Zig Zag Education

Science BTEC (Level 3) | BTEC National

Topic Tests

for BTEC National Applied Science

Principles and Applications of Science I

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Teacher's Introduction

These topic tests have been designed to help you and your students assess their knowledge of a topic after you have taught each part of Unit 1 of the BTEC National Applied Science course. This part of the course corresponds to Principles and Applications of Science I.

Each topic test closely follows the content of the specification and includes:

- Factual questions: Some simpler factual questions are included to ensure that all the content and basics are covered, and to allow weaker learners access to some marks.
- Short-answer questions: These are not in exam style, and the purpose of these is to test different elements, knowledge and skills from the specification in a variety of styles.
- Long-answer questions: Where appropriate, topics may contain one or more extended response questions, to prepare students for what they might meet in the exam, and to test exam skills.

Mathematical skills are also covered in these topic tests.

Tests have been designed to take approximately 25–35 minutes to complete.

Students are able to see the number of marks awarded for each question, allowing them to gauge the level of detail they will require for the answers. Full answers with marks are included at the back of the resource. Additionally, it makes the resource a suitable tool for students to use independently.

The topic tests are suitable for a classroom assessment, revision aid or homework task and are, therefore, suitable for use immediately after a topic is completed in class or at the end of teaching the course.

It is recommended that students have access to a calculator to complete the questions.

We hope you find these tests useful during your teaching.

Topic Tests		
A1	Periodicity and properties of elements	Total = 39
A2	Production and uses of substances in relation to properties	Total = 30
B1	Cell structure and function	Total = 30
B2	Cell specialisation	Total = 26
B3	Tissue specialisation	Total = 39
C1	Working with waves	Total = 40
C2	Waves in Communication	Total = 27
C3	Use of electromagnetic waves in communication	Total = 26

November 2017

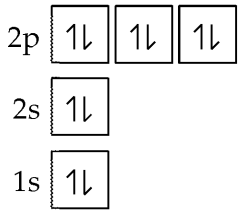
Unit 1 – A1: Periodicity and properties of elements

1. Electrons in atoms fit into shells made up of orbitals.

a) How many electrons can fit in one orbital?

A	One	
B	Two	
C	Four	

b) The electronic structure of a neon atom can be represented as:



i) In this way of writing electronic structures, what does each

.....

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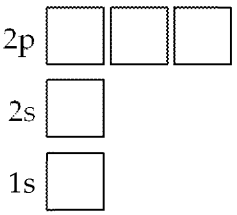
ii) Write the electronic structure of an oxygen atom in this way.



c) Electronic configurations of atoms can be represented in different

The electronic configuration of a beryllium atom can be represent

i) Write the electronic configuration of a nitrogen atom in this w

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.....

ii) In $1s^2$, what does the 1 refer to?

A	Number of electrons	
B	Number of the shell	
C	Number of the orbital	
D	Number of atoms	

2. Potassium chloride, KCl, is sometimes used as an alternative to sodium chloride. Both of these compounds are ionic.

a) Describe how the bonding in KCl is formed.

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b) In KCl, ions are attracted towards each other. Why are the ions in KCl attracted to each other?

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c) Draw a dot and cross diagram, using outer electrons only, to show

d) Potassium has a larger ionic radius than sodium. Explain which c
stronger bonding.

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3. Ethan[illegible]et[illegible] are compounds which contain covalent bonds.

Ethane has the formula C_2H_6.

a) Draw ethane using a dot and cross diagram.

b) Ethene contains as many carbon atoms as ethane, but has a doubl
atoms, which is stronger.

i) Write the formula of ethene.

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ii) Describe the bonding in ethane in terms of

- Carbon-carbon bond length compared to ethene
- Geometry around the carbon atoms
- The number of coordinate bonds

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4. Aluminium is a metal used in lightweight materials. Describe the bon

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5. H_2O, HCl and CH_4 are all compounds with covalent bonds.

a) Predict which of these compounds have only van der Waals force sample of the compound.

A	H_2O and HCl	
B	HCl and CH_4	
C	CH_4 and H_2O	
D	H_2O, HCl and CH_4	

b) Predict which of these compounds have dipole-dipole forces betw sample of the compound.

A	H_2O and HCl	
B	HCl only	
C	CH_4 and H_2O	
D	H_2O, HCl and CH_4	

c) Predict which of these compounds have hydrogen bonding betwe samples of the compounds.

A	H_2O only	
B	HCl only	
C	CH_4 only	
D	H_2O, HCl and CH_4	

6. Aluminium chloride, $AlCl_3$, is an important ... st... n reactions to ma...

$AlCl_3$ is the only product forme... aluminium reacts with chlorin...

Write a balanced e... this reaction.

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7. Chloroethane, C_2H_5Cl, is made industrially using ethene, C_2H_4, and hy
following reaction:

$$C_2H_4 + HCl \rightarrow C_2H_5Cl$$

a) A solution is made using 0.200 mol of HCl and 75.0 cm^3 of distille

i) Calculate the mass of HCl that cont .200 mol of HCl.

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ii) Calculate the concentration of this solution in mol dm^{-3}.

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b) Using an excess of ethene, 4.10 g of chlor n was produced fr

Assuming that there is enou ne, what mass of chloroethan
made from 0.200 m r H

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1. Look at this section of the periodic table.

1	2											3
1.0 **H** hydrogen 1												
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13
39.1 **K** Potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31

Key
relative atomic mass
atomic symbol
name
atomic (proton) number

a) Which period is magnesium in?

A	Period 1
B	Period 2
C	Period 3
D	Period 4

b) Which group is [illegible] in?

.....

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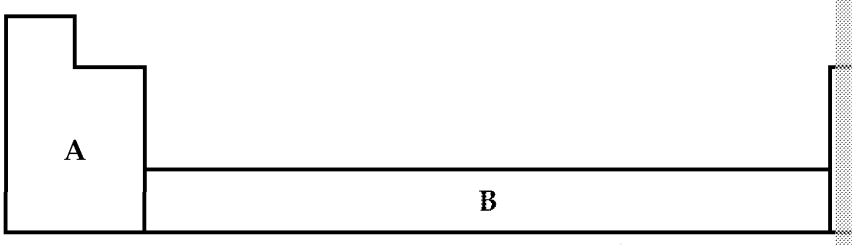
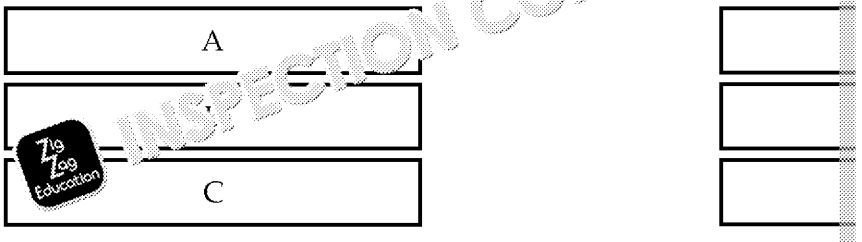
c) A, B and C represent blocks in the periodic table.



Match the letters A, B and C to the correct [illegible] of the periodic ta



2. Elements in Period 3 are all essential to biological life. They have diffe
different electronegativities and first ionisation energies.

a) Explain the trend in first ionisation energy across Period 3 of the p

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b) Electronegativity has a similar trend for similar reasons. Define el

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c) Which one of the following elements in Period 3 has a giant coval

A	Mg	
B	Si	
C	S	
D	P	

3. Elements in Group 7 are all small covalent molecules. They have a lo

a) Explain the increase in boiling points down Group 7.

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b) Metal elements like aluminium have a m... her boiling point t
Explain why most metals have a hig... ling point than Group

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c) Metal elements are often good conductors of electricity. Explain w
electricity.

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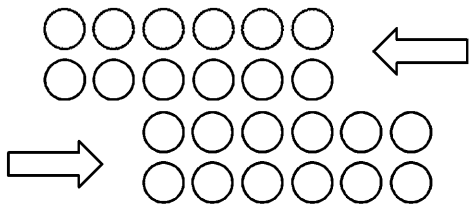
d) M ar malleable, which means they are easy to bend.



Explain how this diagram shows what happens to the particles in
is bent.

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4. Iron and lithium both react with oxygen in a

a) Write a balanced equatio f t reaction of lithium with oxygen

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b) Explain whether oxygen is oxidised or reduced.

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c) Lithium reacts with water. Write a balanced chemical equation fo

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d) Iron can react with sulfuric acid. Write a word equation for this r

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e) Iron is a trans[illegible] and lithium is in Group 1. Predict, base[illegible] p[illegible] which of these metals reacts more quickly with oxy[illegible]

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f) Iron oxide can have two formulae: Fe_2O_3 and FeO. Explain why i[illegible] different formulae.

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5. Look at the reactivity series

Reactivity series	
Potassium	most reactive
Sodium	
Calcium	
Magnesium	
Aluminium	
Zinc	
Iron	
Tin	
Lead	
Copper	
Silver	
Gold	
Platinum	least reactive

a) Magnesium, aluminium and copper [illegible] added to separate solutio[illegible]

Explain which of th[illegible] will displace zinc from zinc bromid[illegible]

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b) Chlorine water, $Cl_{2(aq)}$, and iodine solution, $I_{2(aq)}$, are added to sepa
$ZnBr_{2(aq)}$.

i) Explain which of chlorine and iodine will react with zinc bro

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ii) Write the balanc[illegible] for the reaction in i).

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Unit 1 – B1: Cell structure and function

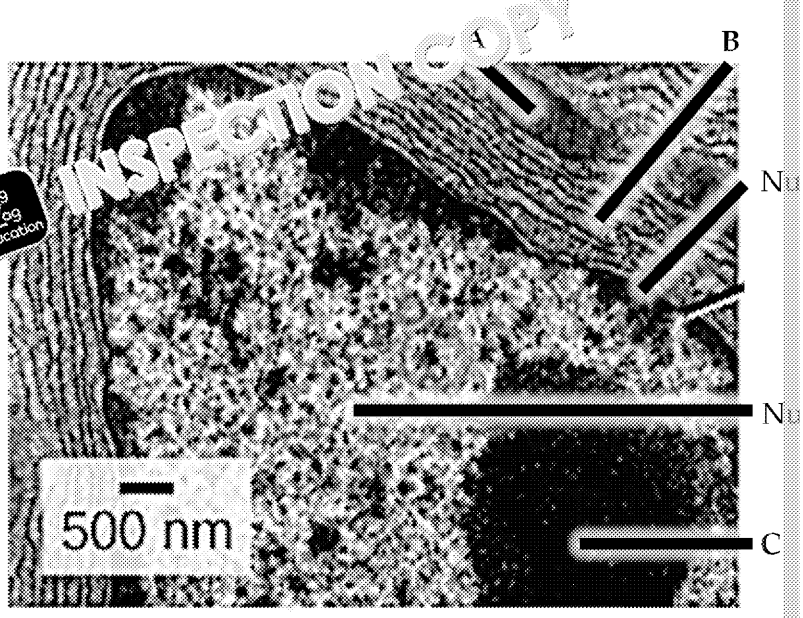
1. Draw lines to identify the cell type to which each of these organelles b

Some organelles may be present in multiple cell types.

Nucleoid	
Golgi apparatus	
5 ribosome	
Centriole	
80S ribosome	
Tonoplast	

2. An electron micrograph of an animal cell is shown below.

Identify the structures labelled A, B and C.



A: .....

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B: .....

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C: .....

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3. A light microscope can be used to observe blood cells.

Describe a method that can be used to observe blood cells using a ligh

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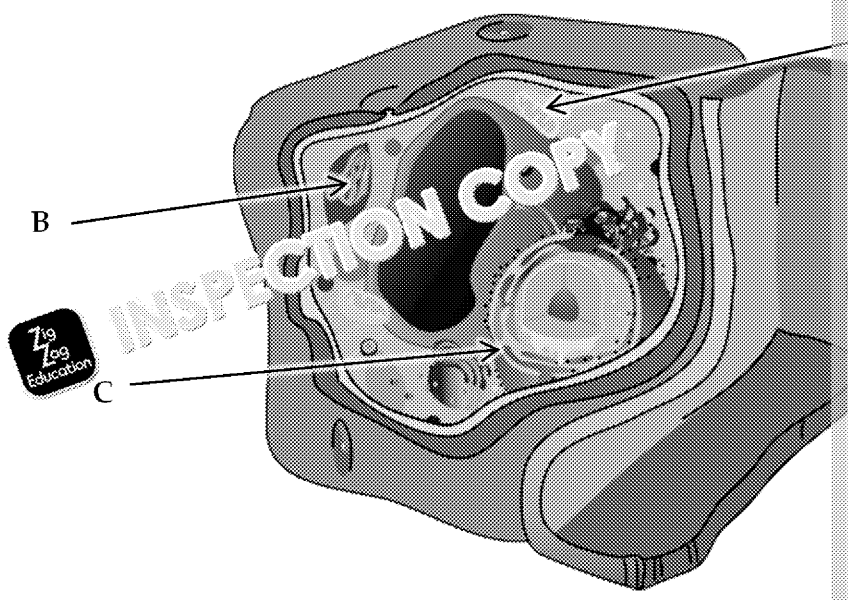
4. A drawing of a plant cell is shown below.



