BTEC

L3 Lead Examiner Report 1906

June 2019

L3 Qualification in Applied Science/Forensics and Criminal Investigations

Unit 1: Principles and Applications of Science I (31617H)

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Grade Boundaries

What is a grade boundary?

A grade boundary is where we set the level of achievement required to obtain a certain grade for the externally assessed unit. We set grade boundaries for each grade, at Distinction, Merit and Pass.

Setting grade boundaries

When we set grade boundaries, we look at the performance of every learner who took the external assessment. When we can see the full picture of performance, our experts are then able to decide where best to place the grade boundaries – this means that they decide what the lowest possible mark is for a particular grade.

When our experts set the grade boundaries, they make sure that learners receive grades which reflect their ability. Awarding grade boundaries is conducted to ensure learners achieve the grade they deserve to achieve, irrespective of variation in the external assessment.

Variations in external assessments

Each external assessment we set asks different questions and may assess different parts of the unit content outlined in the specification. It would be unfair to learners if we set the same grade boundaries for each assessment, because then it would not take accessibility into account.

Grade boundaries for this, and all other papers, are on the website via this link:

http://qualifications.pearson.com/en/support/support-topics/results-certification/grade-boundaries.html

Unit 1 (31617_H01)

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	11	23	40	58

Introduction

This unit is assessed through an examination worth 90 marks with a total time of 2 hours, undertaken in three timed sessions of 40 minutes for each of Biology, Chemistry and Physics. Learners must take all three parts of the single examination in the same series to be awarded a result. The papers included a range of question types, including multiple choice, calculations, short answer and open response. These question types assessed discrete knowledge and understanding of the content in this unit.

Introduction to the Overall Performance of the Unit

Structure and functions of cells and tissues (Biology)

Exam technique and the understanding of the command verbs is improving within the structure and functions of cells and tissues section of the exam. It is beneficial for learners to appreciate the requirement of each of the command verbs so that they can target their response and provide appropriate credit worthy answers. Centres need to fully prepare learners for the exam by practicing exam technique, especially in relation to reading the question carefully and not repeating the stem of the question. Learners should also be taught that when they have answered the question to reread their response in order to ensure that the question set has been addressed in the answer they have given, and that they have used appropriate scientific knowledge and vocabulary. Learners should show that they understand the relationship between the structure and function of cells and tissues. Learners still struggle to recall definitions, even with the gap fill approach to the question asking for the definition of a tissue, many learners were only able to complete half of the definition correctly. Learners find it difficult to provide links between different related aspects of the specification. The additional guidance for the unit provides detail to the depth and breadth of the specification points. Learners did not perform well on the agonist question, with a majority of learners being confused with precursors for neurotransmitters. The extended response question demonstrated that learners understood the basic scientific knowledge of the difference between the Gram positive and Gram negative bacterial cell walls, but learners tended not to develop their discussion and gave limited responses.

The specification and sample assessment materials (SAMs) are located on the BTEC First qualification webpage located here.

Periodicity and Properties of Elements (Chemistry)

This was the fifth sitting of the level 3 applied science Unit 1 chemistry section. With more past papers to practice on and with the publication of the additional guidance to centres, it is pleasing to see that learners are becoming more proficient at answering the paper. The paper split continues to enable learners to focus their attention on the paper and science in hand and apply their chemistry to new situations and contexts. As in the January series of this year, fewer blank responses were seen, showing that learners are entering the exam more prepared and able and more learners are engaging with the paper with fewer answering questions that they thought were there rather that answering the question set.

Learners that were successful this year were able to perform the given calculations using clear and logical working. They were able to understand and use scientific vocabulary in the correct context and apply their knowledge of chemistry explain trends in data and ideas. Their knowledge of basic scientific terminology allowed them to access questions and apply ideas.

To improve in future exam series learners should ensure that they understand basic scientific terminology such as property, element and compound so that they can they explain features and trends in the chemistry in more detail. They should be taught correct methodologies calculations that come up in the unit and practice setting out their work in a logical manner so that they can arrive at a given answer in a concise way.
Learners should continue to practice exam technique, ensuring that they know what is required by specific command words such as give, describe and explain.

Waves in Communication (Physics)

The examination paper tested knowledge of applications of science and the ability of learners to understand, interpret and analyse scientific information in the context of waves and communication. The majority of learners were familiar with the ideas relating to stationary waves but found applying the equation to determine the speed at which waves travel on a string more challenging. Although the equation was given, some learners were not familiar with the symbols used and therefore could not substitute correctly to achieve the first step necessary. Many learners still do not realise that all the waves that make up the electromagnetic spectrum travel at the same speed and they are not familiar with the relative positions of these waves in terms of frequency and wavelength. Amplitude being related to the energy that a wave carries is also a concept that is not well understood.

Learners still find it difficult to describe an analogue signal and need to learn the basic steps required to convert analogue signals to digital signals. Learners are generally more organised in setting out calculations and are more likely to be able to rearrange equations correctly but were not always aware that 'c' is the symbol for the speed of light and made an incorrect substitution. The use of standard form needs to be encouraged as giving an answer for the speed to light to 10 significant figures, whilst accepted, is not good practice when the refractive index is only given to 3 significant figures. Most learners attempted to describe how optical fibres transmit light and this was more successful when a labelled diagram was used. The confusion between reflection and refraction is still apparent and learners frequently wrongly use the phrase 'total internal refraction' for the reason that light travels down an optical fibre. Whilst many learners appreciated how the light was transmitted through the optical fibres very few were able to explain that the endoscope has separate bundles of fibres for the light to travel down and back up and this allows a doctor to see inside the stomach of a patient.

Individual Questions

Structure and functions of cells and tissues (Biology)

Q1a

The majority of learners were able to identify a cell component which is only found in eukaryotic cells from the list given in the multiple choice question.

This response was awarded 1 mark.

The human respiratory system contains ciliated epithelial cells.

Ciliated epithelial cells are eukaryotic.

(a) Which cell component is only found in eukaryotic cells?

(1)

☒ **A** capsule

☒ **B** cell membrane

☒ **C** nucleus

☒ **D** plasmid

Q1b

Most learners were able to gain at least 1 mark from the 3 marks available for completing the table to compare squamous epithelial tissue and columnar epithelial tissue.

A range of descriptions were accepted for (iii) as learners mirrored the example of rectangular which was already given in the table.

This response was awarded 3 marks.

(b) Table 1 compares squamous epithelial tissue and columnar epithelial tissue.

	squamous tissue	columnar tissue
location in the respiratory system	(i)	(ii)
description of the shape of the cells	(iii)	rectangular

Table 1

Identify the missing words in Table 1.

(1)

(i) Alveoli

(1)

(ii) Trachea

(1)

(iii) Square, flattened.

Some learners gave a response for the location in the respiratory system which was too vague or incorrect. Some were also confused with the digestive or reproductive system.

This response was awarded 1 mark.

(b) Table 1 compares squamous epithelial tissue and columnar epithelial tissue.

	squamous tissue	columnar tissue
location in the respiratory system	(i)	(ii)
description of the shape of the cells	(iii)	rectangular

Table 1

Identify the missing words in Table 1.

(1)

(i) lung

(1)

(ii) trachea

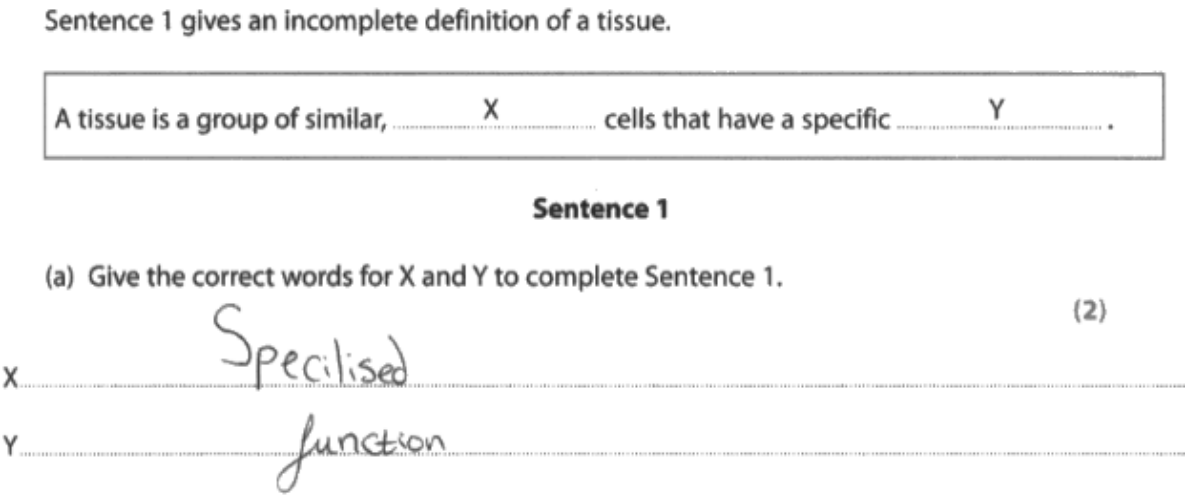
(1)

(iii) long

Q2a

Unfortunately, learners tend to struggle to recall definitions. A gap- fill approach was used in this series to scaffold the learners response and distinction level learners were able to gain 2 marks from correctly completing the definition.

This response was awarded 2 marks.



Sentence 1 gives an incomplete definition of a tissue.

A tissue is a group of similar, X cells that have a specific Y .

Sentence 1

(a) Give the correct words for X and Y to complete Sentence 1.

(2)

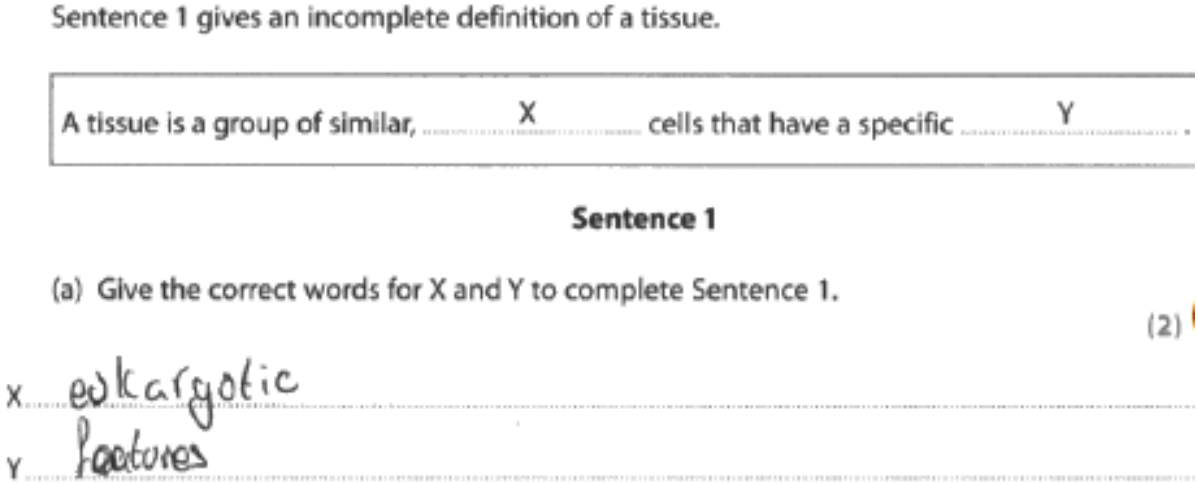
X Specilised

Y function

Some learners did not provided correct words to complete the definition.

