L3 Lead Examiner Report 1806

BTEC

June 2018

Level 3 National in Applied Science Unit 1: Principles and Applications of Science I (31617H)

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August 2018
Publications Code 31617H_1806_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

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	10	21	40	59

Introduction to the Overall Performance of the Unit

Biology

It was clear that learners had made use of the Sample Assessment Material and previous papers as an improvement in exam technique and knowledge was seen in this series. However, centres still need to ensure that learners are fully prepared for the exam, especially in relation to reading the question carefully, giving on topic responses and not repeating the stem of the question in their response, as credit cannot be given for this. Key definitions, such as the definition of the term *eukaryotic*, the conversion between units and the explanation for the adaptations of the red blood cell were not fully developed. The leaners' familiarity with the structure and function of plasmids was very weak. Only the higher scoring learners were able to apply their scientific knowledge and make connections, particularly in questions 4b and 4c. Learners should also be taught to re-read their responses 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.

Chemistry

This was the third sitting of the Level 3 Applied Acience Unit 1 chemistry section. However, this was the first time that the paper had been sat at a separate time to the biology and physics sections, which enabled learners to focus their attention on the chemistry only, as a result fewer blanks across the paper were seen. Learners that did well, were able to apply their knowledge of chemistry to new situations, use scientific vocabulary and conventions when writing formula and balancing equations. Those that did less well, often did not read the question carefully and often repeated the stem of the question as their answer.

Physics

For the first time, the Waves and Communication section of the Applied Science Unit 1 paper was presented as a separate paper. This allowed learners to approach the paper with a fresh perspective and to concentrate solely on physics topics throughout the examination. However, the theory of how a diffraction grating gives an emission spectrum of a gas, showing each of the wavelengths of light produced by the gas as individual spectral lines, was not generally understood sufficiently well for learners to produce a satisfactory explanation. The concepts of superposition, path difference, phase difference and coherence of waves were rarely linked correctly to wavelength or frequency. Learners must also take note of the command words used for a question. A question that requires an explanation will not get full marks if only a description is given or a number of statements are made.

The ability of learners to successfully use mathematical expressions correctly has improved although learners still need to have more practice at rearrangement of equations and must know how to deal with a square root, sin and sin-1. Learners also need to be able to round answers correctly and appreciate that rounding to one decimal place in the first line of a calculation may lead to a final answer which is not within the tolerance allowed. Generally, learners were able to select the correct equation to use for a calculation but some were unable to substitute correctly because the meaning of the symbols used in the equations was not known.

Individual Questions – Biology

Question 1a

This question was well-answered as examples of a membrane bound organelle were an accepted alternative to the main marking point. Most of the learners gained their mark for mentioning the presence of a nucleus.

This response scored 1 mark.

(a) State what is meant by the term **eukaryotic**.

(1)

~~[illegible]~~ cell with one single ~~[illegible]~~ nucleus

Those learners that answered incorrectly either provided too vague a response, such as “plant or animal cell”, or confused eukaryotic with prokaryotic and described bacteria or viruses and said does not contain a membrane-bound nucleus.

This response scored 0 marks.

(a) State what is meant by the term **eukaryotic**.

(1)

plant and animal cells

Question 1b

This was a multiple- choice question.

Most learners were able to correctly identify the organelle present in both plant and animal cells.

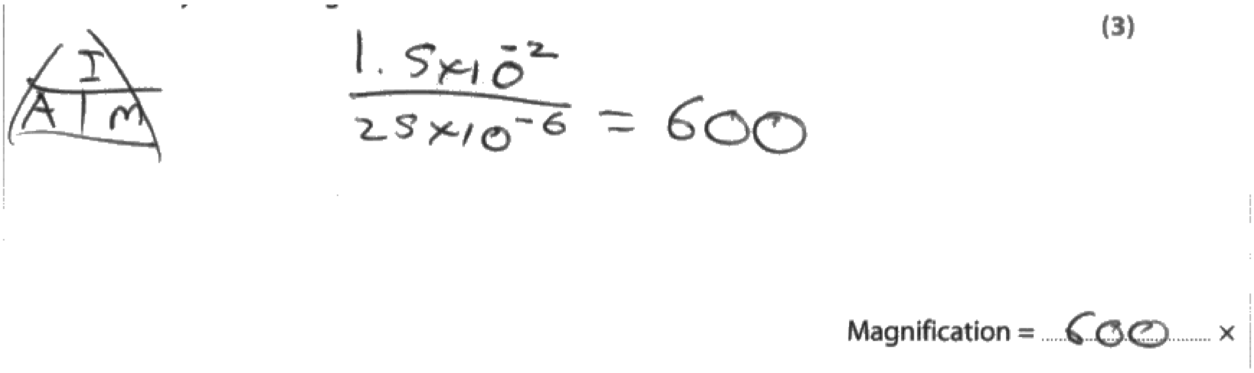
This response scored 1 mark.

- ☐ **A** cell wall
- ☐ **B** 70S ribosomes
- ☒ **C** mitochondria
- ☐ **D** tonoplast

Question 1c

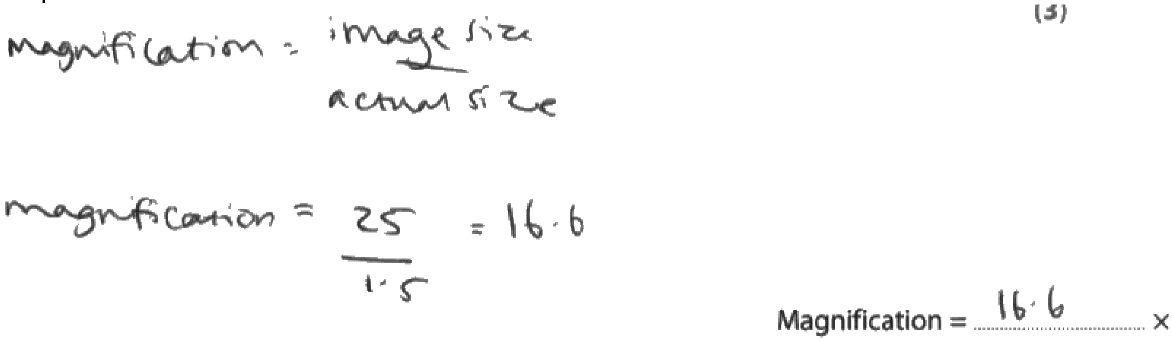
Most learners scored three marks for the correct answer or two marks for the answer with a power of ten error, due to an incorrect conversion between units.

This response scored 3 marks.



The most common errors seen related to incorrect substitutions or confusing whether the numbers should be multiplied or divided.

This response scored 0 marks.



Question 2a

This was a multiple-choice question.

Only some learners were able to correctly identify the capsule. Most learners attempted the question and should be encouraged to give a response for multiple choice questions as they are not negatively marked if an incorrect response is given.

This response scored 1 mark for correctly identifying the capsule.

- ☒ **A**
- ☐ **B**
- ☐ **C**
- ☐ **D**

Question 2b

In general learners tended to score poorly on this question. Credit-worthy responses almost exclusively earned their mark for mentioning extra or beneficial DNA, with some giving named examples.

This response scored 1 mark.

Function one contain extra genes which are used for antibiotic resistance.

Function two ~~they figth pathogens~~ they control what comes in and out ~~of~~ ~~t~~ the cell

A failure to mention that the DNA was 'extra' led to a significant number of learners missing out on the mark and a lot of responses incorrectly described protein synthesis. The transfer of DNA or a vector in genetic engineering were very rarely seen as responses.

This response scored 0 marks.

Function one Make proteins.

Function two Carry genetic information/control cell's function.

Question 2c

This was a multiple-choice question.
Very few learners correctly identified the row which showed the correct cell wall structure of Gram-negative bacteria.

This response scored 1 mark as row B stated a thin peptidoglycan layer and an outer membrane.

☐ **A** 1

☒ **B** 2

☐ **C** 3

☐ **D** 4

Question 3ai

Most learners correctly said one or both of the correct responses, Actin and Myosin.

This response scored 2 marks.

Actin and myosin

A number incorrectly answered with mylin, myolin, myoglobin, sarcolemma, axon, actone filament, sarcomere.

This response scored 1 mark for myosine as phenetic spellings were accepted.

myosine & acetone

Question 3aii

Few learners gave the correct response. Phenetic spellings were accepted.

This response scored 1 mark.

Sarcolema

Some approached this question like a comprehension and selected a word from the labelled diagram. Some learners attempted to name the cell surface membrane of the skeletal muscle cell.

This response scored 0 marks.

Saccrplamic recticulum

Question 3b

The majority of learners scored well on this question, often scoring a maximum of 2 marks. Learners demonstrated a good understanding of the concepts involved, with most able give glycogen as a source of energy and linking this to contraction or movement. There were also a high proportion who gave aerobic or anaerobic respiration as well.