What is the function of the organelles labelled A, B and C?

A: .....

.....

B: .....

.....

C: .....

.....

5. Bacterial cells can be classified as either gram negative or gram positiv

a) What part of a bacterial cell determines the result of the test?

A	Nucleoid	
B	Plasmid	
C	Cell wall	
D	Ribosome	

b) H his test performed?

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c) How can the result of this test be used to decide the method of tre diseases?

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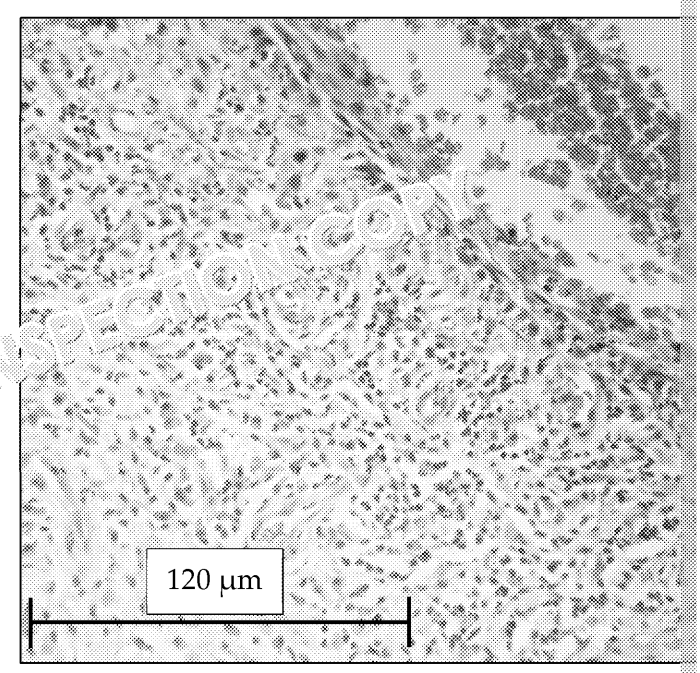
6. A microscope slide of skin cells was imaged and is shown below.



a) Calculate the magnification of the image, using the scale bar on th

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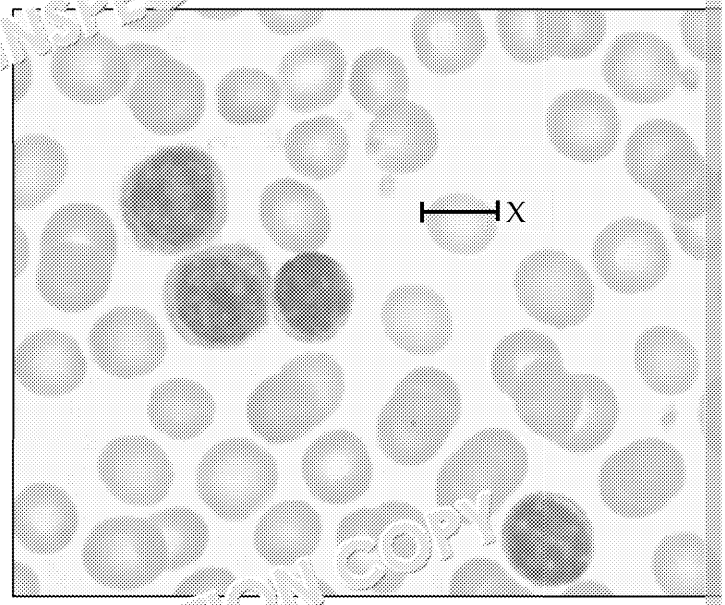
b) The image below is of [illegible]s. It is magnified at 1000 x.



Calculate the tr[illegible] of the cell labelled X.

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Unit 1 – B2: Cell specialisation

1. Root hair cells are specialised cells of the plant root.

a) Draw a root hair cell and label the parts of the cell in the space be

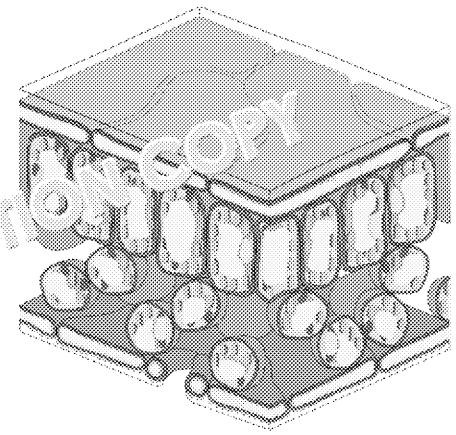
b) Connect the adaptations of root hair cells to their function in a pla

Many mitochondria	Increases
Long projection	
Large vacuole	Active

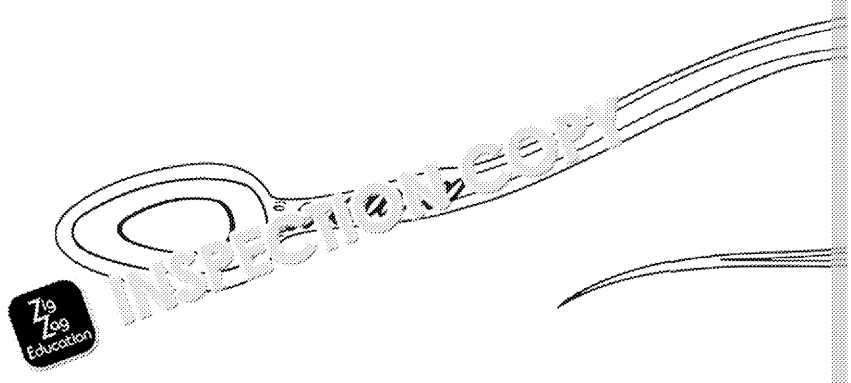
2. **a)** Tick the name give[illegible] th[illegible]pecialised cells that perform photosy

	[illegible]or[illegible] mesophyll	
B	Palisade mesophyll	
C	Guard cell	
D	Epithelial cell	

b) Label three adaptations of this cell type on the diagram of the lea



3. A sperm cell is shown below. This type of cell is essential to fertility a



a) Label **two** adaptations present in this cell type that allow it to per

b) Give the name of an adaptation that is common between both spe

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c) State the importance of this adaptation during reproduction.

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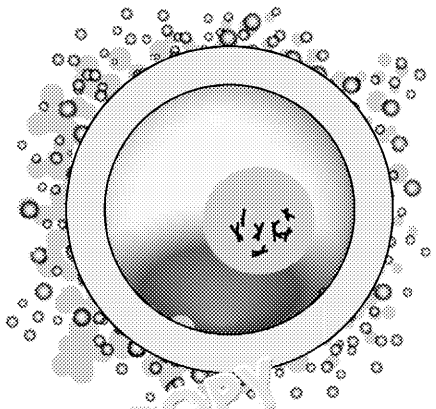
4. An egg [illegible] is shown below.

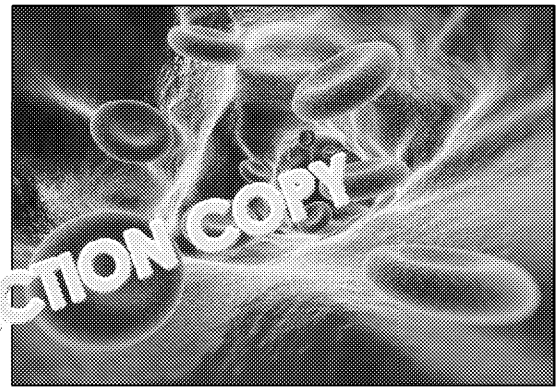


On the diagram, l[illegible] the correct name:

a) T[illegible] is vital for recognition of sperm cells

b) The structure that is a supply of protein to a developing embryo

5. Consider the computer-generated image of red blood cells shown belo



a) State the purpose of red blood cells.

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b) From the image, state two adaptations of red blood cells in the bl

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c) What percentage of blood is ...ed by white blood cells? Tick the list below.

A	...%	
B	...0%	
C	20–40%	
D	>40%	

d) What are the functions of white blood cells, and how are they ada

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Unit 1 – B3: Tissue specialisation

1. Epithelial tissue can be found in many locations throughout the huma

a) Name the two types of epithelial tissue present in the body.

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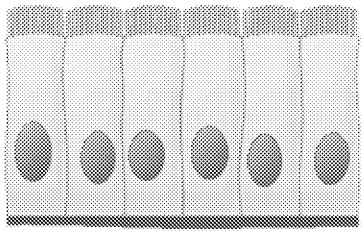
b) Identify the type of epithelium represented in the image below.



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One location of epithelial t[illegible] alveolar epithelium of the lungs.

c) W[illegible] it [illegible] rtant that the lung epithelium is made of a thin lay

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Chronic obstructive pulmonary disease (COPD) is a disease seen regu
The disease causes the epithelium to become inflamed and to thicken.

d) Suggest how COPD can be detrimental to g[illegible] change.

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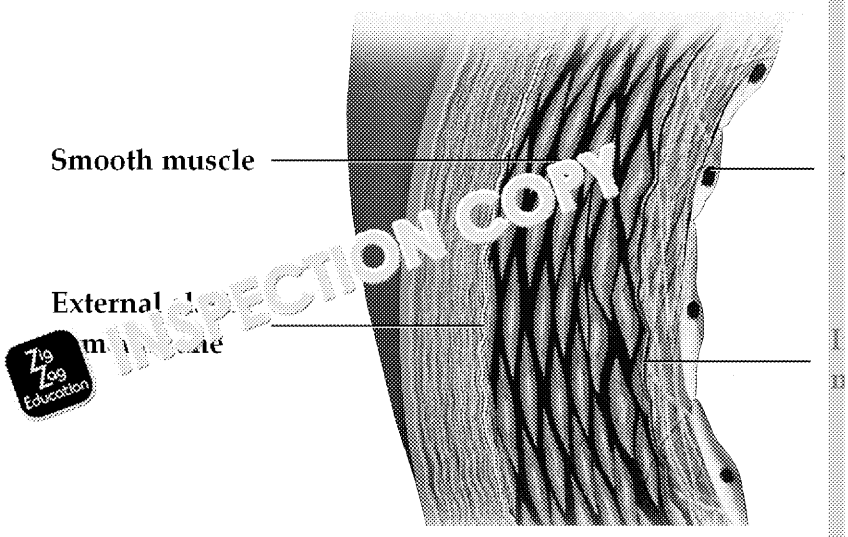
2. The tissue layers of a medium-sized artery are shown below.



a) What name is given to the tissue type indicated by X?

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Damage to this layer can cause significant cardiovascular problems.

b) Name two risk factors that make damage to this layer more likely

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Atherosclerosis is a disease in which this layer becomes thickened and

c) Suggest why atherosclerosis can lead to severe cardiac problems.

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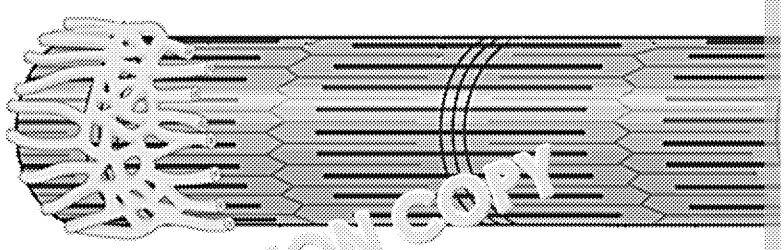
3. The figure below shows a single muscle fibre.



a) Wh[illegible] are responsible for the typical banding pattern m[illegible]

A	Myosin	
B	Elastin	
C	Titin	
D	Actin	

b) What name is given to the mesh that wraps around a muscle fibre

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Muscle contraction is thought to occur as a result of the sliding filame[illegible]

c) Give an outline of the sliding filament theory, stating how it bring[illegible] contraction.

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Two types of muscle fibres exist; fast- and slow-twitch.

d) Explain why fast-twitch muscles are paler than slow-twitch musc

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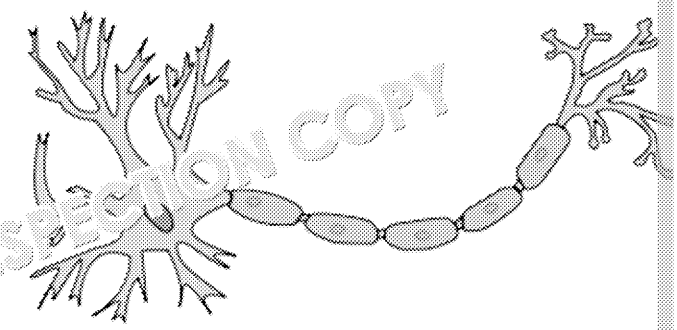
e) T ich **two** of these sports are likely to benefit most from fast

A	Archery	
B	Sprinting	
C	Weightlifting	
D	Marathon running	

4. A myelinated motor neurone is shown below.



a) Give **one** function of the myelin sheath.

