Name: _____

Summer Transition Work for New Applied Science Students

Welcome to Applied Science.

Here is a list of tasks for you to complete and bring to your **first** Applied Science lesson in September. There will be a **TEST** on this work in the first 2 weeks of term.

You will also **need to bring** a folder with dividers, lined A4 file paper, calculator, ruler, pens, highlighters and pencils.

Task	Description of task	Task complete (✓)
1.	Diagrams and notes on Organelles of Eukaryotic cells	
2.	Graph to draw and follow up Questions. Use **graph paper** on p5 of booklet.	
3.	Units and some simple mathematical tasks	
4.	Ions	
5.	Molecules & Balancing Equations	
6.	Parallel circuit problems	
7.	Investigation skills	

Task 1 - Eukaryotic cells *answer on A4 Paper*

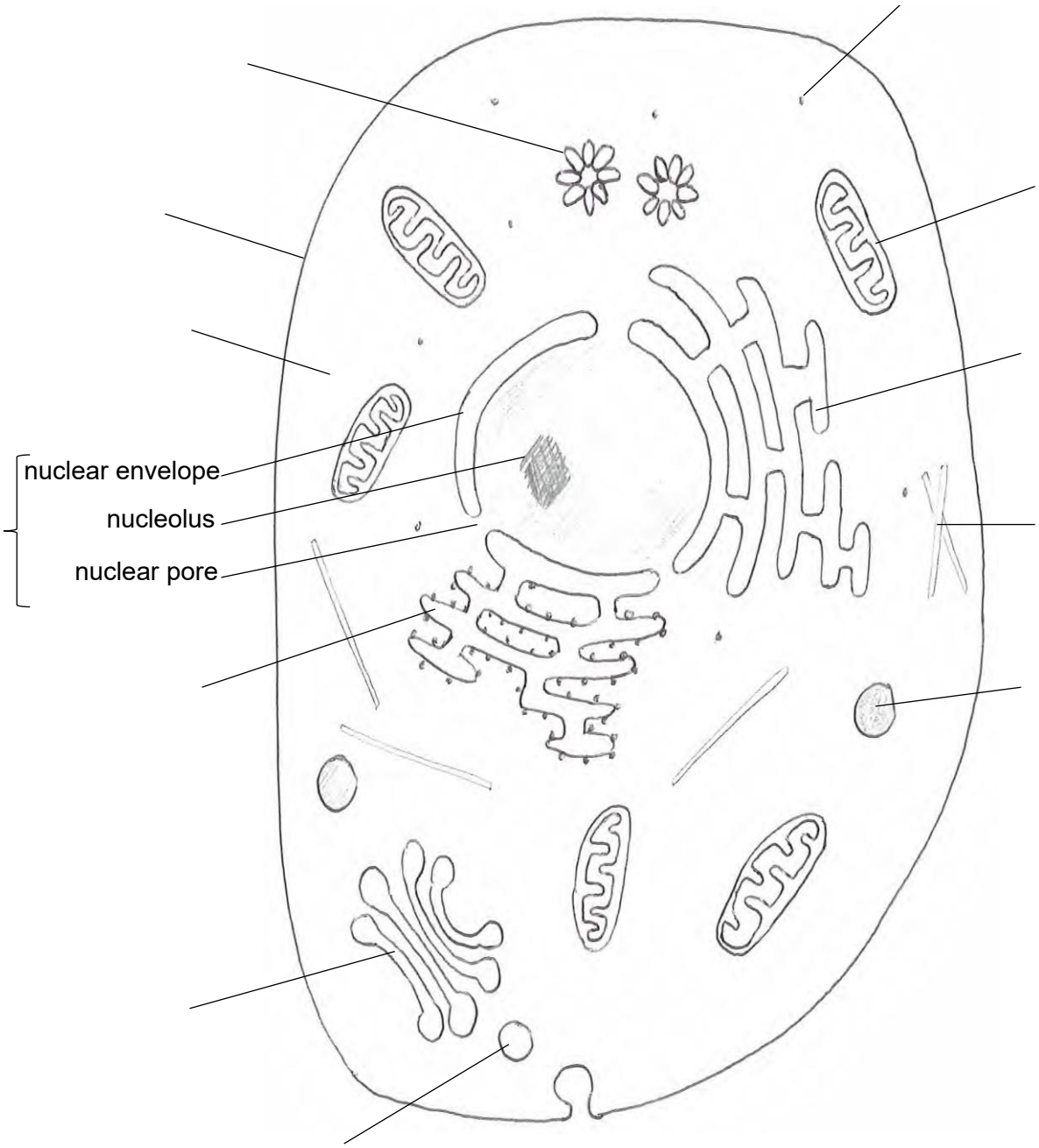
Use the resource links below to complete the questions. If you Google "A level Biology eukaryotic cells" you will get lots of other suitable links too