This response scored 2 marks.

glycogen is used to provide glucose for respiration to provide energy for the muscle in order to aid contractions

A common misconception was that energy was used for respiration. The use of glucose was sometimes missing. Some referred to glycogen as a lipid. Storing/ transporting oxygen or for bones to move were also common errors.

This response scored 0 marks.

It provides oxygen which encourages diffusion to occur all around the body.

Question 3c

This question was answered well by most learners.

This response scored 3 marks.

Mitochondria allows energy to be released. the more mitochondria present, the longer the marathon runner can run for because they will have more energy. This energy is provided by aerobic respiration which means the marathon runners need more oxygen. This means the muscles don't tire easily

(Total for Question 3 = 8 marks)

Some preferred to answer in the converse, and still gained the marks.

Some learners were confused over aerobic respiration and this led to quite a few saying that mitochondria provide oxygen needed for muscle contraction. Also, a common misconception was that energy was produced for respiration rather than respiration producing the energy.

Many mentioned slow release of energy, instead of more and seemed to be confused with fast and slow contractions.

The most common errors included referring to the athlete fatiguing rather than the muscles/fibres, stating ‘respiration’ unqualified, not emphasising ‘more’ ATP/energy and giving 'can run for longer' without indication of no fatigue, reiterating the question.

This response scored 0 marks.

By having more mitocnondria in their muscus it auows for respiration of the Ceus to take place so they can function efficiently ~~efficiently~~, and it alles the production ~~produce~~ of ATP to take place to ensure energy is produced throughout the marathon.

Question 4a

A number of learners incorrectly named region X as the synapse, rather than the synaptic cleft. A number of learners described region X as the synaptic gap.

This response scored 1 mark.

Synaptic Cleft

Question 4b

This question was poorly answered.

This response scored 2 marks.

A neurotransmitter ~~is ret~~ (serotonin) is released from the axon of the primary neurone. The serotonin receptors on the secondary neurone's dendrite's then recieve the impulse via the neurotransmitter that has diffused across the synapse.

The learners’ responses tended to lack detail and did not differentiate between the pre and post synaptic neuron. Most learners mentioned receptors, but some had confusion as to what they are for with many describing them as magnets. There was a lot of confusion about the role of the vesicles, with learners describing the vesicle moving off the neurone and then coming back.

This response scores 0 marks. The learner has incorrectly stated that the neurotransmitter is stored, without reference to release. They have then said the vesicles transport the impulse, which is also incorrect. Their idea of the impulse over to the receptor is too vague.

The neurotransmitter is temporarly stored in the vesicle at the end op the synaptic bulb. The vesicles then transport the impulse over to the serotonin receptor. The vesicles cannot travel back and hence only go in such direction

Several learners attempted to give a response from the previous series and so referred to dopamine. Some talked about the various ion channels opening and closing. Others talked about one end being positive and the other negative. Of the few who referred to 'diffusion', many went on to incorrectly define as movement from a low to high concentration.

Question 4c

Most learners correctly identified the Identification point and linked it to depression/anxiety or feeling happy/good so were awarded 2 marks. Very few learners offered an explanation as to why the change in mood happens with reference to receptors or impulses, so this shows that they are not correctly interpreting the command verbs. Some learners understood less neurotransmitter across the synapse. However, many did not commit to either increased or decreased level of serotonin.

This response scored 1 mark.

An imbalance in serotonin means the connection across a synaptic cleft cannot be correctly created so signals either cannot pass across or will struggle to pass. This means the recieved signal will be none existant or incomplete so the response to the signal will not be as intended, this could mean that signals that are sent to initiate a certain mood will not be correct, resulting in an affected mood.

The use of the description 'happy drug/ hormone' was very common.
Learners tended to go off track with this question and discuss the use of drugs generally or specifically to control the amount of serotonin. This was often linked to an addiction to drugs. Some talked about the types of medication that was used to treat a lack of serotonin as well as the effects of MDMA.

The stronger candidates were usually scoring 3 marks by referring to fewer receptors on postsynaptic neurone are stimulated. Learners tended to omit that therefore there would be fewer impulses in the brain.

This response scored 3 marks.

Without serotonin the body will not be able to transport signals from one side of the synapse to the other, therefore mood will be lowered and depression can be caused. This is because the serotonin is absorbed. However too high levels can make the person mood too excited.

Some learners made incorrect references to the myelin sheath, Nodes of Ranvier and the jumping of the impulse. There were also lots of accounts about dopamine and Parkinson's Disease.

Question 5
Most learners were able to describe structural adaptations and demonstrated some knowledge of the topic but were unable to provide a well-structured answer with supported lines of reasoning. The reasoning was often mismatched or incorrect when present.
The most common structure mentioned were the biconcave shape but with many

stating concave shape, disc shape, flat disc with divots. It was very common to see increased surface being attributed to the biconcave shape, rather than increased surface area to volume ratio. The ratio, when used, was often the wrong way around. Another common known adaptation was the absence of a nucleus. Some then added the line of reasoning that this increased surface area allowing it to hold more oxygen and/or haemoglobin.

This response scored 4 marks.

Red blood cells have a biconcave
shape that allows them to travel
through narrow cappilaries and vessels
in order to reach places quickly. Red
blood cells also have no necleus
in order ~~[illegible]~~
to carry more hemaglobin
around the body. As well as that
red blood cells increase their
surface area to vol ratio in order
to carry as much oxygen around
the body as possible. ~~[illegible]~~ Red blood
cells are also very flexiable that
allows them to travel quickly and
again, squeeze through narrow gaps,

Few other adaptations were given. There were many references to red blood cells being able to squeeze through small gaps in the capillary walls, confusing them with white blood cells.

This response scored 1 mark.

Red blood cells have a biconcave shape which means that they have a large surface area. They can carry and transport lots of oxygen.

Firstly they travel to the lungs to absorb the oxygen then back to the heart (once oxygenated) to then transport the oxygen around your entire body.

Some learners incorrectly suggested that red blood cells contained white blood cells, divided fast- sometimes after saying they had no nucleus, they diffused through the capillary, had a cell wall one cell thick or that they lots of mitochondria. Some learners described the journey of a red blood cell through the lungs/alveoli and some reiterated what was in the question line or stem. Red blood cells were also often referred to as smooth and therefore able to flow.

Individual Questions – Chemistry

Question 1a(i) A good proportion of learners were able to state that a covalent bond meant that electrons were shared. Few knew that a shared pair were involved but were still able to gain credit for the understanding that electrons were shared.

Very few learners could take this further and show an understanding that the bond involved the electrostatic attraction between the nuclei of the atoms and the electrons.

As in the example below which scored just 1 mark.

1 Hydrocarbons are molecules which are made of hydrogen and carbon only.

The bonding between atoms of hydrogen and carbon is covalent.

(a) (i) State what is meant by the term **covalent bond**.

(2)

bond with strong electrostatic forces where electrons are shared

In this case the learner scored both marks for the good level 3 description of a covalent bond.

1 Hydrocarbons are molecules which are made of hydrogen and carbon only.

The bonding between atoms of hydrogen and carbon is covalent.

(a) (i) State what is meant by the term **covalent bond**.

(2)

A strong electrostatic attraction between the nucleus of an atom and the shared pair of electrons.

In some cases, learners seemed confused between ionic and covalent bonding and talked about losing and gaining electrons or formation of ions. In these cases, the learner scored no marks.

1 Hydrocarbons are molecules which are made of hydrogen and carbon only.

The bonding between atoms of hydrogen and carbon is covalent.

(a) (i) State what is meant by the term **covalent bond**.

(2)

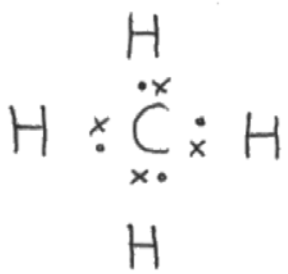
where an elecron is lost (carbon) and
an arion is added to the other molecule
Sharing an elecron

Question 1a(ii) A good proportion were able to draw the dot and cross diagram for a molecule of methane to score both of the available marks.

As in this example, some learners drew their diagrams with no circles to represent the orbits, this is perfectly acceptable and gained both marks.

(ii) Methane is a hydrocarbon and has the molecular formula CH_4.

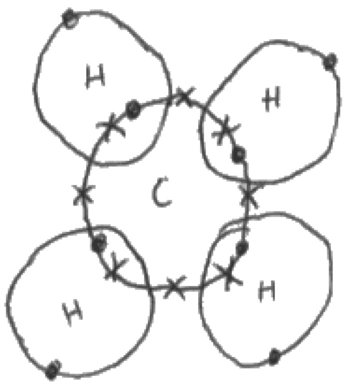
Draw a dot-and-cross diagram for a molecule of methane.
Show outer electrons only.



In some cases, learners were able to draw the correct pairs of electrons between the hydrogen and carbon atoms, but also included an extra electron on the hydrogen therefore making the ‘rest of the molecule’ incorrect and not gaining the second mark.

(ii) Methane is a hydrocarbon and has the molecular formula CH_4.