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b) Complete the gaps in this description of how an action potential i

There is a polarity across the membrane of a neurone – the outside o

..... relative to the inside.

Upon activation, sodium channels open and cause Na^+ ions to diffuse

The polarity of the cell gradually chan..., ...g a greater change i

positive feedback loop.

A pe... po... ...fference is observed, with the outside of a neurone

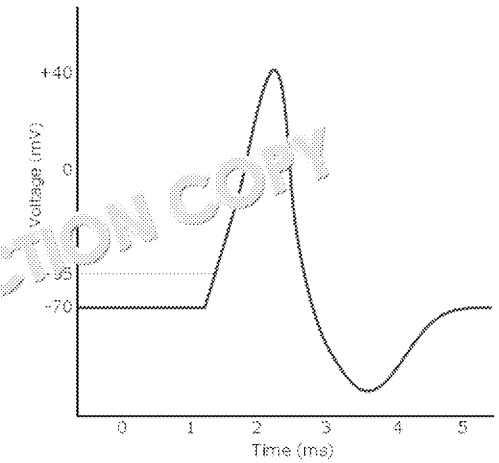
re... ...o the inside.

At peak, the sodium channels ..... and K^+ channels o

K^+ ions diffuse ..... and cause a return of the polarity

There is an overshoot, called ..... before the original p

c) Label this trace with the key words shown below.



Action potential, Refractory period

d) How does the myelin sheath affect the transmission of an action p

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Neurones do not make direct contact with each other. Synapses are p
neurones.

e) What is the role of acetylcholine at a synapse?

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5. Dopam[illegible] is a neurotransmitter. It is produced in the brain at a regio

a) What disease can result from the loss of dopamine-producing neu

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b) What treatment is often offered to patients suffering from this dis

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Serotonin is a different type of neurotran[illegible]te. Its shortage is assoc

c) Suggest how a shortag[illegible]rain can lead to depression.

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Unit 1 – C1: Working with waves

1. There are many examples of waves in nature, such as sound waves or water.

a) Complete the sentences below using the following words. Some words may be used more than once or not at all.

amplitude	period	rate	s
frequency	distance	phase	displ

A ..... is the rate at which it transfers energy.

particles in a wave is called an ..... .

The time taken for one complete wavelength to pass through a point

the number of waves passing a point in a second is its .....

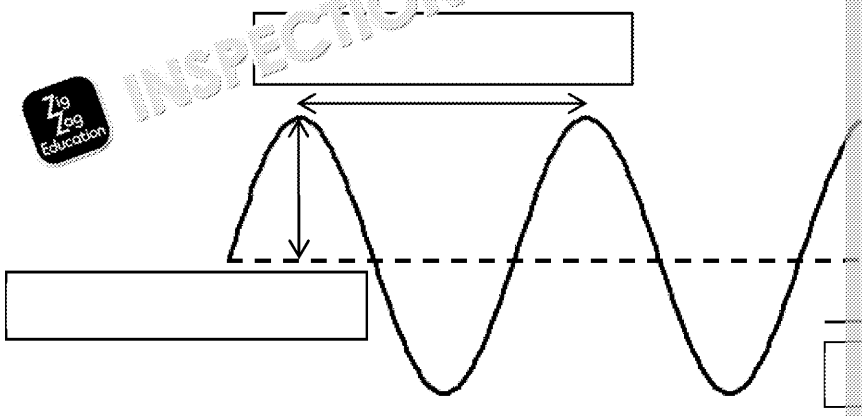
The distance that particles have been moved from their equilibrium p

..... . The maximum distance of particles from their e

the wave's ..... .

b) Fill in the boxes with the words provided to label the wave below.

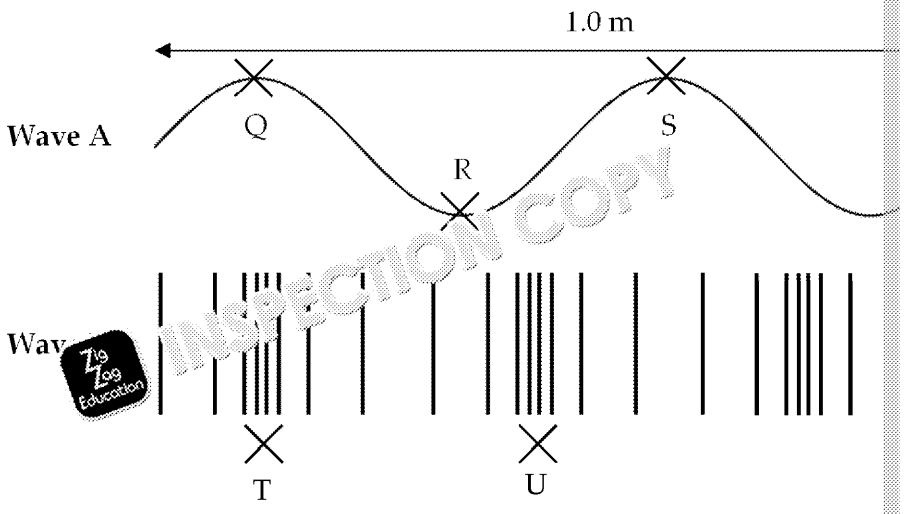
Frequency	Wavelength	Displacement	Amplitude	Velo



c) Match the quantities below to their symbol and unit.

Speed	f
Frequency	λ
Wavelength	v

2. The diagrams below show two waves, A and B, with several points m



a) Which of the waves is a transverse wave and which is a longitudi answer.

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b) Gi e example of a transverse wave and one example of a long

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c) Wave A is travelling at a speed of 30 m s^{-1}. Using an equation fro calculate the frequency of wave A.

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d) State the phase difference between the points:

i) Q and R

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ii) Q and S

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iii) T and U

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3. When two coherent waves meet they can interfere.

a) What is meant by the term *coherent*?

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b) D what happens during constructive and destructive inter

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c) Select the option that describes the phase difference required for

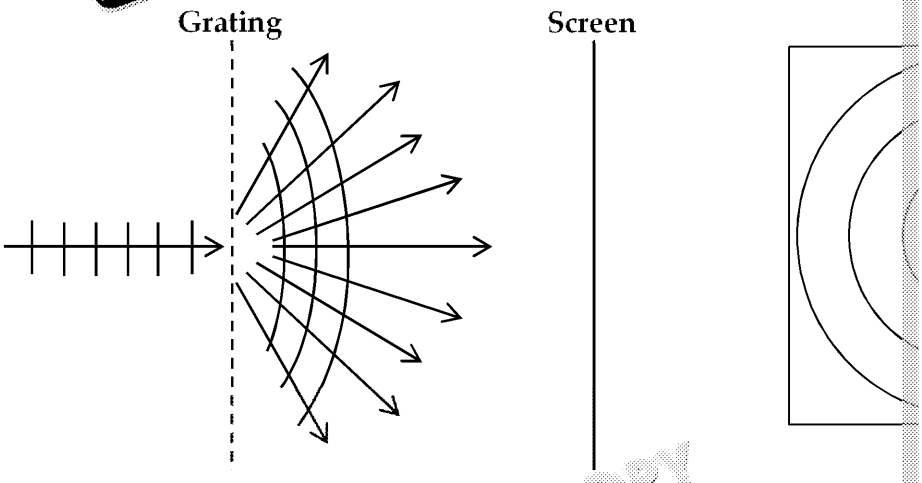
A	Multiple of 45°	
B	Multiple of 90°	
C	Multiple of	
	ltiple of 360°	

d) Select the option that describes the path difference required for co

$n = 0, 1, 2 \ldots$

A	$n\lambda$	
B	$\frac{n}{2}\lambda$	
C	$\frac{n+1}{2}\lambda$	
D	$(n+1)\lambda$	

4. The di[illegible] shows a process used in industry, including the pa



a) Name the process shown ab[illegible]

.....

.....

b) Mark the brightest spot on the pattern produced on the screen wi[illegible]

.....

.....

c) How can the process above be used in industry to identify gases?

.....

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5. **a)** Draw the 3rd harmonic of a stationary wave. Label any nodes and

.....

.....

.....

.....

b) Describe how a stationary wave is formed.

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.....

c) How does a trumpet use stationary waves to create sounds?

.....

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d) A transverse wave moves along a string.

The tension on the string is 15 N and a 2.0 metre length of the string has a mass of 15 g.

Using an equation from the formulae sheet, calculate the velocity of the string.

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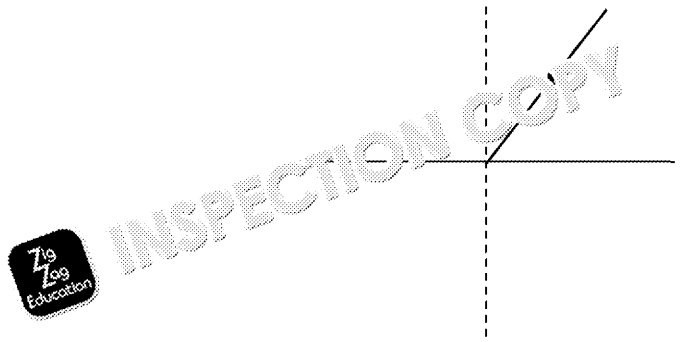
1. The diagram below shows the path of light as it passes from air to wa



a) Select the name given to the dotted line.

A	Incident	
B	Parallel	
C	Normal	
D	Perpendicular	

b) Complete the diagram above to show the path of light from air to

c) The refractive index of a type of glass is 1.2.

Using an equation from the formulae sheet, calculate the speed of

Use speed of light in a vacuum = 3.0×10^8 m s^{-1}

.....

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d) Light enters a block of glass from air at 12 ° to the normal to the s
index of the glass is 1.4.

Using an equation from the formulae sheet, calculate the angle th
makes to the normal to the surface.

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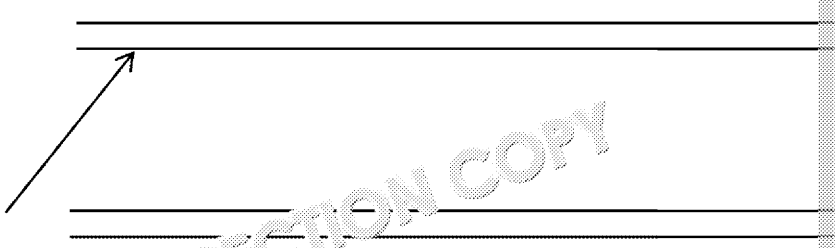
2. Fibre optic cables have many applications in computing and medical

a) Complete the diagram below to show the path a ray of light takes



b) Th ctive index of the core is 1.57.

Using an equation from the formulae sheet, calculate the critical a
between the core and air.

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c) Using the words below, fill in the gaps to describe the relative ref
cladding and core of an optical fibre.

higher	lower	equal	refraction
transmission	diffraction	interface	membrane

It is important that the core has ..... refrac

because light ... undergo ..... at the .....

be... a material with a ..... refractive inde

currently in.

d) Describe how fibre optics are used in medical imaging.

.....

.....

.....

.....

3. Fibre optics are frequently us... communications.

a) What are the ... differences between analogue and digital signa

.....

.....

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.....

.....

b) What are the advantages of digital signals ov... nalogue signals

.....

.....

.....

.....

c) Order the steps below to describe how an analogue signal is conv

A	Select an appropriate sampling rate, which sets how frequen
B	Transmit the data through an aerial or optical fibre.
C	Sample the analogue signal using an ana gue-to-digital con
D	The cable must be screened by ar g to avoid electrical in
E	Connect the o ut o the input of an analogue-to-digital co
F	le allest appropriate unit for converting the voltag
G	a transducer to produce an analogue electrical signal pr you want to send.

d) Select the main advantage of using a multimode fibre optic over s

A	Uses less power
B	Can send multiple sets of data along a single fibre
C	Cheaper
D	Can send data at a higher frequency

Unit 1 – C3: Use of electromagnetic waves in commun

1. a) Use the words below to fill in the gaps to describe the speed of el

some	most	all	*c*	*l*
water	fastest	slowest	th	withou

..... electro[illegible]et ..... waves travel at the speed of light i[illegible]

given the s[illegible] ..... .

Th[illegible]e ..... speed that anything can travel at, and [illegible]

mass can travel at this speed.

b) Select the value of the speed of light.

A	3.00×10^{8} m s^{-1}	
B	340 m s^{-1}	
C	2.64×10^{5} m s^{-1}	
D	7.19×10^{10} m s^{-1}	

2. a) $I = \frac{k}{r^2}$ is an important equation for th[illegible]nsity of a wave.

State the name given to this equation.

.....