- https://www.cellsalive.com/cells/cell_model_js.htm interactive cell models
- http://www.ivyroses.com/Biology/Cells/Plant-Cell-Structure.php
- On YouTube- "Crash courses Biology-Eukaryopolis-The City of Animal Cells: Crash course Biology #4 https://www.youtube.com/watch?v=cj8dDTHGJBY
- Crash course Plant cells #6 https://www.youtube.com/watch?v=9UvlqAVCoqY

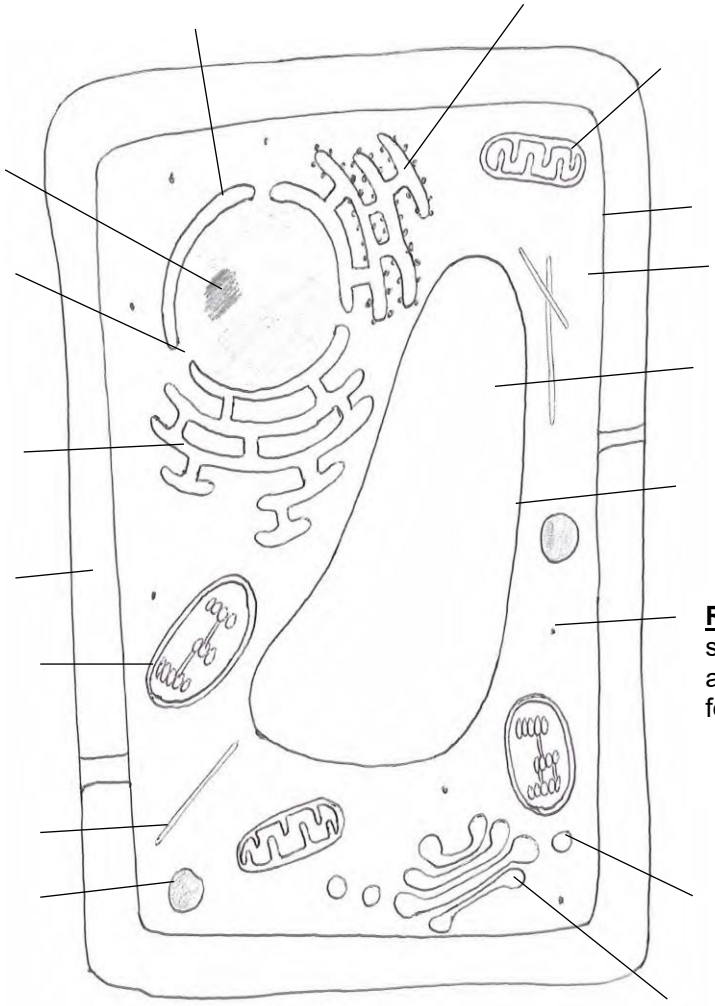
1. What is the key feature of a Eukaryotic cell?
2. List 4 groups of organisms that have Eukaryotic cells
3. What is a Prokaryotic cell?
4. What is an organelle?
5. Clearly label the two diagrams below. An animal cell and a plant cell as seen under a Transmission Electron microscope. You will need to **LEARN the names of these structures for the test.** Structures may look slightly different on different diagrams.
6. Make a table in your notes to show the key differences between plant and animal cells

Animal Cell

Ribosome - Site of protein synthesis where amino acids are condensed together to form polypeptides (proteins)



Plant Cell



Ribosome - Site of protein synthesis where amino acids are condensed together to form polypeptides (proteins)

7. Next make brief notes on the **function** of each of the organelles listed below. Tick them off as you do them.

   You could present this information as a table or clearly annotate the diagrams above. **Ribosome has been done for you on both diagrams.**

Cell/Plasma membrane		Vesicle	
Cell Wall		Golgi apparatus/bodies	
Nucleus		Mitochondria	
Nucleolus		Chloroplast	
Lysosome		Centriole/Centrosome	
Ribosome	✓	Cilia	
Rough Endoplasmic Reticulum		Flagellum	
Smooth Endoplasmic Reticulum		Cytoplasm (cytosol)	

Task 2 - Drawing a line graph and some follow up questions

When an animal such as a rabbit is knocked down and killed by a car, flies soon find its body. They lay their eggs on it. The eggs hatch into maggots which burrow into the body. The maggots grow rapidly and then moult to form pupae. A new generation of flies emerges from these pupae.