A range of words were accepted for X and Y.

This response was awarded 0 marks.



Sentence 1 gives an incomplete definition of a tissue.

A tissue is a group of similar, X cells that have a specific Y .

Sentence 1

(a) Give the correct words for X and Y to complete Sentence 1.

(2)

X eukaryotic

Y features

Q2b

Most learners were able to gain at least one mark from this explain question. Of the marking points many of the creditworthy responses mentioned increased surface area and some mentioned turgidity and pushing chloroplasts to the edge of the cell. Many of the learners talked about the general function of the vacuole rather than its relation to photosynthesis. However some learners were unaware of how the vacuole assists in this function, with a number of references to the vacuole storing energy, absorbing light, being involved in diffusion, and even storing water and glucose for carrying out photosynthesis itself. Mention of chloroplasts and even mitochondria inside the vacuole was common. Reference to shorter diffusion distances and reducing competition for raw materials was not seen often but were creditworthy responses.

This response was awarded 3 marks. The learner has stated that the vacuole provides rigidity, that the surface area is increased and added a reference to 'more' sunlight (even though they have phrased this in terms of 'reaching'), which is just sufficient for a mark.

(b) A palisade mesophyll cell contains a vacuole.

Explain how the vacuole in a palisade mesophyll cell helps to increase the rate of photosynthesis.

(3)

The vacuole gives the leaf of the plant a physical support, so it stays rigid and flat to increase the surface area so the leaf can reach more sunlight and increase the rate of diffusion

This response was awarded 0 marks. Although the learner has linked photosynthesis to chloroplasts, they think the chloroplasts are inside the vacuole and so their comment is not creditworthy.

(b) A palisade mesophyll cell contains a vacuole.

Explain how the vacuole in a palisade mesophyll cell helps to increase the rate of photosynthesis.

(3)

The vacuole contains chloroplast which is the site of photosynthesis. Chlorophyll can help the vacuole increase the rate of photosynthesis

Q2c

Most learners were able to correctly identify the cell structure from the electron micrograph.

Identify the cell structure labelled M in Figure 2.

(1)

- ☒ A amyloplast
- ☒ B cell wall
- ☒ C plasmodesmata
- ☒ D tonoplast

Q3a

This question was very well answered, and most students obtained 2 marks. Many responses gave marking points twice in two different ways. Mention of transmitting impulses was most commonly seen, as was the direction they travel and reference to travelling across nerves/between neurones.

However, some learners seemed to think that the impulse does not go anywhere or goes into the body and reference to the electrical impulse passing through the synapse was seen quite frequently.

Reference to regenerating impulses or filtering out low level stimulus was very rarely seen although would have been creditworthy responses.

This response was awarded 2 marks. The learner has stated that the synapse is where neurotransmitters cross between two neurons.

They have also used the word 'message', which is a repeat of the first marking point. The same marking point cannot be credited twice, and maximum marks have already been achieved.

(a) Describe the function of a synapse.

(2)

A synapse is the gap between two neurons where neurotransmitters cross. This is carrying a message ~~through~~ though the body. The synapse keeps this message going.

This response was awarded 0 marks. The term 'signs' is not an acceptable answer for the first marking point and 'around the body' is too vague for a mark.

(a) Describe the function of a synapse.

(2)

A synapse sends ~~right~~ signs around the body. It is in ~~be~~ the spine & the synapse sends a signs or waves around the body in order for the body to react.

Q3bii

Some learners were able to identify the correct statement.

(b) (i) Identify the correct statement.

(1)

- ☒ A acetylcholine is an enzyme
- ☒ B acetylcholine is a hormone
- ☒ C acetylcholine is a neurotransmitter
- ☒ D acetylcholine is a vesicle

The most common incorrect response was B, closely followed by A.

Q3bii

Although this question was scored well in general, the scientific language used by the learners was often quite poor. The most commonly achieved marking points were for reference to the breakdown of acetylcholine by an enzyme. Mention of the acetylcholine diffusing away and being used again were seen frequently, although the latter was often not expressed very clearly. Reference to the re-synthesis of acetylcholine was rare.

This response was awarded 3 marks. The learner has stated that the acetylcholine is reabsorbed back, broken down by acetylcholinease, and also implies that it can be reused. The maximum of 3 marks can be awarded.

(ii) Explain what happens to acetylcholine after its function is complete.

(3)

It can be reabsorbed back into the presynaptic neurone through a process called reuptake or it can be broken down in the synapse It is broken down by acetylcholinerase where it can then be used.

Those learners who failed to achieve creditworthy responses often did so by describing the effect of acetylcholine instead of what happens to it and the suggestion that acetylcholine would be “digested by the stomach”, which was seen a number of times. Some learners misinterpreted the question and described the action potential generation in the post synaptic neurone.

This response was awarded 0 marks. The term 'disappears' is insufficient as a replacement for 'diffuses away'. The learner has not given sufficient details about acetylcholine being reused or recycled after its function is complete.

(ii) Explain what happens to acetylcholine after its function is complete.

(3)

acetylcholine is a hormone, once the hormone has finished its function it disappears and another acetylcholine hormone is produced to complete the same function again

Q3c

In general this question was answered poorly with very few learners providing creditworthy answers.

However, this response was awarded 4 marks. The learner has mentioned that nicotine has a similar shape to acetylcholine, that it "also fills the space in the same receptor" and that it 'tricks the brain', which is a sufficient just alternative to 'acts like acetylcholine' for marking point 2.

(c) Acetylcholine causes the release of hydrochloric acid in the stomach.

Nicotine is an agonist for acetylcholine.

Explain why nicotine causes higher levels of hydrochloric acid in the stomach.

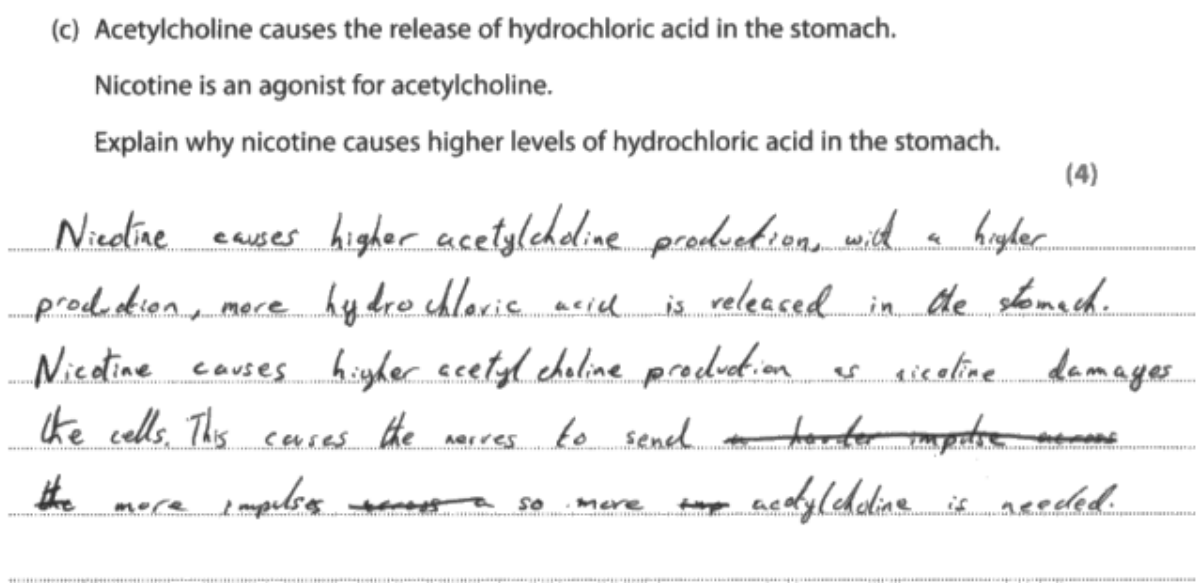
(4)

nicotine has a similar shape to acetylcholine and can also fill the space in the same receptor. when some one intakes nicotine, the molecules fill this particular space on the receptor and trick the brain into producing more - abnormal levels of hydrochloric acid in the stomach, than usual. this can be fixed or reduc -ed by limiting or stopping any nicotine that enters the body. that way there will be a healthy level of HCl in stomach

It was clear that many were unfamiliar with the term “agonist” and many suggested this meant that nicotine is a precursor for acetylcholine. It was not uncommon to see the facts stated in the question merely repeated in the answer. Learners should be encouraged to use the information from the stem of the questions but not to repeat it as material from the stem would not be creditworthy.

Among the most common misconceptions was the idea that nicotine stimulates acetylcholine release which in turn stimulates further acid secretion in the stomach. There was mention of nicotine interfering with acetylcholine uptake and many learners became focused on the effects of tobacco smoking, including references to, tar, cilia, and addiction.

This response was awarded 0 marks.



(c) Acetylcholine causes the release of hydrochloric acid in the stomach.

Nicotine is an agonist for acetylcholine.

Explain why nicotine causes higher levels of hydrochloric acid in the stomach.

