Transition from GCSE to A Level 2020

Moving from GCSE Science to A Level can be a daunting leap. You'll be expected to remember a lot more facts, equations, and definitions, and you will need to learn new maths skills and develop confidence in applying what you already know to unfamiliar situations.

This worksheet aims to give you a head start by helping you:

- **to pre-learn some useful knowledge from the first chapters of your A Level course**
- **understand and practice of some of the maths skills you'll need.**

Learning objectives

After completing the worksheet you should be able to:

- **define practical science key terms**
- **recall the answers to the retrieval questions**
- **perform maths skills including:**
  - **converting between units and standard form and decimals**
  - **balancing chemical equations**
  - **rearranging equations**
  - **calculating moles and masses**
  - **calculating percentage yield and percentage error**
  - **interpreting graphs of reactions.**

Retrieval questions

You need to be confident about the definitions of terms that describe measurements and results in A Level Chemistry.

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

Practical science key terms

When is a measurement valid?	**when it measures what it is supposed to be measuring**
When is a result accurate?	**when it is close to the true value**
What are precise results?	**when repeat measurements are consistent/agree closely with each other**
What is repeatability?	**how precise repeated measurements are when they are taken by the *same* person, using the *same* equipment, under the *same* conditions**
What is reproducibility?	**how precise repeated measurements are when they are taken by *different* people, using *different* equipment**
What is the uncertainty of a measurement?	**the interval within which the true value is expected to lie**
Define measurement error	**the difference between a measured value and the true value**
What type of error is caused by results varying around the true value in an unpredictable way?	**random error**
What is a systematic error?	**a consistent difference between the measured values and true values**
What does zero error mean?	**a measuring instrument gives a false reading when the true value should be zero**
Which variable is changed or selected by the investigator?	**independent variable**

What is a dependent variable?	**a variable that is measured every time the independent variable is changed**
Define a fair test	**a test in which only the independent variable is allowed to affect the dependent variable**
What are control variables?	**variables that should be kept constant to avoid them affecting the dependent variable**

Atomic structure

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many answers as you can. Check and repeat.

What does an atom consist of?	a nucleus containing protons and neutrons, surrounded by electrons
What are the relative masses of a proton, neutron, and electron?	1, 1, and respectively
What are the relative charges of a proton, neutron, and electron?	+1, 0, and -1 respectively
How do the number of protons and electrons differ in an atom?	they are the same because atoms have neutral charge
What force holds an atomic nucleus together?	strong nuclear force
What is the atomic number of an element?	the number of protons in the nucleus of a single atom of an element
What is the mass number of an element?	number of protons + number of neutrons
What is an isotope?	an atom with the same number of protons but different number of neutrons
What is an ion?	an atom, or group of atoms, with a charge
What is the function of a mass spectrometer?	it accurately determines the mass and abundance of separate atoms or molecules, to help us identify them
What is a mass spectrum?	the output from a mass spectrometer that shows the different isotopes that make up an element

What is the total number of electrons that each electron shell (main energy level) can contain?	**$2n^2$ electrons, where n is the number of the shell**
How many electrons can the first three electron shells hold each?	**2 electrons (first shell), 8 electrons (second shell), 18 electrons (third shell)**
What are the first four electron sub-shells (orbitals) called?	**s, p, d, and f (in order)**
How many electrons can each orbital hold?	**a maximum of 2 electrons**
Define the term ionisation energy, and give its unit	**the energy it takes to remove a mole of electrons from a mole of atoms in the gaseous state, unit = $kJ\ mol^{-1}$**
What is the equation for relative atomic mass (A_r)?	**relative atomic mass =**
What is the equation for relative molecular mass (M_r)?	**relative molecular mass =**

Maths skills

1 Core mathematical skills

A practical chemist must be proficient in standard form, significant figures, decimal places, SI units, and unit conversion.

1.1 Standard form

In science, very large and very small numbers are usually written in standard form. Standard form is writing a number in the format A × 10^x where A is a number from 1 to 10 and x is the number of places you move the decimal place.

For example, to express a large number such as 50 000 mol dm^{-3} in standard form, A = 5 and x = 4 as there are four numbers after the initial 5.

Therefore, it would be written as 5×10^4 mol dm^{-3}.

