

Name _____

GCSE Science

Year 10 Mock Exam Revision



1 Which of these is the best definition for 'resolution'? Tick one:

- the smallest distance between two points that can still be seen as two points
- the longest object that can be observed using a microscope
- the amount that a microscope can magnify by

2 a Hooke's microscope is on the left and a modern light microscope is on the right. Draw lines from the boxes to show which features belong with which microscope. Some features belong to *both* microscopes.



contains a barrel with two lenses

uses light

magnification up to $\times 30$

magnification up to $\times 1500$

resolution down to 0.0001 mm

resolution down to 0.002 mm



b Complete the following sentences to compare today's light microscopes with Hooke's.

Hooke's and today's light _____ are similar because they both contain two _____. However, Hooke's microscope had a much lower _____ than today's. And Hooke's microscope did not have as good a _____ as today's microscopes, so he could not see things in as much detail.

3 A microscope with a $\times 10$ objective lens and a $\times 3$ eyepiece lens has a total magnification of $10 \times 3 = \times 30$. What would be the magnification if a $\times 20$ objective lens were used instead? _____

4 a Name a type of microscope that does not use light to produce an image. _____

b How does this microscope's resolution compare with a light microscope? _____

5 A piece of hair is 0.05 mm wide.

a What is the width of the hair in micrometres? _____

b The hair is magnified $\times 100$. How wide is the magnified image in millimetres? _____

3 Shiv examines some animal hairs using a microscope. Hair X is $20 \mu\text{m}$ wide and hair Y is $60 \mu\text{m}$ wide.

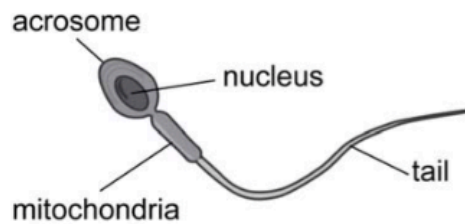
a How many times wider is hair Y compared with hair X? Show your working.

b Shiv examines hair X using a total magnification of $\times 150$. How wide will the hair appear under the microscope, in micrometres?

c Give your answer to part b in millimetres.

- 1 a Animal cells and plant cells are eukaryotic whereas bacterial cells are prokaryotic. Use ticks (✓) to complete this table to compare the different types of cells.

Cell structure	Found in animals?	Found in plants?	Found in bacteria?
cytoplasm			
chloroplast			
nucleus			
plasmid			
ribosomes			
cell membrane			
cell wall			
mitochondria			
large permanent vacuole			
DNA			



Human sperm cell (magnification $\times 1000$)

- Human sperm cells are haploid. What does this mean?

- The cells that divide to form sperm cells are diploid. What must happen during this type of cell division to make haploid sperm cells?

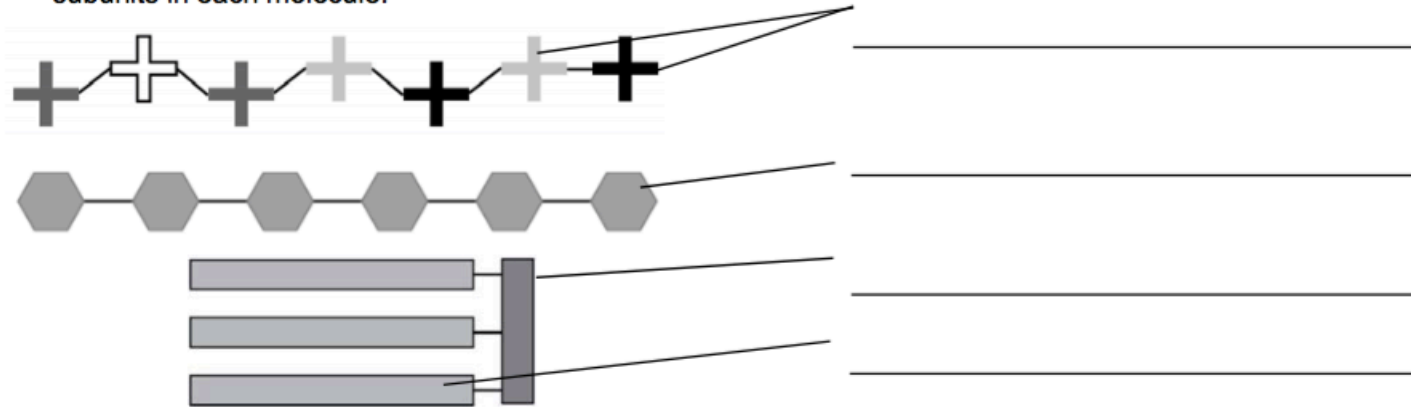
- Sperm cells have several adaptations that help them travel through the oviduct and fertilise an egg cell. Explain how each of these adaptations helps:
 - tail _____
 - lots of mitochondria _____
 - acrosome _____
- Measure the length of the sperm in the diagram and then use the magnification to calculate the real length of a sperm. Give your answer in cm, mm and μm .

- 5 A jelly layer surrounds an egg cell.

- a What is the function of the jelly layer before the egg cell is fertilised?

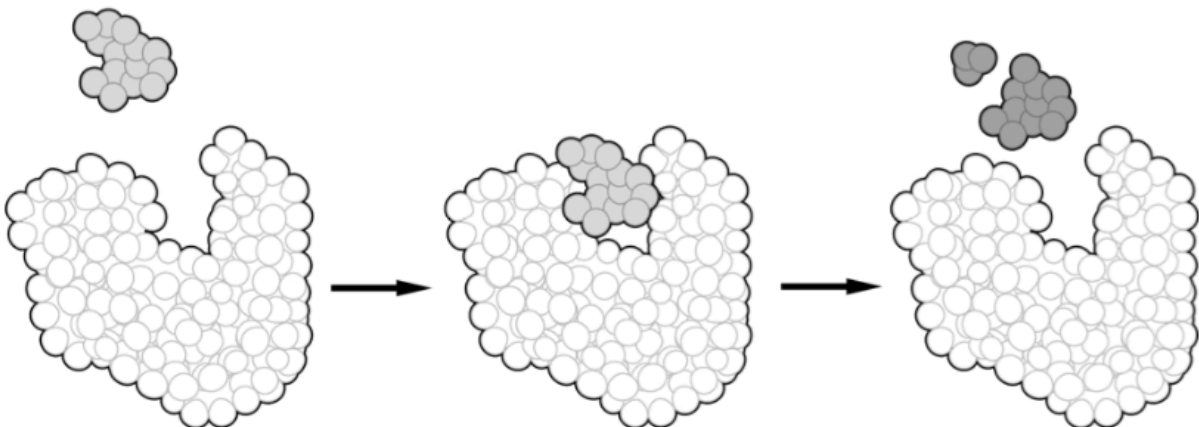
- b How does the jelly layer change immediately after a sperm cell fuses with the egg cell?

1 The diagram shows some large organic (biological) molecules. Add labels to the lines to identify the subunits in each molecule.



2 Which kind of large organic molecule are enzymes? _____

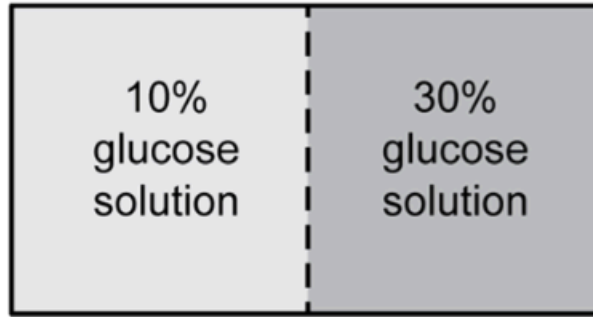
3 Enzymes are biological catalysts. Explain what this means.



- 1 Label the enzyme in each diagram.
- 2 The active site is where the substrate sits in the enzyme.
 - a Label the active site in the middle diagram.

4 If the temperature increased, the special shape of the enzyme would change. Suggest how this change in shape would affect how the enzyme catalyses the breakdown of the substrate. Explain your answer.

The diagram shows a semi-permeable membrane separating two glucose solutions.



1 What is meant by a 'semi-permeable membrane'?

2 Glucose molecules are small enough to pass through the semi-permeable membrane in the diagram.

a Circle the transport method by which glucose molecules move through the membrane:

active transport diffusion osmosis

b In which direction will there be overall movement of glucose molecules in the diagram?

c Explain your answer to part b.

3 In a similar experiment, substance X is used instead of glucose. It is soluble in water but has much larger particles that cannot pass through the semi-permeable membrane.

a Name the process that will occur in this case, in which there is an overall movement of water molecules.

b In which direction will there be overall movement of water molecules?

c Explain your answer to part a.

4 A piece of potato of initial mass 25 g was placed in water. After 15 minutes its final mass was 50 g. Calculate the percentage gain in mass of the potato.

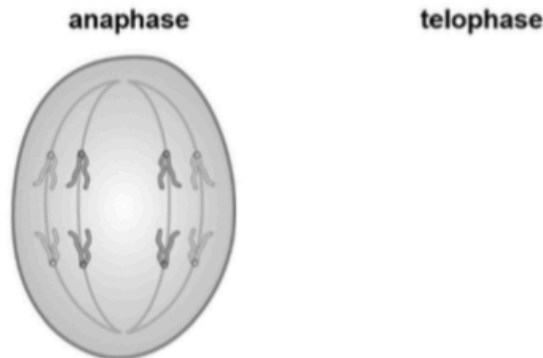
5 Some cells take in substances against their concentration gradient.

a Which transport method is used for this? _____

b Cells that use this transport method have lots of mitochondria. Explain why.

- 1 State two parts of a cell that make copies of themselves before **mitosis** begins.

- 2 Look at the diagram below and draw what the cell looks like in the next stage of mitosis.



- 3 Which part of the **cell cycle** is taking place when:

- a the chromosomes line up on the equator of the cell _____
- b the nucleus membrane is breaking down _____
- c DNA and sub-cellular parts are copied _____
- d the cytoplasm of the cell is separated? _____

- 4 Why is mitosis important for organisms? Tick three boxes to show three reasons.

- growth evolution respiration
- repair reproduction digestion

- 5 The cells produced from mitosis are genetically identical, **diploid** cells.

- a Describe what 'genetically identical' means.

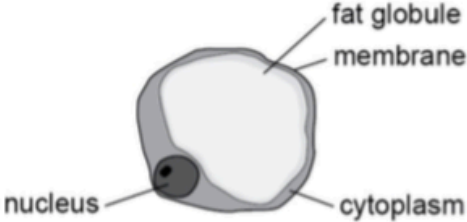
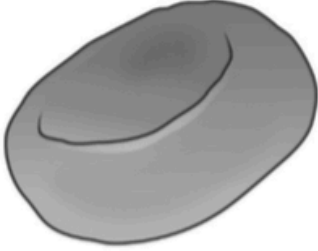
- b Explain what 'diploid' means and why it is important to the cell. (*Hint: What would happen to a cell if it was not diploid and went through two rounds of the cell cycle?*)

1 Growth of an animal can be defined as **cell division** followed by **cell differentiation**. Explain what the bold words mean.

cell division _____

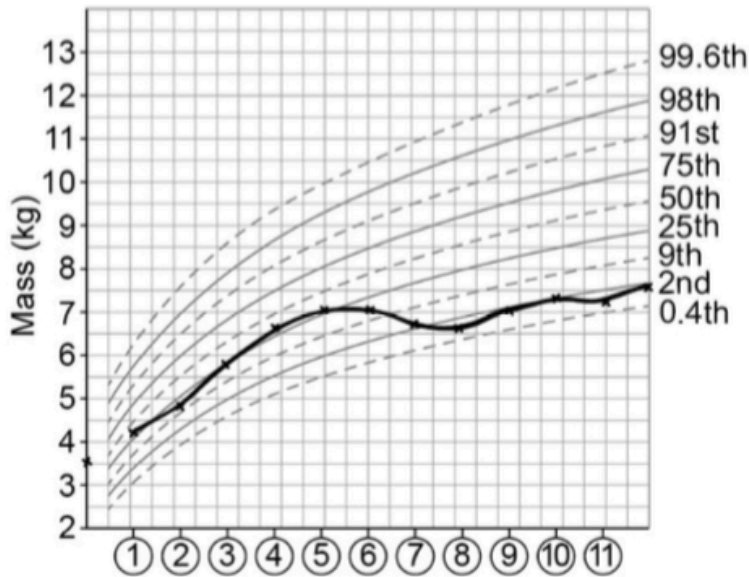
cell differentiation _____

2 The diagrams in the table show some specialised human cells. Complete the table to describe how each cell is specialised and the function of each cell.