(4)

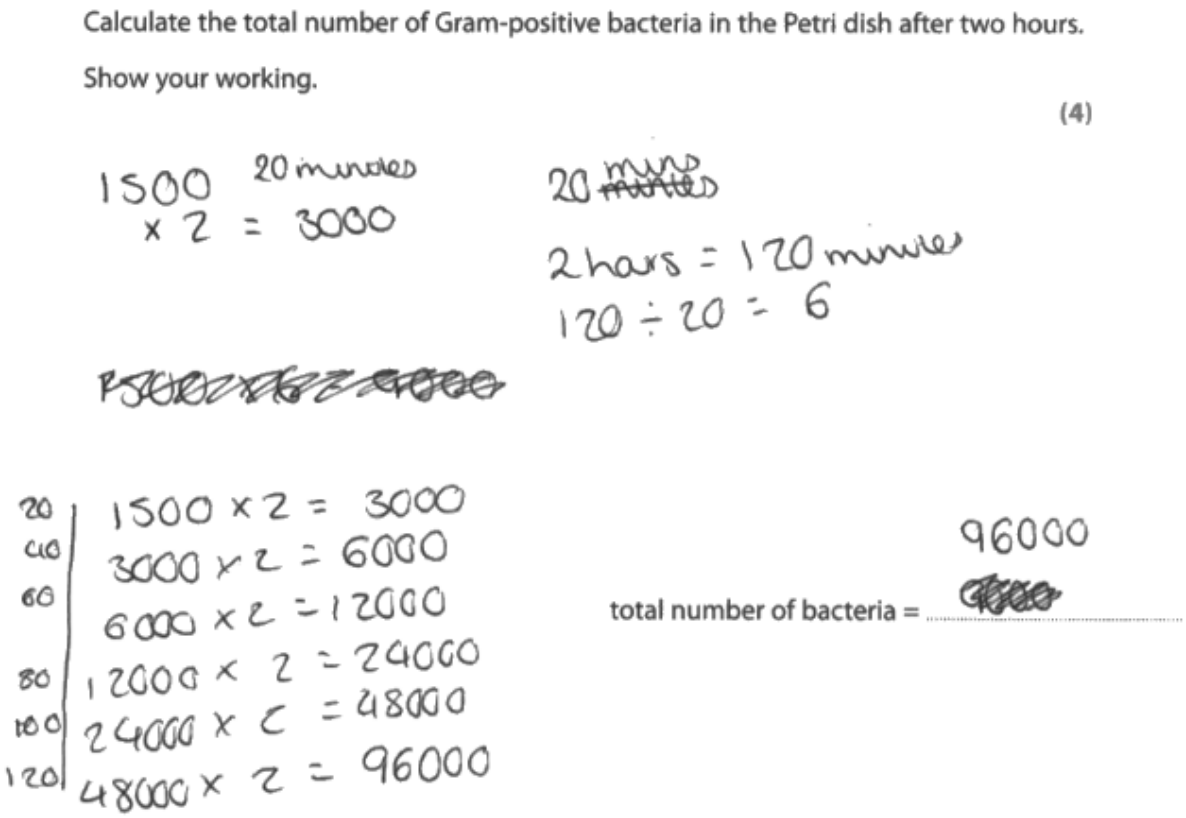
Nicotine causes higher acetylcholine production, with a higher production, more hydrochloric acid is released in the stomach.
Nicotine causes higher acetyl choline production as nicotine damages the cells. This causes the nerves to send ~~a harder impulse~~ the more impulses ~~a~~ so more ~~top~~ acetylcholine is needed.

Although the learner says there are more impulses, the context of this is incorrect and so is not creditworthy. The learner has said that nicotine increases the levels of acetylcholine.

Q4a

Many correct answers for 4 marks. Those that didn't achieve maximum marks usually gained 3 marks by selecting an incorrect number of divisions (usually 5 or 7).

This response was awarded 4 marks.


Calculate the total number of Gram-positive bacteria in the Petri dish after two hours.

Show your working.

(4)

1500 20 minutes
x 2 = 3000

20 mins

2 hours = 120 minutes
120 ÷ 20 = 6

20 | 1500 x 2 = 3000
40 | 3000 x 2 = 6000
60 | 6000 x 2 = 12000
80 | 12000 x 2 = 24000
100 | 24000 x 2 = 48000
120 | 48000 x 2 = 96000

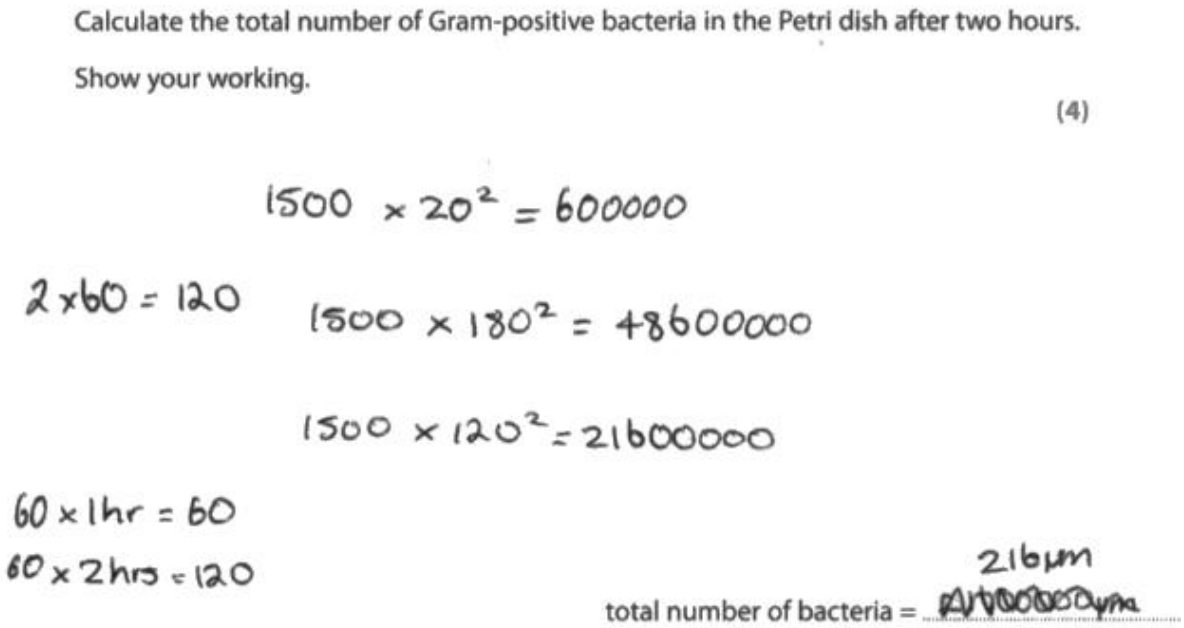
96000

total number of bacteria = ...

With the correct answer (96 000) on the answer line 4 marks can be awarded.
This response shows an alternative method of getting full marks without using the equation given. The learner has correctly stated that there are 120 minutes in 2 hours and that in this time there will be 6 doublings. Rather than put this number into the equation given, the learner has calculated the number of bacteria after each doubling, repeating this six times to get the correct answer. Some responses using this method have used the incorrect number of doublings, usually by stating the first doubling gives the 1500 and so therefore only gave the number of bacteria after 5 divisions.

If the learner did not give the correct value marks could be gained from the working out, if the learner had provided this.

This response was awarded 1 mark.


Calculate the total number of Gram-positive bacteria in the Petri dish after two hours.

Show your working.

(4)

$1500 \times 20^2 = 600000$

$2 \times 60 = 120$

$1500 \times 180^2 = 48600000$

$1500 \times 120^2 = 21600000$

$60 \times 1hr = 60$

$60 \times 2hrs = 120$

216µm

total number of bacteria = [illegible]

This response is awarded one mark for correctly converting 2 hours into 120 minutes, but the learner has not calculated the number of divisions. The learner has not substituted or evaluated correctly and so error carried forward marks cannot be awarded.

Q4b

This question was answered very poorly with few learners achieving over 2 marks and very few providing a level 3 response.

The knowledge that was shown was more often than not confined to short, simple statements regarding the differences between gram-positive and gram-negative bacteria.

Of those answers that were creditworthy, marks were most often given for reference to differences in the thickness of the walls or membranes. There was rare mention of water moving into a disrupted cell and/or the cell bursting and rarer still reference to this taking place in newly forming cells.

This response was awarded level 3, 6 marks. Comprehensive knowledge was demonstrated with a clear and logical response.

Discuss why penicillin prevents the growth of Gram-positive bacteria but not Gram-negative bacteria.

Your answer should refer to the differences in the cell walls of the two types of bacteria.

(6)

Penicillin is an antibiotic meaning that it targets bacteria. Its job is to inhibit cell wall synthesis, and so when bacteria divide and begin sharing information on how to construct new organelles, penicillin stops the cell wall from being created. This allows white blood cells in the body to destroy the bacteria by releasing enzymes, leading to cell lysis. Gram negative bacteria is unaffected by penicillin as unlike with Gram positive bacteria, it has an outer membrane which acts as a barrier stopping penicillin from damaging the cell wall and therefore stopping white blood cells from destroying the bacteria. Gram positive bacteria only have a thick peptidoglycan layer, which is not sufficient defense for the drug.

In terms of this experiment, the zone of inhibition present in the Gram positive bacteria agar plate shows all the dead bacteria that was in close proximity to the penicillin. There are no white blood cells, and so the bacteria have died because of osmotic lysis; the cell wall stops too much water from entering the cell via osmosis and so without it the bacteria bursts.

This response was awarded level 2, 3 marks. The learner has described the Gram-positive and Gram-negative cell wall. It is a little unclear, but the description of the Gram positive bacteria having a thick layer of peptidoglycan and the Gram positive having an internal cell wall with another outer membrane is sufficient for credit, as is stating that the peptidoglycan is broken down in the Gram positive bacteria. The comment about fat being immune to antibiotics can be ignored.

Discuss why penicillin prevents the growth of Gram-positive bacteria but not Gram-negative bacteria.

Your answer should refer to the differences in the cell walls of the two types of bacteria.

(6)

In gram Positive bactiria the cell has a thick layer of peptidoglycan and a thinner Second layer, on the other hand gram negative bactiria have an internal cell wall of peptidogly with an nother outer membrane layer of lipopolysacharide, which is made of fat, this layer of fat is immune to antibiotics. In terms of the diagram the lipopolysachride layer protected the bactiria, while on the other diagram the Peltidoglycan is broken down by the antibiotics

The most commonly observed errors were found in the learners' descriptions of gram staining, often confusing this process with the experiment detailed in the question. Cell walls and membranes were often described incorrectly and interchangeably. Most learners showed very little understanding of the mechanism of the inhibition of cell wall synthesis, referring instead to penicillin inhibiting cell division.

This response was awarded level 1, 1 mark. The learner has made a very common misconception in confusing the relative thickness of the cell walls. However, this can be awarded one mark as the learner has shown some knowledge in indicating that the cell walls are different, and that penicillin stops the growth.

Discuss why penicillin prevents the growth of Gram-positive bacteria but not Gram-negative bacteria.

Your answer should refer to the differences in the cell walls of the two types of bacteria.

(6)

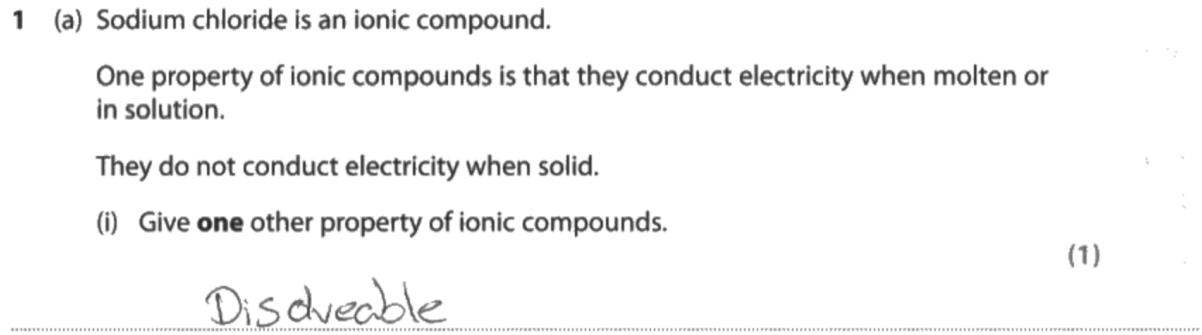
Penecillin prevents the growth of gram positive bacteria as it has a ~~thicker~~ thin cell wall so it can enter the bacteria and stop the growth. However the gram-negative bacteria has a thicker more supportive cell wall and does not let penecillin through therefore the it can't stop the growth.