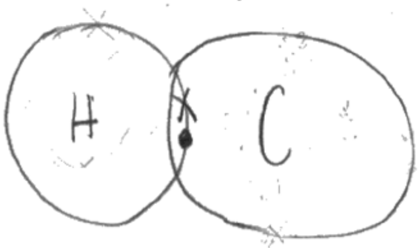
Draw a dot-and-cross diagram for a molecule of methane.
Show outer electrons only.



Some learners knew that a carbon atom and a hydrogen atom share one pair of electrons, this scored 1 mark.

(ii) Methane is a hydrocarbon and has the molecular formula CH_4.

Draw a dot-and-cross diagram for a molecule of methane.
Show outer electrons only.



In **question 1b**, many learners were able to score 1 mark on this question for stating that methane has a low melting point. However, few were able to take this further to explain why the melting point is so low.

Learners seemed confused between covalent, and in some cases ionic, bonding and Van der Waals forces.

Where Van der Waals forces were understood, learners often went on to score full credit. London forces or induced dipole interactions for Van der Waals were accepted throughout.

There were however, a significant proportion that thought that the melting point was high, therefore giving the reverse argument that the bonds were weak. These arguments did not score credit. As in this example.

(b) The melting point of methane is –182 °C.

Explain, in terms of intermolecular forces, the melting point of methane.

(3)

it has a high melting point because it is a melt so it has a strong meltic bond. The stronger the bond the higher the melting point because it needs more energy to break the bond. Intermole force are the bond between the electrons and protons as protons allow electrons to move freely (sea electrons) by being attracted to it.

(Total for Question 1 = 7 marks)

In this example, the learner scored 2 marks 2 marks, 1 for stating that the low melting point is low. The learner talks about weak intermolecular forces **within** the molecule which is wrong and cannot score, although they do state that it does not require large amount of energy to break the intermolecular forces, so a second mark was awarded.

(b) The melting point of methane is –182 °C.

Explain, in terms of intermolecular forces, the melting point of methane.

(3)

Methane has a low melting point. This is due to the factor that there is are weaker intermolecular forces within the molecule. Therefore these forces are easier to break apart as they do not require large amounts of energy to break but infact require less energy.

(Total for Question 1 = 7 marks)

This example of a good response scored full marks.

(b) The melting point of methane is −182 °C.

Explain, in terms of intermolecular forces, the melting point of methane.

(3)

methane has a low melting point due to its intermolecular forces, Methane has weak intermolecular forces because the forces between the molecules are van - der - vall forces which are the weakest intermolecular force.

(Total for Question 1 = 7 marks)

Part (a) of question 2 was generally well answered with many learners being able to give the correct subshells and correct number of electrons in these shells to gain both marks available.

This example gained both marks.

2 (a) A phosphorus atom contains 15 electrons.

Complete the electronic configuration for a phosphorus atom.

10 12

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$

In some cases, learners were able to give the correct subshells 3s and 3p to gain one mark, but were not able to give the correct number of electrons in these shells.

2 (a) A phosphorus atom contains 15 electrons.

Complete the electronic configuration for a phosphorus atom.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$

In others, the learner gave the incorrect subshells and lost the first mark, but gained the second mark for being able to give the correct arrangement of electrons.

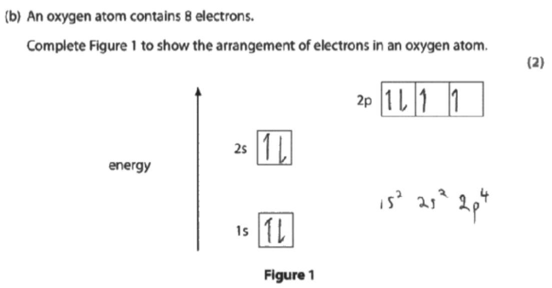
2 (a) A phosphorus atom contains 15 electrons.

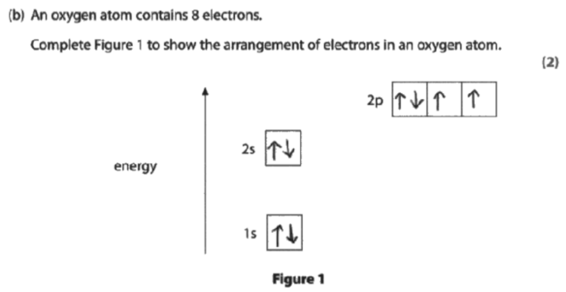
Complete the electronic configuration for a phosphorus atom.

$1s^2$ $2s^2$ $2p^6$ $3p^2$ $4p^3$

It was pleasing to see many correct answers to this question that scored the full two marks available.

Some learners used full arrows and some half arrows, both were accepted as in these examples, both gained full marks.





In some cases, learners gave just the number of electrons as a number. These learners were given credit for understanding how many electrons should be present but were not able to get the second mark for showing the direction of spin on the electrons.

(b) An oxygen atom contains 8 electrons.

Complete Figure 1 to show the arrangement of electrons in an oxygen atom.

(2)

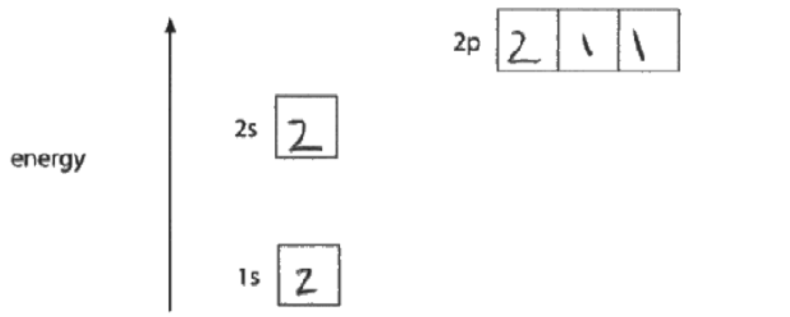


Figure 1

Learners should be taught to draw arrows (full or half) to represent electrons in these types of diagrams so they can show their understanding of electron spin.

Learners did not do so well in part a of question 3. A large proportion of learners were able to give one product, either the calcium sulfate or the hydrogen but few gave both to score the two marks available.

This good example scored the two marks.

3 Calcium is a metal.

Word equations for two reactions of calcium are shown.

calcium + oxygen → calcium oxide

calcium + hydrochloric acid → calcium chloride + hydrogen

(a) Complete the word equation for the reaction of calcium with sulfuric acid.

(2)

calcium + sulfuric acid → calcium sulfate + hydrogen

In some cases, learners confused sulfate with sulfide or sulfur and therefore did not get the mark for the calcium sulfate.

3 Calcium is a metal.

Word equations for two reactions of calcium are shown.

calcium + oxygen → calcium oxide

calcium + hydrochloric acid → calcium chloride + hydrogen

(a) Complete the word equation for the reaction of calcium with sulfuric acid.

(2)

calcium + sulfuric acid → Calcium sulfide + hydrogen

There were many cases where learners gave answers that included elements not present in the reactants, such as carbon dioxide.

3 Calcium is a metal.

Word equations for two reactions of calcium are shown.

calcium + oxygen → calcium oxide

calcium + hydrochloric acid → calcium chloride + hydrogen

(a) Complete the word equation for the reaction of calcium with sulfuric acid.

(2)

calcium + sulfuric acid → Calcium sulphate + Carbon dioxide

Learners should be taught to predict the products of reactions detailed in the specification with the understanding that the elements present in the reactants should be present in the products.

Learners found writing the balanced equation for the reaction of calcium with oxygen, in **part b of question 3**, difficult.

A common error was not writing oxygen as a diatomic molecule. This meant that the formulae were incorrect and therefore the balancing mark could not be scored.

(b) Write the balanced equation for the reaction of calcium, Ca, with oxygen. **(2)**

$2Ca + 2O \rightarrow 2CaO$

In the same manner, some learners were not able to give the correct formula for the calcium oxide and therefore the balancing mark could not be scored and no marks were scored.

(b) Write the balanced equation for the reaction of calcium, Ca, with oxygen. **(2)**

$Ca + O_2 \rightarrow CaO_2$

Some learners were able to write the formulae of the substances in the reaction but were not able to balance them and so therefore scored just 1 mark.

(b) Write the balanced equation for the reaction of calcium, Ca, with oxygen. **(2)**

$Ca + O_2 \rightarrow CaO$

This good example scored both available marks.

(b) Write the balanced equation for the reaction of calcium, Ca, with oxygen. **(2)**

$2Ca + O_2 \rightarrow 2CaO$

In **question 3c**, although many learners found calculating the maximum of calcium chloride formed in the reaction quite difficult, it was pleasing to see that a good proportion scored full marks on this question.

Of those that did not score full marks, many were able to calculate the number of moles of calcium but few were able to take it further so scored just 1 mark.

Learners used other methods to calculate the mass of calcium chloride formed which were accepted.

