BTec National Extended Diploma in Applied Science

Summer Independent Learning

Y11-12

Part 1 – Compulsory Content

There are 3 sections to the compulsory content (**Biology**, **Physics** and **Chemistry**)

For each section.

1. Watch the videos and complete the notes – you may consider adding flashcards / condensed notes, so you can use them to test yourself (metacognition)
2. Complete the follow up application questions
3. Where available, correct and improve questions (mark scheme at the end of the document)

Part 2 – Highly Recommended

There are 3 sections to the highly recommended content (**Biology**, **Physics** and **Chemistry**)

Part 1 – Compulsory Content

BIOLOGY

Cells and Microscopy

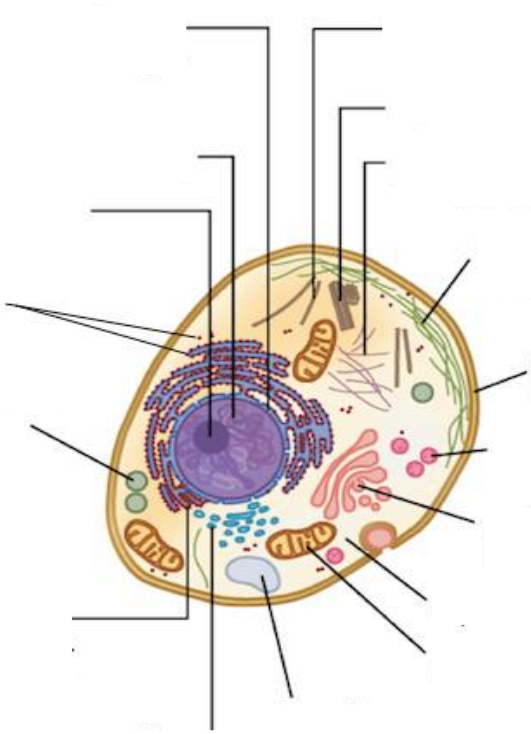
REVIEW

Use the resources below to support you with the questions

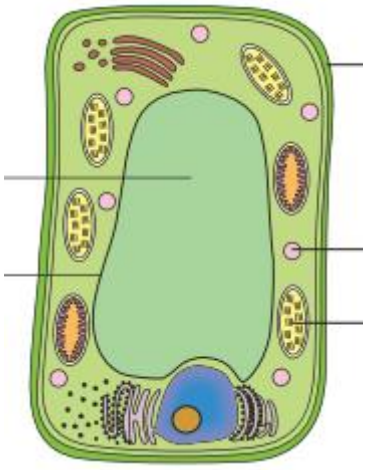
https://www.savemyexams.co.uk/gcse-biology-aqa-new/revision-notes/

Q1. Label the cells below

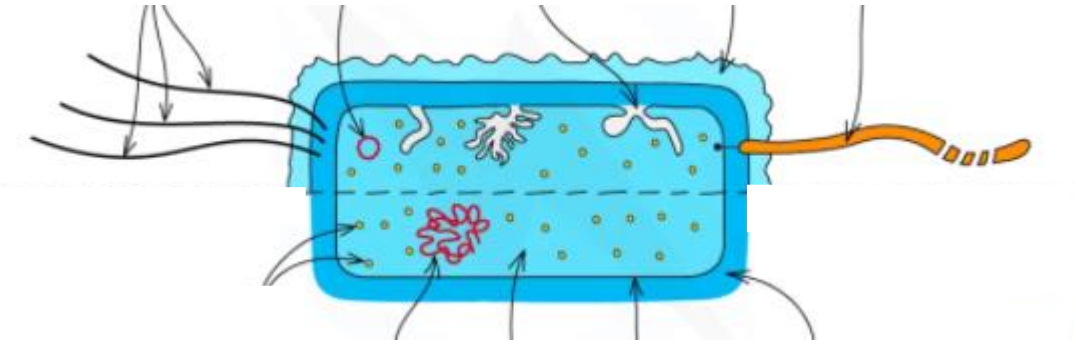
EUKARYOTIC CELL



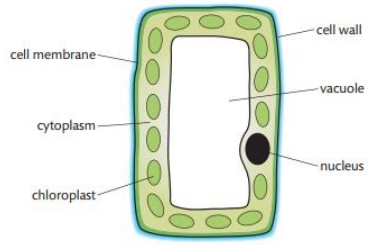
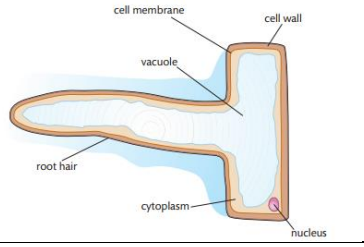
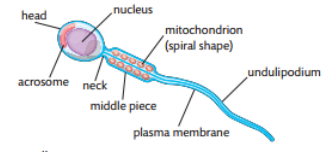
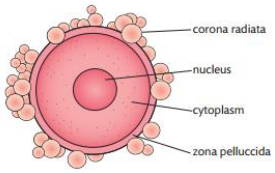
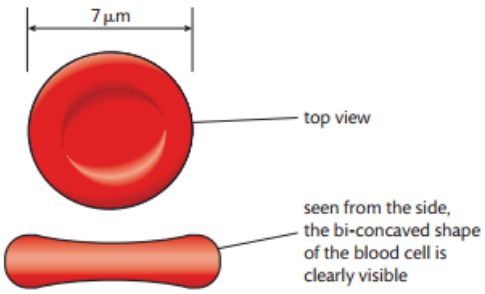
PLANT CELL

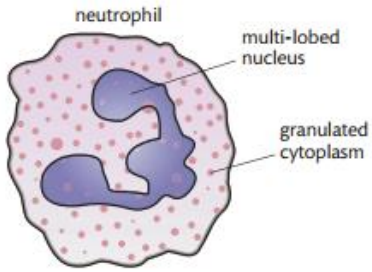


PROKARYOTIC CELL



Q2. Fill out the table with the strctures which make each specialised cell adapted to its function

Specialised Cell	Characteristics
PLANT CELL 	
ROOT HAIR CELL 	
SPERM CELLS 	
EGG CELL 	
RED BLOOD CELL 	

WHITE BLOOD CELL	
	

Microscopy

Q3. When a cell was viewed with a light microscope the image of the cell nucleus had a diameter of 12mm. The cell had been observed at a magnification of X 200. What was the actual size of the nucleus in µm?

_____

_____

Q4. A red blood cell has a diameter of 8 µm. A photograph of a red blood cell was taken using an optical microscope with a magnification of X 1000. What will the diameter of the cell be on the photograph in mm?

_____

_____

Q5. A chloroplast has a diameter of 2 µm. The image of a chloroplast observed using an optical microscope had a diameter of 20mm. What was the magnification of the microscope used?

_____

_____

Q6. If a measurement is given in mm how can it be converted to µm?

_____

_____

Q7. If a measurement is given in µm how can it be converted to mm?

_____

_____

Tissue Structure and Function

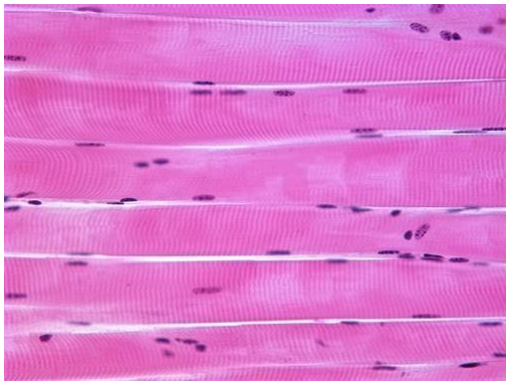
Epithelial Tissue

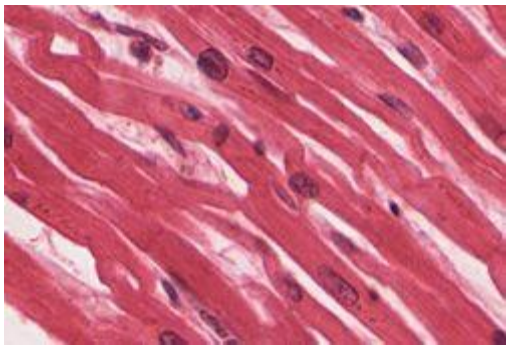
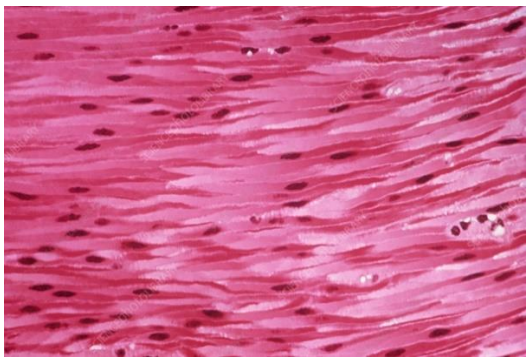
Q1. Draw a diagram below of each type of epithelial tissue and label the key structures

Type of epithelium	Diagram
Squamous	
Ciliated	

Muscle Tissue

Q2. Below are the three main types of muscle tissue. Describe where each is found.

Type of Muscle Tissue	Location
Skeletal 	

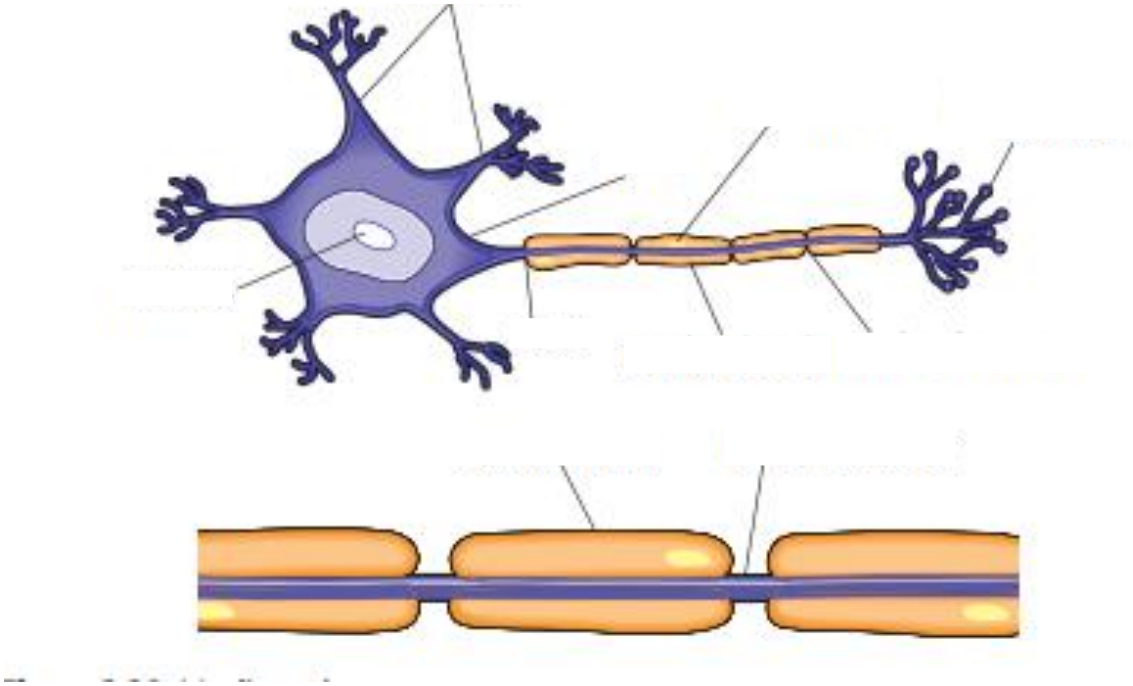
Cardiac 	
Smooth 	

Q3. List some of the key characteristics of fast twitch and slow twitch muscle fibres

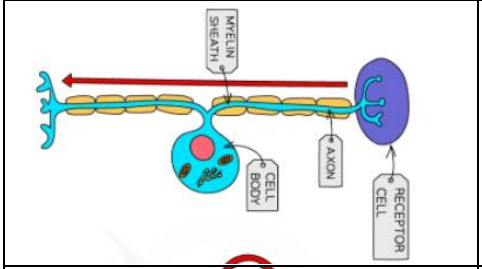
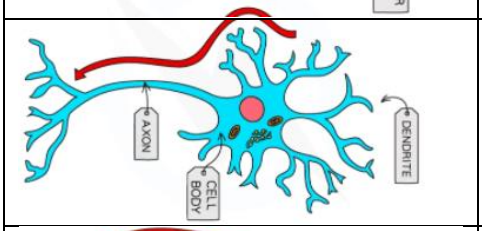
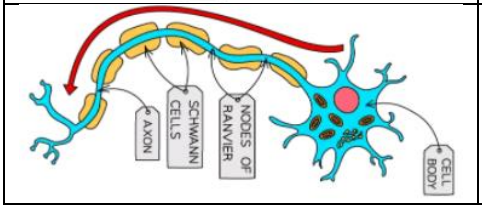
Fast Twitch	Slow Twitch

Nervous Tissue

Q4. Label the diagram of a neuron



Q5. Identify the different types of neuron shown below and describe their function

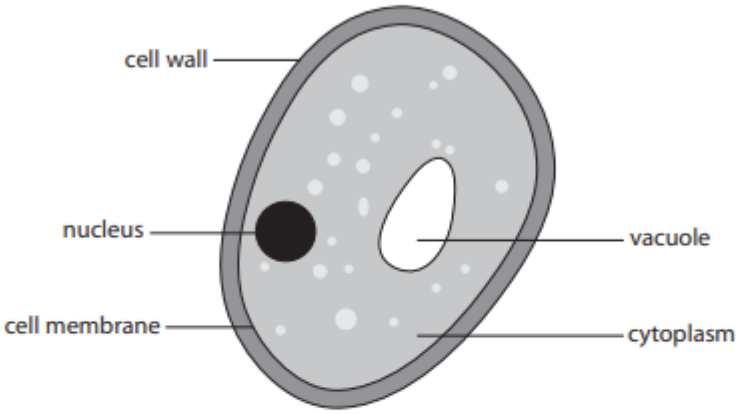
	Type of Neuron	Function
		
		
		

APPLY

Q1.

