BTEC

L3 Lead Examiner Report 1901

January 2019

L3 Qualification in Applied Science
Unit 5: Principles and Applications of Science II (31627H)

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Grade Boundaries

What is a grade boundary?

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

Setting grade boundaries

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

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

Variations in external assessments

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

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

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

Unit 5: Principles and Applications of Science II

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	16	33	54	76

Introduction to the Overall Performance of the Unit

Biology - Organs and Systems

Many learners were well prepared for the examination and were able to understand the questions and select relevant and appropriate information to give their responses.

A few questions involving recall of learnt definitions or items of factual knowledge were not well answered.
Some of the questions involving application, for example interpreting and using information from diagrams or pictures and applying their knowledge, were better answered.

Learners also showed good ability in interpreting information from a graph and relating it to their knowledge of the circulatory system.
Some learners need more practice at calculating percentage changes and at calculating magnification factor.

Chemistry - Properties and Uses of Substances

Candidates on this component paper generally did well where questions allowed for free response and the ability to express ideas (i.e. Q1b(ii), Q1d, Q3a and Q5). This continues a trend observed over the first two papers for this unit. However, other free response questions, where the marks available totaled 4 or more, demanded a better grasp of terminology and sustained lines of reasoning, which was not shown by many learners (i.e. Q2b, Q4b(iv) and Q5, at the higher level). Greater confidence in demonstrating understanding and literacy in the subject needs to be fostered in candidates.

Calculations on this paper, Q3c and Q3d(i), were often well attempted by candidates, and it was rare for no credit at all to be given. Further practice with energy cycle calculations (where at least one value will need to be reversed) would be beneficial to weaker candidates. Closer attention to units and conversion should also be encouraged so that candidates can maximise their scores.

Equation writing still remains a challenge for many, in spite of this being a fundamental skill in chemistry. Q1(c) provided the product side of the equation, so only the reactants needed to be given – this resulted in a wide variety of answers, few of which were completely correct. Candidates need to be shown how an equation relates to a context or practical situation they are faced with, and more opportunities to practice deducing an equation for a given reaction should be provided.

Multiple choice questions and single word answers proved to divide candidates sharply. Where a stimulus or application was involved, candidates did well (i.e. Q1a – formula of alumina, Q4b(i) – drawing a bromoalkane, Q4b(iii) – naming a bromoalkane). Where specific recall was required, many candidates struggled (i.e. Q1b(i) – cryolite, Q2(a) – draw a catalysed reaction profile diagram, Q3(b) – states of matter and standard conditions, Q4(b)(ii) – propene is an asymmetric alkene). This suggests that closer focus upon revision of key facts is needed.

Physics – Thermal Physics, Materials and Fluids

Learners were able to access most parts of the paper and show achievement in the various topics from the specification tested in this series.

Some calculations were found to be challenging, particularly those requiring taking data from a graph. In general, mathematical ability has improved with evidence that learners can rearrange equations confidently and provide an evaluation. In some calculations learners gave answers that were incorrectly rounded and this can potentially lose marks. The truncation of an answer by ignoring the last decimal figure, rather than rounding it correctly should be explained to learners as not the correct way to give a final answer.

In some questions the instruction in the command line was not fully used by learners. This led to some learners not gaining marks as they were answering a different question to the one asked. This was particularly evident in questions that asked for an explanation.

The paper identified some common misconceptions that learners should be made aware of, typically learners interchanged the words ‘heat’ and ‘temperature’ and ‘force’ and ‘energy’ and ‘viscosity’ and ‘viscous drag’ in explaining some ideas.

Some learners mixed up units or were not aware that there were some quantities that did not require units. For example, efficiency is a number without a unit and Specific Heat Capacity has a different unit to Heat /Thermal Capacity.

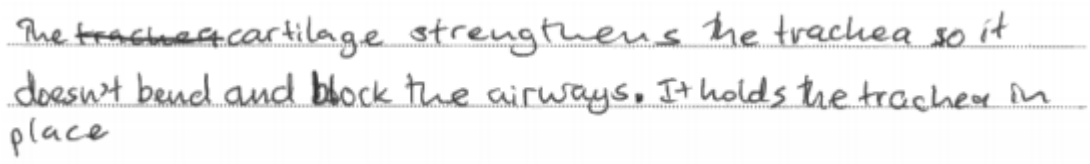
Individual Questions

Biology

Question 1a

Learners did not perform as anticipated when responding to this question. Many gave vague statements about the cartilage but not its function of preventing collapse or keeping the airway open. About 50% of learners achieved this mark. Some learners answered a different question about why the rings of cartilage in the trachea are C-shaped but that was not being tested here.

The example below scored a mark for saying that the cartilage prevents bending and blocking of the trachea.



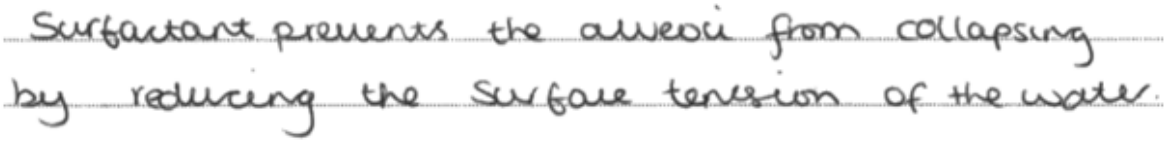
Question 1b

This question was well answered with only a very few learners giving the responses in the incorrect sequence. A significant few used the words contract and relax but these were not credited as those words were in the stem of the question and refer to the smooth muscle in the walls of the airways.

Question 1c

Many learners gave rather vague responses here but some did give the expected answer that it prevents the alveoli from sticking together or collapsing and hence maintaining a large surface area for gaseous exchange.

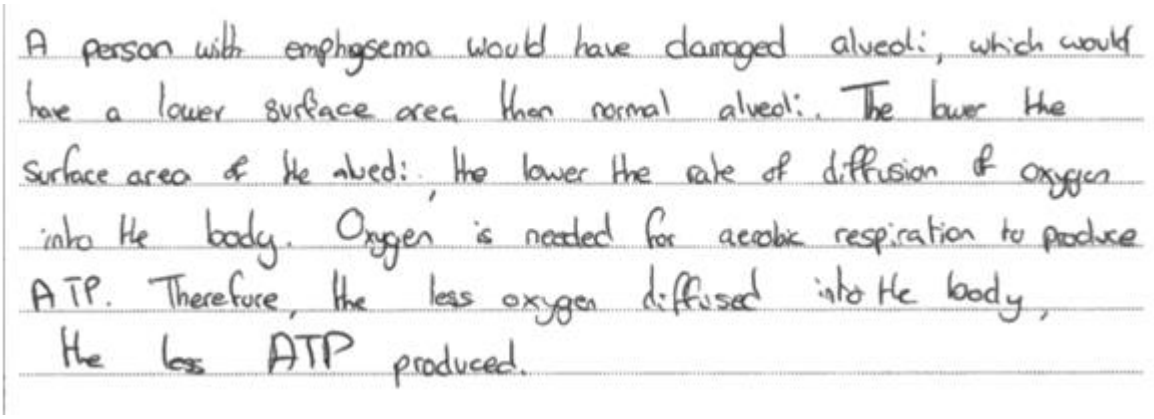
Below is an example of an excellent response



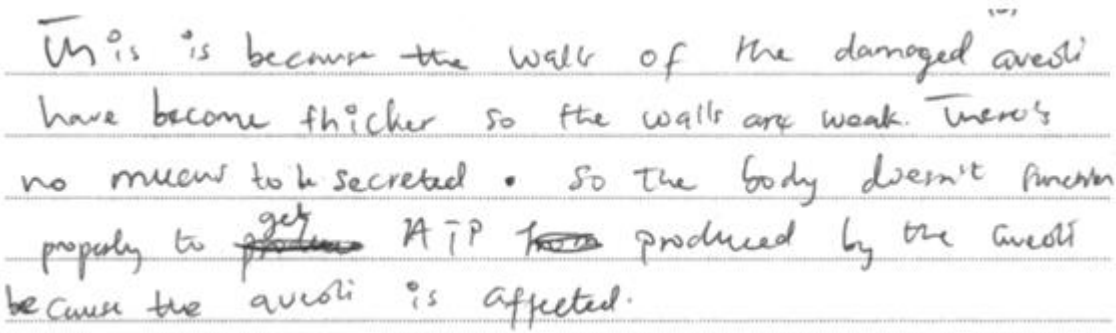
Question 1d

Many learners answered this question well. They used the information in the pictures and linked the loss of alveoli to reduction in surface are for gaseous exchange and therefore the reduction in oxygen for aerobic respiration. Some talked, correctly, of thicker walls of the remaining alveoli leading to a longer diffusion pathway for gaseous exchange.

Below is an example of a response that demonstrated excellent knowledge and understanding and scored full marks:


A person with emphysema would have damaged alveoli, which would have a lower surface area than normal alveoli. The lower the surface area of the alveoli, the lower the rate of diffusion of oxygen into the body. Oxygen is needed for aerobic respiration to produce ATP. Therefore, the less oxygen diffused into the body, the less ATP produced.

The response below scored just one mark for stating that the walls are thicker. However there is no link to diffusion of oxygen or respiration and the reference to ATP does not gain a mark as that is in the question.


This is because the walls of the damaged alveoli have become thicker so the walls are weak. There's no mucus to be secreted. So the body doesn't function properly to get ATP produced by the alveoli because the alveoli is affected.

Question 1e

Many learners substituted correctly into an equation and that the magnification is calculated by dividing the image size by the actual size, hence 10/0.2, which is 50x.

Some managed to get the division upside down and got an answer of 0.02. Many of those learners then multiplied that by 100 or 1000, possibly realising that a magnification of 0.02 would not help us to see small objects under a microscope.

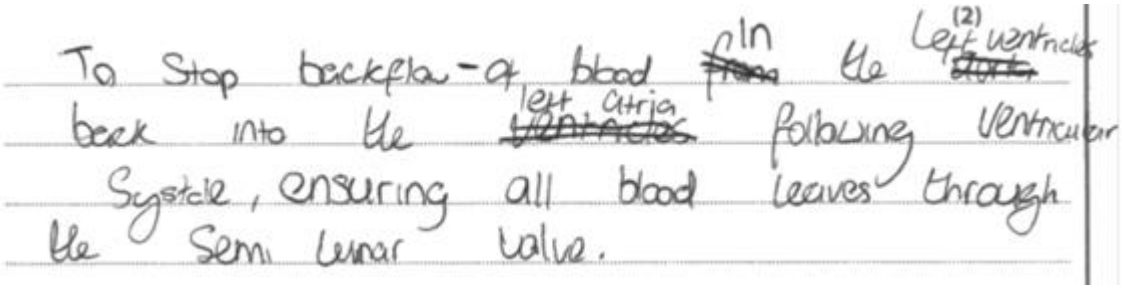
Question 2a (i)

A great many learners used their knowledge of heart structure, together with information in Figure 3, to deduce the correct response, which was option B, knowing that the aortic valve is at the base of the aorta; that the coronary artery originates from the aorta and noticing that the coronary artery branches off from the vessel containing the valve labelled B in the diagram. It is very encouraging to see learners apply their knowledge to interpret an unfamiliar diagram.

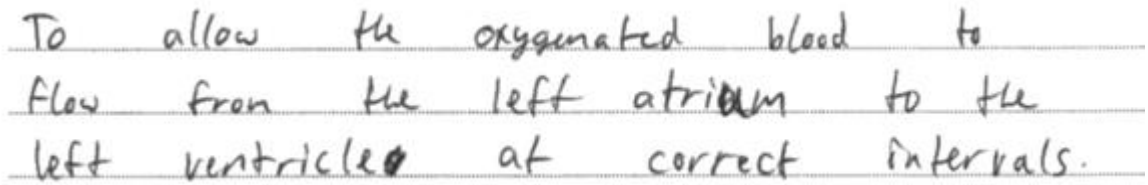
Question 2a (ii)

Many learners scored the mark for referring to preventing backflow but fewer got the second mark which was for identifying where the blood was prevented from flowing back from/to. A significant few learners referred, incorrectly, to the right side of the heart.

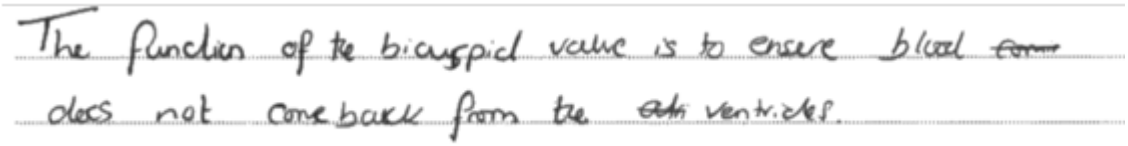
Below is an example of a response scoring both marks.



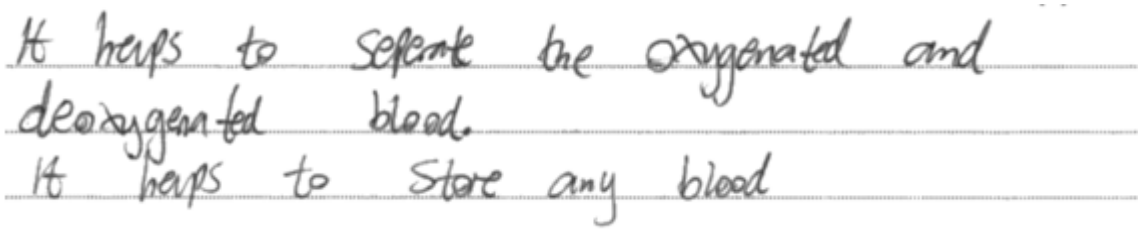
The response below gained one mark; had the candidate gone on to say 'and then stops it flowing back' they would have gained both marks.



This response also gained one mark



The following response gained no marks as there is no creditworthy content



Question 2b

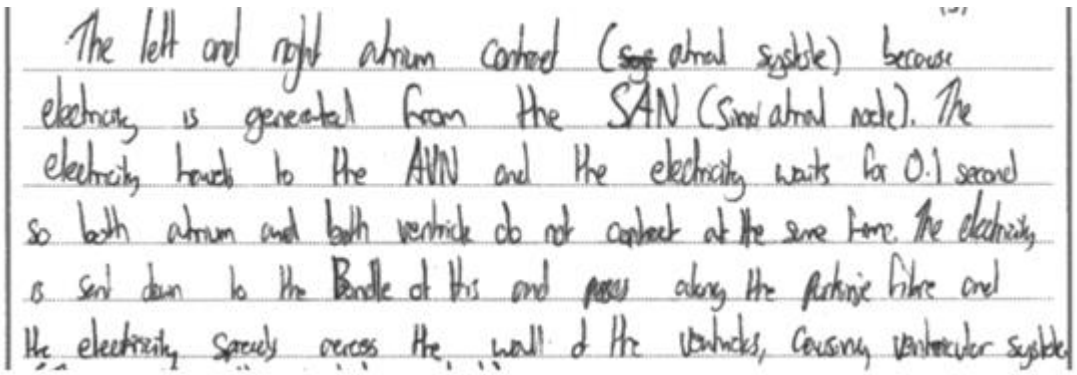
Most learners could correctly identify the location of the AVN, from the information in Figure 4.

Question 2c

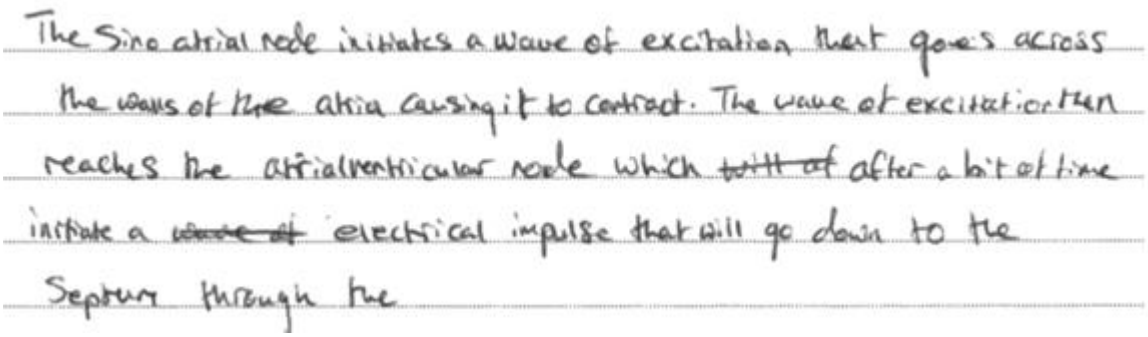
Many learners achieved full marks here. The information in Figure 3 should have cued them and helped them to recall the pathway and the names of the structures involved: – SAN, atrial wall/muscle, AVN, septum, Bundle of His and Purkinje/Purkyne fibres. Some learners also referred to the time delay at the AVN. Some learners lost a mark by giving an incorrect sequence - the most common error for this being to get the sequence of the bundle of His and Purkinje fibres reversed. Some learners mistakenly thought that the AVN and SAN are valves that allow blood to enter or leave heart chambers.

Some learners are under the misapprehension that there are nerves within the heart, as opposed to specially adapted muscle fibres, with fewer myofibrils, that conduct electrical impulses. This did not lose them any marks in this question but the misconception is worth noting.

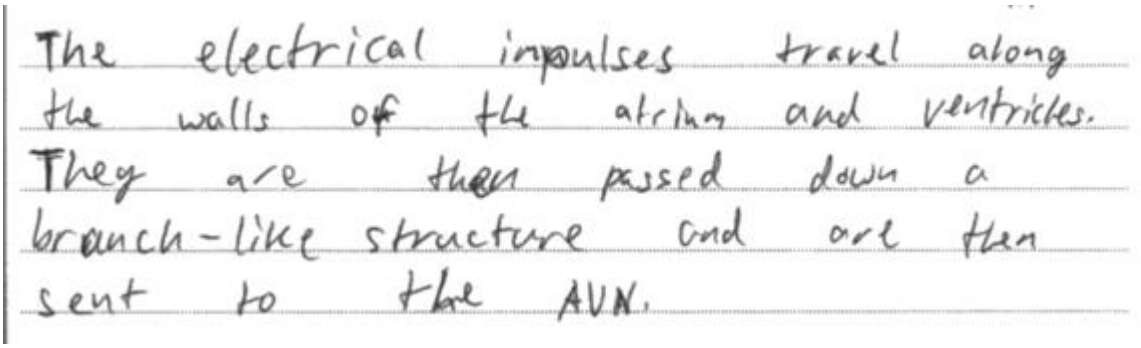
The response below gives a good account and gained the maximum of all three marks



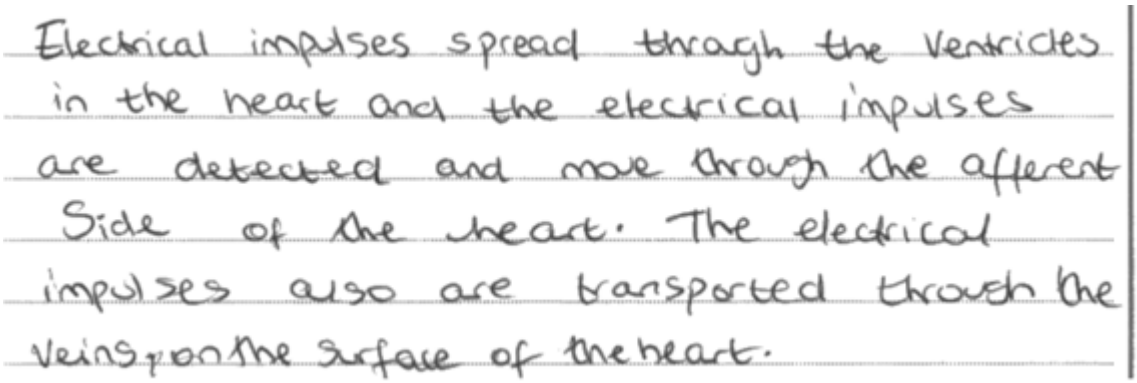
The following response also gained full three marks even though the full story is not told.



