BTEC

# L3 Lead Examiner Report 1901

January 2019

**L3 Qualification in Applied Science/Forensics and Criminal Investigations**

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

Pearson

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January 2019
Publications Code 31617H_1901_ER

# 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: Principles and Applications of Science I

| Grade | Unclassified | Level 3 | | | |
|---|---|---|---|---|---|
| | | N | P | M | D |
| Boundary Mark | 0 | 10 | 21 | 39 | 57 |

# Introduction to the Overall Performance of the Unit

## Biology

Exam technique and the understanding of the command verbs is improving. 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 and find it difficult to provide links between different related aspects of the specification. The extended response question demonstrated that learners understood the basic scientific knowledge about the formation of atherosclerosis but were unable to correctly link this to the negative effects of smoking.

## Chemistry

This was the fourth sitting of the level 3 applied science Unit 1 chemistry section, but the second time that the paper has been sat at a separate time to the biology and physics sections. As in the previous series, learners seem to becoming more familiar with the style and structure of 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. It was pleasing to see again fewer blank responses than in previous series, showing that learners are entering the exam more prepared and able.

Learners that did well this session, applied their knowledge of chemistry to new situations, used scientific vocabulary and could use calculations. Those that did less well, often did not read the question carefully and gave answers to a question they thought was there rather than the question that was there.

To improve in future exam series learners should ensure that they understand the basics so that they can they explain features and trends in the chemistry in

more detail. They should ensure that they are specific in their answers so that there is no ambiguity in their answers.
Learners should practice exam technique, ensuring that they know what is required by specific command words such as state, describe, explain and discuss.

## Physics

The examination paper tested knowledge, understanding and the ability to interpret and analyse scientific information in the context of waves and communication. It was clear that the features of longitudinal waves had not been given the same importance as the same features of transverse waves. Whilst rarefaction was generally assigned correctly the wavelength of a longitudinal wave was rarely measured within tolerance as the learners did not know what constituted a wavelength for a longitudinal wave. Learners must be specific and use specific scientific terms in descriptions and explanations and not resort to generalisations. Often 'weather' was given as a reason for not receiving a mobile phone signal this covers a wide range of possibilities and was not creditable. Learners need to use diagrams not only to help their own explanations but also because they provide important information which will help them to answer questions.

The setting out of calculations has improved with most learners able to gain a mark for substitution although some learners are not able to identify the symbols used in the equations so the first step cannot be achieved. The rearrangement of equations still presents problems to some learners and this also needs practice as does the use of calculators for standard form and for $\sin^{-1}$. Learners also need to round values correctly rather than truncate the values and should be aware that rounding within a calculation can take the final answer out of tolerance. The rounding should be left until the answer line.

# Individual Questions

## Biology

### Q1ai

The majority of learners were able to correctly identify the golgi apparatus from the figure.

This response was awarded 1 mark.


(a) (i) Name organelle X in Figure 1.

(1)

Golgi apparatus

There were quite a few students who attempted to make an educated guess at endoplasmic reticulum.

This response was awarded 0 marks.


(a) (i) Name organelle X in Figure 1.

(1)

Smooth Endoplasmic reticulum

## Q1aii

The question was mostly well answered

This response was awarded 1 mark.

(ii) Identify organelle Y in Figure 1.

☒ **A** centriole

☒ **B** endoplasmic reticulum

☒ **C** mitochondrion

☒ **D** vesicle

## Q1aiii

This question was also mostly well answered.

This response was awarded 1 mark.

(iii) Identify the function of the nucleolus.

- ☒ **A** forms spindle fibres during cell division
- ☒ **B** makes RNA and ribosomes
- ☒ **C** regulates cellular activity
- ☒ **D** synthesises and transports lipids and carbohydrates

A common wrong answer was C, the learners' likely mistaking nucleolus for nucleus.

This response was awarded 0 marks.

(iii) Identify the function of the nucleolus.

- ☒ **A** forms spindle fibres during cell division
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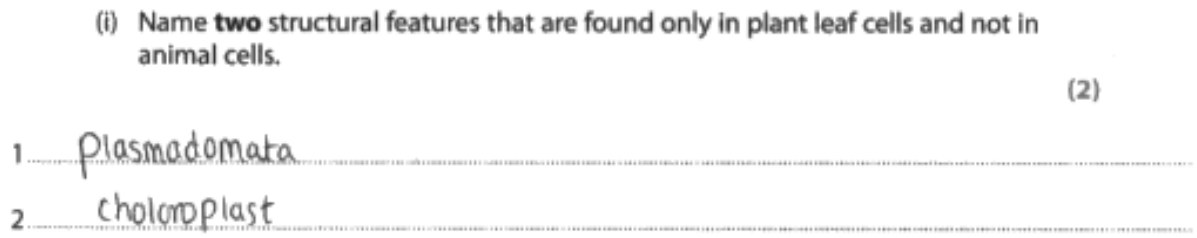
- ☒ **D** synthesises and transports lipids and carbohydrates

## Q1bi

Overall this question was well answered. The most common responses included chloroplast, cell wall and vacuole, although a few mentioned tonoplast, plasmodesmata and amyloplast. The learners rarely qualified the vacuole in the plant cell as large or permanent which would have shown a deeper understanding.

This response was awarded 2 marks.



(i) Name **two** structural features that are found only in plant leaf cells and not in animal cells.

(2)

1 Plasmadomata

2 choloroplast

Many candidates put chlorophyll, indicating a lack of understanding of the chemical or a confusion with chloroplast. Some candidates also commented on differences between plants tissue rather than plant and animal cells, for example, presence of phloem and spongy mesophyll

This response was awarded 1 mark.

(2)

1 Chloroplasts

2 palisade cells

## Q1bii

This question was poorly answered, with fewer than half of the responses being credit-worthy. Centrioles was a common response with scoring learners, although spelling was generally poor. Very few learners stated cilia.

This response was awarded 1 mark.


A common mistake was misremembering centriole as centricle.

This response was 0 awarded marks.

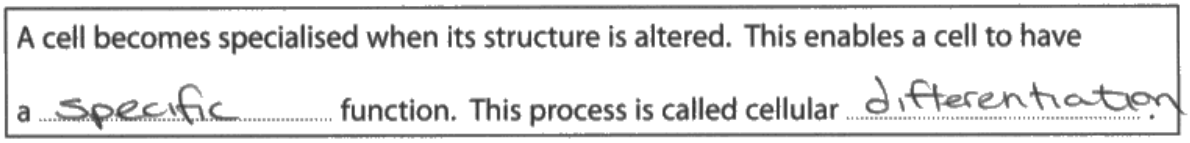

A wide variety of incorrect answers were given for this question including nucleus, cell membrane, ribosomes, mitochondria, golgi apparatus and endoplasmic reticulum.

Some learners stated organelles present in plant cells and not in animal cells, thus answering the previous question again. Some learners confused prokaryotes and eukaryotes stating plasmids or nucleoid in response to this question.

## Q2a

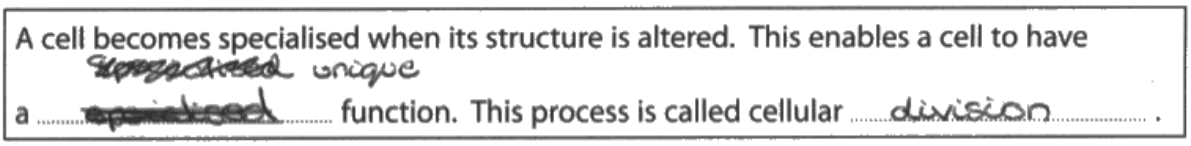
Most learners were awarded a mark for correctly completing the first missing word from the definition by providing an acceptable synonym for specific, commonly giving unique, different, and particular. Few learners were awarded the second mark for “differentiation”.

This response was awarded 2 marks


A cell becomes specialised when its structure is altered. This enables a cell to have a specific function. This process is called cellular differentiation.

Those learners who failed to achieve the first marking mostly did so by simply repeating 'special' from the stem of the question. This was also seen in the majority of responses for the second marking point with most learners giving 'specialisation' and division.

This response was awarded 1 mark


A cell becomes specialised when its structure is altered. This enables a cell to have a unique function. This process is called cellular division.

## Q2bi

The majority of learners were able to correctly identify the correct answer.

This response was awarded 1 mark.

(i) Identify the type of cell labelled W in Figure 3.

- ☒ A ciliated
- ☒ B columnar
- ☒ C endothelial
- ☒ D stratified

## Q2bii

There were a good number of learners who answered with the idea of a multi-lobed nucleus giving flexibility to squeeze through the pores in the capillary. The subject was quite well understood by the learners on the whole. The idea of flexibility was widely seen even if the word 'flexible' was rarely used. Many learners described the idea of the shape being able to change, which was accepted.

This response was awarded 2 marks.

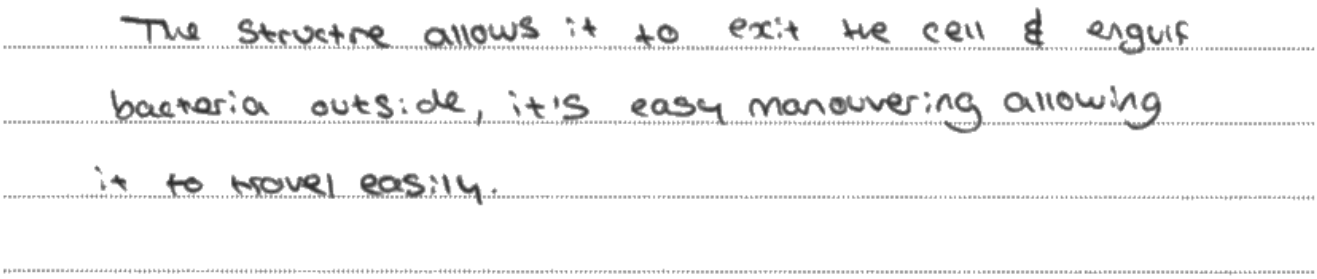
A neutrophil has a multi-lobed nuclei which allows the white blood cell to squeeze through small gaps to reach the site of infection or injury faster.

Some learners confused neutrophils with other specialised cells from the specification content and explained how the structure of red blood cells or sperm allow them to perform their function. Some learners stated that neutrophils contain a large number of lysosomes and, whilst this is correct, does not answer the question as it is not an adaptation which allows them to leave capillaries.

Some responses lost marks by stating that the neutrophils could move through the capillaries, therefore repeating the question.

Quite a few responses confused the idea of the cell being flexible with the cell actually changing size, saying that it got smaller to squeeze through the capillaries then got bigger again. There were also a significant number of responses in which the learner had confused neutrophils with other organelles, describing synthesis and transportation of lipids, proteins or carbohydrates and some describing energy production. There were also a number of responses that vaguely referred to immune response.

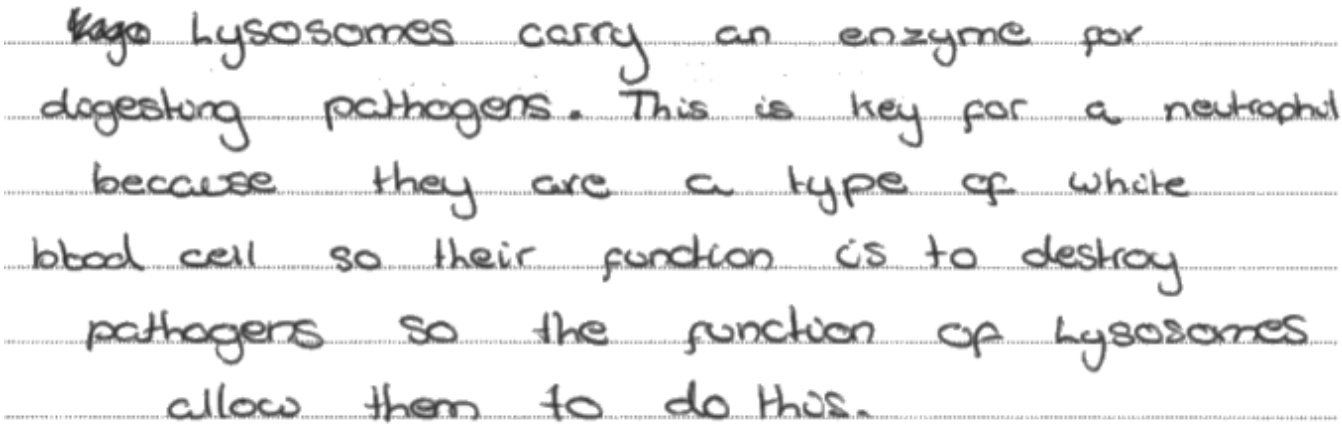
This response was awarded 0 marks



## Q2biii

This question was generally well-answered and the subject was quite well understood, with many of the learners achieving marking point 3 and a significant number earning two marks for the concept of 'destroying pathogens'. Some even gave detail about the phagocytic vesicle fusing with the lysosome. Most refereed to enzymes in the lysosome. Very few learners mentioned the formation of phagolysosome.