In this example the learner scored the full three marks available for calculating the number of moles of calcium, then the mass of calcium chloride and then evaluating their answer correctly.

(c) The equation for the reaction of dilute hydrochloric acid with calcium is

$$Ca + 2HCl \rightarrow CaCl_2 + H_2$$

Calculate the maximum mass of calcium chloride produced by reacting 8.02 grams of calcium with excess hydrochloric acid.

relative atomic mass: Ca = 40.1
relative formula mass: $CaCl_2$ = 111.1

Show your working.

(3)

(ration 1 : 1)

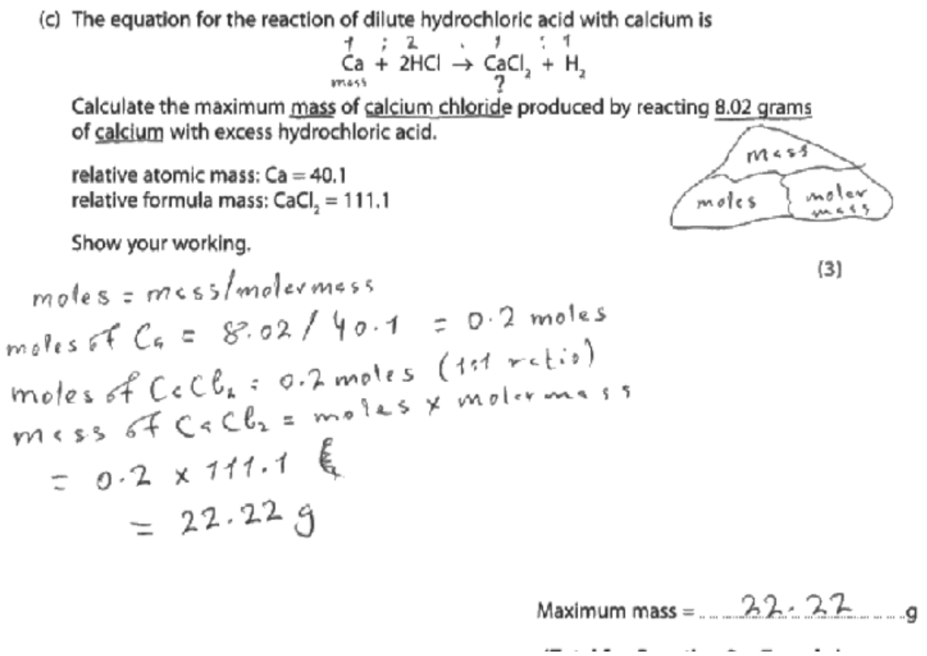
Ca $CaCl_2$

×0.2 (40.1   111.1) ×0.2

8.02   22.22

Maximum mass = 22.22 g

This learner also gained the full three marks.



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Calculate the maximum mass of calcium chloride produced by reacting 8.02 grams of calcium with excess hydrochloric acid.

relative atomic mass: Ca = 40.1
relative formula mass: $CaCl_2$ = 111.1

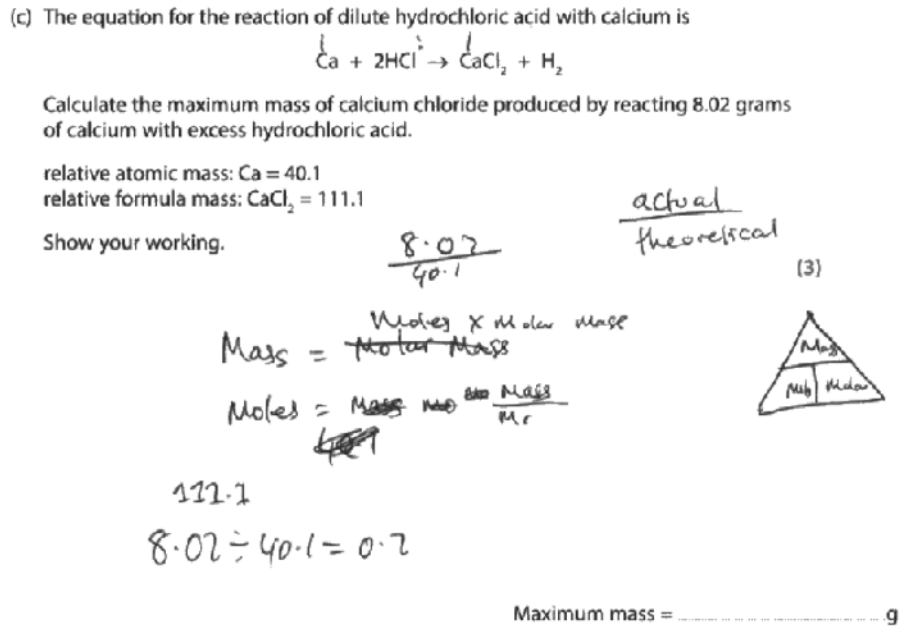
Show your working.

(3)

moles = mass/molermass
moles of Ca = 8.02 / 40.1 = 0.2 moles
moles of CaCl₂ : 0.2 moles (1:1 ratio)
mass of CaCl₂ = moles x molermass
= 0.2 x 111.1
= 22.22 g

Maximum mass = 22.22 g

In this example, the learner has calculated the number of moles but has not taken this further so gained just 1 mark.



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Calculate the maximum mass of calcium chloride produced by reacting 8.02 grams of calcium with excess hydrochloric acid.

relative atomic mass: Ca = 40.1
relative formula mass: $CaCl_2$ = 111.1

Show your working.

(3)

actual / theoretical

8.02 / 40.1

Mass = Moles x Molar Mass

Moles = Mass / Mr

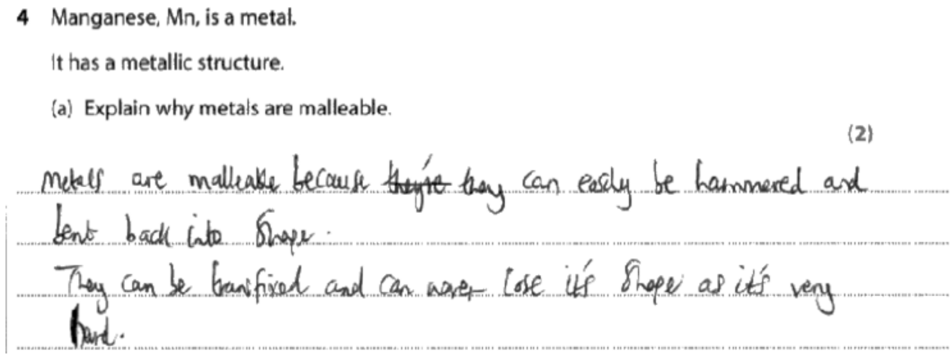
111.1

8.02 ÷ 40.1 = 0.2

Maximum mass = ... g

In **question 4 (a)** Learners found it difficult to more difficult to explain the malleability of metals than they have in previous paper explaining other properties.

Many misread the question and explained what is meant by the term malleable rather than why metals are malleable as in this example that scored 0 marks.


4 Manganese, Mn, is a metal.

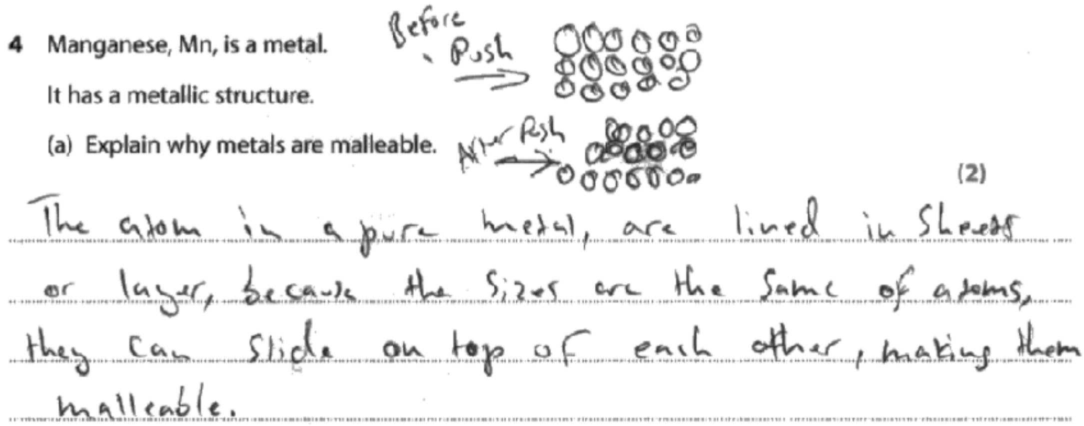
It has a metallic structure.

(a) Explain why metals are malleable.

(2)

metals are malleable because ~~they're~~ they can easily be hammered and bent back into shape.
They can be transfixed and can never lose it's shape as it's very hard.

This example gained two marks 2 marks. The learner scored both marks in the description. Although not needed in this example, labelled diagrams were also allowed to gain credit.