The response below gained one mark for reference to the walls of the atrium; the bundle of His has not been named and the AVN is in the incorrect sequence



The following response gained no marks .



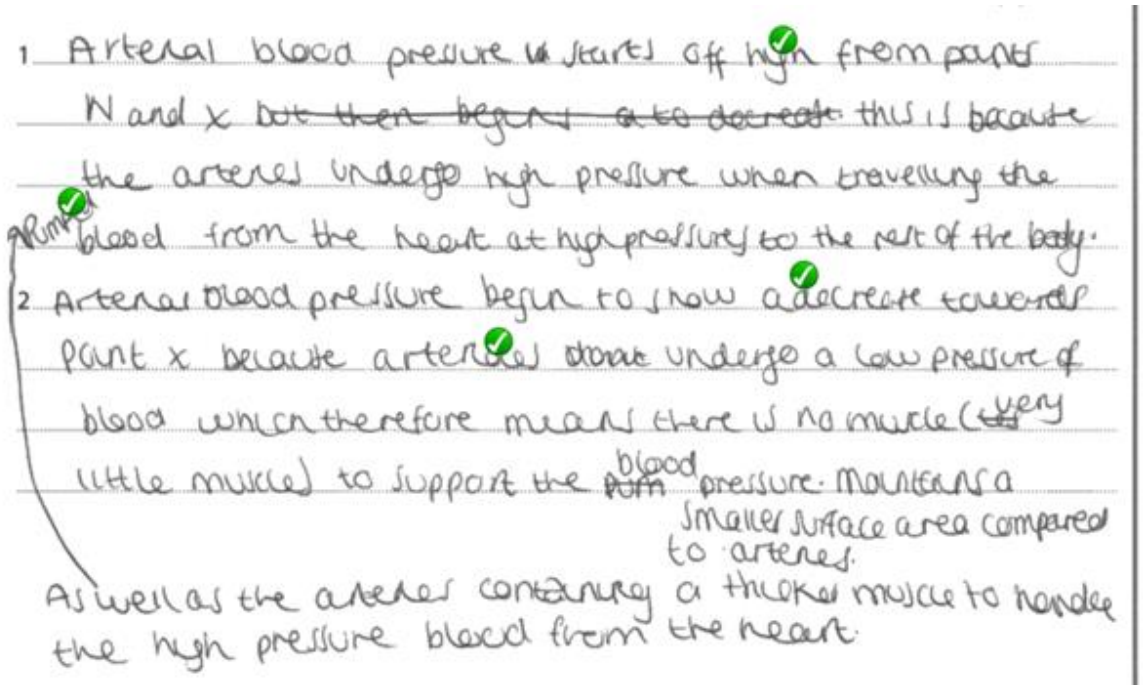
Question 2d

Many learners applied their knowledge of the circulatory system and deduced the correct response that nicotine absorbed into the blood, in the lungs, would reach the right atrium (chamber 2 of Figure 5) of the heart.

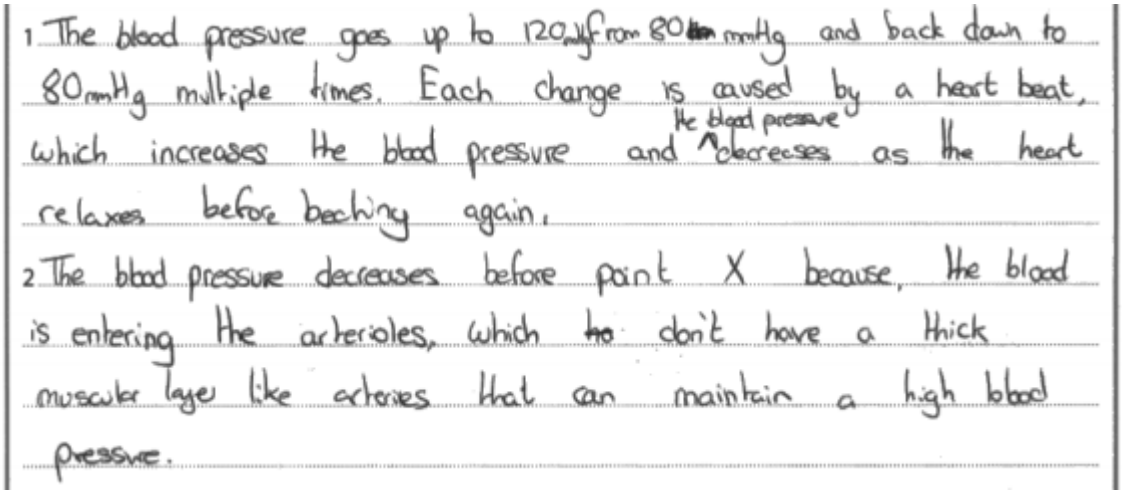
Question 2e (i)

All learners attempted this question and many gave good responses, worthy of credit. The responses demonstrated that candidates interpreted the graph (Figure 6) correctly and applied their knowledge of the cardiac cycle and of the differences between blood vessels to explain two of the changes in arterial blood pressure shown on the graph. Many identified that the arteries contain blood at high pressure but fewer linked that to ventricular systole; many described the drop in blood pressure as the arteries divide into arterioles, which have thinner walls. Some correctly described the reduction in fluctuation size and linked it to less elastin in arteriole walls or to the fluctuations being smoothed out. Some learners correctly described the 120 mm pressure being linked to (left) ventricle systole and the 80 mm being linked to ventricular diastole. Misconceptions included stating that arteries pump blood or generate the high pressure.

The following response gained four marks


1 Arterial blood pressure starts off high from point X and ~~but then begins to decrease~~ this is because the arteries undergo high pressure when travelling the pump blood from the heart at high pressure to the rest of the body.
2 Arterial blood pressure begin to slow decrease towards point x because arteries do not undergo a low pressure of blood which therefore means there is no muscle (~~very~~ little muscle) to support the ~~pump~~ blood pressure. Maintains a smaller surface area compared to arteries.
As well as the arteries containing a thicker muscle to handle the high pressure blood from the heart.

This response also gained four marks and is more clearly expressed


1 The blood pressure goes up to 120 mmHg from 80 mmHg and back down to 80 mmHg multiple times. Each change is caused by a heart beat, which increases the blood pressure and the blood pressure decreases as the heart relaxes before beating again.
2 The blod pressure decreases before point X because, the blood is entering the arterioles, which don't have a thick muscular layer like arteries that can maintain a high blood pressure.

Question 2e (ii)

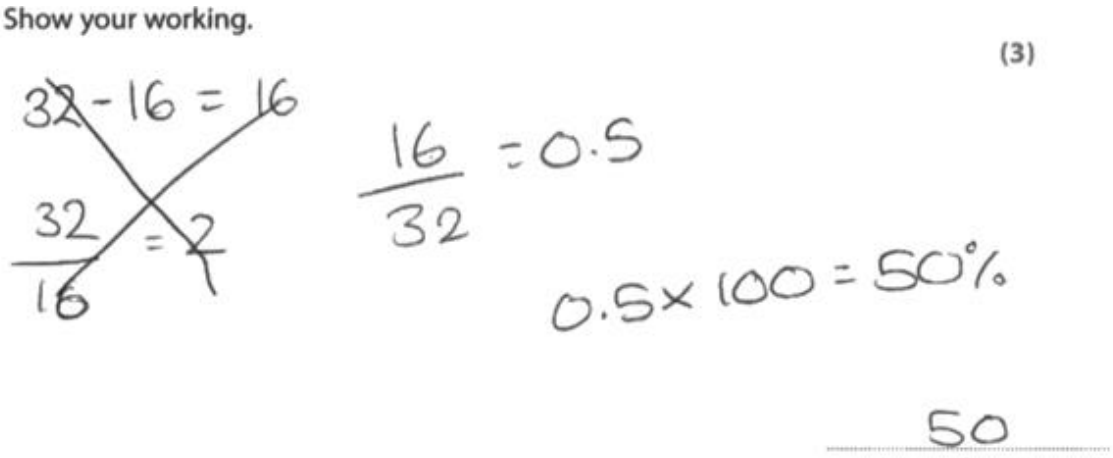
Many learners are still not proficient at calculating percentage change. Those who did used a variety of methods – all of which were worthy.

Some used the formula: change/ original x 100.

Others used the formula: 100 - (final/original x 100)

Many failed to take the product of the sum shown here in brackets away from 100. Some only got as far as finding the difference and, provided that was shown, they gained a mark. Some learners took the wrong readings from the graph, using points W and X rather than Y and Z as asked.

The responses shown below gained all three marks. Due to the thickness of the lines on the graph, there was a range of acceptable answers.


Show your working.

(3)

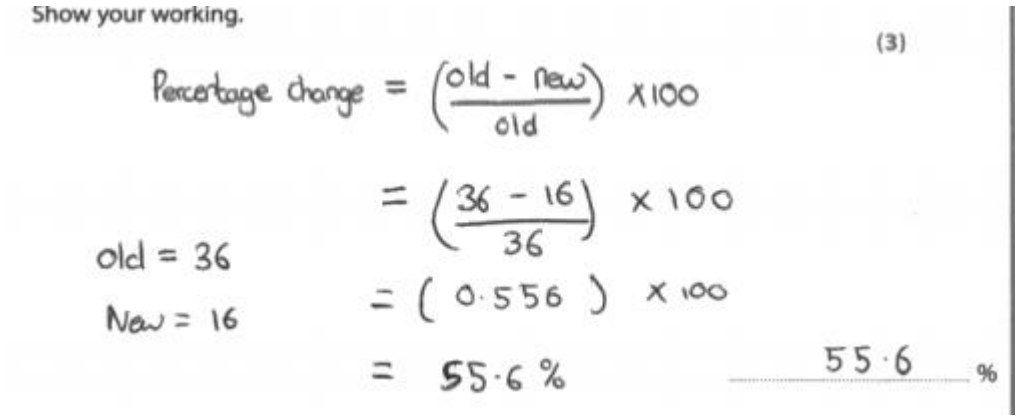
32 - 16 = 16

32 / 16 = 2

16 / 32 = 0.5

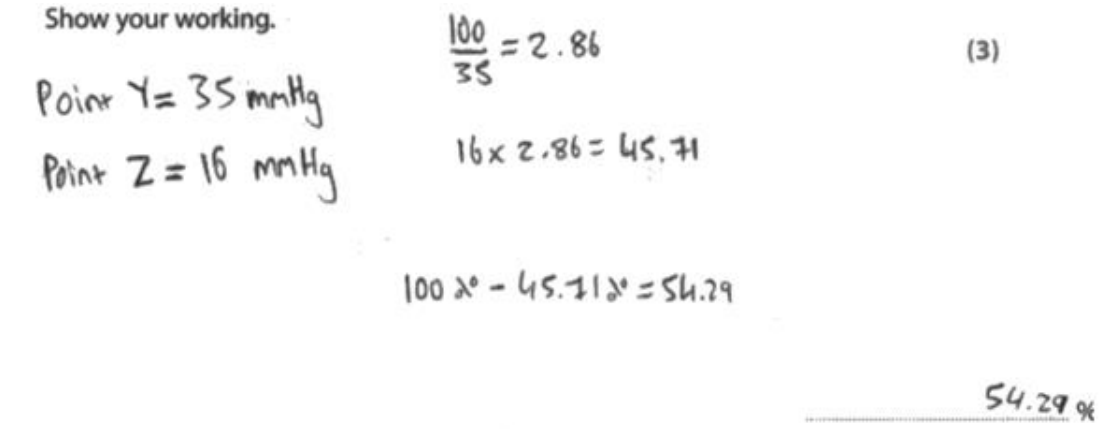
0.5 x 100 = 50%

50

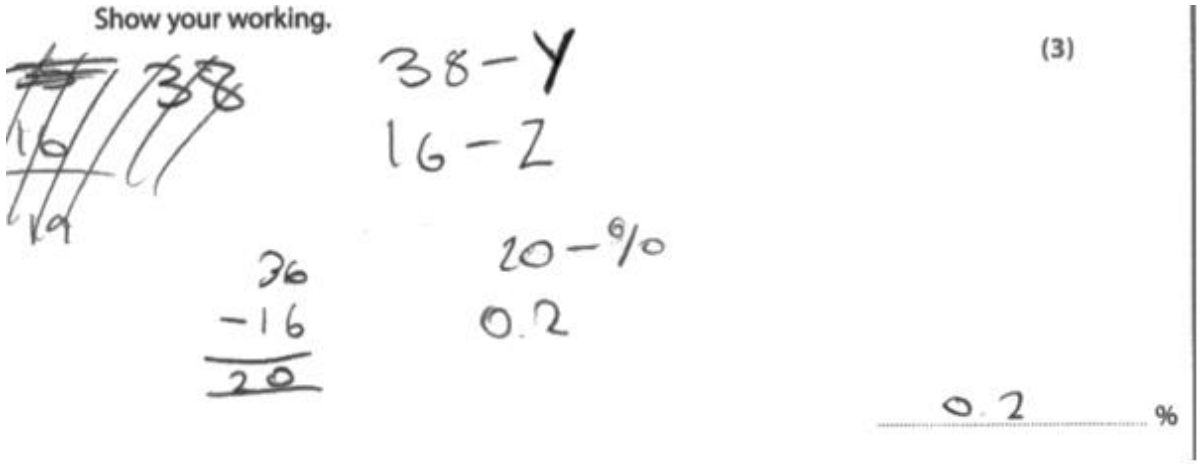


The following response has used the alternative method correctly and gained 3 marks.

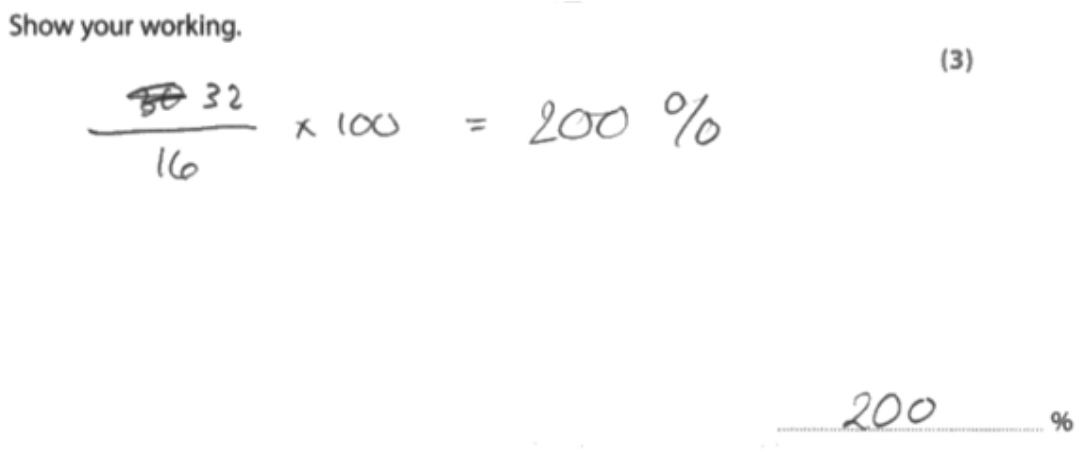
[100/original x final] is the same as [final/original x 100] and this learner has also correctly taken that answer away from 100.



The following response gained 1 mark for finding the difference.



In the following response the learner has the division upside down but has x 100 so gained 1 mark, as error carried forward, for that


Show your working.

(3)

~~50~~ 32 / 16 x 100 = 200 %

200 %

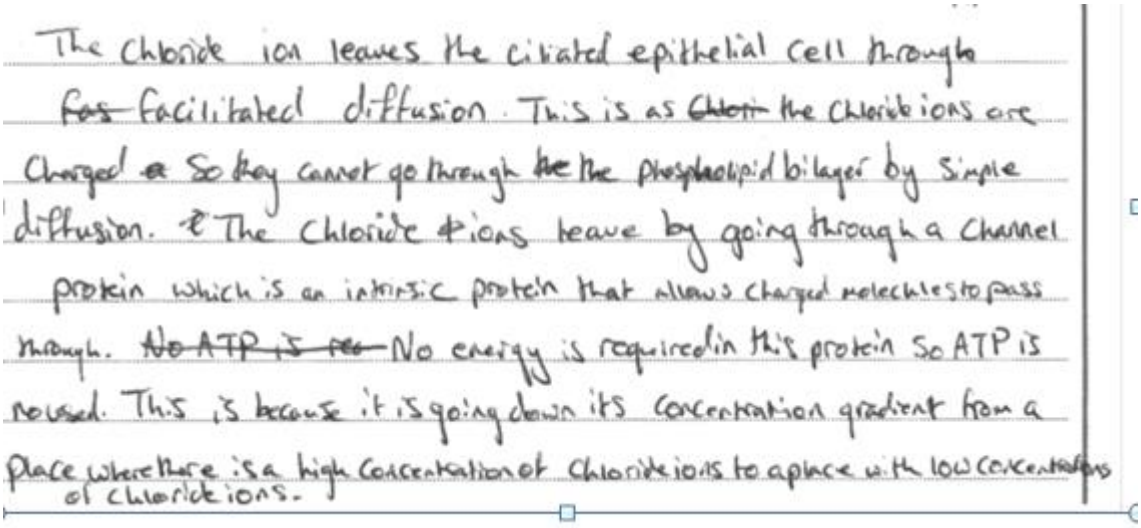
Question 3a

It was very encouraging to find that many learners used the information in Figure 7 and worked out that as the sodium ions are moving against a concentration gradient and that, as ATP is involved, sodium ions leave the cell at point 1 by active transport.

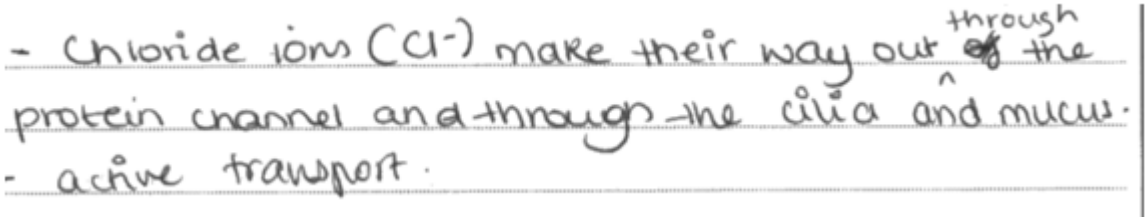
Question 3b

Most learners used their knowledge and also used the information in Figure 7 to give very good explanations of how the chloride ions move down their concentration gradient, through protein channels, by facilitated diffusion, which is a passive process. Very few learners had little or no idea, or the wrong idea, of how the chloride ions leave the cell and, surprisingly, those learners did not seem to use the information in Figure 7 to help them.