Table 1 The effect of temperature on the time taken for fly eggs to hatch

Temperature /°C	Time taken for eggs to hatch /hours
5	230
10	90
11	70
13	50
17	30
19	25

1. Plot the data in the table as a suitable graph (graph paper on next page). Draw a smooth curve of best fit.
   - *Remember that the Independent variable (in this case the Temperature) goes on the x axis. Think carefully about your scales on your axes so as to use most of the graph paper. Use a sharp pencil to accurately plot your points. Label axes etc.*

Answer the following questions on lined paper

2. A dead badger was found half-hidden among some bushes. There were many fly eggs on it and some of these had just hatched. Use your graph to estimate how many hours had passed since the badger's death if the temperature at the place where it was found was:
   a) 15°C
   b) 7°C

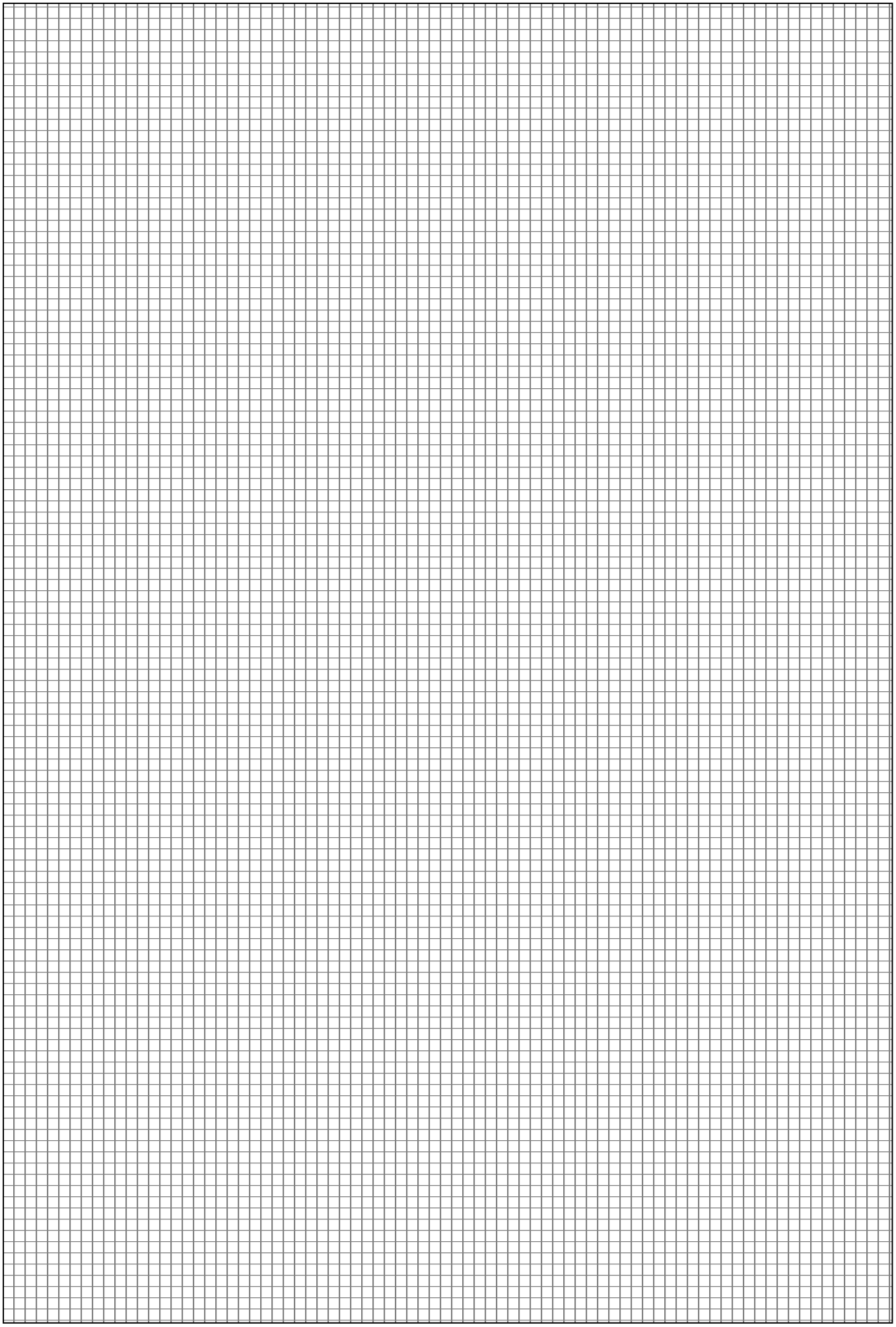
3. Use your graph to **estimate** the temperature of the environment that these eggs were in if flies eggs take 180 hours to hatch.