Yeasts are microorganisms that are used in the brewing and baking industries.

The diagram shows a yeast cell.



(a) (i) State **two** ways in which the structure of this yeast cell differs from the structure of a bacterial cell.

(2)

Q2.

Describe the functions of white blood cells.

(2)

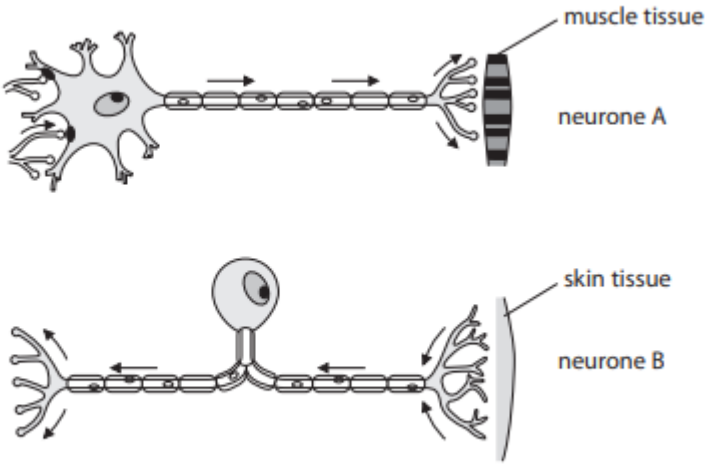
Person B has a low number of red blood cells compared to the healthy person.

Suggest an effect this may have on person B.

(1)

Q3.

The diagrams show the structure of two neurones A and B.



(a) Complete the sentences by putting a cross (☒) in the box next to your answer.

(i) Neurone A is a

(1)

- ☐ **A** motor neurone
- ☐ **B** reflex neurone
- ☐ **C** relay neurone
- ☐ **D** sensory neurone

(ii) Neurone B sends information to the

(1)

- ☐ **A** brain and spinal cord
- ☐ **B** hormones which results in a response
- ☐ **C** muscle tissue
- ☐ **D** receptor cells in the skin

(b) Explain how information travels along the axon of a sensory neurone.

(2)

(c) Describe the role of the myelin sheath.

(2)

PHYSICS –

NOTES (recall)

Watch the following videos and complete the notes on waves:

You may also wish to refer to BBC bitesize (link)

You don't need to include any derivations of formulae.

Wave basics (link)

1. Define a mechanical wave and provide two examples

_____

_____

_____

2. Define an electromagnetic wave and provide the names of two frequency bands

_____

_____

_____

3. Complete the sentence for the definition of waves

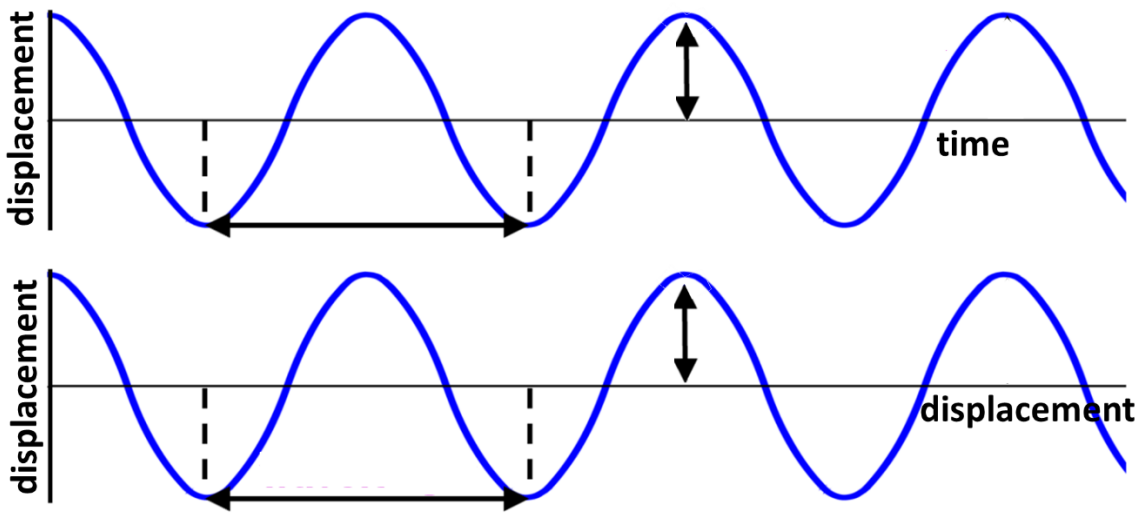
Waves transfer _____ without the transferring _____

Wavelength, Period, Amplitude and Phase Difference (link)

1. **a.** Complete the sentence for the **transverse** waves**:**

The oscillations of the medium are parallel / perpendicular to the direction of energy transfer.

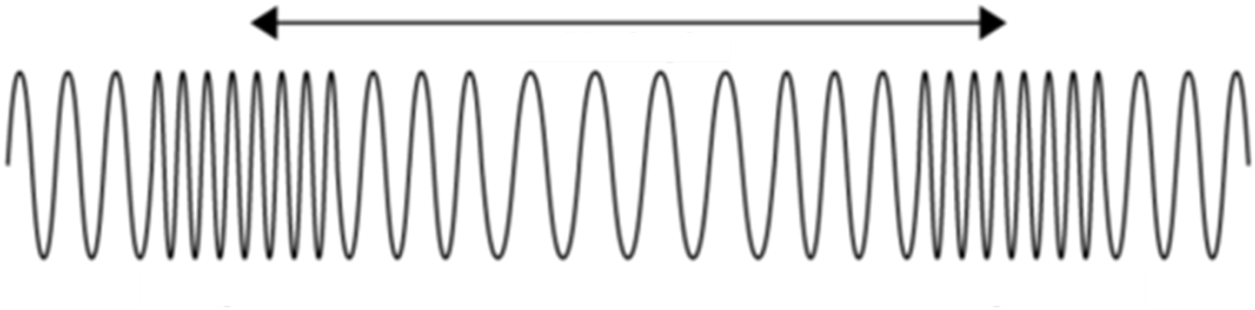
b. Add labels (wavelength, amplitude x2 and period) for the diagrams of **transverse** waves**:**



2. **a.** Complete the sentence for the **longitudinal** waves**:**

The oscillations of the medium are parallel / perpendicular to the direction of energy transfer.

b. Add labels (compression, rarefaction and wavelength) for the diagram of a **longitudinal** waves**:**



[try the simulation of a longitudinal wave https://ophysics.com/w5.html]

The wave equation (link)

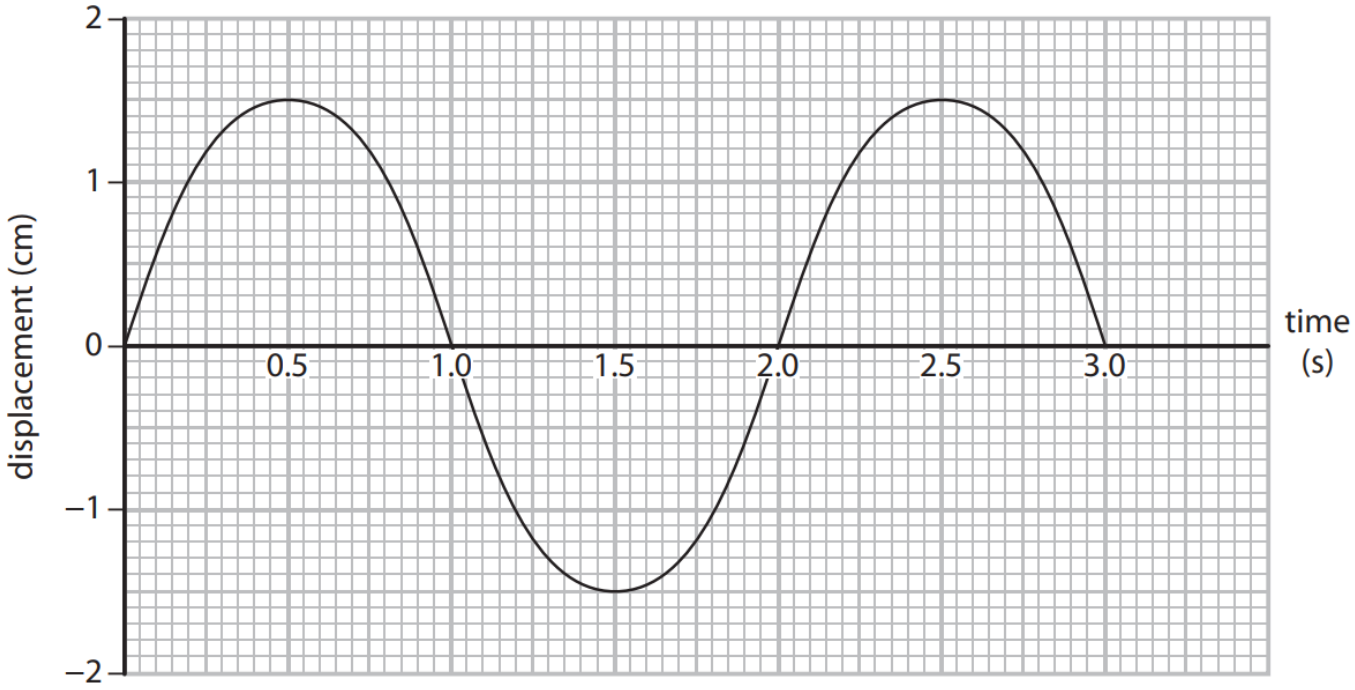
1. State the equation linking the frequency, f, (the number of cycles per second) and the time period of a wave, T (the time taken for a complete cycle).

2. Provide the unit for frequency _____

3. State the wave equation which links the wave speed, v, the frequency of a wave, f, and the period of the wave, T.

PTO

APPLY – QUESTIONS



Use the graph to answer the following questions:

1. Provide the amplitude of the wave.

2. Provide the time period of the wave.

3. Calculate the frequency of the wave.

4. Complete the missing values in the table below provided that $f = 1/T$:

f / Hz	T / s
	2
	5
	10
	2.8
	0.6
	36.5
	8×10^{-5}
	0.094
	86 400

f / Hz	T / s
4	
20	
50	
7.2	
0.005	
28	
7×10^{13}	
3200	
6.5×10^{-6}	

5. Complete the missing values in the table below provided $v = f \times \lambda$:

v / m/s	f / Hz	λ / m
	2	12
	125	20
	15	3
7		0.3
5		0.4
8		24
256	25	
330	450	
7500	350	

v / m/s	f / Hz	λ / m
	1.2	256
	360 000	0.0004
	2.9	5.7
400		1500
3.0×10^{8}		7.5×10^{-7}
3.8×10^{5}		0.25
215	525	
3.0×10^{8}	7×10^{14}	
0.036	57	

6. Provide two example calculations for the above showing your workings below.

Q1. (a) Which one of the following is not an electromagnetic wave?