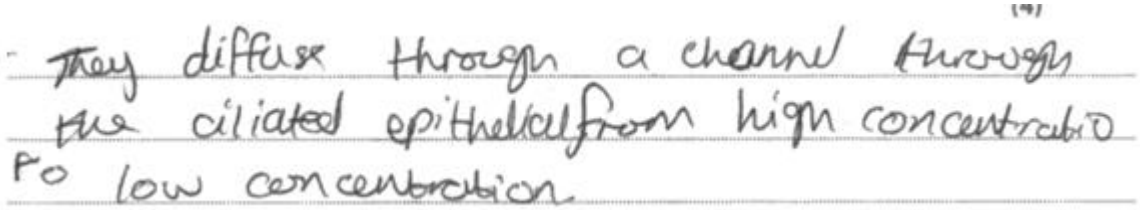
Here is a very good response, demonstrating clear understanding


The Chloride ion leaves the ciliated epithelial cell through ~~for~~ facilitated diffusion. This is as ~~Chlori~~ the Chloride ions are Charged ~~a~~ so they cannot go through ~~the~~ the phospholipid bilayer by simple diffusion. The Chloride ions leave by going through a channel protein which is an intrinsic protein that allows charged molecules to pass through. ~~No ATP is req~~ No energy is required in this protein so ATP is not used. This is because it is going down its concentration gradient from a place where there is a high concentration of Chloride ions to a place with low concentrations of Chloride ions.

The flowing gained 1 mark for the reference to a protein channel


- Chloride ions (Cl^-) make their way out through ~~of~~ the protein channel and through the cilia and mucus.
- active transport.

This response gained 3 marks for: stating that the chloride ions diffuse; reference to a channel and a description of the ions passing down a concentration gradient


- ~~They~~ diffuse through a channel ~~through~~ the ciliated epithelial from high concentration to low concentration.

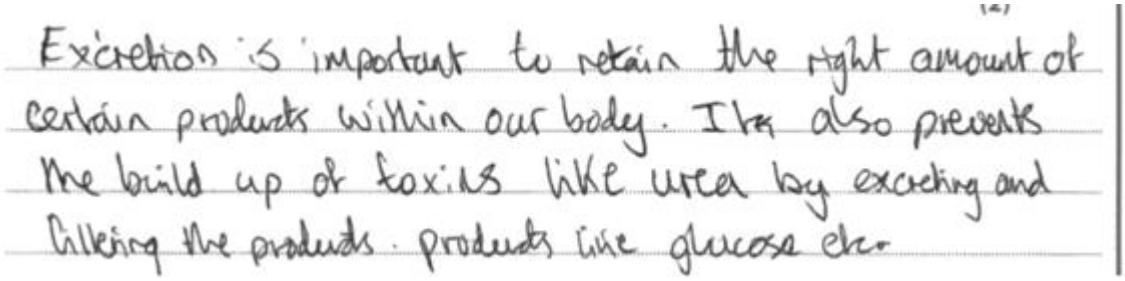
Question 3d

The majority of learners correctly identified osmosis as the process by which water leaves the cell**.** Some learners lost the mark by giving a list and including another option, such as osmoregulation.

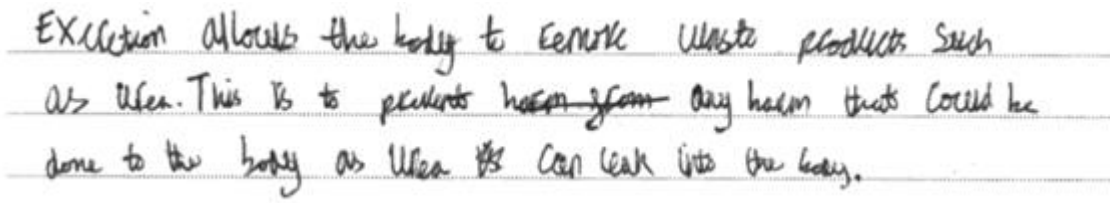
Question 4a (i)

As the question asked about the importance of excretion, learners did not have to give a definition of excretion, although if they did it was credited. Other most commonly seen responses were that the waste is toxic and would build up of not removed. The majority of learners gained one of the two marks.

The response below gained 2 marks. The reference to glucose is irrelevant and was ignored.



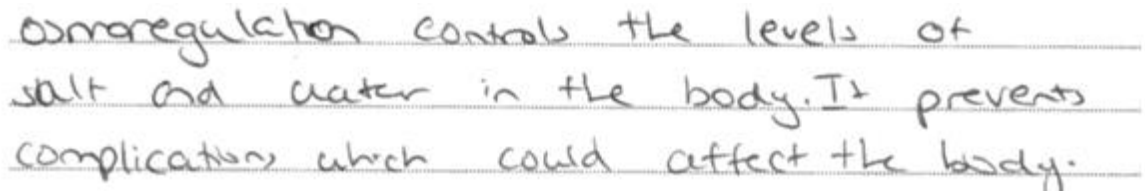
The following gained one mark.



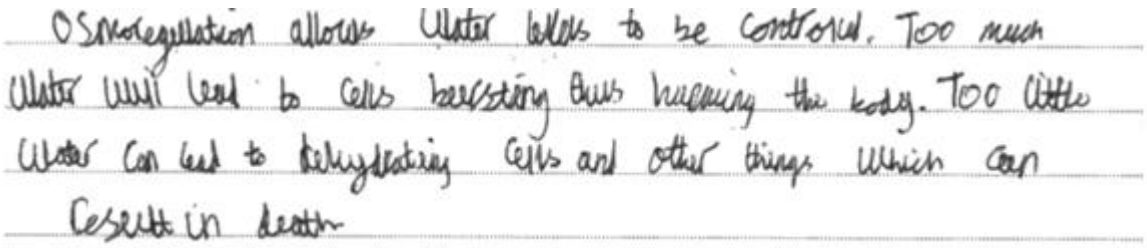
Question 4a (ii)

Many learners tried to explain the process of osmoregulation but failed to state that it is the regulation of the water **and** salt (ion/electrolyte) content of the body. However they could gain two marks for two relevant ideas as to why the process is important. Most often seen were references to cells becoming bloated and bursting or cells losing water and shrivelling (the same marking point). Some learners then commented that shrivelled cells could not carry out their metabolic, enzyme-catalysed reactions. Others commented on the need for maintaining a suitable blood volume and therefore pressure or to maintaining the ability to sweat and regulate temperature.

The following gained one mark for reference to controlling the levels of salt and water but the next sentence was too vague to gain a further mark.



The response below gained two marks. Although the explanation did not mention salts, the learner then referred to cells bursting, which gained a mark. The reference to preventing dehydration gained another mark.



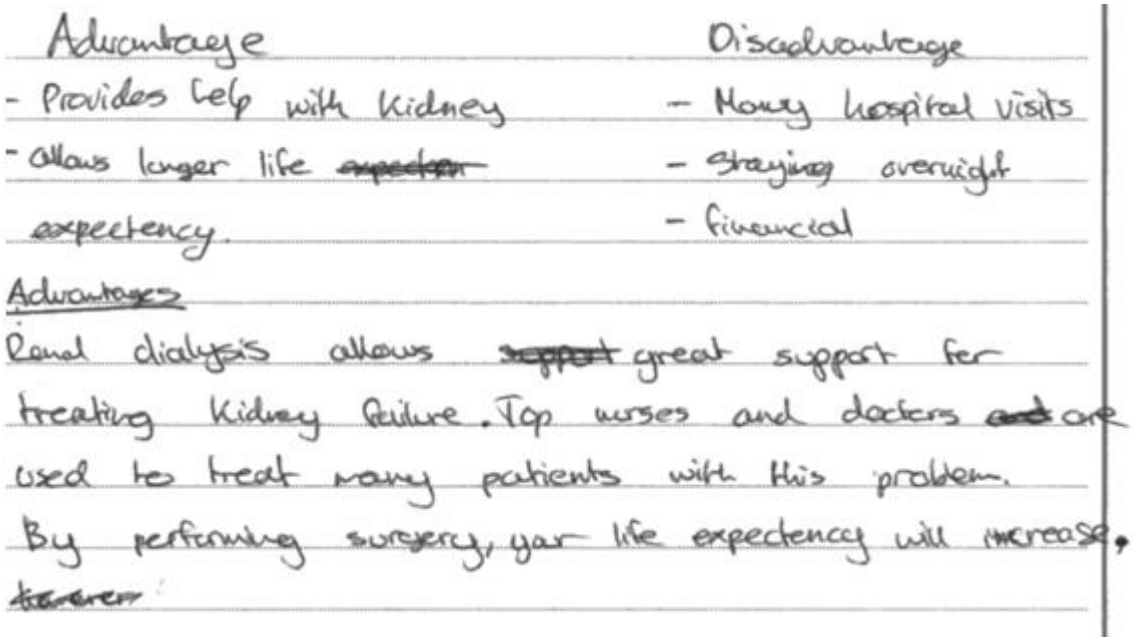
Some learners confused excretion with osmoregulation.

Question 4b

Many learners tackled this question well. Their responses demonstrated that they knew and understood the pros and cons of renal dialysis. A few became confused in their responses and started talking about surgery – presumably confusing treatment by dialysis with treatment by kidney transplant. However the better responses gave balanced accounts with several advantages and disadvantages of renal dialysis. Some gave unexpected, but nevertheless creditworthy, responses such as making the point that dialysis does not raise any ethical or religious objections as transplant surgery might do.

Weaker responses were vague and showed little understanding of the advantages or disadvantages of renal dialysis; many of the weaker responses indicated that the learners mistakenly think that dialysis is more cost effective than transplant surgery or that patients spend all of their time on a dialysis machine. Some of the weaker responses indicated confusion between the side effects of immunosuppressants and the effects of dialysis.

The following response is at level 1. The plan demonstrates that the learner understands that having to go to hospital for treatment is a disadvantage but there is no discussion about the fact that treatment is available immediately, nor is there any reference to how often and for how long the dialysis needs to be carried out. The paragraph about the advantages is very weak.



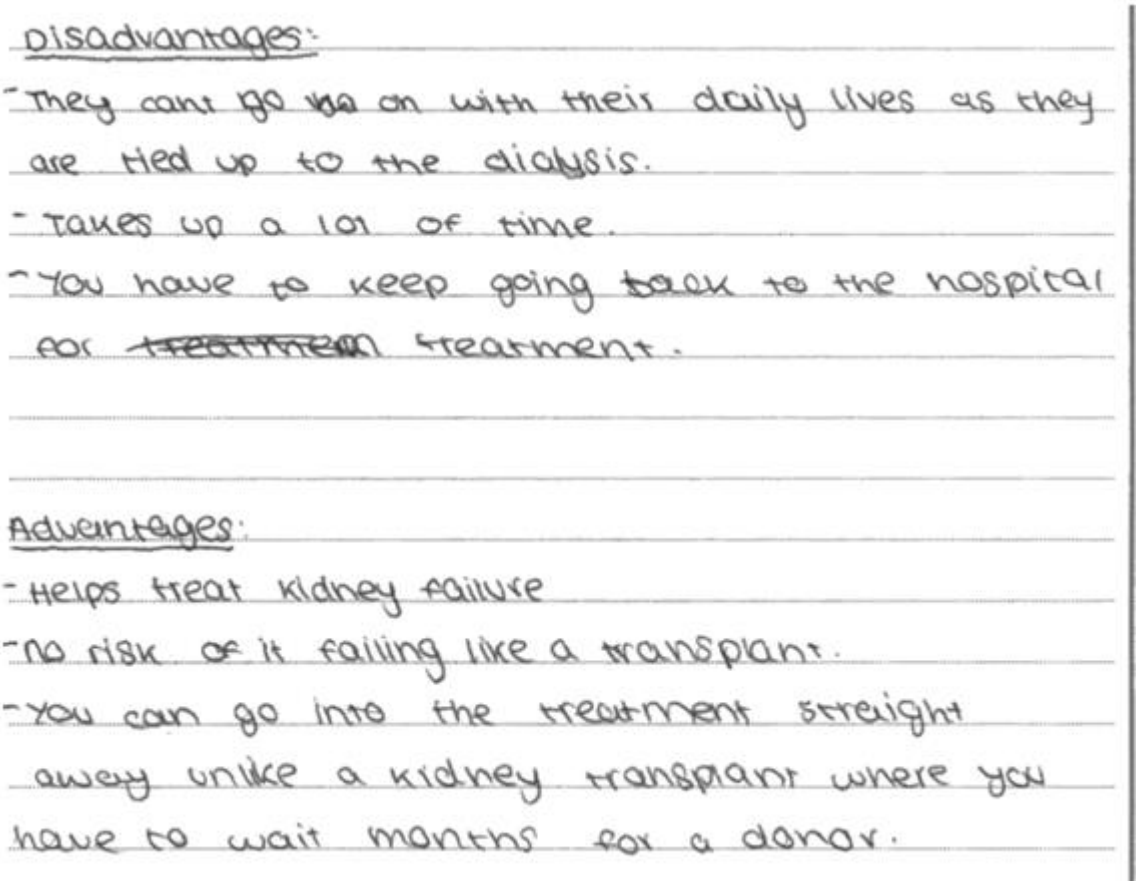
Advantage
- Provides help with kidney
- allows longer life ~~expectancy~~ expectency.

Disadvantage
- Many hospital visits
- staying overnight
- financial

Advantages

Renal dialysis allows ~~support~~ great support for treating kidney failure. Top nurses and doctors ~~and~~ are used to treat many patients with this problem. By performing surgery, your life expectency will increase. ~~however~~

The following response is at the bottom of level 2, with 3 marks. The format chosen by the learner is perfectly acceptable. The response is concise but has covered a range of points and shows good knowledge and understanding, and has included analyses of pros and cons. There is some supporting evidence and it is easy to follow their reasoning as the account is clear.



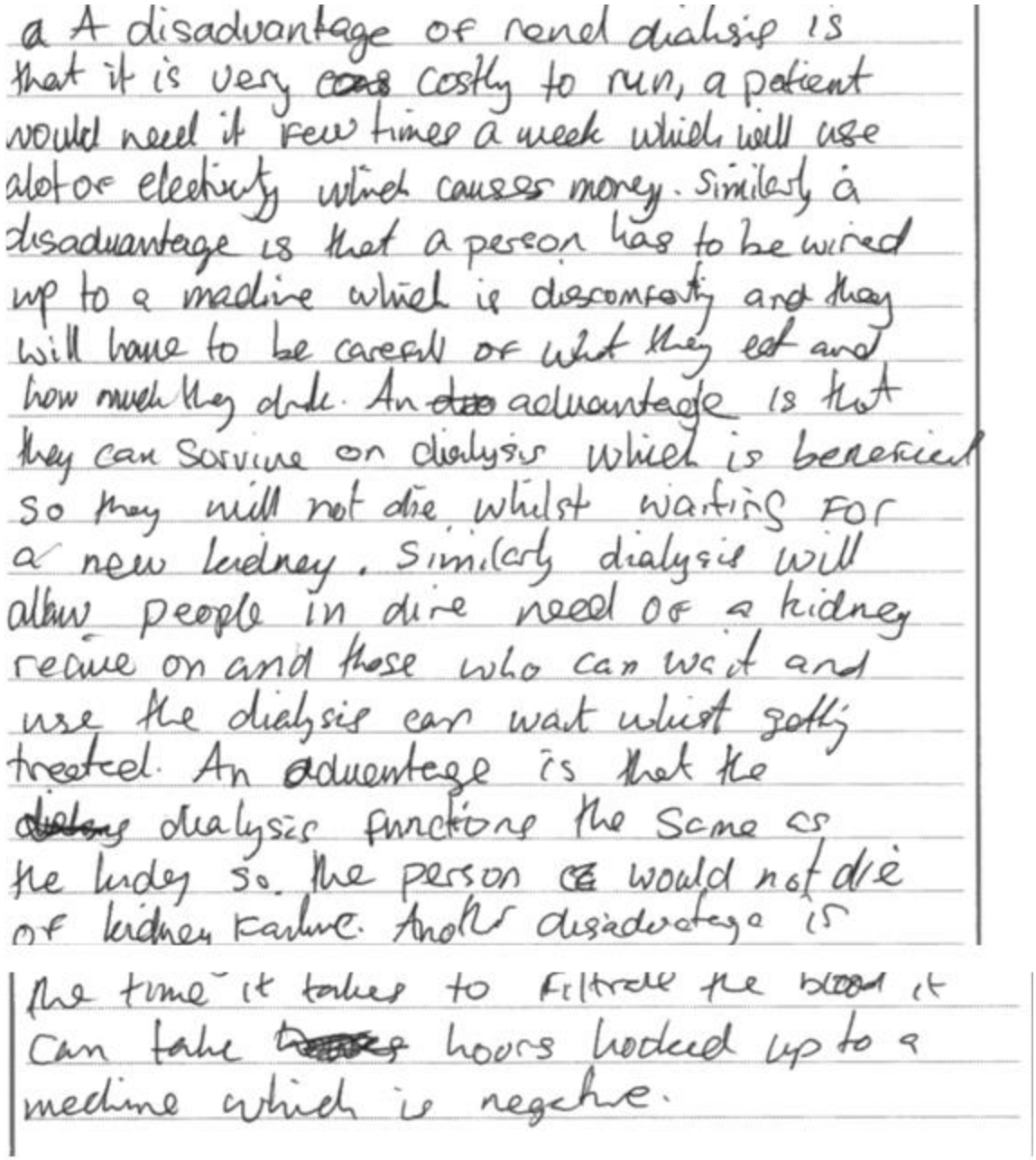
Disadvantages:

- They can't go on with their daily lives as they are tied up to the dialysis.
- Takes up a lot of time.
- You have to keep going back to the hospital for treatment.

