A Level Chemistry Summer Independent Learning

Welcome to A Level Chemistry!

This pack contains a selection of tasks to help you prepare for the start of the course in September.

The tasks are split into 2 parts. The tasks in Part 1 are compulsory and should be completed ready for your first lesson at New College, whilst the tasks in Part 2 are strongly recommended. You can print the booklet, write on the pdf file or answer the questions on paper or a Word document.

Please be aware that you will have to sit an **assessment** on the knowledge and skills covered in Part 1 within a week of you starting at New College. There will be an opportunity to review your Summer Independent Learning and answer any questions you may have in one of the lessons before you sit the assessment.

Part 1 – Compulsory	**Approximately 6 hours**	**Pages 2 - 18**

This part is split into two sections:

- **Section A – GCSE Review** **Pages 2 - 8**

  This section should take approximately 2 hours to complete.

  The tasks will give you the opportunity to review and practise knowledge and skills from four key areas of your GCSE Chemistry/Combined Science studies.

- **Section B – Foundations in A-level Chemistry** **Pages 9 - 18**

  This section should take approximately 4 hours to complete.

  The first part of this section contains tasks to help you remember key formulae of elements, compounds and ions, and to ensure you that you are comfortable with writing and balancing symbol equations from scratch.

  The second part of this section contains tasks to develop your current understanding of the mole and to introduce you to mass spectrometry as a technique for determining the relative atomic mass of an element in a sample.

Part 2 – Strongly Recommended	**Approximately 6 hours**	**Pages 19 - 29**

This part looks at **Key Skills for A-level Chemistry**.

The tasks are designed to help you solidify key skills from your GCSE, such as:

- writing symbols and numbers
- significant figures, decimal places and standard form
- rearranging equations
- units
- tabulating data and drawing graphs

Part 1 - Compulsory

Section A – GCSE Review

This section should take approximately 2 hours to complete

Below are a selection of exam questions on the following topics from your GCSE studies

1 – Atomic Structure and the Periodic Table
A whole topic summary can be found at: https://youtu.be/bgyuXU97jaI

2 – Bonding, Structure and the Properties of Matter
A whole topic summary can be found at: https://youtu.be/YpEQ-NWxKBc

3 – Quantitative Chemistry
A whole topic summary can be found at: https://youtu.be/eAibVvhmsK0

4 - Chemical Changes
A whole topic summary can be found at: https://youtu.be/KTmXEIiU_Go

Task

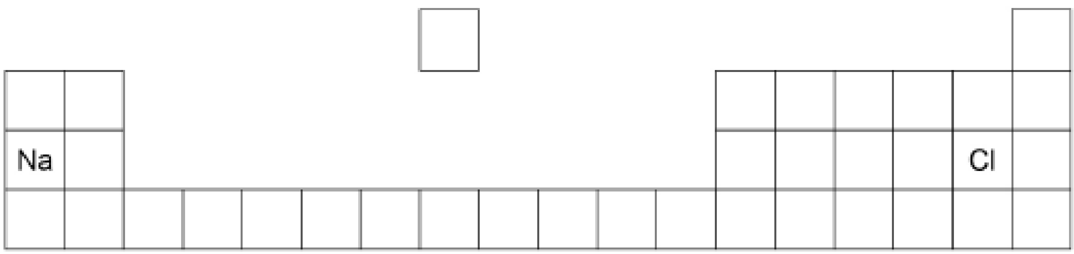
Please complete the exam questions below

Paper: Jun18/8464/C/1H **Q2.1**

This question is about sodium and chlorine.

Figure 2 shows the positions of sodium and chlorine in the periodic table.

Figure 2



1 State **one** difference and **one** similarity in the electronic structure of sodium and of chlorine.

[2 marks]

Difference ____

____

Similarity ____

____

Paper: Jun18/8464/C/1H **Q4.1-4.2**

This question is about the halogens.

1 Write the state symbol for chlorine at room temperature.

[1 mark]

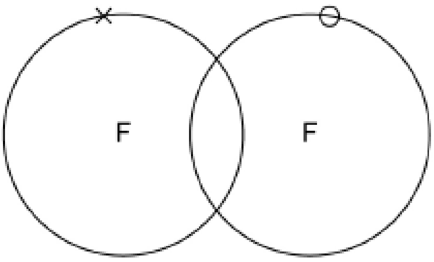
Cl_2 (______)

2 **Figure 4** represents one molecule of fluorine.