This response was awarded 3 marks.




Some learners showed confusion over what a lysosome is, describing them as enzymes or organelles within the cell and made general statements about 'getting rid' of pathogens or 'breaking down' waste material. Cell division was a common theme among the incorrect responses and there were a few that mentioned digestive enzymes.

Many incorrect responses described the lysosome engulfing the pathogen and a significant number mentioned protein synthesis. There was even the occasional reference to lysosomes as an energy source.

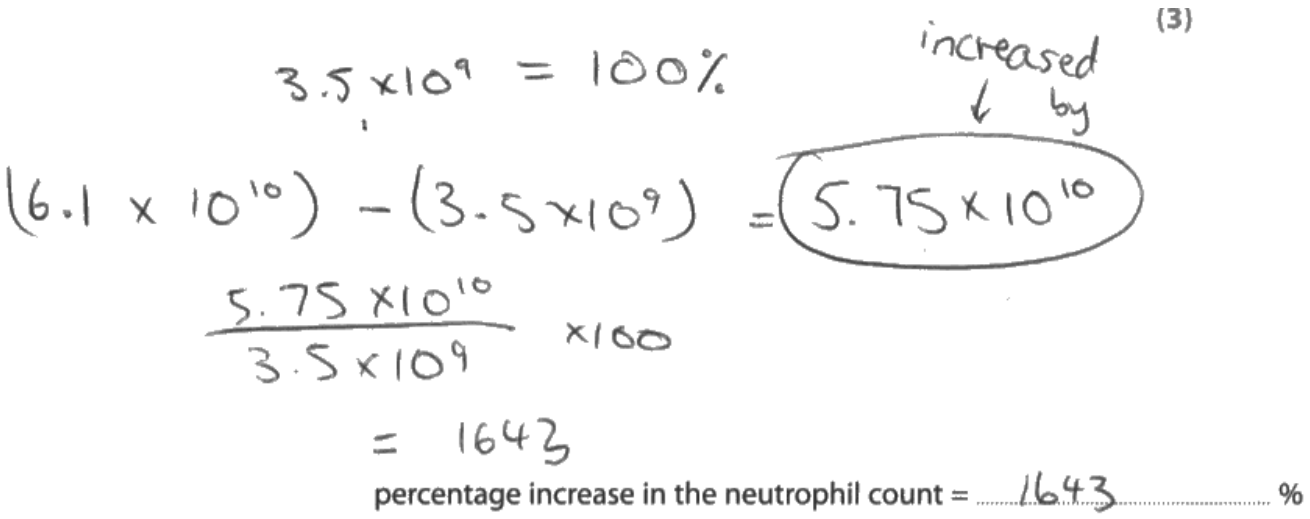
This response was awarded 1 mark

Neutrophils contain lysosomes. Lysosomes are a main part of a neutrophil, it allows them to attack a pathogen or unwanted foreign body to protect the individual from infection.

## Q2c

The full range of marks were observed in this question, but very few learners achieved all three.

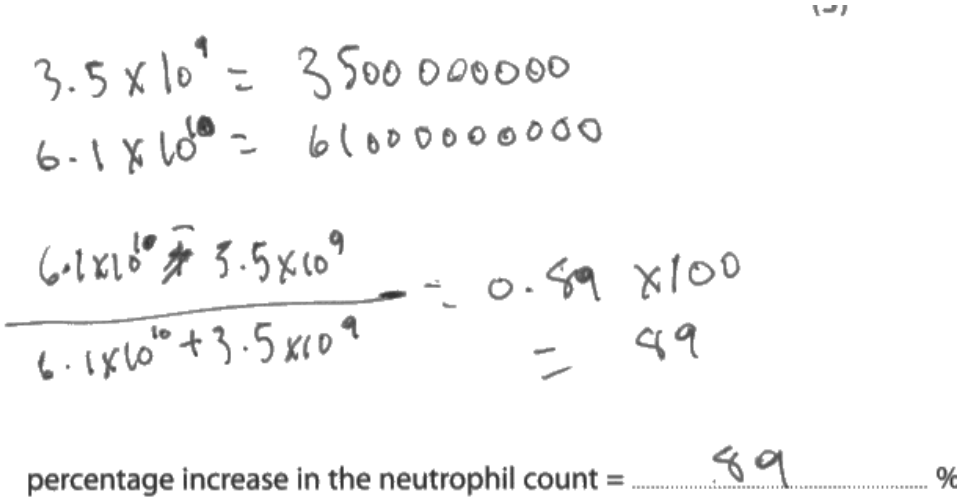
This response was awarded 3 marks. The learner has given 1643 on the answer line, which is an acceptable rounding of the correct evaluation.




Marking point 1 was by far the most common mark achieved, most using the third method to calculate their answer. Very few learners attempted the second method. A lot of candidates took the numbers out of standard form to do the calculations. A few learners achieved 1 or 2 marks by using the third method from the mark scheme but few took away 100 to give the correct response.

Many learners appeared to have difficulty with the numbers being in standard form, which often led them to get the difference wrong. A significant number of learners got their divisions upside down and a number don't appear to have understood that it is possible to have an increase of more than 100%.

This response was awarded 2 marks.




In this example, the learner has used the first method from the mark scheme. They have substituted the values to calculate the difference in their working out and is shown on the top of their division. Therefore, Mp1 can be awarded. The learner has not divided their calculated difference by the original value and so therefore cannot be awarded with mp2. However, the learner has then multiplied their division by 100 and so can be awarded mp3 as an error carried forward mark.

## Q3a

This question was well answered, but with many learners answering phonetically or misspelling Ranvier.

This response was awarded 1 mark.

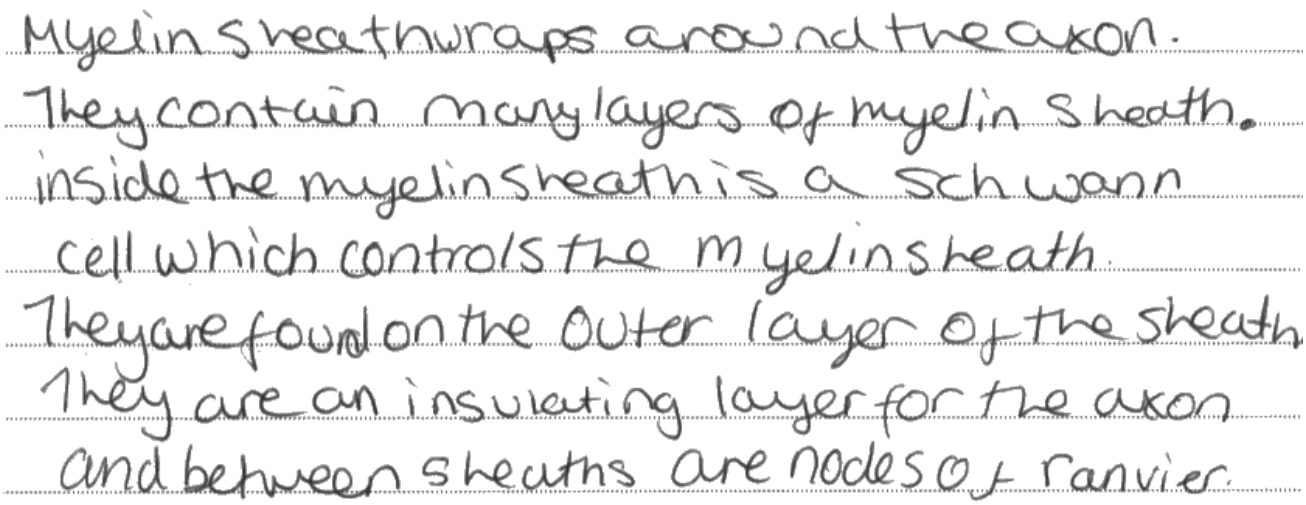

Many learners restated myelin sheath or incorrectly thought that the region was the synapse or axon although some just said node, which was insufficient for the mark.

This response was awarded 0 marks.


## Q3b

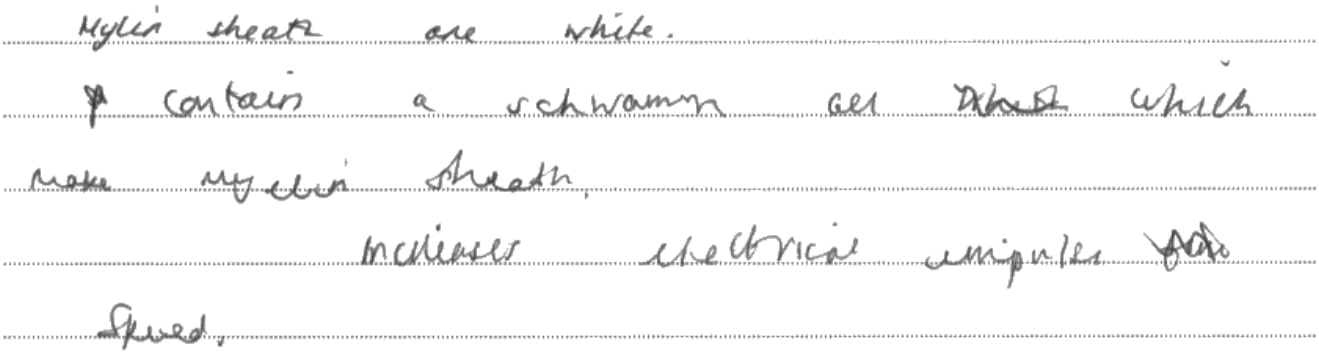
Overall, there were many very good responses with a significant number of learners achieving 4 marks. The learners showed a good understanding of the myelin sheath being wrapped around the axon and/or acting as an insulator and many included Schwann cells and lipids/fat. However, very few learners gave "has a nucleus" as a response.

This response was awarded 3 marks




Most learners who lost marks did so by focusing on the function of the sheath rather than its structure. A lot of answers merely reiterated the stem, were too vague.

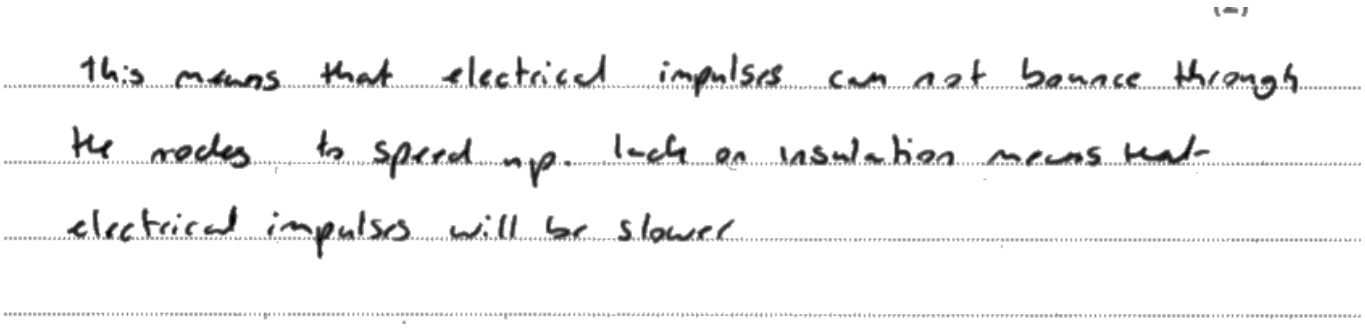
This response was awarded 1 mark for Schwann cell.



## Q3c

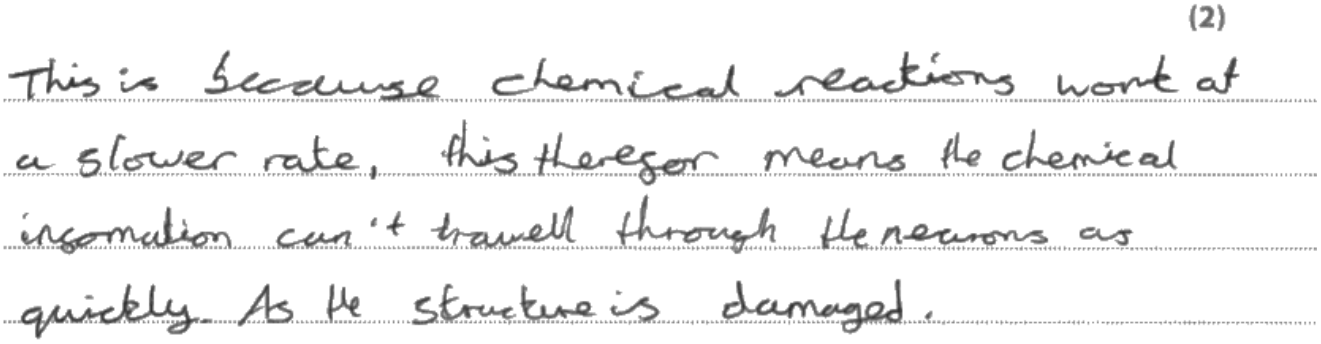
This question was quite poorly answered with very few answers mentioning anything beyond insulation and saltatory conduction (commonly referred to as 'impulse jumping'). Very rarely were references to loss of ions/less shielding seen.