Also penecilin is a negative substance and opposites attract so that means it reacts with the gram positive bacteria because they are opposites.

Periodicity and Properties of Elements (Chemistry)

Q1ai

Question 1(a)(i) was generally well answered by learners with the majority being able to give a property of ionic compounds with the most common correct answer being that ionic compounds have a high melting or boiling point. Some stated that a property is that the ionic compounds dissolve in water or are dissolvable, which was accepted for the mark.


1 (a) Sodium chloride is an ionic compound.

One property of ionic compounds is that they conduct electricity when molten or in solution.

They do not conduct electricity when solid.

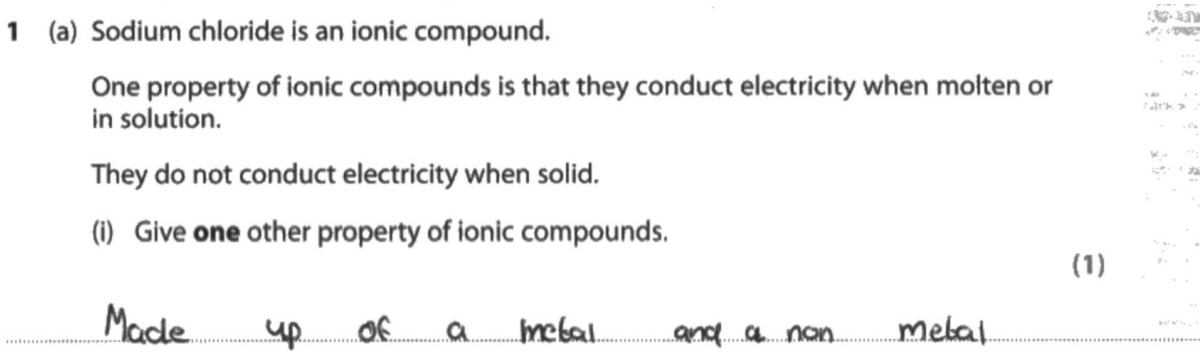
(i) Give **one** other property of ionic compounds.

(1)

Disdveable

Where learners did not gain marks, it was often as they repeated the stem of the question and commented on the conductivity of the ionic solids or gave properties of a metal such as malleability or ductility. Learners should be taught to use the information in the stem but not to repeat it as no credit will be given for information copied from the stem of the question.

In other cases, learners appeared not to know what was meant by the term property and gave a description of the type of types of elements that make up an ionic substance, this was not accepted and did not gain credit.


1 (a) Sodium chloride is an ionic compound.

One property of ionic compounds is that they conduct electricity when molten or in solution.

They do not conduct electricity when solid.

(i) Give **one** other property of ionic compounds.

(1)

Made up of a metal and a non metal

Q1b

Learners found question 1(b) more difficult with few being able to give a full explanation as to why potassium metal has a lower melting point that calcium metal. A main problem in this question for learners was the lack of understanding as to what happens when a metal melts. A large proportion of learners did not use the information stated in the question and thought that potassium and calcium were compounds and referred to intermolecular forces between them. Another common incorrect answer referred to the metal's ionisation energies and stated that as calcium required more energy to melt as it had to lose two electrons rather than one. Few learners referred to metallic bonding, or referred to delocalised electrons.

Where learners did score, if was often as they were able to compare the radius of the atom, number of protons or nuclear charge. In this example, the learner gains 1 mark for stating that potassium has a lower proton number than calcium.

(b) Potassium and calcium are metals.

Table 1 shows some information about potassium and calcium.

	melting point (°C)	atomic number	group number
potassium	63.5	19	1
calcium	842.0	20	2

Table 1

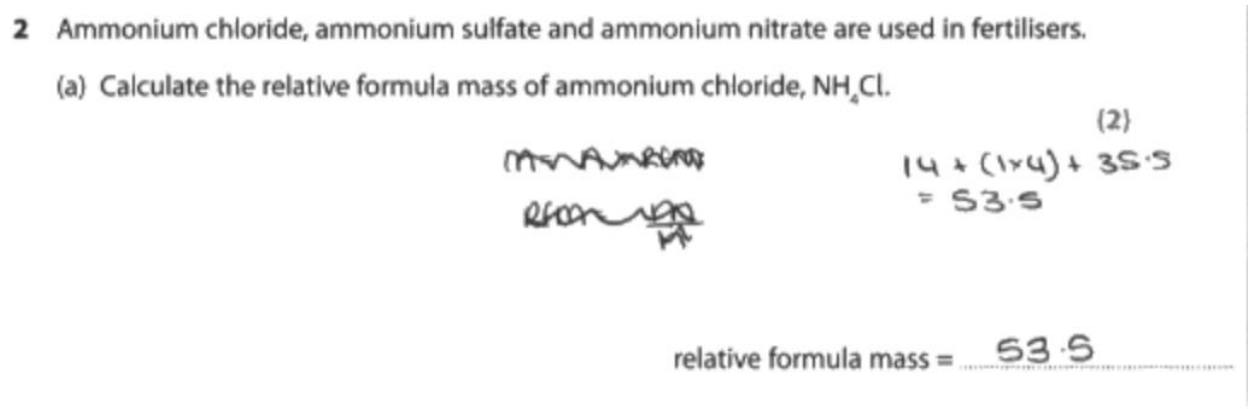
Explain why the melting point of potassium is lower than the melting point of calcium.

(3)

Potassium is an element from group 1 and calcium is from group 2. Potassium has a lower melting point because it has a lower proton and election number.

Q2a

In question 2(a), the majority of learners were able to calculate the relative formula mass of ammonium chloride. Those that did well often set their working out clearly and gained both marks as in this example.



2 Ammonium chloride, ammonium sulfate and ammonium nitrate are used in fertilisers.

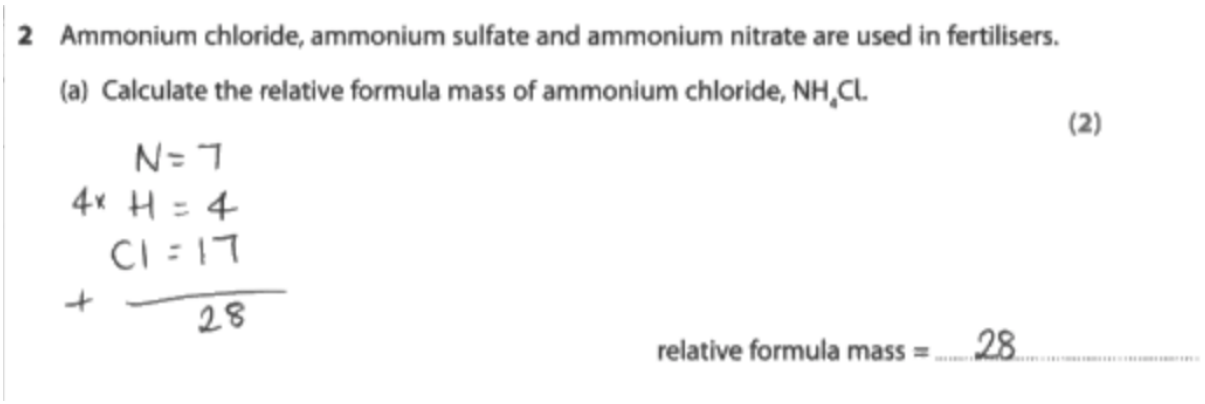
(a) Calculate the relative formula mass of ammonium chloride, NH_4Cl.

(2)

$14 + (1 \times 4) + 35.5$
$= 53.5$

relative formula mass = 53.5

Where learners did not gain full marks, it was often as they had used the atomic number rather than the atomic mass, this one error meant that a mark of 1 was awarded as in this example.



2 Ammonium chloride, ammonium sulfate and ammonium nitrate are used in fertilisers.

(a) Calculate the relative formula mass of ammonium chloride, NH_4Cl.

(2)

$N = 7$
$4 \times H = 4$
$Cl = 17$
$+ \quad 28$

relative formula mass = 28

Q2b

In general, learners scored at least 1 mark in question 2(b), this was often for giving the correct number in front of ammonia. Fewer learners gained both marks as they found it hard to recall the formula of sulfuric acid. Many gave the formula of the sulfate ion rather than for sulfuric acid, as in this example that just gained 1 mark for the

(b) Ammonia reacts with sulfuric acid to form ammonium sulfate.

Complete and balance the equation for this reaction.

(2)

Although the learner has not written the elements in the formula of the sulfuric acid in the conventional manner, credit was still awarded and this example gained both marks.

(b) Ammonia reacts with sulfuric acid to form ammonium sulfate.

Complete and balance the equation for this reaction.

Q2c

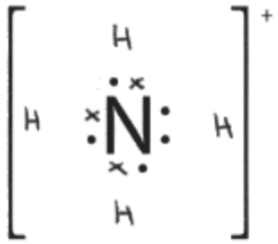
Question 2(c) performed less well. Many learners were able to at least one mark for the correct electron arrangement without showing the four hydrogens. Fewer were able to gain full marks for the complete diagram as in this example.

(c) Figure 1 shows the arrangement of electrons in the outer shell of an atom of nitrogen and in an atom of hydrogen.

Figure 1

Complete the dot and cross diagram to show the bonding in the ammonium ion, NH_4^+.

(2)



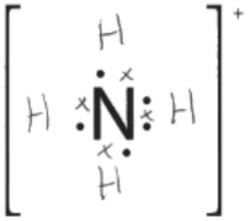
Although the formula for the ammonium ion was given in the question, many learners omitted the hydrogens in their answer or only added 3 hydrogens. Of the learners that did understand that 4 hydrogens were needed, many of these then often added 4 electrons to the nitrogen so that a total of 9 electrons were present and therefore gained just 1 mark.

(c) Figure 1 shows the arrangement of electrons in the outer shell of an atom of nitrogen and in an atom of hydrogen.

Figure 1

Complete the dot and cross diagram to show the bonding in the ammonium ion, NH_4^+.

(2)



Q2d

It was pleasing to see that learners have become more competent at calculating reacting masses with many learners being able to score the full three marks available for correctly calculating the mass of ammonia required to make 5.0g of ammonium nitrate. Learners that did well here often did well as they carried out logical working to get to the correct answer. Although the learner has rounded their answer up, the fully correct method and this answer did not detract.

