GETTING AHEAD

HSDC ALTON

Start to develop skills that are relevant to your course before you join HSDC this September!

Applied Science – Level 3 Extended Certificate

We are looking forward to welcoming you to Applied Science at HSDC Alton in September. We have produced this document to help you bridge the gap between your GCSE Chemistry and the Chemistry content you will study with us in Unit 1.

You will be following the CTEC (OCR) Level 3 Applied Science syllabus and OCR have produced this worksheet as a useful transition to the course. We have added some YouTube links and links to simulations to download that will help with the content.

We have also added the answers to the questions at the end of the document for you to check your progress.

Look forward to meeting you soon!

Here are some links for you to look at before you start.

https://chemistrychimp.jimdofree.com/gcse-to-a-level-transition/bridging-tasks/reading/

https://www.compoundchem.com/infographics/

https://theodoregray.com/periodictable/Elements/006/index.s7.html

https://www.dailymotion.com/playlist/x2igjq#video=xxw6pr

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Transition from GCSE to A Level

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
    - calculating 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.

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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

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Atoms, ions, and compounds

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 $\frac{1}{1836}$ 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
How does the number of protons differ between atoms of the same element?	it does not differ – all atoms of the same element have the same number of protons
What force holds an atom nucleus together?	strong nuclear force
What is the proton number / atomic number of an element?	the number of protons in the atom's nucleus 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 the equation for relative isotopic mass?	$\text{relative isotopic mass} = \frac{\text{mass of an isotope}}{\frac{1}{12}^{\text{th}} \text{ mass of 1 atom of } {}^{12}\text{C}}$
What is the equation for relative atomic mass (A_r)?	$\text{relative atomic mass} = \frac{\text{weighted mean mass of 1 atom}}{\frac{1}{12}^{\text{th}} \text{ mass of 1 atom of } {}^{12}\text{C}}$
What is the equation for relative molecular mass (M_r)?	$\text{relative molecular mass} = \frac{\text{average mass of 1 molecule}}{\frac{1}{12}^{\text{th}} \text{ mass of 1 atom of } {}^{12}\text{C}}$

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What is an ion?	an atom or group of atoms with a charge (a different number of electrons to protons)
Define the term cation	a positive ion (atom with fewer electrons than protons)
Define the term anion	a negative ion (atom with more electrons than protons)
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 a binary compound?	a compound which contains only two elements

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 $A \times 10^x$ 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.

Here are a couple of YouTube clips to help with writing numbers in standard form

https://www.youtube.com/watch?v=AKvp2PvBvo4

https://www.youtube.com/watch?v=ceneATH5EZ8

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Practice questions

1 Change the following values to standard form.

a boiling point of sodium chloride: 1413 °C

b largest nanoparticles: 0.0 001×10^{-3} m

c number of atoms in 1 mol of water: 1806×10^{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.

Here is a YouTube clip to help with significant figures
https://www.youtube.com/watch?v=l2yuDvwYg5g

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

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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.

Here are a couple of YouTube clips and simulation exercises to help with balancing equations
https://www.youtube.com/watch?v=X7ckfeRjjvI&vl=en
https://www.youtube.com/watch?v=e_C-V5vJv80
https://phet.colorado.edu/en/simulation/balancing-chemical-equations
https://phet.colorado.edu/sims/html/reactants-products-and-leftovers/latest/reactants-products-and-leftovers_en.html

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.
  $C_2H_6 + 3½O_2 \rightarrow 2CO_2 + 3H_2O$
- Finally, multiply the equation by 2 to get whole numbers.
  $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

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

5.3 Calculating percentage error in apparatus

Here is a YouTube clip to help with calculating percentage errors

https://www.youtube.com/watch?v=9ufLjQeKgIk

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

$$\text{percentage error} = \frac{\text{maximum error}}{\text{measured value}} \times 100\%$$

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.