Complete the dot and cross diagram on **Figure 4**

You should show only the electrons in the outer shells.

[2 marks]



Paper: Jun18/8464/C/1H **Q4.3-4.5**

3 A fluorine atom can be represented as ${}^{19}_{9}F$

What is the total number of electrons in a fluorine molecule (F_2)?

[1 mark]

Tick **one** box.

9 ☐   14 ☐   18 ☐   38 ☐

4 Aluminium reacts with bromine to produce aluminium bromide.

Complete the balanced chemical equation for this reaction.

[2 marks]

_____Al + _____Br_2 → 2 ___________

5 When chlorine reacts with potassium bromide, chlorine displaces bromine.

$$Cl_2 + 2\,KBr \rightarrow Br_2 + 2\,KCl$$

Explain why chlorine is more reactive than bromine.

[3 marks]

Paper: Jun18/8464/C/1H **Q6.1, 6.2**

Group 2 metal carbonates thermally decompose to produce a metal oxide and a gas.

1 Give the formula of each product when calcium carbonate ($CaCO_3$) is heated.

[2 marks]

__________________ and __________________

2 The relative formula mass (M_r) of a Group 2 metal carbonate is 197

Relative atomic masses (A_r): C = 12 O = 16

Calculate the relative atomic mass (A_r) of the Group 2 metal in the metal carbonate.

Name the Group 2 metal.

[3 marks]

____

____

____

____

____

____

Relative atomic mass (A_r) = __________________

Metal __________________

Paper: Jun18/8464/C/1H **Q8.1-8.3**

This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

. 1 Name the other product.

[1 mark]

____

. 2 Suggest how any unreacted iron can be separated from the mixture.

[1 mark]

____

____

Magnesium reacts with iron chloride solution.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

. 3 0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24   Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

____

____

____

____

____

____

____

____

____

____

Mass of iron = ______________________ mg

Q8.4

0 8 . 4 Explain which species is reduced in the reaction between magnesium and iron chloride.

$$3\ Mg + 2\ FeCl_3 \rightarrow 2\ Fe + 3\ MgCl_2$$

Your answer should include the half equation for the reduction.

[3 marks]

Q4.2, 4.3

A bag of fertiliser contains 14.52 kg of ammonium nitrate (NH_4NO_3).

Relative formula mass (M_r): NH_4NO_3 = 80

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

Give your answer in standard form to 2 significant figures.

[4 marks]

Moles of ammonium nitrate = ____________________ mol

The fertiliser also contains potassium chloride.

Explain why potassium chloride has a high melting point.

[4 marks]

Section B - Foundations for A Level Chemistry

This section should take approximately 4 hours to complete

Chemical formulae

You will need to use the formulae of ions to write formulae for ionic compounds. You will use the formulae for ionic compounds and molecules to write balanced equations.

Common formulae - ***you must learn!***

H_2	Hydrogen
N_2	Nitrogen
O_2	Oxygen
F_2	Fluorine
Cl_2	Chlorine
Br_2	Bromine
I_2	Iodine
NH_3	Ammonia
CO_2	Carbon Dioxide
CO	Carbon Monoxide

Common Acids - ***you must learn!***

HCl	Hydrochloric Acid
HNO_3	Nitric Acid
H_2SO_4	Sulphuric Acid
H_3PO_4	Phosphoric Acid
CH_3COOH	Ethanoic Acid

Common Ions

The ions in italic can be worked out using your periodic table.
Where there are brackets with roman numerals, this corresponds to the charge on the ion.

Positive Ions	**Negative Ions**
H^+ - Hydrogen ion	*F^- - Fluoride ion*
Li^+ - Lithium ion	*Cl^- - Chloride ion*
Na^+ - Sodium ion	*Br^- - Bromide ion*
K^+ - Potassium ion	*I^- - Iodide ion*
NH_4^+ - Ammonium ion	OH^- - Hydroxide ion
Ag^+ - Silver ion	NO_3^- - Nitrate ion
Cu^+ - Copper (I) ion	HCO_3^- - Hydrogencarbonate ion
	CN^- - Cyanide ion
Mg^{2+} - Magnesium ion	
Ca^{2+} - Calcium ion	*O^{2-} - Oxide ion*
Sr^{2+} - Srontium ion	*S^{2-} - Sulfide ion*
Ba^{2+} - Barium ion	SO_4^{2-} - Sulfate ion
Zn^{2+} - Zinc ion	CO_3^{2-} - Carbonate ion
Cu^{2+} - Copper (II) ion	$Cr_2O_7^{2-}$ - Dichromate ion
Fe^{2+} - Iron (II) ion	
Pb^{2+} - Lead (II) ion	PO_4^{3-} - Phosphate ion
	N^{3-} - Nitride ion
Al^{3+} - Aluminum ion	*P^{3-} - Phosphide ion*
Cr^{3+} - Chromium (III) ion	
Fe^{3+} - Iron (III) ion	

Task 1

Learn the list of 'Common Formulae' and 'Common Acids' on the previous page.