<p>Cell</p>	<p>A</p>  <p>fat globule membrane nucleus cytoplasm</p>	<p>B</p> 
<p>How the cell is specialised</p>		
<p>Function of the cell</p>		

3 The mass of a boy was measured every month after birth for his first year, and recorded on **percentile** curves, as shown in the graph.

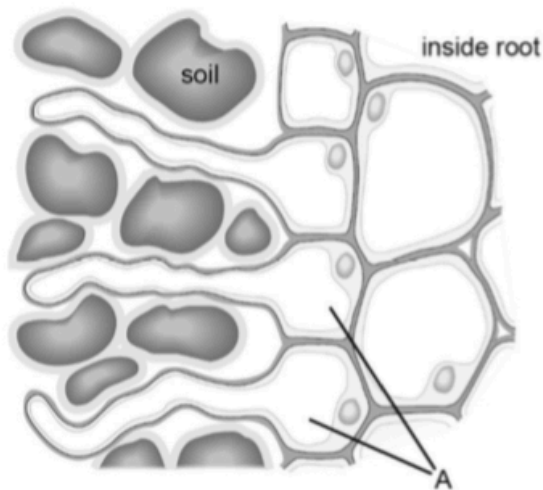
a The boy's mass lay on the 25th percentile when he was 3 months old. What does this mean compared with the mass of other 3-month-old baby boys? Explain your answer.



mass of a baby boy (thick line) displayed on percentile curves

- 1 a Circle the two processes that result in growth of the seedling.
 cell differentiation cell division cell **elongation**
- b Name the part of a shoot or root tip where cell division occurs. _____
- c The cells produced by cell division all look the same. Name the process that results in cells becoming different from one another. _____

- 2 The diagram shows cells along the outer surface of a tree root.



- a Name the type of cell labelled A. _____
- b What feature does this cell have that makes it different from other types of root cell?

- c Explain how this type of cell is adapted to its function.

- d Explain why the adaptation of these cells is important for the plant.

- 3 One month after germination the tree seedling has a mass of 65 g. One year later it has a mass of 345 g. Use this formula to calculate the percentage gain in mass of the tree seedling:

$$\text{percentage change in mass} = \frac{\text{final mass} - \text{starting mass}}{\text{starting mass}} \times 100\%$$

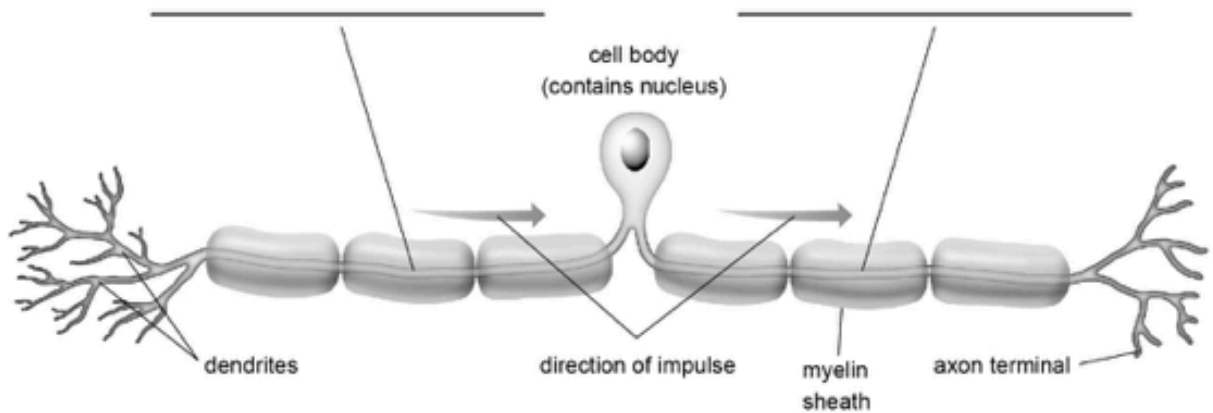
1 The sentences below describe how you feel something that touches the heel of your foot. Write in numbers 1 to 7, to show the order in which the events occur.

- | | |
|--|--|
| _____ impulses transmitted through sensory neurone | _____ object touches the heel |
| _____ brain processes the impulses | _____ you feel the object touching your heel |
| _____ impulses generated in receptor cell | _____ impulses transmitted through neurones in the spinal cord |
| _____ impulses reach the brain | |

2 Unmuddle the letters to show the names of the three main parts of the nervous system.

- REV ENS _____
- RANCID SLOP _____
- IN BAR _____

3 a What sort of cell is shown in the diagram below? _____



- b Add in the two missing labels.
- c Describe one function of the myelin sheath. _____
- _____

4 Explain why the body uses reflex arcs. _____

3 This statement is incorrect: 'Impulses travel through synapses to get from one neurone to another.'

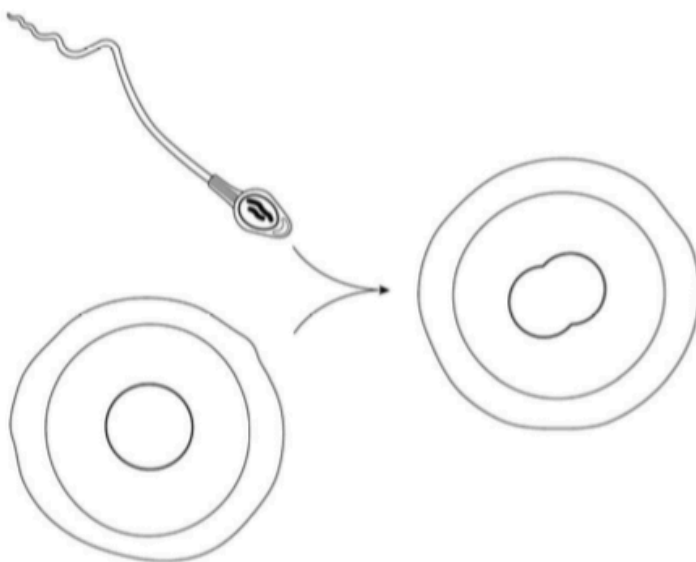
- a Explain why this is incorrect. _____
- _____

1 A zygote contains the genome of an organism.

a What is a genome? Tick one.

- all the DNA in each cell in an organism
- everything inside the cell membrane of the cell
- a description of what an organism looks like
- all the proteins inside the cells of an organism

b The diagram below shows a zygote being formed in an organism that has two different types of chromosome (short and long).



What process is happening in the diagram? Tick one.

- meiosis
- mitosis
- fertilisation
- embryology

c On the diagram, label a zygote and a gamete.

d On the diagram, draw in the missing chromosomes.

2 A haploid cell contains one set of chromosomes.

a Name one of the cells in the diagram in question 1 that is haploid. _____

b How many sets of chromosomes does a diploid cell contain? _____

3 A chromosome contains a length of DNA. Certain sections of the DNA carry instructions.

a What are these sections called? _____

b What do they contain the instructions for? _____

4 a What process makes gametes? _____

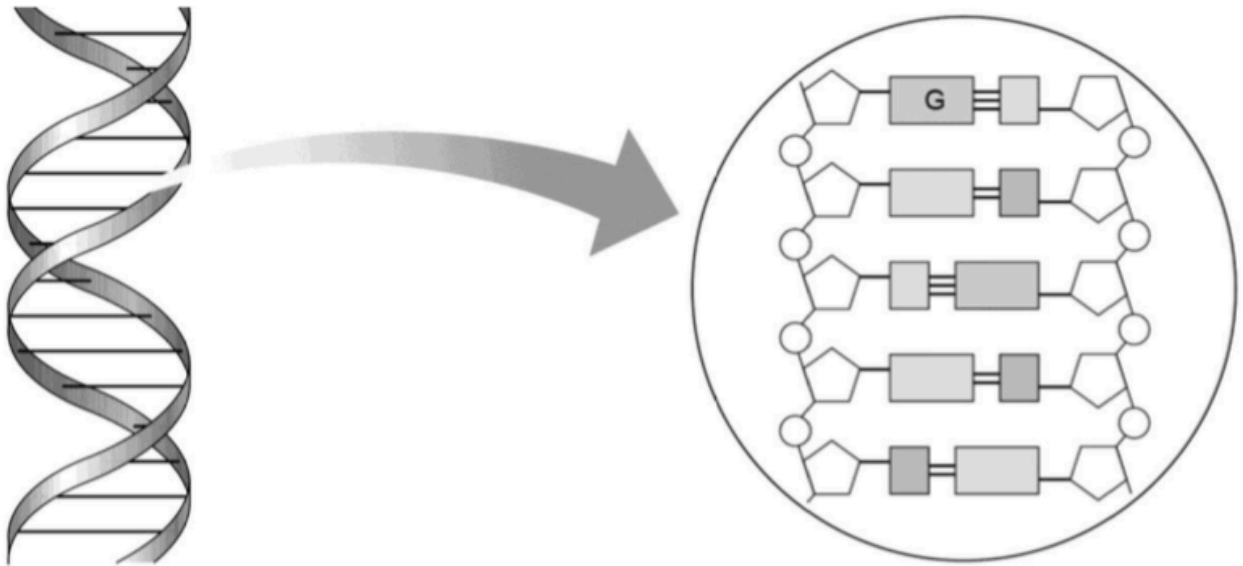
b In this process, how many daughter cells does one cell produce? _____

c These daughter cells are described as being $1n$. What does this mean? _____

d Why do the daughter cells need to be $1n$? _____

e By what process does a zygote grow into an embryo? _____

- 1 DNA contains four types of base: adenine, cytosine, thymine and guanine. Adenine and guanine are bigger than cytosine and thymine. The backbones or spines of the two strands in a DNA molecule are made of small phosphate groups and a sugar that has a pentagon shape. The diagram shows the structure.



- Label each sugar with an 'S'.
- One guanine has been labelled with a 'G'. Label all the other bases with the letters 'A', 'C', 'G' and 'T'.
- Label each phosphate group with a 'P'.
- Label one hydrogen bond with an 'H'.
- Complete this sentence to explain how the two strands in a DNA molecule are held together. All the words you need can be found somewhere on this sheet.

The two strands of a _____ molecule each have a backbone of _____ groups and _____. One of four _____ is attached to each sugar (A, C, T or G). The bases on one strand are attracted to bases on the other strand – A always attracts _____ and _____ always attracts _____. The attractions between the bases are called _____ bonds. The pairs of bases are _____ base pairs. They hold the strands of a DNA molecule together.

- 2 Explain why the structure of DNA is described as a 'double helix'. _____

1 a Diane has the genotype Kk. How many copies of the dominant allele does she have? Tick one.

- none one two three

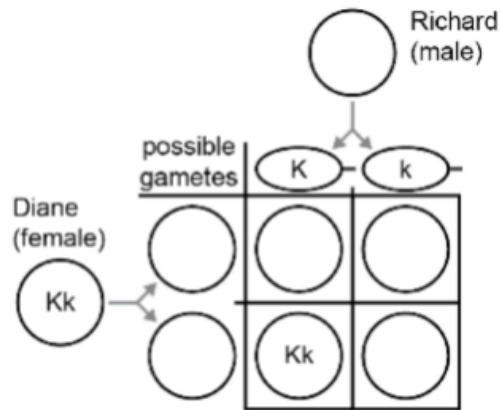
b What is a genotype like this called? Tick one.

- heterozygous homozygous dominant phenotypic

c What alleles will Diane's gametes contain?

- K and K K and k k and k neither K nor k

d Richard has the same genotype as Diane. Complete the Punnett square to show the different combinations of alleles that their children could have.