Tick **one** box.

Gamma rays ☐ Ultraviolet ☐

Sound ☐ X-rays ☐

(1)

(b) What type of electromagnetic wave do our eyes detect?

_____

(1)

(c) What is a practical use for infrared waves?

Tick **one** box.

Cooking food ☐ Medical imaging ☐

Energy efficient lamps ☐ Satellite communications ☐

(1)

Scientists have detected radio waves emitted from a distant galaxy.

Some of the radio waves from the distant galaxy have a frequency of 1 200 000 000 hertz.

(d) Which is the same as 1 200 000 000 hertz?

Tick **one** box.

1.2 gigahertz ☐

1.2 kilohertz ☐

1.2 megahertz ☐

1.2 millihertz ☐

(1)

(e) Radio waves travel through space at 300 000 kilometres per second (km/s).

How is 300 000 km/s converted to metres per second (m/s)?

Tick **one** box.

300 000 ÷ 1000 = 300 m/s ☐

300 000 × 1000 = 300 000 000 m/s ☐

300 000 + 1000 = 301 000 m/s ☐

300 000 – 1000 = 299 000 m/s ☐

(1)

(f) Write the equation which links frequency, wavelength and wave speed.

_____

(1)

(g) Calculate the wavelength of the radio waves emitted from the distant galaxy.

Give your answer in metres.

_____

_____

_____

wavelength = _____ m

(3)

(Total 9 marks)

Q2. The figure below shows an incomplete electromagnetic spectrum.

A	microwaves	B	C	ultraviolet	D	gamma

(a) What name is given to the group of waves at the position labelled **A** in the figure above?
Tick **one** box.

infrared ☐ visible light ☐

radio ☐ X-ray ☐

(1)

(b) Electromagnetic waves have many practical uses.

Draw **one** line from each type of electromagnetic wave to its use.

Electromagnetic wave	Use
Gamma rays	For fibre optic communications
Microwaves	For communicating with a satellite
Ultraviolet	To see security markings
	To sterilise surgical instruments

(3)

(c) Complete the sentence.
Use an answer from the box.

black body	ionising	nuclear

X-rays can be dangerous to people because X-rays are

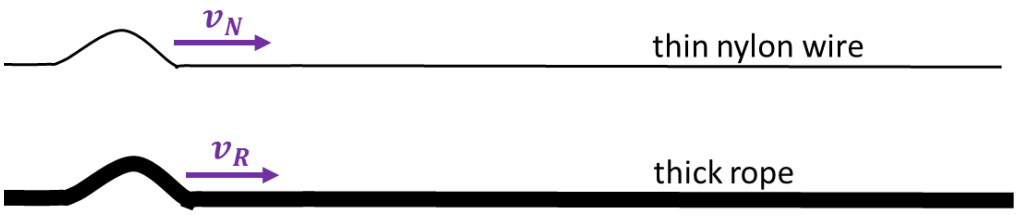
_____ radiation.

(1)(Total 5 marks)

WAVES ON A STRING UNDER TENSION

1. Wave pulses are sent along two wires subjected to the same tension. One wire is a thin nylon wire, the other is a thick rope. On which rope do you think pulses will move fastest?

_____



The equation for the speed, v, of a wave on a string on mass per unit length, μ, under a tension, T, is:	$v = \sqrt{\frac{T}{\mu}}$

2. Calculate the mass per unit length $\mu = m/l$, where, m, is the string mass and, l, is a given length for the two wires.

	m/kg	l/m	$\mu/\mathrm{kg/m}$
nylon wire	0.00080	2.0	
rope	0.0040	1.0	

3. Both strings are held with a tension of 4.0 N. Calculate the wave speed of:
   a. Pulses on the nylon wire.

   b. Pulses on the rope.

4 Did you answer agree with your prediction?

_____

5. The tension is increased to 8.0 N calculate the new wave speed for.
   a. Pulses on the nylon wire.

   b. Pulses on the rope.

6. Describe how increasing the tension changes the speed of a wave on a string.

_____

_____

WAVES IN COMMUNICATION

Electromagnetic waves enable devices to be connected and are the bedrock of modern communication. These wireless connections occur over multiple frequency bands.

Some methods of wireless information transfer are listed below

Using your existing knowledge, which of the frequency bands:

1. Communicate between a remote control and a television?

_____

2. Communicate between two mobile phones?

_____

3. Communicate between a satellite and a satellite dish?

_____

4. Communicate between a radio tower and an FM radio?

_____

5. Communicate between a wireless router and a laptop?

_____

6. Communicate between a mobile phone and some wireless earbuds?

_____

7. Has the longest wavelength?[1]

_____

8. Has the shortest wavelength?

_____

9. Is reflected by the ionosphere?

_____

[1] See more information at

NOTES (preview)

Watch the following videos and complete the notes on waves:

Optical fibres

Watch the video on refraction (link) optical fibres (link1, link2) and answer the following questions:

1. Link the correct term to the correct description:

Refraction		The spreading of a wave as it passes through a gap or a past an obstacle.
Reflection		The change in direction of a wave as it passes through the interface between two different materials.
Diffraction		The change in direction of a wavefront at an interface between two different media so that the wavefront returns into the medium from which it originated.

2. Describe total internal reflection

_____

_____

_____

3. Describe how total internal reflection is used in optical fibres.

_____

_____

_____

4. Sketch the path of one light ray as it propagates along an optical fibre.

CHEMISTRY

Unit 1: Principles and Applications of Science I

Answer all the questions. There are links to websites which you may find helpful.
You will be given a test on these concepts at the start of the term.

This unit covers some of the key science concepts in biology, chemistry and physics.

This section looks at some of the chemistry concepts you have covered at GCSE and will cover in more depth in Unit 1.

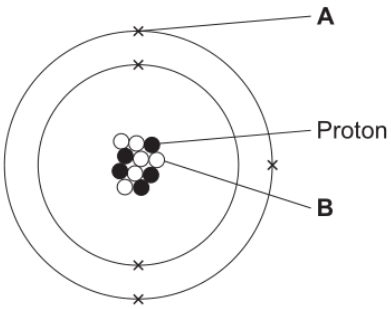
Periodicity and properties of elements

❑ Atomic Structure

https://www.bbc.co.uk/bitesize/guides/zwn8b82/revision/3 (pages 3,4 and 5)
https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Q1. Figure 1 shows an atom of element **G**.

Figure 1



Draw a ring around the correct answer to complete each sentence.

(a) Label **A** shows

an electron **an ion** **a nucleus** **(1)**

(b) Label **B** shows

an isotope **a molecule** **a neutron** **(1)**

(c) The atomic number of element **G** is

(d) The mass number of element **G** is

5 **6** **10** **11** **16** **(1)**

❑ Periodic Table

https://www.bbc.co.uk/bitesize/guides/ztv797h/revision/2 (pages 2-8)
https://www.rsc.org/periodic-table/

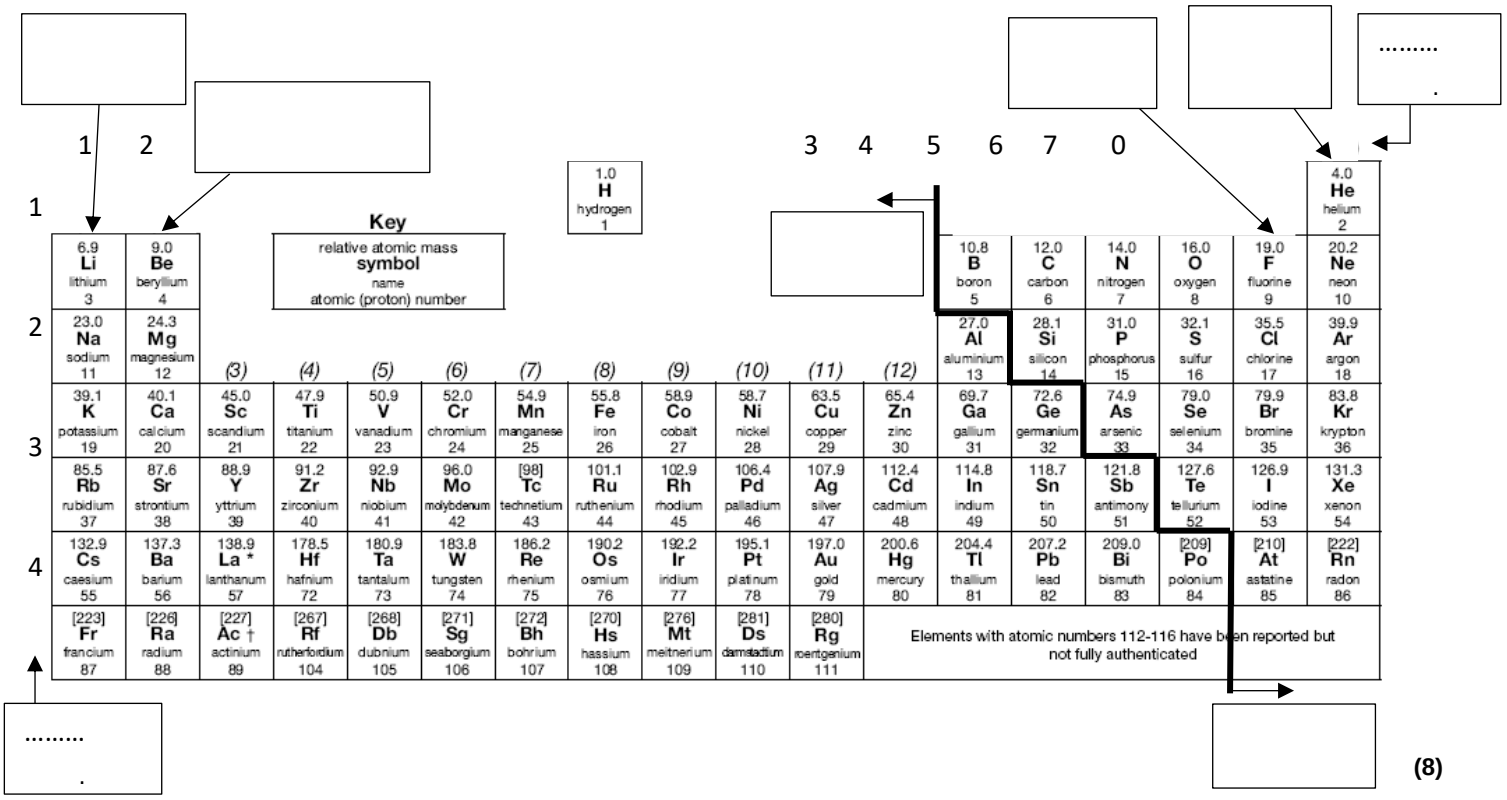
Q2. The Periodic table below contains **six** errors. Highlight these.

					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							

(6)

Q3. Complete the labels on the diagram below using the following terms:

metals **non-metals** **group** **period**
Noble gases **Alkaline-Earth metals** **Halogens** **Alkali metals**



(8)

Q4. Read the information below on element **X** carefully. Use this to help you answer the questions which follow.

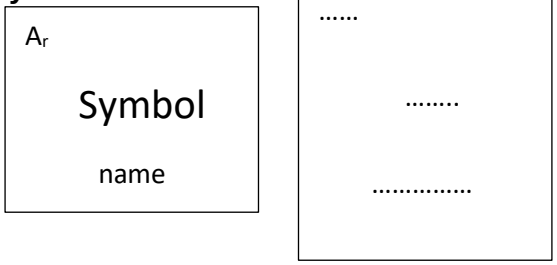
> Element **X** has two different isotopes, both of which contain 17 protons. The least abundant isotope contains 20 neutrons. The second isotope is three time more abundant and contains 2 more neutrons. All the atoms contain 2 electrons in the first shell, 8 electrons in the second shell and 7 electrons in the third.

(a) Where in the Periodic Table is element **X** found:

Group: …… Period: …… **(2)**

(b) Use the Periodic Table in **Q3.** the **key** and your answer to **Q4.(a)** to complete **Figure 2.** for element **X**

Key



(4)

(c) Is element **X** a metal or non-metal? …….. **(1)**

(d) Identify an element, in the same group as **X**, which has a lower boiling point than **X**.

…… **(1)**

❑ Chemical reactions and equations

https://www.bbc.co.uk/bitesize/guides/zy4pmsg/revision/1 (pages 1-6)
https://www.bbc.co.uk/bitesize/guides/z2bfxfr/revision/1 (pages 1,2)

Equations are used to show chemical reactions.
Reactants are written on the left of the arrow and products are written on the right.