In an uncharged compound, the total number of + and – charges must be exactly the same.
You can use as many of the + and – ions as necessary to work out the formula.

Example:

Magnesium sulfate : contains Mg^{2+} and SO_4^{2-} , the total number of + and – charges are equal therefore the formula will be $MgSO_4$.

Calcium hydroxide: contains Ca^{2+} and OH^- , the total number of + and – charges are not equal to make them equal you need an additional OH^- therefore the formula will be $Ca(OH)_2$.

Task 2

Using the tables on the previous page, write the formulae for the following compounds.

1. Silver bromide
2. Sodium carbonate
3. Potassium oxide
4. Iron (III) oxide
5. Aluminium nitrate
6. Sodium sulfate
7. Zinc hydrogencarbonate
8. Sodium Nitride
9. Barium hydroxide
10. Ammonium chloride

Writing and balancing equations

At A Level you will need to:

- Identify products made, so you will need to know your general reactions
- work out formulae and write an equation
- balance the atoms (this means you can only change the big numbers in front of each reactant and product, not by change the actual formula of any element or compound)

<u>General reactions – ***you must learn***</u>

metal + water ⟶ metal hydroxide + hydrogen

metal + acid ⟶ salt + hydrogen

metal hydroxide + acid ⟶ salt + water

metal oxide + acid ⟶ salt + water

metal carbonate + acid ⟶ salt + water + carbon dioxide

ammonia + acid ⟶ ammonium salt

The type of salt made depends on the acid made:

- Hydrochloric acid makes chlorides
- Sulfuric acid makes sulfates
- Nitric acid makes nitrates
- Phosphoric acid makes phosphates
- Ethanoic acid makes ethanoates

Example:

Magnesium and nitric acid:

- Identify products made; Metal + acid form salt + hydrogen. Nitric acid has been used therefore a nitrate is formed
- Work out formulae and write out equation; Magnesium Mg reacts with Nitric acid HNO_3 to form Magnesium Nitrate Mg^{2+} NO_3^- therefore formula will be $Mg(NO_3)_2$ and Hydrogen H_2

  $$Mg + HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$$

- Balance the atoms in the equation – numbers in front of reactants and products only

  $$Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2$$

<u>Task 3</u>

Learn the 'General Equations' and the 'Type of Salt Made' outlined above.

Task 4

Write and balance the following equations:

1. Sodium oxide and sulfuric acid

2. Calcium hydroxide and nitric acid

3. Sodium carbonate and phosphoric acid

4. Potassium and hydrochloric acid

5. Ammonia and sulfuric acid

Task 5

Balance the following equations:

1. $N_2 + O_2 \longrightarrow NO_2$

2. $Li + O_2 \longrightarrow Li_2O$

3. $O_2 \longrightarrow O_3$

4. $Li + O_2 \longrightarrow Li_2O_2$

5. $B + O_2 \longrightarrow B_2O_3$

6. $N_2 + O_2 \longrightarrow N_2O_5$

7. $SO_2 + HI \longrightarrow I_2 + S + H_2O$

8. $SiO_2 + HF \longrightarrow SiF_4 + H_2O$

9. $KMnO_4 + HCl \longrightarrow KCl + MnCl_2 + Cl_2 + H_2O$

10. $HCl + MnO_2 \longrightarrow MnCl_2 + Cl_2 + H_2O$

Time of Flight Mass Spectrometry

Mass spectrometry is a powerful instrument method of analysis. It can be used to find the mass and abundance of each isotope in an element allowing us to determine its relative atomic mass.

A common form of mass spectrometry is Time of Flight mass spectrometry.

Task 6

Read the student guide at the following link and answer the questions below.

https://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-SG-TOFMS.PDF

1. Name the four stages of Time of Flight mass spectrometry

2. Write an equation to show an electron is knocked off from a particle forming a 1+ ion.

3. What does the velocity of each particle depend on?

4. What does the size of current at the detector tell us?

The mass spectra produced from this process allows us to calculate the Relative Atomic mass.