(d) Ammonia reacts with nitric acid to make ammonium nitrate.

$$NH_3 + HNO_3 \rightarrow NH_4NO_3$$

Calculate the mass of ammonia required to make 5.0 g of ammonium nitrate.

relative formula mass of $NH_3 = 17$

relative formula mass of $NH_4NO_3 = 80$

(3)

mols = mass / Mr

mols = 5 / 80

mols = 0.0625

mole ratio = 1:1

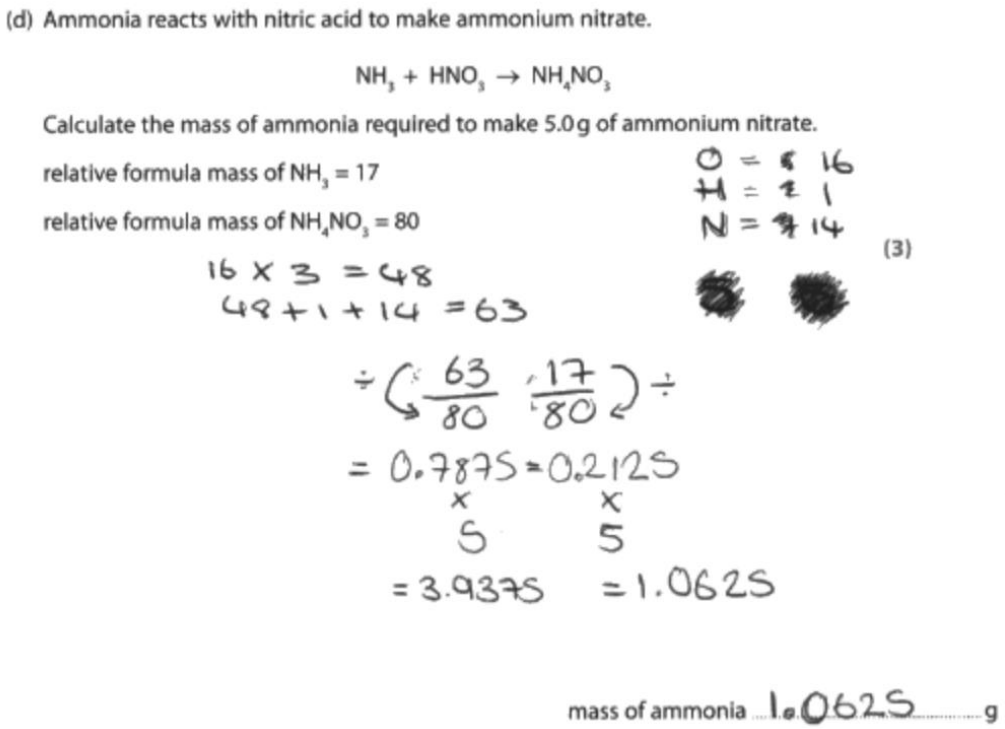
mass = 0.0625 x 17

mass = 1.0625

mass = 1.1 }

mass of ammonia 1.1 g

Some learners used different methods, these were accepted and full marks still awarded.


(d) Ammonia reacts with nitric acid to make ammonium nitrate.

$NH_3 + HNO_3 \rightarrow NH_4NO_3$

Calculate the mass of ammonia required to make 5.0 g of ammonium nitrate.

relative formula mass of NH_3 = 17

relative formula mass of NH_4NO_3 = 80

O = 16
H = 1
N = 14

(3)

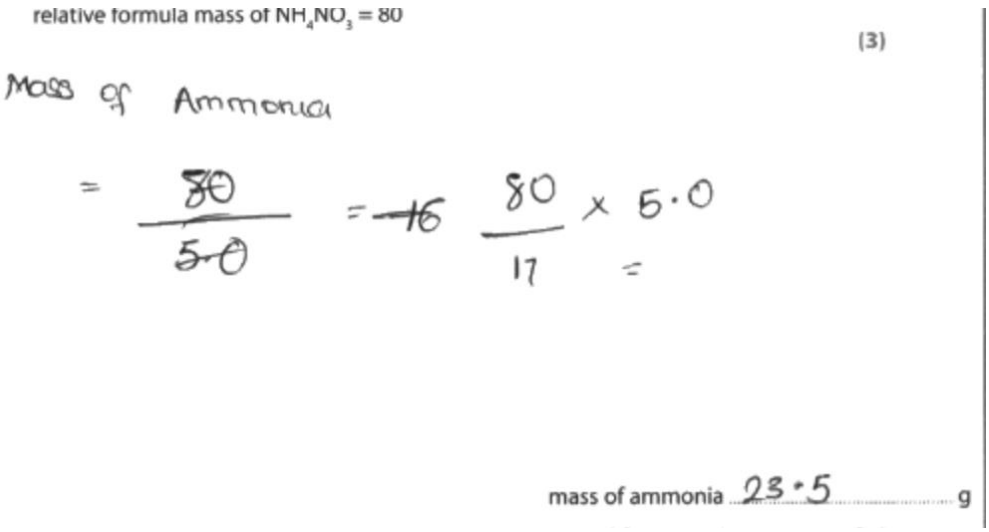
16 x 3 = 48
48 + 1 + 14 = 63

÷ (63/80 : 17/80) ÷

= 0.7875 : 0.2125
x 5 x 5
= 3.9375 = 1.0625

mass of ammonia 1.0625 g

Learners that did not gain full marks often lost marks as they some initial working incorrect, most often this was for inverting the fraction for the number of moles. However, with this one error and the error carried forward, 2 marks were still awarded.


relative formula mass of NH_4NO_3 = 80

(3)

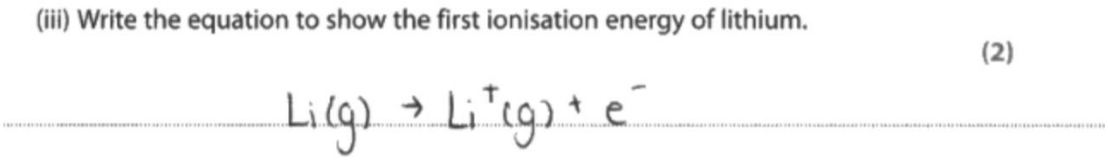
Mass of Ammonia

= 80/5.0 = 16 80/17 x 5.0 =

mass of ammonia 23.5 g

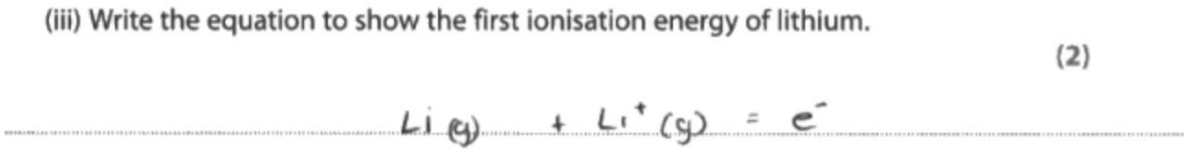
Q3aiii

Question 3(a)(iii) proved very difficult for learners with few being able to gain full marks as in this example.



Where learners did score a mark it was often for understanding that the lithium lost an electron to become a positive ion, this mark was awarded even though the electron was on the wrong side of the equation.

The state symbol mark was awarded independently and so learners that did not get the species correct, were still able to gain the mark for the correct state symbols.



Q3b

Learners performed better in question 3(b) with many scoring. The idea of the number of shells and shielding of nuclear attraction and the effect this has of the first ionisation energy of the group 1 elements seemed to be well understood.

This example gained the full 4 marks available. The learner stated that as the atomic number increases there are more shells and that this means that the further away outer electron is from the nucleus, they discuss shielding and say that as the result of more shielding the electrostatic attraction decreases. They have stated in the last sentence that less energy is required to break the bonds, this would not be sufficient for the last marking point but all four marks have already been scored and it does detract from the rest of the answer.

(b) Table 2 shows the atomic number and first ionisation energy of some of the elements in group 1.

element	atomic number	first ionisation energy (kJ mol^{-1})
lithium	3	520
sodium	11	496
potassium	19	419

2.8.8.1

Table 2

Explain why the first ionisation energy of the group 1 elements in Table 2 decreases as the atomic number increases.

(4)

This is because as the atomic number increases this means we have more electrons and more shells as lithium would have 2 shells and potassium would have 4 shells. This means that as the atomic number increased the further the outer electron is to the nucleus as a result of more shielding meaning that the electrostatic attraction became weaker resulting in a lower first ionisation energy as it is easier to break the bonds. less energy required

(Total for Question 3 = 8 marks)

The following example scored 3 marks, the learner states that as you move down the group the number of shells increase, they say that the attraction between the nucleus and the outermost shell decreases and therefore the electron is more easily taken.

(b) Table 2 shows the atomic number and first ionisation energy of some of the elements in group 1.

element	atomic number	first ionisation energy (kJ mol^{-1})
lithium	3	520
sodium	11	496
potassium	19	419

Table 2

Explain why the first ionisation energy of the group 1 elements in Table 2 decreases as the atomic number increases.

(4)

Because as you go down the group the number of shells the atom has increases so it attraction between the nucleus and furthest away shell decreases. so as you go down the group the ionising energy decreases because the atomic number increase and the electron on the outer shell is more easily taken because the attraction between the nucleus and the outer electron isn't very strong.

(Total for Question 3 = 8 marks)

In some cases, learners were able to interact with the question and had the correct idea but were not precise with their answers and so did not gain credit. Here the learner states that the electrons get further from the nucleus, this was not sufficient for credit as it was not clear that it is the outer electrons that are further from the nucleus.

(b) Table 2 shows the atomic number and first ionisation energy of some of the elements in group 1.

element	atomic number	first ionisation energy ($kJ\,mol^{-1}$)
lithium	3	520
sodium	11	496
potassium	19	419

Table 2

Explain why the first ionisation energy of the group 1 elements in Table 2 decreases as the atomic number increases.

(4)

Because the electrons get further away from the nucleus, meaning it is harder to react.

Q4

It was pleasing to see in question 4 that a lot of work has evidently gone into the teaching of the nature and significance of intermolecular forces, although there remains a good deal of confusion about the difference between dipole-dipole and induced dipole forces.

There seems to be a common misunderstanding that boiling is a chemical rather than a physical change and thus discussions of breaking covalent (and even occasionally ionic) bonds were not uncommon. Whilst saying this, it was not uncommon to see good level 2 and level 3 answers.

In this example, the learner gained the full 6 marks available in level 3.

The learner starts by stating that it takes more energy to break the forces and bonds in water than it does in methane. They then go on to state that they are bonded in the same way but the forces are different. They explain that London forces (which is an acceptable alternative to Van der Waals) are present in both molecules. They then state that both molecules have dipole dipole forces and explain how these occur, but it is not correct that they are present in methane. Lastly they go on to state that only water has hydrogen bonding and gives a explanation as to what hydrogen bonding is and why methane does not have it. In summary the learner has the intermolecular forces in water correct and some of intermolecular forces in methane correct, they have started to explain how these forces occur and linked this to the higher boiling point and energy needed to break the forces.

The only downfall is the lack of understanding of dipole-dipole in methane. However, we are not looking for perfection and this good answer which links the energy required to break the forces to the type of forces and starts to explain these gives it full marks in level 3.