This response was awarded 2 marks


This means that electrical impulses can not bounce through the nodes to speed up. Lack of insulation means that electrical impulses will be slower

Many errors were seen in the responses to this question. Most commonly a confusion between insulation and conduction or simple descriptions of the diagram e.g. 'myelin is broken/damaged' were given. A lot of learners simply repeated the stem of the question. Of the marking points available, few learners achieved points three to six, often failing to apply their knowledge and relate it to a relevant marking point, especially in reference to action potentials. Some learners showed confusion over speed and mitochondria and the need for energy.

This response was awarded 0 marks


(2)

This is because chemical reactions work at a slower rate, this therefor means the chemical information can't travell through the neurons as quickly. As the structure is damaged.

## Q4

This question was, in general, quite poorly answered. Most learner responses described the formation of atherosclerosis but failed to mention the contribution of smoking, restricting responses to level 2, 3-4 marks. Many low scoring responses described damage to cilia and the formation of mucus. Some learners scored marks for including the migration of white blood cells to the damaged area and a very small minority showed an understanding of foam cells.

Quite a lot of responses were able to link smoking to the damage to cells and the resultant inflammation followed by a build-up of plaque under the cells. Some linked carbon monoxide from tobacco smoke (although some confused it with carbon dioxide) to reduced oxygen-carrying capacity and increased blood pressure/strain on heart and linked nicotine to increased stickiness of platelets and formation of thrombus.

This response was awarded 5 marks.

Discuss how smoking is a risk factor for the development of atherosclerosis.

(6)

When a human smokes, those particles or bad cholesterol (LDL) cholesterol, deposits on the endothelial tissue, when it sits on the tissue, white blood cells come to engulf the particles or the bad cholesterol, which ends up forming foam cells. The accumulation of these foam cells due to more smoking and other activities, leads to a fatty plague. Calcium ions also accumulate and deposit on the foam cells which leads to atheroma. Deposition of more atheroma which is white blood cells, foam cells and calcium ions leads to a fatty plague thus

causing the development of atherosclerosis. The human artery is scarred, enlarged and it blocks the efficiency in the flow of blood which could lead to blood clots or heart cardiac disease and high blood pressure. This happens when the blood is struggling to by pass the fatty plague which may lead to reduced blood flow. Blood cannot flow smoothly in the artery if its affected by atherosclerosis.

Many learners were not able to distinguish between the effects of smoke on lungs and arteries, with a significant number discussing how hot smoke could burn cilia. A significant number also suggested that it was tar/mucus that blocked the arteries and some who were under the impression that plaques were formed of food and saliva. There was a lot of repetition in some answers

Overall, there was a lot of confusion, mainly to do with damage to the lungs (cilia damage, build-up of mucus, alveoli damage etc.) although this could have been creditworthy had they linked it to lower oxygen levels in the blood leading to higher blood pressure. Responses often contained discussions of problems caused by atherosclerosis rather than why smoking is a risk factor.

This response was awarded 2 marks.

Firstly smoking is a risk factor of causing atherosclerosis because in the bodies arteries there will be an increase of blood pressure, this has a negative effect on the bodies arteries, this therefore means mucus is trapped in the artery and the amount of blood flow is reduced causing muscles to have a less volume of oxygenated blood.

Smoking is also a risk factor ~~for~~ for causing atherosclerosis, this is because the heart is scared and put under strain, this means it has to work harder to pump blood, in addition the smaller area for the blood to travell through means the arteries have a higher pressure within them.

Futheromore in gaseous exchang blood won't be able to do that as effectivly because the arteries can't carry as much blood, this therefor means red blood cells have a decreased store of hymaglobin aswell.

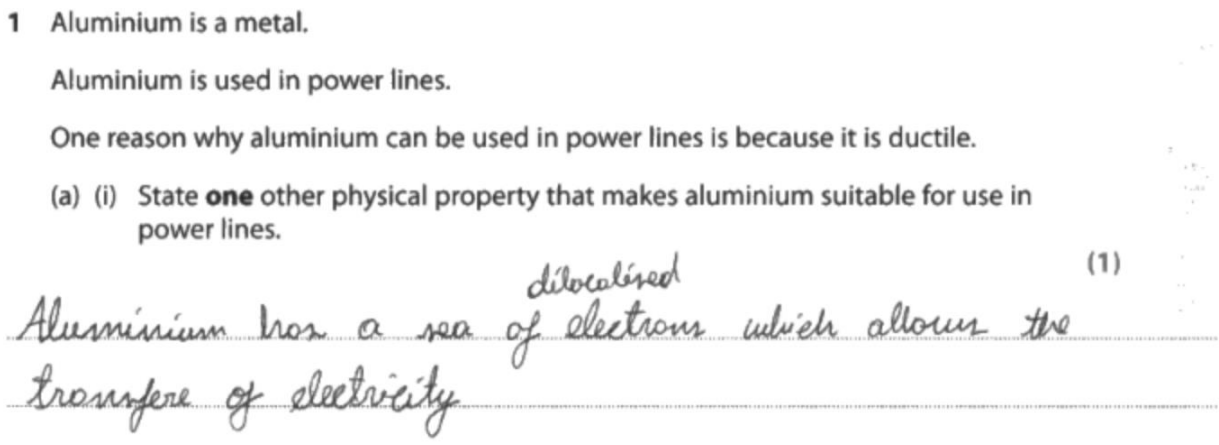
Smoking also a risk factor for producing atherosclorsis because the increase store of mucus and mocus production as the body constantly tries to clear it.

# Chemisty

## Q1ai

This item was well answered with the majority of learners being able to state a physical property of aluminium that makes it suitable for use in power lines.

Many learners showed an understanding that aluminium conducts electricity to gain the mark. In some cases, learners also tried to explain why the metals conduct electricity, the explanation alone was ignored and did not gain credit but the understanding that the metal conducts electricity gained the mark. Learners should be taught to look at the command word in the question and only give an explanation if one is asked for.



1 Aluminium is a metal.

Aluminium is used in power lines.

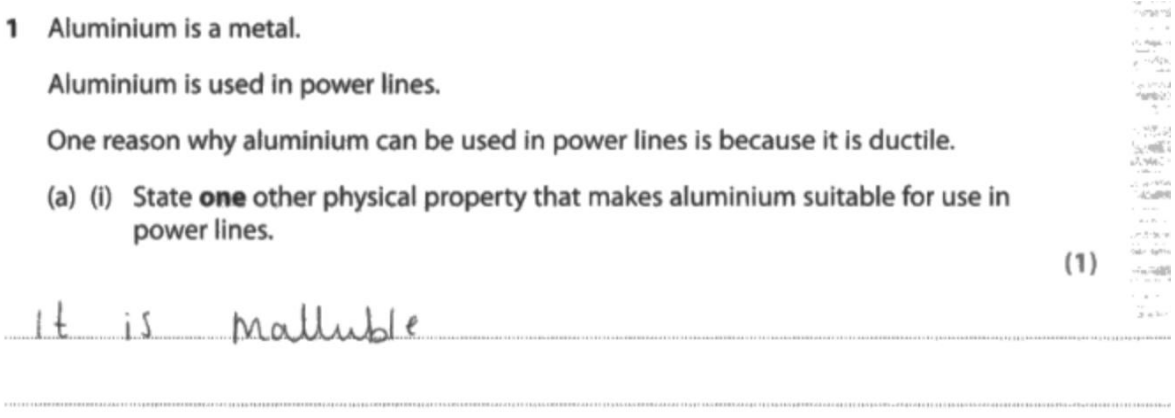
One reason why aluminium can be used in power lines is because it is ductile.

(a) (i) State **one** other physical property that makes aluminium suitable for use in power lines.

(1)

Aluminium has a sea of delocalised electrons which allows the transfere of electricity

Another common allowable answer given was that aluminium is malleable.



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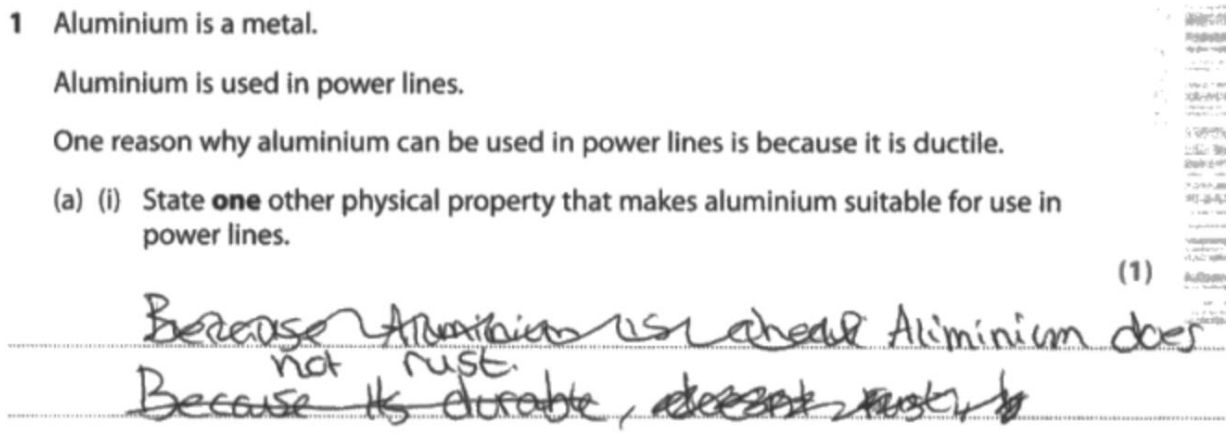
One reason why aluminium can be used in power lines is because it is ductile.

(a) (i) State **one** other physical property that makes aluminium suitable for use in power lines.

(1)

It is mallable

Some learners stated that aluminium does not rust, this was not accepted and gained no marks. Learners should be taught that rusting is a term specific to iron only.



1 Aluminium is a metal.

Aluminium is used in power lines.

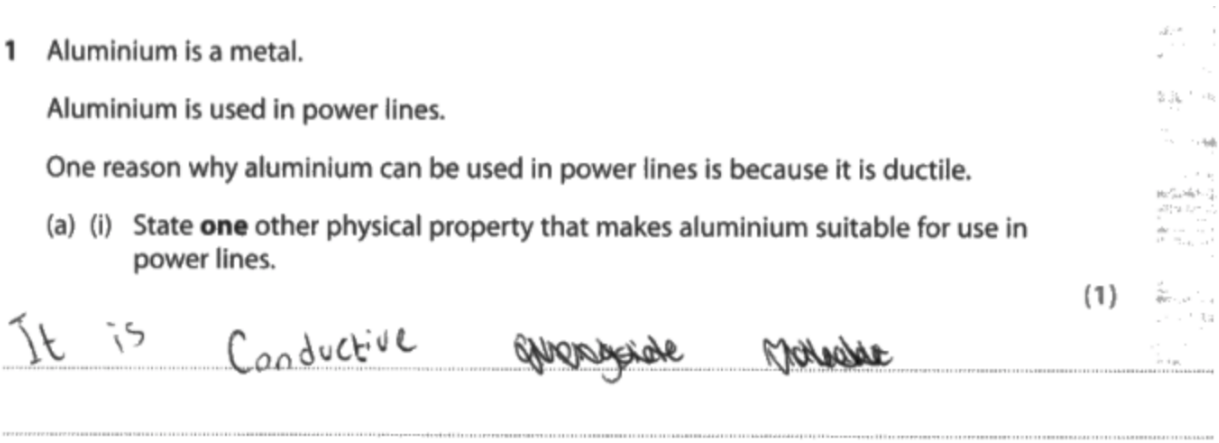
One reason why aluminium can be used in power lines is because it is ductile.

(a) (i) State **one** other physical property that makes aluminium suitable for use in power lines.

(1)

Because Aluminium is cheap Aliminium does not rust.
Because its durable,

In some cases, learners just stated that the metal was conductive, this alone was not accepted. Learners should be taught that they should be specific in their answers and when talking about properties such as conduction they should talk about conduction of electricity or conduction of heat.