- **Relative Atomic Mass (A_r) - The weighted mean mass of an atom of an element compared with 1/12th the mass of an atom of Carbon-12.**
- **Relative Isotopic Mass – is the mass of an isotope relative to 1/12th the mass of an atom of Carbon-12.**

Task 7

Learn the definitions of 'Relative Atomic Mass' and 'Relative Isotopic Mass' outlined above.

Using Mass Spectra to calculate Relative Atomic Mass

Example 1:

Gallium is a mixture of two isotopes with mass numbers 69 and an abundance of 60.2% and mass number 71 and an abundance of 39.8%. Calculate the relative atomic mass to 1 decimal place.

$$Ar = \frac{(\text{isotope 1 relative abundance x mass number}) + (\text{isotope 2 relative abundance x mass number})}{\text{Total abundance}}$$

$$A_r = \frac{(69 \times 60.2) + (71 \times 39.8)}{100} = 69.8$$

Example 2:

A naturally occurring sample of the element boron has a relative atomic mass of 10.8. In this sample, boron exists as two isotopes, 10B and 11B. Calculate the percentage abundance of 10B in this naturally occurring sample of boron.

$$Ar = \frac{(\text{isotope 1 relative abundance x mass number}) + (\text{isotope 2 relative abundance x mass number})}{\text{Total abundance}}$$

We do not know what the % of abundance of each isotope is so we will name these x and y. If the total abundance is 100% and we know x then y will equal 100 – x.

i.e. If x = 90, y= 100 – 90 = 10. In terms of x and y this means y = 100-x

Substitute into the equation:

$$10.8 = \frac{(10 \times X) + (11 \times (100-X))}{100} \quad = \quad 1080 = 10X + 1100 - 11X$$

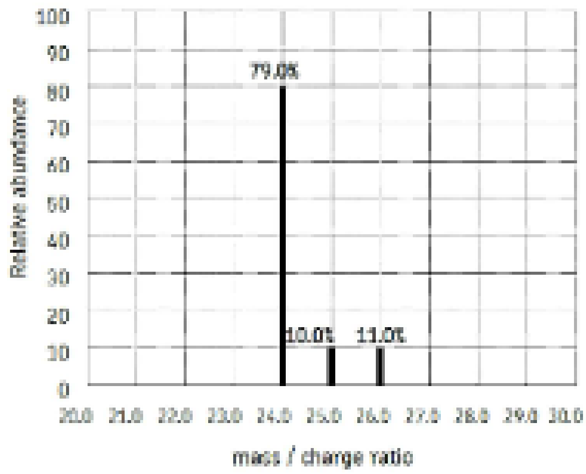
$$1080 - 1100 = 10X - 11X$$

$$-20 = -X$$ – Percentage abundance of 10B = 20%

Task 8

Answer the following questions.

1. Calculate the relative atomic mass of magnesium, using the mass spectrum below:



2. Silicon is a mixture of three isotopes with mass numbers 28, 29 and 30 with the relative abundances 92.18%, 4.70% and 3.12% respectively. Calculate the Ar to 1 decimal place.

3. The element indium exists as a mixture of two isotopes of mass numbers 113 and 115. The relative atomic mass of indium =114.82. Calculate the percentage of the two isotopes in a naturally occurring sample of indium.

The mole and Avogadro constant

One mole of anything contains 6.022×10^{23} of those things.

For example one mole of bananas is 6.022×10^{23} is 6.022×10^{23}.

This number is known as the Avogadro's constant = 6.022×10^{23}.

The Avogadro number was chosen so that the mass of one mole of particles of a substance equals the Molecular Mass (M_r) in grams.

For example the M_r of water is 18.0 and the mass of one mole of water molecules is 18.0 grams.

Number of moles = $\dfrac{\textbf{mass (g)}}{\textbf{Relative Molecular Mass}}$ $\qquad$ $n = \dfrac{m}{Mr}$

Number of particles = number of moles x Avogadro constant $\qquad$ **N = n x L**

Task 9

Learn the equations outlined above.

Task 10

Use the equations above to answer the following questions.