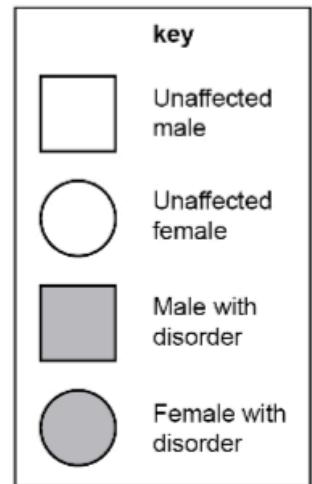
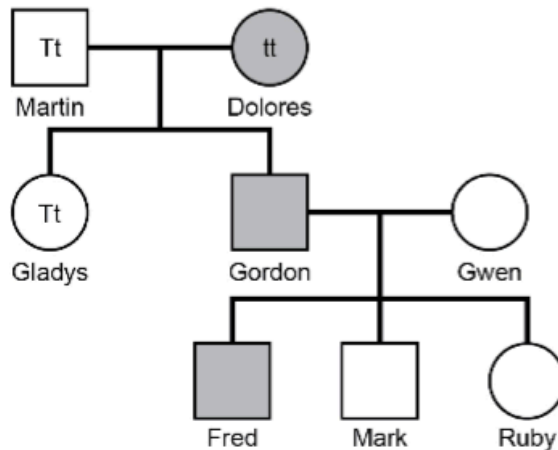


e How many of the offspring should have a dominant allele?

f The disorder PKU is caused by the recessive allele k. What is the ratio of offspring without PKU to offspring with PKU?

g What is the probability that a child of Richard and Diane's will not have PKU? Answer using a percentage and a decimal.

2 The diagram on the right shows a family pedigree chart for a genetic disorder caused by a recessive allele.



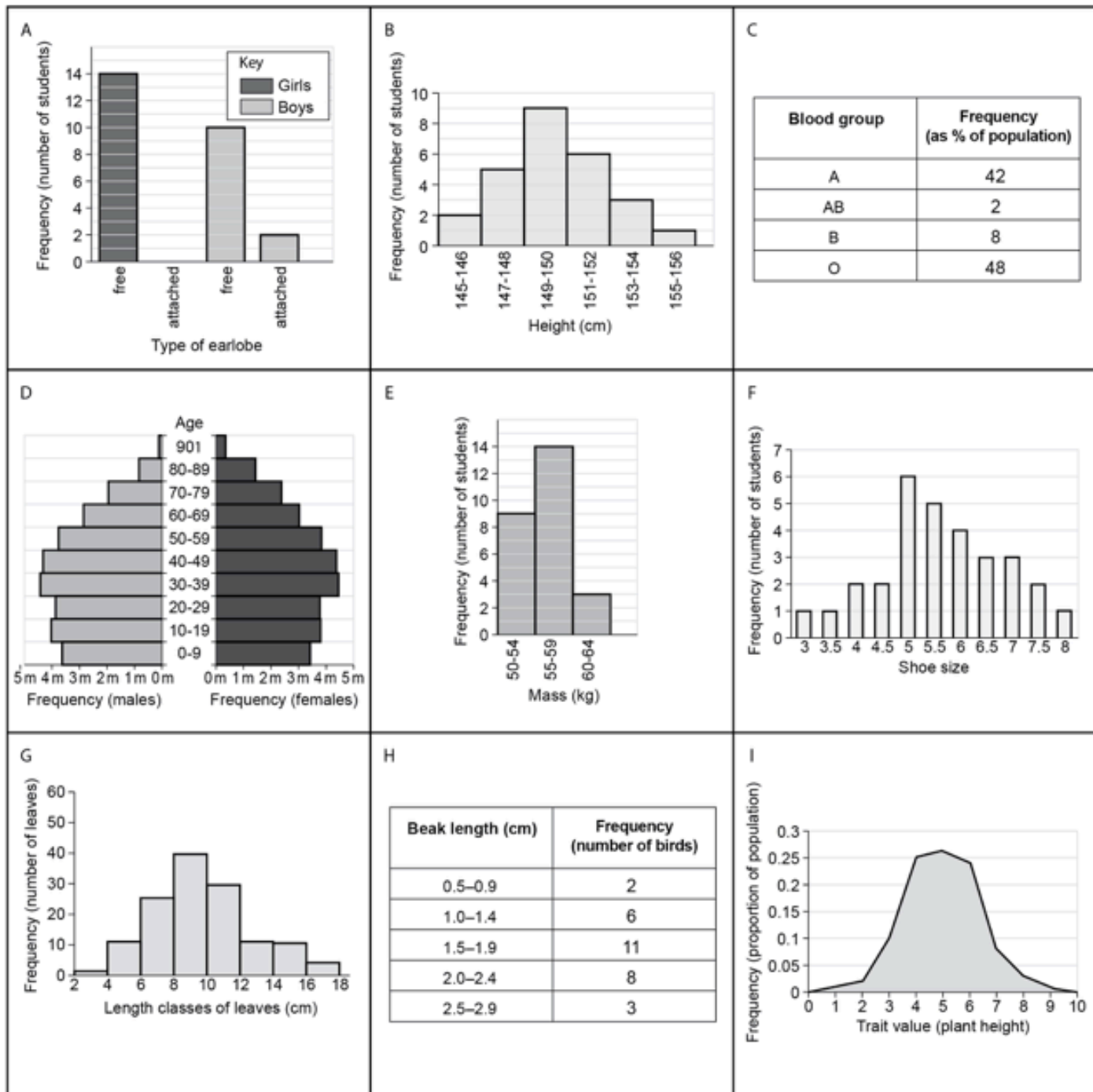
a In Gordon and Gwen's children, what is the ratio of unaffected children to children with the disorder? _____

b Which of Mark's grandparents is homozygous? _____

c What is Gordon's genotype? _____

d What sex chromosomes does Gordon have? _____

These charts and tables present data showing variation in organisms. Look at the data sets then answer the questions below.



1 Decide which tables/charts show examples of the following, and explain your answers:

- continuous variation
- discontinuous variation
- genetic variation
- environmental variation
- normal distribution.

2 For tables C and H, describe how you would present each data set in a chart. Explain your choices.

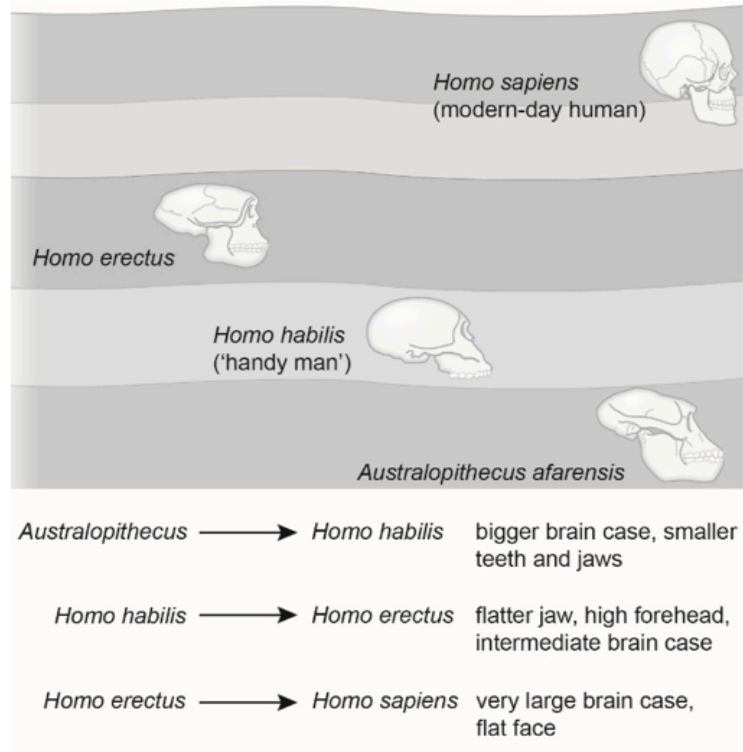
1 Look at the diagram showing some skulls of human-like **species** found in different layers of rock.

a What does the term '**evolution**' mean?

b Label the diagram to show the order of the ages of the skulls.

c How have you worked out this order?

d State one trend from the oldest to the youngest.



e Why can scientists not be sure that each species in the diagram has evolved into the next species?

2 On the diagram above, circle the skull that was found by Richard Leakey in 1984.

3 What is the binomial name of modern humans? _____

4 Some bones from *Ardipithecus ramidus* were discovered in 1994 and found to be 4.4 million years old.

a What nickname was given to this individual? _____

b Where on the diagram above would you expect to find these fossils? _____

5 a Suggest one way stone tools were used by human-like species. _____

b Describe how the stone tools used by human-like species changed over millions of years. _____

c How is the age of a stone tool worked out? _____

d Most scientists think that to make better tools, these animals needed to have bigger brains. What piece of evidence supports this idea about human evolution? _____

1 Peppered moths are naturally speckled or black. Scientists captured 500 black moths and 500 speckled ones. They placed a small white paint dot on the underneath of each one and let the moths go in a polluted part of a city, where many of the buildings were black. Two months later they recaptured moths in the same area. Of the ones with dots on, 34 were speckled and 62 were black.

a Suggest one reason why not all the moths with dots on were recaptured.

b Which type of moth seemed to survive better in the city?

c Why do you think this moth survived better in the city?

d What causes the differences between peppered moths?



2 a Read the sentences below and number them in the order in which you think they occurred.

- A The predator ate more of the mammals with softer hair, because they were easier to eat.
- B A new predator entered the area in which the mammals lived.
- C Over thousands of years, the mammals with the stiffer hairs were more likely to survive and reproduce.
- D Several million years ago, a species of mammal had long, thick hair. By chance, some of the mammals had stiffer hair than others.
- E Over millions of years, this became a species of mammal with spines.

b Read sentence E in question 2a again. What process is occurring in this sentence? Circle one.

environmental variation natural selection evolution adaptation

3 a An antibiotic is added to a large population of bacteria. Explain why not all the bacteria die.

b If the antibiotic remains at constant levels, eventually there will be a large population of bacteria again. Explain why.

1 Add a tick to the column in the table that identifies the correct **kingdom** for each organism.

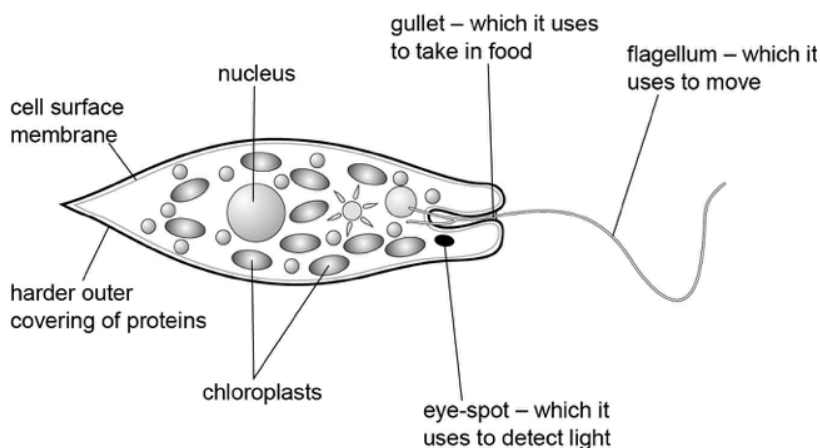
Organism	animals	plants	fungi	protists	prokaryotes
a Multicellular organism that lives attached to rotten trees, on which it feeds. Its cells have a nucleus but not chloroplasts.					
b Its cells have a nucleus but do not have cell walls. The organism has tissues and organs.					
c Single-celled organism that has a large loop of DNA in its cytoplasm.					
d Its cells have cell walls made of cellulose and contain a large permanent vacuole.					
e Its cells have mitochondria but not chloroplasts, nor cell walls.					
f Unicellular organism that has a nucleus and cytoplasm, but its cell surface membrane is covered by a layer of proteins and not a cell wall.					

3 *Bacillus subtilis* is unicellular. Its cells have no nuclei. Its genes do not contain unused pieces of DNA. It moves using flagella. *Methanosarcina barkeri* is single-celled. Its cells do not have nuclei. Its genes contain unused pieces of DNA. It is not able to move by itself.

a Give one reason why both these organisms were originally put in the same kingdom. _____

b These organisms are now often put in two domains. Why are they in different **domains**? _____

c *Methanosarcina barkeri* is in the Archaea domain. What domain is *Bacillus subtilis* in? _____



a Describe one feature that could put *Euglena* in the plant kingdom.

b State why members of the *Euglena* genus are not plants.

c What kingdom does the *Euglena* genus belong in?

d What domain is the genus *Euglena* in? Explain your reasoning.

e What is genetic analysis?

f Explain why genetic analysis would have settled the argument about which kingdom *Euglena* belongs to earlier.

1 Name the state of matter in which the particles:

a are close together and randomly arranged.