1 Aluminium is a metal.

Aluminium is used in power lines.

One reason why aluminium can be used in power lines is because it is ductile.

(a) (i) State **one** other physical property that makes aluminium suitable for use in power lines.

(1)

It is Conductive

## Q1aii

Learners found question Q1aii quite difficult. A common misconception was that the property of ductility meant that the metal could conduct electricity, this gained no marks.

(ii) Explain why metals are ductile.
You should refer to atoms in your answer.

(2)

Metals has a electronstatic ~~e~~structure. Meaning delocalised electrons can move around and carry electricity.

Those that knew the meaning of ductility were often able to explain why the metal is ductile in terms of the atoms in the structure to gain both marks.

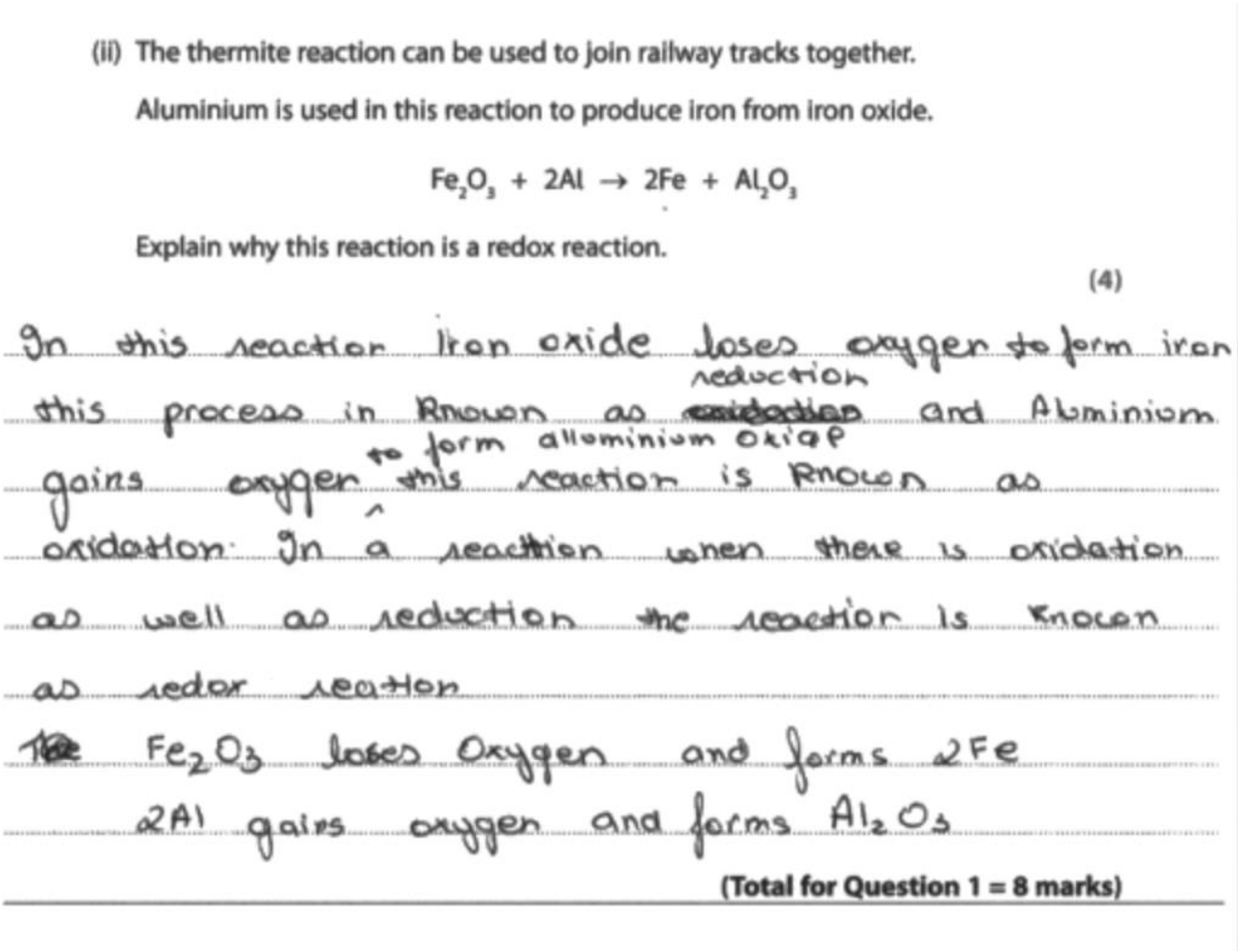
(ii) Explain why metals are ductile.
You should refer to atoms in your answer.

(2)

Metals are ductile as the atoms in a metal are arranged in layers which can slide over one another causing them to be ductile

## Q1bii

This item was well attempted with some very good explanations of why the thermite reaction is a redox reaction to gain the four marks available, as in this example.



(ii) The thermite reaction can be used to join railway tracks together.

Aluminium is used in this reaction to produce iron from iron oxide.

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Explain why this reaction is a redox reaction.

(4)

In this reaction iron oxide loses oxygen to form iron this process in known as reduction and Aluminium gains oxygen to form aluminium oxide this reaction is known as oxidation. In a reaction when there is oxidation as well as reduction the reaction is known as redox reaction

$Fe_2O_3$ loses Oxygen and forms 2Fe

2Al gains oxygen and forms $Al_2O_3$

(Total for Question 1 = 8 marks)

In some cases, learners lost marks as they contradicted themselves and stated that aluminium gained electrons and iron lost electrons.

A common answer that did not gain credit is where learners tried to explain in terms of the reaction being a displacement reaction, this was insufficient and gained no marks.

(ii) The thermite reaction can be used to join railway tracks together.

Aluminium is used in this reaction to produce iron from iron oxide.

$$Fe_2O_3 + 2Al \rightarrow 2Fe + Al_2O_3$$

Explain why this reaction is a redox reaction.

(4)

It is because two metals are switching places during the reaction and they both are sharing the same number of electrons ~~as~~ with oxygen

## Q2ci

Learners found question 2ci difficult. Many knew that there was a drop in melting point from carbon to nitrogen, but only a minority knew the complete and correct trend in melting points across the elements in period 2 to gain both marks.

This example gained both marks.

(c) (i) Figure 2 shows the relative melting points of some of the elements in period 2.

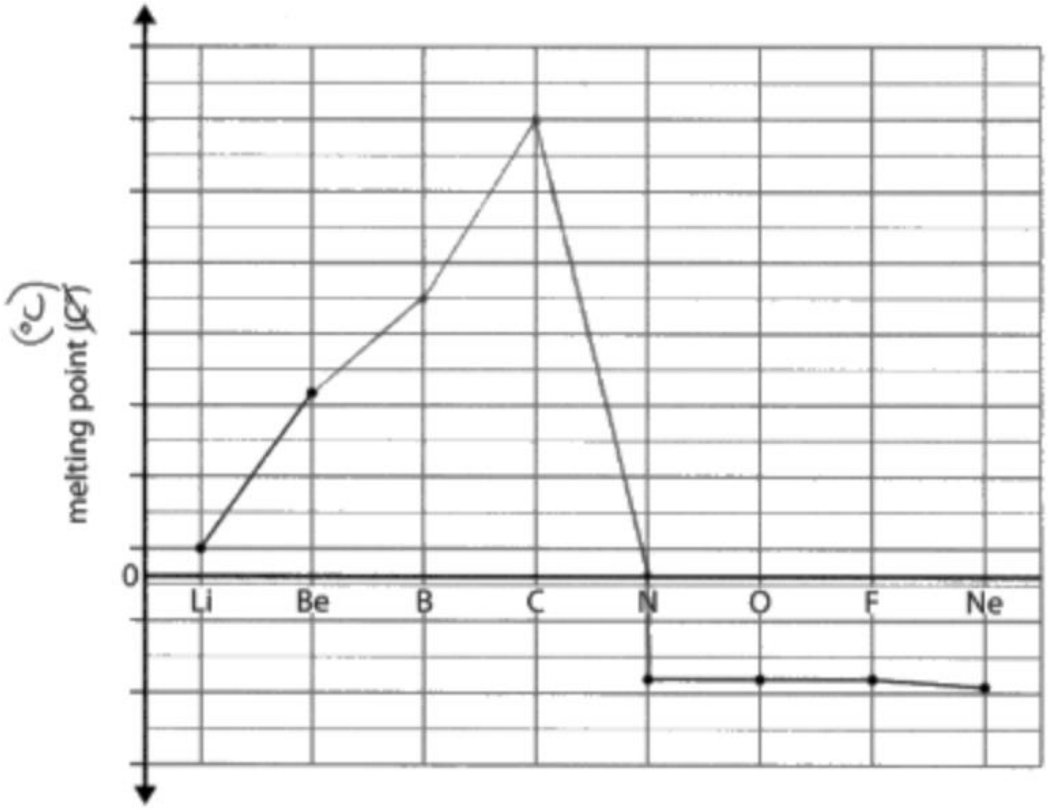



**Figure 2**

Complete Figure 2 to show how the relative melting points change from Be to N.

(2)

In some cases, learners confused the melting points with ionisation energies and tried to draw a graph of ionisation energies rather than the trend in melting points. Learners must be taught to read the question carefully so that they answer the question posed, not one that they think has been asked.

## Q2cii

Question 2cii proved very difficult for learners. Many knew that the increase in atomic number meant that there would be an increase in the number of electrons, but fewer were then able to link this to an increase in Van der Walls forces. Those that did show an understanding of intermolecular forces, were often able to link this to an increase in heat energy required to break these Van der Walls forces or intermolecular forces to gain the third marking point. Whilst a reference to breaking 'bonds' alone was not accepted, breaking intermolecular bonds was allowed.

This example, shows a response that gained the three marks available.

(ii) Table 1 shows the atomic numbers and melting points of the elements in group 7.

| group 7 | atomic number | melting point (°C) |
|---|---|---|
| fluorine | 9 | −220 |
| chlorine | 17 | −101 |
| bromine | 35 | −7 |
| iodine | 53 | 114 |
| astatine | 85 | 302 |

**Table 1**

Explain why the melting point increases as the atomic number increases.

(3)

The melting point increases as the atomic number increases as there are more electrons which require more electron shells. This means that more energy is required to break the down more intermolecular bonds.

Where learners did not score, it was often as they did not appreciate what happens when a substance melts, answers such as electrons melting, atoms splitting and covalent bonds breaking were often cited. Some learners thought that the melting point increased as there were more electrons in the outer shell, this gained no marks.

(ii) Table 1 shows the atomic numbers and melting points of the elements in group 7.

| group 7 | atomic number | melting point (°C) |
|---|---|---|
| fluorine | 9 | −220 |
| chlorine | 17 | −101 |
| bromine | 35 | −7 |
| iodine | 53 | 114 |
| astatine | 85 | 302 |

**Table 1**

Explain why the melting point increases as the atomic number increases.

**(3)**

as the atomic number increases the higher the melting point because the element is then having more electrons on its outer shell.

A common misconception, that gained no credit, was that because there was increasing number of protons in the nucleus, there would be an increase in the electrostatic attraction between the nucleus and the outer electrons. Again this answer scored no credit.

(ii) Table 1 shows the atomic numbers and melting points of the elements in group 7.

| group 7 | atomic number | melting point (°C) |
|---|---|---|
| fluorine | 9 | −220 |
| chlorine | 17 | −101 |
| bromine | 35 | −7 |
| iodine | 53 | 114 |
| astatine | 85 | 302 |

**Table 1**

Explain why the melting point increases as the atomic number increases.

**(3)**

when the number of electrons increase, more shells are there. There are more electrostatic forces between the electrons in the shell, and the protons in the nucleus that has to be broken, therefore requiring more energy causing it to have a higher melting point to break the bond.

## Q3a

The majority of learners were able to score at least one mark of the two available for drawing the dot and cross diagram of a molecule of oxygen in question 3(a). The majority knew that the bond was covalent and therefore would involve a shared pair of electrons and gained the first marking point.

**3** Oxygen exists as the molecule $O_2$ in the Earth's atmosphere and is needed for combustion.

(a) Draw the dot and cross diagram for a molecule of oxygen, $O_2$.

**(2)**

Show the outer electrons only.

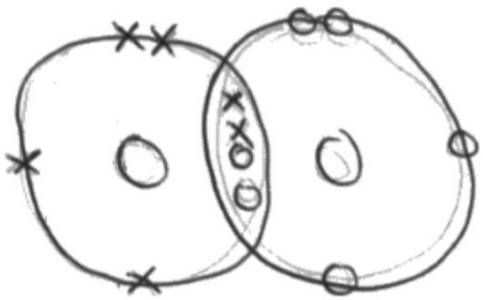
Fewer, showed a deeper understanding and showed two shared pairs in the fully correct molecule to gain both marks.