1. Calculate the number of molecules in 0.7 moles of oxygen (O_2)

2. Calculate the number of atoms in 1.25 moles of nitrogen (N_2)

3. How many moles are there in each of the following?

   a) 72.0 g of Mg

   b) 4.00 kg of CuO

c) 39.0 g of $Al(OH)_3$

d) 1.00 tonne of NaCl

e) 20.0 mg of $Cu(NO_3)_2$

4. What is the mass of each of the following?

   a) 5.00 moles of Cl_2

   b) 0.200 moles of Al_2O_3

   c) 0.0100 moles of Ag

   d) 0.00200 moles of $(NH_4)_2SO_4$

   e) 0.300 moles of $Na_2CO_3.10H_2O$

5. Use the following data to calculate the mass of the particles shown.
   Mass of proton = 1.6726 x 10-24 g
   Mass of electron = 9.1094 x 10-28 g
   Mass of neutron = 1.6749 x 10-24 g
   Avogadro constant = 6.022 x 1023 mol^{-1}

   a) Calculate the mass of a ^1H atom

   b) Calculate the mass of an $^1H^+$ ion

   c) Calculate the mass of one mole of 3 H atoms

Part 2 – Strongly Recommended

Key Skills for A Level Chemistry

This section should take approximately 4 hours to complete.

Chemical symbols

It is important that chemical symbols and formulae are written accurately.

https://www.bbc.co.uk/bitesize/guides/zt2hpv4/revision/3 (pages 3 & 4)

https://www.rsc.org/periodic-table/

Task I.

The Periodic table below contains **six** errors. Highlight these.

					H												He
Li	Be											B	C	N	O	Fl	Ne
na	Mg											Al	Si	P	S	CL	Ar
K	Ca	Sc	Ti	V	Cr	Mn	fe	CO	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	pD	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg							

Writing numbers

It is also important that numbers are written clearly.

https://www.aqa.org.uk/resources/science/as-and-a-level/teach/maths-skills-briefings

Candidates should write l without any 'tops' and 'tails', eg l **not** 1 or 1, and write 7 without a cross, eg 7 **not** 7.

Task 2.

For the rest of the tasks in this section, ensure that you write numbers according to the guidance above.

Significant figures

https://www.calculatorsoup.com/calculators/math/significant-figures-counter.php

Digits 1, 2, 3, 4, 5, 6, 7, 8 & 9 are significant. Values containing a 0 in between any of these digits is also considered significant.

For example:

12.45 has four significant figures

12045 has five significant figures

Any 0s at the end of a number, to the right of the decimal point are significant.

For example:

12.450 has five significant figures

Any 0s at the start of a number are not significant.

For example:

0.01245 has four significant figures

Any 0s written at the end of a number are **not** significant if the number is written **without** a decimal point.

However, a 0 written at the end of a number **with** a decimal point **is** significant.

For example:

12450 has four significant figures

12450.0 has six significant figures

Task 3.

Complete the table by rounding the original number to the specified number of significant figures.

Original number	3 significant figures	2 significant figures	1 significant figure
2.856			
44.503			
18.29			
0.099			
532.41			
0.00102			

Significant figures when completing calculations

It is important to show all workings and write each step in a calculation separately.

Calculated quantities should be given to the appropriate number of significant figures. This means that the answer should be given to the same number of significant figures as the raw data used with the least number of significant figures.

For example:

Calculate the mass of sodium hydroxide in 25 cm^3 of a 0.105 mol dm^{-3} solution.

Relative formula mass (M_r): NaOH = 40.0

Give your answer to the appropriate number of significant figures.

(25 ÷ 1000) x 0.105 = 0.002625

0.002625 x 40.0 = 0.105

*Mass of NaOH …*0.11*… g*

25 cm^3 is 2 s.f. 0.105 mol dm^{-3} and 40.0 are 3 s.f. ∴ answer is given to 2 s.f.

Task 4.

Answer the following question.

0.1 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced. Give your answer to the appropriate number of significant figures.

How many significant figures should the final answer be given to? ………………………

Decimal places

These are the number of digits (0, I, 2, 3, 4, 5, 6, 7, 8 or 9) shown to the right of the decimal point.

For example:

I.20 is written to two decimal places

0.024 is written to three decimal places

Task 5.

Complete the table by rounding the original number to the specified number of decimal places.

Original number	2 decimal places	I decimal place	0 decimal places (an Integer)
I2.947			
84.3524			
0.765			

Standard form

A number written in standard form shows a value (I, 2, 3, 4, 5, 6, 7, 8 or 9) in terms of a power of I0 (x I0^{a}). The power of I0 (**a**) shows the number of places the decimal place must be moved to give the number in decimal form.

A positive value of **a** is used for values larger than one. A negative value of **a** is used for values smaller than one.

