---|---|---|---|
| **1** | 3.131 88 | | |
| **2** | 1000 | | |
| **3** | 0.000 65 | | |
| **4** | 1006 | | |

| | | | |
|---|---|---|---|
| **5** | 560.0 | | |
| **6** | 0.000 480 | | |

(6 marks)

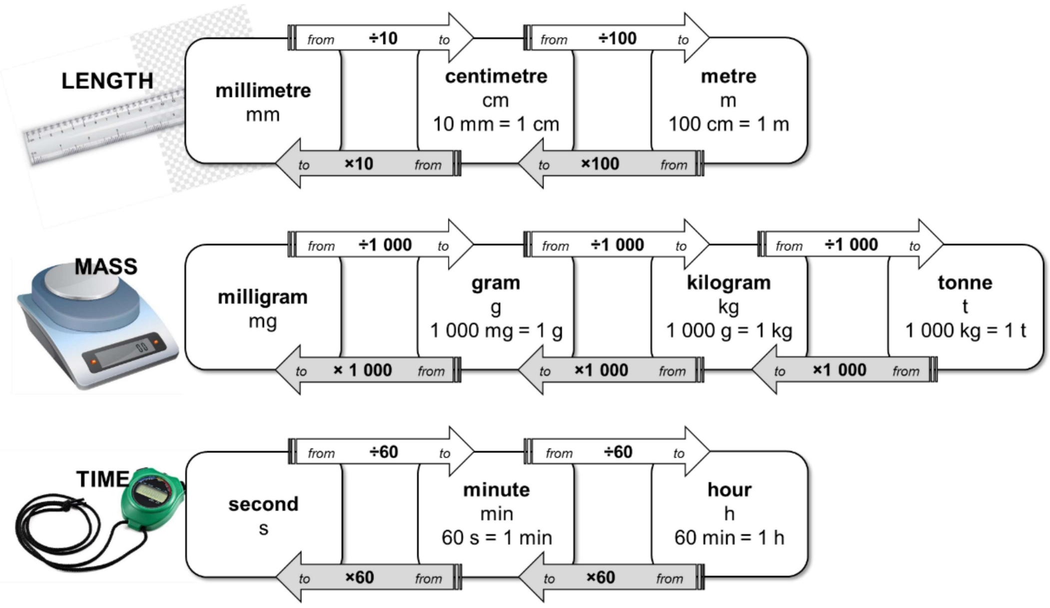
**7.** Round the following numbers to (i) 3 significant figures and (ii) 2 decimal places. a. 0.075 84

b. 231.456

(4 marks)

# 2.
# Transition skills
### 0.2.6 Unit conversions 1 – Length, mass and time

Mo's teacher has drawn a diagram on the board to help him with converting quantities from one unit into another.




*For example, to convert a length in millimetres into units of centimetres, divide by 10, eg 10 mm = 1 cm.*

Use the diagram to help with the following unit conversions. (10 marks)

**1.** A block of iron has a length of 1.2 cm. Calculate its length in millimetres.

**2.** The width of the classroom is 7200 cm. Calculate its length in metres.

**3.** A reaction reaches completion after 4½ minutes. Convert this time into seconds.

**4.** The stop clock reads 2 min 34 s. Convert this time into seconds.

**5.** A method states that a reaction needs to be heated under reflux for 145 min. Calculate this time in hours and minutes.

**6.** A factory produces 15 500 kg of ammonia a day. Calculate the mass of ammonia in tonnes.

**7.** A paper reports that 0.0265 kg of copper oxide was added to an excess of sulfuric acid. Convert this mass of copper oxide into grams.

**8.** A packet of aspirin tablets states that each tablet contains 75 mg of aspirin. Calculate the minimum number of tablets that contain a total of 1 g of aspirin.

**9.** A student measures a reaction rate to be 0.5 g/s. Convert the rate into units of g/min.

**10.** A factory reports that it produces fertiliser at a rate of 10.44 kg/h. Calculate the rate in units of g/s.

## 2.
### 0.2.7 Unit conversions 2 – Volume

The SI unit for volume is **metre cubed, m$^3$**. However as volumes in chemistry are often smaller than 1 m$^3$, fractions of this unit are used as an alternative.