.....

b) At a distance of 0.5 m from a bulb, the intensity of light from the l

Calculate the intensity of light from the bulb at a distance of 4.0 m

.....

.....

.....

.....

3. Electromagnetic waves are grouped into regions based on their freque

a) Fill in the table below to describe the regions of electromagnetic w applications.

Region	Frequency	A
Radio	30 kHz to 3 G	
Microwave	GHz to 300 GHz	
	300 GHz to 400 THz	Cooking food, nigh controls, motion se
	400 THz to 800 THz	Human sight, phot
	800 THz to 30 PHz	Forensic analysis, d
X-rays	30 PHz to 30 EHz	
Gamma rays	> 30 EHz	

b) Why are higher frequency microwaves used in satellite communi frequency radio waves are used in mobile phone communication?

.....

.....

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c) Bluetooth and Wi-Fi both use similar frequencies. How are Bluet interfere with Wi-Fi signals?

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d) Why are infrared waves chosen for their use in remote controls?

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e) What makes high frequency electromagnetic waves, such as X-rays and ultraviolet, unsuitable for use in communication?

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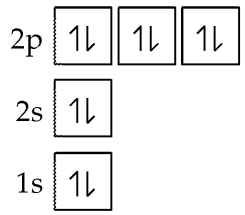
Unit 1 – A1: Periodicity and properties of elements

1. Electrons in atoms fit into shells made up of orbitals.

a) How many electrons can fit in one orbital?

A	One
B	Two
C	Four
D	Eight

b) The electronic structure of a neon atom can be represented as:



i) In this way of writing electronic structures, what does each

ii) Write the electronic structure of an oxygen atom in this way.

c) Electronic configurations of atoms can be represented in different

The electronic configuration of a beryllium atom can be represente

i) Write the electronic configuration of a nitrogen atom in this w

ii) In $1s^2$, what does the 1 refer to?

A	Number of electrons
B	Number of the shell
C	Number of the orbital
D	Number of atoms

2. Potassium chloride, KCl, is sometimes used as an alternative to sodium chloride. Both of these compounds are ionic.

a) Describe how the bonding in KCl is formed.

b) In KCl, ions are attracted towards each other. Why are the ions in each other?

c) Draw a dot and cross diagram, using outer electrons only, to show

d) Potassium has a larger ionic radius than sodium. Explain which stronger bonding.

3. Ethane and ethene are compounds which contain covalent bonds.

Ethane has the formula C_2H_6.

a) Draw ethane using a dot and cross diagram.

b) Ethene contains as many carbon atoms as ethane, but has a double bond between two carbon atoms, which is stronger.

i) Write the formula of ethene.

ii) Describe the bonding in ethane in terms of

- Carbon-carbon bond length compared to ethene
- Geometry around the carbon atoms
- The number of coordinate bonds

4. Aluminium is a metal used in lightweight materials. Describe the bonding in aluminium.

5. H_2O, HCl and CH_4 are all compounds with covalent bonds.

a) Predict which of these compounds have only van der Waals forces between samples of the compound.

A	H_2O and HCl
B	HCl and CH_4
C	CH_4 and H_2O
D	H_2O, HCl and CH_4

b) Predict which of these compounds have dipole-dipole forces between samples of the compound.

A	H_2O and HCl
B	HCl only
C	CH_4 and H_2O
D	H_2O, HCl and CH_4

c) Predict which of these compounds have hydrogen bonding between samples of the compound.

A	H_2O only
B	HCl only
C	CH_4 only
D	H_2O, HCl and CH_4

6. Aluminium chloride, $AlCl_3$, is an important catalyst in reactions to make plastics.

$AlCl_3$ is the only product formed when aluminium reacts with chlorine.

Write a balanced equation for this reaction.

7. Chloroethane, C_2H_5Cl, is made industrially using ethene, C_2H_4, and hy
following reaction:

$$C_2H_4 + HCl \rightarrow C_2H_5Cl$$

a) A solution is made using 0.200 mol of HCl and 75.0 cm^3 of distille

i) Calculate the mass in g of HCl that co[illegible] 0.200 mol of HC

ii) Calculate the concentra[illegible] this solution in mol dm^{-3}.

b) Using an [illegible] ethene, 4.10 g of chloroethane was produced fr
A[illegible]g that there is enough ethene, what mass in g of chloroet
made from 0.200 mol of HCl?

1. Look at this section of the periodic table.

1	2											3
1.0 **H** hydrogen 1												
6.9 **Li** lithium 3	9.0 **Be** beryllium 4											10.8 **B** boron 5
23.0 **Na** sodium 11	24.3 **Mg** magnesium 12											27.0 **Al** aluminium 13
39.1 **K** Potassium 19	40.1 **Ca** calcium 20	45.0 **Sc** scandium 21	47.9 **Ti** titanium 22	50.9 **V** vanadium 23	52.0 **Cr** chromium 24	54.9 **Mn** manganese 25	55.8 **Fe** iron 26	58.9 **Co** cobalt 27	58.7 **Ni** nickel 28	63.5 **Cu** copper 29	65.4 **Zn** zinc 30	69.7 **Ga** gallium 31

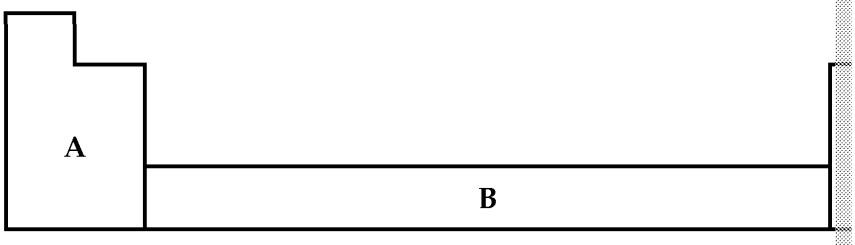
Key
relative atomic mass
atomic symbol
name
atomic (proton) number

a) Which period is magnesium in?

A	Period 1
B	Period 2
C	Period 3
D	Period 4

b) Which group is [illegible] in?

c) A[illegible] represent blocks in the periodic table.



Match the letters A, B and C to the correct block of the periodic ta

A	
B	
C	

2. Elements in Period 3 are all essential to biological life. They have diffe
different electronegativities and first ionisation energies.

a) Explain the trend in first ionisation energy across period 3 of the p

b) Electronegativity has a similar trend for similar reasons. Define el

c) Which one of the following elements in Period 3 has a giant coval

A	Mg
B	
C	
D	P

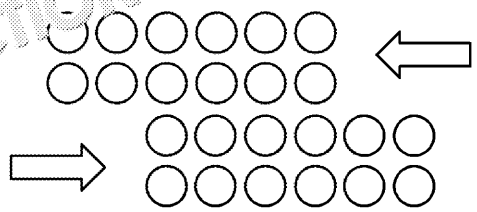
3. Elements in Group 7 are all small covalent molecules. They have a lo

a) Explain the increase in boiling points down Group 7.

b) Metal elements like aluminium have a much higher boiling point t
Explain why most metals have a higher boiling point than Group 7

c) Metal elements are often good conductors of electricity. Explain w
electricity.

d) Metals are also malleable, which means they are easy to bend.



Explain how this diagram shows what happens to the particles in
is bent.

4. Iron and lithium both react with oxygen in air.

a) Write a balanced equation for the reaction of lithium with oxygen

b) Explain whether oxygen is oxidised or reduced.

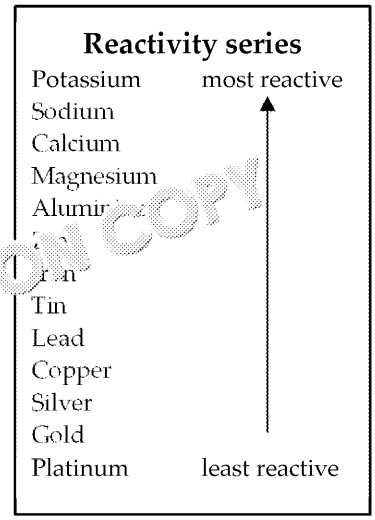
c) Lithium reacts with water. Write a balanced chemical equation for

d) Iron can react with sulfuric acid. Write a word equation for this re

e) Iron is a transition metal, and lithium is in Group 1. Predict, based
periodic table, which of these metals reacts more quickly with oxy

f) Iron oxide can have two formulae: Fe_2O_3 and FeO. Explain why i
different formulae.

5. Look at the reactivity series.



a) Magnesium, aluminium and copper are added to separate solutio

Explain which of these metals will displace zinc from zinc bromid

b) Chlorine water, $Cl_{2(aq)}$, and iodine solution, $I_{2(aq)}$, are added to sepa $ZnBr_{2(aq)}$.

i) Explain which of chlorine and iodine will react with zinc bro

ii) Write the balanced equation for the rea in i).

Unit 1 – B1: Cell structure and function

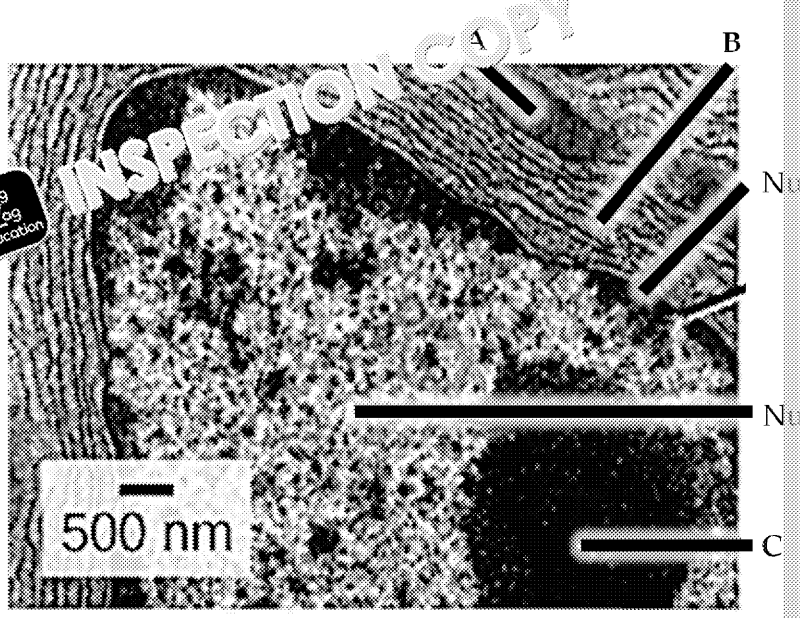
1. Copy the boxes below and draw lines to identify the cell type to which e

Some organelles may be present in multiple cell types.

Nucleoid	
Golgi apparatus	
70S ribosome	
Centriole	
80S ribosome	
Tonoplast	

2. An electron micrograph of an animal cell is shown below.

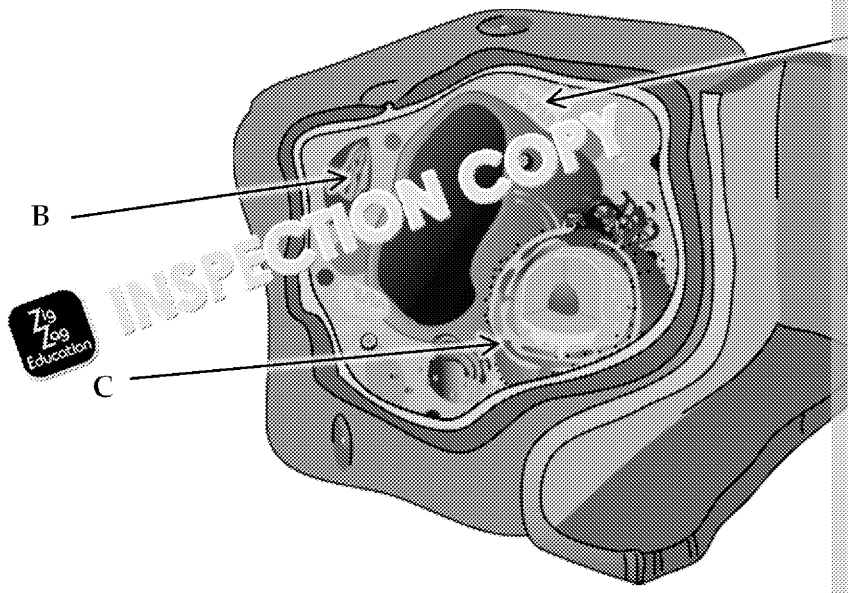
Identify the structures labelled A, B and C.



3. A light microscope can be used to observe bl[illegible]s.

Describe a method that can be us[illegible] observe blood cells using a ligh

4. A drawing of a plant cell is shown below.



What is the function of the organelles labelled A, B and C?