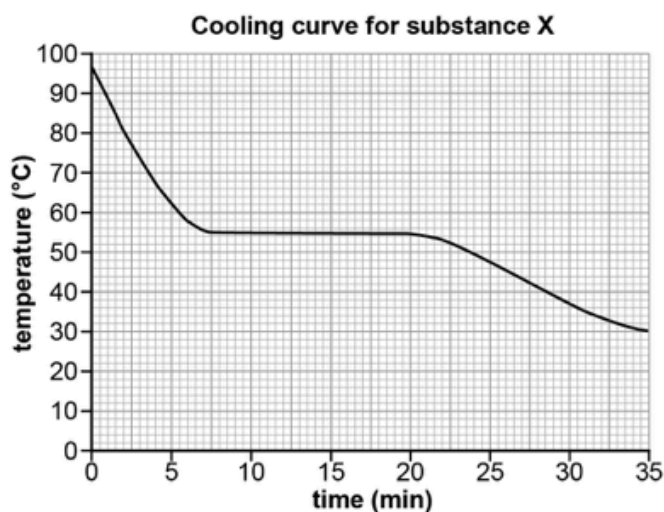
b are regularly arranged.

c have no attractive forces between them.

2 Describe what happens to the arrangement and movement of particles when a substance boils.

3 Explain why changes of state are physical changes.

4 The diagram shows the cooling curve for substance X.



Add the labels **a**, **b**, **c** or **d** to the graph to show:

a where the substance is freezing

b the melting point of the substance

c where the substance is in the liquid state and cooling down

d where the mean energy of the particles is highest.

5 Butane is a fuel. Its melting point is $-140\text{ }^{\circ}\text{C}$ and its boiling point is $-1\text{ }^{\circ}\text{C}$.

Predict the state of butane at $-150\text{ }^{\circ}\text{C}$ and at $25\text{ }^{\circ}\text{C}$.

1. Match each word to the correct definition.

solute	material remaining in the filter after mixture has passed through it
solution	solution passing through a filter
insoluble	formed when a substance has dissolved in a liquid
residue	substance that has dissolved in a liquid to make a solution
filtrate	describes a substance that cannot be dissolved in a certain liquid
solvent	the liquid in which a solute dissolves to make a solution

2. The list below shows the steps for separating sand and salt. Number the steps to show the correct order starting with 1.

crystallisation [] crushing [] dissolving [] heating [] filtration []

3. Show which type of mixtures can be separated by filtration and/or by crystallisation. Put ticks in the correct boxes to show a method that can be used.

Method of separation	Filtration	Crystallisation
a Large-particle insoluble solids from a liquid		
b Soluble salts from a solution		
c Insoluble impurities from a salt solution		

4. Draw and label a diagram to show how you would set up equipment to filter and crystallise a mixture of salt, sand and water to get samples of salt and sand.

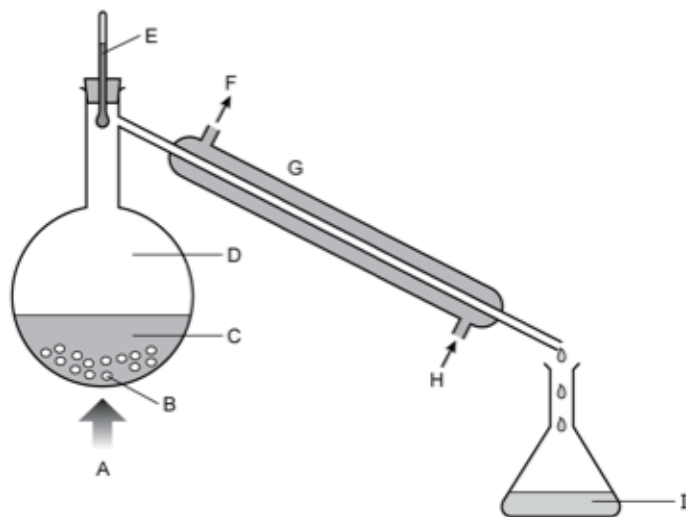
5. List two hazards for filtration and crystallisation. For each hazard state how the risk can be reduced.

Hazard:	Ways of reducing the risk:

Here is a diagram of a still. Look at the diagram and then answer the questions.

1 Which letter shows:

- the thermometer _____
- where you would put the Bunsen burner _____
- where pure water is collected _____
- the anti-bumping granules _____
- the condenser _____
- where the temperature might be higher than 100 °C _____
- where tap water goes into the condenser _____
- where tap water comes out of the condenser _____
- where water vapour is rising? _____



2 The paragraph below describes how fractional distillation can be used to separate ethanol and water. Complete the sentences using words from this list:

condenser	condenses	distillate	evaporates
heat	liquid	stays	vapour

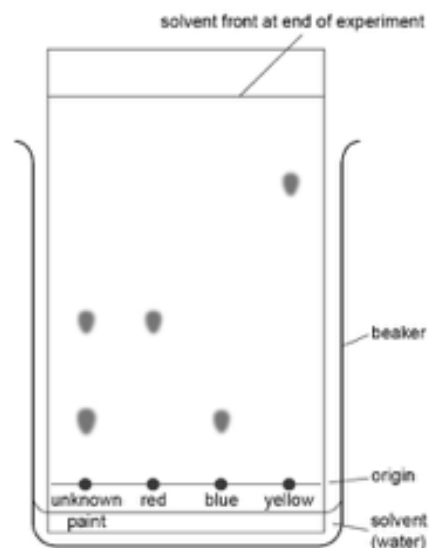
The Bunsen burner is used to _____ the round flask. The _____ mixture starts to boil. The ethanol _____ before the water, because it has a lower boiling point. The water _____ in the round flask. The ethanol _____ rises to the top of the flask – the thermometer reads about 80 °C. The ethanol vapour moves down the side arm into the _____. The ethanol vapour _____ on the cool tube and turns back into a liquid. Ethanol (the _____) collects in the conical flask.

1 Jack did an experiment to look at the pigments in some water-soluble paint. He used paper chromatography.

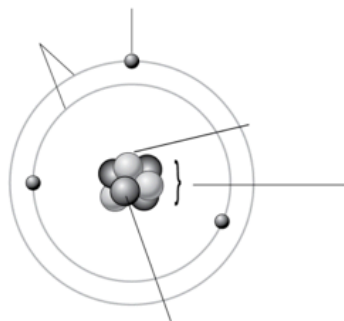
- Why is the level of the solvent lower than the level of the spots?
- Why has he put the red, blue and yellow paints next to the unknown paint?

The diagram on the right shows the chromatogram that Jack obtained.

- What colour paints were in the 'unknown' paint that Jack used? Explain your answer.



2 Complete the labels on the diagram of this atom.



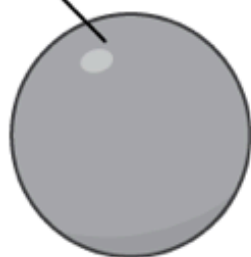
electron
neutron
nucleus
proton
shells

3 Complete the table about subatomic particles using the information in the box below.

Subatomic particle	Relative charge	Relative mass	Where found in atom
neutron	+1	in the nucleus	1
electron	-1	negligible (almost 0)	around the nucleus

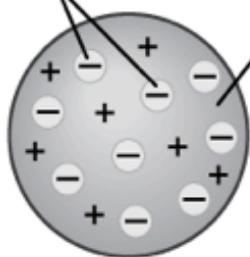
Because of the discovery of new evidence, most scientific theories change and develop over the years. Atomic structure is a good example of a theory that has changed over the last 200 years as new evidence has been obtained.

solid sphere



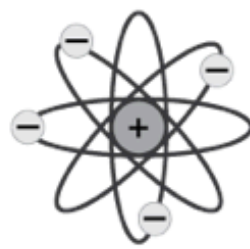
Dalton's billiard ball model of an atom
1805

negative particles



Thomson's 'Plum pudding' model
1904

solid positive sphere



Rutherford's nuclear atomic model
1911

The first model represents John Dalton's 'tiny solid particles' that make up all matter. Then, almost 100 years later, after the discovery of charged particles, JJ Thomson proposed his 'plum-pudding' model. At the start of the twentieth century there was increased interest in investigating theories about atoms. This led to further evidence of charged particles and how they were arranged inside the atom. This resulted in Ernest Rutherford's model with each atom having a small positive central mass.

- How did Dalton's ideas about atoms help to explain the difference between elements?
- Look at Thomson's 'plum-pudding' model.
 - Suggest a name for the negatively charged particles in this model.
 - Why do you think it was called the 'plum-pudding' model?
- How could Thomson's atomic model be used to explain the differences between elements?

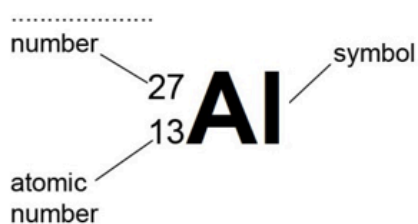
2 Complete this table.

Element's symbol	Atomic number	Mass number	The number of ...		
			protons	electrons	neutrons
O	8	16			
Zn	30	65			
Au	79	197			

3 Complete the missing information below and in the figure opposite.

number of protons = _____

number of neutrons = _____



4 Complete the table below by adding in the missing information.

Symbols	protons	electrons	neutrons
$^{81}_{35}\text{Br}$			
$^{40}_{20}\text{Ca}$			

3 The table below shows some information about different atoms of the element lead.

Name	Z	A	Number of			Abundance in natural lead samples
			protons	neutrons	electrons	
lead	82	206				26.5%
lead		207		125	82	26.5%
		208	82	126		47%

a Complete the table by filling in the missing numbers.

b The relative atomic mass of lead is 207.205. Explain why the relative atomic masses of elements are rarely whole numbers.

1 a Explain the main features of the modern periodic table using the diagram below.

In each box, write a brief description of the feature it points to.

b Draw a line to show the boundary between metals and non-metals.

The diagram shows a periodic table with the following elements and their atomic numbers:

1	2											3	4	5	6	7	0		
																			4
																			He
																			2
7	9											11	12	14	16	19	20		
Li	Be											B	C	N	O	F	Ne		
3	4											5	6	7	8	9	10		
23	24											27	28	31	32	35.5	40		
Na	Mg											Al	Si	P	S	Cl	Ar		
11	12											13	14	15	16	17	18		
39	40	45	48	51	52	55	56	59	59	63.5	65	70	73	75	79	80	84		
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr		
19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36		
85	88	89	91	93	96	[98]	101	103	106	108	112	115	119	122	128	127	131		
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe		
37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54		
133	137	139	178	181	184	186	190	192	195	197	201	204	207	209	[209]	[210]	[222]		
Cs	Ba	La*	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn		
55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86		
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	Elements with atomic numbers 112-116 have been reported but not fully authenticated								
Fr	Ra	Ac*	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg									
87	88	89	104	105	106	107	108	109	110	111									

2 Dmitri Mendeleev arranged the elements in order of increasing relative atomic mass.

a Explain why, according to this order, he should have placed tellurium (Te) and iodine (I) the other way around.

b Explain why tellurium is placed before iodine in the modern periodic table.

c Atoms may have the same atomic number but different mass numbers. What are such atoms called?

3 a Give the modern meaning of the term 'atomic number'.

b Explain, in terms of their properties, why helium and neon are placed in the same group.

1 What name is used to describe the arrangement of electrons around the nucleus of an atom?

2 Complete this table to show the number of electrons in each atom.

Element	Li	O	Al	Ar
Atomic number	3	8	13	18
Number of electrons				

3 The atomic number of nitrogen is 7, so nitrogen atoms contain 7 protons (and so 7 electrons). The electronic configuration of nitrogen is 2.5 (two electrons in the first shell and five in the outer shell).

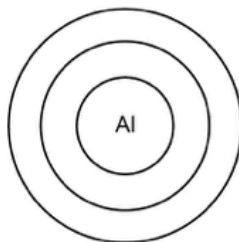
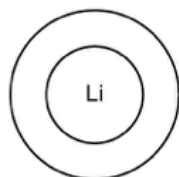
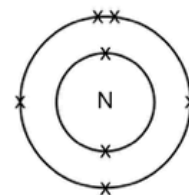
Use your answers to question 2 to help you complete this table.

Element	Li	O	Al	Ar
Electronic configuration				

4 The diagram on the right shows the electronic configuration of nitrogen.

Use your answers to question 3 to draw the electronic configurations of lithium and aluminium in the space below.

Show each electron as a cross. The correct number of shells have already been drawn for you.



5 In the space below, draw the electronic configurations of oxygen and argon.

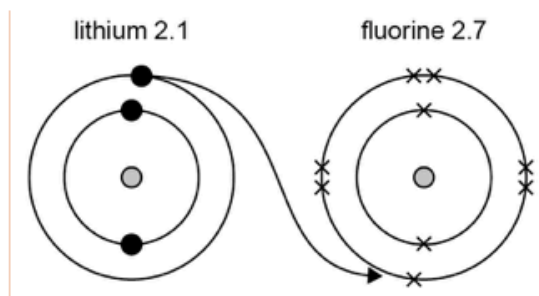
S1 How do you work out the electronic configuration of an element?