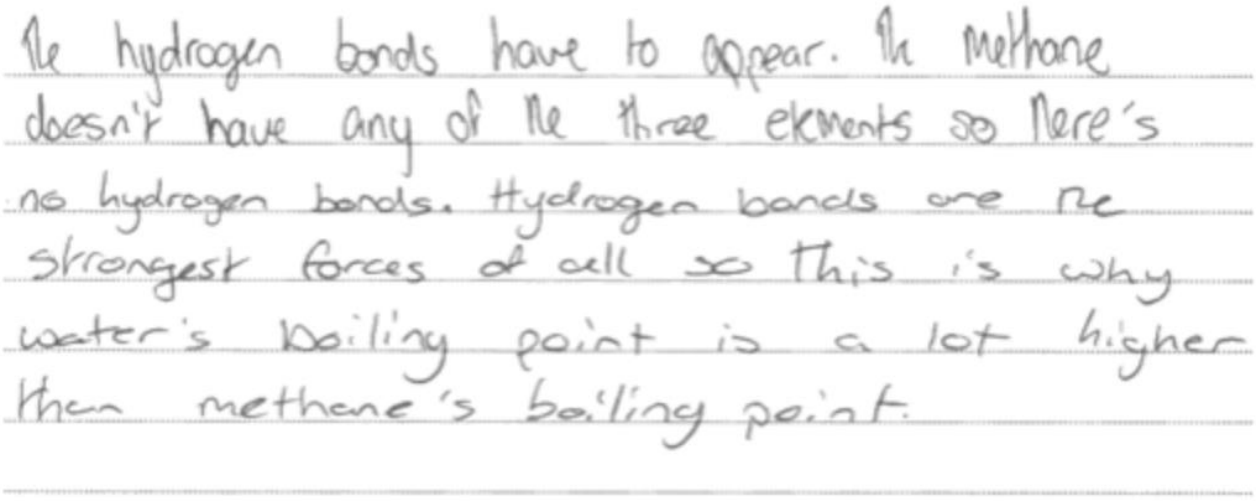
4 Water, H_2O, and methane, CH_4, are simple covalent compounds.

The boiling point of water is 100°C.
The boiling point of methane is –164°C.

Explain the difference in boiling points between water and methane, in terms of intermolecular forces present.

(6)

Water's boiling point is much larger than methane's boiling point meaning that it takes more energy to break apart the forces and bonds in water than it does in methane.
Both compounds are bonded together in the same way but it's the forces that hold them together that are different. Both compounds have London forces as these forces (have) can be found in nearly everything. They are the most common type. Again, both (the) compounds have permanent dipoles holding them together. Dipoles only occur when the two elements joining together have a difference in electronegativities. All elements have different electronegativities and these compounds are different elements bonded (together) together therefore they have (the) these forces.
The main difference between these compounds is that water contains hydrogen forces while methane doesn't. Hydrogen forces only occur when a hydrogen is bonded to a nitrogen, oxygen or a flurine. (flurine)
In water, there's a hydrogen bonded to an oxygen so



This second example, exemplifies an answer that gained a mark at level 2.

The first part of the learners work has been crossed out is therefore ignored.

The learner has recognised that water contains hydrogen bonds, van der Waals forces and dipole dipole bonding. They understand that methane has van der Waals forces. However, they also state that methane has dipole forces which is not correct. Not all forces have to refer to answer the question. They go on to explain that the intermolecular forces in water are stronger as it contains all three, whereas methane doesn't and relates this to methane not needing as much energy to break the weaker forces.

Although, this is a good answer that links the higher boiling point of water for the need for more energy and linked this correctly to the intermolecular forces. There are no explanations of how any of these intermolecular forces occur so therefore is not level 3.

The link between intermolecular forces and energy and the types of forces present in both molecule gains full credit at level 2.

4 Water, H_2O, and methane, CH_4, are simple covalent compounds.

The boiling point of water is 100°C.
The boiling point of methane is –164°C.

Explain the difference in boiling points between water and methane, in terms of intermolecular forces present.

(6)

In water, hydrogen bonds are present, Van der Waals are present and also dipole - dipole. In methane, van der Waals and dipole - dipole forces are present. Water has a much stronger force of attraction compared to methane. Water has a higher boiling point as the

The water compound ~~molecule~~ has a hydrogen bond and Van der Waal forces present. Dipole dipole are also present. The methane compound has Van der Waal forces present and dipole dipole forces. The forces of attraction in water are stronger as it has all intermolecular forces present. Whereas, methane doesn't so the bonds would be easier to break and therefore don't require as much energy. Water has a higher boiling point than methane.

This last example exemplifies an answer in level 1. At this level, the learner has recognised that the intermolecular forces in water are stronger than those in methane and that therefore they required more heat energy to break. The other irrelevant information was ignored. There is no reference to which type of intermolecular forces are present in either of the molecules.

4 Water, H_2O, and methane, CH_4, are simple covalent compounds.

The boiling point of water is 100°C.
The boiling point of methane is –164°C.

Explain the difference in boiling points between water and methane, in terms of intermolecular forces present.

(6)

Water (H_2O) has a much higher boiling point than methane. Methane is a gas, so therefore the intermolecular forces are extremely weak. Water is a liquid so the electrons are free to move around, but not as much as they are able to in methane. H_2O has stronger inter-molecular forces, which means that more heat energy is needed to break the bonds, than in methane.

Waves in Communication (Physics)

Q1ai & 1aii

The same diagram was used for both of these questions firstly asking for the number of complete wavelengths shown on the string then for a one node to be identified.

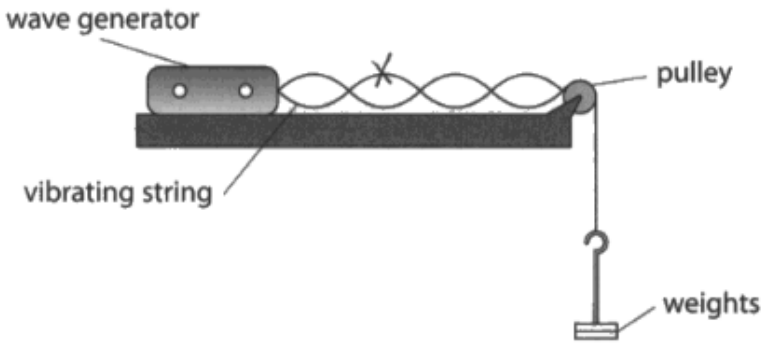


Figure 1

(a) (i) Give the number of complete wavelengths shown on the string in Figure 1.

(1)

number of complete wavelengths = 2

(ii) Add a letter X to Figure 1 to show the position of **one** antinode.

(1)

This example shows the antinode correctly identified with an X and the number of complete wavelengths being given correctly as 2.

Q1aiii

The majority of learners identified the process that causes stationary waves to be resonance.

Q1aiv

There were several difficulties encountered by learners when attempting this calculation. Some learners were unable to identify the symbols used in the equation and did not know that μ is mass per unit length which as the string is 1m long is 2.1g. Quite frequently the value of μ was not converted to kg per metre. Without the conversion learners could gain 3 marks for a substitution and calculating the square root. Only a few learners calculated the speed of the wave on the string correctly (41m/s) but many more showed substitution and attempted an evaluation to gain some marks. It is important to show working to make it possible for interim marks to be awarded even if the final answer is not correct. The answer is given to two significant figures because no more than two significant figures are given for the values used in the calculation

(iv) The string in Figure 1 is 1.0 m long.

The string has a mass of 2.1 g.

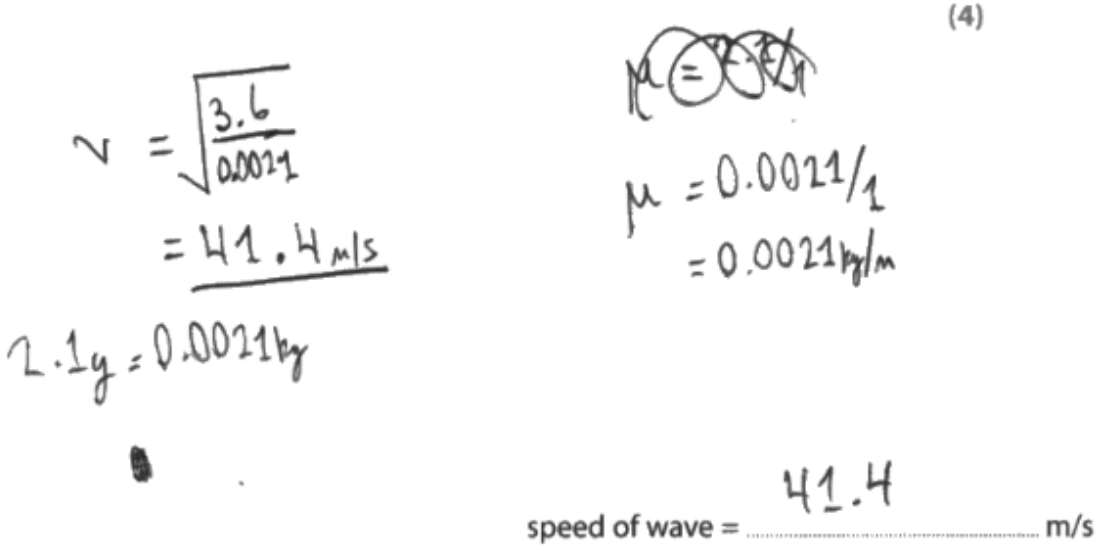
The tension in the string is 3.6 N.

Calculate the speed, *v*, of the wave on the string in Figure 1.

Use the equation: $v = \sqrt{\frac{T}{\mu}}$

Show your working.

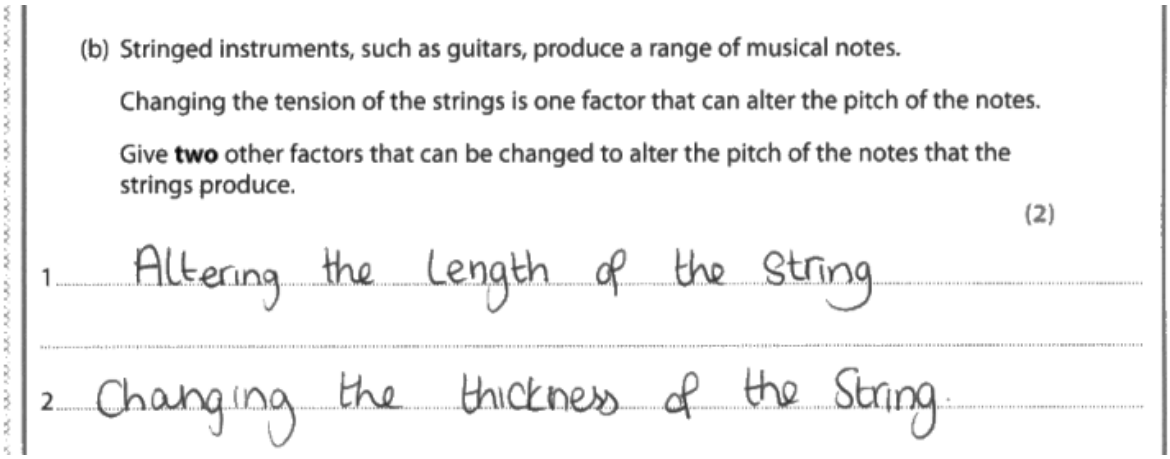
(4)



Q1b

Many learners only gained one mark because they confused amplitude and frequency (pitch) or did not read the question properly and repeated, from the stem, that the tension could be changed.