4. Describe the pattern of results (where possible use data to help you)

5. a) When the temperature rose from 5 to 10°C there was a decrease of 140 hours in the time taken for the eggs to hatch. (230-90). Calculate the percentage decrease.

$$\% \text{ decrease} = \frac{\text{change}}{\text{initial value}} \times 100 =$$

b) What is the percentage decrease in the time taken for eggs to hatch when the temperature rose from 5 ^{0}C to 17°C?



Task 3 – Maths skills: Units, Standard form and calculations

Answers on this sheet please

1. A student measured the length of some onion cells under a microscope in micrometres (μm) here are the results: 250, 200, 200, 320, 200, 250, 300, 290, and 160.
   a) What is the range of the results, don't forget the units! _____
   b) What is the mode? _____
   c) What is the median? _____
   d) What is the mean? _____

2. **Units** – You may need to convert between units. Cells are very small and so we often use micrometres as a unit of length when measuring cells. Complete these tables.

1mm = 1000 micrometres (μm) or 1 X 10^3 μm
So 1cm = 10mm=10,000 micrometres (μm) or 1 X10^4μm

In metres (m)	In centimetres (cm)	In millimetres (mm)	In micrometres (μm)
2	200	2000	2000000
		11	
		3.4	
0.35			
	65		
			78500
			25

3. Convert these and write all your answers in **standard form**

In metres (m)	In centimetres (cm)	In millimetres (mm)	In Micrometres (μm)
$2.3x10^0$	$2.3x10^2$		$2.3x10^6$
$4x10^{-6}$		$4x10^{-3}$	$4x10^0$
			$4x10^1$
		$1.2x10^1$	
	$2.5x10^0$		

4. Give these numbers to 2 **significant figures**.
   a) 156 _____
   b) 2929385 _____
   c) 0.000837965 _____
   d) 10490 _____

Task 4 – Ions

Learn

- Metal elements form positive ions by losing electrons.
- Non-metal elements form negative ions by gaining electrons.
- Ionic compounds are mostly between metal and non-metal elements.

*Look at your Periodic Table and **learn** these two simple rules:*

1. For Group 1, 2 and 3 metals: group number = size of positive charge

   ie Group 1 form 1+ ions *eg* Na^+ Group 3 form 3+ ions *eg* Al^{3+}

2. For Group 5, 6 and 7 non-metals: (8 - group number) = size of negative charge

   ie Group 7 form 1- ions *eg* Cl^- Group 6 form 2- ions *eg* O^{2-}

*Note that metal ions have the name of the metal eg Na^+ is called a sodium ion, but non-metal ions' names end in **ide** eg Br^- is a bromide ion, S^{2-} a sulfide ion.*

Cover the last column, then fill column A to test yourself to the complete table ***A***

name of ion	formula	formula	formula	formula	formula
hydroxide					OH^-
carbonate					CO_3^{2-}
sulfate					SO_4^{2-}
nitrate					NO_3^-
ammonium					NH_4^+

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Understand

- The formulae of ionic compounds arise from the charges of their ions:
- Ionic bonds are the attractions between positive ions and negative ions so that the total number of positives equals the total number of negatives.