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

| | | | |
|---|---|---|---|
| |  |  |  |
| | drinks bottle | sugar cube | washing machine |
| **Approx. volume** | | | |

**2.** Complete the following sentences; (1 mark)

To convert a volume in **cm$^3$** into a volume in **dm$^3$**, divide by ..............................

To convert a volume in **cm$^3$** into a volume in **m$^3$**, divide by ................................

**3.** a. A balloon of helium has a volume of 1600 cm$^3$. What is its volume in units of dm$^3$?

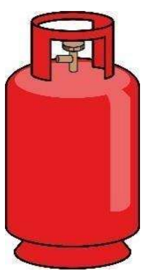
b. The technician has prepared 550 cm$^3$ of HCl(aq). What is its volume in units of m$^3$?

c. An experimental method requires 1.35 dm$^3$ of NaOH(aq). What volume is this in cm$^3$?

d. A swimming pool has a volume of 375 m$^3$. What volume is this in cm$^3$?

e. A 12 g cylinder of $CO_2$ contains 6.54 dm$^3$ of gas. What volume of gas is this in units of m$^3$? (5 marks)

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



| | | |
|---|---|---|
| $2.13 \times 10^6$ cm$^3$ of propane for £15.49 | 2700 dm$^3$ of propane for £21.25 | 7 m$^3$ of propane for £28.75 |

# 2.
# 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 a dozen?**

*Stating the amount of substance in moles isjust the same describing a quantity of eggs in dozens. could say you had 24 or 2 dozen eggs*

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

**1.** Calculate the amount of substance, in moles, in: (3 marks)

a. 32 g of methane, $CH_4$ (molar mass, 16.0 g mol$^{-1}$)

b. 175 g of calcium carbonate, $CaCO_3$

c. 200 mg of aspirin, $C_9H_8O_4$

**2.** Calculate the mass in grams of: (3 marks)

a. 20 moles of glucose molecules (molar mass, 180 g mol$^{-1}$)

b. 5.00 × 10$^{-3}$ moles of copper ions, $Cu^{2+}$

c. 42.0 moles of hydrated copper sulfate, $CuSO_4{\bullet}5H_2O$

**3.** a. 3.09 g of a transition metal carbonate was known to contain 0.0250 mol.

i. Determine the molar mass of the transition metal carbonate. (1 mark) ii.

Choose the most likely identity for the transition metal carbonate from the list below:

**$CoCO_3$** **$CuCO_3$** **$ZnCO_3$** (1 mark)

b. 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)

**$CrCO_3$** **$Cr_2(CO_3)_3$** **$Cr(CO_3)_3$**

# 2. Transition skills

## 0.2.9 Moles and concentration

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

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

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 dm$^3$ of water produces a solution with a concentration of ..............................mol dm$^{-3}$. (1 mark)

b. 250 cm$^3$ of a solution of HCl(aq) with a concentration of 0.0150 mol dm$^{-3}$ contains ................................ moles. (1 mark)

c. A solution with a concentration of 0.85 mol dm$^{-3}$ that contains 0.125 mol has a volume of .................................. dm$^3$. (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 $NaHCO_3$ dissolved in 100 cm$^3$ of water produces a solution with a concentration of ........................... mol dm$^{-3}$. (2 marks)

b. 25.0 cm$^3$ 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, $CoCl_2$, with a concentration of 1.3 mol dm$^{-3}$ that contains 2.5 g of $CoCl_2$ is ...................... cm$^3$. (3 marks)

# 3.Transition skills

## 0.3.1 Laboratory equipment

Practical work is a key aspect in the work of a chemist.

To help you plan effective practical work it is important that you are familiar with the common laboratory equipment available to you.

For each of the pieces of glassware shown in the images below, state their name and give a possible volume(s).

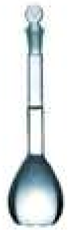
Name: ……………………………………

Possible volume(s): ……………………………………

b.

Name: ……………………………………

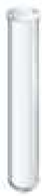
Possible volume(s): ……………………………………



Name: ……………………………………

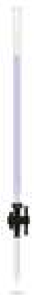
Possible volume(s): ……………………………………

d.