For example:

ethane + oxygen → carbon dioxide + water (word equation)

C_2H_6 O_2 CO_2 H_2O

Atoms cannot be created or destroyed. They are simply rearranged. Therefore, the equation with formulae needs balancing. (You can only add more of the same molecules. You cannot change the formula of any.)

$2C_2H_6$ + $7O_2$ → $4CO_2$ + $6H_2O$ (balanced equation)

The relative formula mass of a molecule/compound (M_r) can be calculated by adding the A_r of all the atoms it contains. The A_r value for all elements can be found in the Periodic Table.

A_r of C is 12.0, A_r of H is 1.0 and A_r of O is 16.0

M_r of C_2H_6 = (2 x 12.0) + (6 x 1.0) = 30.0 M_r of O_2 = (2 x 16.0) = 32.0

M_r of CO_2 = 12.0 + (2 x 16.0) = 44.0 M_r of H_2O = (2 x 1.0) + 16.0 = 18.0

The total mass of the reactants = the total mass of the products

Mass of reactants = (2 x M_r C_2H_6) + (7 x M_r O_2) = (2 x 30.0) + (7 x 32.0) = 284.0

Mass of products = (4 x M_r CO_2) + (6 x M_r H_2O) = (4 x 44.0) + (6 x 18.0) = 284.0

Q5. Lithium reacts with water to form lithium hydroxide and hydrogen.

(a) Balance the symbol equation for this reaction

…… Li(s) + ……. H_2O(l) → …….. LiOH(aq) + H_2(g) **(1)**

(b) (i) Complete the table below for this reaction **(8)**

	Reactant or product	State	M_r
Lithium			
Water	reactant	liquid	18.0
Lithium hydroxide			
Hydrogen			

(ii) Calculate the total mass of the reactants. Are these the same as the total mass of the products? Show your workings.

……

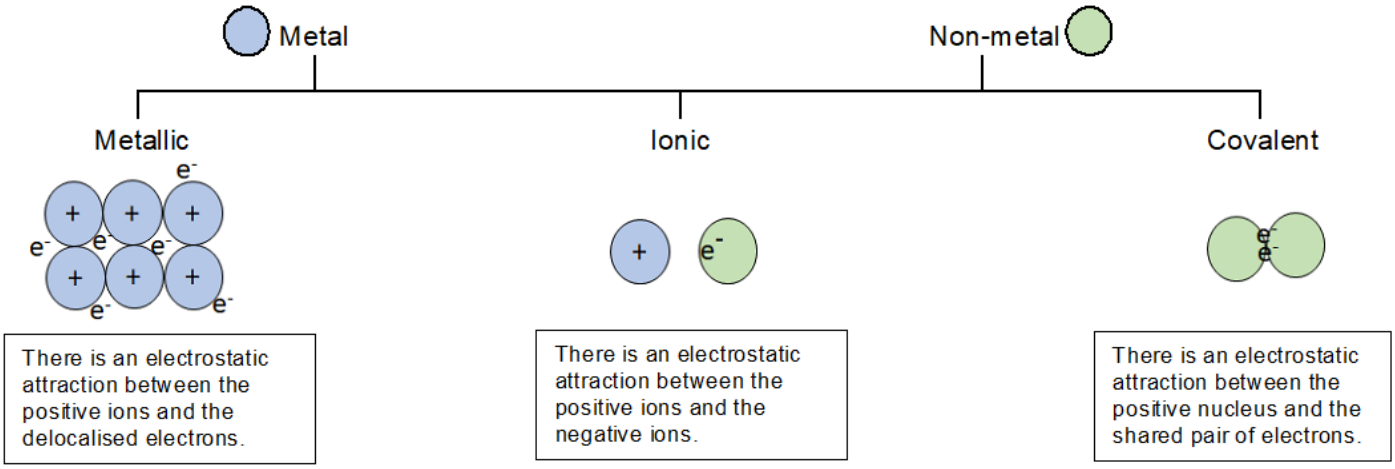
…… **(2)**

❑ Bonding

Chemical reactions involve the breaking and making of bonds. This involves electrons being transferred or shared between atoms.
The total number of electrons at the end of the reaction must be the same as at the start.
Metal atoms **lose** electrons and form **positively** charged **ions**.
Non-metal atoms **gain** electrons and form **negatively** charged ions
OR by **sharing** them (in pairs) with another non-metal atom

https://www.bbc.co.uk/bitesize/topics/z33rrwx (ionic compounds, small molecules, metals and alloys)

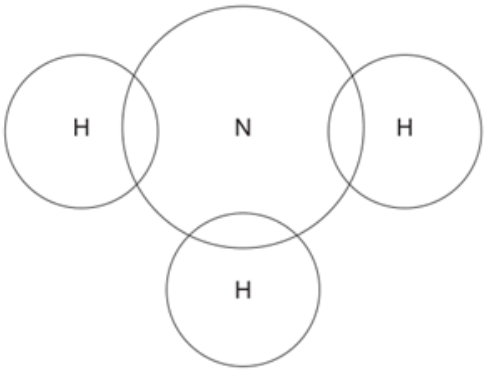
How do you know which type of bonding is present in an element or compound? Consider the type of element(s) it contains:



Q6. The electronic structure of a potassium atom is 2,8,8,1
Draw a diagram to show the electronic structure of a potassium ion. Show the charge on the ion.

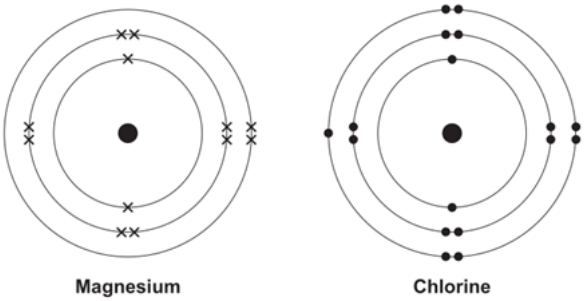
(2)

Q7. Complete the dot and cross diagram to show the electrons in the outer shells of ammonia, NH_3.
Use the periodic table to help you.



(2)

Q8. The diagrams shown an atom of magnesium and an atom of chlorine.



Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce Magnesium chloride, $MgCl_2$.
You may draw labelled diagrams.

……

……

……

……

……

……

……

…… **(4)**

Unit 2: Practical Scientific Procedures and Techniques

In this unit you will be required to complete a lot of practical procedures and so it is important that you know about laboratory safety.

❑ **Laboratory Safety**

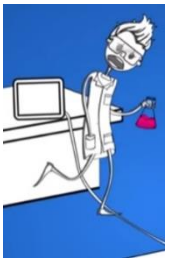
- Watch the video on safety in the laboratory: https://www.youtube.com/watch?v=RhlOYhOvCsQ

Use this to complete a list of safety rules to follow when completing any experiment.

1. ……
2. ……
3. ……
4. ……
5. ……
6. ……
7. ……
8. ……

(8)




You will be using a number of different chemicals and apparatus when completing these experiments.

- Follow the instructions provided to complete the table below on hazard symbols

i) Match the old hazard symbol to the new symbol.

ii) Match the new hazard symbol to the hazard name.
https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-secondary-safety-guidelines.pdf (page 22 and 23)

iii) List the precautions which should be taken (in addition to wearing a labcoat and safety glasses) when handling chemicals with these hazards to minimise the chance of an accident occurring.
https://www.acs.org/content/dam/acsorg/about/governance/committees/chemicalsafety/publications/acs-secondary-safety-guidelines.pdf (pages 38-40)

Old	New	Name	Precautions
		**harmful / irritant**	
		oxidising agent	
		flammable	
		harmful to the environment	
		corrosive	
		toxic	

(19)

❑ Practical techniques

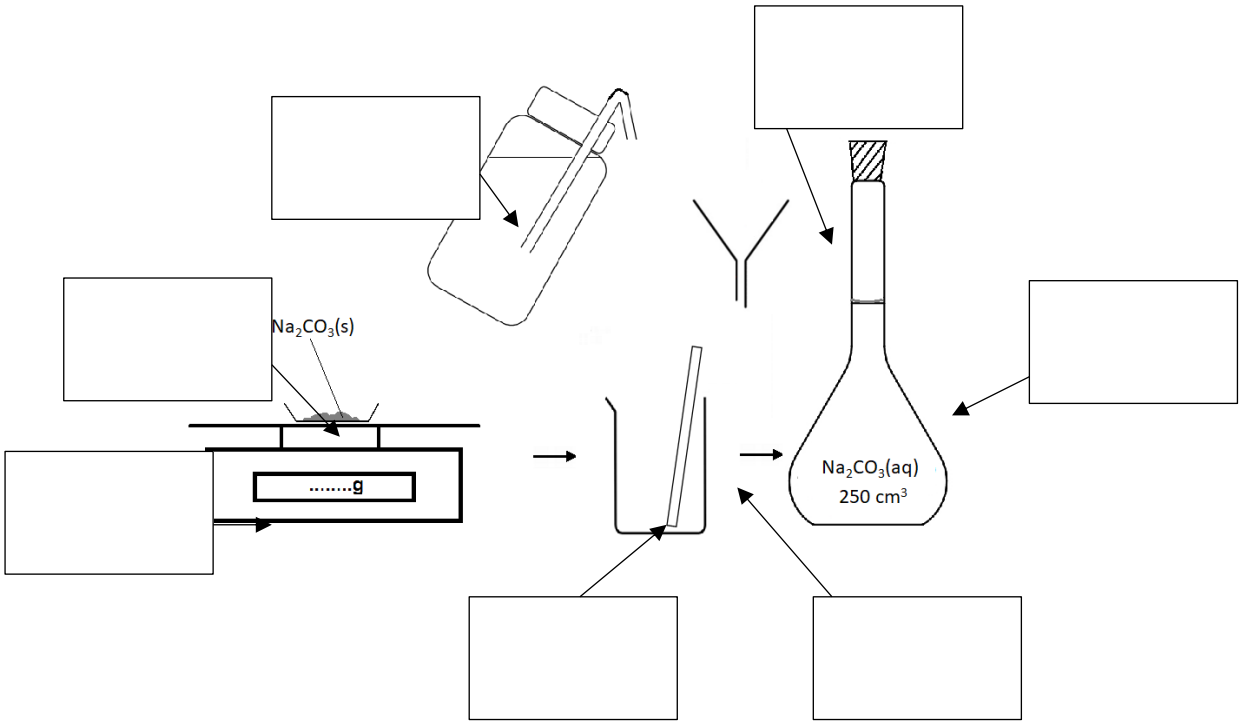
One of the practical techniques you will need to complete is the preparation of a standard solution and performing a titration to test the solution you have prepared.

- Watch these videos to help you answer the questions
  https://www.youtube.com/watch?v=xBKyjXUhJy0
  https://www.youtube.com/watch?v=rLc148UCT2w
  https://www.youtube.com/watch?v=gzvzvDv_BnA

Q1. (a) What is a standard solution? ……

……**(1)**

(b) The diagram below shows the apparatus used to make a standard solution of sodium carbonate. Complete the labels. **(7)**



(c) The standard solution prepared can be used to find the concentration of a solution of hydrochloric acid.

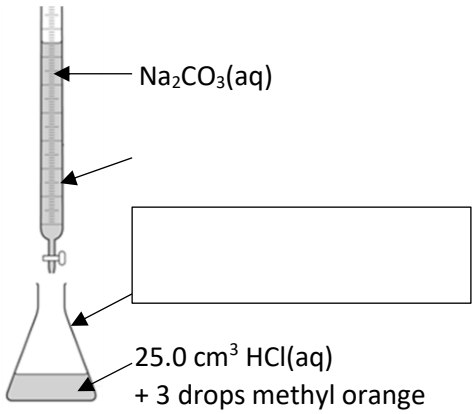
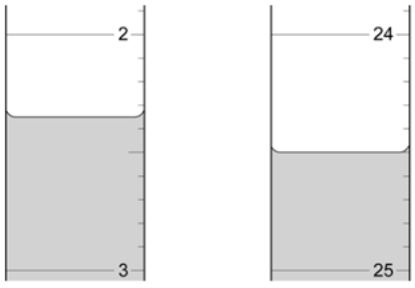


Figure 2.



(i) Complete the label to show name of the apparatus in which the acid is placed. **(1)**

(ii) What is the name given to this procedure? …… **(1)**

(iii) **Figure 2.** shows the level of the sodium carbonate solution in the burette at the start and the end of one titration. Use these to work out the volume of sodium carbonate added in the titration. Give your answer to 2 d.p.