Examples:

potassium chloride contains K^+ and Cl^- so formula is KCl

magnesium hydroxide contains Mg^{2+} and OH^- *here two 1- hydroxide ions are needed to make the negative charge equal the positive charge* so the formula is $Mg(OH)_2$

ammonium carbonate contains NH_4^+ and CO_3^{2-} giving $(NH_4)_2CO_3$

Note how brackets are used when a formula contains two or more of an ion that has more than one element symbol, such as SO_4^{2-} or NO_3^-.

Try

Referring to the information above, write formula for the following names:

Example: sodium carbonate *contains Na^+ ions and CO_3^{2-} ions so **two** Na^+ are needed since 2 x 1+ equals the 2- ion charge to give a formula of Na_2CO_3*

a) potassium bromide _____ b) magnesium chloride _____

c) sodium sulfide _____ d) sodium oxide _____

e) calcium nitrate _____ f) aluminium sulfate _____

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Task 5 – Atoms in molecules and balancing equations

Learn

- **Molecules** contain atoms joined by **covalent** bonds.

*Use this Cover & Write grid to **learn** the formulae for these simple molecules:*

name of molecule	formula	formula	formula	formula	Formula
hydrogen					H_2
oxygen					O_2
nitrogen					N_2
chlorine					Cl_2
bromine					Br_2
carbon dioxide					CO_2
ammonia					NH_3

- **Metals** contain atoms joined by **metallic** bonds.
- The formula of any metal is its symbol *eg* sodium is Na, copper is Cu

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Understand

In equations the total number of reactant symbols for each element must equal the total number of product symbols for each element. This is called "balancing the equation".

Burning ethane in oxygen: $C_2H_6 + 3.5\ O_2 \rightarrow 2\ CO_2 + 3\ H_2O$

Check: there are 2C, 6H and 7O on each side of the arrow

Electrolysing aluminium oxide: $2\ Al_2O_3 \rightarrow 4\ Al + 3\ O_2$

Check: there are 4Al and 6O on each side of the arrow

- ***Note that since the formulae of substances cannot change, numbers are put in front of them to make the equation "balance".***
- ***Always check the total number of symbols.***

Try

Balance the following reactant and product formulae: *READ THIS*

Burning propane: $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

check:

Oxidising sodium: $Na + O_2 \rightarrow Na_2O$

check:

Making ammonia: $N_2 + H_2 \rightarrow NH_3$

check:

Making hydrogen: $CH_4 + H_2O \rightarrow CO + H_2$

check:

Write the reactant and product formulae and then balance the equation:

ethene (C_2H_4) and oxygen → carbon dioxide and water

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Task 6 – Parallel circuit problems

Answers on this sheet please

You will have learnt about series and parallel circuits. In Applied Science exams, you are given formulae. You may find these formulae useful when answering the questions:

Total resistance in series = resistance of resistor 1 + resistance of resistor 2 + …	$R_T = R_1 + R_2 + \ldots$
$\frac{1}{\text{Total resistance in parallel}} = \frac{1}{\text{Resistance of resistor 1}} + \frac{1}{\text{Resistance of resistor 2}} + \ldots$	$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$

1. Figure 1 shows a cell in series with an ammeter and a lamp in parallel with a resistor.

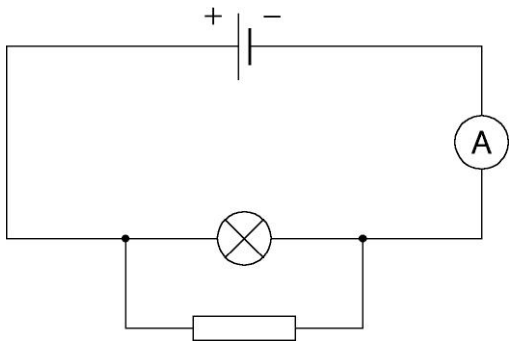


Figure 1

a) Complete the following sentences using words from the list below.

greater than **less than** **the same as**

i) The current through the ammeter is …… the current through the resistor.

ii) The potential difference across the battery is …….. the potential difference across the resistor.

iii) The current through the lamp is …… the current through the battery.

iv) The potential difference across the lamp is …… the potential difference across the resistor.

b) In Figure 1, the cell has a potential difference of 2.0 V and the resistor has a resistance of 5.0 Ω. The ammeter reading is 0.9 A.

i) Show that the current through the resistor is 0.4 A.

.....