To give a small number such as 0.000 02 Nm^2 in standard form, A = 2 and there are five numbers before it so x = −5.

So it is written as 2×10^{-5} Nm^2.

Practice questions

1 Change the following values to standard form.

a boiling point of sodium chloride: 1413 °C

b largest nanoparticles: 0.0 001$\times10^{-3}$ m

c number of atoms in 1 mol of water: 1806$\times10^{21}$

2 Change the following values to ordinary numbers.

a 5.5×10^{-6} b 2.9×10^2 c 1.115×10^4 d 1.412×10^{-3} e 7.2×10^1

1.2 Significant figures and decimal places

In chemistry, you are often asked to express numbers to either three or four significant figures. The word significant means to 'have meaning'. A number that is expressed in significant figures will only have digits that are important to the number's precision.

It is important to record your data and your answers to calculations to a reasonable number of significant figures. Too many and your answer is claiming an accuracy that it does not have, too few and you are not showing the precision and care required in scientific analysis.

For example, 6.9301 becomes 6.93 if written to three significant figures.

Likewise, 0.000 434 56 is 0.000 435 to three significant figures.

Notice that the zeros before the figure are *not* significant – they just show you how large the number is by the position of the decimal point. Here, a 5 follows the last significant digit, so just as with decimals, it must be rounded up.

Any zeros between the other significant figures are significant. For example, 0.003 018 is 0.003 02 to three significant figures.

Sometimes numbers are expressed to a number of decimal places. The decimal point is a place holder and the number of digits afterwards is the number of decimal places.

For example, the mathematical number pi is 3 to zero decimal places, 3.1 to one decimal place, 3.14 to two decimal places, and 3.142 to three decimal places.

Practice questions

3 Give the following values in the stated number of significant figures (s.f.).

a 36.937 (3 s.f.) b 258 (2 s.f.) c 0.043 19 (2 s.f.) d 7 999 032 (1 s.f.)

4 Use the equation:

number of molecules = number of moles × 6.02 × 10^{23} molecules per mole

to calculate the number of molecules in 0.5 moles of oxygen. Write your answer in standard form to 3 s.f.

5 Give the following values in the stated number of decimal places (d.p.).

a 4.763 (1 d.p.) b 0.543 (2 d.p.) c 1.005 (2 d.p.) d 1.9996 (3 d.p.)

1.3 Converting units

Units are defined so that, for example, every scientist who measures a mass in kilograms uses the same size for the kilogram and gets the same value for the mass. Scientific measurement depends on standard units – most are *Système International* (SI) units.

If you convert between units and round numbers properly it allows quoted measurements to be understood within the scale of the observations.

Multiplication factor	Prefix	Symbol

10^9	giga	G
10^6	mega	M
10^3	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

Unit conversions are common. For instance, you could be converting an enthalpy change of 488 889 J mol^{-1} into kJ mol^{-1}. A kilo is 10^3 so you need to divide by this number or move the decimal point three places to the left.

488 889 ÷ 10^3 kJ mol^{-1} = 488.889 kJ mol^{-1}

Converting from mJ mol^{-1} to kJ mol^{-1}, you need to go from 10^3 to 10^{-3}, or move the decimal point six places to the left.

333 mJ mol^{-1} is 0.000 333 kJ mol^{-1}

If you want to convert from 333 mJ mol^{-1} to nJ mol^{-1}, you would have to go from 10^{-9} to 10^{-3}, or move the decimal point six places to the right.

333 mJ mol^{-1} is 333 000 000 nJ mol^{-1}

Practice question

6 Calculate the following unit conversions.

a 300 μm to m

b 5 MJ to mJ

c 10 GW to kW

2 Balancing chemical equations

2.1 Conservation of mass

When new substances are made during chemical reactions, atoms are not created or destroyed – they just become rearranged in new ways. So, there is always the same number of each type of atom before and after the reaction, and the total mass before the reaction is the same as the total mass after the reaction. This is known as the conservation of mass.

You need to be able to use the principle of conservation of mass to write formulae, and balanced chemical equations and half equations.