**3** Oxygen exists as the molecule $O_2$ in the Earth's atmosphere and is needed for combustion.

(a) Draw the dot and cross diagram for a molecule of oxygen, $O_2$.

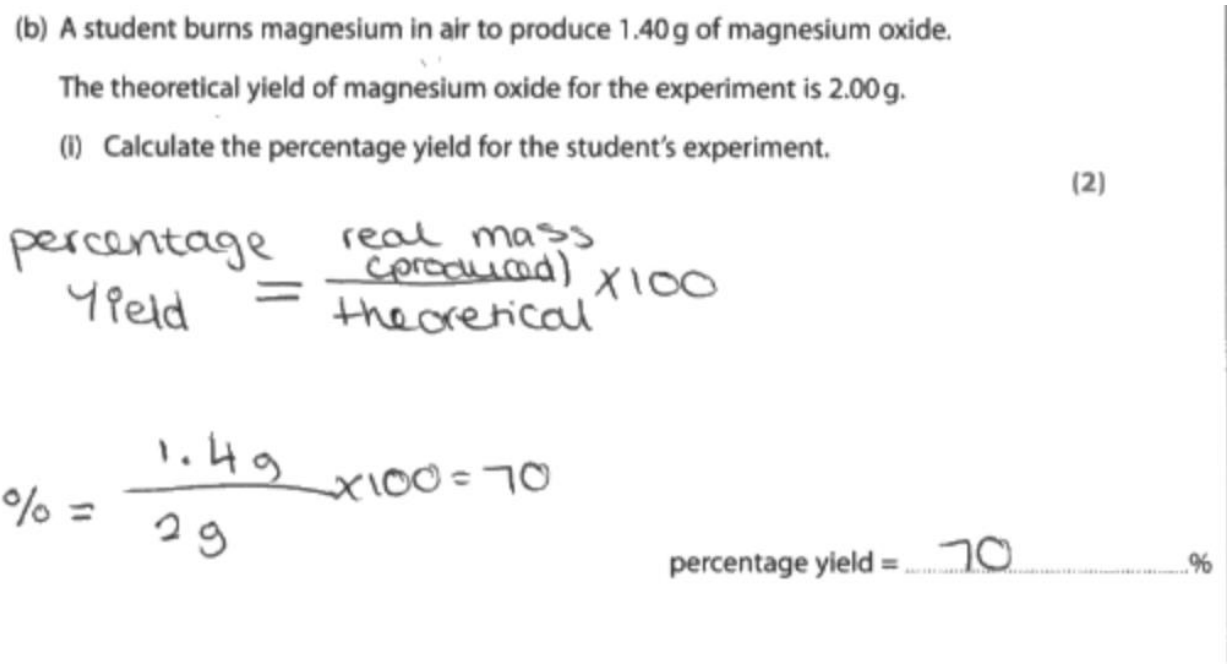
**(2)**

Show the outer electrons only.



## Q3bi

This item performed well with the majority of learners scoring credit. Many were able to correctly calculate the percentage yield of magnesium oxide to gain both marks.



(b) A student burns magnesium in air to produce 1.40 g of magnesium oxide.

The theoretical yield of magnesium oxide for the experiment is 2.00 g.

(i) Calculate the percentage yield for the student's experiment.

(2)

percentage yield = $\frac{\text{real mass (produced)}}{\text{theoretical}} \times 100$

$\% = \frac{1.4\text{ g}}{2\text{ g}} \times 100 = 70$

percentage yield = 70 %

Those that didn't score full marks often did so as they inverted the fraction and divided the theoretical yield by the actual yield. Answers such as this gained just 1 mark for calculating the fraction, even though the yields had been inverted.

(b) A student burns magnesium in air to produce 1.40 g of magnesium oxide.

The theoretical yield of magnesium oxide for the experiment is 2.00 g.

(i) Calculate the percentage yield for the student's experiment.

(2)

$\frac{1.40}{2.00} = 0.6 \times 100 = 60\%$

$\frac{2.00}{1.40} = 1.5 \times 100 = 15\%$

$2 \overline{)1.4}$ 0.6

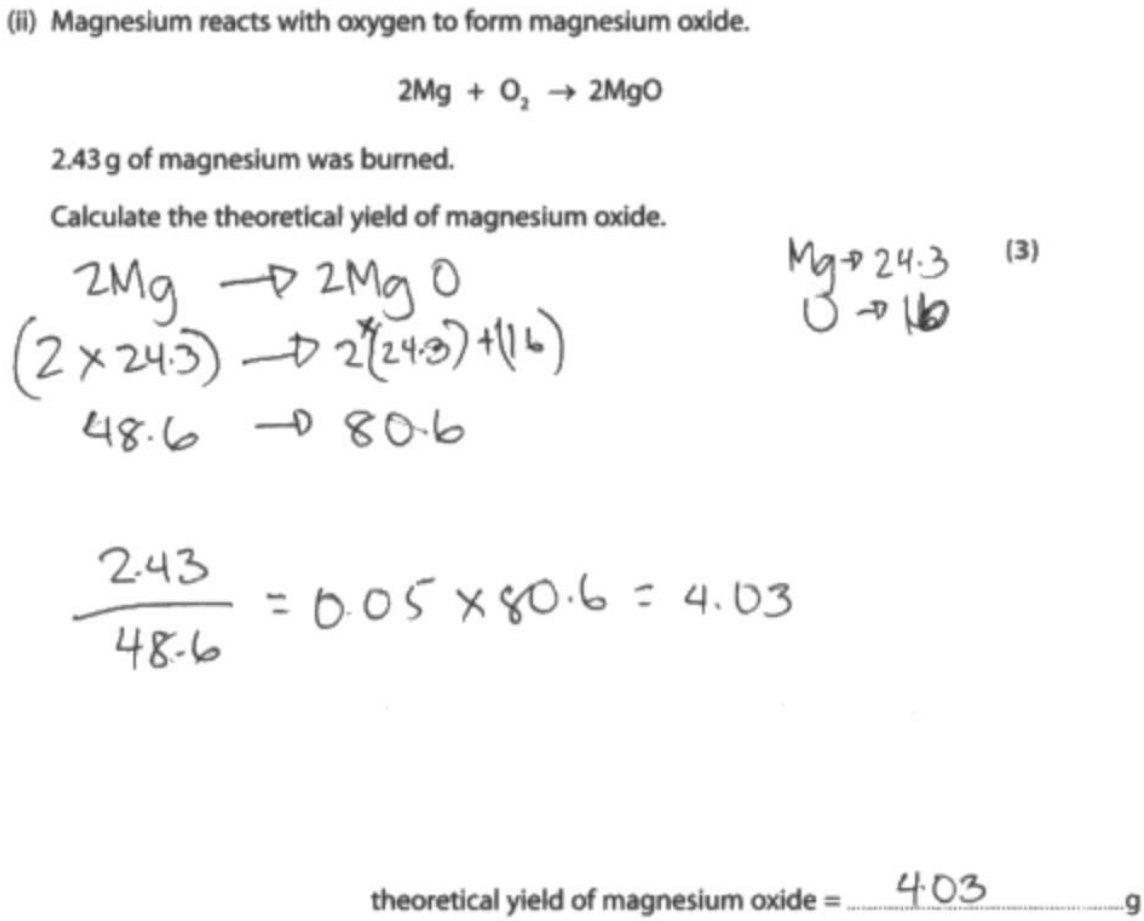
$1.4 \overline{)2.00}$ 1

$14 \overline{)20.0}$ 1.5

percentage yield = 15 %

## Q3bii

This part of the question did not perform so well with only the minority of learners being able to correctly calculate the theoretical yield and gain the three marks available.



(ii) Magnesium reacts with oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

2.43 g of magnesium was burned.

Calculate the theoretical yield of magnesium oxide.

(3)

$2Mg \rightarrow 2MgO$

$(2 \times 24.3) \rightarrow 2(24.3) + (16)$

$48.6 \rightarrow 80.6$

Mg → 24.3

O → 16

$\frac{2.43}{48.6} = 0.05 \times 80.6 = 4.03$

theoretical yield of magnesium oxide = 4.03 g

In some cases, learners used 24 rather than 24.3 in their calculation, which was acceptable for all marking points.

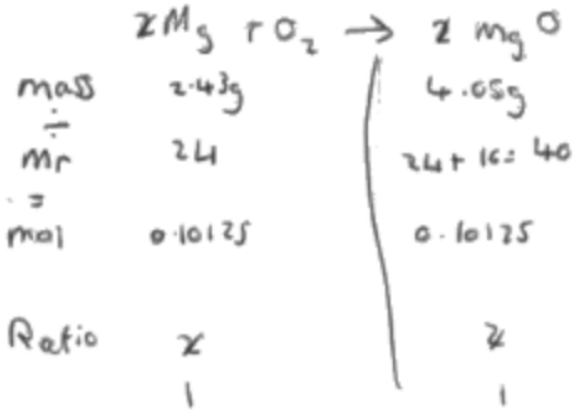
(ii) Magnesium reacts with oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

2.43 g of magnesium was burned.

Calculate the theoretical yield of magnesium oxide.

(3)




0.10125 × 40 = 4.05

theoretical yield of magnesium oxide = 4.05 g

Those that did not gain full marks, often gained part marks from their working, regularly for calculating the relative formula mass of the magnesium oxide.

(ii) Magnesium reacts with oxygen to form magnesium oxide.

$$2Mg + O_2 \rightarrow 2MgO$$

2.43 g of magnesium was burned.

Calculate the theoretical yield of magnesium oxide. (3)

~~2Mg~~ $O_2$
$M_r = 16+16$
$= 32$

$2MgO$
$= 2(24.3+16)$
$= 2(40.3)$
$= 80.6$

$\frac{80.6}{32} = 2.52$
$= 2.52 \times 2.43$
$= 6.12g$

theoretical yield of magnesium oxide = 6.12 g

## Q4

Question 4 was a good discriminator with learners providing a good range of answers.

At level 1, learners were able to give an adequate interpretation of the information in the table, often making generalised comments.

In this example, the learner has linked the idea that the ionic radius is bigger than the atomic radius to the fact that electrons have been gained. They have repeated this same link for fluorine, oxygen and sulfur but have not discussed this in any further detail. A mark of 2 in level 1 was awarded.

Table 2 shows the data.

| atomic radius (nm) | ionic radius (nm) |
|---|---|
| O = 0.073 | $O^{2-}$ = 0.140 |
| F = 0.071 | $F^{-}$ = 0.133 |
| S = 0.102 | $S^{2-}$ = 0.185 |

**Table 2**

Discuss the atomic radius and ionic radius data in Table 2.

(6)

~~Atomic radius~~ The ionic radius is always bigger than the atomic radius. Sulfur has the biggest atomic radius out of all ~~their~~ three elements. Oxygen has gained 2 electron to become stable which makes the ionic radius bigger. Sulfur has also gained 2 electron making ~~positively~~ negatively charged making the ionic radius bigger. Fluorine has gained one electron making it negatively charged making the ionic radius bigger.

At level 2 learners were able to give a good analysis of the scientific information with a discussion that shows a mostly clear structure.

In this example, the learner starts by stating that O and S are in the same group and links this to the fact that the atomic radius increases, unfortunately they then explain this in terms of them having more electrons in their outer shell rather than them having more shells which is incorrect.

| atomic radius (nm) | ionic radius (nm) |
|---|---|
| O = 0.073 | $O^{2-}$ = 0.140 |
| F = 0.071 | $F^{-}$ = 0.133 |
| S = 0.102 | $S^{2-}$ = 0.185 |

**Table 2**

Discuss the atomic radius and ionic radius data in Table 2.

(6)

O and S are in the same group meaning that as you go down the group the atomic radius increased as there's more electrons in the outer shell and since its in the same group the same principles apply for ionic radius as they both [redacted] gain 2 electrons in order to have a full outer shell. Since [redacted] they are all non-metals also [redacted], they always gain electrons which is why the radius becomes bigger. for F the reason as to why its ionic radius is smaller than O and S is because its in group 7 meaning it only gains 1 electron

They go on to explain that the ionic radius is bigger than the atomic radius due to the atoms gaining electrons, they understand that fluorine has a smaller radius as it only gains 1 electron rather than 2. A mark of 4 in level 2 was awarded.

At level 3, learners were able to give comprehensive analysis of the scientific information, their discussion showing a well-developed structure which is clear, coherent and logical

In this example, the learner has shown an understanding that fluorine has a lower atomic radius than oxygen due to it being the same shell but having more protons. They have shown an understanding that sulfur has more shells and therefore shielding takes place.