For example:

I25 is written as I.25 x I0^{2}

0.00I25 is written as I.25 x I0^{-3}

Task 6.

Convert the following numbers into standard form:

a) 32 000 ………………………… b) 0.0006 …………………………………

c) I04 000 …………………………. d) 0.0020I9 ……………………………….

Rearranging equations

https://www.bbc.co.uk/bitesize/guides/zqpfcj6/revision/4

You will need to commit a number of different equations to memory and rearrange them to change the subject of an equation.

For example:

$\frac{5a + 3}{2} = 8$ a = ?

$\left(\frac{5a + 3}{2}\right) \times 2 = 8 \times 2$ ∴ 5a + 3 = 16

5a + 3 – 3 = 16 - 3 ∴ 5a = 13

$\frac{5a}{5} = \frac{13}{5}$ ∴ a = 2.6

Task 7.

Rearrange the following equations to calculate the subject shown:

a) $m = n \times M_m$

n = ...

b) n = c x V

c = ...

c) y = mx + c

m = ...

d) pV = nRT

n = ...

e) $E = ½mv^2$

v = ...

Units

The table below shows some of the common units you will be using in Chemistry calculations.

You should commit the SI units (shown in **bold**) to memory.

Quantity	Name of Unit	Symbol for Unit	Conversion factor
mass, m	tonne kilogram gram milligram	t kg **g** mg	I t = I 000 kg = I 000 000 g = I 000 000 000 mg
volume, V	cubic metre cubic decimetre cubic centimetre	**m^3** (for a **gas**) **dm^3** (for a **solution**) cm^3	I m^3 = I 000 dm^3 x ↓ ÷ ↑ = I 000 000 cm^3
pressure, p	megapascal kilopascal pascal	MPa kPa **Pa**	I MPa = I 000 kPa = I 000 000 Pa
temperature, T	Kelvin degrees Celsius	**K** ºC	273 K ↓ +273 = 0 °C
amount, n	mole	**mol**	
molar mass, M_m	grams per mole	g mol^{-1}	
concentration, c	moles per dm^3	**mol dm^{-3}**	

You may be given these quantities in different units and will need to be able to convert them.

When converting a measurement into a smaller unit the number will be larger. When converting to a larger unit the number will be smaller.

For example, when converting a mass from tonnes to grams

I t = I 000 000 g ∴ 2.5 t = I 000 000 x 2.5 = 2 500 000 g

Task 8.

Learn the SI units that are in bold in the table above.

Task 9.

Complete the following conversions

a) Masses

i) 2 kg = ……………………………… g   ii) 3.4 mg = …………………………….. g

iii) I.3 t = …………………………… g   iv) 0.50 g = ……………………………. mg

b) Volumes

i) 30 cm^3 = …………………………… dm^3 ii) 3 dm^3 = …………………………….. m^3

iii) 2 500 cm^3 = ……………………….. m^3 iv) 0.50 dm^3 = ……………………….. cm^3

c) Pressures

i) 3 MPa = ……………………………. Pa   ii) 20 kPa = …………………………… Pa

iii) 240 Pa = ………………………….. kPa   iv) 350 Pa = ………………………….. MPa

d) Temperatures

i) 25 °C = ……………………………… K   ii) I0 °C = ……………………………… K

iii) 300 K = …………………………….. °C   iv) 373 K = ……………………………. °C

Task 10.

Learn the conversions shown for mass, volume, pressure and temperature in the table on Page 24.

Tabulating data

https://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-PHBK.PDF (page 37 & 38)

It is important to keep a record of all data whilst carrying out practical work. It is good practice to draw a table before starting the experiment and then enter results straight into the table.

Tables should have clear headings with units.

Time / min	**Temperature / °C**
0	27.6
1	27.4
2	27.2

The independent variable is the left-hand column in a table, with the following columns showing the dependent variables.

All measurements should be written to the same number of decimal places (matching the precision of the measuring instrument).

https://www.bbc.co.uk/bitesize/guides/zcxp6yc/revision/1

https://www.bbc.co.uk/bitesize/guides/zcxp6yc/revision/6

Task 11.

Answer the following question.

A student was told to complete a practical to investigate how temperature affects the rate of a reaction.

The student carried out the reaction at five different temperatures and recorded the time taken for each.