2.2 Balancing an equation

The equation below shows the correct formulae but it is not balanced.

$$H_2 + O_2 \rightarrow H_2O$$

While there are two hydrogen atoms on both sides of the equation, there is only one oxygen atom on the right-hand side of the equation against two oxygen atoms on the left-hand side. Therefore, a two must be placed before the H_2O.

$$H_2 + O_2 \rightarrow 2H_2O$$

Now the oxygen atoms are balanced but the hydrogen atoms are no longer balanced. A two must be placed in front of the H_2.

$$2H_2 + O_2 \rightarrow 2H_2O$$

The number of hydrogen and oxygen atoms is the same on both sides, so the equation is balanced.

Practice question

1 **Balance the following equations.**

a $C + O_2 \rightarrow CO$

b $N_2 + H_2 \rightarrow NH_3$

c $C_2H_4 + O_2 \rightarrow H_2O + CO_2$

2.3 Balancing an equation with fractions

To balance the equation below:

$C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

- **Place a two before the CO_2 to balance the carbon atoms.**
- **Place a three in front of the H_2O to balance the hydrogen atoms.**

$C_2H_6 + O_2 \rightarrow 2CO_2 + 3H_2O$

There are now four oxygen atoms in the carbon dioxide molecules plus three oxygen atoms in the water molecules, giving a total of seven oxygen atoms on the product side.

- **To balance the equation, place three and a half in front of the O_2.**

$C_2H_6 + 3\frac{1}{2}O_2 \rightarrow 2CO_2 + 3H_2O$

- **Finally, multiply the equation by 2 to get whole numbers.**

$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

Practice question

2 **Balance the equations below.**

a $C_6H_{14} + O_2 \rightarrow CO_2 + H_2O$

b $NH_2CH_2COOH + O_2 \rightarrow CO_2 + H_2O + N_2$

2.4 Balancing an equation with brackets

$Ca(OH)_2 + HCl \rightarrow CaCl_2 + H_2O$

Here the brackets around the hydroxide (OH^-) group show that the $Ca(OH)_2$ unit contains one calcium atom, two oxygen atoms, and two hydrogen atoms.

To balance the equation, place a two before the HCl and another before the H_2O.

$Ca(OH)_2 + 2HCl \rightarrow CaCl_2 + 2H_2O$

Practice question

3 Balance the equations below.

a $Mg(OH)_2 + HNO_3 \rightarrow Mg(NO_3)_2 + H_2O$

b $Fe(NO_3)_2 + Na_3PO_4 \rightarrow Fe_3(PO_4)_2 + NaNO_3$

3 Rearranging equations and calculating concentrations

3.1 Rearranging equations

In chemistry, you sometimes need to rearrange an equation to find the desired values.

For example, you may know the amount of a substance (n) and the mass of it you have (m), and need to find its molar mass (M).

The amount of substance (n) is equal to the mass you have (m) divided by the molar mass (M):

You need to rearrange the equation to make the molar mass (M) the subject.

Multiply both sides by the molar mass (M):

$M \times n = m$

Then divide both sides by the amount of substance (n):

Practice questions

1 Rearrange the equation to make:

a *n* the subject of the equation

b *V* the subject of the equation.

2 Rearrange the equation $PV = nRT$ to make:

a *n* the subject of the equation

b *T* the subject of the equation.

3.2 Calculating concentration

The concentration of a solution (a solute dissolved in a solvent) is a way of saying how much solute, in moles, is dissolved in 1 dm^3 or 1 litre of solution.

Concentration is usually measured using units of mol dm^{-3}. (It can also be measured in g dm^3.)

The concentration of the amount of substance dissolved in a given volume of a solution is given by the equation:

where *n* is the amount of substance in moles, *c* is the concentration, and *V* is the volume in dm^3.

The equation can be rearranged to calculate:

- the amount of substance *n*, in moles, from a known volume and concentration of solution
- the volume *V* of a solution from a known amount of substance, in moles, and the concentration of the solution.

Practice questions

3 Calculate the concentration, in mol dm^{-3}, of a solution formed when 0.2 moles of a solute is dissolved in 50 cm^3 of solution.

4 Calculate the concentration, in mol dm^{-3}, of a solution formed when 0.05 moles of a solute is dissolved in 2.0 dm^3 of solution.