They go on to show some understanding that the ionic radius is always larger than the atomic radius as they gain electrons. They understand that oxygen and sulfur gain 2 electrons whereas fluorine only gains 1 however this section is a little confused.

Whilst there is some confusion, there is a comprehensive interpretation of the scientific information, there are clear ideas about the trends and clear lines of argument and a mark of 5 in level 3 was awarded.

| atomic radius (nm) | ionic radius (nm) |
|---|---|
| O = 0.073 | $O^{2-}$ = 0.140 |
| F = 0.071 | $F^{-}$ = 0.133 |
| S = 0.102 | $S^{2-}$ = 0.185 |

**Table 2**

Discuss the atomic radius and ionic radius data in Table 2.

**(6)**

Fluorine has the ~~lowest~~ lowest atomic radius in table 2 because even though it has more electrons than oxygen, it has the same number of shells and only one increase in proton number, causing the electronegativity of the atom higher. However it has a lower atomic radius than sulfur, because sulfur has more electrons than fluorine, with more shells. Although it has a higher number of protons, the electron sheilding will decrease due and the distance from the nucleus to the electron will be larger, causing the electronegativity to decrease.

they all have a larger ionic radius than their atomic radius, and this is because they all gain one electron to stabilise themself. Sulfur has the highest ionic radius because it gained 2 electrons ~~to the [illegible]~~ but still has

the same number of protons. Fluorine has the lowest atomic radius because it only gains 1 electron. While oxygen has a higher ~~electronegativity~~ ionic radius, because it gains 2 electron. the reason for Sulfur having a higher atomic radius than Oxygen even though they gained the same amount of electrons, is because sulfur already had a higher atomic radius, so the gain of electrons made it even more the radius even more higher.

Sulfur will have the highest melting and boiling point because it has highest atomic and ionic radius.

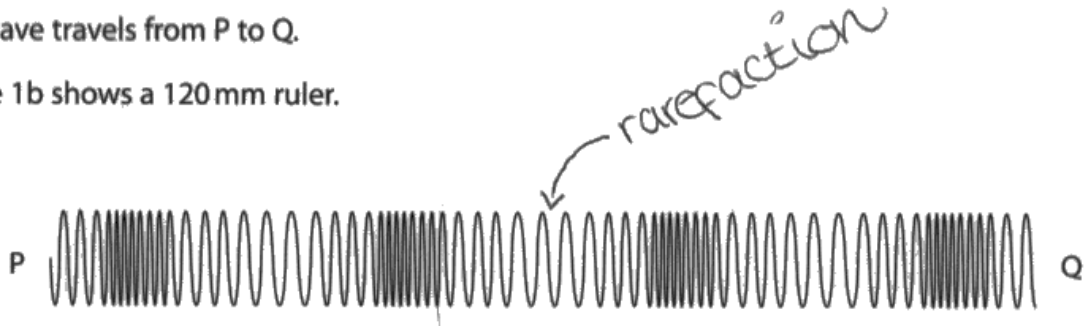
# Physics

## Q1ai

Any of the following designations of rarefaction were allowed although the first example with rarefaction pointing to the centre was preferred. As the others include areas which show the unstretched spring.

The wave travels from P to Q.

Figure 1b shows a 120 mm ruler.

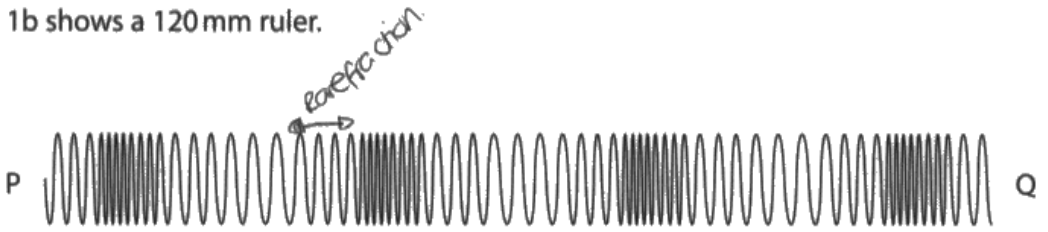


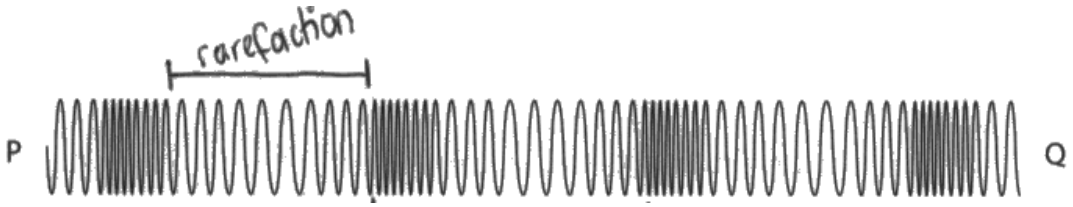

1 A slinky spring can be used to show different types of wave.

Figure 1a shows a longitudinal wave on a slinky spring.

to Q.

Figure 1b shows a 120 mm ruler.



## Q1aii

The response below shows that the learner knows what one wavelength is and the measures it correctly in mm.

Figure 1b shows a 120 mm ruler

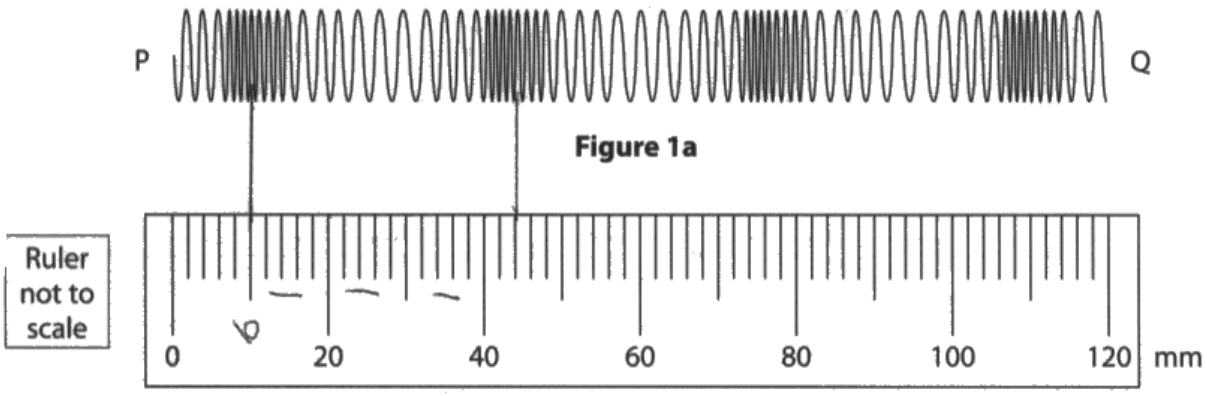



**Figure 1a**

**Figure 1b**

(ii) Give the wavelength of the longitudinal wave in the slinky spring.

Use the ruler in Figure 1b.

**(1)**

wavelength = 34 mm

Some learners ignored the unit and probably used cm but as there was no unit attached to their measurement no mark was given.

## Q1aiii

This answer gained both marks as it had the idea of moving the slinky forward and that the motion was parallel to the direction in which it was being pushed.

(iii) Describe how a longitudinal wave is produced on a slinky spring.

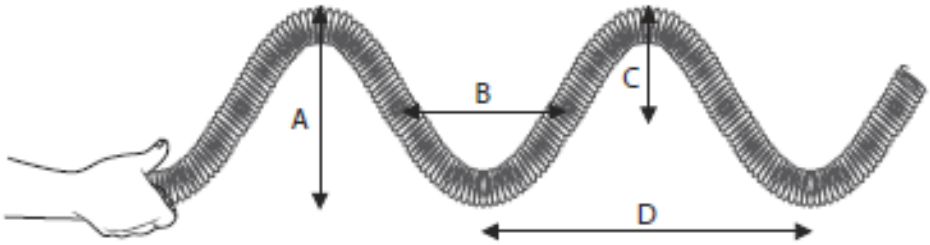
(2)

The slinky spring would have to be held and jolted forward to create ossilations parrallel to that of the force. If you do this multiple times you will create many waves with rarefactions and compressions.

## Q1b

Many learners recognised the correct answer as C. The amplitude being the maximum displacement from the central position.

The slinky spring is being moved up and down to produce a transverse wave



## Q2a

The correct answer, C was arrived at by understanding the diagram of emission spectra, and reading the information.

2 (a) Figure 3 shows the emission spectra of four different gases, A, B, C and D.

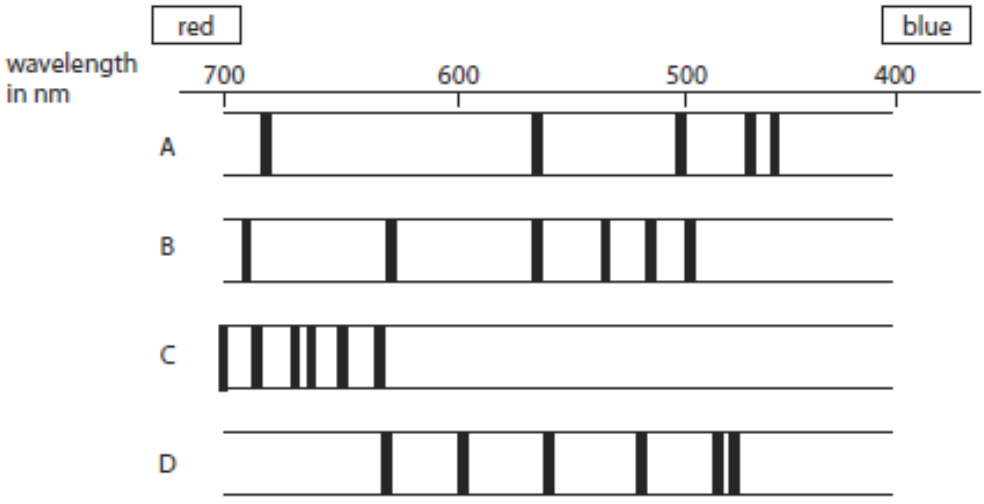



**Figure 3**

Neon has two spectral lines that are about 10 nm apart.

These spectral lines are at the red end of the spectrum.

Which is the emission spectrum of neon?

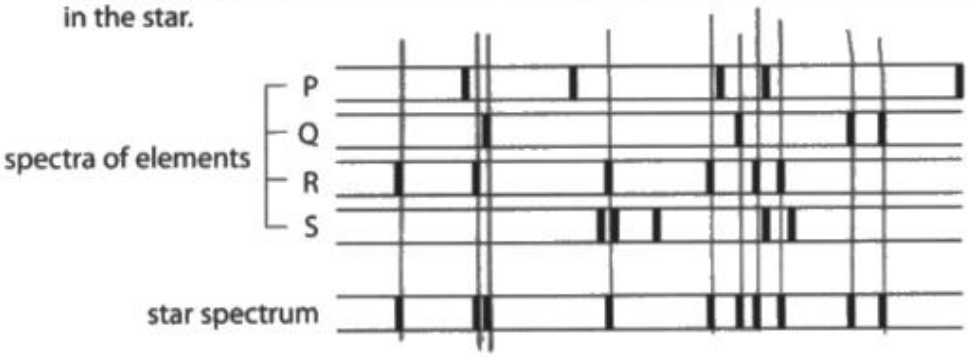
## Q2b

The example below gained 3 marks. The elements found in the star were clearly identified and the correct justification was given.

(b) A diffraction grating is used to analyse the light from a star.

The diffraction grating produces a spectrum of the light.

Figure 4 shows the emission spectra of elements P, Q, R and S, which can be found in the star.




R x Q

**Figure 4**

Identify, and justify, which of the elements P, Q, R, S, are found in the star spectrum in Figure 4.

**(3)**

You may add to Figure 4 to support your answer.

Elements R and Q are in the star spectrum. As you can see when looking at Figure 4, R and Q are the only elements that have matching spectrums to the star spectrum.

Many learners did not appreciate that there was more than one element in the star spectrum or that spectral lines are like finger prints for elements and they have to match exactly. Below is a typical one mark answer as only one element was identified and the remaining lines in the star spectrum were ignored

(b) A diffraction grating is used to analyse the light from a star.

The diffraction grating produces a spectrum of the light.

Figure 4 shows the emission spectra of elements P, Q, R and S, which can be found in the star.