4 Manganese, Mn, is a metal.

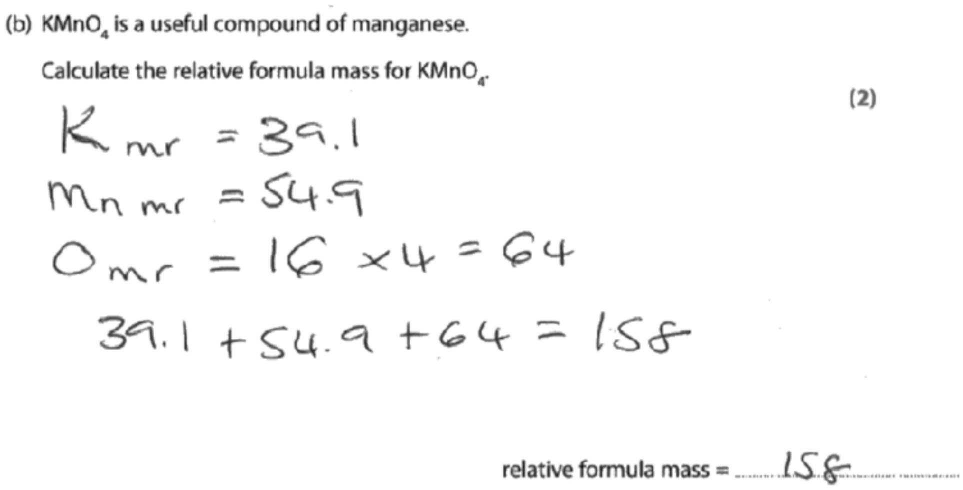
It has a metallic structure.

(a) Explain why metals are malleable.

(2)

The atom in a pure metal, are lined in sheets or layer, because the sizes are the same of atoms, they can slide on top of each other, making them malleable.

The majority of learners were able to calculate the relative formula mass in **question 4b** to gain both marks as in this example.



(b) $KMnO_4$ is a useful compound of manganese.

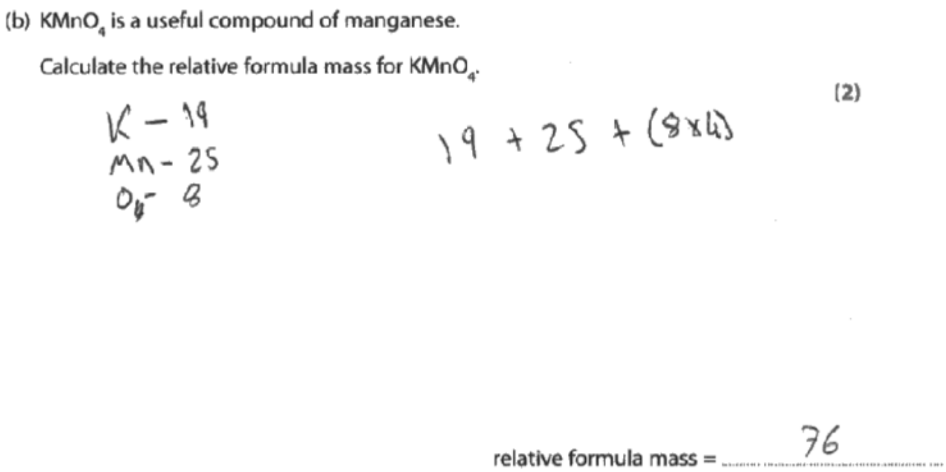
Calculate the relative formula mass for $KMnO_4$.

(2)

K mr = 39.1
Mn mr = 54.9
O mr = 16 x4 = 64
39.1 + 54.9 + 64 = 158

relative formula mass = 158

In some cases, learners used the atomic number rather than the atomic mass and scored just 1 mark.



(b) $KMnO_4$ is a useful compound of manganese.

Calculate the relative formula mass for $KMnO_4$.

(2)

K – 19
Mn – 25
O4 – 8

19 + 25 + (8x4)

relative formula mass = 76

Where learners did not score, it was often as they were not familiar with the elements in the compound and thought that the 'n' related to nitrogen and so included the mass of nitrogen in their calculation and therefore gained no credit.

(b) $KMnO_4$ is a useful compound of manganese.

Calculate the relative formula mass for $KMnO_4$.

(2)

$KmnO_4$

K = 39·1

M = 24·3

n = 14·0

O = 4 × 16 = 64

141·4

relative formula mass = 141·4

In general, learners found **question 4**, the six mark extended question difficult, but many scored some credit.

Many learners were able to discuss why manganese is classified as a transition metal, but zinc is not using the information in the table along with their knowledge of the transition metals and electronic configuration.

Learners that scored in level 1 generally used the information in the table to discuss that manganese is a transition metal because it has more common oxidation states where as zinc has just one. At level 2, learners expanded on this and often discussed the fact that manganese has an incomplete d subshell and is therefore able to form different oxidation states.

Level 3 learners gave a good discussion including ideas about variable oxidation states, incomplete d subshells and referred to the properties of the transition metals.

This example scored level 3 – 6 marks.
the learner has given a good discussion which goes above and beyond what would be required for 6 marks.

X1 Manganese and zinc are both metals in the d block of the periodic table.

Table 1 shows some information about manganese and zinc.

metal	short electronic configuration	common oxidation states
manganese	[Ar] $3d^5\,4s^2$	+2, +4, +7
zinc	[Ar] $3d^{10}\,4s^2$	+2

Table 1

Discuss why manganese is classified as a transition metal, but zinc is not.

(6)

Transition metals are metals that are able to form stable ions ~~with~~ when they lose electrons from their 4s orbital but will have partially filled d orbital.

Therefore, when zinc loses electrons (+2) from its 4s orbital, it forms a fully filled 3d ~~orbi~~ orbital ($3d^{10}$) and this does not make zinc a transition metal. On the other hand, manganese will have partial filled 3d orbital ($3d^5$) when it loses electrons from its 4s ~~orb~~ orbital and thus makes it a transition metal.

Also, zinc is not a transition metal because it is unable to ~~f~~ have variable oxidation states, unlike ~~Unlike manganese as mangese~~ manganese which can have oxidation states +2, +4, ~~+7~~ and +7. This is because when zinc loses electrons from its 4s shell, it will have a fully filled electron configuration and thus will not need to lose any more electrons and that is why it has an oxidation state of only +2. Manganese can lose more electrons from its 3d shell after electrons have been taken from the 4s shell and that is why it has ~~very~~ many oxidation states.

Moreover manganese is a transition metal because it is able to form coloured ~~compo~~ compounds ~~which~~ whilst zinc on the other hand remains colourless when it forms compounds ~~wh~~ with other elements.

Lastly, zinc is not a transition metal because it ~~is~~ cannot form complex ions. Manganese can form many complex ions because it has ~~a~~ a lot of oxidation states allowing it to bond with many different compounds to form the complex ions.

(Total for Question 4 = 10 marks)

TOTAL FOR PAPER = 30 MARKS

In the next example, the learner scored level 2 - 4 marks.

The learner has stated that manganese does not fill the '3rd' shell but zinc does and that this is a feature of transition metals. This is a linked idea although the learner is a little confused between 3rd and 3d shells so would only just be sufficient for the bottom of level 2. However, they also state that manganese has more common oxidation states so altogether we can award 4 marks at level 2. Incorrect and irrelevant statements are ignored as long as they do not contradict statements that you are crediting.

(c) Manganese and zinc are both metals in the d block of the periodic table.

Table 1 shows some information about manganese and zinc.

metal	short electronic configuration	common oxidation states
manganese	[Ar] $3d^5$ $4s^2$	+2, +4, +7
zinc	[Ar] $3d^{10}$ $4s^2$	+2

Table 1

Discuss why manganese is classified as a transition metal, but zinc is not.

[6]

- Manganese has more common oxidation states, it is ~~more~~ less common than zinc to be oxidised
- Zinc is less likely to be reduced. (reduction, gain electrons, only +2) where as manganese is more likely to go through reduction due to more common oxidation states.
- Manganese also doesn't fill all of the 3rd shell oppose to zinc which does, a feature of transition metals
- Zinc is also not very reactive oppose to manganese which is
- Zinc is

In this example, the learner has stated that manganese has many different oxidation states whereas zinc only has one. these basic facts which form the beginning of a discussion gain 2 marks at level 1.

(c) Manganese and zinc are both metals in the d block of the periodic table.

Table 1 shows some information about manganese and zinc.

metal	short electronic configuration	common oxidation states
manganese	[Ar] $3d^5\ 4s^2$	+2, +4, +7
zinc	[Ar] $3d^{10}\ 4s^2$	+2

Table 1

Discuss why manganese is classified as a transition metal, but zinc is not.