.....

ii) The ammeter reading is 0.9 A. Calculate the current through the lamp.

.....

.....

iii) Calculate the resistance of the lamp in this circuit.

.....

.....

2. A 12 V battery is connected to a 10 Ω resistor in parallel with a 15 Ω resistor, as shown in Figure 2.

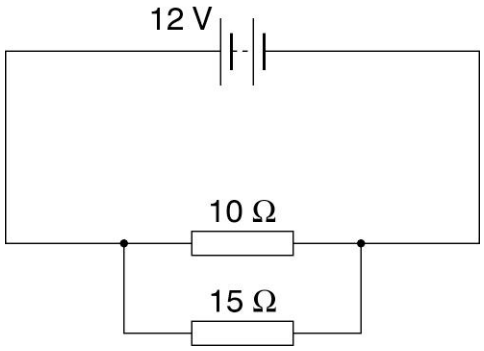


Figure 2

a) Calculate the current through:

i) the 10 Ω resistor.

.....

.....

ii) the 15 Ω resistor.

.....

.....

iii) the battery.

.....

b) What would be the resistance of a single resistor that would have the same current if it was connected on its own to the same battery?

.....

.....

.....

.....

Task 7 – Investigation skills

Answers on this sheet please

You will complete five units throughout the course. Two of these will assessed by using exams and three will use coursework investigations, so investigation skills are a large part of the course.

Maths skills are also fundamental to success in Applied Science as they will be at least 25% of exam marks and 10% of coursework marks.

Complete the following activities. Some use physics examples, some are more general.

Activity 1 Scientific vocabulary: Designing an investigation

Instructions for multiple choice: tick **one** correct answer for each question

1. What is a **hypothesis**?
   A. A variable that is kept constant
   B. A proposal intended to explain observations
   C. A measured variable
   D. The range of values

2. What is a **dependent variable**?
   A. A variable you change
   B. A variable kept constant
   C. A variable measured as the outcome
   D. A range of readings

3. What is an **independent variable**?
   A. A variable kept constant
   B. A variable measured
   C. A variable selected and changed
   D. The result of an experiment

4. What is a **control variable**?
   A. A variable that is measured
   B. A variable that is changed
   C. A variable kept constant
   D. The interval between readings

5. What is the **range**?
   A. The difference between readings
   B. The maximum and minimum values
   C. The average value
   D. The smallest measurable change

6. What is an **interval**?
   A. The difference between readings
   B. The maximum value
   C. A controlled variable
   D. The measured result

Activity 2 Scientific vocabulary: Making measurements

Link each term on the left to the correct definition on the right.

True value	The range within which you would expect the true value to lie
Accurate	A measurement that is close to the true value
Resolution	Repeated measurements that are very similar to the calculated mean value
Precise	The value that would be obtained in an ideal measurement where there were no errors of any kind
Uncertainty	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading

Activity 3 Scientific vocabulary: Errors

Link each term on the left to the correct definition on the right.

Random error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Systematic error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero
Zero error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next

⭐ Activity 4: Challenge Questions

1. A student repeats an experiment and gets results that are very close together but far from the true value. What can you conclude?
   A. The results are accurate but not precise
   B. The results are precise but not accurate
   C. The results are both accurate and precise
   D. The results are neither accurate nor precise

2. Which change would **reduce random error** in an experiment?
   A. Calibrating equipment
   B. Taking repeated measurements and calculating a mean
   C. Using a different unit
   D. Changing the independent variable

3. Which of the following is an example of a **systematic error**?
   A. Temperature fluctuating during the experiment
   B. Human reaction time when using a stopwatch
   C. A ruler with incorrect markings
   D. Variations in repeated measurements

4. A balance reads **0.05 g when empty**. What type of error is this?
   A. Random error
   B. Systematic error
   C. Human error
   D. Precision error

5. Why is it important to keep control variables constant?
   A. To make results more accurate
   B. To ensure only the independent variable affects the dependent variable
   C. To reduce uncertainty
   D. To improve precision

6. A student measures length using a ruler with millimetre markings. What is the **resolution** of the ruler?
   A. 1 cm
   B. 0.1 mm
   C. 1 mm
   D. 10 mm

7. Which statement best describes **uncertainty**?
   A. The difference between two readings
   B. The exact true value
   C. The range within which the true value lies
   D. The smallest interval