5 Calculate the number of moles of NaOH in an aqueous solution of 36 cm^3 of 0.1 mol dm^{-3}.

4 Molar calculations

4.1 Calculating masses and gas volumes

The balanced equation for a reaction shows how many moles of each reactant and product are involved in a chemical reaction.

If the amount, in moles, of one of the reactants or products is known, the number of moles of any other reactants or products can be calculated.

The number of moles (*n*), the mass of the substance (*m*), and the molar mass (*M*) are linked by:

Note: The molar mass of a substance is the mass per mole of the substance. For $CaCO_3$, for example, the atomic mass of calcium is 40.1, carbon is 12, and oxygen is 16. So the molar mass of $CaCO_3$ is:

40.1 + 12 + (16 × 3) = 100.1. The units are g mol^{-1}

Look at this worked example. A student heated 2.50 g of calcium carbonate, which decomposed as shown in the equation:

$$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$$

The molar mass of calcium carbonate is 100.1 g mol^{-1}.

a Calculate the amount, in moles, of calcium carbonate that decomposes.

= 2.50/100.1 = 0.025 mol

b Calculate the amount, in moles, of carbon dioxide that forms.

From the balanced equation, the number of moles of calcium carbonate = number of moles of carbon dioxide = 0.025 mol

Practice questions

1 In a reaction, 0.486 g of magnesium was added to oxygen to produce magnesium oxide.

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

a Calculate the amount, in moles, of magnesium that reacted.

b Calculate the amount, in moles, of magnesium oxide made.

c Calculate the mass, in grams, of magnesium oxide made.

2 Oscar heated 4.25 g of sodium nitrate. The equation for the decomposition of sodium nitrate is:

$$2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$$

a Calculate the amount, in moles, of sodium nitrate that reacted.

b Calculate the amount, in moles, of oxygen made.

3 0.500 kg of magnesium carbonate decomposes on heating to form magnesium oxide and carbon dioxide. Give your answers to 3 significant figures.

$MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$

a Calculate the amount, in moles, of magnesium carbonate used.

b Calculate the amount, in moles, of carbon dioxide produced.

5 Percentage yields and percentage errors

5.1 Calculating percentage yield

Chemists often find that an experiment makes a smaller amount of product than expected. They can predict the amount of product made in a reaction by calculating the percentage yield.

The percentage yield links the actual amount of product made, in moles, and the theoretical yield, in moles:

percentage yield =

Look at this worked example. A student added ethanol to propanoic acid to make the ester, ethyl propanoate, and water.

$C_2H_5OH + C_2H_5COOH \rightarrow C_2H_5COOC_2H_5 + H_2O$

The experiment has a theoretical yield of 5.00 g.

The actual yield is 4.50 g.

The molar mass of $C_2H_5COOC_2H_5$ = 102.0 g mol^{-1}

Calculate the percentage yield of the reaction.

Actual amount of ethyl propanoate: = 4.5/102 = 0.0441 mol

Theoretical amount of ethyl propanoate: = 5.0/102 = 0.0490 mol

percentage yield = (0.0441/0.0490) × 100% = 90%

Practice questions

1 Calculate the percentage yield of a reaction with a theoretical yield of 4.75 moles of product and an actual yield of 3.19 moles of product. Give your answer to 3 significant figures.

2 Calculate the percentage yield of a reaction with a theoretical yield of 12.00 moles of product and an actual yield of 6.25 moles of product. Give your answer to 3 significant figures.

5.3 Calculating percentage error in apparatus

The percentage error of a measurement is calculated from the maximum error for the piece of apparatus being used and the value measured:

percentage error = × 100%

Look at this worked example. In an experiment to measure temperature changes, an excess of zinc powder was added to 50 cm^3 of copper(II) sulfate solution to produce zinc sulfate and copper.

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

The measuring cylinder used to measure the copper(II) sulfate solution has a maximum error of ±2 cm^3.

a Calculate the percentage error.

percentage error = (2/50) × 100% = 4%

b A thermometer has a maximum error of ±0.05 °C.

Calculate the percentage error when the thermometer is used to record a temperature rise of 3.9 °C. Give your answer to 3 significant figures.

percentage error = (2 × 0.05)/3.9 × 100% = 2.56%

(Notice that two measurements of temperature are required to calculate the temperature change so the maximum error is doubled.)