(6)

~~Magne~~ Manganese is classified as a transition metal because it has many oxidation states. This means it more reactive than zinc whereas zinc only ~~has~~ has one oxidation state. A transition metal is metal that is highly reactive ~~as's~~

~~Even though both ~~mage~~ manganese and zinc are both on the same block it doesn't mean~~

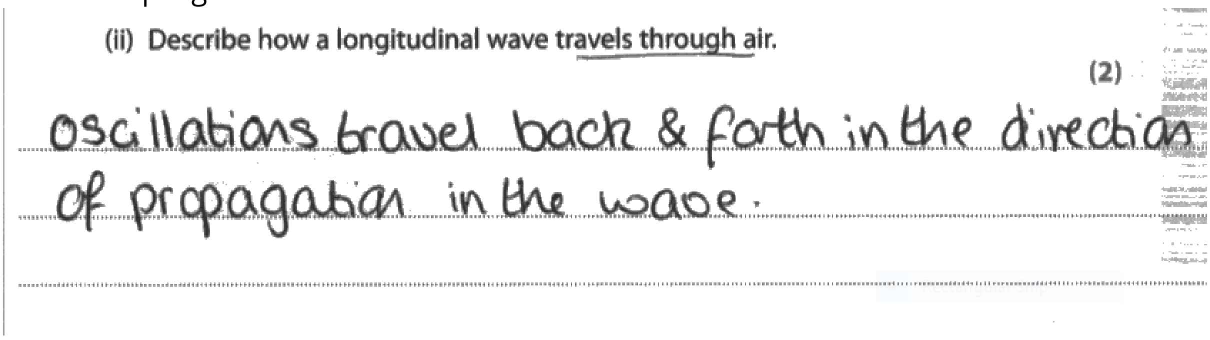
Individual Questions – Physics

Question 1

a(i) The most common correct answer was 'sound'. Although quite a number of learners gave the object that produced the sound e.g. microphone and this did not gain a mark.

a(ii) The question required learners to describe how a longitudinal wave travelled through air. As air was given in the question then the movement of the air particles and /or compressions or rarefactions needed to be included in the answer. Many learners knew that longitudinal waves were 'parallel' but did not mention to what they were parallel to gain the mark

This example gained two marks



(ii) Describe how a longitudinal wave travels through air.

(2)

oscillaions travel back & forth in the directian of propagation in the wave.

b(i) To answer the question learners had to realise that using the graph the time for one wave could be found and the reciprocal of time gives the frequency.

This example gained the mark.

Figure 1 shows a transverse wave.

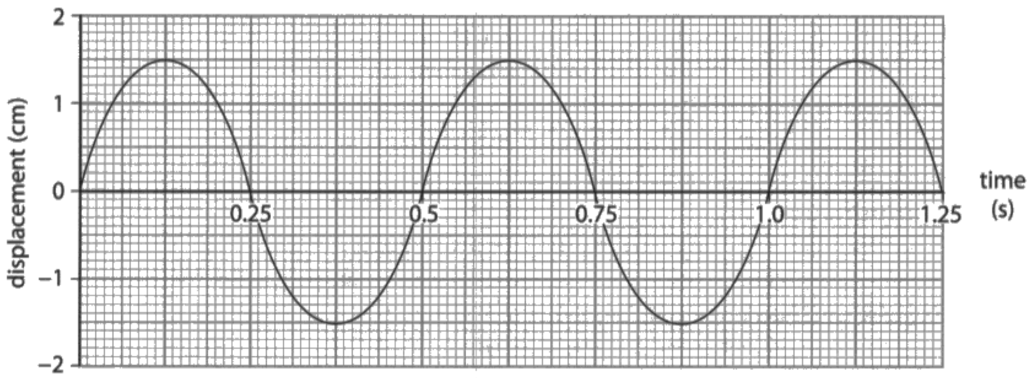


Figure 1

(b) (i) Give the frequency of the wave.

(1)

$f = \frac{1}{T}$ $T = 0.5$

$f = \frac{1}{0.5}$

frequency = 2 Hz

b(ii) about half of the learners recognised B as the correct answer as points in be one wavelength apart.

Question 2

(a) The majority of learners gave either microwaves or radio waves as the correct answer as the height of orbit of the satellite was not specified then both are acceptable.
b The question refers to the advantages and disadvantages of infra red being used to control a television and not for any other use.
b(i) Requires one explanation of an advantage , this therefore needs a description of the advantage with a reason as given in the following example

(b) Television remote controls use infrared radiation to send information.

(i) Explain **one** advantage of using infrared radiation to control a television.

(2)

They have a large frequency so they can carry a lot of information so it is easy to control your television

b(ii) Similarly the second part of the question which requires a disadvantage to be explained.

(ii) Explain **one** disadvantage of using infrared radiation to control a television.

(2)

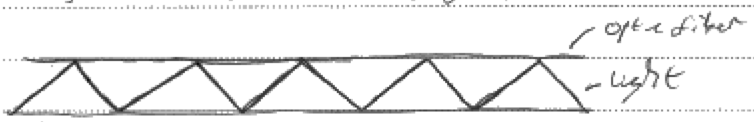
Has to be pointed directly at the tv, so you cannot use it in another room, as it cannot penetrate through the walls

Question3

3a The question indicated with a diagram how an endoscope was used and required learners to explain how the light travelled back through the endoscope to enable the lining of the patient's stomach to be observed. Most learners picked up one mark for knowing that light is reflected at the edge of the fiber but very few were able to link this correctly to the reason. Although light 'bounces back' was allowed as an alternative to light is reflected at this level the correct scientific name for the effect should be used. Total internal reflection (often written as total internal REFRACTION) was frequently mentioned but no reason given. Learners often drew diagrams and could have gained two marks for this if the diagrams had been labelled.
The following example gains one mark from the diagram because it shows multiple reflections. No other marks are awarded because refraction is used instead of reflection.

(4)

It uses total internal refraction



The light refracts back upon itself to send ~~out~~ an image down the fibre.

The example following scores 4 marks form two linked pairs which are underlined. The first relates reflection to the angle to incidence being greater that the critical angle and the second relates total internal reflection to light not escaping from the fibre.

(a) Explain how light travels back through the endoscope so an image of the lining of the patient's stomach can be seen. You may use diagrams to support your answer.

(4)

Endoscopes use optic fibres to be able to see ~~the lining~~ internal organs. Optic fibres are based on the principle of total internal reflection. Optic fibres are made from glass that has a high refractive index. This means light is 'trapped' in the fibre and it reflects the light internally. It does this as ~~it~~ the fibre has a greater angle of incidence than the critical angle. ~~The light~~ Total internal reflection also occurs as the optic fibre is denser and has a higher refractive than its surroundings, meaning light will not escape through the cladding. Only at the ends of the optic fibre.

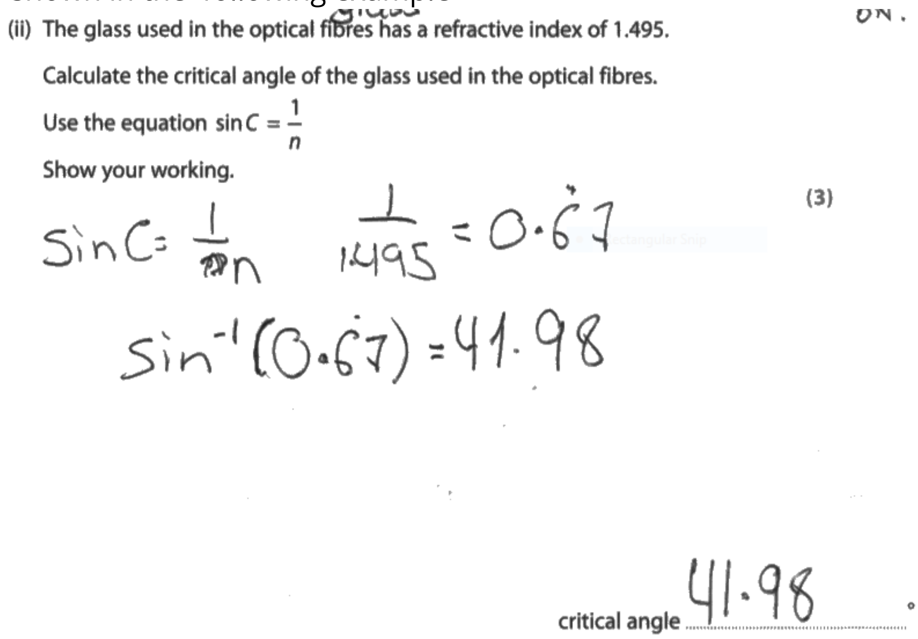
3b(i) As this question was ambiguous then a mark was awarded for the answer 'the light speed reduces' as it does when travelling from air into an optical fibre and also for 'the light speed stays the same' as it does when in the optical fibre. However, many learners thought the light speed increased and did not gain a mark.

3b(ii)

Many more learners can now use their calculators to work out a sin -1 and find an angle although the algebra of the rearrangement of equations using sin still causes problems.