6 Describe the link between the group number and the number of electrons in the outer shell, and the period number and the number of occupied shells. You may need to use a periodic table to help you.

Copy and complete the table below. One row has been done for you.

Element	Electron arrangement	Group number	Metal or non-metal	Electrons lost or gained	How many electrons	Charge on ion	Ion symbol
Li	2.1	1	metal	lost	1	1+	Li ⁺
Na							
Mg							
Al							
O							
S							
F							
Cl							

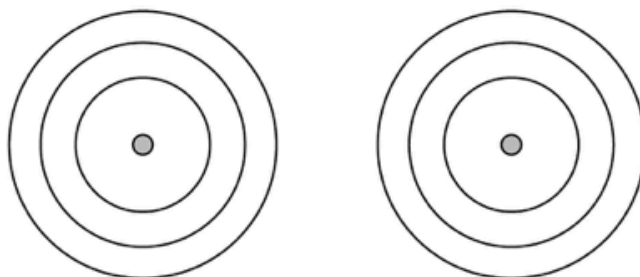
2 Use the diagram below to answer the questions that follow.



- a Which atom loses an electron? _____
- b Which atom gains an electron? _____
- c Write the symbols for the positive and negative ions formed: _____ and _____.

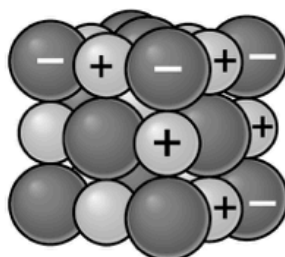
S1 Describe what happens when lithium (group 1) and fluorine (group 7) react to form an ionic bond.

3 Complete the dot and cross diagrams below to show the electron arrangements of the ions formed in question 2. You will not need electrons in all the shells.



- 1 Complete the diagram and sentences below about the structure of ionic compounds.

The anion is the _____ ion.



The _____ is the positive ion.

This is a cubic _____ structure.

The ions are held together by strong _____ forces of attraction. The attraction is between _____ and _____ charged _____. This regular arrangement holds _____ of ions together in the lattice.

- 2 Complete these tables of ion names and formulae.

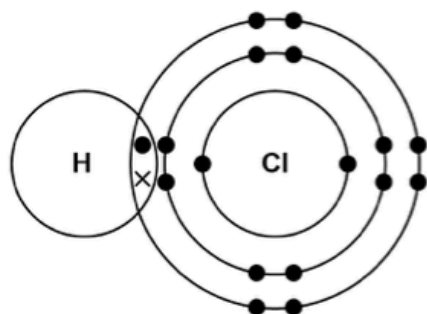
Positive ion name	Formula	Charge
sodium	Na ⁺	1+
ammonium	NH ₄ ⁺	
	Li ⁺	
calcium	Ca ²⁺	
aluminium		3+
	Mg ²⁺	

Negative ion name	Formula	Charge
	N ³⁻	
chloride		1-
oxide	O ²⁻	2-
	NO ₃ ⁻	
sulfate	SO ₄ ²⁻	
carbonate	CO ₃ ²⁻	

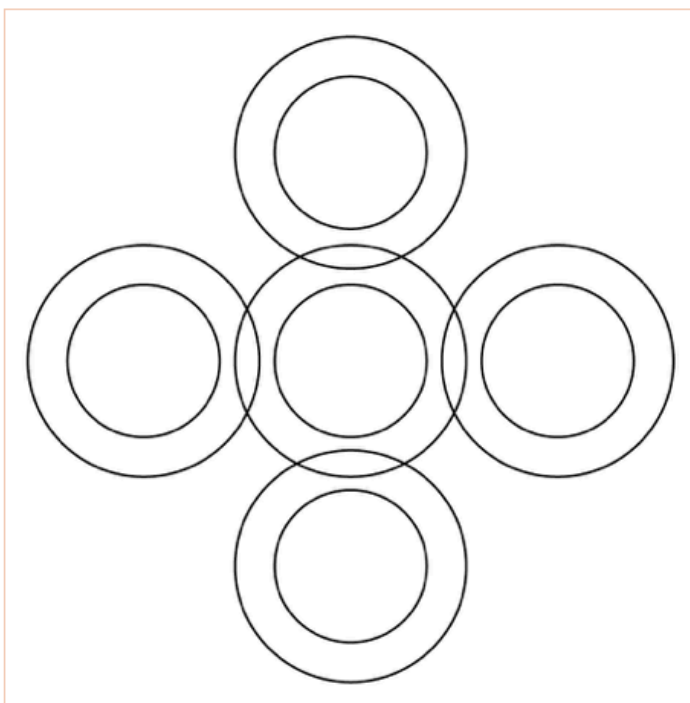
- 3 Use the ion formulae above to complete the two tables below with the correct formulae of the ionic compounds formed by the named ions.

a	chloride	oxide	nitride
sodium		Na ₂ O	
calcium		CaO	
aluminium	AlCl ₃		

S1 What does this diagram tell you about hydrogen chloride?



6 Complete the drawing opposite to give a dot and cross diagram that explains the bonding between carbon (electronic configuration 2.4) and fluorine (electronic configuration 2.7).

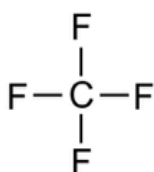


1 A molecule can be formed from four atoms of fluorine (electronic configuration 2.7) and one atom of carbon (electronic configuration 2.4).

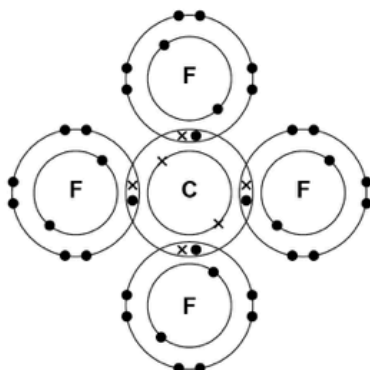
This molecule can be represented in different ways, for example:



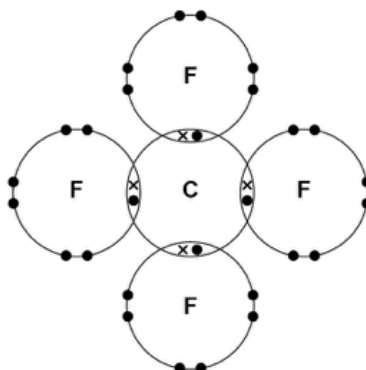
Molecular formula



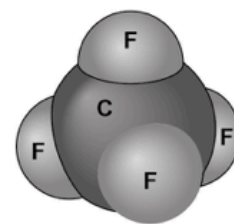
Structural formula



Full dot and cross diagram



Outer shell dot and cross diagram



3D structure

- Explain the difference between a molecular formula and a structural formula.
- Draw four different representations of a water molecule. A water molecule contains two atoms of hydrogen (electronic configuration 1) and one atom of oxygen (electronic configuration 2.6).

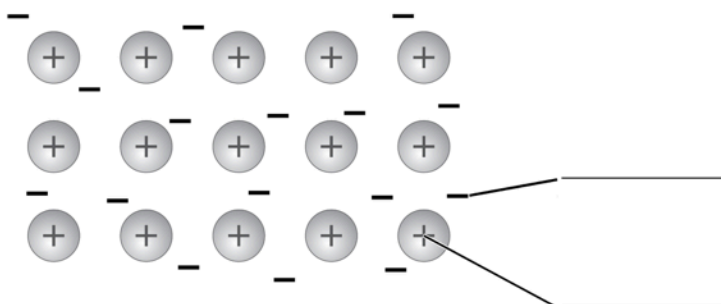
Material	Structure and bonding	Properties	Uses
Diamond			
Graphite			
Graphene			
C ₆₀			

used as a dry lubricant has a layered structure	a single sheet of carbon with free electrons conducts electricity well	giant covalent structure poor conductor of electricity	a 2D hexagonal sheet of carbon light (not heavy)
three covalent bonds per carbon atom giant structure covalently bonded	spherical fullerene made up of 60 carbon atoms	weak intermolecular forces between simple molecules	a very hard material used in cutting tools
2D structure with strong covalent carbon-carbon bonds exceptional strength	rigid network of carbon atoms four covalent bonds per carbon atom	strong bonds within molecule, but weak forces between molecules soft and slippery	delocalised electrons act as charge carriers used to make electrodes for electrolysis

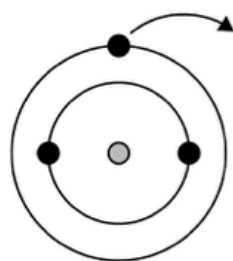
- 1 Complete the sentences below using words from the box. Each word may be used once, more than once or not at all.

brittle	dull	good	high	low	malleable	poor	shiny
---------	------	------	------	-----	-----------	------	-------

- a Most metals have a _____ melting point.
- b Metals are _____ when polished and they are _____ conductors of electricity.
- c Solid non-metals are _____ when they are hit with a hammer.
- d Non-metals are _____ conductors of electricity.
- 2 a The diagram below shows the particles in a metal. Label the particles.

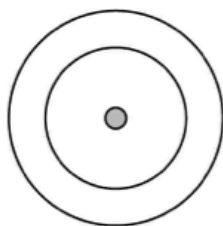


1 Complete the diagrams below showing different models of the bonding and structure of lithium fluoride.

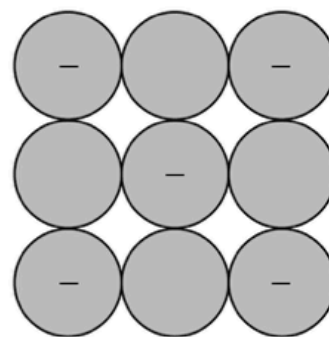


lithium 2.1

a



fluorine 2.7



b

2 Complete the descriptions of the structure and bonding of the following substances.

Substance	Melting point (°C)	Boiling point (°C)	Conductor of electricity when:			Type of structure and bonding (covalent, simple molecular; covalent, giant molecular; ionic; or metallic)
			solid	liquid	in solution	
A	1083	2567	yes	yes	insoluble	
B	-107	13	no	no	no	
C	2300	4000	no	no	insoluble	
D	605	1350	no	yes	yes	
E	6	80	no	no	insoluble	

3 Complete the following sentences.

a Simple molecular substances have low melting points because _____

b Ionic substances conduct electricity when molten or dissolved in water because _____

4 Complete the missing words in the sentences below, which describe some strengths and weaknesses of the structure and bonding models shown at the top of the page.

a D_____ and cross diagrams are useful as they show what happens to the e_____ when a b_____ is formed. However, these diagrams do not show the s_____ of the structure formed by the atoms when they bond.

b An ionic lattice diagram shows how the oppositely charged i_____ are packed together to form the l_____. However, it does not show how the b_____ are formed.

Element	H	Li	C	N	O	Na	Mg	S	Cl	K	Ca	I
Relative atomic mass (A_r)	1	7	12	14	16	23	24	32	35.5	39	40	127

1 Calculate the **relative formula mass** of each of the following compounds.

a potassium iodide, KI _____ $M_r =$ _____

b sodium sulfate, Na_2SO_4 _____ $M_r =$ _____

c calcium hydroxide, $\text{Ca}(\text{OH})_2$ _____ $M_r =$ _____

2 Write the **empirical formula** of each of the following substances.

a N_2H_4 _____

b C_6H_{14} _____

c C_9H_{20} _____

3 Calculate the empirical formula of each of the following substances with the following compositions.

a 3.60 g of magnesium and 10.65 g of chlorine

b 9.1 g of lithium and 10.4 g of oxygen

4 State the difference between an empirical formula and a **molecular formula**.

5 Work out the molecular formula of each of the following substances.

a octane, with empirical formula C_4H_9 and $M_r = 114$

b butanoic acid with empirical formula $\text{C}_2\text{H}_4\text{O}$ and $M_r = 88$

The **empirical formula** of magnesium oxide can be determined using the apparatus shown.