The student then calculated the rate of reaction for each experiment using the equation:

$$\text{rate of reaction} = \frac{1}{\text{time}}$$

The student's results and calculations are shown below:

at 24.5 °C the experiment took 340 seconds — $1/340 = 0.0029\ s^{-1}$

at 39.0 °C it took 256 sec — $1/256 = 0.0039\ s^{-1}$

at 58.0 °C the experiment took 124 s — $1/124 = 0.0081\ s^{-1}$

80.5 °C 62 s — $1/62 = 0.0161$

51 °C 186 s — $1/186 = 0.0054$

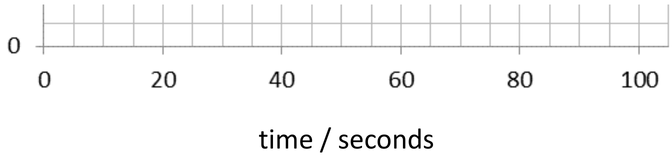
Tabulate the student's data in an appropriate manner.

……………………… / ……	……………………… / ……	……………………… / ……

Drawing a graph of the results obtained usually makes it easier to interpret the data and draw conclusions.

The independent variable is shown on the *x*-axis and the dependent variable is shown on the *y*-axis.

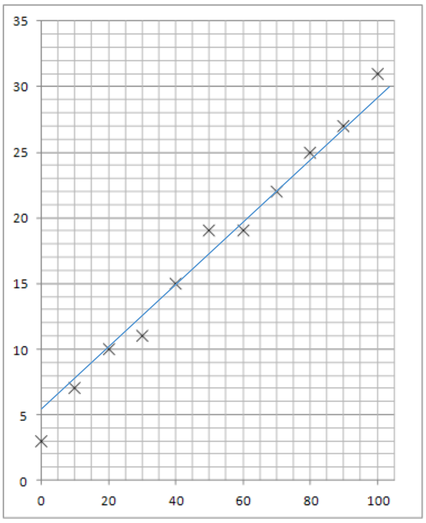
Axes should always be labelled with the quantity being measured and the units.

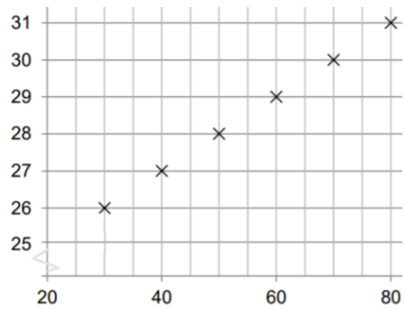


Data points should be marked with a cross, x.

When choosing the scales consider:

- the maximum and minimum values of each variable
- whether 0,0 should be included as a data point
- how to draw the axes without using difficult scale markings (e.g. multiples of 3, 7, etc)
- the data points should cover at **least half** of the grid supplied for the graph
  - this may require you to use a false origin (i.e. start the axis above 0)

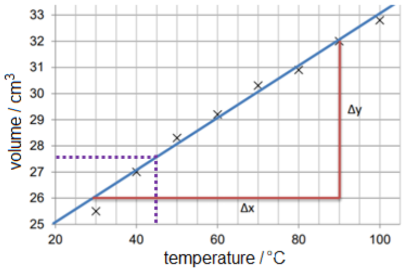




Consider the following when deciding where to draw a line of best fit:

- the line can be straight or curved
- the line should pass through, or very close to, the majority of plotted points (ignoring any anomalous points)
- for points not on the line make sure that there are as many points on one side of the line as the other
- the line should be continuous and drawn with a sharp pencil (use a rule for a straight line)
- the line will go through the origin (0,0) if a value of 0 for the independent variable would produce a value of 0 for the dependent variable

You may be asked to use the graph to find a value and/or to calculate the gradient.



For example:

at 45 °C the volume is 27.6 cm^3

$$\frac{(32 - 26)}{(90 - 30)} = \frac{6}{60} = 0.1\ \text{cm}^3 / °\text{C}$$

More information can be found at:

https://www.bbc.co.uk/bitesize/guides/z8fq6yc/revision/8

https://filestore.aqa.org.uk/resources/chemistry/AQA-7404-7405-PHBK.PDF (pages 48 - 55)

Task 12.

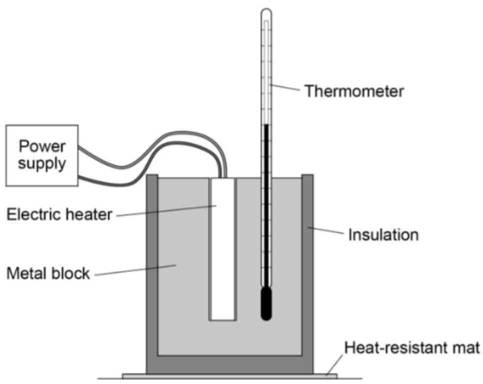
Answer the following question.