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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

1 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

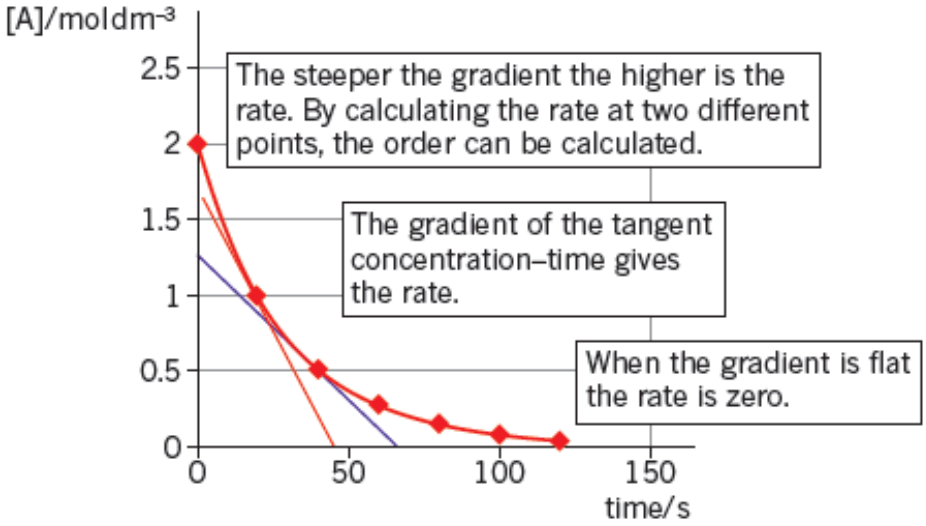
2 A thermometer has a maximum error of ±0.5 °C. Calculate the maximum percentage error when recording these temperature rises. Give your answers to 3 significant figures.

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 $\frac{-1.75}{48}$ = −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.

Here is a YouTube clips to help half-life calculations

https://www.youtube.com/watch?v=_pZO_qMlqE4

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.

Here are some practice questions to test your knowledge

Circle the correct answers in this section

1 Which row shows the atomic structure of an atom of the ^{19}F isotope?

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	protons	neutrons	electrons
A	9	9	10
B	9	10	9
C	10	9	10
D	10	10	9

[1]

2 Which row shows the numbers of neutrons and electrons in an $^{56}Fe^{3+}$ ion?

	neutrons	electrons
A	26	27
B	29.8	56
C	30	23
D	33	20

[1]

3 What is the total number of electrons in a nitrate ion, NO_3^-?

A 32 **B** 33

C 47 **D** 64

[1]

4 Calcium hydroxide contains Ca^{2+} and OH^- ions.

What is the formula of calcium hydroxide?

A CaOH **B** $CaOH_2$

C Ca_2OH **D** $Ca(OH)_2$

[1]

5 The mass of an object measured on a 4 decimal place balance is 7.0855 g

What is this mass to 3 significant figures?

A 7.09 g **B** 7.19 g

C 7.085 g**D** 7.086 g

[1]

7 Lithium reacts with oxygen to form lithium oxide, Li_2O

Which equation is correct for this reaction?

A $Li + O_2 \rightarrow Li_2O$

B $Li + O_2 \rightarrow LiO_2$

C $2Li + O_2 \rightarrow Li_2O_2$

D $4Li + O_2 \rightarrow 2Li_2O$

[1]

8 Balance the equation below.

$$\_\_\_K_3PO_4 + \_\_\_Ca(NO_3)_2 \rightarrow \_\_\_KNO_3 + \_\_\_Ca_3(PO_4)_2$$

[2]

Tick the boxes next to the correct answers in this section

11 Sodium carbonate contains sodium ions and carbonate ions.

Which statement(s) is/are correct?

The formula of sodium carbonate is $NaCO_3$. ☐

The relative formula mass of sodium carbonate is 106. ☐

A carbonate ion has the formula CO_3^{2-}. ☐

A sodium ion contains one electron in its outer shell. ☐

[1]

12 A sample of copper contains two isotopes, ^{63}Cu and ^{65}Cu.
The relative atomic mass of copper is 63.5.

Which statement(s) is/are correct? Tick **two** boxes

^{65}Cu has two more neutrons than ^{63}Cu ☐

^{65}Cu has two more protons than ^{63}Cu ☐

^{63}Cu and ^{65}Cu contain the same number of electrons ☐

^{65}Cu has two more electrons than ^{63}Cu ☐

[1]

14 Which statement describes the structure of an atom?

a sphere of positive charge with electrons embedded in it ☐

a nucleus of protons and neutrons, orbited by electrons ☐

a solid sphere that cannot be divided into smaller parts ☐

protons and electrons in a nucleus, surrounded by neutrons ☐

[1]

15 Which force holds an atom's nucleus together?

electrostatic force ☐

electromagnetic force ☐

strong nuclear force ☐

weak intermolecular interactions ☐

[1]

16 What type of error is caused by results varying around the true value in an unpredictable way?

measurement error ☐

systematic error ☐

random error ☐

zero error ☐

[1]

Answer the questions in the spaces provided in this section

17 Describe what it means when results are described as:

accurate:

precise:

[2]

18 This question is about atoms, isotopes and ions.

a i Complete the table below to show the properties of the particles.