1 Identify the pieces of apparatus labelled from **A** to **F**.

A _____

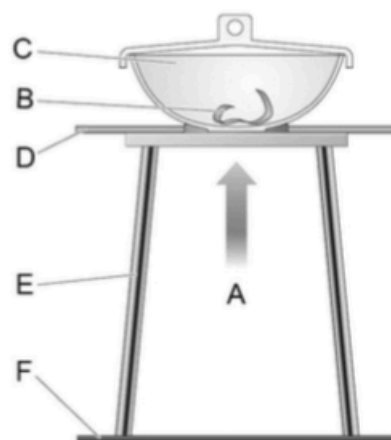
B _____

C _____

D _____

E _____

F _____



2 List the measurements that need to be taken.

3 State why the lid needs to be lifted occasionally during heating.

4 State how you will know when all the magnesium has reacted.

5 Number the steps below in the order that you would do them to work out the empirical mass of magnesium oxide. The first one has been done for you.

[] Divide both answers by the smaller of the two to find the simplest ratio.

[] Find the mass of oxygen used.

[1] Look up the relative atomic masses of magnesium and oxygen.

[] Write out the empirical formula.

[] Divide the mass of each element by its A_r .

[] Find the mass of magnesium used.

[] Find the simplest whole number ratio.

Use the following relative atomic masses: C = 12, O = 16, Na = 23, Cl = 35.5, K = 39

Potassium carbonate reacts with hydrochloric acid as shown in the equation.



1 Give the names of the products in this reaction.

2 Explain why there appears to be a loss in mass during this reaction.

3 Calculate the relative formula mass of:

a K_2CO_3 _____

b KCl. _____

4 The equation shows that K_2CO_3 produces 2KCl.

Complete the following sentence using your answers to question 3.

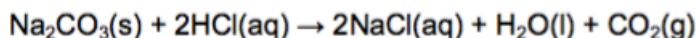
_____ g of K_2CO_3 produces _____ g of KCl.

5 Write the fraction for the mass of KCl produced from 1 g of K_2CO_3 .

6 Calculate the maximum mass of KCl produced from 1.38 g of K_2CO_3 .

7 Carry out the following calculation. Explain each step in your working so that a friend who missed the lesson can follow it.

Calculate the maximum mass of sodium chloride formed when 5.3 g of sodium carbonate reacts with excess dilute hydrochloric acid, as shown in the equation.



mass of sodium chloride formed = _____ g

Element	H	C	N	O	Na	S	Cl	K
Relative atomic mass (A_r)	1	12	14	16	23	32	35.5	39

The **Avogadro constant** is $6.02 \times 10^{23} \text{ mol}^{-1}$.

1 Describe what is meant by a **mole** of sodium atoms.

2 Calculate the number of moles of water molecules, H_2O , in 27 g of water.

3 Calculate the mass of 0.25 mol of sodium chloride, NaCl .

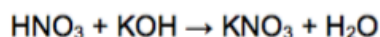
4 Calculate the number of molecules in 0.5 mol of sulfur dioxide, SO_2 .

5 Calculate the number of moles in 3.01×10^{22} atoms of calcium.

6 Calculate the number of molecules in 8 g of oxygen, O_2 .

7 Calculate the mass of 1.204×10^{22} molecules of ethane, C_2H_6 .

8 A solution containing 0.1 mol of potassium hydroxide was added to a solution containing 0.15 mol nitric acid, HNO_3 . The reaction taking place is



a Explain which of the reactants is the **limiting reactant**.

b Calculate the maximum mass of potassium nitrate, KNO_3 , that could be produced in this reaction.

1 Write 'scalar' or 'vector' next to each of the following quantities.

- a speed _____ b displacement _____ c time _____
 d mass _____ e velocity _____ f distance _____
 g energy _____ h weight _____ i force _____

2 The distance from Sally's home to school in a straight line is 0.8 km. Complete Sally's statements using words from the box. You can use each word once, more than once or not at all.

a The distance I walked was _____
 _____.

b My _____ was the same during the journey but my _____ changed because the road has bends.

c The time I took for my journey was _____
 _____.

d My displacement when I arrived at school was _____.

0.2 0.8 1.0 10 15 km
 min speed velocity

S1 A peregrine falcon flies at 50 m/s for 7 s. How far does it fly?

1 The boxes on the right show two formulae linking speed, time and distance. Which one do you need to use to answer the question above? _____

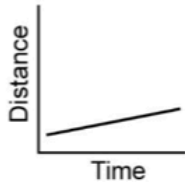
A $speed = \frac{distance}{time}$

2 Fill in the numbers below and then work out the answer.

B $distance = speed \times time$

_____ = _____ × _____
 = _____ m

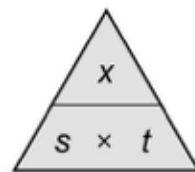
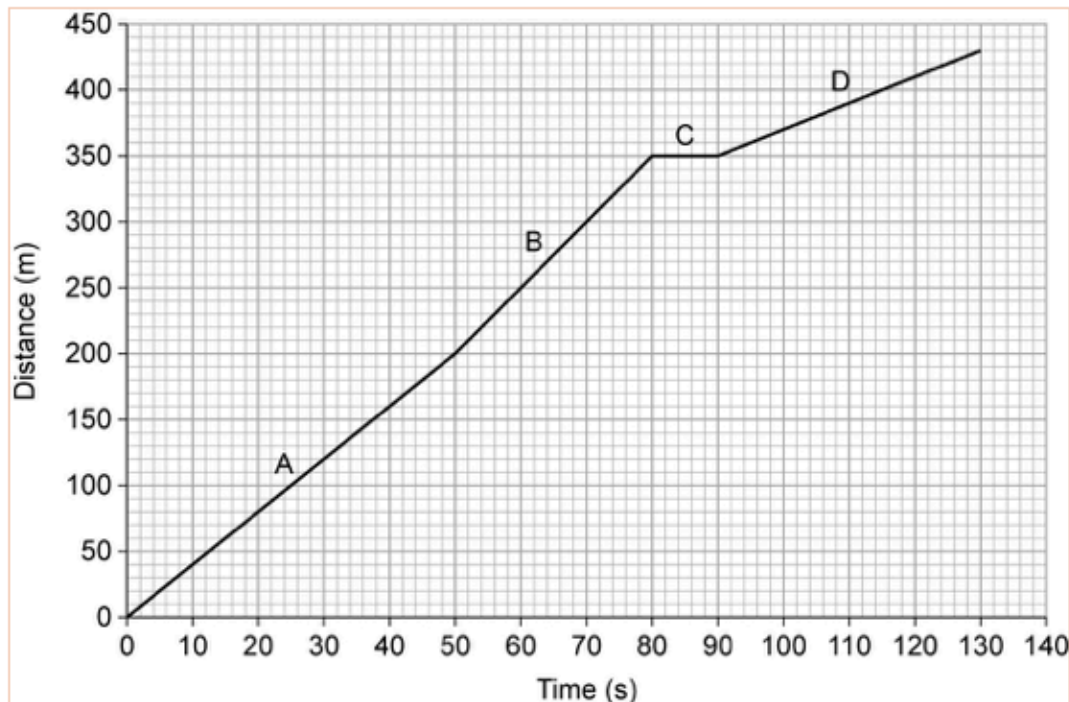
3 The four graphs below are all drawn with the same scales. They show different speeds. Write the speed under each graph, choosing numbers from the box on the right.



- 0 m/s
 2 m/s
 4 m/s
 6 m/s

speed = _____ speed = _____ speed = _____ speed = _____

This is a distance/time graph for a cyclist travelling along a road.



This triangle can help you rearrange the formula for speed. Cover up the quantity you want to calculate, then write what you can see on the right of your = sign.

Remember, x represents distance.

- 1 a Which section of the graph shows where the cyclist waited at a junction? _____
 b For how long did the cyclist wait? _____
- 2 a Which section of the graph shows where the cyclist was travelling the fastest? _____
 b How can you tell from the graph that the speed was fastest here? _____
- 3 a How far did the cyclist travel in the first 50 s? _____
 b Calculate the speed in the first 50 s.

speed = _____ m/s

- 4 Part of the journey was uphill. Explain which part of the graph is likely to show this part of the journey.

- 5 A cheetah can run for a short time at 3 m/s (70 mph). How far can it travel in 19 s?

distance = _____ m

- 6 A tortoise can crawl at a top speed of 0.2 m/s. How long will it take the tortoise to travel 15 m?

time = _____ s

1 Complete the following sentences using words from the box. You can use each word once, more than once or not at all.

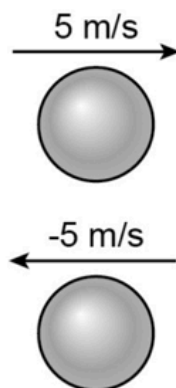
Speed is a _____ quantity and velocity is a _____ quantity.

_____ quantities have both a size and a _____.

The two objects on the right both have the same _____. They have different _____, because one is moving in the opposite direction to the other. This is shown by the _____ sign.

Acceleration is a change in _____, so it is also a _____ quantity.

An acceleration in the same direction as an object is moving will make a moving object _____. An acceleration in the opposite direction to the movement of an object will make the object _____ (_____). An acceleration of _____ will not change the velocity of an object.



decelerate direction magnitude minus scalar slow down
 speed up vector velocities velocity zero

S2 A car travelling at 40 m/s comes to a halt in 8 seconds. What is the car's acceleration and how far does it travel while it is stopping?

2 The box on the right shows the formula for calculating acceleration.

$$a = \frac{v - u}{t}$$

a Use the information in question **S2** to complete the table.

b Calculate the value of $(v - u)$.

c Calculate the acceleration.

Symbol	represents...	value in question	unit
a	acceleration	??	
v			
u			
t		8	s

3 The box on the right shows the formula relating velocities, acceleration and distance. Use your answers to question **2** to fill in the gaps below, and then work out the answer.

$$x = \frac{v^2 - u^2}{2 \times a}$$

$$x = \frac{(0 \text{ m/s} \times 0 \text{ m/s}) - (\text{_____ m/s} \times \text{_____ m/s})}{2 \times \text{_____}}$$

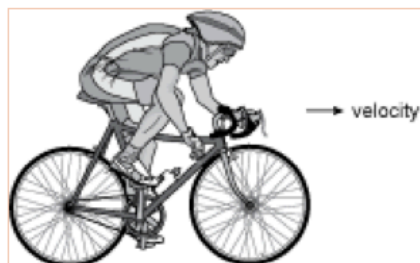
distance = _____ m

- 1 Work out the value of acceleration for each bicycle. Use the formula in the box.

$$a = \frac{v - u}{t}$$

Draw an arrow in the space above each diagram to show the direction in which the acceleration is acting.

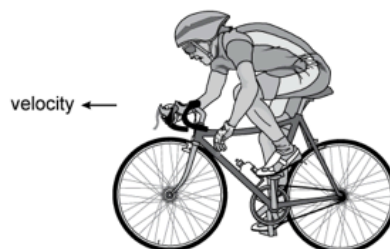
a



$$u = 8 \text{ m/s} \quad v = 12 \text{ m/s} \quad t = 4 \text{ s}$$

$$a = \underline{\hspace{2cm}} \text{ m/s}^2$$

b



$$u = 11 \text{ m/s} \quad v = 5 \text{ m/s} \quad t = 3 \text{ s}$$

$$a = \underline{\hspace{2cm}} \text{ m/s}^2$$

- 2 Calculate the following accelerations.

a At the start of a race, a sprinter accelerates from rest to 10 m/s in 2 seconds.

b At a set of traffic lights, a lorry slows down from 30 m/s to 0 m/s in 20 seconds.

- 3 You drop a tennis ball to the ground. What is the acceleration of the ball as it leaves your hand?

- 4 A car accelerates from rest (0 m/s) to 50 m/s in 5 seconds. Its acceleration is 10 m/s².

a Which of the formulae below do you need to use to calculate how far it travels while it is accelerating? Tick one box.

$t = \frac{v - u}{a}$

$x = \frac{v^2 - u^2}{2 \times a}$

$a = \frac{v^2 - u^2}{2 \times x}$

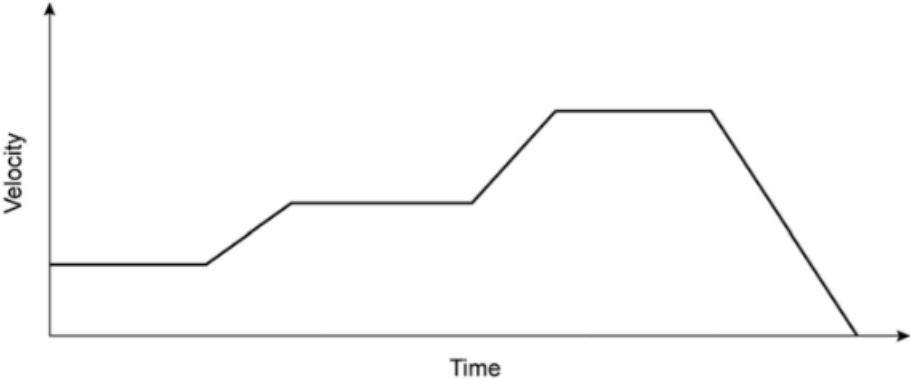
b Which piece of information in the question do you *not* need to answer the question? _____

c Calculate how far the car travels while it is accelerating.

distance $x = \underline{\hspace{2cm}}$ metres

1 This is a velocity/time graph for a horse and rider travelling along a straight track. (A gallop is faster than a trot.)