Practice questions

3 A gas syringe has a maximum error of ±0.5 cm^3. Calculate the maximum percentage error when recording these values. Give your answers to 3 significant figures.

a 21.0 cm^3 b 43.0 cm^3

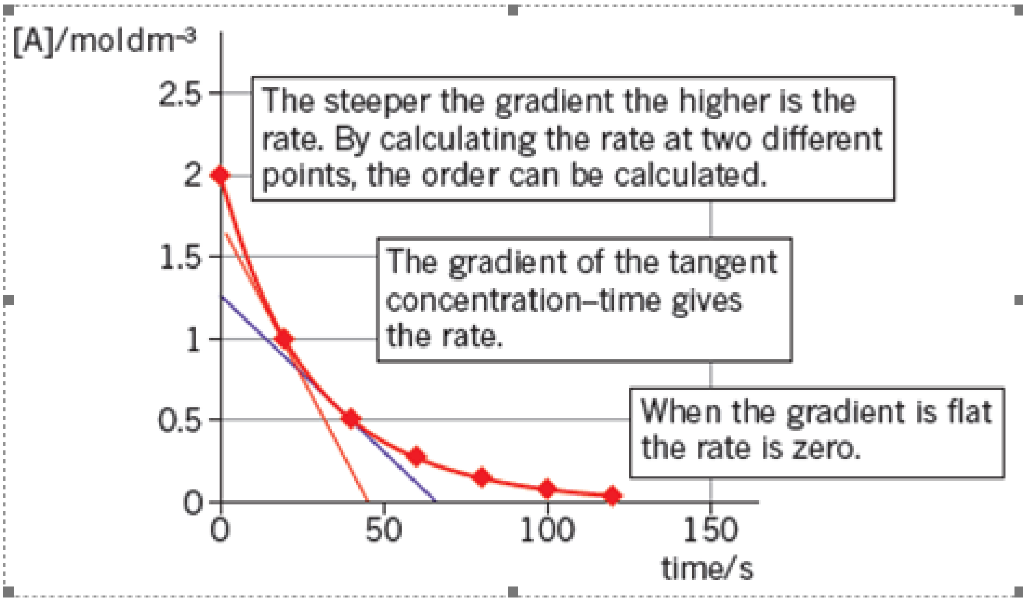
4 A thermometer has a maximum error of ±0.5 °C. Calculate the maximum percentage error when recording these temperature rises. Give your answers to 3 significant figures.

a 12.0 °C **b 37.6 °C**

6 Graphs and tangents

6.1 Deducing reaction rates

To investigate the reaction rate during a reaction, you can measure the volume of the product formed, such as a gas, or the colour change to work out the concentration of a reactant during the experiment. By measuring this concentration at repeated intervals, you can plot a concentration–time graph.



Note: When a chemical is listed in square brackets, it just means 'the concentration of' that chemical. For example, $[O_2]$ is just shorthand for the concentration of oxygen molecules.

By measuring the gradient (slope) of the graph, you can calculate the rate of the reaction. In the graph above, you can see that the gradient changes as the graph is a curve. If you want to know the rate of reaction when the graph is curved, you need to determine the gradient of the curve. So, you need to plot a tangent.

The tangent is the straight line that just touches the curve. The gradient of the tangent is the gradient of the curve at the point where it touches the curve.

Looking at the graph above. When the concentration of A has halved to 1.0 mol dm^{-3}, the tangent intercepts the *y*-axis at 1.75 and the *x*-axis at 48.

The gradient is = −0.0365 (3 s.f.).

So the rate is 0.0365 mol dm^{-3} s^{-1}.

Practice question

1 Using the graph above, calculate the rate of reaction when the concentration of A halves again to 0.5 mol dm^{-3}.

6.2 Deducing the half-life of a reactant

In chemistry, half-life can also be used to describe the decrease in concentration of a reactant in a reaction. In other words, the half-life of a reactant is the time taken for the concentration of the reactant to fall by half.

Practice question

2 The table below shows the change in concentration of bromine during the course of a reaction

Time / s	$[Br_2]$ / mol dm^{-3}
0	0.0100
60	0.0090

120	0.0066
180	0.0053
240	0.0044
360	0.0028

a Plot a concentration–time graph for the data in the table.

b Calculate the rate of decrease of Br_2 concentration by drawing tangents.

c Find the half-life at two points and deduce the order of the reaction.