5. Bacterial cells can be classified as either gram negative or gram positiv

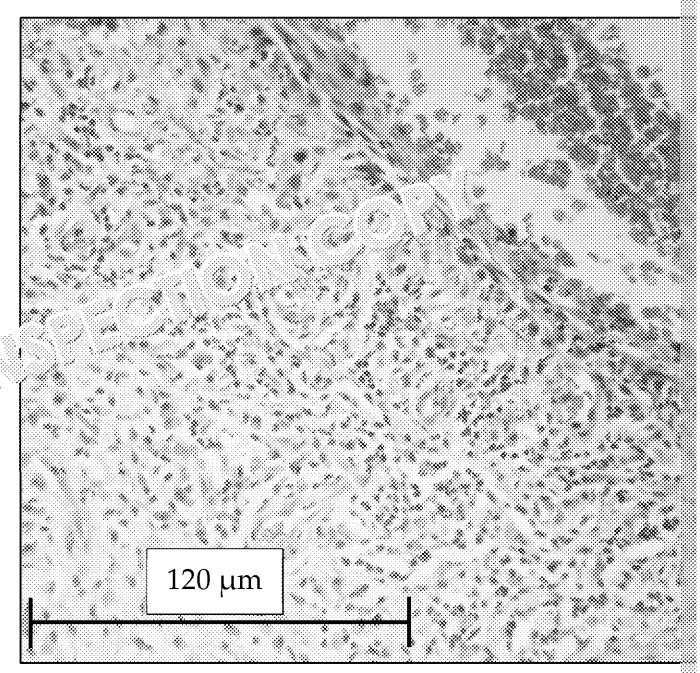
a) What part of a bacterial cell determines the r t of the test?

A	Nucleoid
B	Plasmid
C	ell
D	osome

b) How is this test performed?

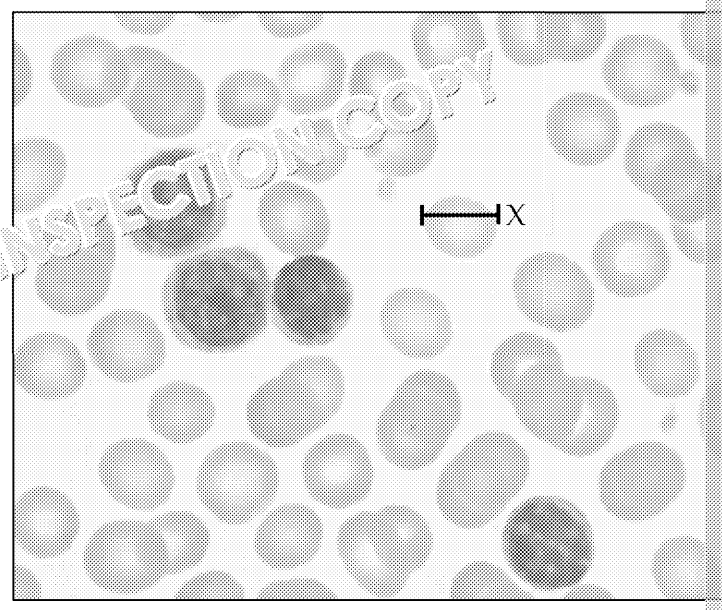
c) How can the result of this test be used to decide the method of tre diseases?

6. A microscope slide of skin cells was imaged and is shown below.



a) Calculate the magnification of the image, using the scale bar on th

b) The image below is of blood cells. It is magnified at 1000 x.



Calculate the true size of the cell labelled X.

Unit 1 – B2: Cell specialisation

1. Root hair cells are specialised cells of the plant root.

a) Draw a root hair cell and label the parts of the cell.

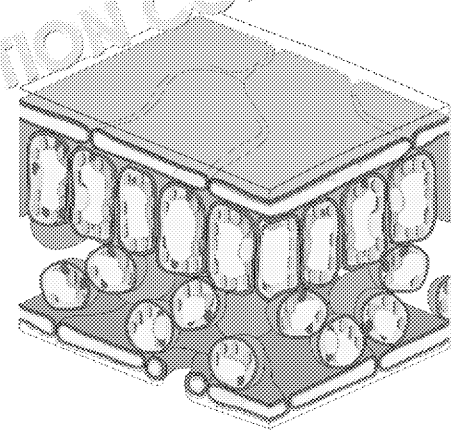
b) Match the adaptations of root hair cells to th[eir] function in a plan[t]

Many mitochondri[a]	Increases [surface area]
Lo[w] [resistance] to [water]	[Cell wall]
Large vacuole	Active [transport]

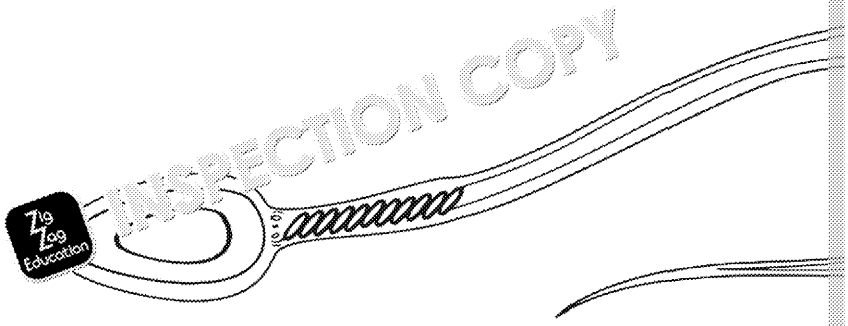
2. **a)** What is the name given to the specialised cells that perform photo[synthesis]

A	Spongy mesophyll
B	Palisade mesophyll
C	Guard cell
D	Epithelial cell

b) Give three adaptations of this cell type as seen [in] the diagram of [it]



3. A sperm cell is shown below. This type of cell is essential to fertility a[nd]

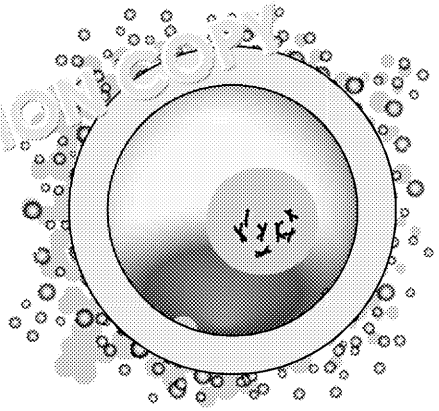


a) Sketch the sperm cell and label **two** adaptations present in this ce[ll] perform its function.

b) Give the name of an adaptation that is common between both spe

c) State the importance of this adaptation during reproduction.

4. An egg cell is shown below.

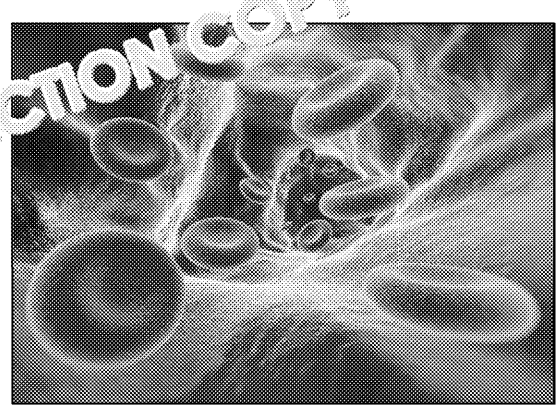


Copy the diagram and label it with the correct name of:

a) The region that is vital for recognition of sperm cells

b) The structure that is a supply of protein to a developing embryo

5. Consider the computer-generated image of red bl cells shown belo



a) State the purpose of red blood cells.

b) From the image, state two adaptations of red blood cells in the bl

c) What percentage of blood is occupied by white blood cells?

A	<1%
B	1–20%
C	20–40%
	0%

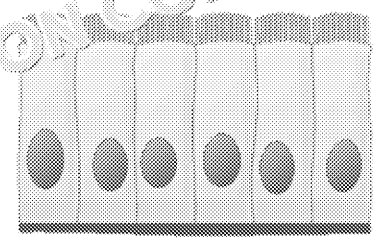
d) What are the functions of white blood cells, and how are they ada

Unit 1 – B3: Tissue specialisation

1. Epithelial tissue can be found in many locations throughout the huma

a) Name the two types of epithelial tissue present in the body.

b) Identify the type of epithelium represented in the image below.



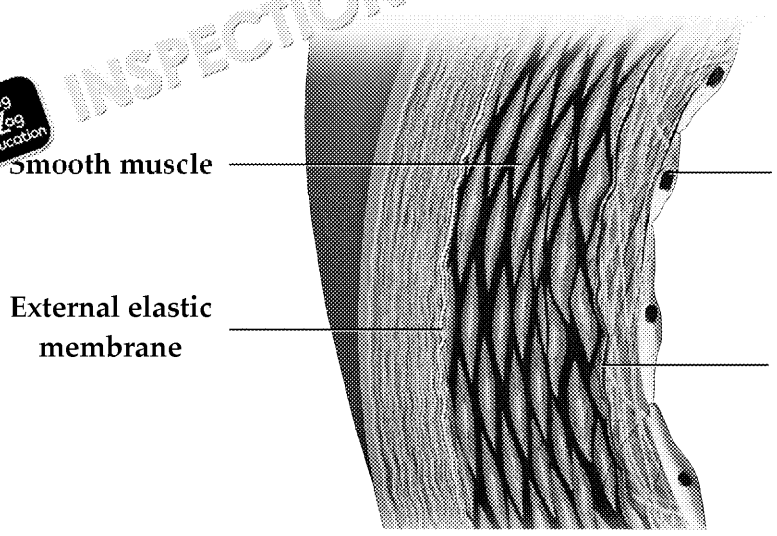
One location of epithelial tissue is the alveolar epithelium of the lungs.

c) Why is it important that the lung epithelium is made of a thin laye

Chronic obstructive pulmonary disease (COPD) is a disease seen regul
The disease causes the epithelium to become inflamed and to thicken.

d) Suggest how COPD can be detrimental to gas exchange.

2. The tissue layers of a medium-sized artery are shown below.



a) What name is given to the tissue type indicated by X?

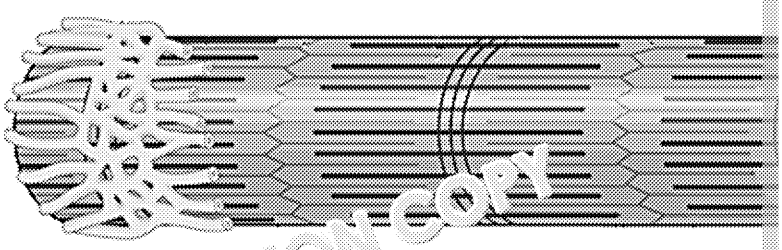
Damage to this layer can cause significant cardiovascular problems.

b) Name two risk factors that make damage to this layer more likely.

Atherosclerosis is a disease in which this layer becomes thickened and

c) Suggest why atherosclerosis can lead to severe cardiac problems.

3. The figure below shows a single muscle fibre.



a) Wh[illegible] are responsible for the typical banding patter[illegible]

A	Myosin
B	Elastin
C	Titin
D	Actin

b) What name is given to the mesh that wraps around a muscle fibr[illegible]

Muscle contraction is thought to occur as a result of the sliding filame[illegible]

c) Give an outline of the sliding filament theo[illegible]ating how it bring[illegible] contraction.

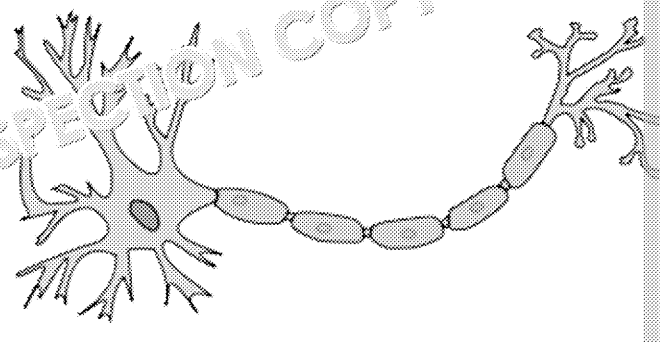
Two types of muscle fi[illegible] ev[illegible], fast- and slow-twitch.

d) E[illegible] why fast-twitch muscles are paler than slow-twitch musc[illegible]

e) Choose which **two** of these sports below are likely to benefit from[illegible]

A	Archery
B	Sprinting
C	Weightlifting
D	Marathon running

4. A myelinated motor neuron is shown below.



a) Give **one** function of the myelin sheath.

b) List the missing words in this description of how an action poten

There is a polarity across the membrane of a neuron – the outside of

..... relative to the inside.