Advantages:

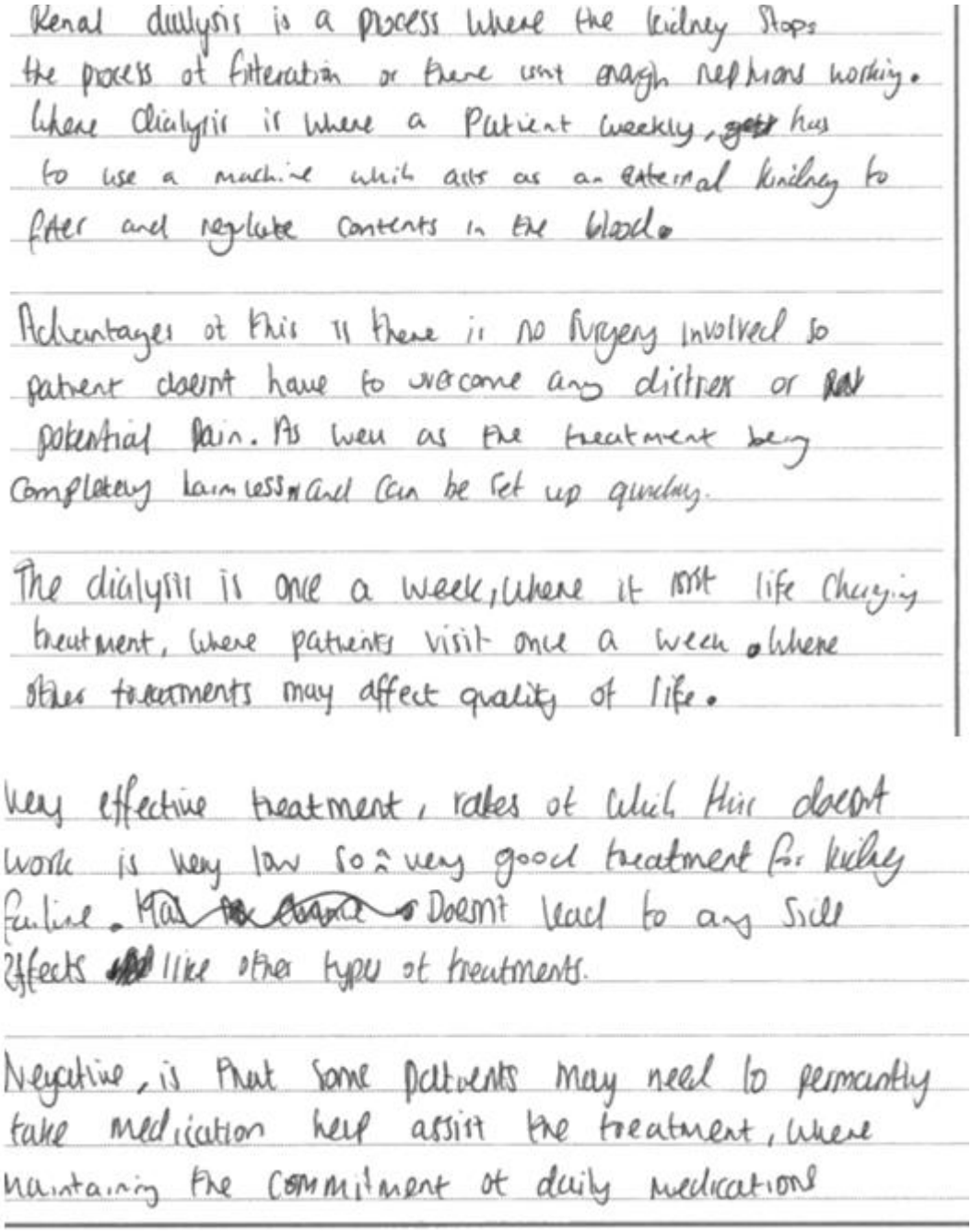
- Helps treat kidney failure
- no risk of it failing like a transplant.
- You can go into the treatment straight away unlike a kidney transplant where you have to wait months for a donor.

The next response is at the top of level 2 with 4 marks. All the points made by the learner are relevant and show good knowledge, understanding and analysis. The learner has discussed pros and cons and there is a reasonable range of ideas here. Learners are not expected to cover all the points given in the indicative content of the mark scheme. This response has a reasonable structure, although it would have benefitted from being split into paragraphs, and is clear and coherent.



a A disadvantage of renal dialysis is that it is very ~~cost~~ costly to run, a patient would need it few times a week which will use alot of electricity which causes money. Similarly a disadvantage is that a person has to be wired up to a machine which is discomfortly and they will have to be careful of what they eat and how much they drink. An ~~dis~~ advantage is that they can survive on dialysis which is beneficial so they will not die whilst waiting for a new kidney. Similarly dialysis will allow people in dire need of a kidney recive on and those who can wait and use the dialysis can wait whilst safly treated. An advantage is that the ~~dialysis~~ dialysis functions the same as the kidney so the person ~~ca~~ would not die of kidney failure. Another disadvatage is the time it takes to filtrate the blood it can take ~~hours~~ hours hooked up to a machine which is negative.

The following response shows comprehensive knowledge and understanding and has discussed a wide range of advantages and disadvantages. The lines of argument are supported but the account lacks coherence in some places so this response is at the bottom of level 3 with 5 marks.



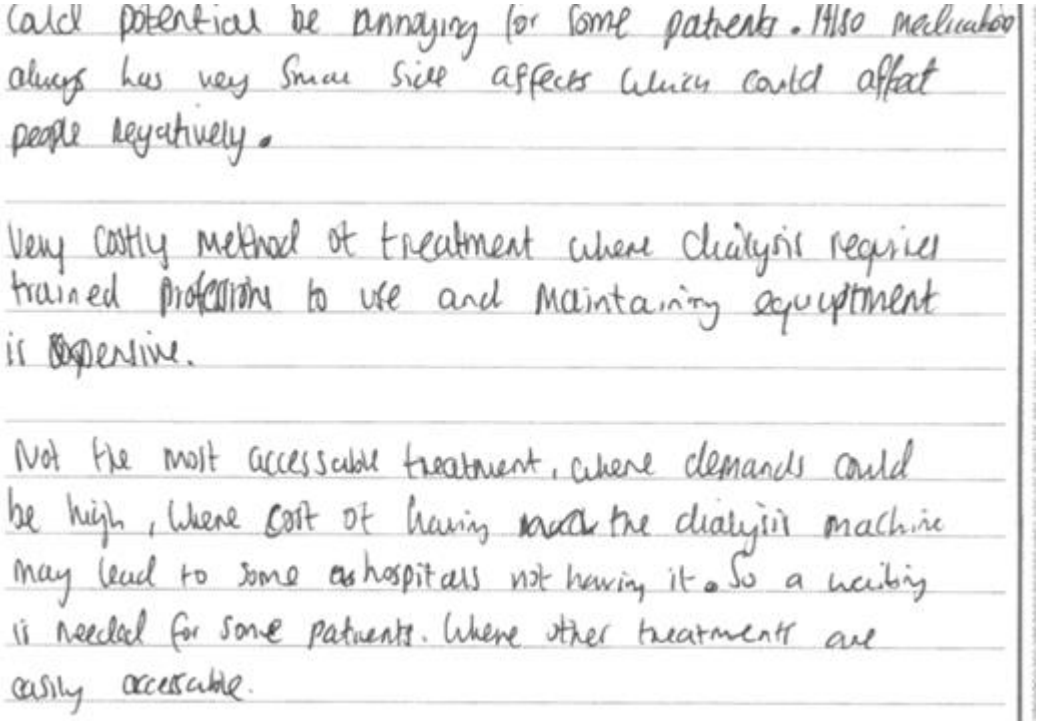
Renal dialysis is a process where the kidney stops the process of filteration or there isnt enough nephrons working. Where dialysis is where a Patient weekly, ~~gets~~ has to use a machine which acts as an external kidney to filter and regulate contents in the blood.

Advantages of this is there is no surgery involved so patient doesnt have to overcome any distress or potential pain. As well as the treatment being completely painless and can be set up quickly.

The dialysis is one a week, where it isnt life changing treatment, where patients visit once a week. where other treatments may affect quality of life.

Very effective treatment, rates of which this doesnt work is very low so very good treatment for kidney failure. ~~Has the chance~~ Doesnt lead to any side effects like other type of treatments.

Negative, is that some patients may need to permantly take medication help assist the treatment, where maintaining the commitment of daily medications


could potential be annoying for some patients. Also medication always has very small side affects which could affect people negatively.

Very costly method of treatment where dialysis requires trained professions to use and maintaining equiptment is expensive.

Not the most accessable treatment, where demands could be high, where cost of having each the dialysis machine may lead to some as hospitals not having it. So a waiting is needed for some patients. Where other treatments are easily accessable.

The final example shows comprehensive knowledge, understanding, interpretation and analysis. The advantages and disadvantages discussed are consistently supported by sustained application of relevant evidence and knowledge. It has a very well-developed structure that is clear, coherent and logical. Despite the lack of paragraphs the reasoning can be easily followed. This response fulfils the criteria for being at the top of level 3 with 6 marks.

One advantage of treating kidney failure with dialysis is that the patients health would improve. Dialysis works by filtering the blood of toxic urea. If the urea was built up, it would affect the patient's health drastically. So another advantage is that there would be no build up of toxic waste. Dialysis means that the patient wouldn't have to go on the transplant list for a new kidney and be on medications such as immunosuppressants which would increase the risk of infections. However there are some disadvantages to treating kidney failure. For example, one disadvantage would be that the patient would have to make regular visits to the hospital or centre. This would take up so much of the patients time. Dialysis also takes hours to complete meaning more time is being spent at the hospital. This means that the patients quality of life will be effected since they have to make regular hospital visits - another disadvantage is that it is not a permanent solution to treat renal failure. This means that the patient would have ~~this~~ renal failure for the rest of their lives before the condition worsens and ~~not~~ kills them.

Chemistry

Question 1

This question relates to content from A1: Relating properties to uses and production of substances. The question focuses specifically upon the electrolysis of alumina and the conditions used.

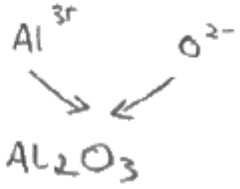
Question 1a

The correct formula of alumina being Al_2O_3 was well known by candidates. Other answers were rarely selected in this multiple choice question.

Occasionally, better candidates demonstrated their understanding of formulae to work out the answer.

(a) Identify the chemical formula of alumina.

- ☒ **A** AlO
- ☒ **B** AlO_2
- ☒ **C** Al_2O
- ☒ **D** Al_2O_3



It is recommended that candidates are made familiar with formulae of substances mentioned within the Unit 5 specification or are equipped to work them out.

Question 1b (i)

The correct answer of cryolite tended to be selected by better candidates in response to what alumina is dissolved in for electrolysis. The other three answers were also regularly selected in this multiple choice question, particularly bauxite and sodium hydroxide.

Candidates need to consider the context of a question carefully - in this case, it was the electrolysis of alumina rather than its extraction and purification from its ore.

Question 1b (ii)

This question was generally well answered, with most candidates either scoring 1 or both marks. Most candidates were able to identify that the melting point was high or that there would be an energy implication. Where only 1 mark was scored, it was because candidates had not responded to the "explain" command verb and had not made the appropriate link between these two ideas. Candidates need to be encouraged to provide linking statements to show their understanding when an explanation is required.

~~It may be~~ Alumina is dissolved rather than melted due to its high melting point, which is 2072°C.

In this response, the candidate has only recognised that the melting point of 2072 °C is high (1 mark awarded).

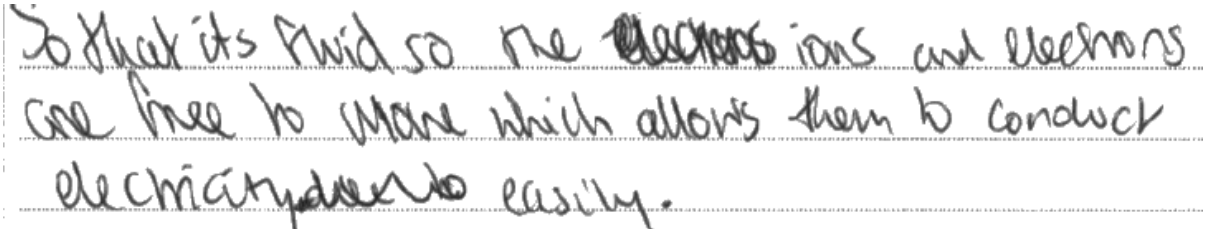
dissolving uses less energy than melting it does

In this response, the candidate has only recognised that more energy will be required in melting (1 mark awarded).

When dissolved, ~~the~~ the melting point is lowered therefor not as much energy is required to keep alumina constantly molten.

In this response, the candidate correctly links the use of less energy with lowering of the melting point (2 marks awarded).

Responses that did not score often relied upon chemical ideas that were not directly relevant, for example, ions being free to move. Again, it is important that candidates appreciate the context of the question being asked, rather than simply recalling information about a topic.



In this response, the candidate refers to ions and electrons now being free to move and conduct electricity – this idea is not relevant to the dissolving of alumina in preference to melting of the substance (0 marks awarded).

Question 1c

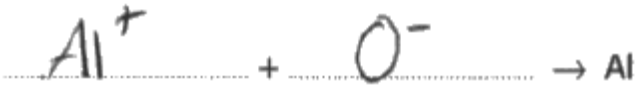
This question was normally attempted but only the best candidates were able to complete and balance the equation.

In this response the candidate has correctly given the formula of the aluminium ion and the correct number of electrons to needed balance this (2 marks awarded).

Whilst the majority of candidates did appreciate that the equation involved the addition of electrons to a positive ion, key problems encountered were writing the correct charge on the aluminium ion or balancing the equation.

In this response, the formula of the aluminium ion is incorrect. However, the candidate has demonstrated that they understand that an electron needs to be added to a positive ion (1 mark awarded).

Some candidates were clearly unfamiliar or uncertain about the use of half equations to represent electrolysis processes, and equations which did not involve ions or electrons at all were common. Others did not realise that other elements, such as oxygen or carbon, could not be part of the equation.



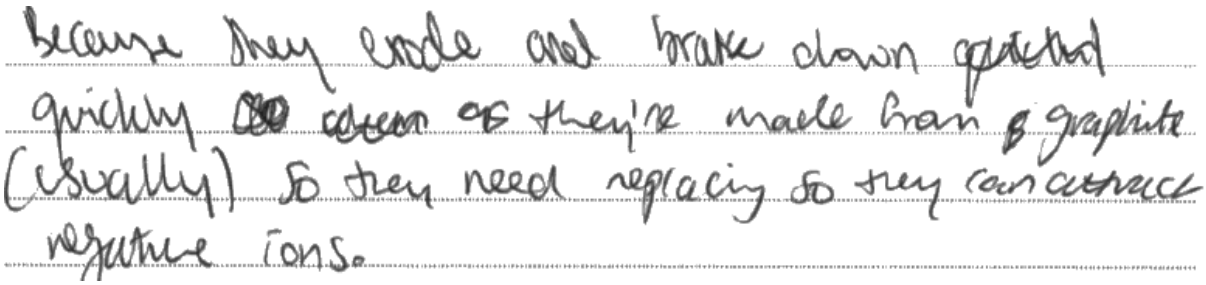
In this response, the candidate has not recognised that electrons must be involved in electrolysis and the answer is not credit worthy (0 marks awarded).

In this response, the candidate has attempted to use aluminium oxide and carbon, and the answer is not credit worthy (0 marks awarded).

Question 1d

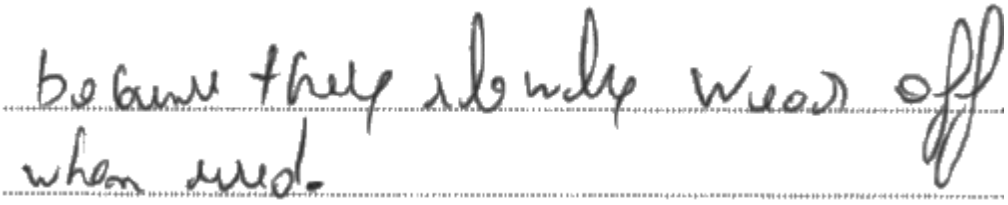
This question was reasonably well answered, with most candidates either scoring 1 or both marks. A better understanding of the chemistry involved was required by comparison to Q1b(ii).

Where only 1 mark was scored, it was often because candidates failed to identify that oxygen was evolved at the anode, and was the reason that the anode decomposed or was eroded.



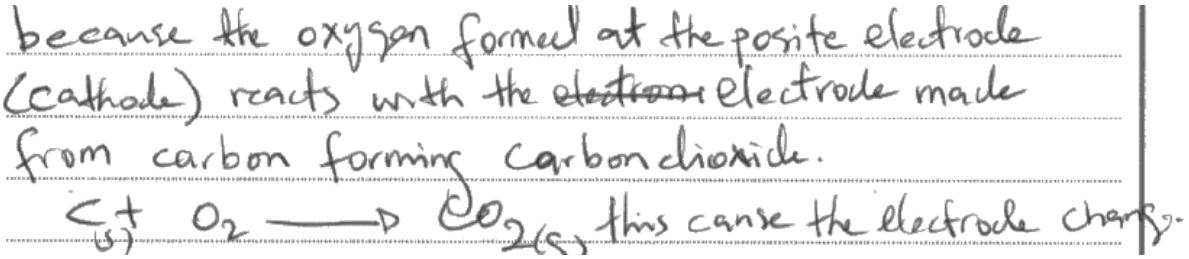
In this response, the candidate has identified that the anodes need replacing because they erode / break down but has not explained why this occurs (1 mark awarded).

A range of alternative wording was frequently observed for decompose or erode, some of which was not acceptable (e.g. rusts) – candidates should be encouraged to use more technical language and do so correctly.



In this response, the candidate has poorly expressed their ideas by stating that the anode would "wear off" when used (0 marks awarded).

Better answers explained that oxygen reacted with the carbon anode and that carbon dioxide gas was formed.


because the oxygen formed at the posite electrode (cathode) reacts with the ~~electrode~~ electrode made from carbon forming carbon dioxide.
$C_{(s)} + O_2 \longrightarrow CO_{2(g)}$ this cause the electrode charg...

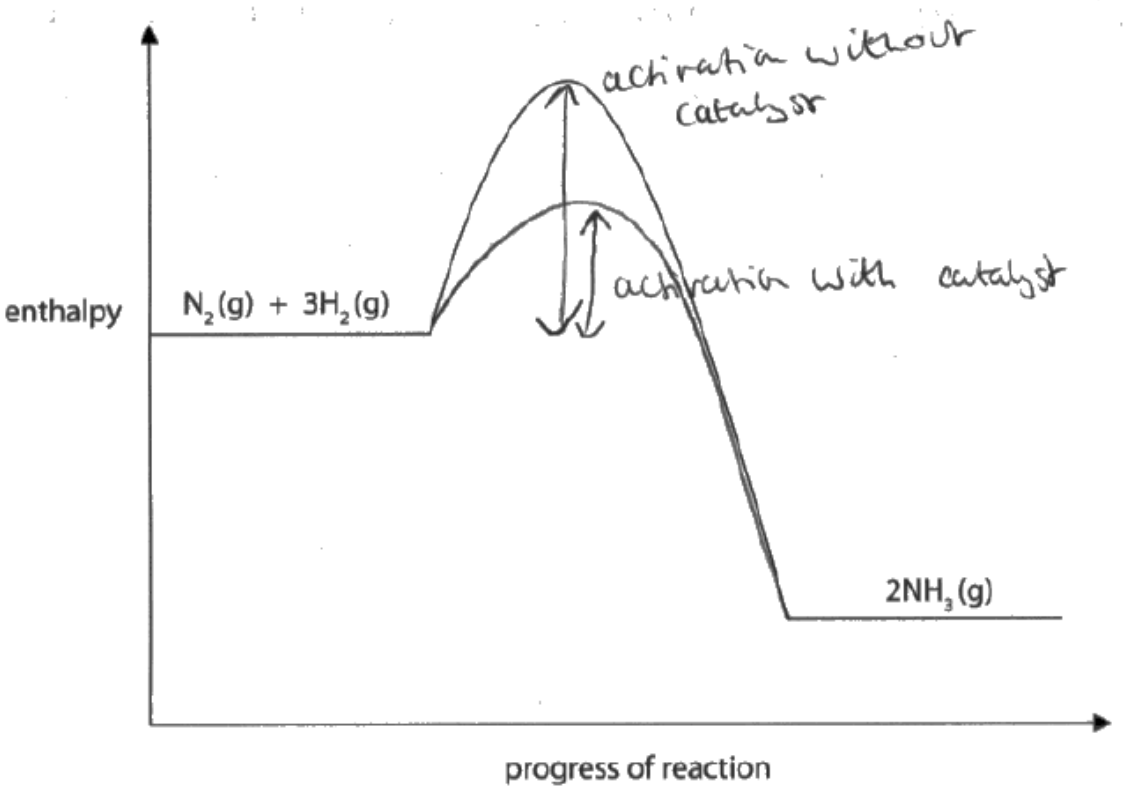
In this response, the candidate has identified that oxygen reacts with carbon. Further, they have identified that carbon dioxide forms and provided an equation (2 marks awarded).