- galloping at a steady velocity
- slowing down to a stop
- speeding up into a gallop
- walking at a steady velocity
- trotting at a steady velocity
- speeding up into a trot

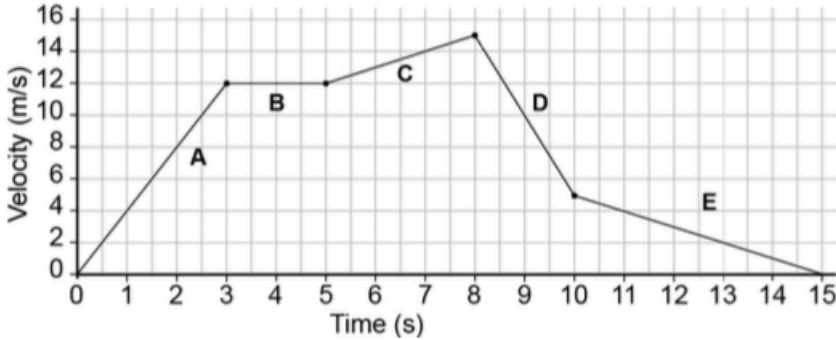


- a Draw a line from each label to the correct part of the graph.
- b Which acceleration was greater? Tick the correct answer.

speeding up into a gallop speeding up into a trot

Explain your choice. _____

2 a Calculate the acceleration in part C of this graph.



b Calculate the acceleration in part D of the graph.

c Calculate the distance travelled in the first five seconds. (Hint: Calculate the distance travelled in part A by working out the area of a triangle. Calculate the distance travelled in part B by working out the area of a rectangle.)

S1 You are cycling along a flat road and your speed is increasing. Explain the resultant forces on you in the horizontal and vertical directions.

- 1 You are cycling along a flat road.
 - a Are you moving up or down? _____
 - b What is the force that is pulling you downwards? _____
 - c There is a force from the road acting on the bike. Is this force acting upwards or downwards?

 - d Are the forces in **b** and **c** balanced or unbalanced? _____
 - e What is the size of the resultant force on you in the vertical direction? _____
- 2 As you cycle along the flat road your speed is increasing.
 - a What are the forces acting in a horizontal direction? _____
 - b Are the forwards and backwards forces balanced? _____
 - c Circle the two words that describe the resultant force on you in a horizontal direction.

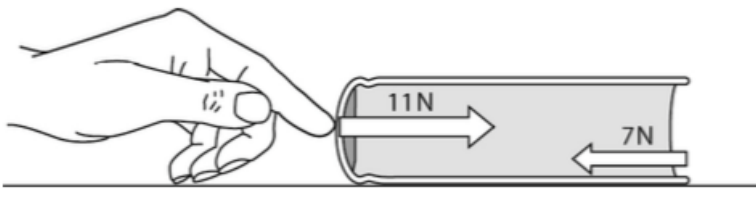
backwards forwards non-zero zero

- 3 Complete these sentences using words from the box below. You can use each word once, more than once or not at all.
 - a If forces in opposite directions are equal in size, the forces are _____.
The resultant force is _____.
 - b Balanced forces on a moving object _____ change its speed or _____ of movement.
 - c If the forces are _____, there is a _____ resultant force on the object.
 - d A resultant force can make a _____ object start to move. If the object is moving, the force _____ change the speed or direction of movement.

balanced can direction do not large non-zero small stationary unbalanced zero

2 Look at the diagram of the book. Circle the correct answer to each of the questions.

- a Which way will the book move?
left right up down
- b What is the resultant force on the book?
4 N 7 N 11 N 18 N



1 a Write a sentence to describe what the mass of an object is. Include the word 'matter' in your answer.

b What are the units used for measuring mass? _____

2 a Write a sentence to describe what the weight of an object is. Include the words 'force' and 'gravity' in your answer.

b What are the units used for weight? _____

S2 A cat has a mass of 2 kg. Calculate its weight on Earth.

3 a Write out the formula for calculating weight. weight = _____ × gravitational _____

b Substitute the values into the formula. Gravitational field strength on Earth is 10 N/kg. weight = _____ kg × _____ N/kg

c Work out the answer. weight = _____ N

4 Calculate the weight of the cat on Mars, where the gravitational field strength is 3.7 N/kg.

weight = _____ kg × _____ N/kg
= _____ N

5 A toolbox on Mars has a weight of 40 N. Calculate its mass.

mass = _____ kg

1 Calculate the weights of the following objects. Use a value of 10 N/kg for the gravitational field strength.

a a 5 kg bag of bird seed

b a car with a mass of 1200 kg

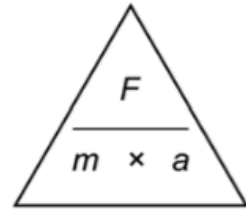
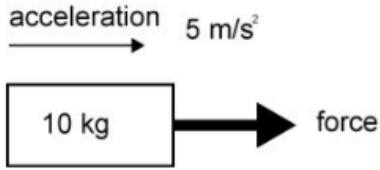
c a suitcase with a mass of 15 kg

d a 200 g piece of meat

e an apple with a mass of 100 g

f a tablet with a mass of 50 mg

1 What are the resultant forces acting on these objects?



a An object of mass 10 kg accelerating at 5 m/s^2 .
 _____ N

b mass 15 kg, acceleration 5 m/s^2 _____ N

c mass 20 kg, acceleration 8 m/s^2 _____ N

d mass 16 kg, acceleration 10 m/s^2 _____ N

2 Complete these sentences using the words 'greater' or 'smaller'.

a For objects of the same mass, a larger resultant force will give a _____ acceleration.

b For the same resultant force, the more massive the object, the _____ the acceleration.

3 For each of the following diagrams:

- calculate the resultant force
- give the direction of the resultant force
- calculate the acceleration of the object.

<p>a</p> <p>10 N 2 kg 2 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>	<p>b</p> <p>5 N 0.2 kg 3 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>	<p>c</p> <p>5 N 4 kg 2 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>
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<p>d</p> <p>7 N 2 N 10 kg 4 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>	<p>e</p> <p>2.5 kg 100 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>	<p>f</p> <p>10 N 10 kg 3 N 1 N</p> <p>resultant force _____ N</p> <p>direction _____</p> <p>acceleration _____ m/s^2</p>
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1 This helium balloon is tied to a brick to stop the balloon from floating away. Some of the forces acting are listed below.

- pull of string on the brick = 0.5 N pull of string on the balloon = 0.5 N
- pull of balloon on the string = 0.5 N pull of brick on the string = 0.5 N
- weight of the balloon = 0.5 N upthrust from the air = 1.0 N



- a In the list above there are two pairs of action and reaction forces. Use lines to join the forces in each pair.
- b Which force(s) pull the balloon down?

- c Which force(s) pushes the balloon up?

2 Astronauts train for space walks in a tank of water. The floating feeling in water is similar to the feeling in space.

Complete the following sentences using words from the box. You do not need all the words.

The upwards force is _____ from the water. The downwards force is the astronaut's _____. The two forces are _____ forces because they are acting on _____.



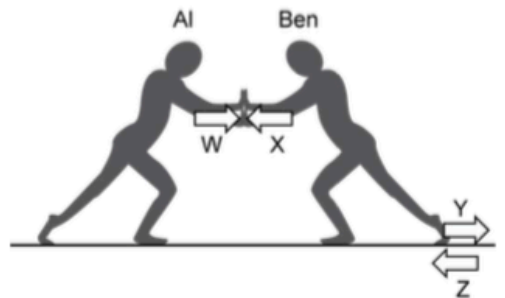
action–reaction	balanced
different objects	the same object
upthrust	weight

3 Two boys are pushing on each other. They are not moving.

- a Draw arrows on AI to show the action–reaction pair of forces at his feet.
- b Force W is 40 N. What force is Ben putting on AI?

- c What kind of force causes forces Y and Z?

- d Ben is not moving, so the forces on him must be balanced. Which two of the forces on the diagram (W, X, Y, Z) form a pair of balanced forces on Ben?



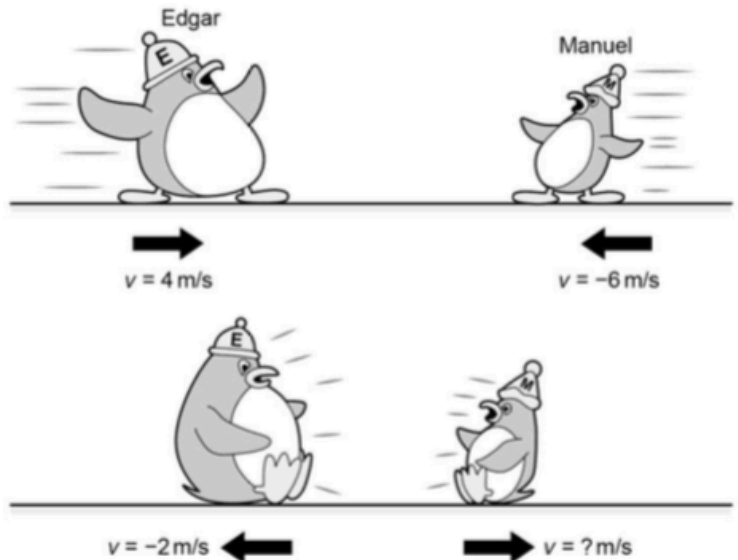
S1 Two 5000 kg railway trucks are travelling at 5 m/s in opposite directions when they collide. After the collision they are stationary. Show that **momentum** is conserved.

- 1 Truck A has a mass of 5000 kg and a velocity of +5 m/s. Calculate its momentum.
- 2 **a** Explain why we say that truck B has a velocity of -5 m/s.
b Calculate the momentum of truck B.
- 3 What is the total momentum of the two trucks before they collide?
- 4 **a** What is the momentum of the two trucks after the collision?
b Explain how your answers show that momentum has been conserved.

Edgar the Emperor penguin has a mass of 14 kg and Manuel the Magellan penguin has a mass of 6 kg.

Their velocities are shown before and after they crash into each other. The negative sign indicates a velocity to the left whereas positive values show velocities to the right.

- 5 **a** What is Edgar's momentum before the collision?
b What is Manuel's momentum before the collision?
c How are the directions of their momentums different before the collision?
d What is the total momentum before the collision?
e What is Edgar's momentum after the collision?
f Explain why Manuel's momentum is 48 kg m/s after the collision.
g How fast is Manuel moving?



- 6 A trolley with a mass of 4 kg accelerates from rest to 3 m/s in 2 seconds. What force is needed to produce this acceleration?
- 7 A 20 N force accelerates a 5 kg trolley from 2 m/s to 5 m/s. How long does this change of velocity take?

- 1 Complete the sentences to show how different factors affect the stopping distance of a car. Choose words from the box.

braking thinking longer shorter

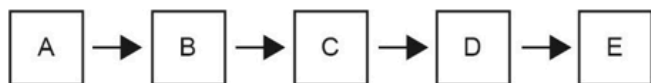
- a Stopping distance is made up of a _____ distance and a _____ distance.
- b Mass: the greater the mass of a vehicle the _____ the _____ distance.
- c Speed: the greater the speed, the greater the _____ and the _____ distances.
- d **Reaction time:** the shorter the driver's reaction time the _____ the _____ distance.
- e If the brakes are worn the _____ distance will be _____.
- f If the road is slippery the _____ distance will be _____.
- g If there is a lot of friction between the tyres and the road the _____ distance will be _____.

- 2 Complete these sentences about reaction times using words from the box. You can use each word once, more than once or not at all.