All learners should show substitution into the equation to get one mark this shows that they do recognise the symbol n as the refractive index

. Having done this many calculated 1/1.494 and got the answer 0.6689 this gives the angle C 41.98° which could be rounded to 42°. If 0.6689 is rounded to 0.67 the evaluation is 42.06°. However if 0.6689 is rounded to 0.7 (correct rounding to one decimal place) then the evaluation is 44.42° and this does not round to 42° and does not get the final evaluation mark as it is not the critical angle for glass of refractive index 1.495. Learners must be careful not to use excessive rounding within a calculation as this can give an answer which is outside the acceptable range.
Many more learners can now use their calculators to work out a sin -1 and find an angle as shown in the following example


(ii) The glass used in the optical fibres has a refractive index of 1.495.

Calculate the critical angle of the glass used in the optical fibres.

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

Show your working.

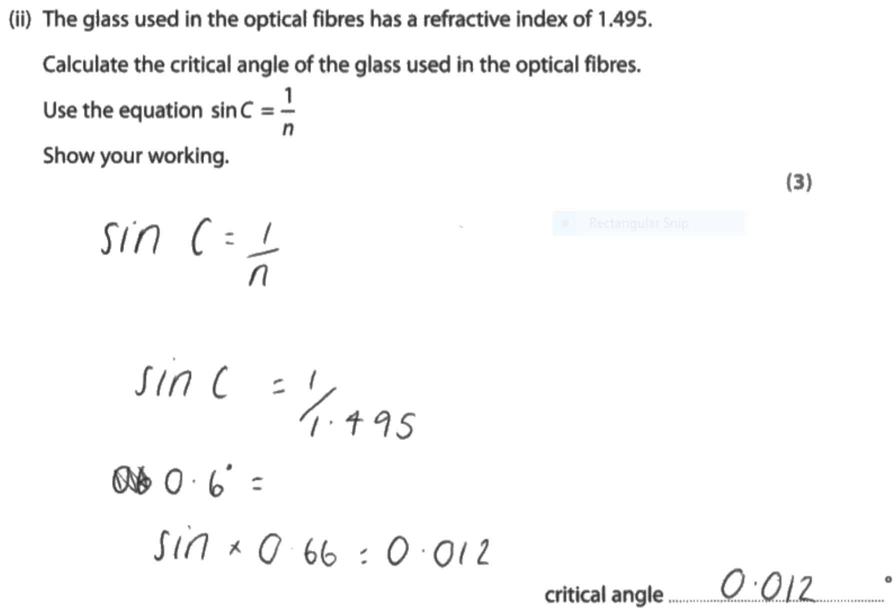
(3)

$\sin C = \frac{1}{n}$ $\frac{1}{1495} = 0.67$

$\sin^{-1}(0.67) = 41.98$

critical angle 41.98 °

However, many learners are still unable to deal with being given the sin of an angle an having to use sin-1on the calculator to determine the angle. As shown in the following example.


(ii) The glass used in the optical fibres has a refractive index of 1.495.

Calculate the critical angle of the glass used in the optical fibres.

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

Show your working.

(3)

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

$\sin C = 1/1.495$

$0.6 =$

$\sin \times 0.66 = 0.012$

critical angle 0.012 °

Question 4
4a The learners were asked to describe what was meant by coherent light waves and

the majority were unable to score one mark on this two mark question. Very few recognised the for waves to be coherent they have to be in phase or have a constant phase difference but some gained for the same frequency or wavelength.

The following example shows a good two mark response.

4 A diffraction experiment makes use of coherent light waves.

(a) Describe what is meant by the term **coherent light waves**.

(2)

coherence is where light waves travel at the same frequencies and are in phase with each other.

They follow the same pattern.

4c This is an extended response question and asks for an explanation of how a diffraction grating can be used to produces dark and light lines of an emission spectrum from the light that comes from a gas discharge tube . The indicative content is split into five sections each considering part of the process which could be given in the explanation. Although a complete explanation would not be expected for learners to achieve Level 3 it is expected that learners would have sufficient knowledge of scientific concepts to produce a logical explanation.

The example following is a Level 1 response the diagram indicates that the learner understands what diffraction is and that a diffraction pattern is produced by passing light through a diffraction grating but there is no mention of constructive and destructive superposition or coherence.

(b) A technician wants to identify the gas in a discharge tube.

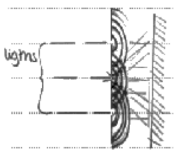
The technician uses a diffraction grating to produce emission spectra for the gas.

Each spectrum consists of a series of light and dark lines on a screen.

Explain how the diffraction grating produces the light and dark lines on the screen. You may draw diagrams to support your answer.

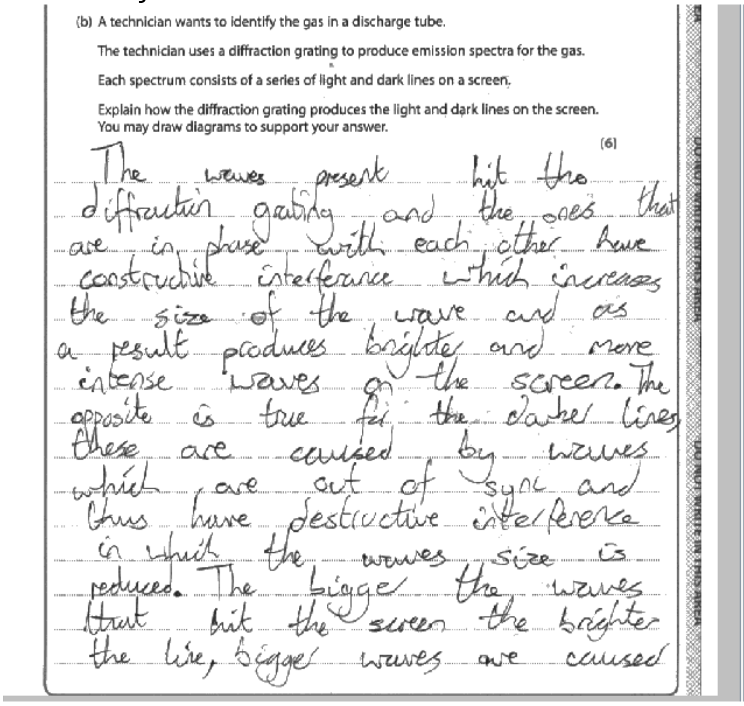
(6)

Diffraction grating a series of waves at each point meets and correspond to emit series of light and dark lines. Dark lines are produced as the ~~waves of the light~~ wavelength of the light decreases.



Each waves meet points and produces rays of light, the middle gap produces more bright light as emission of wave ~~there~~ meet and light waves are sent at different point. When the light travels straight its point will have a ~~lighter~~ brighter light, but as the point of the light ~~away~~ wave travels the frequency decreases ~~and the wavelength~~ ~~...~~ In diffraction grating the light waves travel proportionally.

The example following is representative of a Level 2 response. There is mention of constructive and destructive interference and this is related to bright and dark lines but not fully explained. The learner appreciates that the light has to pass through the diffraction grating and knows that the central lines will be brighter but cannot explain why this is the case



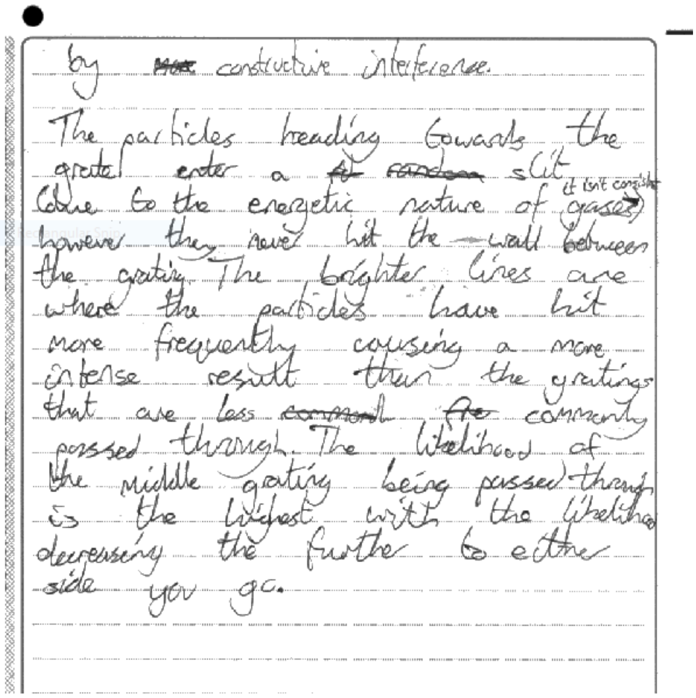
(b) A technician wants to identify the gas in a discharge tube.

The technician uses a diffraction grating to produce emission spectra for the gas.

Each spectrum consists of a series of light and dark lines on a screen.