The example below gains two marks



(b) Stringed instruments, such as guitars, produce a range of musical notes.

Changing the tension of the strings is one factor that can alter the pitch of the notes.

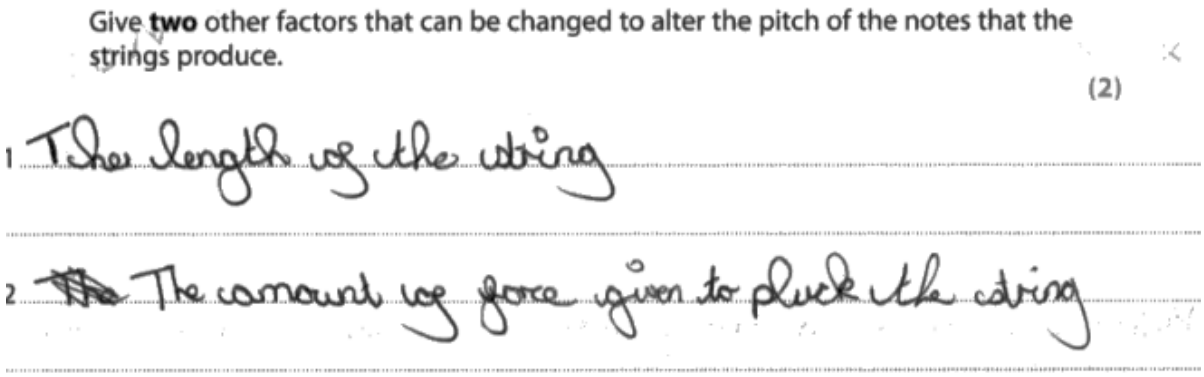
Give **two** other factors that can be changed to alter the pitch of the notes that the strings produce.

(2)

1 Altering the Length of the String

2 Changing the thickness of the String

However the following example only gained one mark as the force used changes the amplitude not the frequency of a note.



Give **two** other factors that can be changed to alter the pitch of the notes that the strings produce.

(2)

1 The length of the string

2 ~~The~~ The amount of force given to pluck the string

Q2a

The order in terms of frequency of the parts of the electromagnetic spectrum should be learnt and it must be accepted that all waves in the electromagnetic spectrum travel at the same speed (the speed of light).

Q2b

This item requires an explanation of an advantage of using microwaves for satellite communication. To gain two marks the advantage must be correctly explained. The example below scored two marks for stating the microwaves can reach the satellite and linking this with the correct reason.

(b) Explain **one** advantage of using microwaves to carry the signal for satellite communication.

(2)

Microwaves do not reflect of ionsphere meaning they can reach satellites.

Whereas the example below only scored one mark because the reason for microwaves being able to travel the long distance (to the satellite) is not related to the wavelength.

(b) Explain **one** advantage of using microwaves to carry the signal for satellite communication.

(2)

Microwaves have a long wavelength so they can be used to communicate through long distances.

Q2ci & 2cii

A few learners were able to reason that upload and download frequencies are different to prevent interference to gain a mark for 2ci. Below is a correct answer to 2ci

(c) The upload signal received at the satellite is different from the download signal transmitted from the satellite in frequency and amplitude.

(i) Give **one** reason why the upload signal and download signal have different frequencies.

(1)

So that there is no interference between the 2 signals

However, very few learners considered the fact that the further a wave travels the less energy it has and therefore the smaller the amplitude and the greater the need for amplification. An example of an answer which gained a mark is given below

(ii) Give **one** reason why the satellite needs to amplify the upload signal.

(1)

because the further the wave travels, the weaker the signal becomes.

Q3a

The majority of learners were able to read the graph correctly although some need practice at reading scales which do not represent one unit by one division.

Q3b

The correct definition of an analogue signal was given by less than half of the learners. A correct version is given in the answer below.

Complete Sentence 1 for the correct definition of an analogue signal.

(2)

The signal in Figure 3 is analogue because the voltage varies consistantly with time.

Q3c

Very few learners were able to gain three marks by providing a description of how an analogue signal can be converted to a digital signal. Sampling the analogue signal at fixed intervals of time was rarely mentioned even though the way this can be done is given in the additional guidance which has been issued to centres. Some learners gained a mark either for knowing the digital signal was binary or a compensatory mark for knowing the process can be carried out with an analogue to digital converter. An answer which gains all three marks is given below.

(c) Describe how an analogue signal can be converted into a digital signal. (3)

An analogue to digital converter can be used which samples the analogue signals at intervals, converting it to whole numbers, while keeping a sample rate. Outputting the data into binary where 1 indicates on and 0 indicates off. The converted is usually attached to circuits.

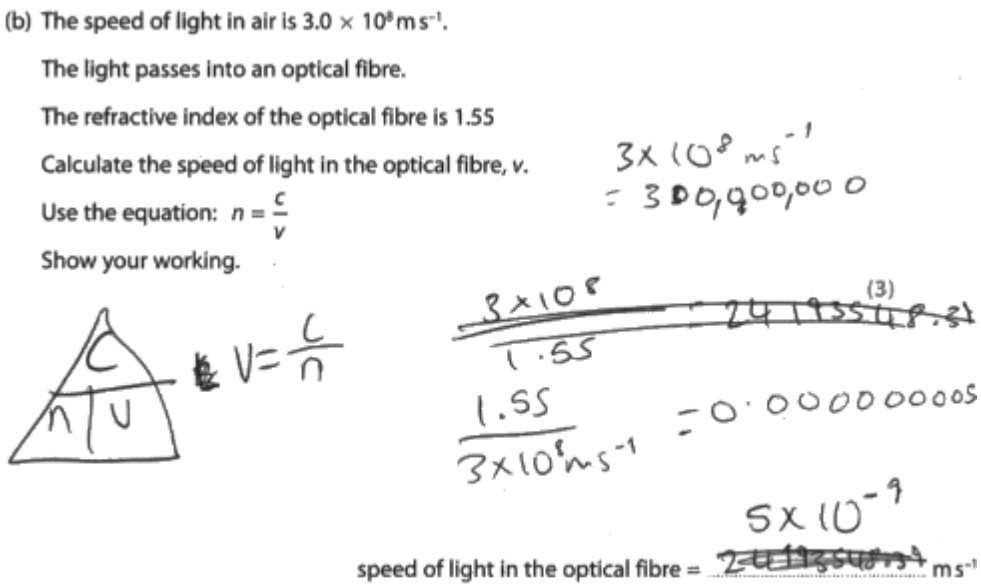
Q4a

Less than half of learners were able to recognise the correct diagram showing refraction of light passing from air into an optical fibre. Learners need to be able to recognise this and other effects of light and draw diagrams to illustrate the effects.

Q4b

It was found that some learners did not know the symbol for the speed of light in air and confused c either with v or with sinC. As with all equations that need rearrangement it is better for learners to substitute first and get the mark for substitution then to rearrange the equation. Many learners were able to gain all three marks for this calculation and most showed their workings and were able to gain at least one mark.

The example below shows where one mark is gained for correctly rearranging the equation but the substitution is then incorrect suggesting that the learner does not know the meaning of the symbols used in the equation.


(b) The speed of light in air is $3.0 \times 10^8\ m\,s^{-1}$.

The light passes into an optical fibre.

The refractive index of the optical fibre is 1.55

Calculate the speed of light in the optical fibre, *v*.

Use the equation: $n = \frac{c}{v}$

Show your working.

$3 \times 10^8\ ms^{-1}$
$= 300,000,000$

(3)

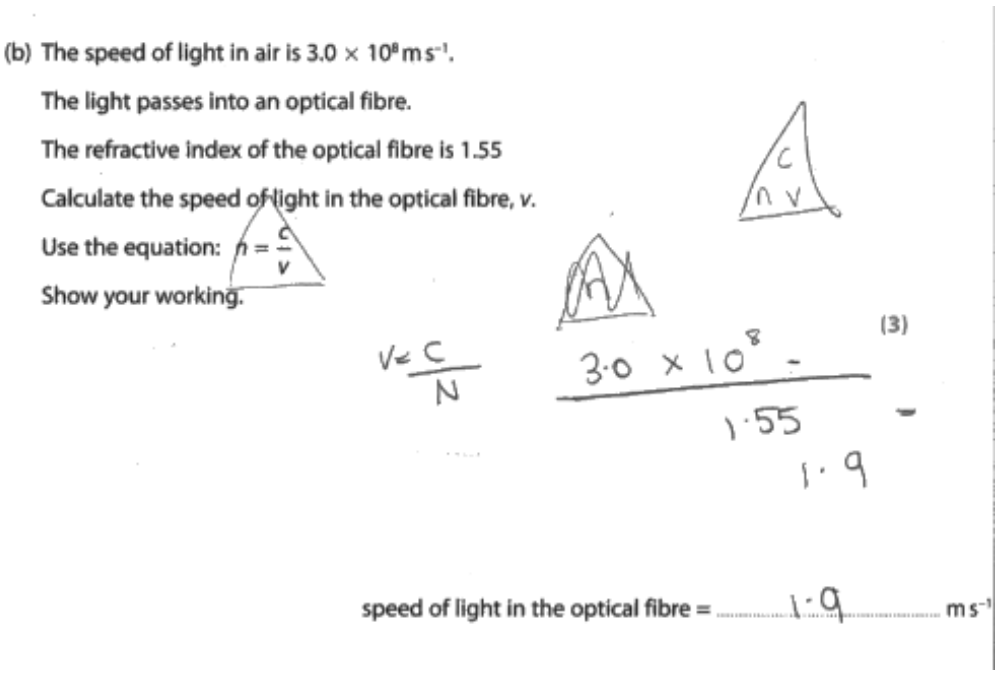
$\frac{3 \times 10^8}{1.55}$ = 24 193 548.51

$\frac{1.55}{3 \times 10^8\ ms^{-1}} = 0.000000005$

5×10^{-9}

speed of light in the optical fibre = 24 193 548.51 $m\,s^{-1}$

The example below gains two marks, the rearrangement is correct and so is the substitution but only the numerical values have been divided, no account has been taken of the 10^8 in the answer line.


(b) The speed of light in air is $3.0 \times 10^8\ m\,s^{-1}$.

The light passes into an optical fibre.

The refractive index of the optical fibre is 1.55

Calculate the speed of light in the optical fibre, *v*.

Use the equation: $n = \frac{c}{v}$

Show your working.

$V = \frac{C}{N}$

$\frac{3.0 \times 10^8}{1.55} =$

1.9

(3)

speed of light in the optical fibre = 1.9 $m\,s^{-1}$

The answer below gains all three marks. It shows the correct substitution and rearrangement in the first line and then the numerical answer. This answer was accepted but this learners shows the correct answer in standard form which is to be preferred and learners should be encouraged to become familiar with calculator settings so that answers can be expressed in standard form.