Question 2

This question relates to content from A3: Energy changes in industry and A1: Relating properties to uses and production of substances. There is a particular focus on catalysis and its effect on a reaction profile diagram.

Question 2 (a)

Although the question was straightforward, only the best candidates were able to draw the required reaction profile diagram.

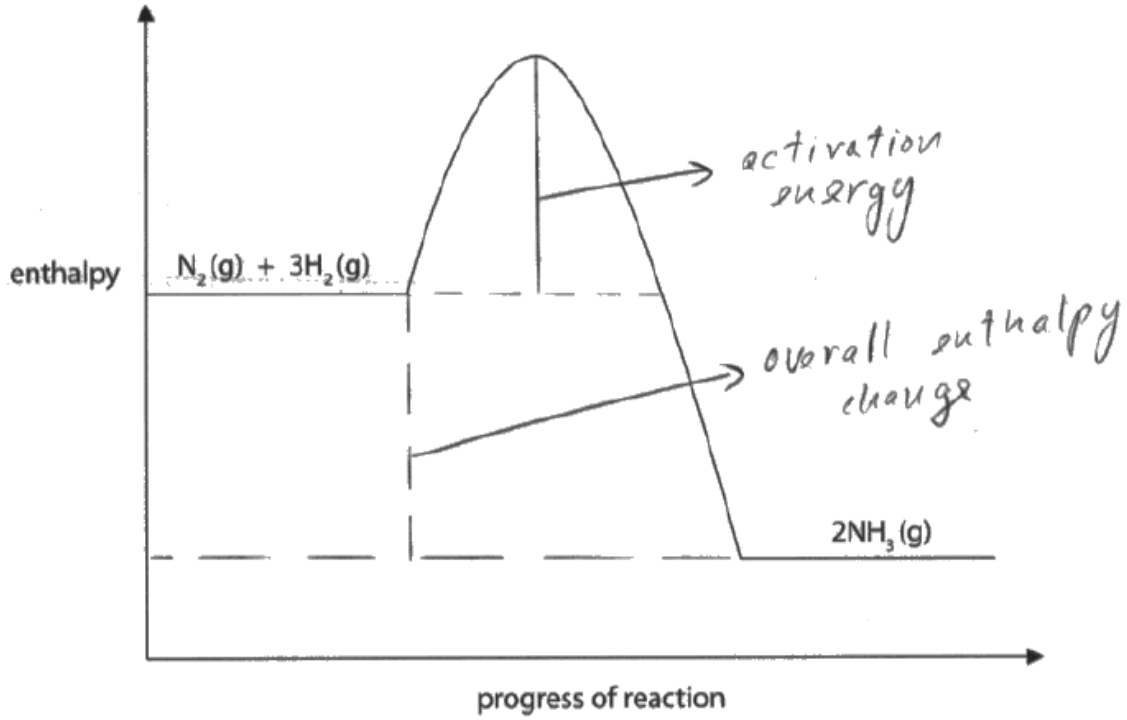


In

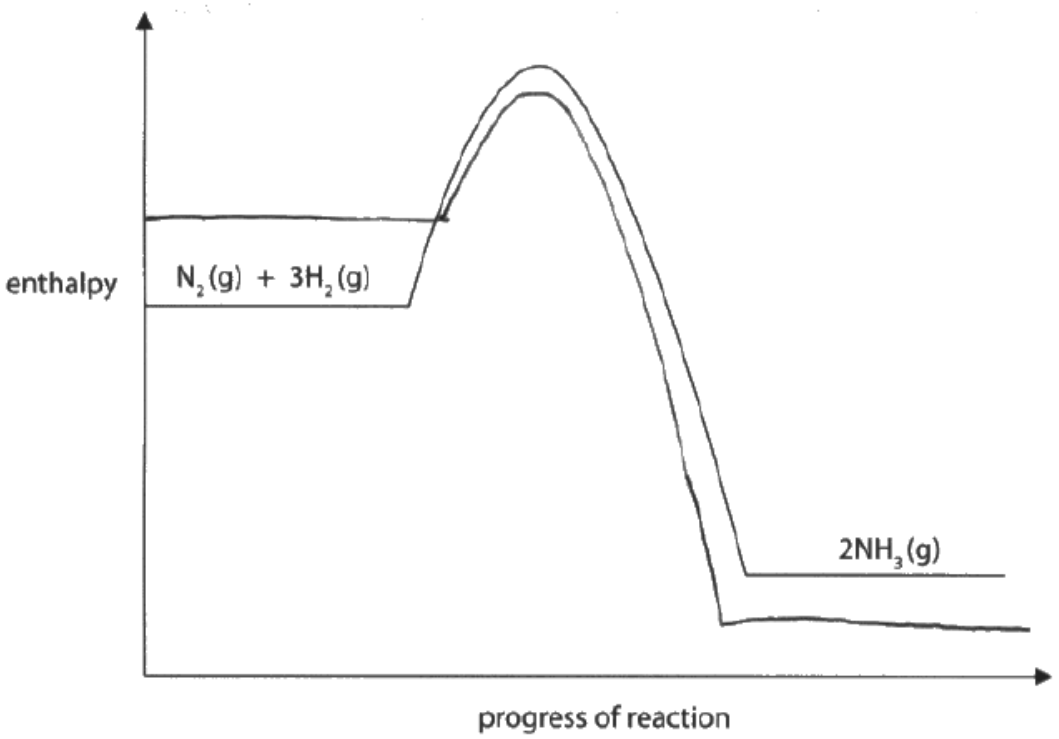
This response, the candidate has correctly drawn the catalysed enthalpy profile underneath the uncatalysed profile diagram (with appropriate start and end points). Whilst not required, the candidate has clearly shown the effect on the activation energy in their diagram (1 mark awarded).

Many candidates struggled to correctly draw the reaction profile curve for the catalysed reaction on to the original diagram, revealing poor recall. Common errors observed included:

- Not starting the curve at the reactant level and/or not ending at the product level
- Drawing a completely separate reaction profile diagram
- Only labelling the activation energy on the diagram



In this response, the candidate has simply labelled the activation energy and overall enthalpy change, with no attempt to redraw the curve (0 marks awarded).



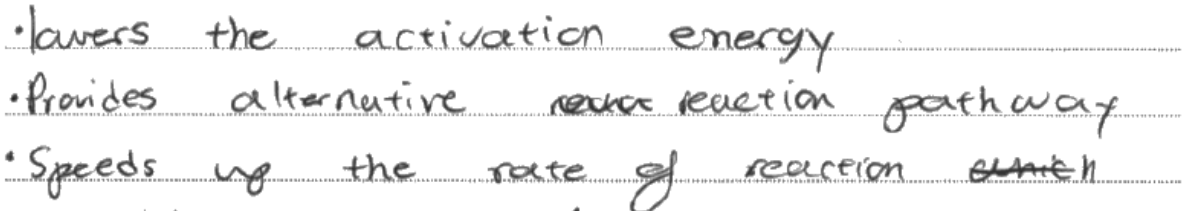
In this response, the candidate has begun the curve at a position higher than the reactants enthalpy level and finished at a position lower than the product enthalpy level (0 marks awarded).

Question 2b

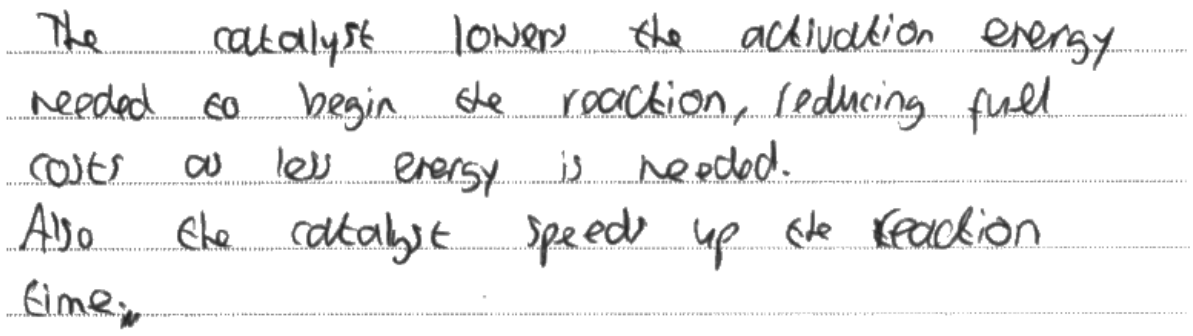
Responses to this question generally received credit but it was rare to see full marks awarded.

Most candidates were able to identify one or two relevant effects of a catalyst, often that the rate of reaction was increased, less energy was required or that an alternative route of reaction was followed.

The catalyst being "unchanged" was also common but is not an effect of <u>using</u> the catalyst, as stated in the question. Many candidates also gave "lowering the activation energy" as a response, but this had clearly been established in the introductory context of the question, and could therefore not be awarded credit for repetition of the point.

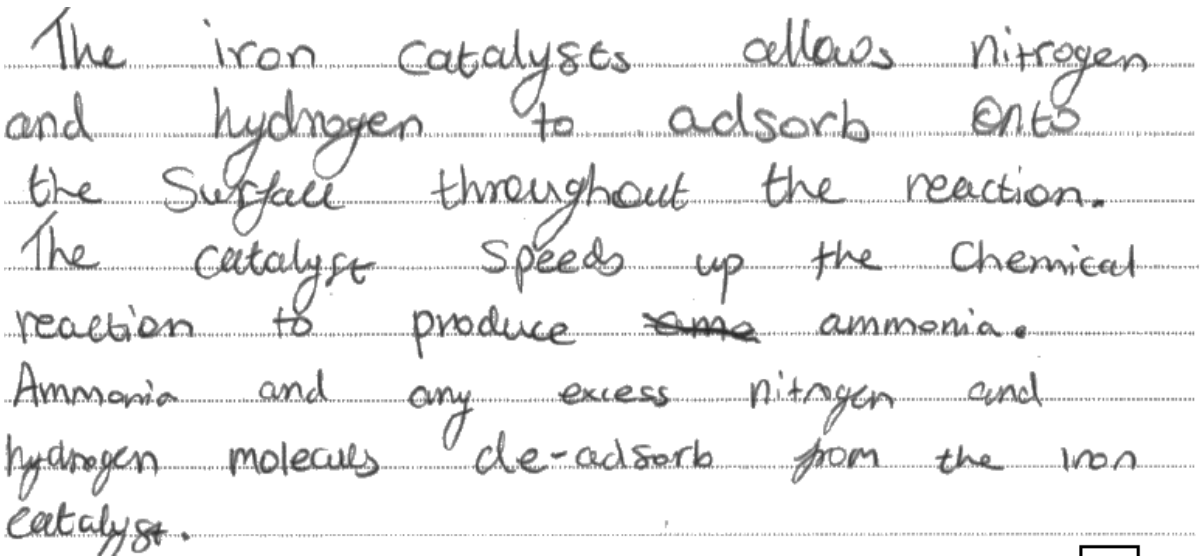


This response begins with "lowers the activation energy" which is not credit worthy. However, reference to providing an "alternative reaction pathway" and speeding up the rate of reaction are two valid points (2 marks awarded).



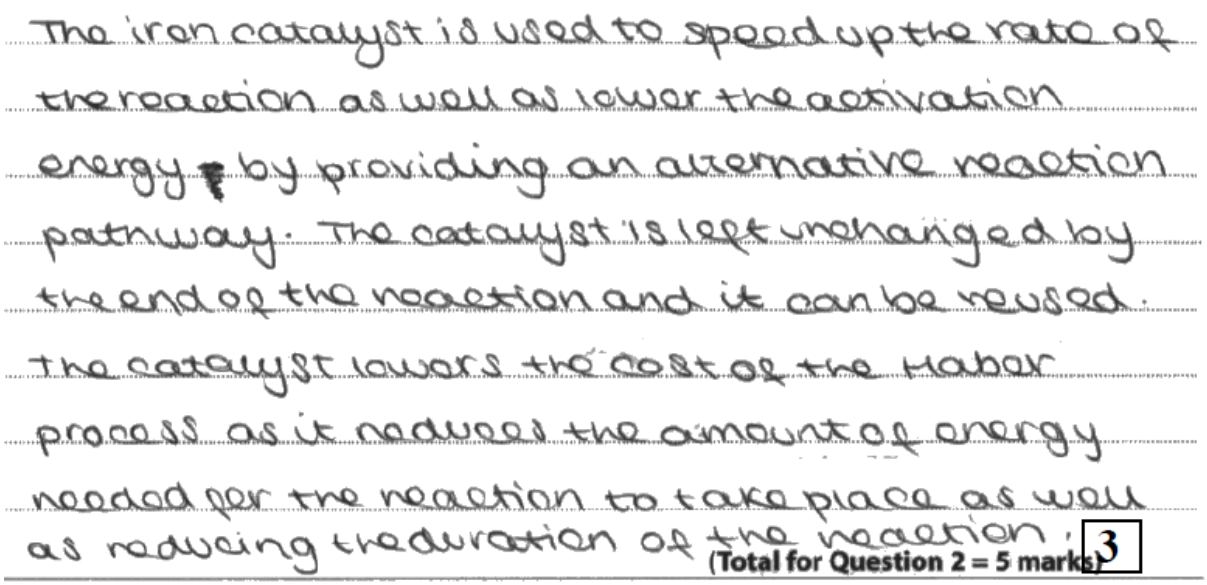
This response also begins with "lowers the activation energy" but does recognise that this means that less energy / fuel is required and that rate of reaction speeds up (2 marks awarded).

Only occasionally, did some candidates provide deeper understanding of how the catalyst actually provided an alternative route.



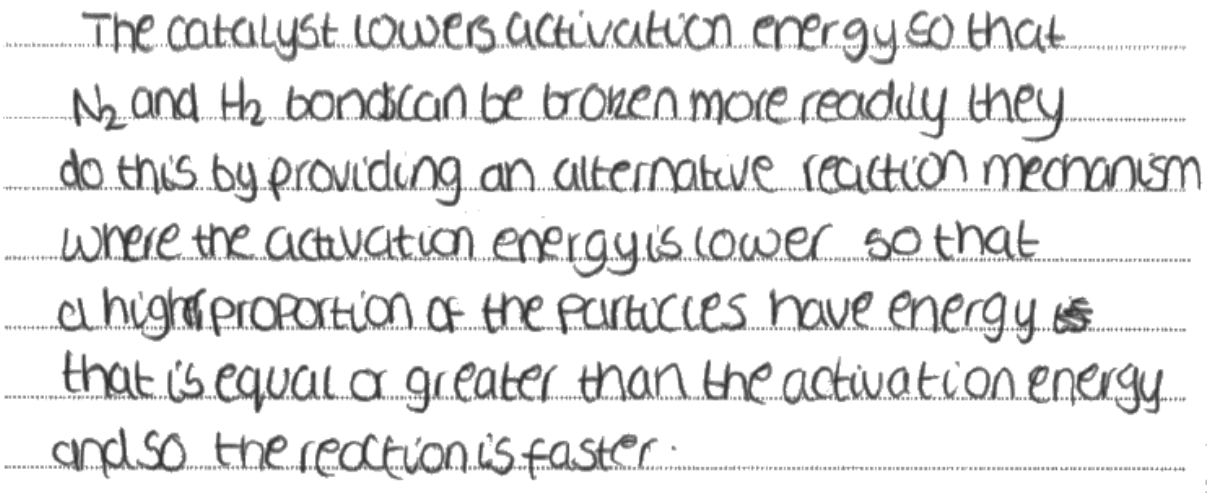
In this response, the candidate recognises the importance of the surface of the catalyst in speeding up the reaction. The answer could have been developed further to refer to weakening of bonds, more successful reactions or even that this is an alternative route in order to achieve full marks (2 marks awarded).

Stronger candidates tended to structure their responses better, following a chain of reasoning so that an effect was identified, explained and consequence given.


The iron catalyst is used to speed up the rate of the reaction as well as lower the activation energy by providing an alternative reaction pathway. The catalyst is left unchanged by the end of the reaction and it can be reused. The catalyst lowers the cost of the Haber process as it reduces the amount of energy needed per the reaction to take place as well as reducing the duration of the reaction.

(Total for Question 2 = 5 marks) 3

In this response, the candidate identifies the key reason for the use of a catalyst (i.e. to speed up rate) and follows through with sound reasoning (i.e. providing an alternative reaction pathway, and reducing the energy needed). The answer could have been developed further to refer to a lowering of temperature as a consequence of the reduced need for energy (3 marks awarded).



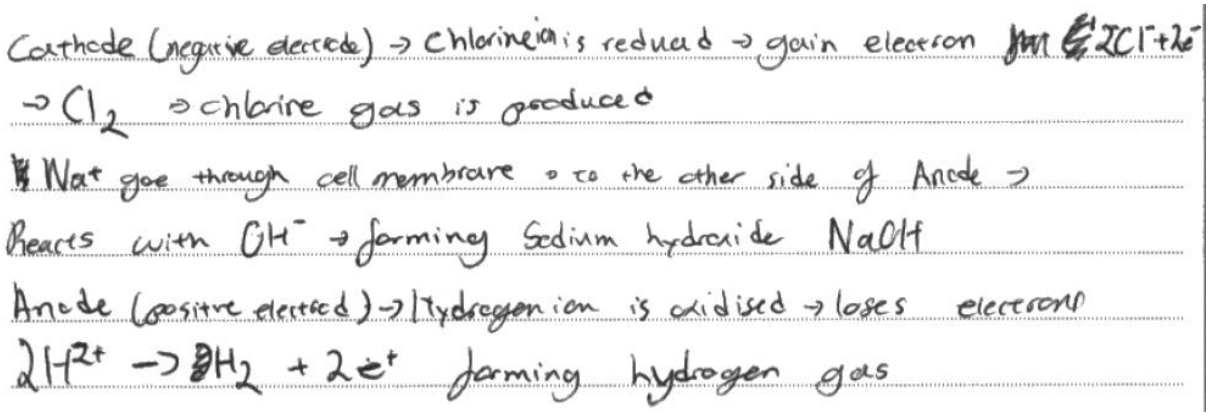
In this response, the candidate puts forward several key ideas and links them - that the bonds in nitrogen and hydrogen molecules are more easily broken, which is an alternative reaction mechanism, and that there is a greater proportion of particles that now have the energy to react. This builds up to the key effect identified by the candidate that the reaction is faster (4 marks awarded).

Question 3

This question relates to content from A1: Relating properties to uses and production of substances and A3: Energy changes in industry. There is a particular focus on the electrolysis of brine, the definition of the standard enthalpy change of hydration, energy calculations and consideration of the differences in standard conditions.