8. A student increases the number of readings from 3 to 10. What is the main benefit?
   A. Improves resolution
   B. Reduces systematic error
   C. Improves reliability and reduces random error
   D. Changes the independent variable

9. If a measurement is both accurate and precise, it means:
   A. It is close to the true value and repeatable
   B. It is close to the true value but varies
   C. It is repeatable but incorrect
   D. It has no uncertainty

10. Which combination would **improve both accuracy and precision**?
    A. Repeat measurements only
    B. Use more sensitive equipment only
    C. Calibrate equipment and repeat measurements
    D. Increase the range of values

Understanding and using SI units

Understand

All measurements have a size (eg 2.7) and a unit (eg metres or kilograms).
Sometimes, there are different units available for the same type of measurement. For example, milligram, gram, kilogram and tonne are all units used for mass. Some values like strain and refractive index are not followed by a unit.
To reduce confusion, and to help with conversion between different units, there is a standard system of units called the SI units which are used for most scientific purposes.
These units have all been defined by experiment so that the size of, say, a metre in the UK is the same as a metre in China.
There are seven SI base units, which are given in the table.

Physical quantity	Unit	Abbreviation
Mass	kilogram	kg
Length	metre	m
Time	second	s
Electric current	ampere	A
Temperature	kelvin	K
Amount of substance	mole	mol
luminous intensity	candela	cd

Using prefixes and power of ten

Understand

SI units often need to be written in forms that are either much larger or much smaller than the base unit. To do this, we use **prefixes**, each of which represents a specific **power of ten**.
These prefixes allow us to express quantities in a more convenient way.
For example:

- Instead of writing **0.000001 m**, we write **1 µm**.
- Instead of writing **1,000,000 W**, we write **1 MW**.

Common SI prefixes

The most common prefixes you will encounter are given in the table.

Prefix	Symbol	Power of 10	Multiplication factor	
Tera	T	10^{12}	1 000 000 000 000	
Giga	G	10^{9}	1 000 000 000	
Mega	M	10^{6}	1 000 000	
kilo	k	10^{3}	1000	
deci	d	10^{-1}	0.1	1/10
centi	c	10^{-2}	0.01	1/100
milli	m	10^{-3}	0.001	1/1000
micro	µ	10^{-6}	0.000 001	1/1 000 000
nano	n	10^{-9}	0.000 000 001	1/1 000 000 000
pico	p	10^{-12}	0.000 000 000 001	1/1 000 000 000 000
femto	f	10^{-15}	0.000 000 000 000 001	1/1 000 000 000 000 000

Why prefixes matter

Using prefixes helps to:

- Avoid very long numbers
- Make data easier to read and compare
- Keep scientific writing consistent and standardised

Activity 4 SI units and prefixes

1. Re-write the following quantities using the correct SI units.
    a) 1 minute =
    b) 1 milliamp =
    c) 1 tonne =

2. What would be the most appropriate unit to use for the following measurements?
    a) The wavelength of a wave in a ripple tank ……
    b) The temperature of a thermistor used in hair straighteners ……
    c) The half-life of a source of radiation used as a tracer in medical imaging ……
    d) The diameter of an atom ……
    e) The mass of a metal block used to determine its specific heat capacity ……
    f) The current in a simple circuit using a 1.5 V battery and bulb ……

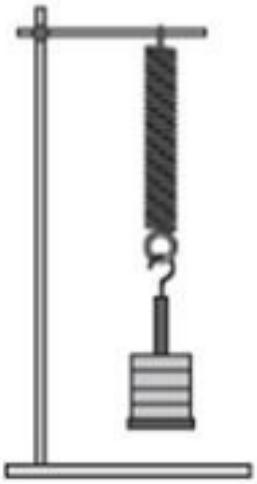
Activity 5 Converting data

Re-write the following quantities.

1. 1.5 kilometres in metres ……
2. 450 milligrams in kilograms ……
3. 96.7 megahertz in hertz ……
4. 5 nanometers in metres ……
5. 3.9 gigawatts in watts ……

Activity 6 Investigating springs

A group of students investigated how the extension of a spring varied with the force applied. They did this by hanging different weights from the end of the spring and measuring the extension of the spring for each weight.



The results are below.