0.001 seconds 0.25 seconds 2 seconds alcohol brake coffee
 decreased fast increased distracted longer road shorter
 slow **stimulus** stopping thinking time

- a A person's reaction _____ is the time it takes them to react to a _____. For a driver, the _____ could be a person running into the _____ in front of them, or a car turning into their path.
- b For an average person, the reaction time is about _____.
- c The reaction time affects the _____ distance, which is the distance the car travels between the hazard occurring and the driver pressing the _____ pedal.
- d A person with a _____ reaction time will have a shorter _____ distance than a person with _____ reaction time.
- e Reaction times are _____ if the person is tired or ill. Drinking _____ or taking some drugs increases the reaction time.

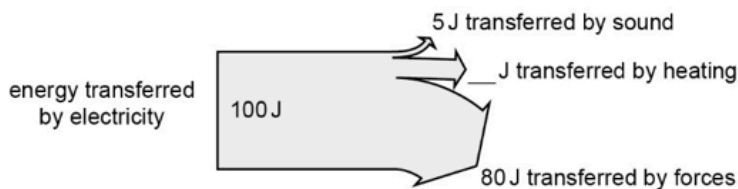
- 4 When a ball bounces, energy is transferred between different stores. The sentences below go into the energy flow diagram. Write one letter from the diagram next to each sentence to show where it goes.



- _____ energy stored in the moving ball (kinetic energy)
 _____ energy stored in the moving ball (kinetic energy)
 _____ energy stored in the squashed ball as it hits the floor (elastic potential energy)
 _____ energy stored in the ball before it drops (**gravitational potential energy**)
 _____ energy stored in ball as it rises (gravitational potential energy)

- 5 The diagram shows the energy transfers in an electric motor.

- a Fill in the missing number.
 b Explain how you worked out the answer to part a.



- 1 Which equation is the correct equation for calculating the **efficiency** of a machine? Tick one box.

efficiency = $\frac{\text{total energy transferred}}{\text{useful energy transferred}}$ $\frac{\text{wasted energy transferred}}{\text{useful energy transferred}}$ $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$

- 2 Some of these statements are true and some are false. Tick the boxes to show which ones are which.

	True	False
a An old-style light bulb uses 60 J of energy to transfer 6 J of useful energy by heating.	<input type="checkbox"/>	<input type="checkbox"/>
b The efficiency of an old-style light bulb is usually around 0.05 to 0.1.	<input type="checkbox"/>	<input type="checkbox"/>
c A low energy bulb uses 15 J of energy to give 6 J of useful energy transferred by light and only wastes 9 J of energy by heating.	<input type="checkbox"/>	<input type="checkbox"/>
d The efficiency of the low energy bulb = $\frac{6}{9} = 0.67$	<input type="checkbox"/>	<input type="checkbox"/>
e An efficient appliance wastes more energy than an inefficient one.	<input type="checkbox"/>	<input type="checkbox"/>
f You always get the same amount of energy out of a machine as you put into it.	<input type="checkbox"/>	<input type="checkbox"/>

- 4 Calculate the efficiency of the radio in question S2 below: efficiency = $\frac{\text{--- J}}{\text{--- J}} = \text{---}$

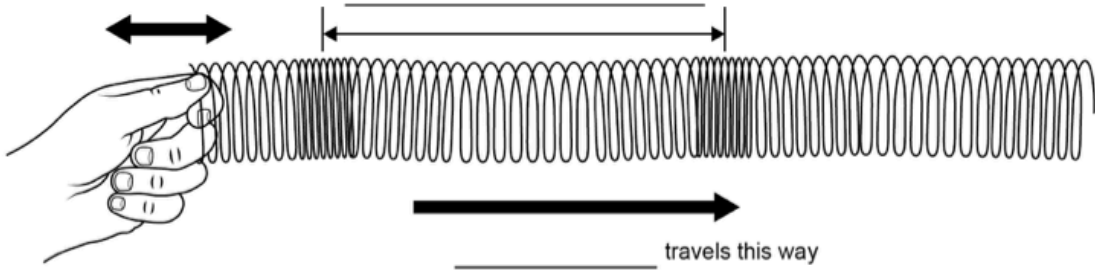
S2 A radio is supplied with 50 J of energy and transfers 5 J of this by sound. Explain what happens to the rest of the energy and calculate the efficiency of the radio.

1 The diagrams show a Slinky spring being used to model different kinds of wave.

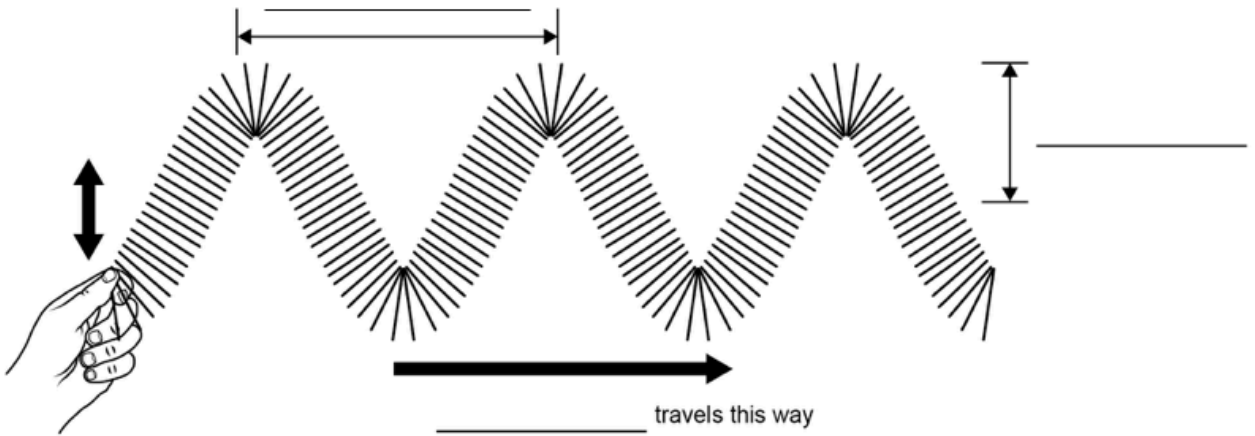
Label the diagrams using words from the box. You can use each word once, more than once, or not at all.

a _____ wave

amplitude	energy	frequency	longitudinal
particles	period	transverse	wavelength



b _____ wave



2 Give two examples of each type of wave.

a longitudinal (i) _____ (ii) _____

b transverse (i) _____ (ii) _____

2 A longitudinal seismic wave travels through 2 km of rock in 2.5 s.

a How far is 2 km in metres? _____

b Calculate the speed of the wave in rock.

$$\text{wave speed} = \frac{\text{distance}}{\text{time}}$$

=

$$\text{wave speed} = \text{_____ m/s}$$

3 A transverse seismic wave travels at 3000 m/s in rock. How long will it take this wave to travel 10 km?

$$\text{time} = \text{_____ s}$$

4 The call of a whale has a frequency of 30 Hz. Sound travels at around 1500 m/s in sea water.

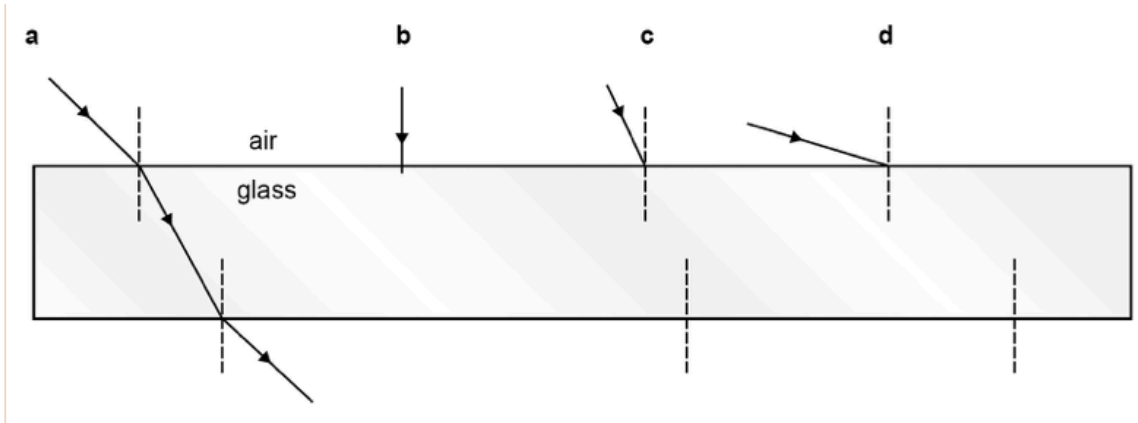
a Calculate the wavelength of the sound waves.

$$\text{wavelength} = \text{_____ m}$$

1 Which is the best definition of the normal line on a ray diagram? Tick one box.

- a line at right angles to the interface between two materials
- the line where two different materials meet
- the way light bends when it enters a material

2 The diagrams show rays of light entering and then leaving a glass block. Finish drawing the rays. Part a has been done for you.



3 Complete these sentences by crossing out the words that are wrong.

- a When light travels from air to glass it bends (towards/away from) the normal.
- b When light travels from glass to air it bends (towards/away from) the normal.

4 Complete these sentences using words from the box. You can use each word once, more than once or not at all.

All waves can be _____ when they travel from one _____ into another. The line where the two materials join is called the _____.

Light is _____ when it goes from air into water, and when it goes from water into air.

This is why it is difficult to see things clearly when you are looking into _____.

Anglerfish, which spit at insects above the water, learn to take account of _____ when aiming their jet of water.

area	boundary	interface	medium	reflected	reflection
	refracted	refraction	water	mirror	

H When light goes from one medium to another, its frequency does not change. The wavelength of red light travelling in a vacuum is 700 nm ($1 \text{ nm} = 1 \times 10^{-9} \text{ m}$). Calculate the wavelength of this light in:

- a glass b water c diamond.

Speed of light = $3 \times 10^8 \text{ m/s}$

- 1 Write the names of the seven groups that the **electromagnetic spectrum** is divided into. The initial letters have been given to help you.

G _____ I _____ M _____
 R _____ U _____ V _____
 X _____

- 2 Complete these sentences using words from the box below. You can use each word once, more than once or not at all.

The waves in the electromagnetic spectrum are divided into groups according to their _____ and wavelengths.

Waves with high frequencies have _____ wavelengths, and waves with _____ frequencies have long _____.

Radio waves have the _____ frequencies and the longest _____.

Gamma rays have the highest _____ and the _____ wavelengths.

Visible light is in the middle of the electromagnetic _____.

Visible light can be divided further into the _____ colours of the visible _____.

These colours are red, _____, yellow, _____, blue, indigo and _____.

Red light has the lowest frequency and longest _____. Violet light has the _____ frequency and _____ wavelength.

frequencies	green	highest	low	lowest	orange	pink	purple	seven	short
	shortest	spectrum	violet	wavelength	wavelengths				

- 4 Use the equation to calculate the frequency of a typical wave in each group of the electromagnetic spectrum. One example has been done for you on the right.
- 5 A student says: 'Ultraviolet waves are 100 times longer than the waves in gamma rays'.
- a Explain whether the student is correct.
- b Write a similar statement to compare microwaves and radio waves.

For visible light:

$$\begin{aligned} \text{frequency} &= \frac{\text{wave speed}}{\text{wavelength}} \\ &= \frac{3 \times 10^8 \text{ m/s}}{1 \times 10^{-6} \text{ m}} \\ &= 3 \times 10^{14} \text{ Hz} \end{aligned}$$

Extra challenge

- 6 Light travels at around 2×10^8 m/s in glass. When light enters a glass block its frequency does not change. Calculate the wavelength of visible light in glass.
- 7 Gamma rays with a wavelength of 5 nm have a frequency of 2.4×10^{16} Hz when they pass through lead. Calculate the speed of gamma rays in lead.

Radiation	Uses	Dangers
Radio waves		
Microwaves		
Infra-red		
Visible light		
UV		
X-rays		
Gamma rays		

Communications can be sent by radio waves and microwaves. Optical fibres can also be used to send communications signals using visible light. The equation triangle on the right shows the relationship between speed, distance and time.

- How long would it take a radio signal to travel 50 km?
- How much longer would it take to send the same signal using optical fibres?
- Describe how radio waves are:
 - produced
 - detected.
- Explain why radio waves can be detected at much greater distances than microwaves. Use the phrase 'change velocity' in your answer.

These questions are about radio waves, microwaves, infrared and visible light.

- How does the transmission or absorption of these waves vary with wavelength in the following materials? Explain how you worked out your answers.
 - glass
 - brick



x = distance, v = speed, t = time
 speed of light in air = 3×10^8 m/s
 speed of light in glass = 2×10^8 m/s