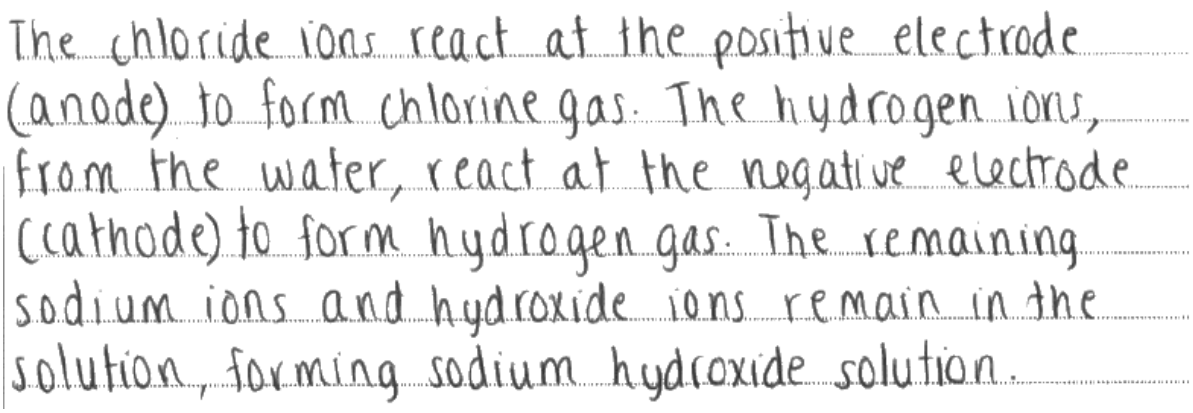
Question 3a

A large number of candidates scored 2 or all 3 marks. Generally, two marks were often gained by simply identifying that chlorine was formed at the anode / positive electrode and hydrogen at the cathode / negative electrode. Some learners, however, did confuse the two. Some good understanding of the processes involved was demonstrated, such as equations and details of membrane cells, but was not relevant to what the question asked which was to describe **where**, not how, the products are made.



In this response, the candidate provides more detail than is required by the question (i.e. equations and processes occurring) and mixes up the products at the cathode and anode. The formation of sodium hydroxide is described but a location of formation is not clearly given (0 marks awarded).

The exact location of the formation of sodium hydroxide was often known (ie around the cathode) for the third mark, but equally, responses would refer to where it exited the cell or provide vague statements such as "the bottom of the cell". Credit was given where candidates recognised that sodium hydroxide formed in the solution, left behind after the chloride and hydrogen ions were discharged.


The chloride ions react at the positive electrode (anode) to form chlorine gas. The hydrogen ions, from the water, react at the negative electrode (cathode) to form hydrogen gas. The remaining sodium ions and hydroxide ions remain in the solution, forming sodium hydroxide solution.

In this response, the candidate accurately answers the question by simply giving the locations that each product is found at (3 marks awarded).

Question 3b

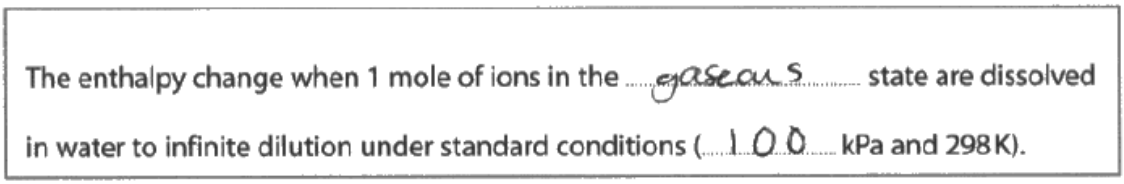
A large number of candidates were not able to complete the definition for the standard enthalpy change of hydration, despite equations being given that showed the ions in the gaseous state of matter.

Common responses given in place of "gaseous" included:

- Standard
- Aqueous
- Liquid
- Solid
- Hydration

Equally, candidates were not able to recall 100kPa as being standard pressure. Common responses given in place of "100" included:

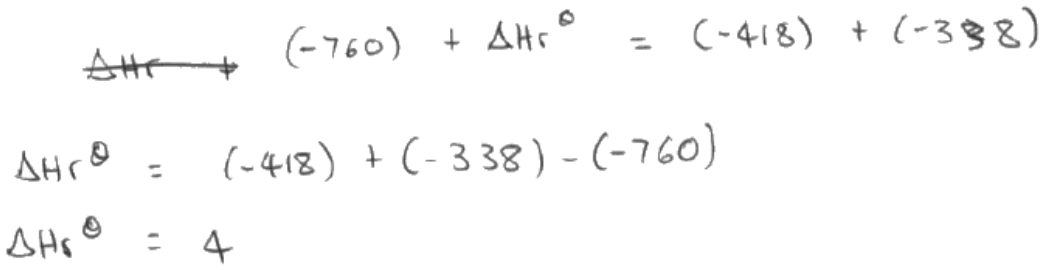
- 1
- 101
- 273
- 1000
- 1×10^5



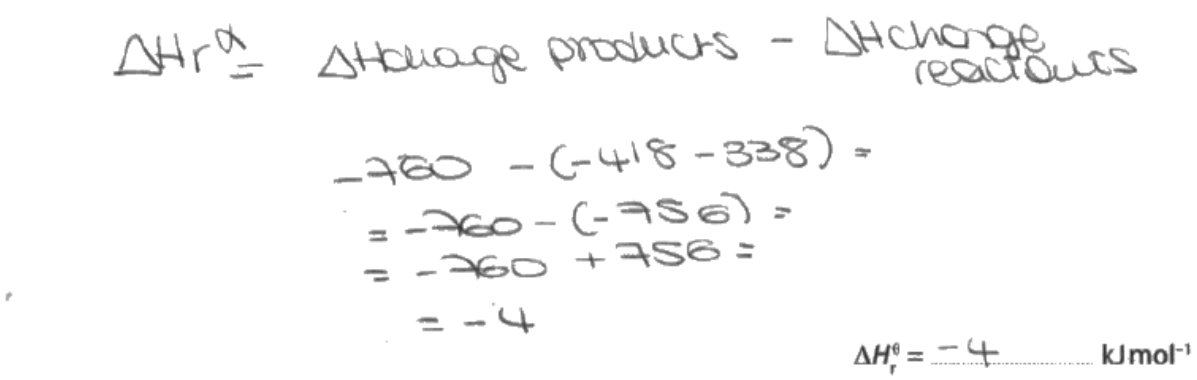
The candidate has completed the definition correctly and is awarded both marks (2 marks awarded).

Question 3c

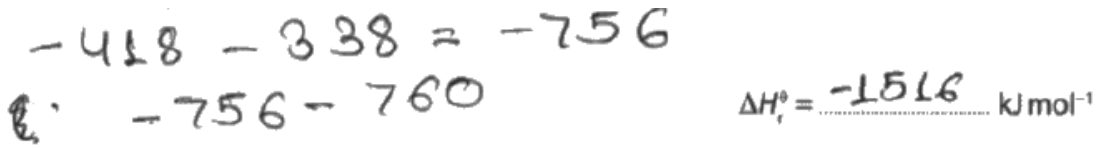
In general, candidates were usually able to achieve 2 marks on this question. Frequently, this was by way of an incorrect calculation where the answer given matched one of the commonly derived values shown in the mark scheme. The most common issue for learners was that they had not reversed the sign of -760 and so either calculated the answer to be -4 or gained two working marks for the summation of -418 and -338 and an evaluation. A significant number of candidates showed good understanding and carried out the calculation accurately to gain 3 marks. A few initially produced creditworthy responses and then proceeded to divide their answer by a number, for no accountable reason. There were occasions where no attempt had been made at all, and candidates should always be encouraged to attempt and show their working as the probability of achieving at least 1 mark is good.



In this response, the candidate correctly gives 4 as the answer. The working clearly shows a good understanding of how to solve this problem, with the summation of -418 and -338, and the reverse of the sign for -760 (3 marks awarded).



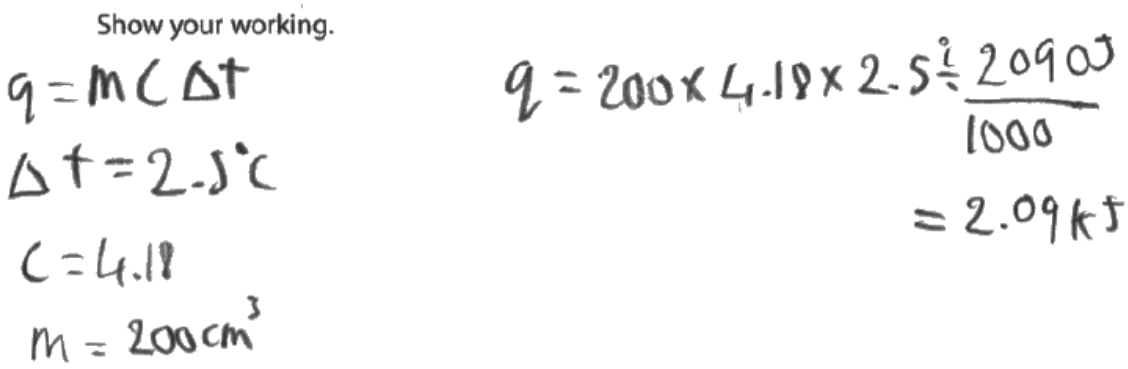
In this response, the candidate incorrectly gives -4 as the answer. The working clearly shows the summation of -418 and -338, but has reversed the sign of this rather than of -760. The evaluation of this sum is correct (2 marks awarded).



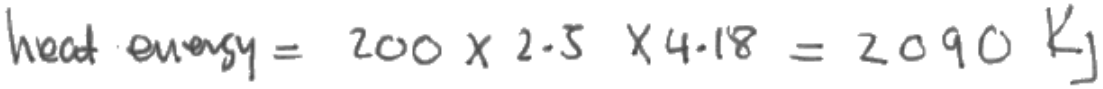
In this response, the candidate incorrectly gives -1516 as the answer. The working clearly shows the summation of -418 and -338, but also of -760. The evaluation of the sum is correct (2 marks awarded).

Question 3d (i)

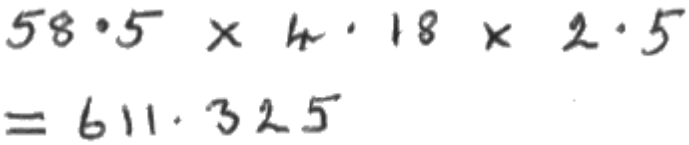
Only a small proportion of candidates scored the full 3 marks. The majority scored 2 marks, using the equation provided correctly but losing a mark by not converting the mass to kg. A number of candidates unnecessarily determined a new temperature change value to use, either by converting to Kelvins or subtracting the temperature change from an arbitrary room temperature. A smaller number of candidates calculated the relative formula mass of sodium chloride to use as the mass.



In this response, the candidate correctly gives the answer 2.09kJ and provides their working (3 marks awarded).



In this response, the candidate incorrectly gives 2090 as the answer, having omitted to divide through by 1000 to convert to kJ (2 marks awarded).



In this response, a mass of 58.5 has been used (presumably the RFM of NaCl) to give an answer (0 marks awarded).

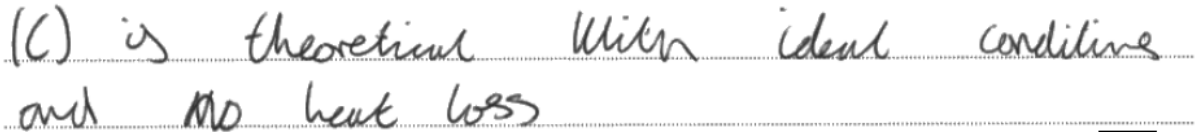
Question 3d (ii)

This question proved challenging for the majority of candidates. The key word within the question was "valid" and so candidates needed to provide a response which identified why the values were not comparable.

Responses that were not creditworthy included:

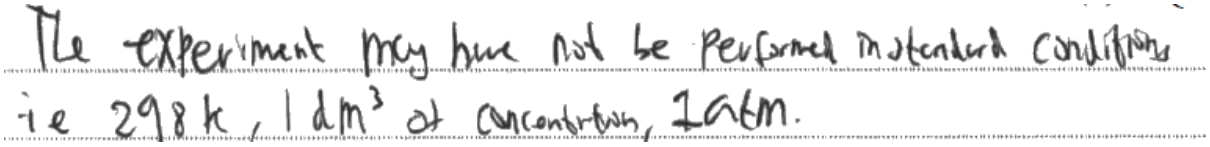
- one was heat change and the other was enthalpy change
- one was endothermic and the other was exothermic
- heat loss or experimental error in 3(d)(i)
- theoretical / estimated value in 3(c) or how this calculated
- different masses of water or different specific heat capacities were used in the calculations

These are not reasons that would undermine the validity of the comparison.

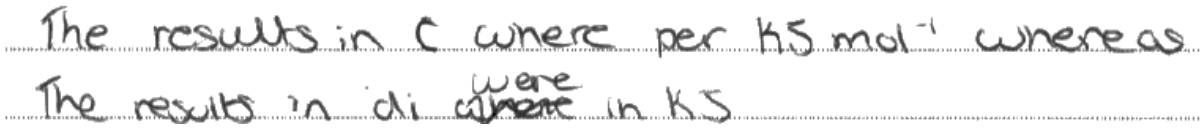


In this response, the candidate's reasoning is that a theoretical value cannot be compared against a practically derived value – whilst this is an argument about the accuracy or reliability of the values, it is not relevant to the validity of comparing the two values (0 marks awarded).

Credit-worthy answers varied in depth of understanding. Some responses only just achieved the mark for commenting that there was a difference - "different units" or "different conditions". Better answers were more specific, such as identifying kJ mol^{-1} in 'c' and kJ in 'd(i)', or identifying that the value in 'c' was determined under standard conditions, whilst 'd(i)' gave no indication.



(1 mark awarded)



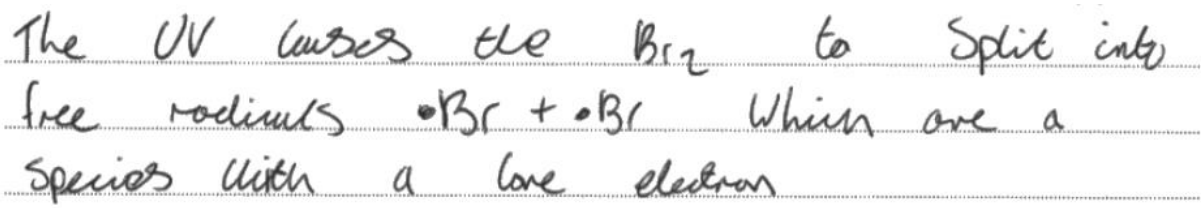
(1 mark awarded)

Question 4

This question relates to content from A2: Structures, reactions and properties of commercially important organic compounds. There is a particular focus on the initiation step in a free radical mechanism, naming and drawing structural formulae, and identifying structural features to explain chemical reactivity.

Question 4a

Most candidates were able to give a good attempt in response to this question, but with varying degrees of success. The idea of what was occurring in the first stage of the reaction was familiar to most, and 1 mark was normally awarded where the formation of free radicals was referred to.



(1 mark awarded)

However, both marks were only achievable if deeper understanding was shown (i.e. that bromine free radicals were formed by the breaking of the bond in Br_2). The level of technical language required to answer this question was therefore high and it was pleasing to see reference to homolytic bond fission being applied correctly.

It causes the formation of a free radical - $Br_2 \rightarrow 2Br\bullet$ by homolytic bond fission of an ~~outermost~~ the Halogen.

(2 marks awarded)

Answers that did not achieve any marks were frequently because the use of correct terminology was poor, irrelevant information about catalysis or energy was presented, or that there was confusion about which molecule was affected by the ultraviolet light.

Ultraviolet triggers the initiation process therefore, it radicalises ~~the~~ one of the elements. The radicalised element is very reactive (highly) therefore, it is exposed for an electron to be attracted and react.

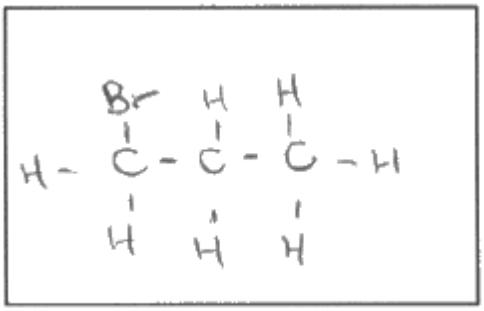
(0 marks awarded)

The Ultraviolet (UV) light provides heat which gives the particles more kinetic energy thus they collide more and can react. The UV light also helps breakdown the reactants making them easier to react.

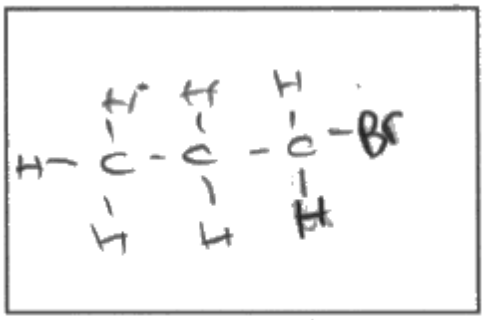
(0 marks awarded)

Question 4b (i)

Most learners were able to provide a sensible displayed structural formula for a bromoalkane, but this was just as likely to be a version of 1-bromopropane rather than the expected answer of 2-bromopropane.

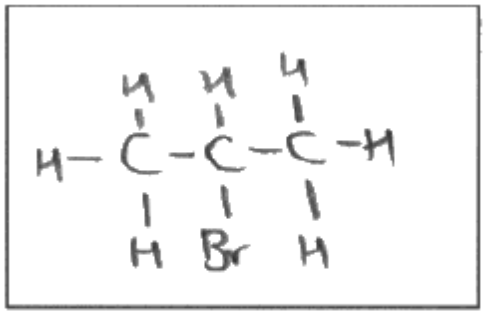


bromoalkane Y

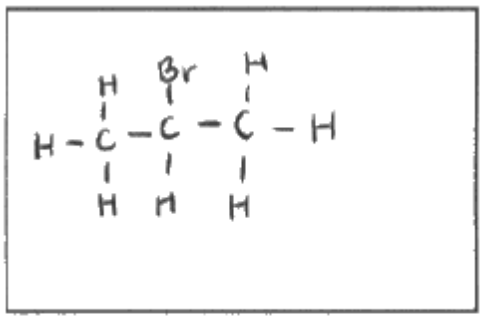


bromoalkane Y

(0 marks awarded)



bromoalkane Y



bromoalkane Y

(1 mark awarded)

It was rarer to see other answers, but a range of molecules which had double bonds or HBr intact, showed that these candidates did not appreciate what type of reaction was occurring, in spite of the example provided by bromoalkane X. Occasionally, a molecular formula was observed, which indicated that the term "displayed structural formula" was not understood.

Question 4b (ii)

Only a small section of the candidates were able to identify that the reason that propene could form two bromoalkanes was because it was asymmetrical. Whilst all four options were selected, propene having cis and trans isomers was the most popular choice. This is most likely because this type of isomerism is closely associated with alkenes, but candidates need to be aware that not all possess this feature.