Volume $Na_2CO_3(aq)$ added = …….. cm^3 **(1)**

Another practical technique you will need to complete is chromatography.

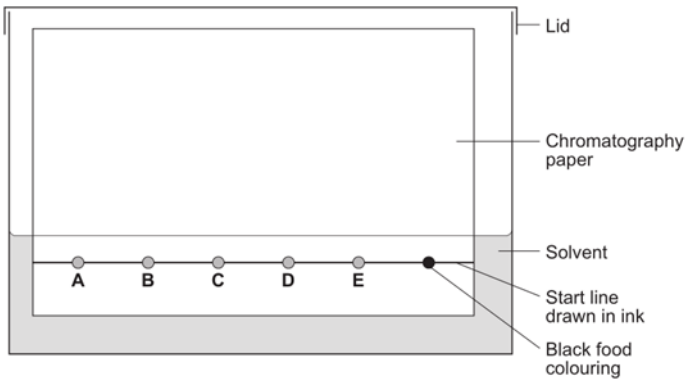
- The links below may help you to answer the questions on this technique.
  https://www.youtube.com/watch?v=lj5OWzhZSac
  https://www.bbc.co.uk/bitesize/guides/z9dfxfr/revision/4

Q2. (a) What is chromatography used for? …….

…….**(1)**

(b) A student used paper chromatography to analyse a black food colouring. They placed spots of known food colours, **A**, **B**, **C**, **D** and **E** and the black food colouring on a sheet of chromatography paper. They set up the apparatus as shown in **Diagram 1.**

Diagram 1



The student made **two** errors in setting up the apparatus. Identify the **two** errors and describe the problem each error would cause.

…….

…….

…….

…….

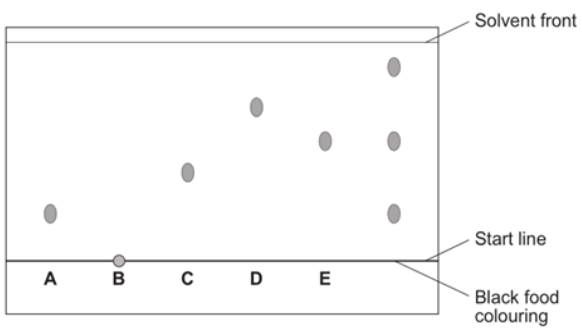
…….

…….

…… **(4)**

(c) A different student set up the apparatus without making any errors. The chromatogram in **Diagram 2.** shows the student's results.

Diagram 2



(i) What do the results tell you about the composition of the black food colouring?

……

……

……**(2)**

(ii) Use **Diagram 2.** to complete **Table 1.** **(2)**

Table 1.

	Distance in mm
Distance from start line to solvent front	
Distance moved by food colour **C**	

(iii) Use your answers in **(c)(ii)** to calculate the R_f value for food colour **C**. Show your workings.

R_f value = …… **(1)**

(iv) **Table 2.** gives the results of chromatography experiments that were carried out on some known food colours, using the same solvent as the students.

Table 2.

Name of food colour	**Distance from start line to solvent front in mm**	**Distance moved by food colour in mm**	**R_f value**
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

Which of the food colours in **Table 2.** could be food colour **C** from the chromatogram? Give the reason for your answer.

……

……

…….…….. **(2)**

❑ Obtaining and analysing results obtained in an experiment

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

Q3. 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, in s^{-1} 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

(a) What is the independent variable in this experiment? Circle the correct answer

rate of reaction **time** **temperature** **(1)**

(b) Tabulate the student's data in an appropriate manner. **(4)**

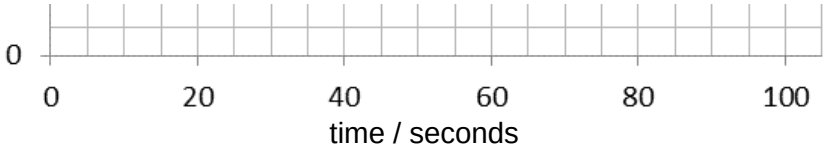
……. / …..	…….. / …….	……. / ……

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

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.

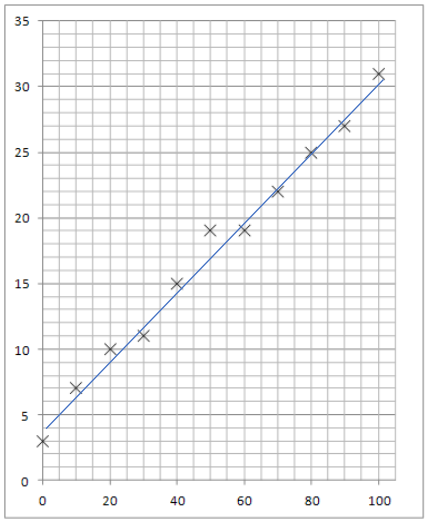
Axes should always be labelled with the quantity being measured and the units.



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.



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

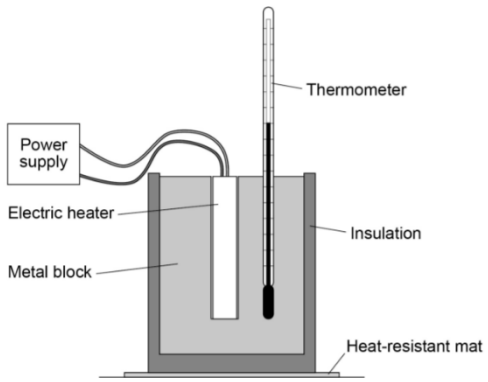
- the line can be straight or curved
- the line should pass through, or very close to, the majority of plotted points (ignoring any anomalous points)
- for points not on the line make sure that there are as many points on one side of the line as the other
- the line should be continuous and drawn with 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

Q4. 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.

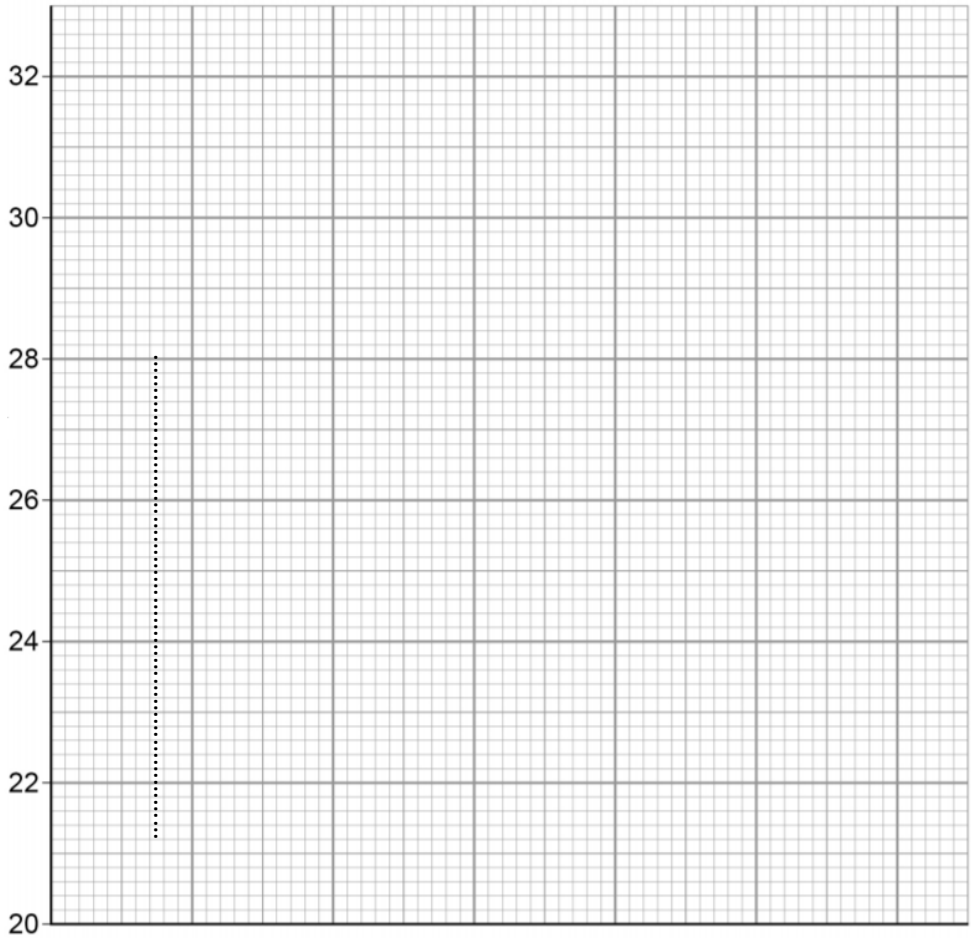
Table 3.

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 = …… °C / s **(2)**

Part 2 – Highly Recommended

BIOLOGY –

Use the resources below to support you in answering the questions

Cell Structure and Function

Muscle Contraction

Nerve Transmission

Cell Structure and Function

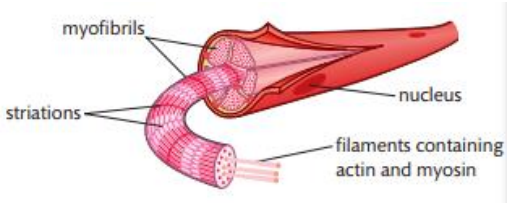
Q1. Complete the table below with the functions of each structure in the eukaryotic cell

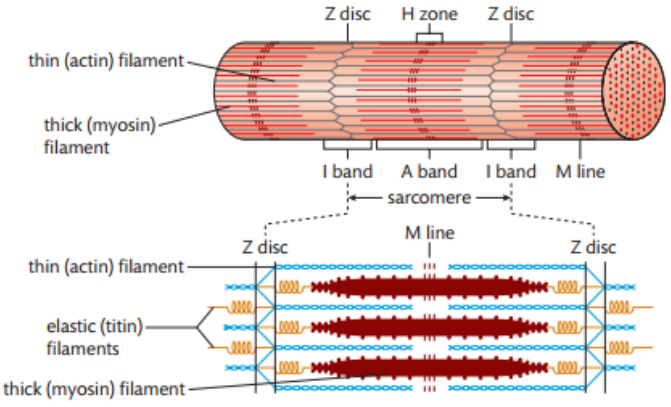
Structure	Function
Plasma Membrane	
Cytoplasm	
Nucleus	
Nucleolus	
Rough Endoplasmic Reticulum	
Smooth Endoplasmic Reticulum	

Golgi Apparatus	
Vesicles	
Lysosomes	
Ribosomes	
Mitochondria	
Centrioles	

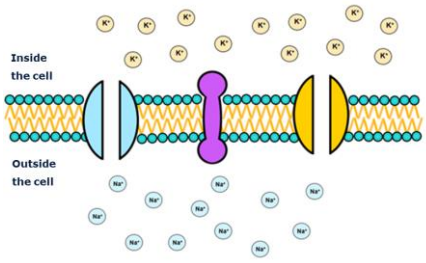
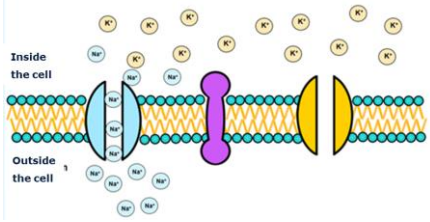
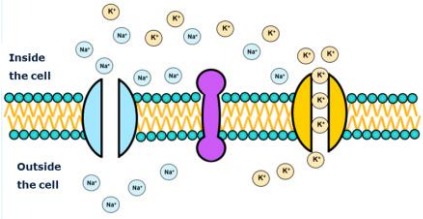
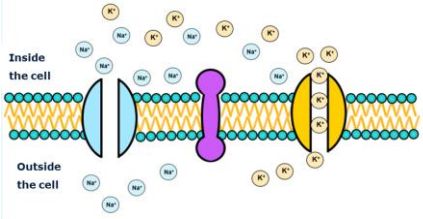
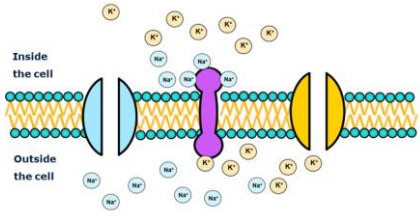
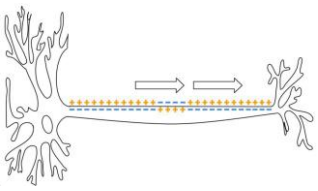
Tissue Structure and Function

Q2. With the aid of the diagram below, describe the process of muscle contraction





Q3.Complete the flowchart with descriptions of each stage of nerve signal transmission

Stage		Description
Resting Potential		
Depolarisation		
Action Potential		
Repolarisation		
Hyperpolarisation		
Nerve Transmission		

PHYSICS –

RESEARCH (preview)

Research the use of optical fibres in medicine with endoscopes:

Use the following resources to help you:

Pages 29-31

How an endoscope works. An outline of things you can include in your description is below:

- A diagram of an endoscope
- Two uses of endoscopes in medicine or other applications
- How total internal reflection is used in endoscopy
- How the object is illuminated with the endoscope
- How the image from the object is propagates to the detector
- How bundles of fibres are used in endoscopy
- How the design of an endoscope affects the resolution of the image

_____

_____

_____

_____

CHEMISTRY –

Make notes from the following resources, then have a go at completing the questions

Titrations and mole calculations

https://www.bbc.co.uk/bitesize/guides/zx98pbk/revision/3

https://www.youtube.com/watch?v=wPGVQu3UXpw

https://www.youtube.com/watch?v=ovx-Sro4NXM

Q1. This question is about acids and alkalis.