Explain how the diffraction grating produces the light and dark lines on the screen. You may draw diagrams to support your answer. [6]

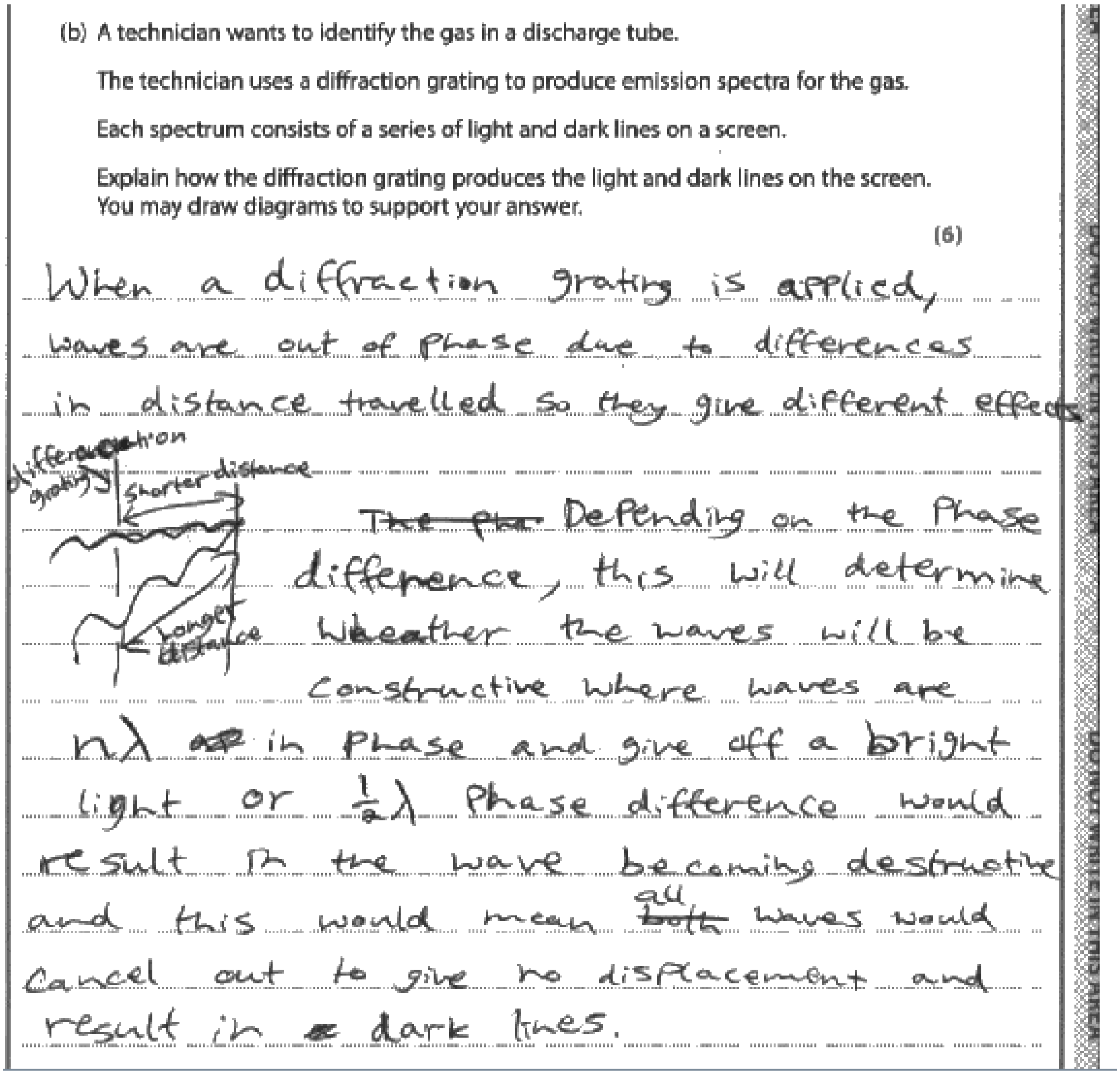
The waves present hit the diffraction grating and the ones that are in phase with each other have constructive interference which increases the size of the wave and as a result produces brighter and more intense waves on the screen. The opposite is true for the darker lines these are caused by waves which are out of sync and thus have destructive interference in which the waves size is reduced. The bigger the waves that hit the screen the brighter the line, bigger waves are caused



by ~~more~~ constructive interference.

The particles heading towards the grate enter a ~~A~~ ~~random~~ slit (it isn't constant) (due to the energetic nature of gases) however they never hit the wall between the grating. The brighter lines are where the particles have hit more frequently causing a more intense result than the gratings that are less ~~commonl~~ ~~Are~~ commonly passed through. The likelihood of the middle grating being passed through is the highest with the likelihood decreasing the further to either side you go.

The example following is representative of work at Level 3. The learner has recognised constructive interference for the bright line and linked this to the correct phase difference and correct number of wavelengths, nλ. This has also been done for the dark line. The diagram although not very clear, is labelled, and does support the learners understanding of how the grating produces the lines. The response shows a comprehensive knowledge and understanding of the topic which is consistently supported by lines of argument.



(b) A technician wants to identify the gas in a discharge tube.

The technician uses a diffraction grating to produce emission spectra for the gas.

Each spectrum consists of a series of light and dark lines on a screen.

Explain how the diffraction grating produces the light and dark lines on the screen.
You may draw diagrams to support your answer.

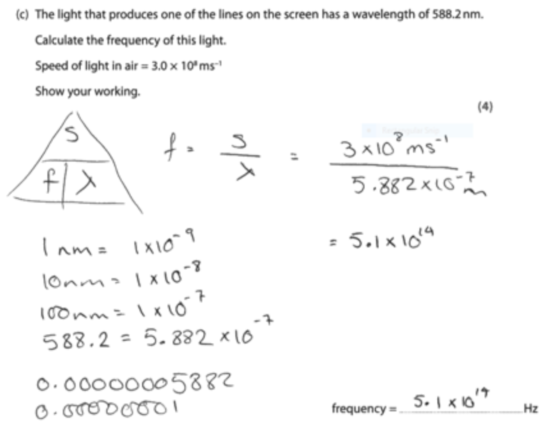
(6)

When a diffraction grating is applied, waves are out of phase due to differences in distance travelled so they give different effects

~~The pha~~ Depending on the phase difference, this will determine wheather the waves will be constructive where waves are nλ in phase and give off a bright light or $\frac{1}{2}\lambda$ phase difference would result in the wave becoming destructive and this would mean all ~~both~~ waves would cancel out to give no displacement and result in dark lines.

4c The learners had to select the correct equation and be able to rearrange it to find the frequency f. The majority of learners were able to do this but could not deal with the powers of ten. Many learners ignored the nanometres for the wavelength and did not attempt a conversion to metres.

The example which follows shows a rare correct evaluation with nanometre (nm) being converted to metre (m)



(c) The light that produces one of the lines on the screen has a wavelength of 588.2 nm.

Calculate the frequency of this light.

Speed of light in air = $3.0 \times 10^8 \text{ ms}^{-1}$

Show your working.

(4)

$f = \frac{s}{\lambda} = \frac{3 \times 10^8 \text{ ms}^{-1}}{5.882 \times 10^{-7} \text{ m}}$

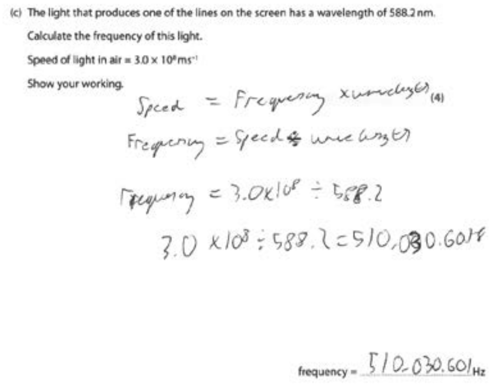
$= 5.1 \times 10^{14}$

1 nm = 1×10^{-9}
10 nm = 1×10^{-8}
100 nm = 1×10^{-7}
588.2 = 5.882×10^{-7}

0.0000005882
0.0000001

frequency = 5.1×10^{14} Hz

 The following example is exemplifies the work of most candidates who either did not arttempt the conversion or did the conversion wrongly and gained 3 marks for having a power of ten error.


(c) The light that produces one of the lines on the screen has a wavelength of 588.2 nm.

Calculate the frequency of this light.

Speed of light in air = $3.0 \times 10^8 ms^{-1}$

Show your working.

(4)

Speed = Frequency x wavelength

Frequency = Speed ÷ wavelength

Frequency = 3.0x10^8 ÷ 588.2

3.0 x10^8 ÷ 588.2 = 510,030.601

frequency = 510.030.601 Hz

To improve in the physics section of the paper learners should:

- Note the command word used for questions
- Link explanations to statements
- Learn the meanings of symbols used in equations
- Always start a calculation by giving the equation to be used
- Learn to use calculators to give values of sin, sin -1 and reciprocals
- Practice unit conversions and learn to use calculators to multiply and divide by positive and negative powers of ten
- Practice rearranging equations.
- Become familiar with the ideas of superposition of waves
- Be able to use ideas of path difference and phase difference for waves.

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