Upon activation, sodium channels open and cause Na^+ ions to diffuse

The polarity of the cell gradually chan[illegible] a greater change i

positive feedback loop

A pe[illegible] difference is observed, with the outside of a neuron

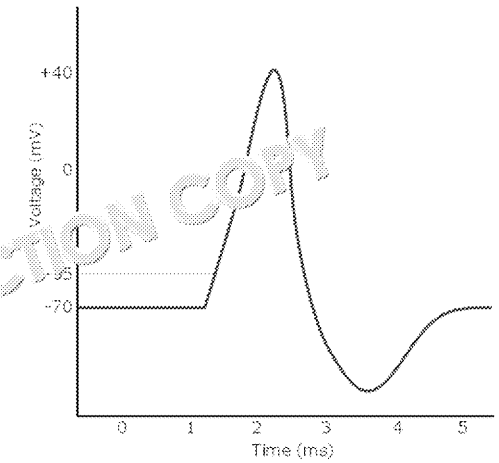
re[illegible] the inside.

At peak, the sodium channels ..... and K^+ channels o

K^+ ions diffuse ..... and cause a return of the polarity

There is an overshoot, called ..... before the original p

c) Copy this trace and label with the key words shown below.



Action potential, Refractory period

d) How does the myelin sheath affect the transmission of an action p

Neurons do not make direct contact with each other. Synapses are pr
neurons.

e) What is the role of acetylcholine at a synapse?

5. Dopamine is a neurotransmitter. It is pr[illegible] the brain at a regio

a) What disease can res[illegible] loss of dopamine-producing neu

b) W[illegible] is often offered to patients suffering from this dis

Serotonin is a different type of neurotransmitter. Its shortage is assoc

c) Suggest how a shortage of serotonin can lead to depression.

Unit 1 – C1: Working with waves

1. There are many examples of waves in nature, such as sound waves or water.

a) Copy and complete the sentences below using the following word used at all.

amplitude	period	rate	s
frequency	distance	phase	displ

A ..... is the rate at which it transfers energy.

particles in a wave is called an ..... .

The time taken for one complete wavelength to pass through a point

the number of waves passing a point in a second is its .....

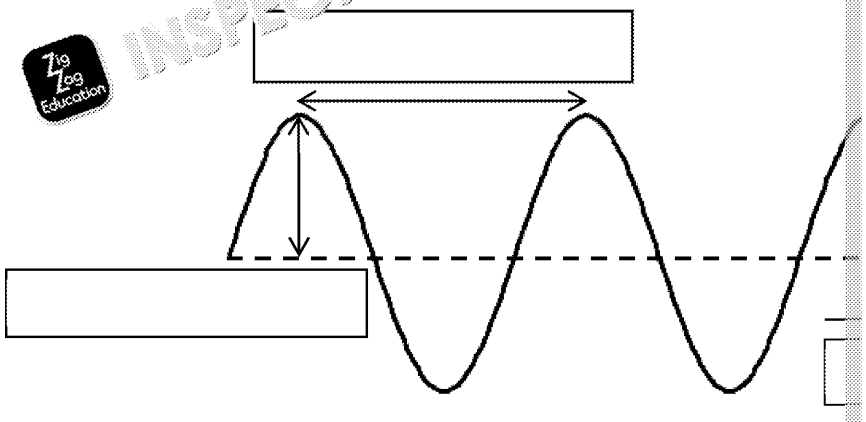
The distance that particles have been moved from their equilibrium p

..... . The maximum distance of particles from their e

the wave's ..... .

b) Copy the diagram below and fill in the boxes with the words pro wave below.

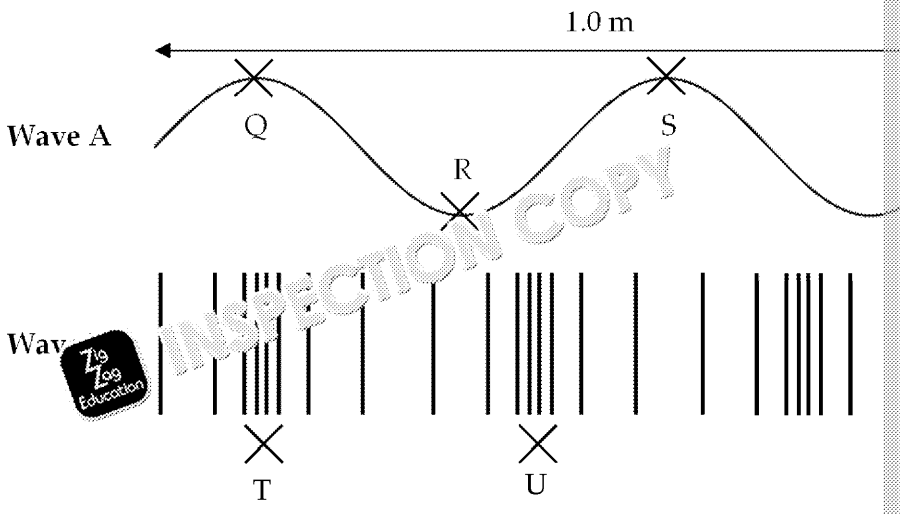
Frequency	Wavele	Displacement	Amplitude	Vel



c) Match the quantities below to their symbol and unit.

Speed		
Frequency	λ	
le	v	

2. The diagrams below show two waves, A and B, with several points m



a) Which of the waves is a transverse wave and which is a longitudi answer.

b) Give one example of a transverse wave and one example of a long

c) Wave A is travelling at a speed of 30 m s^{-1}. Using an equation fro calculate the frequency of wave A.

d) State the phase difference between the p

i) Q and R

ii) Q and S

ii d U

3. When two coherent waves meet they can interfere.

a) What is meant by the term *coherent*?

b) Describe what happens during constructive and destructive inter

c) Select the option that describes the phase difference required for d

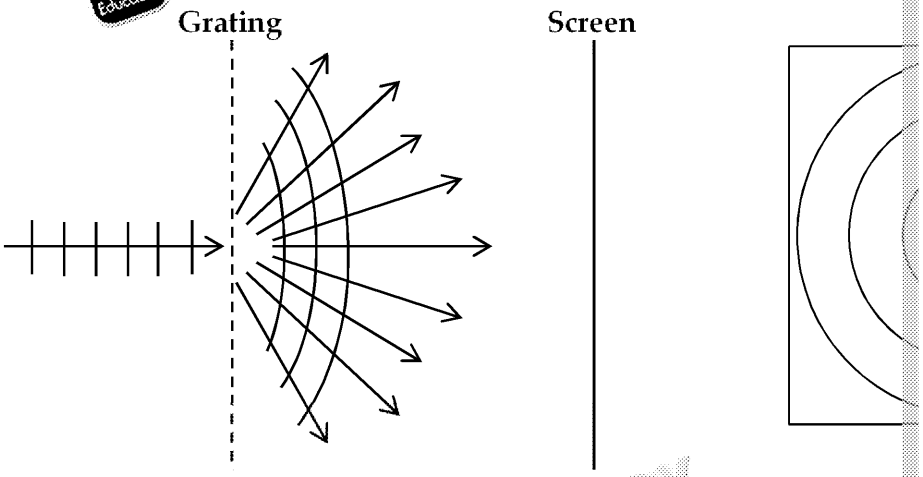
A	Multiple of 45°
B	Multiple of 90°
C	Multiple of 180°
D	Multiple of 360°

d) Select the option that describes the path difference required for co

$n = 0, 1, 2 \ldots$

A	$n\lambda$
B	$\frac{n}{2}\lambda$
C	$\frac{n+1}{2}\lambda$
D	$(n+1)\lambda$

4. The dia[illegible] shows a process used in industry, including the pa



a) Name the process shown abov[illegible]

b) Copy the patt[illegible] mark the brightest spot on the pattern prod[illegible] ar[illegible]

c) How can the process above be used in industry to identify gases?

5. **a)** Draw the 3rd harmonic of a stationary wave. Label any nodes and

b) Describe how a stationary wave is formed.

c) How does a trumpet use stationary waves to create sounds?

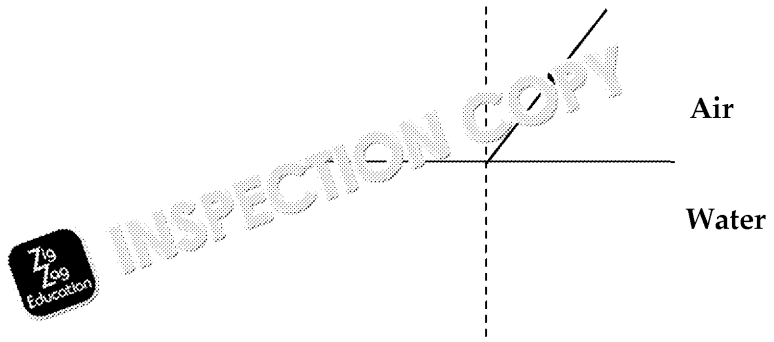
d) A transverse wave moves along a string.

The tension on the string is 15 N and a 2.0 metr[illegible] length of the stri[illegible] mass of 15 g.

Using an equation from th[illegible] or [illegible]ae sheet, calculate the velocity [illegible] string.

Unit 1 – C2: Waves in communication

1. The diagram below shows the path of light as it passes from air to wa



a) Select the name given to the dotted line.

A	Incident
B	Parallel
C	Normal
D	Perpendicular

b) Copy and complete the diagram above to show the path of light f

c) The refractive index of a type of pla[illegible]

Using an equation fro[illegible]ulae sheet, calculate the speed of

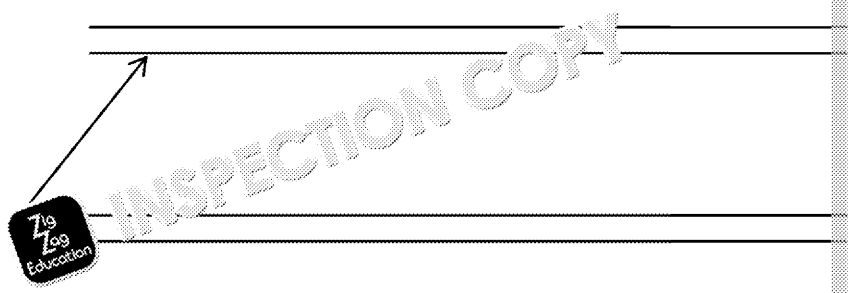
Use the s[illegible]ght in a vacuum = 3.0×10^8 m s^{-1}

d) Lig[illegible]enters a block of glass from air at 12 ° to the normal to the s
index of the glass is 1.4.

Using an equation from the formulae sheet, calculate the angle th
makes to the normal to the surface.

2. Fibre optic cables have many applications in computing and medical i

a) Copy and complete the diagram below to show the path a ray of l
optic cable.



b) The refractive index of the core is 1.57.

Using an equation from the formulae sheet, calculate the critical a
between the core and air.

c) Using the words below, copy the paragraph and fill in the gaps to refractive indices in the cladding and core of an optical fibre.

higher	lower	equal	refraction
transmission	diffraction	interface	membrane

It is important that the core has ..... refrac

because light ... undergo ..... at the .....

be... a material with a ..... refractive inde

currently in.

d) Describe how fibre optics are used in medical imaging.

3. Fibre optics are frequently used in communications.

a) What are the main differences between analogue and digital sign

b) What are the advantages of digital signals over analogue signals

c) Order the steps below to describe how an ana...gue signal is conv

A	Select an appropriate sam...g ...e, which sets how frequen
B	Transmit the ...al th...ugh an aerial or optical fibre.
C	...m... ...analogue signal using an analogue-to-digital con
D	...e cable must be screened by earthing to avoid electrical in
E	Connect the output to the input of an analogue-to-digital co
F	Select the smallest appropriate unit for converting the voltag
G	Use a transducer to produce an analogue electrical signal pr... want to send.

d) Select the main advantage of using a multimode fibre optic over s

A	Uses less power
B	Can send multiple sets of data along a si...le fibre
C	Cheaper
D	Can send data at ... frequency

Unit 1 – C3: Use of electromagnetic waves in commun

1. a) Copy the paragraph below and use the words to fill in the gaps to electromagnetic waves.

some	most	all	c	l
water	fastest	slowe	with	withou

..... magnetic waves travel at the speed of light in a vacuum. The symbol .....

This is the ..... speed that anything can travel at, and only

mass can travel at this speed.

b) Select the value of the speed of light.

A	3.00×10^{8} m s^{-1}
B	340 m s^{-1}
C	2.64×10^{5} m s^{-1}
D	7.19×10^{10} m s^{-1}

2. a) $I = \frac{k}{r^2}$ is an important equation for the intensity of a wave.

State the name given to this equation.

b) At a distance of 0.5 m from a bulb, the intensity of light from the bulb is 4.0 W m^{-2}.

Calculate the intensity of light from the bulb at a distance of 4.0 m.

3. Electromagnetic waves are grouped into regions based on their frequency.

a) Copy and complete the table below to describe the regions of electromagnetic waves and their applications.

Region	Frequency	Applications
Radio	30 kHz to 3 GHz	
Microwave	3 GHz to 300 GHz	
	300 GHz to 400 THz	Cooking food, night vision controls, motion sensors
	400 THz to 800 THz	Human sight, photography
	800 THz to 30 PHz	Forensic analysis, dental
X-rays	30 PHz to 30 EHz	
Gamma rays	> 30 EHz	

b) Why are higher frequency microwaves used in satellite communi
frequency radio waves are used in mobile phone communication?