(a) Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

_____

_____

_____

_____

(2)

A student titrated 25.0 cm^3 portions of dilute sulfuric acid with a 0.105 mol/dm^3 sodium hydroxide solution.

(c) The table below shows the student's results.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of sodium hydroxide solution in cm^3	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:

$$2\ NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2\ H_2O$$

Calculate the concentration of the sulfuric acid in mol/dm^3

Use only the student's concordant results.

Concordant results are those within 0.10 cm^3 of each other.

Concentration of sulfuric acid = _____ mol/dm^3

(5)

(d) Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

(2)

(e) Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): NaOH = 40

Mass of sodium hydroxide = _____ g

(2)

(Total 12 marks)

Q2. A student investigated the reactions of copper carbonate and copper oxide with dilute hydrochloric acid.

In both reactions one of the products is copper chloride.

(a) Describe how a sample of copper chloride crystals could be made from copper carbonate and dilute hydrochloric acid.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(b) A student wanted to make 11.0 g of copper chloride.

The equation for the reaction is:

$$CuCO_3 + 2HCl \rightarrow CuCl_2 + H_2O + CO_2$$

Relative atomic masses, A_r: H = 1; C = 12; O = 16; Cl = 35.5; Cu = 63.5

Calculate the mass of copper carbonate the student should react with dilute hydrochloric acid to make 11.0 g of copper chloride.

_____

_____

_____

_____

Mass of copper carbonate = _____ g

(4)

(c) The percentage yield of copper chloride was 79.1 %.

Calculate the mass of copper chloride the student actually produced.

_____

_____

Actual mass of copper chloride produced = _____ g

(2)

SOLUTIONS

SOLUTIONS TO BIOLOGY

Q1.

Any **two** of the following points: (yeast cell) • has a nucleus (1) • does not have a flagellum (1) • does not have a plasmid (1) (bacterial cell) • has chromosomal DNA / circular DNA (1) • has a capsule (1) • has a slime coat (1) • does not have mitochondria (1)	Accept: has a vacuole accept: named bacterial feature e.g pilli, small ribosome, if not labelled in yeast cell	**(2)**

Q2.

Answer	Acceptable answers	Mark
A description including any **two** of the following points: • involved in defence against disease / part of immune system (1) • phagocytosis (1) • antibody / antitoxin production (1)	accept: (fight pathogen / harmful microorganism / named microorganism) accept: engulf / ingest / surround /digest cells reject: make antigens ignore: refs to role of red blood cells or platelets	**(2)**

Answer	Acceptable answers	Mark
tired / lack of energy / lethargy / short of breath	anaemia /fainting / less oxygen / increased anaerobic respiration reject: references to asthma	**(1)**

Q3.

Answer	Acceptable answers	Mark
A		**(1)**

Answer	Acceptable answers	Mark
A		**(1)**

Answer	Acceptable answers	Mark
an explanation linking the following • from receptor (cells) / sense organ (1) • to the {brain / spinal cord / CNS / synapse / other neurone}(1) • as an electrical impulse (1)	Accept named sense organ electrical message/signal Ignore references to current	**(2)**

Answer	Acceptable answers	Mark
a description including **two** of the following • insulates (electrical signal) (1) • the axon (1) • speeds up the impulse (1)	ignore protects / protection accept message / signal for impulse	**(2)**

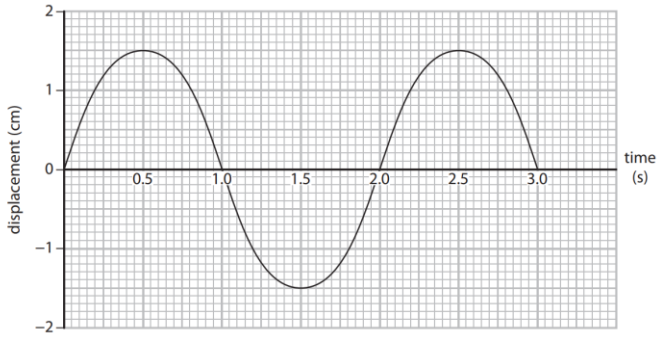
SOLUTIONS TO PHYSICS

Use the graph to answer the following questions:

1. Provide the amplitude of the wave.

2. Provide the time period of the wave.

3. Calculate the frequency of the wave.



4.

f / Hz	T / s
0.50	2
0.20	5
0.027	10
0.36	2.8
1.67	0.6
0.027	36.5
12 500	8×10^{-5}
10.64	0.094
1.16×10^{-5}	86 400

f / Hz	T / s
4	**0.25**
20	**0.05**
50	**0.02**
7.2	**0.14**
0.005	**200**
28	**0.036**
7×10^{13}	**1.4×10^{-14}**
3200	**3.2×10^{-4}**
6.5×10^{-6}	**154 000**

5.

v / m/s	f / Hz	λ / m
24	2	12
2500	125	20
45	15	3
7	**23.3**	0.3
5	**12.5**	0.4
8	**0.33**	24
256	25	**10.24**
330	450	**0.73**
7500	350	**21.4**

v / m/s	f / Hz	λ / m
307.2	1.2	256
144	360 000	0.0004
16.5	2.9	5.7
400	**0.27**	1500
3.0×10^{8}	**4×10^{14}**	7.5×10^{-7}
3.8×10^{5}	**1.5×10^{6}**	0.25
215	525	**0.41**
3.0×10^{8}	7×10^{14}	**4.3×10^{-7}**
0.036	57	**6.3×10^{-4}**

Exam style questions

Q1. (a) sound

1

(b) (visible) light

1

(c) cooking food

1

(d) 1.2 gigahertz

1

(e) 300 000 × 1000 = 300 000 000 m/s

1

(f) wave speed = frequency × wavelength

allow v = f λ

1

(g) 300 000 000 = 1200 000 000 × λ

*an answer of 0.25 scores **3** marks*

1

$$\lambda = \frac{300\,000\,000}{1\,200\,000\,000}$$

*allow ecf from **(e)***

1

λ = 0.25 (m)

1

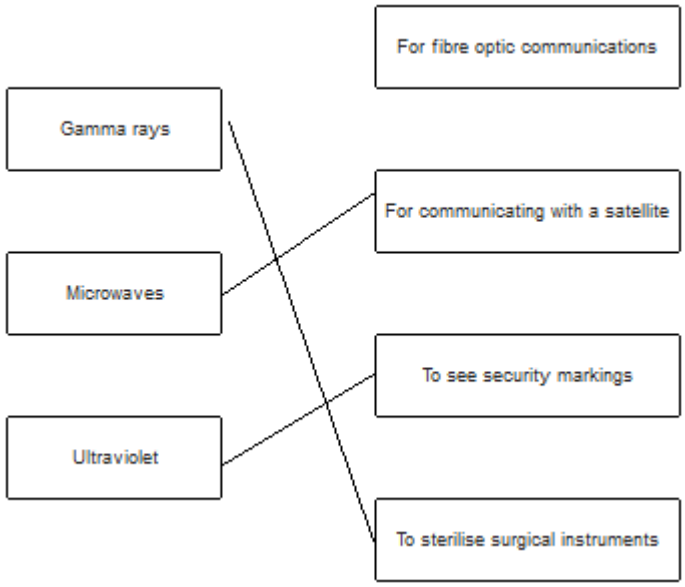
[10]

Q2.

(a) radio

1

(b)



*award **1** mark for each correct line*
if more than one line is drawn from any em wave then none of those lines gain credit

3

(c) ionising

1

[5]

SOLUTIONS TO CHEMISTRY

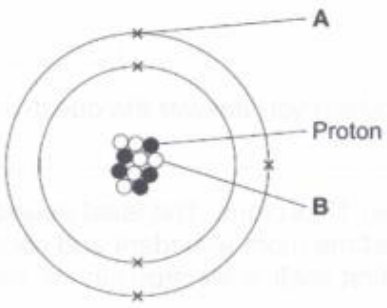
Periodicity and properties of elements

❑ Atomic Structure

https://www.bbc.co.uk/bitesize/guides/zwn8b82/revision/3 (pages 3,4 and 5)
https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html

Q1. Figure 1 shows an atom of element **G**.

Figure 1



Draw a ring around the correct answer to complete each sentence.

(a) Label **A** shows

an electron **an ion** **a nucleus** (1)

(b) Label **B** shows

an isotope **a molecule** **a neutron** (1)

(c) The atomic number of element **G** is

5 **6** **10** **11** **16** = number of protons (1)

(d) The mass number of element **G** is

5 **6** **10** **11** **16** 5 protons + 6 neutrons (1)

❑ Periodic Table

https://www.bbc.co.uk/bitesize/guides/ztv797h/revision/2 (pages 2-8)
https://www.rsc.org/periodic-table/

Q2. The Periodic table below contains **six** errors. Highlight these.

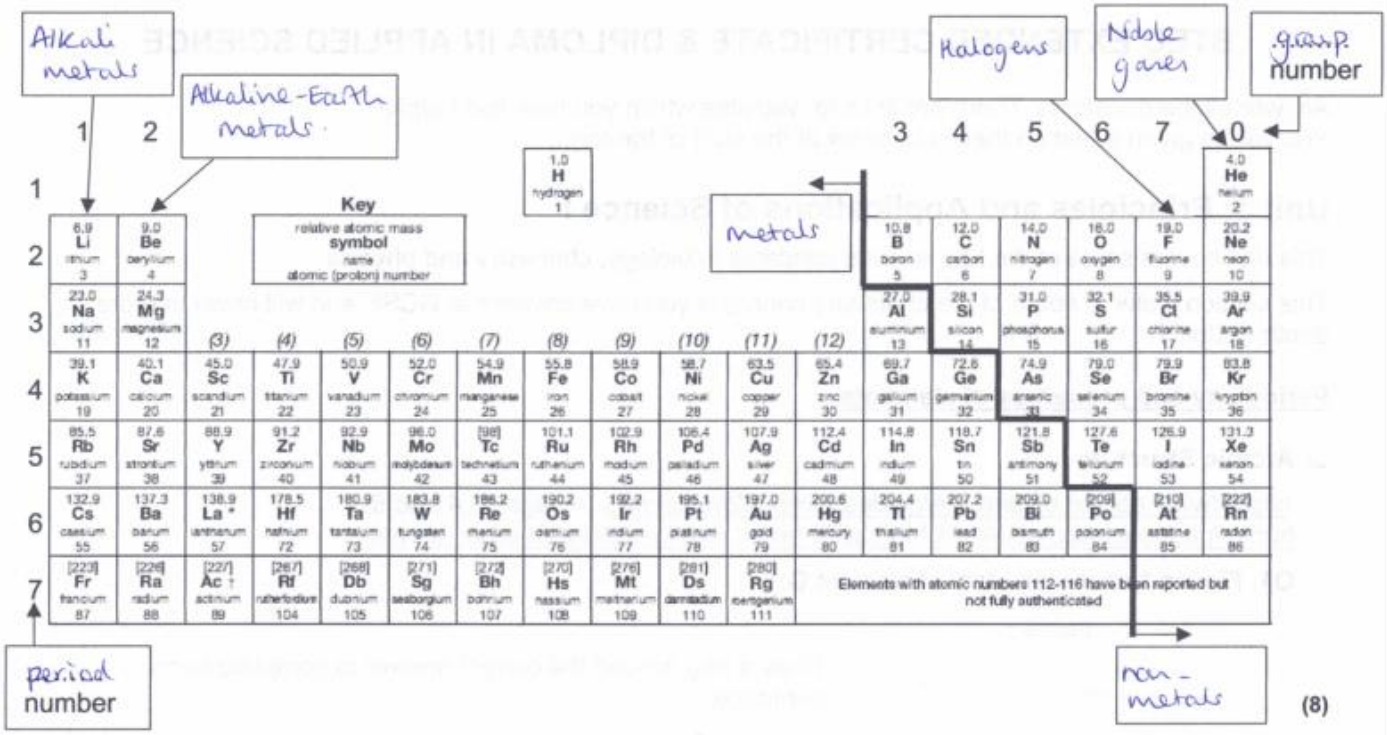
CAPITAL then lower case

							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							

(6)

Q3. Complete the labels on the diagram below using the following terms:

metals	**non-metals**	**group**	**period**
Noble gases	**Alkaline-Earth metals**	**Halogens**	**Alkali metals**



(8)

Q4. Read the information below on element **X** carefully. Use this to help you answer the questions which follow.