(b) The speed of light in air is $3.0 \times 10^8\ m\,s^{-1}$.

The light passes into an optical fibre.

The refractive index of the optical fibre is 1.55

Calculate the speed of light in the optical fibre, *v*.

Use the equation: $n = \frac{c}{v}$

Show your working.

$\frac{3.0 \times 10^8}{1.55}$

193,548,387.1

(3)

speed of light in the optical fibre = 1.93×10^8 $m\,s^{-1}$

Q4c

Most learners recognised that the optical fibres in an endoscope were transparent and made from glass however a few were under the misconception that the fibres were wire and made from copper. To gain a Level 1 mark learners needed to show some knowledge of the passage of light through optical fibres or the way that an endoscope worked, a generic statement with some structure and coherence was sufficient. A diagram of total internal reflection allowed at least a mark to be awarded. Learners should be encouraged to give diagrams and add labels as this is often makes gaining marks easier than attempting to produce a description that is frequently inaccurate. The major cause of errors in writing about light travelling down an optical fibre is for learners to refer to 'total internal refraction', which does not exist, rather than 'total internal reflection' which is the correct process

The example below shows an answer that is Level 1 and gained one mark. The written work is little more than a repeat of the stem of the question and so not credit worthy but the unlabelled diagram does show total internal reflection.

(c) A doctor uses a medical endoscope to see inside the stomach of a patient.

Figure 5 shows the medical endoscope inside the stomach of the patient.

Medical endoscopes contain optical fibres.

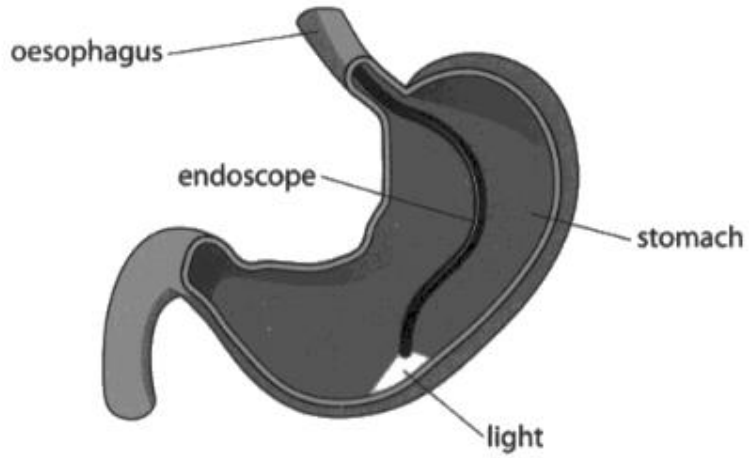


Figure 5

Explain how the optical fibres transmit light so that the doctor can see inside the stomach.

You may include annotated diagrams to support your answer.

(6)

Optical fibres transmit light through the electromagnetic spectrum. ~~The tube~~

The medical endoscope bends at such an angle at which light can be

transmitted through. It stains the ~~organs~~ lave in a white colour so you can

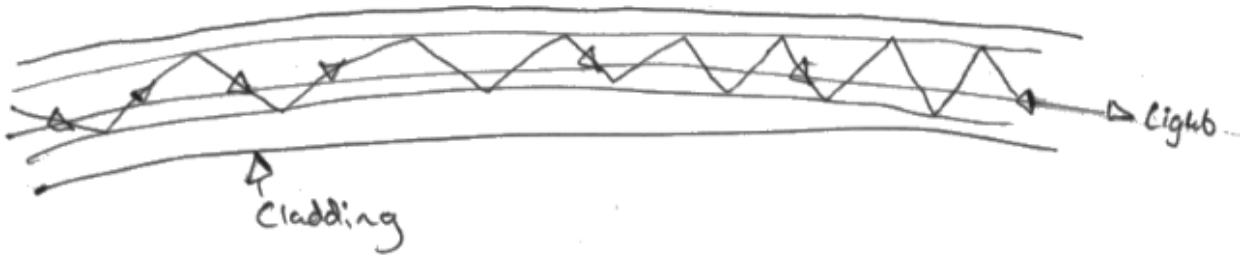
differentiate between flesh and bones.

The second example which is below is still Level 1 but does gain two marks. The diagram is much better, has some labelling and shows total internal reflection. Some of the written work is incorrect but there is also a correct statement in the last line that 'the angle is greater than the critical angle'.

Explain how the optical fibres transmit light so that the doctor can see inside the stomach.

You may include annotated diagrams to support your answer.

(6)



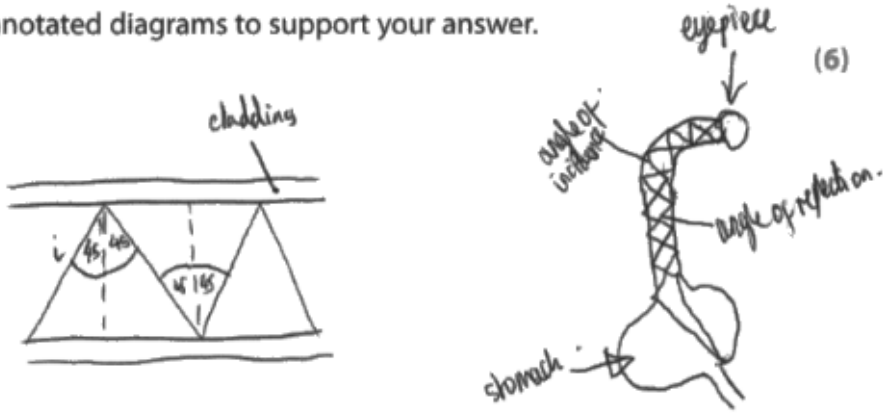
The doctor would send the endoscope to the stomach through the oesophagus. The doctor would attach a light the see-side of the endoscope he is holding so the light passes all the way through. It has supportive so that it can stop the light from escaping. Optical fibres specialise in making sure the light travels faster than it would in copper. The doctor adds a scope to the endoscope so that he can see. The doctors will make sure the light is at an angle which is greater than the critical angle.

To achieve level 2 there must be some good knowledge and understanding which is supported by relevant evidence and shows a clear and logical structure.

The example below is Level 2 and was awarded 4 marks. This gives labelled diagram explains total internal reflection and that light goes down the endoscope to the stomach and is then reflected back up but there is no mention of the two different bundles of fibres which allow this to happen.

Explain how the optical fibres transmit light so that the doctor can see inside the stomach.

You may include annotated diagrams to support your answer. (6)



Light travels from the eyepiece down the optical fibre. ~~The light~~ As the light travels down the optical fibres, the light ~~ener~~ reflects on and off the ~~opposite~~ walls. The angle of incidence is greater than the critical angle so therefore total internal reflection.

Total internal reflection is when the angle of incidence is greater than the critical angle. So therefore light reflects off the optical fibre walls and at total internal reflection, this means the most light will be reflected back, so little to no light energy will be absorbed. Meaning the energy light energy being reflected will be faster, better quality and ete will have

a higher intensity.

The light ~~travels~~ reflects down the optical fibres until it reaches the bottom of the stomach, where it will then reflect back up the optical fibre (not necessarily on the same path as the incoming light). ~~The same idea happen~~ Total internal reflection occurs again, ~~ensure~~ back up to the eyepiece for the doctor to analyse -

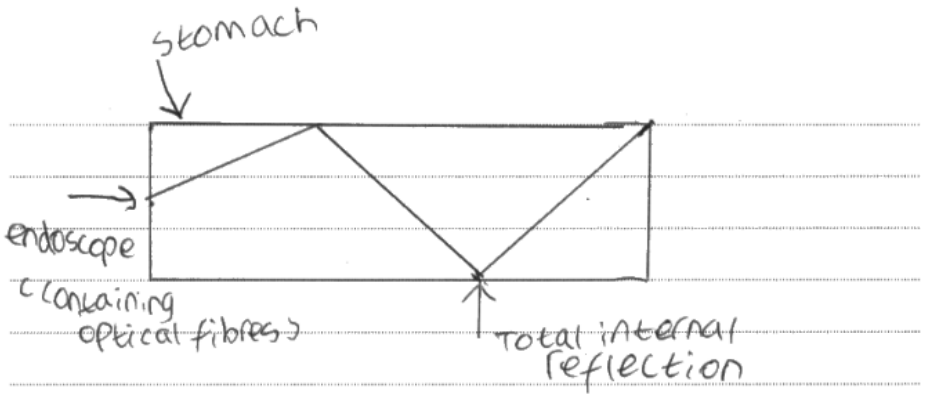
A better quality photo/image is presented of the stomach as ~~not much~~ no energy is absorbed ~~by~~ through the cladding or lost. The intensity ~~will be~~ and speed will also be greater, all due to the total internal reflection of the light energy transmitted.

The final example below is Level 3 and was awarded 6 marks. This answer shows comprehensive knowledge, supported by relevant evidence in an explanation which is clear coherent and logical.

Explain how the optical fibres transmit light so that the doctor can see inside the stomach.

You may include annotated diagrams to support your answer.

(6)



Endoscopes use their optical fibres to allow the doctor to see the stomach through using the total internal reflection, that the endoscope uses. This process allows the light to be transmitted deeper into the stomach through using this process. The endoscopes have thousands of these optical fibres that are required to use total internal reflection as well as transmit the light and image back up to the doctor. Half of the optical fibres will be used to use total internal reflection down the stomach and half of them will use total internal reflection back through up the stomach to create an image for the dactor of the ~~patients~~ patients stomach. The endoscopes will also have cladding ~~affou~~ around the optical fibres. The cladding has a lower refractive index than the optical fibres which makes sure that the maximum amount of light that the optical fibres transmit will be transferred back up to the dactor.

(Total for Question 4 = 10 marks)

Summary

Structure and functions of cells and tissues (Biology)

Based on their performance on this paper, learners should:

- Understand the demand of the command verbs, especially the difference between describe and explain.
- Be familiar with and recognise the ultrastructure and function of organelles in the following cells: prokaryote cells (bacterial cells), eukaryotic cells (plant and animal cells) and eukaryotic cells (plant-cell specific).
- Revise key definitions with level 3 detail, such as tissue, neurotransmitter, etc.
- Show their working out for all calculations to ensure marks can be given for the stages within the calculation even if the final answer is incorrect.
- Use the additional guidance to understand the depth and breadth of the specification

Waves in Communication (Physics)

To improve their mark for this paper learners should:

- Learn the meaning of all the symbols used in equations.
- Draw and refer to diagrams whenever possible.
- Learn the order of waves in the electromagnetic spectrum in terms of frequency and know that all electromagnetic waves travel at the speed of light.
- Learn the difference between frequency and amplitude of a wave.
- Always show their working for a calculation.
- Be aware of the use of rounding to significant figures and standard form.
- Learn the difference between refraction and reflection.
- Learn the process of converting analogue signals to digital signals.

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