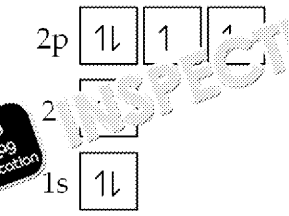
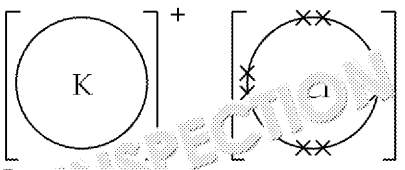
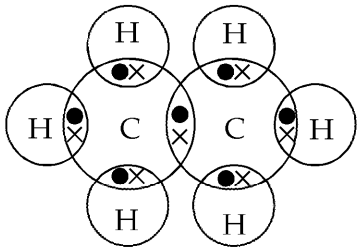
c) Bluetooth and Wi-Fi both use similar frequencies. How are Bluet
interfere with Wi-Fi signals?

d) Why are infrared waves chosen for their use in remote controls?

e) What makes high frequency electromagnetic waves, such as X-ray
unsuitable for use in communication?

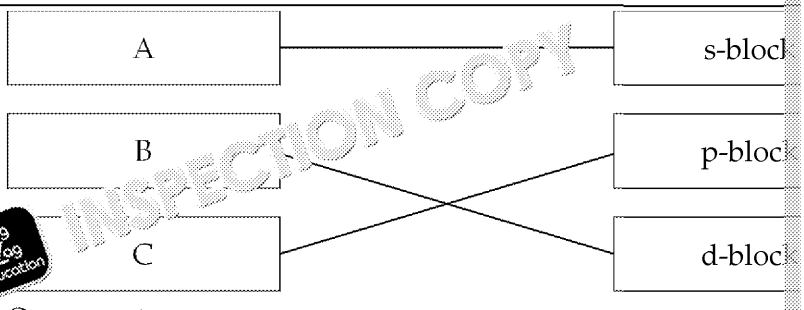
Answers

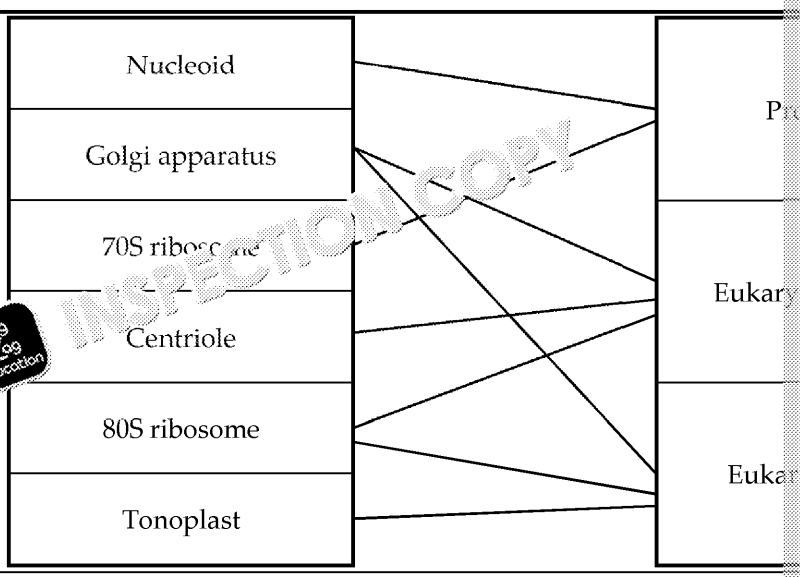
A1: Periodicity and properties of elements

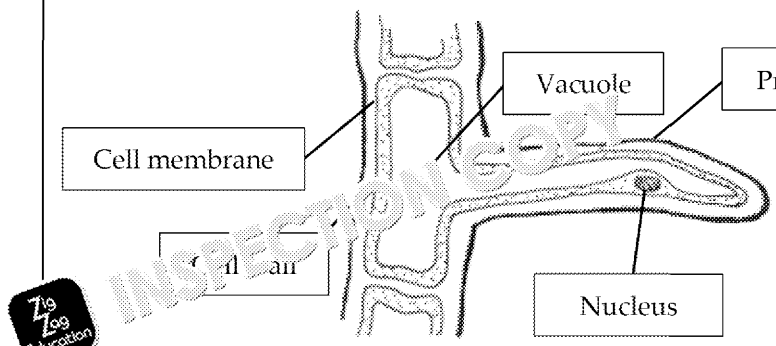
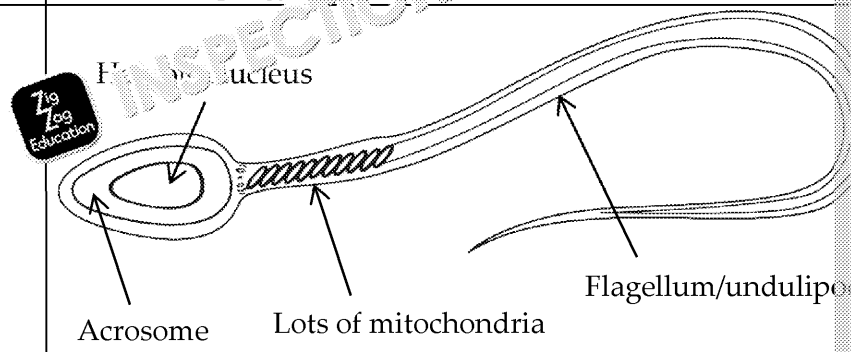
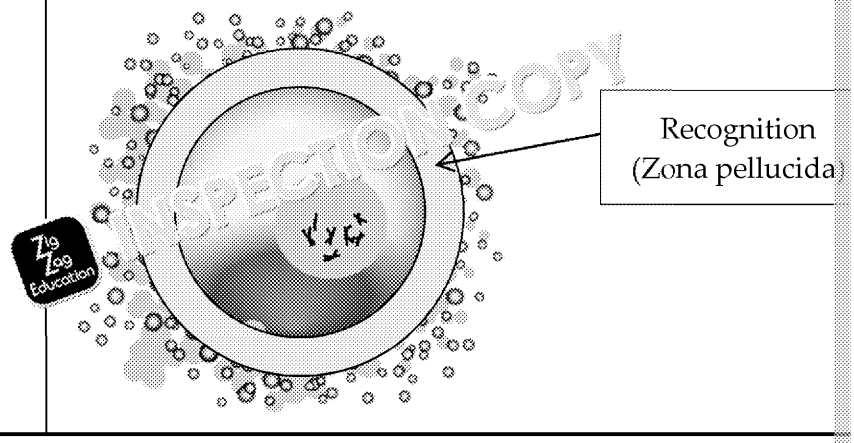
Question	Answer
1a	**B** two
1bi	An orbital
1bii	 Correct number of electrons in each subshell, i.e. $1s^2\ 2s^2\ 2p^4$ 2p subshell has three up-spin and one down-spin electron Down-spin electron in first box
1ci	$1s^2\ 2s^2\ 2p^3$
1cii	**B** Number of the shell
2a	Electron(s) is (are) transferred from potassium to chlorine forming ions/K^+ and Cl^-.
2b	Opposite charge Electrostatic attraction
2c	 ...no ...inner electrons/allow K with a full shell of electrons) ...with seven × and one ● (or vice-versa) Correct charges.
2d	NaCl Sodium ions have a higher charge density than potassium ions Therefore stronger electrostatic attraction
3a	 Correct arrangement of atoms Correct number of electr... ...each atom Each bond contain... ...d one ×
3bi	C_2H_4
3bii	*...d ...gth* ...ene has a shorter bond *Geometry* Geometry is tetrahedral *Coordinate bonds* Ethane has no coordinate bonds

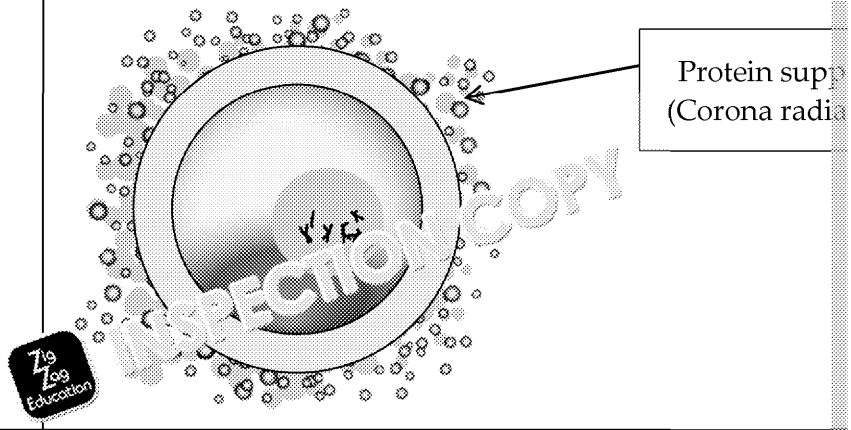
Question	Answer
4	Metallic bonding Positive ions (Sea of) delocalised electrons
5a	D H_2O, HCl and CH_4
5b	A H_2O and HCl
5c	A H_2O only
6	$2Al + 3Cl_2 \rightarrow 2AlCl_3$ Correct species Correctly balanced
7ai	Relative formula mass of HCl = 36.5 36.5 × 0.2 = 7.30 g
7aii	Division of 0.2 by volume (in cm^3 or dm^3) = 2.67 (do not allow 0.00267) mol dm^{-3}
7b	Amount of C_2H_5Cl = 0.2 mol Relative molecular mass of C_2H_5Cl = 64.5 Theoretical mass of C_2H_5Cl = 64.5 × 0.2 = 12.9 g

A2: Production and uses of substances in relation to properties

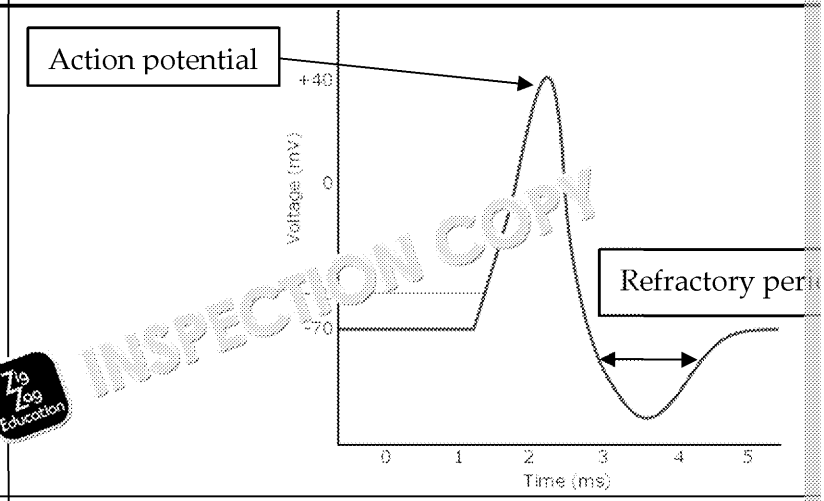
Question	Answer
1a	**C** Period 3
1b	6
1c	 One correct Three correct
2a	Increases *Any two from*: • Screening/shielding stays the same • Atomic radius decreases • Nuclear charge increases
2b	The ability of an atom to attract a pair of electrons
2c	**B** Si
3a	(Increases) Larger molecules Stronger van der Waals forces
3b	Metallic bonding is stronger th[illegible] van [illegible] Waals / intermolecular f[illegible] Requires more energy/high[illegible] temperature to break forces in meta[illegible]
3c	Delocalised [illegible] Can [illegible] charge
3d	[illegible]ers of positive ions/atoms slide over each other
4a	$4Li + O_2 \rightarrow 2Li_2O$ Species Balancing
4b	Reduced because it goes from oxidation state 0 to -2
4c	$2Li + 2H_2O \rightarrow 2LiOH + H_2$ Species Balancing
4d	iron + sulfuric acid → iron sulfate + hydrogen Iron sulfate Hydrogen
4e	Group 1 metals are more reactive Lithium reacts more quickly
4f	It can have multiple [illegible]tes / can be Fe(II) or Fe(III)
5a	Magnesium [illegible]anium They [illegible] reactive than zinc
5bi	[illegible]orine because it is more reactive than bromine
5bii	$ZnBr_2 + Cl_2 \rightarrow ZnCl_2 + Br_2$