> Element **X** has two different isotopes, both of which contain 17 protons. The least abundant isotope contains 20 neutrons. The second isotope is three time more abundant and contains 2 more neutrons. All the atoms contain 2 electrons in the first shell, 8 electrons in the second shell and 7 electrons in the third.

(a) Where in the Periodic Table is element **X** found:

Group: ....7.... Period: ....3.... **(2)**

(b) Use the Periodic Table in **Q3.** the **key** and your answer to **Q4.(a)** to complete **Figure 2.** for element **X**

Figure 2

Key

A_r

Symbol

name

Z

35.5

Cl

chlorine

17

(4)

(c) Is element **X** a metal or non-metal? ....non-metal.... **(1)**

(d) Identify an element, in the same group as **X**, which has a lower boiling point.

....Fluorine.... **(1)**

Q5. Lithium reacts with water to form lithium hydroxide and hydrogen.

(a) Balance the symbol equation for this reaction

..2.. Li(s) + ...2.. H_2O(l) → ...2... LiOH(aq) + H_2(g) **(1)**

(b) (i) Complete the table below for this reaction **(8)**

	Reactant or product	State	M_r
Lithium	reactant	solid	
Water	reactant	liquid	18.0
Lithium hydroxide	product	aqueous (solution)	23.9
Hydrogen	product	gas	2.0

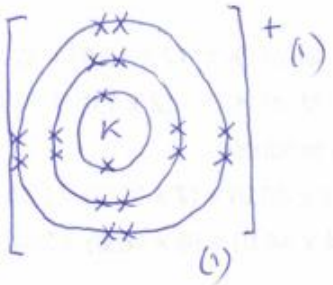
(ii) Calculate the total mass of the reactants. Are these the same as the total mass of the products? Show your workings.

...(2 x 6.9) + (2 x 18.0) = 49.8 ..... total mass of reactants ..... (1) ..

..(2 x 23.9) + 2.0 = 49.8 ... total mass of products .... : .... Yes, they are the same. (1) **(2)**

Q6. The electronic structure of a potassium atom is 2,8,8,1
Draw a diagram to show the electronic structure of a potassium ion. Show the charge on the ion.

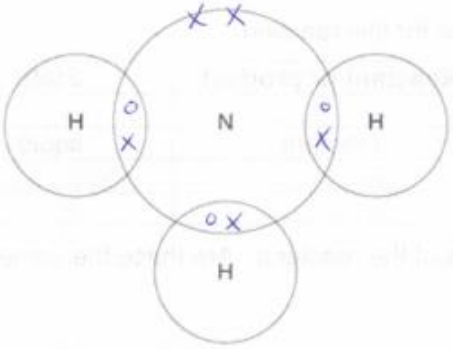
lost the 1 outer e⁻



(2)

Q7. Complete the dot and cross diagram to show the electrons in the outer shells of ammonia, NH_3.
Use the periodic table to help you.

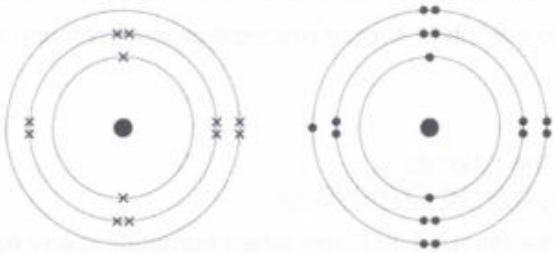
3 x (H)



5 x (1)
3 o
sharing 3 pairs (1)

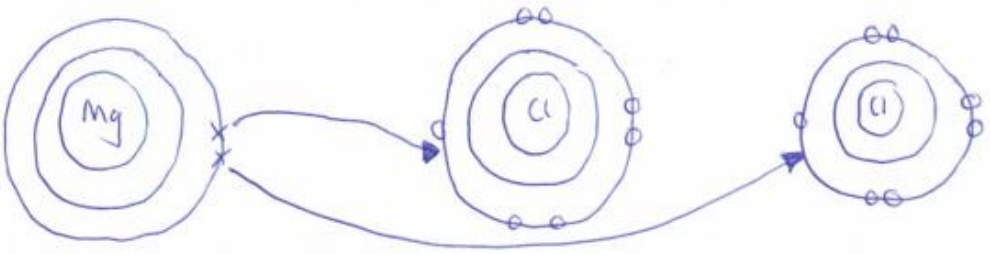
(2)

Q8. The diagrams shown an atom of magnesium and an atom of chlorine.



Magnesium Chlorine

Describe, in terms of electrons, how magnesium atoms and chlorine atoms change into ions to produce Magnesium chloride, $MgCl_2$.
You may draw labelled diagrams.



One Mg atom loses 1 e^- (1) to one Cl atom

It loses a 2nd e^- (1) to a 2nd Cl (1) atom

Mg forms the Mg^{2+} ion and each Cl forms a Cl^- ion

Unit 2: Practical Scientific Procedures and Techniques

In this unit you will be required to complete a lot of practical procedures and so it is important that you know about laboratory safety.

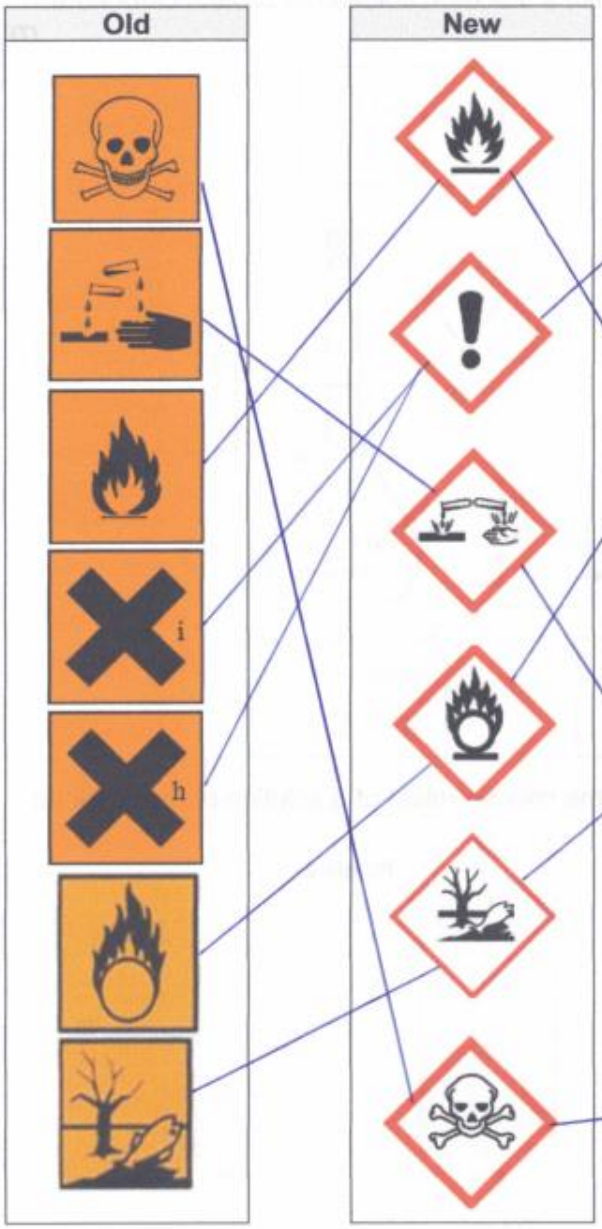
❑ Laboratory Safety

- Watch the video on safety in the laboratory:
  https://www.youtube.com/watch?v=RhlOYhOvCsQ

  Use this to complete a list of safety rules to follow when completing any experiment.

1. Wear a lab coat (buttoned up)
2. Wear safety glasses / goggles
3. Tie back long hair (particularly when using a Bunsen burner)
4. Write a risk assessment (before you complete the practical)
5. Keep the lab tidy
6. Wipe up spillages
7. Do not eat (or drink or chew gum) in the lab
8. Wash your hands (particularly before you leave the lab)

(8)



Name	Precautions
harmful / irritant	wear glaves well-ventilated laboratory
oxidising agent	No naked (open) flame or source of ignition
flammable	No naked (open) flame or source of ignition.
harmful to the environment	Don't pour down the sink
corrosive	wear glaves
toxic	wear glaves Use a fume cupboard

(19)

always wear lab coat + glaves.

❑ Practical techniques

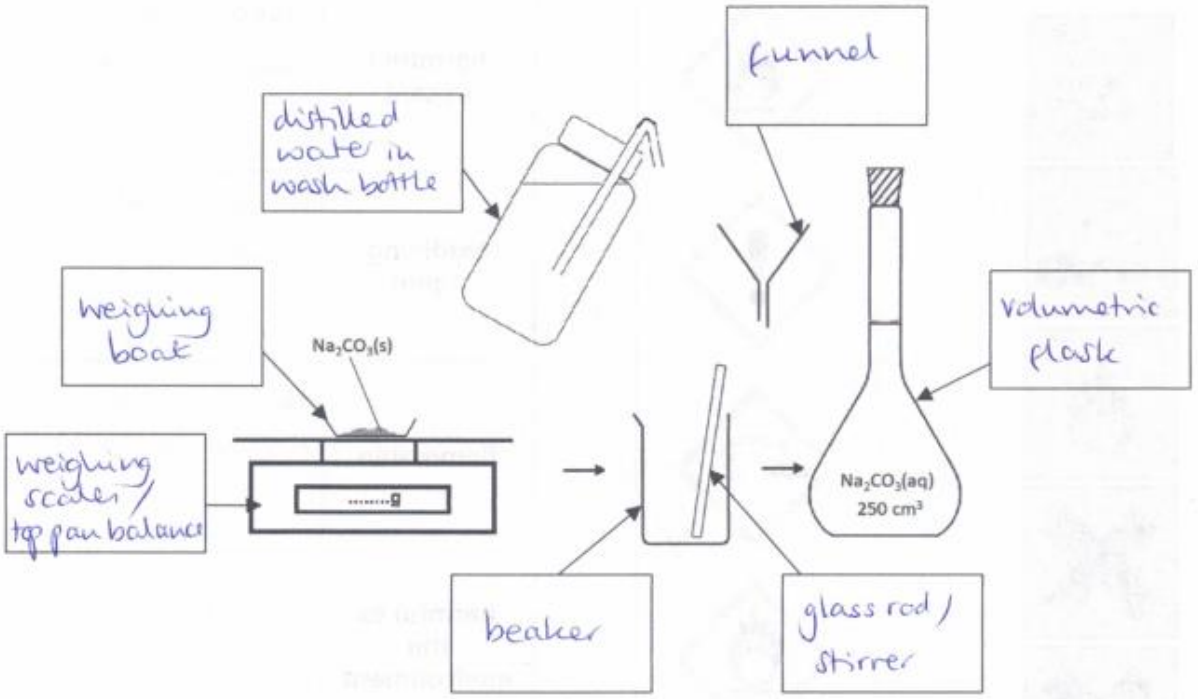
One of the practical techniques you will need to complete is the preparation of a standard solution and performing a titration to test the solution you have prepared.

- Watch these videos to help you answer the questions
  https://www.youtube.com/watch?v=xBKyjXUhJy0
  https://www.youtube.com/watch?v=rLc148UCT2w
  https://www.youtube.com/watch?v=gzvzvDv_BnA

Q1. (a) What is a standard solution? ....It...is...a...solution...of...(accurately)...known.....

....concentration.....**(1)**

(b) The diagram below shows the apparatus used to make a standard solution of sodium carbonate. Complete the labels. **(7)**



(c) The standard solution prepared can be used to find the concentration of a solution of hydrochloric acid.