ANSWERS

Maths skills

1 Core mathematics

Practice questions

1 a 1.413×10^{3} °C b 1.0×10^{-7} m

c 1.806×10^{21} atoms

2 a 0.000 0055 b 290
c 11150 d 0.001 412
e 72

3 a 36.9 b 260
c 0.043 d 8 000 000

4 Number of molecules = 0.5 moles × 6.022×10^{23} = 3.011×10^{23} = 3.01×10^{23}

5 a 4.8 b 0.54
c 1.01 d 2.000

6 a 0.0003 m b $5 \times 10^{9--}$ mJ
c 1×10^{7} kW

2 Balancing chemical equations

Practice questions

1 a $2C + O_2 \rightarrow 2CO$ b $N_2 + 3H_2 \rightarrow 2NH_3$

c $C_2H_4 + 3O_2 \rightarrow 2H_2O + 2CO_2$

2 a $C_6H_{14} + 9O_2 \rightarrow 6CO_2 + 7H_2O$ or $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

b $2NH_2CH_2COOH + 4O_2 \rightarrow 4CO_2 + 5H_2O + N_2$

or $4NH_2CH_2COOH + 9O_2 \rightarrow 8CO_2 + 10H_2O + 2N_2$

3 a $Mg(OH)_2 + 2HNO_3$ à $Mg(NO_3)_2 + 2H_2O$

b $3Fe(NO_3)_2 + 2Na_3PO_4$ à $Fe_3(PO_4)_2 + 6NaNO_3$

3 Rearranging equations and calculating concentrations

Practice questions

1 a $n = cv$ b v = n/c

2 a n = pV/RT b T = pV/nR

3 4.0 mol dm^{-3}

4 0.025 mol dm^{-3}

5 3.6×10^{-3} mol

4 Molar calculations

Practice questions

1 a = 0.02 mol b 0.02 mol

c 0.02 × 40.3 = 0.806 g

2 a = 0.05 mol b = 0.025 mol

3 a = 5.93 mol b 5.93 mol

5 Percentage yields and percentage errors

Practice questions

1 3.19/4.75 × 100 = 67.2%

2 6.25/12.00 × 100 = 52.1%

3 a 0.5/21 × 100 = 2.38% b 0.5/43 × 100 = 1.16%

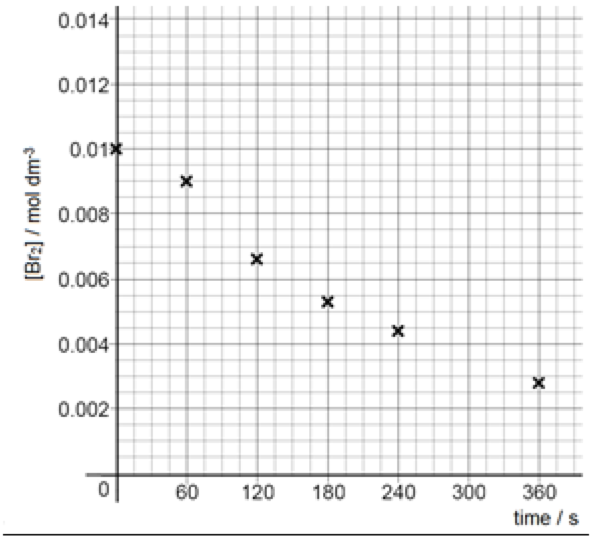
4 a 0.5 × (2/12) × 100 = 8.33% b 0.5 × (2/37.6) × 100 = 2.66%

6 Graphs and tangents

Practice questions

1 -1.25/65 = -0.0192

2 a



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b Half-life is approximately 180 seconds **c The reaction is first order**

2020 A LEVEL CHEMISTRY PRE-COURSE EXERCISE 2

The following questions cover GCSE topics that are an essential foundation for the study of A Level Chemistry.

Module 1 Chemistry will develop GCSE understanding of the following key areas:

- Atomic Structure
- Chemical Bonding
- Mole Calculations

Work through the questions in each key GCSE area.

Atomic Structure

1. (b) Copy and complete the following table.