Name: ……………………………………

Possible volume(s): ……………………………………



Name: ……………………………………

Possible volume(s): ……………………………………

f.

Name: ……………………………………

Possible volume(s): ……………………………………

(6 marks)

Name the common laboratory equipment in the images below.

……………………………

……………………………

……………………………

……………………………

4marks

# 3. Transition skills

## 0.3.2 Recording results

1. A student is looking at endothermic processes. He adds 2.0 g of ammonium nitrate to 50 $cm^3$ of water and measures the temperature change. He repeats the experiment three times.

His results are shown in the table below.

| | Temperature at start | Temperature at end | Temperature change |
|---|---|---|---|
| **Run 1** | 21.0 | –1.1 | 22.1 |
| **Run 2** | 20 | –2 | 22 |
| **Run 3** | 20.2 | 2 | 18.2 |
| **Mean** | | | **22.05** |

Annotate the table to suggest **five ways** in which the table layout and the recording and analysis of his results could be improved. (5 marks)

2. For each of the experiments described below, design a table to record the results.

**Experiment 1:** Simon is investigating mass changes during chemical reactions. He investigates the change in mass when magnesium ribbon is oxidised to form magnesium oxide:

magnesium + oxygen · magnesium oxide

He records the mass of an empty crucible. He places a 10 cm strip of magnesium ribbon in the crucible and records the new mass of the crucible. He heats the crucible strongly until all the magnesium ribbon has reacted to form magnesium oxide. He allows the crucible to cool before recording the mass of the crucible and magnesium oxide.

**Experiment 2:** Nadiya is investigating how the rate of a reaction is affected by concentration. She investigates the reaction between magnesium ribbon and hydrochloric acid.

magnesium + hydrochloric acid · magnesium chloride + hydrogen

She places 25 $cm^3$ of hydrochloric acid with a concentration of 0.5 mol $dm^{-3}$ into a conical flask and fits a gas syringe. She adds a 3.0 cm strip of magnesium ribbon and measures the volume of hydrogen gas produced every 20 s for 3 minutes.

She repeats the experiment with hydrochloric acid with concentrations of 1.0 mol $dm^{-3}$ and then 1.5 mol $dm^{-3}$. (5 marks)

# Transition skills

## 0.3.3 Drawing scatter graphs

When you want to find a correlation between two variables it is helpful to draw a scatter graph.

Key points to remember when drawing scatter graphs include:

- The **independent variable** (the variable that is changed) goes on the *x*-axis and the **dependent variable** (the variable you measured) goes on the *y*-axis.
- The plotted points must cover more than half the graph paper.
- The axes scales don't need to start at zero.
- A straight **line** or smooth **curve of best fit** is drawn through the points to show any correlation.

Karina is investigating the relationship between the volume of a gas and its temperature. She injects 0.2 $cm^3$ of liquid pentane (b.p. 36.1 °C) into a gas syringe submerged in a water bath at 40 °C. After 5 minutes she measures the volume of gas in the syringe. She repeats the experiment three times with the water bath at 40 °C.

She then repeats the experiment for temperatures of 50, 60, 70 and 80 °C.

Her results are shown in the table below:

| **Temperature / °C** | **Volume of gas / $cm^3$** | | | |
|---|---|---|---|---|
| | **Run 1** | **Run 2** | **Run 3** | **Mean** |
| 40 | 40.8 | 43.1 | 42.7 | **42.2** |
| 50 | 46.1 | 46.2 | 46.9 | **46.4** |
| 60 | 54.7 | 48.1 | 48.3 | **48.2** |
| 70 | 49.1 | 49.6 | 49.5 | **49.4** |
| 80 | 51.0 | 47.3 | 51.0 | **51.0** |

**1.** Plot a scatter graph of the volume of the gas against the temperature. (6 marks)

**2.** Add error bars to show the range of readings used to calculate the mean volume of the gas at each temperature. (2 marks)

**3.** Draw in a line of best fit. (1 mark)

**4.** Describe the correlation observed. (1 mark)