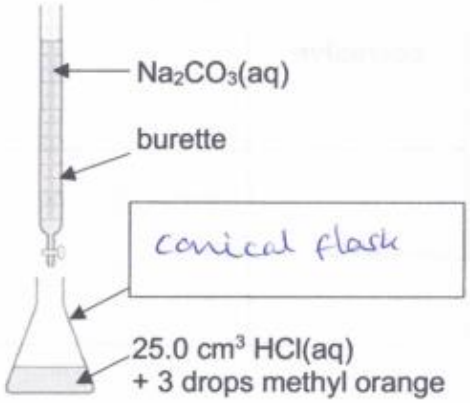
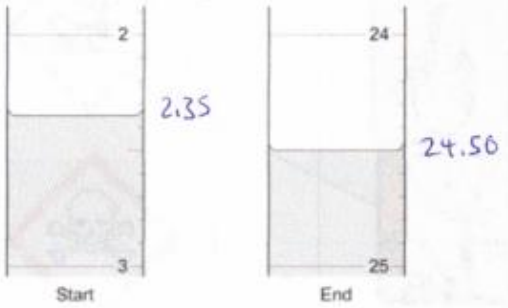


Figure 2.



(i) Complete the label to show name of the apparatus in which the acid is placed. **(1)**

(ii) What is the name given to this procedure? ....titration..... **(1)**

(iii) **Figure 2.** shows the level of the sodium carbonate solution in the burette at the start and the end of one titration. Use these to work out the volume of sodium carbonate added in the titration. Give your answer to 2 d.p.

24.50 − 2.35

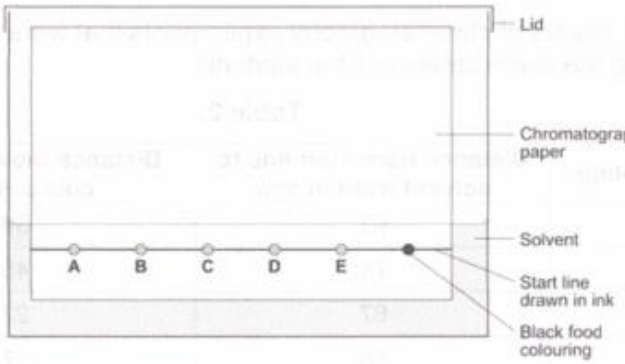
Volume Na_2CO_3(aq) added = ...22.15..... cm^3 **(1)**

2 numbers after the decimal point

Q2. (a) What is chromatography used for? ...to separate (and analyse) components... ...in a mixture... **(1)**

(b) A student used paper chromatography to analyse a black food colouring. They placed spots of known food colours, **A**, **B**, **C**, **D** and **E** and the black food colouring on a sheet of chromatography paper. They set up the apparatus as shown in **Diagram 1.**

Diagram 1

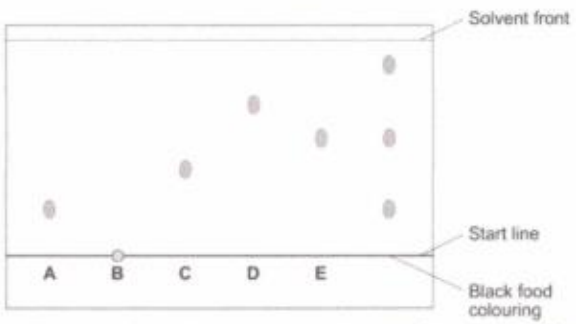


The student made **two** errors in setting up the apparatus. Identify the **two** errors and describe the problem each error would cause.

...Start line drawn in ink... (1)...
...so it will run / dissolve in the solvent... (1)...
...
...Solvent above the start line.../ spots under the solvent... (1)...
...so they will wash off the paper / mix with the solvent... (1)...
...

(c) A different student set up the apparatus without making any errors. The chromatogram in **Diagram 2.** shows the student's results.

Diagram 2



(i) What do the results tell you about the composition of the black food colouring?

...The black food colouring contains A and E... (1)...
...and one other (unknown) substance... (1)... **(2)**

(ii) Use **Diagram 2.** to complete **Table 1.** **(2)**

Table 1.

	Distance in mm
Distance from start line to solvent front	28.5 / 29
Distance moved by food colour **C**	allow 11 – 12

(iii) Use your answers in **(c)(ii)** to calculate the R_f value for food colour **C**. Show your workings.

$$\frac{\text{distance moved by C}}{\text{distance from start line to solvent front}}$$

R_f value = 0.38 – 0.42 **(1)**

(iv) **Table 2.** gives the results of chromatography experiments that were carried out on some known food colours, using the same solvent as the students.

Table 2.

Name of food colour	Distance from start line to solvent front in mm	Distance moved by food colour in mm	R_f value
Ponceau 4R	62	59	0.95
Carmoisine	74	45	0.61
Fast red	67	27	0.40
Erythrosine	58	17	0.29

Which of the food colours in **Table 2.** could be food colour **C** from the chromatogram? Give the reason for your answer.

Fast red (1) allow none

has same / very similar Rf (1) if Rf not same as any

(2)

Q3. 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, in s^{-1} 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

(a) What is the independent variable in this experiment? Circle the correct answer

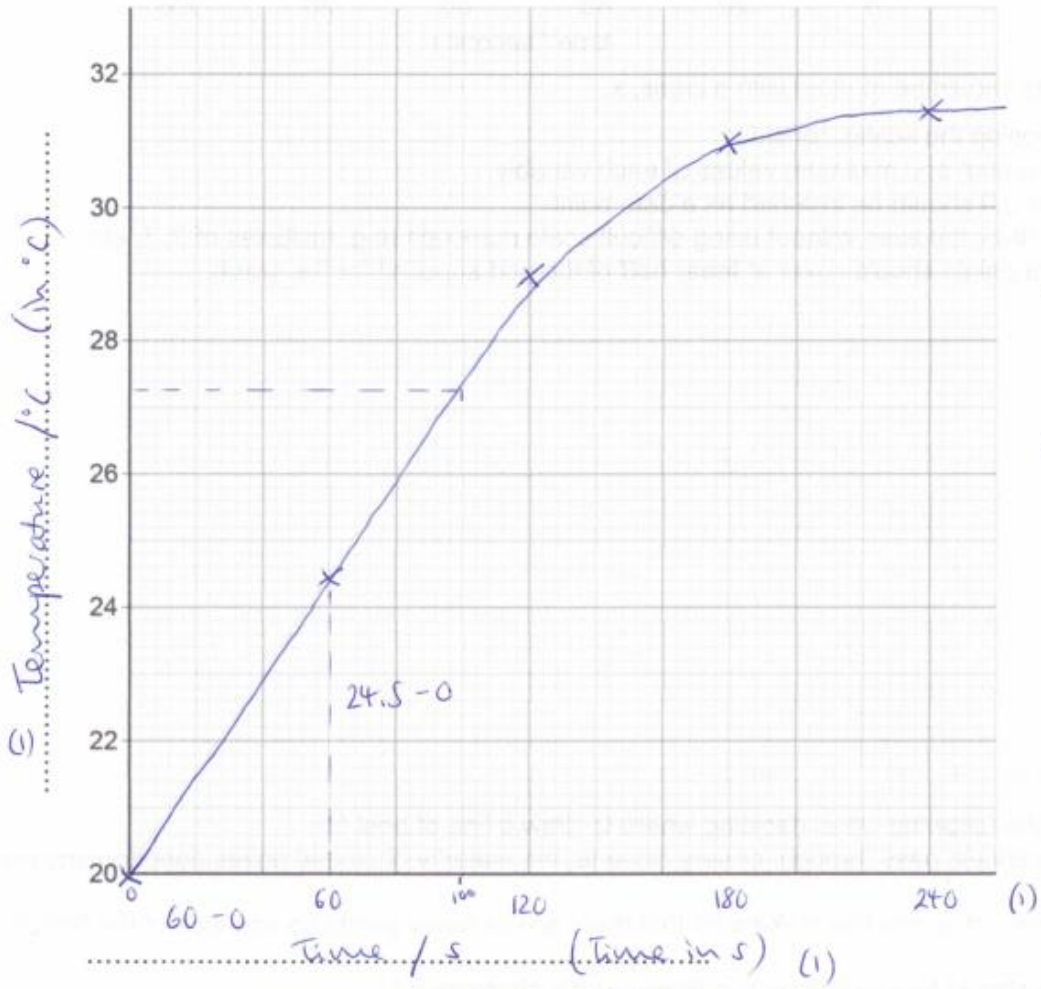
rate of reaction **time** **temperature** **(1)**

(b) Tabulate the student's data in an appropriate manner. **(4)**

temperature ..... / °C	..... time ..... / ..s..	rate of reaction ... / ..s^{-1}
24.5	340	0.0029
39.0	256	0.0039
51.0	186	0.0054
58.0	124	0.0081
80.5	62	0.0161

correct headings (1)
units with headings only (1)
all temperatures written to 1 d.p (1)
temperatures written in order of increasing size (1)

Figure 2.



all points correctly plotted (1)

curve of best fit (1)

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

must match curve / line drawn.

Temperature at 100s = 27.3 °C **(1)**

write to 1dp to match precision in table

(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.

$\frac{24.5 - 0}{60 - 0}$ (1) = 0.41 (1)

Gradient = 0.41 °C / s **(2)**

Highly recommended content

Q1. (a) (strong because) completely ionised (in aqueous solution)

ignore pH
allow dissociated for ionised
*do **not** accept hydrogen is ionising*
*do **not** accept H^+ are ionised*

1

(dilute because) small amount of acid per unit volume

ignore low concentration

1

(c) (titre):

chooses titrations 3, 4, 5

1

average titre = 22.13 (cm^3)

allow average titre = 22.13(3…) (cm^3)
allow a correctly calculated average from an incorrect choice of titrations

1

(calculation):

(moles NaOH =

$$\frac{22.13}{1000} \times 0.105 = 0.002324)$$

allow use of incorrect average titre from step 2

1

(moles H_2SO_4 =

½ × 0.002324 =) 0.001162

allow use of incorrect number of moles from step 3

1

(concentration =

$$\frac{0.001162}{25} \times 1000)$$

= 0.0465 (mol/dm^3)

allow use of incorrect number of moles from step 4

1

alternative approach for step 3, step 4 and step 5

$$\frac{2}{1} = \frac{22.13 \times 0.105}{25.0 \times \text{conc. } H_2SO_4} \text{ (1)}$$

(concentration H_2SO_4 =)

$$\frac{22.13 \times 0.105}{25.0 \times 2}$$

= 0.0465 (mol/dm^3) (1)
*an answer of 0.046473 **or** 0.04648 correctly rounded to at least 2 sig figs scores marking points 3, 4 and 5*
*an answer of 0.092946 **or** 0.09296 **or** 0.185892 **or** 0.18592 correctly rounded to at least 2 sig figs scores marking points 3 and 5*
*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

(d) pipette measures a fixed volume (accurately)

1

(but) burette measures variable volume

allow can measure drop by drop

1

(e) $(\text{moles} =) \frac{30}{1000} \times 0.105$

or 0.00315 (mol)

or

(mass per dm^3 =) 0.105 × 40

or 4.2 (g)

1

$(\text{mass} = \frac{30}{1000} \times 0.105 \times 40)$

= 0.126 (g)

1

*an answer of 0.126 (g) scores **2** marks*
*an answer of 126(g) scores **1** mark*
*an incorrect answer for one step does **not** prevent allocation of marks for subsequent steps*

[12]

Q2.

(a) add excess copper carbonate (to dilute hydrochloric acid)

accept alternatives to excess, such as 'until no more reacts'

1

filter (to remove excess copper carbonate)

reject heat until dry

1

heat filtrate to evaporate some water **or** heat to point of crystallisation

accept leave to evaporate or leave in evaporating basin

1

leave to cool (so crystals form)

until crystals form

1

*must be in correct order to gain **4** marks*

(b) M_r $CuCl_2$ = 134.5

*correct answer scores **4** marks*

1

moles copper chloride = (mass / M_r = 11 / 134.5) = 0.0817843866

1

M_r $CuCO_3$= 123.5

1

Mass $CuCO_3$ (=moles × M_2= 0.08178 × 123.5) = 10.1(00)

1

*accept 10.1 with no working shown for **4** marks*

(c) $\frac{79.1}{100} \times 11.0$

or

11.0 × 0.791

1

8.70 (g)

1

*accept 8.70(g) with no working shown for **2** marks*