Particle	Relative charge	Relative mass
Proton		
Neutron		
Electron		

(3)

(b) An atom of element **Z** has two more protons and two more neutrons than an atom of $^{34}_{16}S$. Give the symbol, including mass number and atomic number, for this atom of **Z.**

....

(2)

(c) An atom has twice as many protons as, and four more neutrons than, an atom of ^{9}Be. Deduce the symbol, including the mass number, of this atom.

....

(2)

(d) The table below shows some data about fundamental particles.

Particle	Proton	neutron	Electron
Mass /g	1.6725×10^{-24}	1.6748×10^{-24}	0.0009×10^{-24}

(ii) Calculate the mass of an atom of hydrogen which is made from a proton and an electron.

....

(iii) Calculate the mass of one mole of such hydrogen atoms giving your answer to four decimal places.

(The Avogadro constant, $L = 6.0225 \times 10^{23}\ mol^{-1}$)

....

(iv) An accurate value for the mass of one mole of hydrogen atoms is 1.0080 g. Give one reason why this value is different from your answer to part (c)(iii).

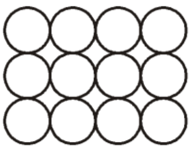
....

(4)

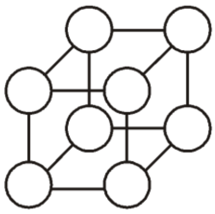
Chemical Bonding

1. At room temperature, both sodium metal and sodium chloride are crystalline solids which contain ions.

(a) On the diagrams for sodium metal and sodium chloride below, mark the charge for each ion.



Sodium metal



Sodium chloride

(2)

(b) (i) Explain how the ions are held together in solid sodium metal.

....

....

(ii) Explain how the ions are held together in solid sodium chloride.

....

....

(iii) The melting point of sodium chloride is much higher than that of sodium metal. What can be deduced from this information?

....

....

(3)

(c) Compare the electrical conductivity of solid sodium metal with that of solid sodium chloride. Explain your answer.

Comparison ....

....

Explanation ....

....

....

(3)

(d) Explain why sodium metal is malleable (can be hammered into shape).

....

....

(1)
(Total 9 marks)

2. Sodium sulphide, Na2S, is a high melting point solid which conducts electricity when molten. Carbon disulphide, CS2, is a liquid which does not conduct electricity.

(a) Deduce the type of bonding present in Na2S and that present in CS2

Bonding in Na2S ....

Bonding in CS2..

(b) By reference to all the atoms involved explain, in terms of electrons, how Na2S is formed from its atoms.

....

....

(c) Draw a diagram, including all the outer electrons, to represent the bonding present in CS2

(6)

3. Diamond and graphite are both forms of carbon.
Diamond is able to scratch almost all other substances, whereas graphite may be used as a lubricant. Diamond and graphite both have high melting points.

Explain each of these properties of diamond and graphite in terms of structure and bonding.
Give **one** other difference in the properties of diamond and graphite.

(Total 9 marks)

The Mole

1. A hydrocarbon, **W,** contains 92.3% carbon by mass. The relative molecular mass of **W** is 78.0

(a) Calculate the empirical formula of **W**.

(b) Calculate the molecular formula of **W**. (4)

2. The carbonate of metal **M** has the formula M2CO3. The equation for the reaction of this carbonate with hydrochloric acid is given below.

M2CO3 + 2HCl → 2MCl + CO2 + H2O

A sample of M2CO3, of mass 0.394 g, required the addition of 21.7 cm^3 of a 0.263 mol dm^{-3} solution of hydrochloric acid for complete reaction.

(i) Calculate the number of moles of hydrochloric acid used.

(ii) Calculate the number of moles of M2CO3 in 0.394 g.

(iii) Calculate the relative molecular mass of M2CO3

(iv) Deduce the relative atomic mass of **M** and hence suggest its identity.

(6)

3. When potassium chlorate is heated strongly it decomposes to produce potassium chloride and oxygen.

$$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$$

(a) Calculate the mass potassium chloride produced from 3.00g of potassium chlorate.

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(b) Heating 3.00 g of potassium chlorate produced 1.60 g of potassium chloride.

What is the percentage yield of this reaction?

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This work should be completed and brought to the first Chemistry lesson in September