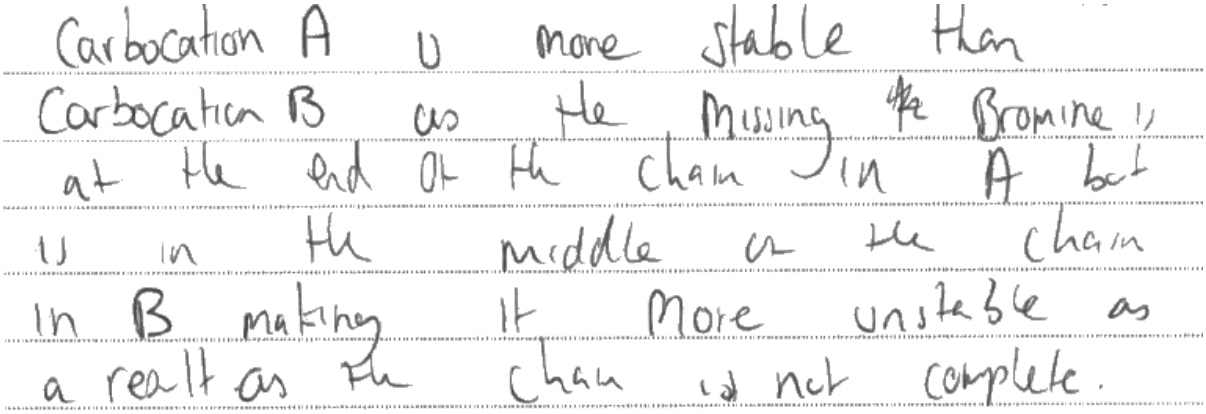
Question 4b (iii)

The correct answer of 1-bromopropane was the most common choice for amongst candidates, revealing that naming and numbering conventions for organic molecules are generally well known. A smaller proportion of candidates selected 3-bromopropane, revealing that more practice in numbering convention is required. Options which contained the suffix "_ene" were almost entirely avoided.

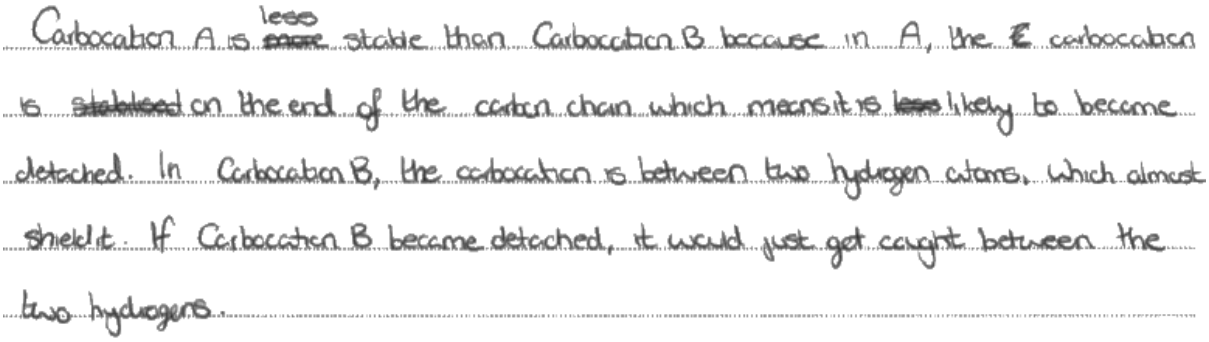
Question 4b (iv)

This was a challenging question and designed to stretch the most able, but would still provide weaker candidates an opportunity to achieve 1 or 2 marks.

A majority of learners only achieved the mark for the comparison of stability, that carbocation A was less stable than B. An incorrect comparison made attainment of further marks unlikely. It was often the case that a poor understanding of stability in this context was observed, irrespective of whether the comparison was correctly made or not. Stability was often taken to mean reactivity and explanations of the mechanism often ensued.


Carbocation A is more stable than Carbocation B as the Missing the Bromine is at the end of the chain in A but is in the middle of the chain in B making it More unstable as a result as the chain is not complete.

In this response, the candidate has incorrectly identified that carbocation A is more stable than carbocation B and there is no other credit worthy point given (0 marks awarded).


Carbocation A is ~~more~~ less stable than Carbocation B because in A, the C carbocation is ~~stabilised~~ on the end of the carbon chain which means it is ~~less~~ likely to become detached. In Carbocation B, the carbocation is between two hydrogen atoms, which almost shield it. If Carbocation B became detached, it would just get caught between the two hydrogens.

In this response, the candidate has correctly identified that carbocation A is less stable than carbocation B for 1 mark. There are no further credit worthy points (1 mark awarded).

Responses that gained 2 marks tended to be those that were able to give sensible and relevant comment about the features surrounding the positively charged carbon, rather than simply identify its location. The use of Figure 5 by some candidates helped to convey their ideas.

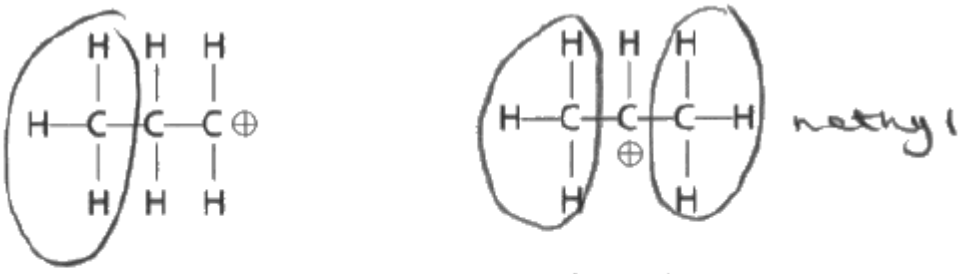


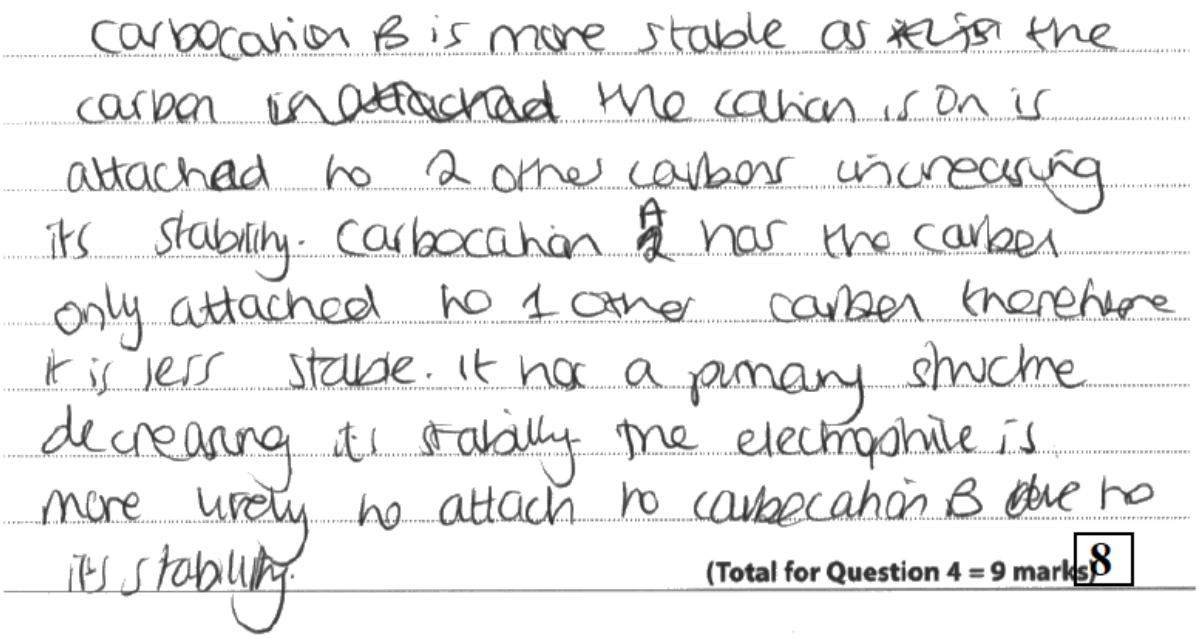
Figure 5

Carbocation B is more stable as it has 2 - alkyl groups, whereas carbocation A has one alkyl group, thus making it less stable. A carbocation is more stable if it has more than one alkyl group. Carbocation A will be less stable as it will be more eager to ~~bid~~ have an attacked atom in order to have two alkyl groups.

In this response, the candidate has correctly identified that carbocation B is more stable and describes relevant differences in the structures for the first two marks. The use of the images has assisted the candidate in their response (2 marks awarded).

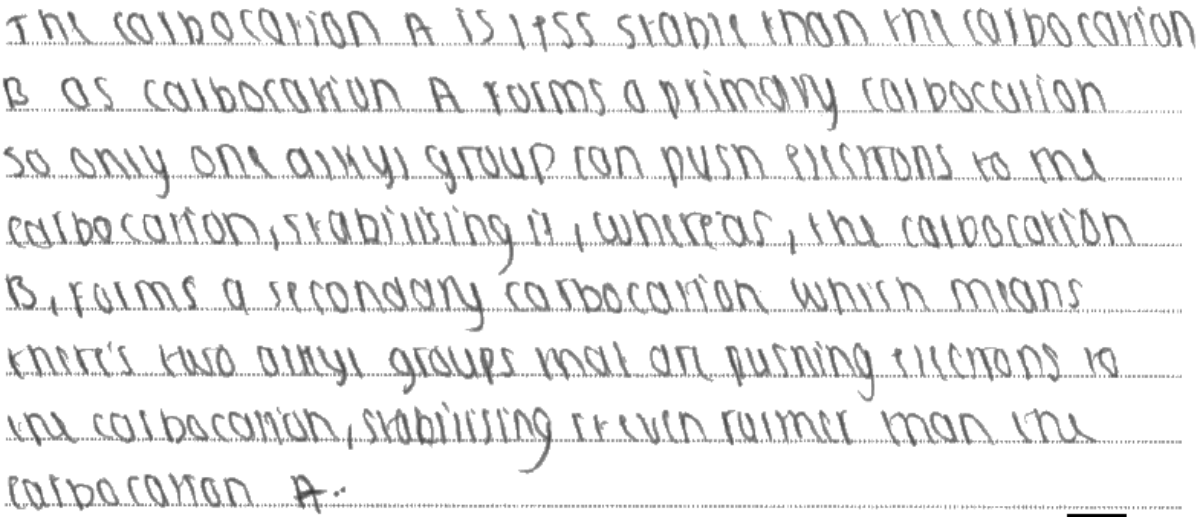
The best responses tended to use better terminology such as alkyl or methyl groups, or primary and secondary carbocations. Again, if there was no reference to this, gaining more than 2 marks on this question was unlikely.

Responses gaining 3 or more marks needed reference to electrons being pushed towards the positive charge, and this effect was only known and expressed coherently by the very best candidates.


carbocation B is more stable as the carbon in attached the cation is on is attached to 2 other carbons increasing its stability. carbocation A has the carbon only attached to 1 other carbon therefore it is less stable. it has a primary structure decreasing its stability the electrophile is more likely to attach to carbocation B due to its stability.

(Total for Question 4 = 9 marks) 8

In this response, the candidate has correctly identified that carbocation B is more stable and describes relevant differences in the structures for the first two marks. A further mark is awarded for expanding the point that an electrophile is more likely to attack carbocation B (3 marks awarded).



In this response, the candidate has correctly identified that carbocation A is less stable. A high level of understanding is shown as the candidate uses the terms primary and secondary carbocation accurately in this context. The relevance of this is expanded upon further by identifying that an alkyl group pushes electrons and that as B has two alkyl groups the carbocation is stabilised more (4 marks awarded).

Question 5

This question relates to content from A2: Structures, reactions and properties of commercially important organic compounds, specifically the commercial importance of the hydration of ethene.

The extended response question offered opportunity for candidates to analyse the information in the table and construct a discussion on the advantages and disadvantages of the manufacture of ethanol from ethene. Candidates that scored no marks arose generally because the question was unattempted. The majority of candidates were able to provide credit worthy answers across the three levels, but in the main, most candidates were in either level 2 or lower level 3 – it was rare to see candidates score either 1 or 6 marks.

Key issues found with responses were:

- identifying that a reversible reaction was an advantage as there was no waste or reactants could be reused
- not fully demonstrating what was known by yield and thereby not qualifying why a lower yield was a disadvantage
- too much reliance on vague statements of "cost", "abundance", "pollution" and "environmentally friendly" to explain an advantage or disadvantage
- simply identifying which process was continuous and which was batch, without explaining what this meant or how it was advantageous or not
- ignoring the comparison of the catalysts or identifying that only hydration of ethene had a catalyst

Level 1 responses tended to provide simple statements of comparison about the two methods of production but without much, if any, expansion (eg hydration of ethene uses a higher temperature than fermentation) or with an explanation that was incorrect or incoherent. More often than not, candidates would achieve 2 marks at this level as the majority of the information from the table was used and at least one point of comparison was expanded upon correctly.

Level 2 responses built upon basic points of comparison by providing some further detail that went beyond the table or had an argument for their point, albeit sometimes not fully developed. At this level, candidates were able to expand upon at least a couple of areas to justify why they were an advantage or disadvantage, and this was typically temperature, sources of the raw materials or the type of process involved. However, information was not always correctly evaluated (eg a reversible reaction means that nothing goes to waste) or was scientifically correct but poorly applied to the context (eg the

catalyst in the hydration of ethene lowers the activation energy, yet a similar argument for yeast in fermentation was overlooked). Many candidates provided responses at this level, with both 3 and 4 marks being equally observed.

Level 3 responses generally included a detailed consideration of advantages and disadvantages of fermentation, alongside that of the hydration of ethene, which consolidated the points being made. A broader recall of specific detail beyond the table for either hydration of ethene or of fermentation was also often evident at this level. These responses also tended to have a better and clearer understanding of more challenging comparisons such as the catalysts used, rate, waste products formed and the significance of the yield, but it was rare to see these linked as a comprehensive analysis and sustained application (eg the continuous process compensates for a low yield by producing ethanol faster and recycles any unused reactants to make the reaction more efficient). Consequently, although a number of responses were seen at Level 3, these were frequently awarded 5 marks rather than 6 marks.

Level 1 (2 marks)

Disadvantages:
The conditions required using the Hydration of ethene method would be more costly. This is because firstly the temperature needed is 300°C which is higher than the temperature needed for fermentation. Also crude oil is needed as a source which [illegible] releases pollution into the environment whereas plant material [illegible] [illegible]
Also a smaller amount of yield is produced then fermentation meaning that fermentation is more effective. Also this reaction is reversible. Also crude oil is needed as a source which releases pollution into the environment whereas plant material is more enviormentally friendly

Advantages:
A continuos process is used for hydration of ethene but in fermention the Batch Process is used. The continuos process is better than the batch process as [illegible] the batch process only produces small amounts of the product at a time.

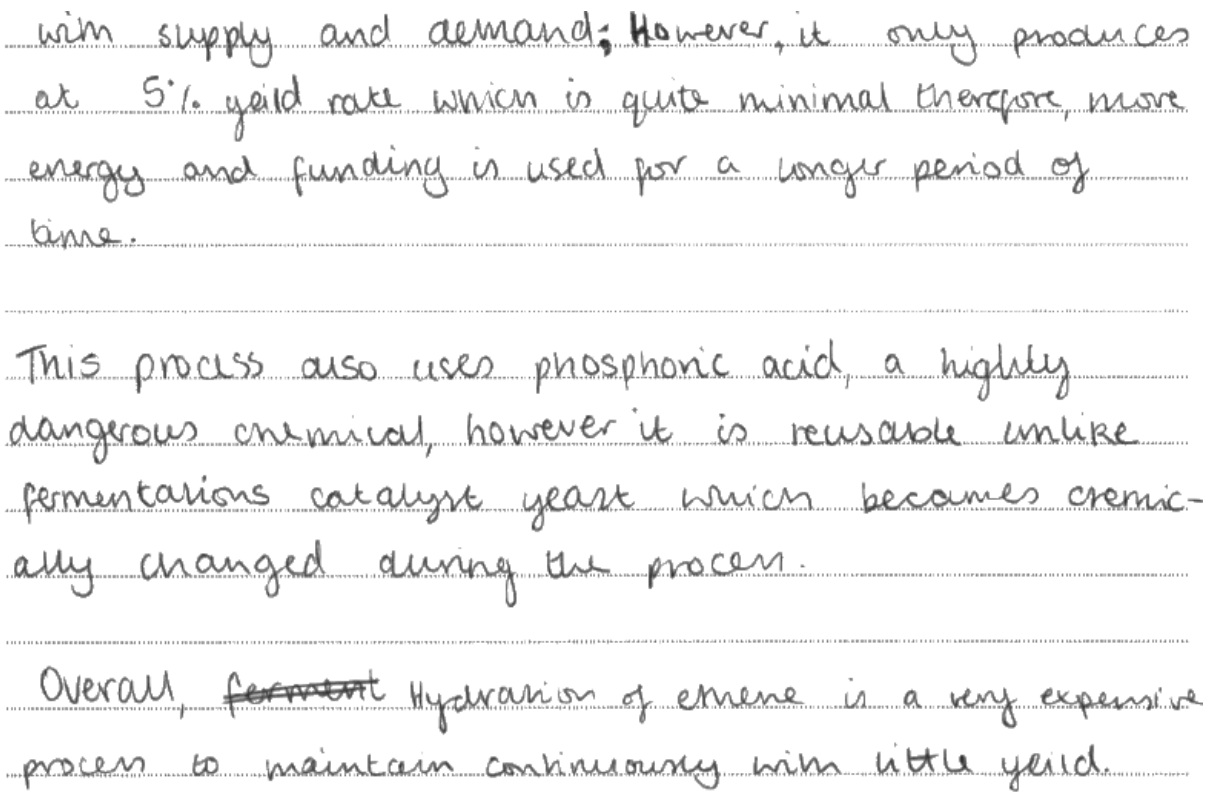
In this example, the candidate has made simple comparisons between the two processes which would be considered adequate (e.g. temperature is higher in hydration of ethene, the yield is lower in hydration of ethene). Expansion of the

points is not presented in most cases, but there is the occasional attempt (eg batch process only produces small amounts of product at a time) and often is not explained (e.g. crude oil releases pollution, plant material is environmentally friendly) which show that lines of reasoning are only partially supported. The discussion shows some structure and coherence. This places the response at the top of Level 1 and 2 marks can be awarded.

Level 2 (3 marks)

The production of ethanol by the hydration of ethene has many disadvantages compared with fermentation. Hydration of ethene requires cracking crude oil, a well known fossil fuel which, when burnt, is harmful to the environment, this process also requires high temperatures; an expensive ~~process~~ condition to maintain. Fermentation only requires 310k compared to hydration of ethene's 500k.

Hydration of ethene however, is a continuous process; this is an advantage as production can keep up


with supply and demand; However, it only produces at 5% yeild rate which is quite minimal therefore, more energy and funding is used for a longer period of time.

This process also uses phosphonic acid, a highly dangerous chemical, however it is reusable unlike fermentations catalyst yeast which becomes chemically changed during the procen.

Overall, ~~fermentt~~ Hydration of ethene is a very expensive procen to maintain continuously with little yeild.