Particle	Relative mass	Relative charge

proton		
neutron		
electron		

[3]

ii Complete the table for an atom and an ion of two **different** elements.

Element	Mass number	Protons	Neutrons	Charge	Electron configuration
		11	13	0	
	34			2–	2.8.8

[2]

(b) State the similarities and differences between isotopes of the **same** element.

Similarities

Differences

[2]

(c) An isotope of an element **X** contains 56 protons and 56 neutrons.

Identify element **X** and write down the mass number and atomic number
of this isotope of **X**.

element **X** =

Atomic number:

Mass number: **[3]**

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19 Describe the function of a mass spectrometer.

.....

..... **[2]**

Total = 30 marks

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** 5×10^9 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** $C_6H_{14} + 9\frac{11}{22}O_2 \rightarrow 6CO_2 + 7H_2O$ **or** $2C_6H_{14} + 19O_2 \rightarrow 12CO_2 + 14H_2O$

b $2NH_2CH_2COOH + 4\frac{11}{22}O_2 \rightarrow 4CO_2 + 5H_2O + N_2$

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

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

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

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%

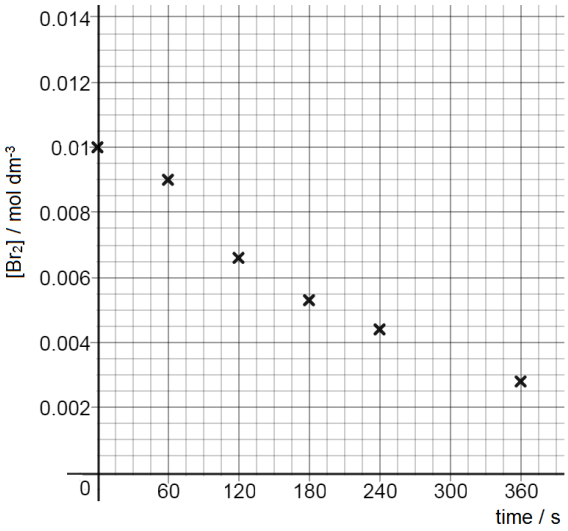
4 **a** 0.5 × (2/12) × 100 = 8.33% **b** 0.5 × (2/37.6) × 100 = 2.66%

6 Graphs and tangents

Practice questions

1 $\frac{-1.25}{65} = -0.0192$

2 **a**



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

Question	Answer	Marks	Guidance
1	B	1	

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2	C	1	
3	A	1	
4	D	1	
5	A	1	
7	D	1	
8	**2** K_3PO_4 + **3** $Ca(NO_3)_2$ → **6** KNO_3 + $Ca_3(PO_4)_2$	1 1	one mark for correct balancing of each side of the equation
11	☐ ✓ ✓ ☐	1	
12	✓ ☐ ✓ ☐	1	
14	☐		

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	☑ ☐ ☐	1	
15	☐ ☐ ☑ ☐	1	
16	☐ ☐ ☑ ☐	1	
17	close to true value repeats close to mean	1 1	

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<table>
<tr><td>18a(i)</td><td>
<table>
<tr><th>Particle</th><th>Relative mass</th><th>Relative charge</th></tr>
<tr><td>proton</td><td>1</td><td>+1</td></tr>
<tr><td>neutron</td><td>1</td><td>–1</td></tr>
<tr><td>electron</td><td>1/1840</td><td>0</td></tr>
</table>
</td><td>1
1
1</td><td>one mark for each correct row</td></tr>
<tr><td>18a(ii)</td><td>
<table>
<tr><th>Element</th><th>Mass number</th><th>Protons</th><th>Neutrons</th><th>Charge</th><th>Electron configuration</th></tr>
<tr><td>Na</td><td>23</td><td>11</td><td>13</td><td>0</td><td>2.8.1</td></tr>
<tr><td>S</td><td>34</td><td>16</td><td>18</td><td>2–</td><td>2.8.8</td></tr>
</table>
</td><td>1
1</td><td>one mark for each correct row</td></tr>
<tr><td>18b</td><td>Similarities: same number of protons and electrons
Differences: different numbers of neutrons</td><td>1</td><td></td></tr>
<tr><td>18c</td><td>Barium
56
112</td><td>1
1
1</td><td></td></tr>
<tr><td>19</td><td>identify molecules
shows isotopes that make up an element</td><td>1
1</td><td></td></tr>
</table>