Weight added to the spring / N	Extension of spring / cm			
	Trial 1	Trial 2	Trial 3	Mean
2	3.0	3.1	3.2	
4	6.0	5.9	5.8	
6	9.1	7.9	9.2	
8	12.0	11.9	12.1	
10	15.0	15.1	15.12	

1. What do you predict the result of this investigation will be?
2. What are the independent, dependent and control variables in this investigation?
3. What is the difference between repeatable and reproducible?
4. What would be the most likely resolution of the ruler you would use in this investigation?
5. Suggest how the student could reduce parallax errors when taking her readings.
6. Random errors cause readings to be spread about the true value.

   What else has the student done in order to reduce the effect of random errors and make the results more precise?

7. Another student tries the experiment but uses a ruler which has worn away at the end by 0.5 cm. What type of error would this lead to in his results?

8. Calculate the mean extension for each weight.

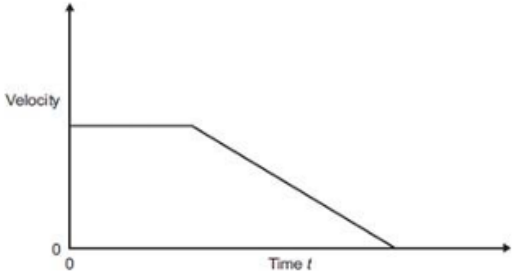
9. A graph is plotted with force on the *y* axis and extension on the *x* axis. What quantity does the gradient of the graph represent?

Answer space for 1-9.

Activity 7 Gradients and areas

1. A car is moving along a road. The driver sees an obstacle in the road at time $t = 0$ and applies the brakes until the car stops.

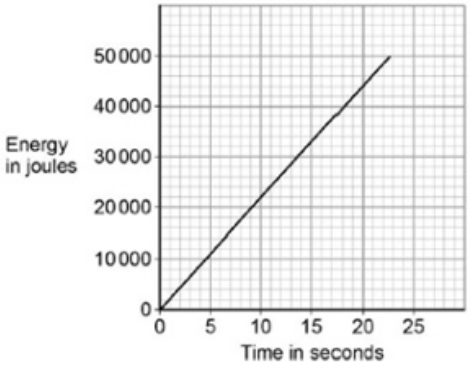
   The graph shows how the velocity of the car changes with time.



   From the list below, which letter represents:
   - the negative acceleration of the car
   - the distance travelled by the car?

   a. The area under the graph
   b. The gradient of the sloping line
   c. The intercept on the y axis

2. The graph shows how the amount of energy transferred by a kettle varies with time.



   The power output of the kettle is given by the gradient of the graph.

   Calculate the power output of the kettle.

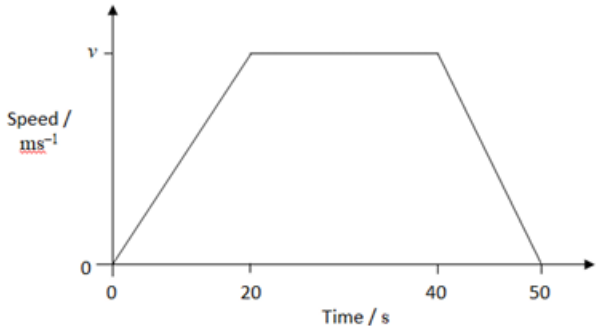
Activity 7 Gradients and areas

3. The graph shows the speed of a car between two sets of traffic lights.

   It achieves a maximum speed of v metres.

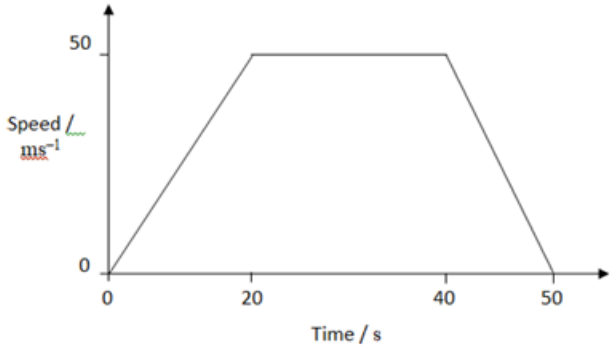
   per second. It travels for 50 seconds.

   The distance between the traffic lights is 625 metres.



   Calculate the value of v.

4. The graph shows the speed of a train between two stations.



   (not drawn accurately)

   Calculate the distance between the stations.