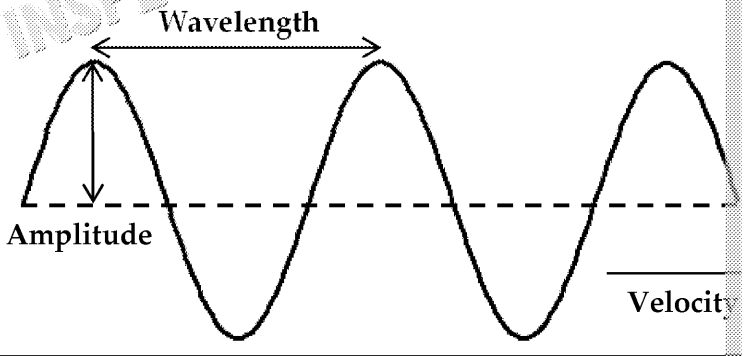
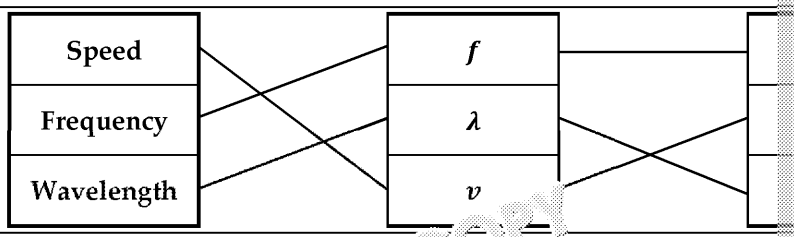
Question	Answer
1	
2	A: Mitochondrion (ALLOW mitochondria) B: Endoplasmic reticulum (ALLOW rough OR smooth) C: Nucleolus
3	*Any four (in logical order) from:* • Produce a (smear) of blood on a slide • Place cover slip above slide • Place slide on stage • Select a low magnification lens • Illuminate the slide • Adjust coarse focus to bring cells into view • Adjust fine focus to increase resolution of slide • Adjust magnification as necessary
4	A: Site of respiration AND produces energy for cell B: Site of photosynthesis AND produces glucose for respiration from CO_2 and water (and su C: Site of protein synthesis AND receives template from nucleus and creates the polypeptide f
5a	C Cell wall
5b	Heat fixation of sample to slide Apply stain (crystal violet) Apply iodine solution Decolorise using ethanol/acetone Counterstain with safranin
5c	Gram positive are more responsive to antibiotics. Gram negative bacteria are more resistant to antibiotics and anoth be needed.
6a	Bar measures 1 cm = 10 000 μm Magnification = image size / object size Magnification = 50 000 / 120 = 416.6 x
6b	Cell measures 1 cm = 10 000 μm Object size = Image size / magnification Object size = 10 000 / 1000 = 10 μm

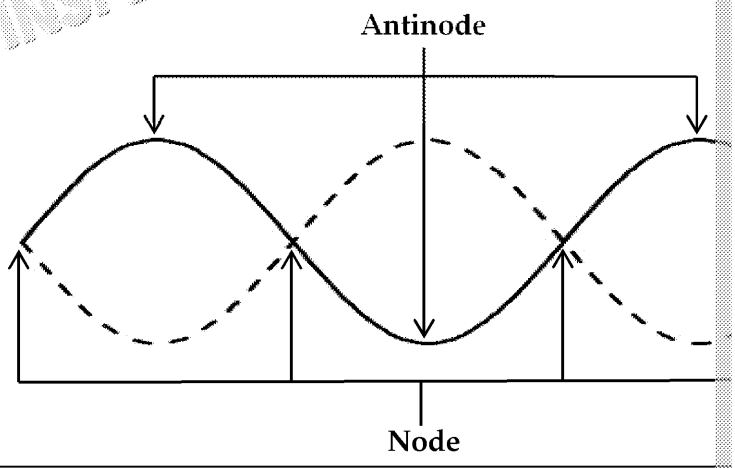
Question	Answer
1a	
1b	Many mitochondria → Increases surface area : v Long projection → Can fill with water Large vacuole → Active transport of ions
2a	B Palisade mesophyll
2b	• Tightly packed • Columnar shape • Orientated to leaf surface • High number of chloroplasts • Short distance from outside / s' on di sion distance • Close to spongy mes close to stomata
3a	
3b	Haploid nucleus (allow half the number of chromosomes)
3c	Required to allow genetic mixing Fertilised egg cell will then have the full number of chromosomes
4a	

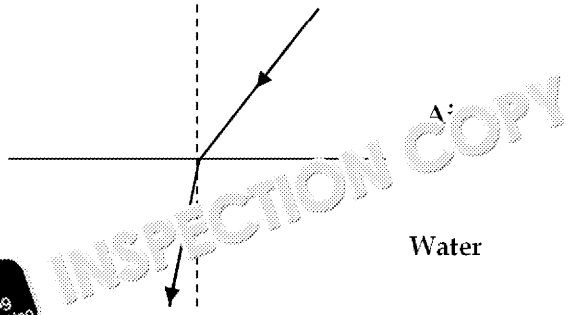
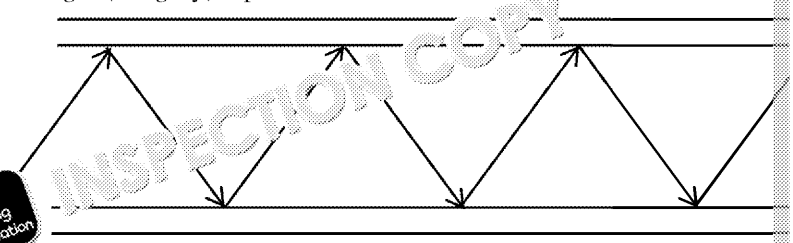
Question	Answer
4b	
5a	Transport oxygen around the body
5b	*Two from:* Large number to facilitate oxygen transport Biconcave shape to increase surface area : volume ratio No nucleus to maximise space for haemoglobin Flexible to fit through tiny vessels
5c	A <1%
5d	*Indicative content* • They defend the body against pathogens • They produce antibodies • They produce antitoxins • They perform phagocytosis • They synthesise proteins • They have many rece[illegible] their cell surface • They can ch[illegible]ge t[illegible]ape of the cell membrane • The[illegible]l[illegible]osomes to digest pathogens T[illegible]y produce enzymes to digest pathogens

Question	Answer
1a	Squamous Columnar
1b	(Ciliated) columnar
1c	Short diffusion distance *to* maximise gas exchange
1d	Reduces ability to [illegible] gases quickly
2a	Endothelium
2b	*One from:* Diabetes • High blood pressure • Aging • High cholesterol • Obesity • Smoking
2c	Reduces the amount of blood flow to vital organs *and* can lead to stroke / heart failure
3a	Actin Myosin
3b	Sarcoplasmic reticulum Stores calcium for rapid induction of an impulse
3c	Action potential travels into the muscle fibre Calcium released from the sarcoplasmic reticulum Calcium binds with tropomyosin, exposing binding sites on actin Myosin heads bind to actin Myosin heads pivot, pulling the actin fibre Myosin heads detach and bind again further up the actin filament
3d	Fast twitch muscles respire anaerobically Do not require extensive blood supply (or the opposite)
3e	Sprinting Weightlifting
4a	*One from:* Protects the axon Speeds impulses
4b	positive into negative close out hyperpolarisation

Question	Answer
4c	
4d	*Two from:* • Does not allow exchange of ions across myelin sheath • Causes jumping of action potential across nodes of Ranvier, sp • Saltatory conduction
4e	Acetylcholine is a neurotransmitter It causes activation of the post-synaptic neurone
5a	Parkinson's disease
5b	Prescription of l-dopa
5c	Serotonin linked to feelings of happiness and contentment. Loss of serotonin means that these brain neur e pathways are not

Question	Answer
1a	In order: speed oscillation periodic time frequency displacement amplitude
1b	
1c	
2a	Wave A is transverse; wave B is longitudinal (Wave A is transverse because) the direction of oscillation is at right speed (Wave B is longitudinal because) the direction of oscillation is in the wave speed
2b	*Transverse – one from*: • Light waves • Waves on water surface • Seismic S-waves *Longitudinal – one from*: • Sound waves • Seismic P-waves
2c	$\lambda = 1.0/2.5$ $\lambda = 0.40$ m $v = f\lambda$ $f = \frac{v}{\lambda}$ $f = \frac{30}{0.40}$ $f = 75$ Hz
2di	π radians or 180 °
2dii	2π radians or 360 °
2diii	[illegible] radians or 360 °
3a	Waves in phase / waves have constant phase difference and with the same frequency
3b	In constructive interference the amplitudes of two waves add to a In destructive interference the opposite amplitudes of two waves a
3c	C Multiple of 180 °

Question	Answer
3d	A $n\lambda$ (where $n = 0, 1, 2\ldots$)
4a	Diffraction
4b	Central spot
4c	Diffraction gratings split up white light into its component colours Missing wavelengths represent the ene[illegible]s[illegible]rbed by excited ga Each type of gas absorbs differe[illegible]nt [illegible]ne[illegible]s, specific to the type of [illegible]
5a	Wave drawn with th[illegible]lf [illegible]avelengths Nodes and [illegible]e correctly identified 
5b	A wave travels backwards and forwards along a cavity/string, inte[illegible] Nodes appear at points of destructive interfere[illegible]ce, antinodes at po[illegible] constructive interference
5c	Stationary waves set up in th[illegible]r i[illegible]e trumpet's horn Many possible har[illegible]produced in the horn, producing ma[illegible] sound at [illegible]
5d	[illegible] $= \frac{}{l}$ $\frac{0.015}{2.0}$ $\mu = 7.5 \times 10^{-3}$ kg m^{-1} $v = \sqrt{\frac{T}{\mu}}$ $v = \sqrt{\frac{15}{7.5\times10^{-3}}}$ $v = 44.7$ m s^{-1}

Question	Answer
1a	C. Normal
1b	
1c	$n = \frac{c}{v}$ $v = \frac{c}{n}$ $v = \frac{3.0\times10^{8}}{1.2}$ $v = 2.5 \times 10^{8}$ m s^{-1}
1d	$n = \frac{\sin i}{\sin r}$ $\sin r = \frac{\sin i}{n}$ $r = \sin^{-1}\frac{\sin i}{n}$ $r = \sin^{-1}\frac{\sin 12}{1.4}$ $r = 8.5\,^{\circ}$
2a	Reflecting when meeting cladding-core boundary At angle (roughly) equal to incidence 
2b	$\sin C = \frac{1}{n}$ $C = \sin^{-1}\frac{1}{n}$ $C = \sin^{-1}\frac{1}{1.57}$ $C = 39.6\,^{\circ}$
2c	1 mark each for every two correct words in order: higher total internal reflection interface lower
2d	Provide light on the inside of the body Transmit images back to screen
3a	An analogue signal can take any value A digital signal is transmitted as bursts of data So they can only have set values and not in between these values
3b	Less interference Can send multiple sets of data along a single fibre
3c	E, D, C, A, F, B (Below A and F reversed)
3d	B Can send multiple sets of data along a single fibre

<table>
<tr><th>Question</th><th>Answer</th></tr>
<tr><td>1a</td><td>In order:
all
a vacuum
c
fastest
without</td></tr>
<tr><td>1b</td><td>A 3.00×10^8 m</td></tr>
<tr><td>2a</td><td>Inverse square law</td></tr>
<tr><td>2b</td><td>$I = \frac{k}{r^2}$
$k = Ir^2$
$k = 3.2 \times 0.5^2$
$k = 0.8$
$I = \frac{0.8}{4.0^2}$
$I = 0.05$ W m^{-2}</td></tr>
<tr><td>3a</td><td>
<table>
<tr><th>Region</th><th>Frequency</th><th>Applicatio</th></tr>
<tr><td>Radio</td><td>3 kHz to 3 GHz</td><td>Television and radio bro
phone communication</td></tr>
<tr><td>Microwave</td><td>3 GHz to 300 GHz</td><td>Cooking food, radar, sat
communication</td></tr>
<tr><td>Infrared</td><td>300 GHz to 400 THz</td><td>Cooking food, night-visio
remote controls, motion s</td></tr>
<tr><td>Visible</td><td>400 THz to 800 THz</td><td>Human sight, photograph</td></tr>
<tr><td>Ultraviolet</td><td>800 THz to 30 PHz</td><td>Forensic analysis, disinfe
zappers</td></tr>
<tr><td>X-ra</td><td>30 PHz to 30 EHz</td><td>Medical imaging</td></tr>
<tr><td>Gamma rays</td><td>> 30 Ehz</td><td>Medical imaging, radiot
sterilisation</td></tr>
</table>
</td></tr>
<tr><td>3b</td><td>(Lower frequency) radio waves bounce off the atmosphere and on
(Higher frequency) microwaves penetrate the atmosphere more ea
satellites</td></tr>
<tr><td>3c</td><td>Bluetooth devices broadcast in short bursts across a range of frequ
while Wi-Fi broadcasts continuously,
so the Bluetooth can only interfere with Wi-Fi for short, unnoticeab</td></tr>
<tr><td>3d</td><td>Some diffraction so don't require direct line of sight
Not absorbed/scattered by water in atmosphere</td></tr>
<tr><td>3e</td><td>Unlikely to reflect or diffract so difficult to dir t
Likely to pass through receiver
Dangerous for humans</td></tr>
</table>