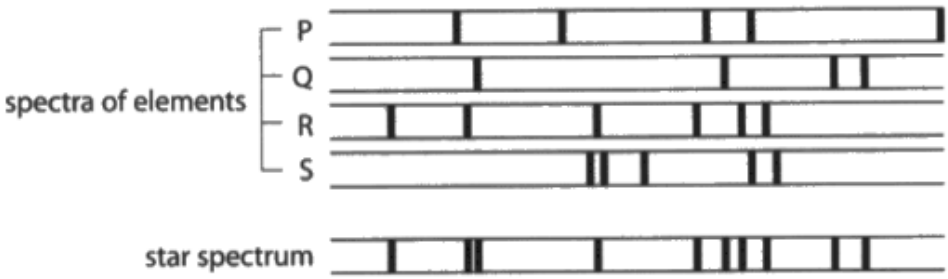



**Figure 4**

Identify, and justify, which of the elements P, Q, R, S, are found in the star spectrum in Figure 4.

**(3)**

You may add to Figure 4 to support your answer.

The spectra line are the wavelengths the light can be absorbed at.
B Element R is found in a star as they had have the ~~most~~ same spectra lines ~~in common~~ as in a star spectrum.

## Q2c

This question showed that many learners do not understand that path difference is given in wavelengths and that to get a bright line the waves have to be in phase and this only happens when the difference between the paths is a whole number of wavelengths.

(c) Figure 5 shows rays of light passing through part of a diffraction grating.

The diffraction grating produces a bright line on the screen.

The distance travelled from the diffraction grating to the screen is different for each ray of light.

This is called the path difference.

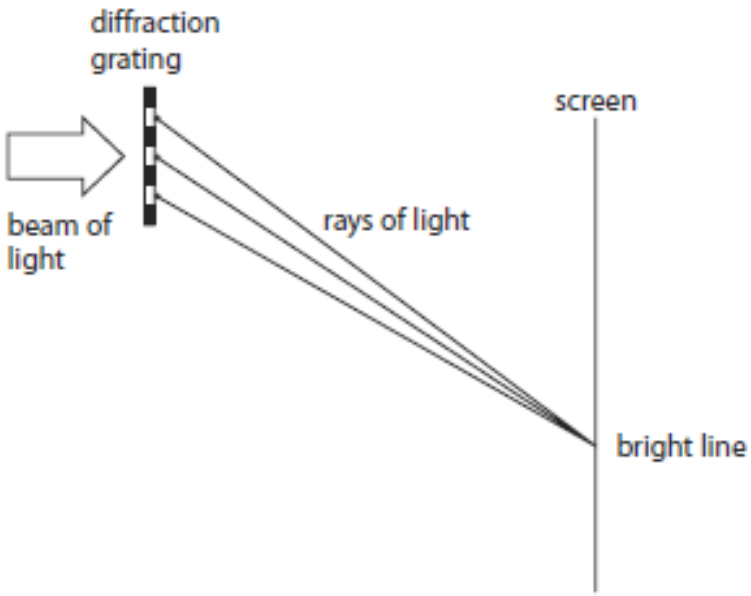



**Figure 5**

Which path difference between the rays of light gives the bright line?

(1)

## Q3a

The answer below gained both marks. The first marking point because a specific place was given where the signal could not be received and the second mark because the reason for this was given in scientific terms. The signal was 'absorbed', Many learners gave the reason as the signal was blocked this was not sufficient to gain the second mark.

**3** Mobile phones should receive a signal when the user is in range of a transmitter.

There are places where mobile phone signals cannot be received even when the user is in range of a transmitter. Figure 6 shows a mobile phone with no signal.

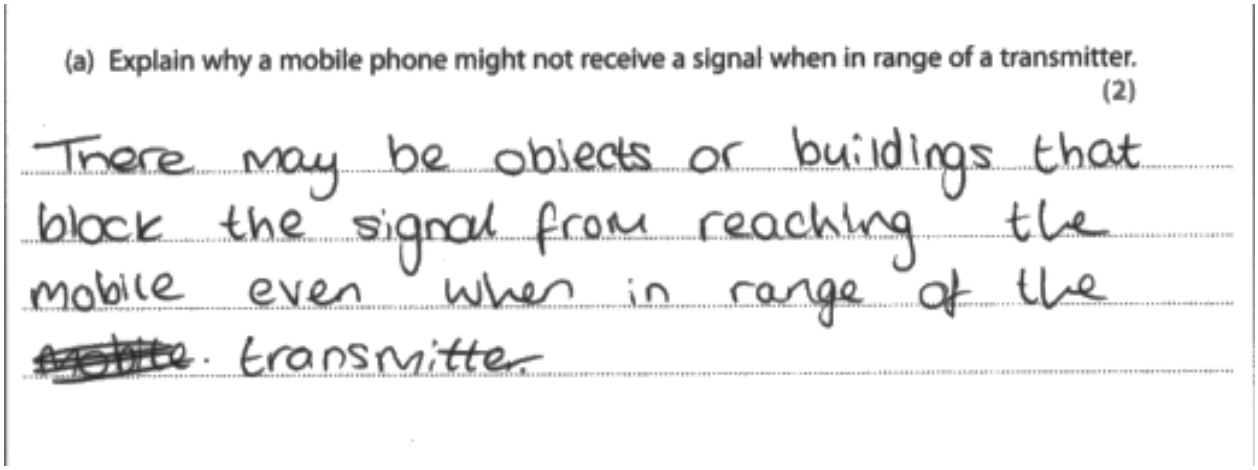

**Figure 6**

(a) Explain why a mobile phone might not receive a signal when in range of a transmitter.

**(2)**

the person may be underground and satellite communication waves may not be able to reach and may be absorbed or reflected by the surroundings, therefore not reaching the transmitter or phone

The example below does not gain a mark. The 'objects or buildings' are not specific enough for the first marking point to be awarded and 'blocked' is not sufficient explanation of why the signal does not reach the mobile phone.



(a) Explain why a mobile phone might not receive a signal when in range of a transmitter.
(2)

There may be objects or buildings that block the signal from reaching the mobile even when in range of the ~~mobile~~. transmitter.

## Q3b

The example below shows the 4 stages of working through the calculation.

Rearrangement, substitution, evaluation of the square root and conversion to km. The learner is able to deal with the square root of a value in standard form.

(b) For a mobile phone to receive a signal, the intensity must be above $9 \times 10^{-10}$ Wm$^{-2}$.

At a distance of 1.1 m from the transmitter, the output signal has an intensity of 1.5 Wm$^{-2}$ and the power given by the constant k is 1.8 W.

Calculate the maximum distance from the transmitter that a signal of intensity $9 \times 10^{-10}$ Wm$^{-2}$ can be received by a mobile phone.

Give your answer in kilometres (km).

Use the equation $I = k/r^2$

Show your working.

(4)

$r^2 = \frac{k}{I}$

$\sqrt{r^2} = \sqrt{\frac{1.8}{9 \times 10^{-10}}}$

$r = 44\,721.35$

$\frac{44\,721.35}{1000} = 44.72$

maximum distance = 44.72 km

The examples below gain1 mark in the first examples for correct rearrangement but the wrong values have been selected for intensity and distance and in the second for correct substitution but the rearrangement is wrong. In both cases the equation has been written out and one mark awarded.

(b) For a mobile phone to receive a signal, the intensity must be above $9 \times 10^{-10}$ Wm$^{-2}$.

At a distance of 1.1 m from the transmitter, the output signal has an intensity of 1.5 Wm$^{-2}$ and the power given by the constant k is 1.8 W.

Calculate the maximum distance from the transmitter that a signal of intensity $9 \times 10^{-10}$ Wm$^{-2}$ can be received by a mobile phone.

Give your answer in kilometres (km).

Use the equation $I = k/r^2$

Show your working.

(4)

$r^2 = \frac{K}{I} \rightarrow r^2 = \frac{1.8}{1.5} = 1.2$

$\sqrt{1.2} = [redacted]\ 1.1$

maximum distance = ..... km

(b) For a mobile phone to receive a signal, the intensity must be above $9 \times 10^{-10}$ Wm$^{-2}$.

At a distance of 1.1 m from the transmitter, the output signal has an intensity of 1.5 Wm$^{-2}$ and the power given by the constant k is 1.8 W.

Calculate the maximum distance from the transmitter that a signal of intensity $9 \times 10^{-10}$ Wm$^{-2}$ can be received by a mobile phone.

Give your answer in kilometres (km).

Use the equation $I = k/r^2$

Show your working.

$I = \frac{k}{r^2}$ (4)

$9 \times 10$

$9 \times 10^{-10} = \frac{1.8}{r^2}$

$r^2 = 9 \times 10^{-10} \times 1.8 = 1.62 \times 10^{-9}$

$r = 1.62 \times 10^{-9}$

maximum distance = ..... km

A common error reducing the mark to 3 was not converting the distance into km as shown in the example below.

Show your working.

(4)

intensity = $9 \times 10^{-10}$
constant = 1.8

$I \times r^2 = k$

$\frac{k}{I} = r^2$ $\frac{9 \times 8w}{9 \times 10^{-10}} = 44721.35955$

maximum distance = 44721 km

## Q3ci

The correct answer of 'frequency hopping' as in the example below was rarely seen. Learners need to take note of the additional guidance issued for this unit

(c) (i) Bluetooth© and Wi-Fi use the same frequency band.
Give **one** reason why a Bluetooth© signal does not interfere with a Wi-Fi signal.

(1)

Bluetooth uses frequency hopping to avoid interference with Wifi signals.

## Q3cii

This question required applications of Bluetooth© but many learners did not gain marks as they gave the advantages of Bluetooth©.

Below is an example of an answer which gained both marks giving two different applications.

(ii) State **two** useful applications of Bluetooth© technology.

(2)

1 Bluetooth can be used for personal devices that require you to be close enough to connect e.g headphones.
2 Bluetooth can be used to share data such as music files with other nearby devices e.g phones.

Many answers similar to the example below were not award any marks.

(ii) State **two** useful applications of Bluetooth© technology.

(2)

1 connects one device to another for communication.
2 can connect to multiple devices.

## Q4a

There are a few learners that do not know the meaning of the symbols but most can now get a value for sin C. The problems arise is rounding to too few decimal places or not being able to use their calculator to covert a number into an angle

The example below gains 2 marks shows the rounding error rounding to 0.7 takes the answer from 41.1°to 44.4°.

**4** Light passes through an optical fibre.

The optical fibre is made of glass.

(a) Calculate the critical angle for the glass. **(3)**

Refractive index of glass (n) = 1.52

Use the equation $\sin C = \frac{1}{n}$

$\sin C = \frac{1}{1.52}$

$\frac{1}{1.52} = 0.6578947...$

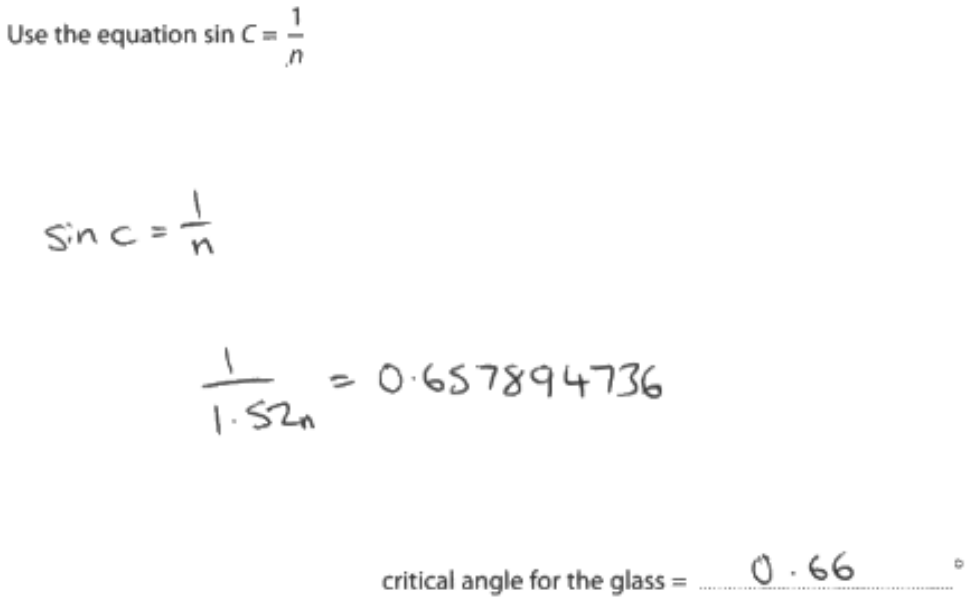
$= 0.7$

$\sin(0.7) = 0.01221700...$

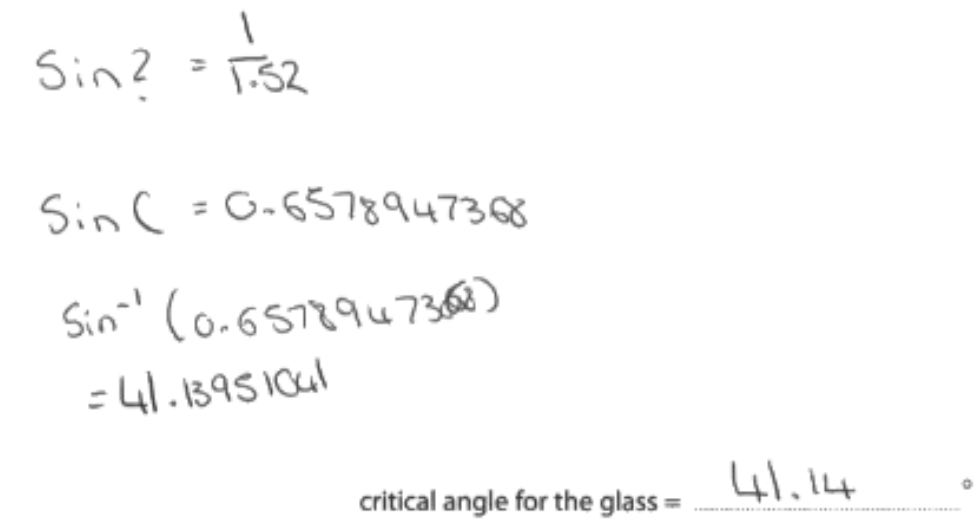
$\sin^{-1}(0.7) = 44.427004$

critical angle for the glass = 44 °

The answer below also gains 2 marks as there is no conversion to degrees.