A student investigated how the temperature of a metal block changed with time.

An electric heater was used to increase the temperature of the block.

The heater was place in a hole drilled in the block as shown in **Figure 1.**

Figure 9



The student measured the temperature of the metal block every 60 seconds. **Table 3.** shows the student's results.

Table 3.

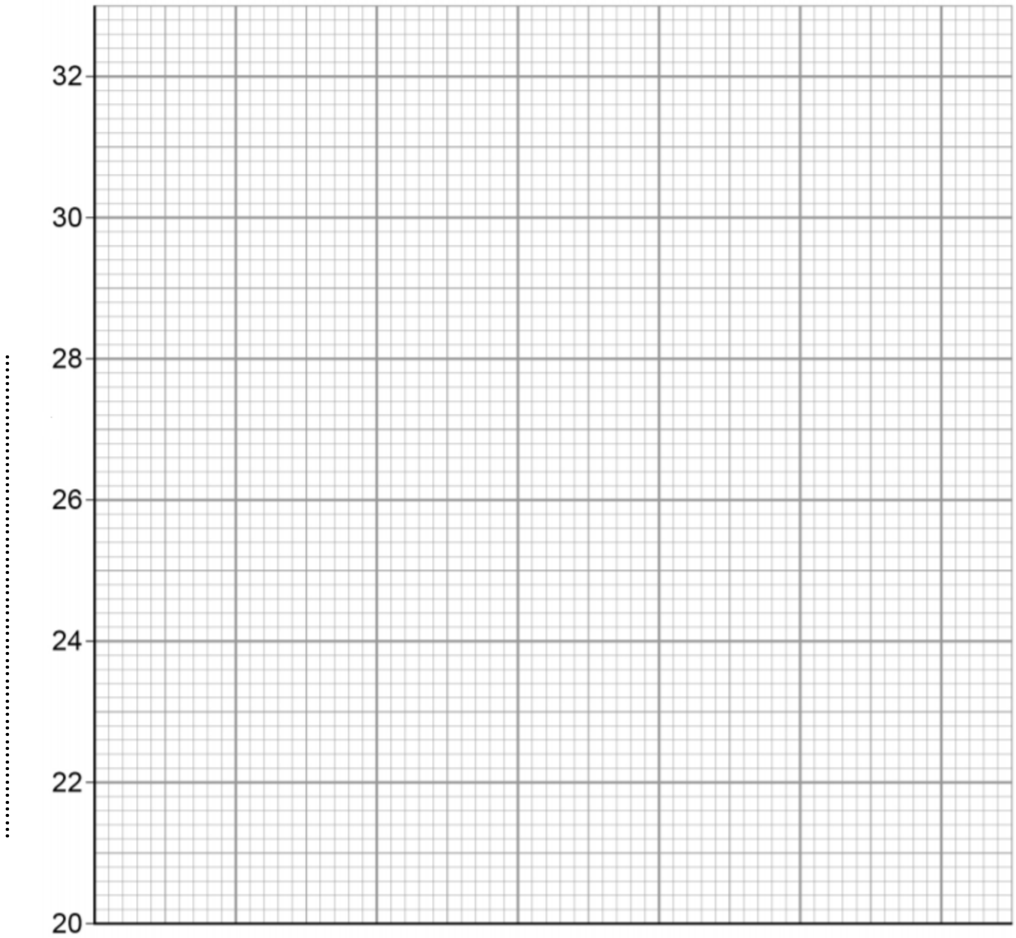
Time in s	Temperature in °C
0	20.0
60	24.5
120	29.0
180	31.0
240	31.5

(a) Complete the graph of the data from **Table 3.** on **Figure 2.**

- Choose a suitable scale for the x-axis.
- Label the x-axis and label the y-axis.
- Plot the student's results.
- Draw a line of best fit.

(5)

Figure 2.



…………………………………………………………..

(b) Use the graph to find the temperature of the metal block at time 100 s.

Temperature at 100s = …………. °C **(1)**

(c) The rate of change of temperature of the block is given by the gradient of the graph.
Determine the gradient of the graph over the first 60 seconds.

……….

……….

……….

……….

Gradient = …………………………. **(2)**