The example below shows the correct calculation gaining 3 marks.



## Q4b

The response below gained two marks although this type of response was rarely seen. The diagram showed that the angle of reflection was larger and from that the expansion was that there were fewer reflections or the light had to travel a shorter distance. The errors that occurred most frequently were ,the use of 'refraction' instead of 'reflection 'and that 'light travels faster' which is ambiguous as it could mean 'light reaches the other end of the fibre in a shorter time' which is correct or 'the velocity of light increases' which is incorrect so does not get a mark.

(b) Optical fibres used in cables can be covered in cladding.

The cladding has a lower refractive index than the optical fibre.

Figure 7a shows light passing through an optical fibre without cladding.

Figure 7b shows light passing through an optical fibre with cladding.

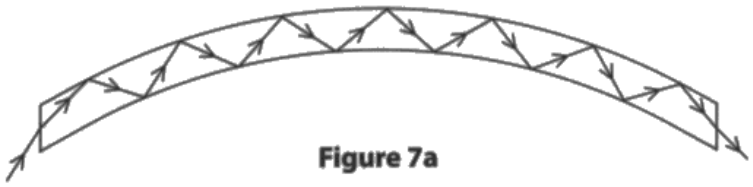


**Figure 7a**

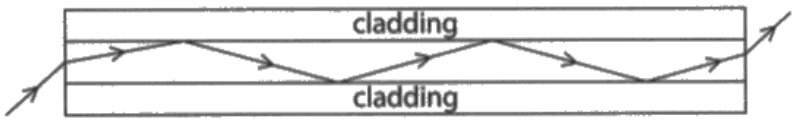



**Figure 7b**

Explain **one** advantage of transmitting light through an optical fibre with cladding.

**(2)**

An advantage could be that it is faster, due to the light having to travel less distance, & reflects in bigger angles. More efficient

The example below shows the use of refraction instead of reflection which does not gain a mark the mark is awarded for 'increases the speed of transmission' which is the same marking point as less reflections

Explain **one** advantage of transmitting light through an optical fibre with cladding.

**(2)**

less refractions in the optical fibres increases the speed of transmition

## Q5

Knowledge of the waves produced by musical instruments was often limited and confused and learners did not note the command word which was 'Compare' and this requires both similarities and differences.

This question is levelled using the generic mark scheme and not by looking for specific points from the indicative content.

The example below shows the minimum needed to award 2 marks at level 1. There is adequate knowledge giving a correct comparison between strings and pipes. There are two correct generic statements and a difference but no similarity. The incorrect statement in the last paragraph is ignored and as a result, the learner gains Level 1, 2 marks.

**5** Musical notes are sound waves.

Plucking strings or forcing air through pipes can produce sound waves.

Compare the types of wave formed on strings and formed in pipes when musical notes are produced.

You may use diagrams to support your answer.

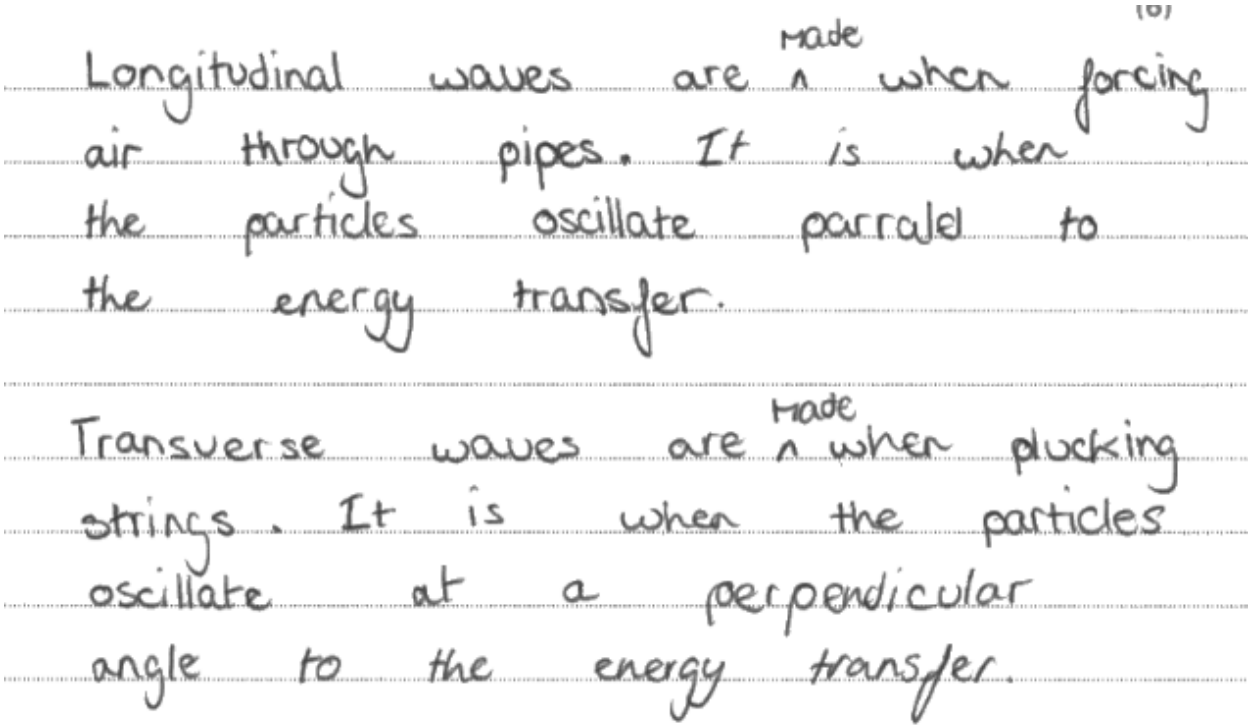
**(6)**

the waves produced from a string instrument is transverse ~~wite~~ while waves from a pipe instrument is longitudinal.

waves from a string it has a higher frequency.

The response below is Level2, 4 marks.

The response considers both strings and pipes and shows a understanding by selecting relevant scientific facts. Lines of argument are supported by relevant evidence. There is a correct difference, longitudinal and transverse being ascribed correctly. There is also a correct similarity in that both waves being caused by oscillations. Also the response in given in a logical order.


Longitudinal waves are made when forcing air through pipes. It is when the particles oscillate parrald to the energy transfer.

Transverse waves are made when plucking strings. It is when the particles oscillate at a perpendicular angle to the energy transfer.

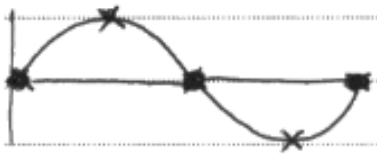
This response is quite different but is also awarded level 2, 4 marks. There is no mention of transverse and longitudinal waves. However there are similarities and differences with some good knowledge and a reasonable line of argument which is expressed logically.

Compare the types of wave formed on strings and formed in pipes when musical notes are produced.

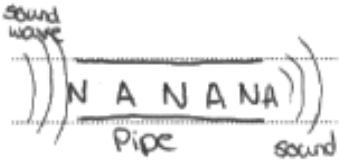
guitar ↓ organ.

You may use diagrams to support your answer.

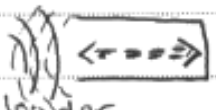
(6)



This is the first harmonic. ° = nodes (where there is no displacement. X = anti-nodes, where there is displacement. This occurs on stationary waves when strings are plucked. As you increase the number of harmonics, you also increase the number of nodes and antinodes. This can alter the pitch of the string.




Nodes and antinodes alternate when air is forced through pipes to create sound waves. The wave enters through one end of the pipe and exists out of the other end, if the end is open. However if the end is closed ~~if~~ it gets reflected back, but superposition occurs so some of the wave and some will be louder. might cancel out ~~and some of the wave may amplify~~



cancels out

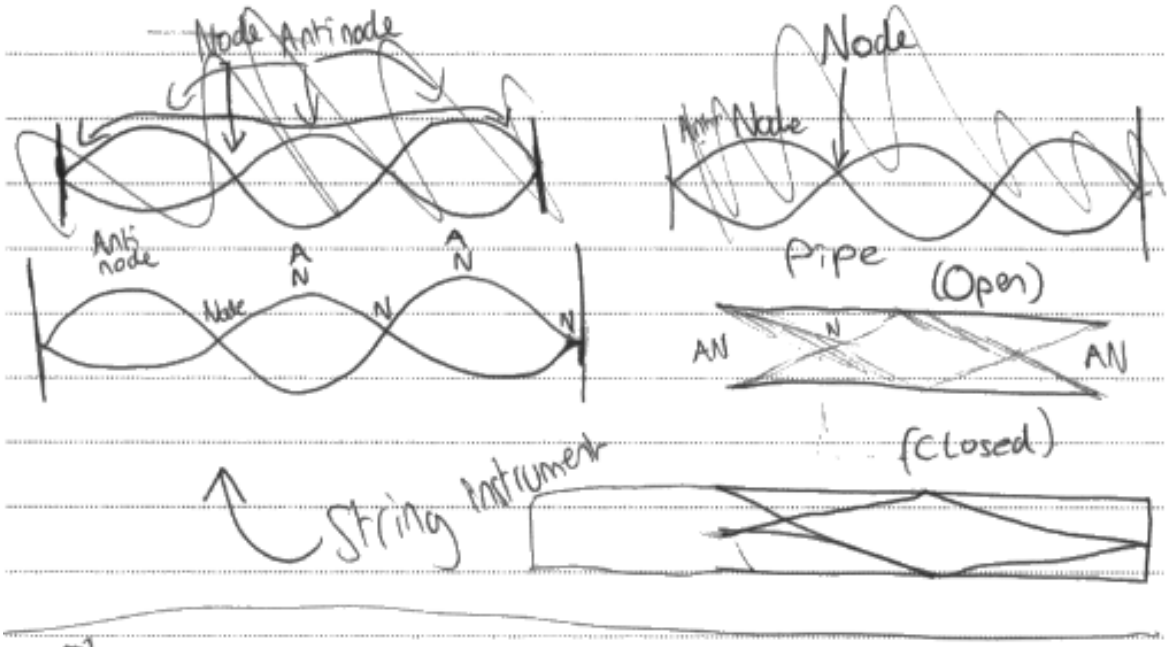
**(Total for Question 5 = 6 marks)**

The response below is Level3, 6 marks

This response shows a comprehensive knowledge of waves on strings and in pipes. Lines of argument are consistently supported throughout. The comparison shows a logical chain of reasoning. There is a similarity because they both oscillate and a correct difference between longitudinal and transverse waves. There are also correct diagrams showing waves in strings and pipes with nodes and antinodes indicated correctly. There is also detail of waves on a string giving the correct relationship, 'high tension, high frequency.

You may use diagrams to support your answer.

(6)




String instruments rely on things such as string tension and weight to increase frequency (high tension high frequency) Whereas in pipe instruments if the pipe is open the wave will come out as an antinode but if closed it will come out as a node which produces different sounds. String instruments als work with transverse waves as the waves oscillate perpendicularly ~~to~~ there's pipe instruments involve Longitudind waves which oscillate parallel perpendicular