In this example, the candidate has looked at a range of information from the table (i.e. the source and production of reactants, temperature difference, process and yield, and catalyst used). However, whilst the areas show some good ideas (e.g. continuous allows supply and demand to be met, low yield for the energy and funding required), these are not always well linked (e.g. cracking and burning of crude oil) or developed (e.g. why high temperature is expensive, why phosphoric acid is dangerous). The discussion shows a structure which is mostly clear, coherent and logical. This places the response at Level 2 and 3 marks can be awarded as the lines of argument were not always supported.

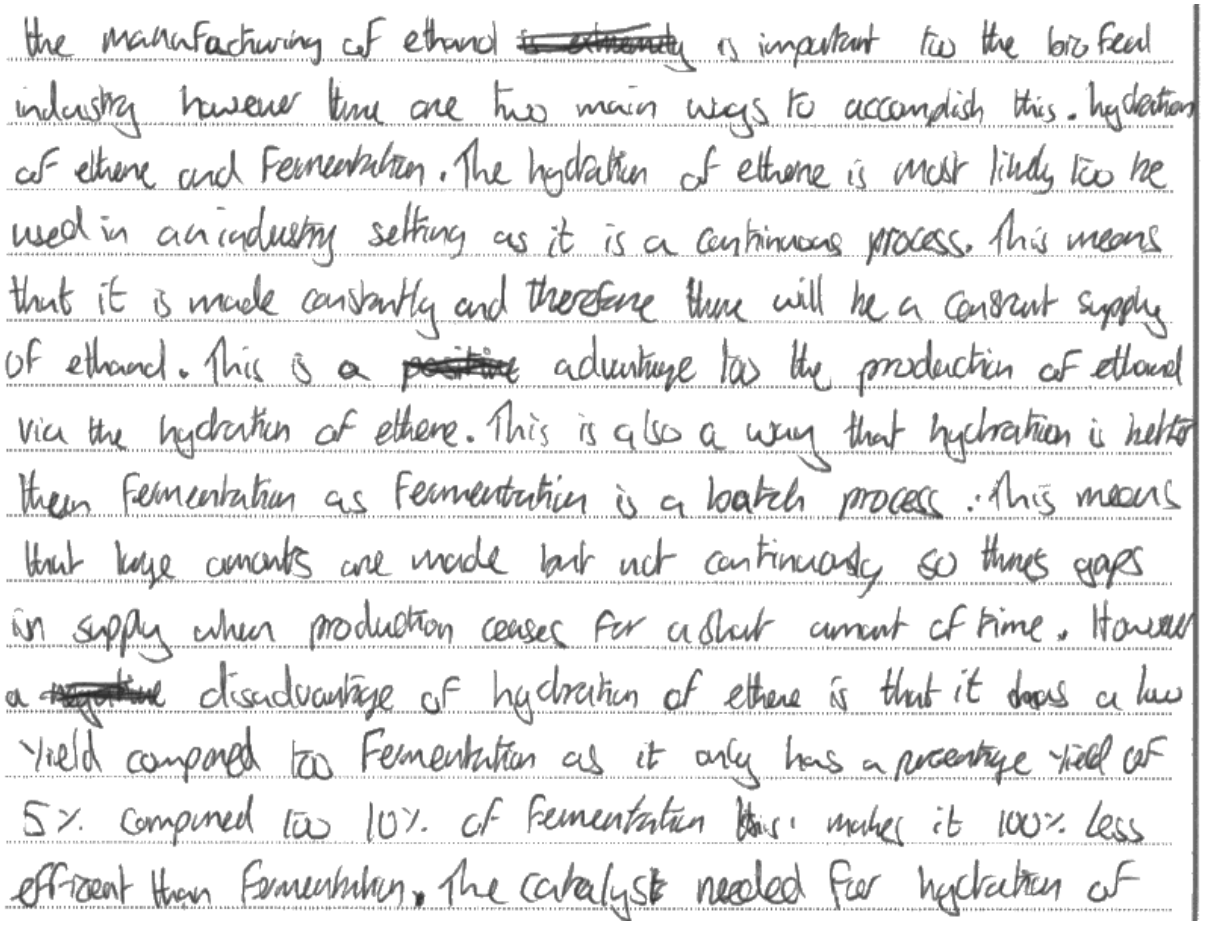
Level 2 (4 marks)

The chemical reaction needed to produce ethanol is reversible, meaning the product can reverse back into its reactants. This can be an advantage as the reactants can be used for another type of reaction or manufacturing process. The reaction uses water as one of its reactants, which is easily accessible and available in large quantities. The other reactant however, ethene is ~~se~~ made from the fractional distillation of crude oil, which is a finite resource and the burning of which can lead to global warming. Another disadvantage is that this process requires ~~harsh~~ harsh conditions such as high temperature (500K) and a ~~dangerous~~ catalyst of phosphoric acid, which can be dangerous if used in high concentrations. The phosphoric acid must be used and disposed off carefully to prevent any environmental damage. These conditions ~~can~~ can be difficult to maintain and hence can make the process expensive. The process only produces 5% of ethanol, which is very low considering the factors that help speed up the process — high temperatures and catalyst. ~~Its~~ Despite this, ethanol is continously made, which allows ethanol to be produced at all times.

In this example, a good range of the information from the table has been used and interpreted within the discussion (i.e. the type of reaction and process, the reactants and their source, temperature, catalyst, and yield). The lines of argument and expansion vary in their logic from sound (e.g. phosphoric acid being dangerous in high concentrations, low yield countered by a continuous process) to muddled (e.g. reversible reaction being an advantage as the reactants can be used for something else, ethene being made from fractional distillation). The discussion shows a structure which is mostly clear, coherent

and logical. This places the response at the top of Level 2 and 4 marks can be awarded.

Level 3 (5 marks)



the manufacturing of ethanol ~~is extremely~~ is important to the biofuel industry however there are two main ways to accomplish this. hydration of ethene and Fermentation. The hydration of ethene is most likely to be used in an industry setting as it is a continuous process. this means that it is made constantly and therefore there will be a constant supply of ethanol. this is a ~~positive~~ advantage to the production of ethanol via the hydration of ethene. this is also a way that hydration is better than fermentation as Fermentation is a batch process. this means that large amounts are made but not continuously so there gaps in supply when production ceases for a short amount of time. However a ~~negative~~ disadvantage of hydration of ethene is that it does a low yield compared to Fermentation as it only has a percentage yield of 5% compared to 10% of Fermentation this makes it 100% less efficient than Fermentation. The catalyst needed for hydration of ethene is phosphoric acid which is more costly than Fermentation which uses yeast which is naturally occuring. Also the temperature needed for hydration of ethene is 500c which is higher than that of Fermentation meaning more energy is needed in hydration of ethene therefore making it more costly and less energy efficient. Also the source of the raw materials is crude oil which is damaging to the environment when mined/pumped this also makes it environmentally damaging. Overall I believe that hydration of ethene is both less efficient both economically and energy wise and has a large negative impact on the environment compared to other options that could be used such as Fermentation.

In this example, the candidate has utilised a good range of the information from the table and interpreted this within their discussion (i.e. the type of process, the reactants and their source, temperature, catalyst, and yield) – there are other areas that could have been considered (e.g. the impact of reversible reaction, consideration of the raw materials used in fermentation) so coverage is not as extensive as it could be. However, the advantages and disadvantages of points identified are expanded upon well and lines of argument are developed in relation to these (e.g. the continuous process as an advantage over the batch process, the higher temperature in hydration needing more energy and cost thereby being less efficient) – in the main this is consistent, although some areas could have been developed further (e.g. the comparison of yield, the issues with the raw materials). The discussion shows a well-developed structure which is clear, coherent and logical. This places the response in Level 3 and is awarded 5 marks as there was scope for further expansion of the points made.

Physics

Q1b (i)

Learners were generally able to identify that the word 'change' was required for this answer. Learners sometimes included an example of what might change, which was ignored as it was only the meaning of the symbol that was required.

Q1b (ii)

Learners found this more challenging than the first question. A typically correct answer is shown.

Most learners giving the correct answer wrote this or the word 'length'. It was rare to see the word 'displacement' used.

Many learners appeared not to have read the question carefully and attempted to give an answer connected in some way to the diagram. Typical incorrect answers were words such as, 'area', 'volume' and 'pressure'.

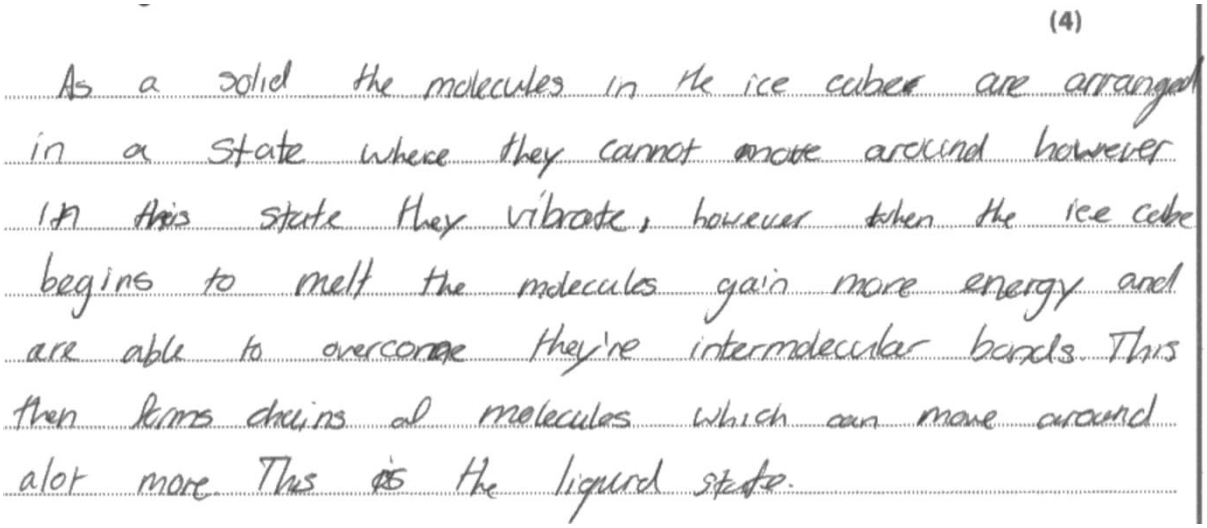
Q2a

This multiple choice question was poorly answered. Many learners confused the idea of Heat/Thermal Capacity and Specific Heat Capacity, giving the incorrect answer D, rather than the correct answer C.

Q2a

The question was designed to test understanding of the process of melting in terms of the behaviour of molecules. Learners were expected to consider the energy transfer involved in the process and the effect on the arrangement of the particles. The question makes clear that learners must make mention of molecules, or an equivalent idea, such as particles in order to gain marks. Many learners gave a general explanation which did not meet this requirement.

This response gained three marks.



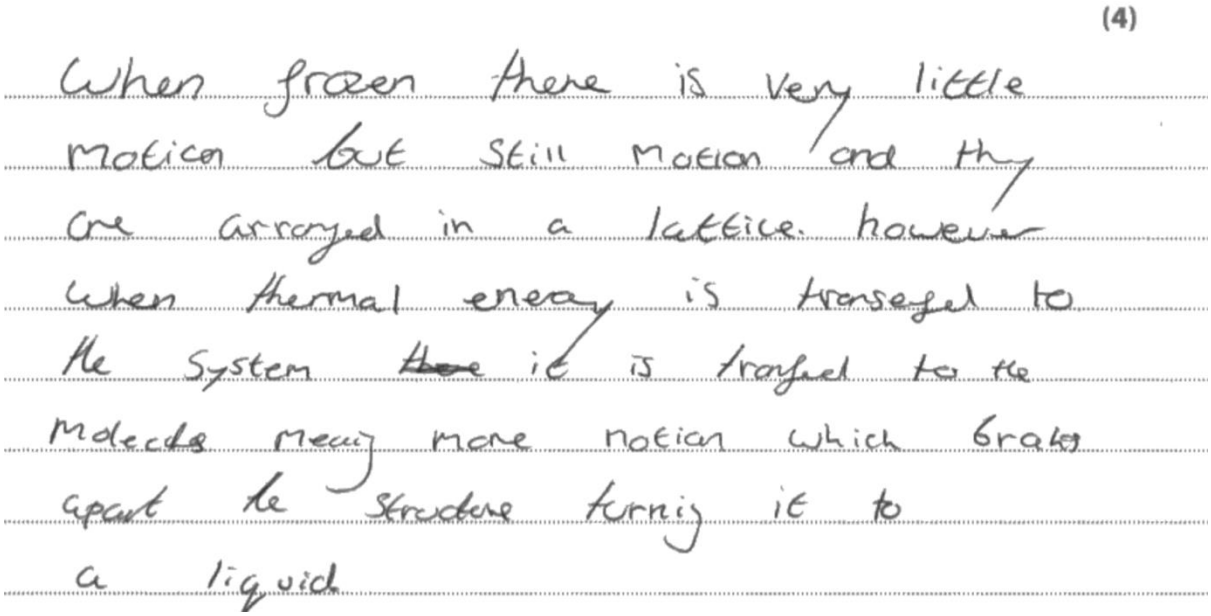
(4)

As a solid the molecules in the ice cubes are arranged in a state where they cannot move around however in this state they vibrate, however when the ice cube begins to melt the molecules gain more energy and are able to overcome they're intermolecular bonds. This then forms chains of molecules which can move around alot more. This is the liquid state.

This response gains the second marking point, and the third and fourth points for a statement about energy gained and then the movement of molecules. There is no comparative statement for the first marking point. Had the learner stated that the molecules move faster or the equivalent, this response would have scored all four marks.

It was rare to see a complete answer to this question.

This response gained two marks.



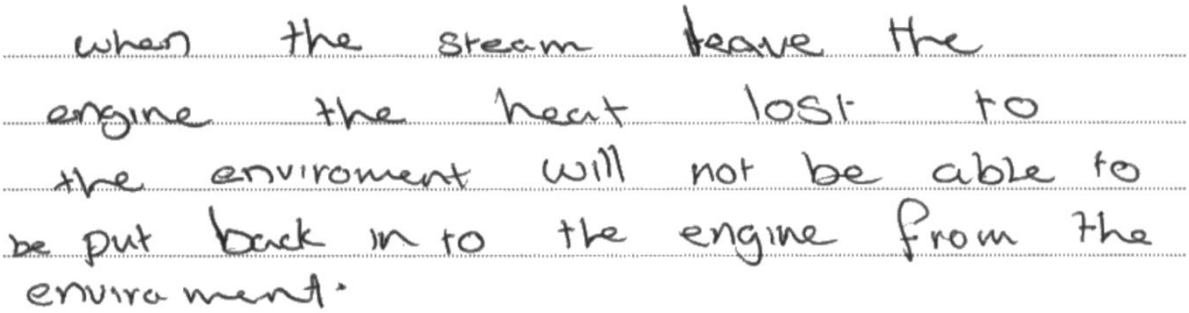
The marks were gained for the second and third marking points. There is no comparative statement for the first marking point and no mention of intermolecular forces for the final point from the mark scheme.

The requirement in this question to use technical language in a correct way was a challenge for many learners.

Q3a (ii)

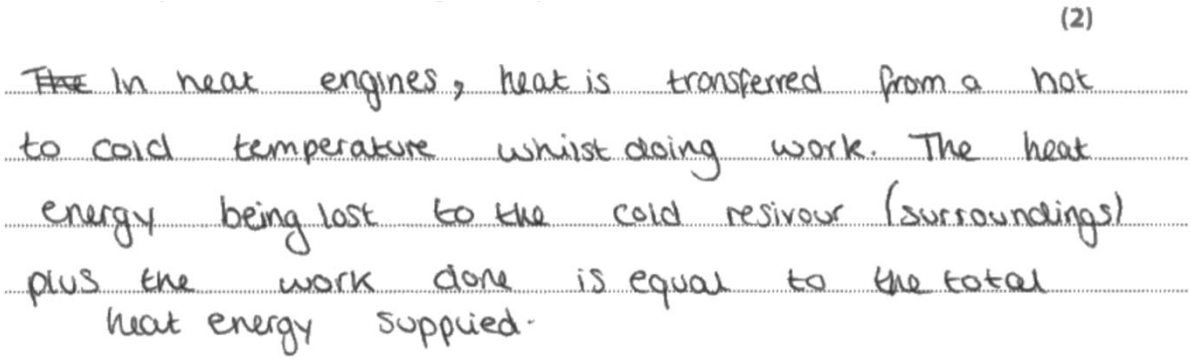
This question was a challenge to many learners. In previous series questions have been asked about the first and second laws of thermodynamics, and responses were weak. This remained the case in this examination, where on this occasion the second law was tested. Learners confused the first and second laws, giving answers relating to energy conservation. The answer expected learners to explain that in this example of a steam engine, that it could not convert all the input energy into work, as some energy is lost to the environment/surroundings.

Some learners were able to arrive at a partial answer. This example gained one mark.



This response gained the second marking point from the mark scheme. There was no indication of the first marking point. Learners that were able to give an incomplete creditworthy response, generally made this kind of point.

This two mark answer was much more rarely seen.


(2)

~~The~~ In heat engines, heat is transferred from a hot to cold temperature whilst doing work. The heat energy being lost to the cold resivour (surroundings) plus the work done is equal to the total heat energy supplied.

This answer gains the first marking point from what is in the additional guidance for the last two lines. The second marking point is also gained for the statement about loss of heat loss to the surroundings.

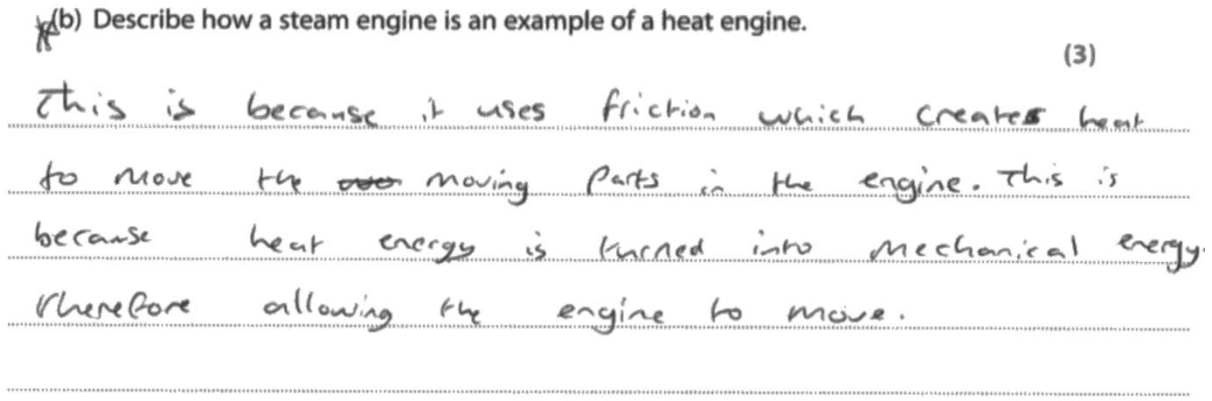
Some learners wrote lengthy explanations for these two marks, but never correctly used the correct language to explain themselves clearly.

Q3b

Learners were asked to describe how a steam engine was an example of a heat pump. The answer had to relate the idea of an energy change from heat to a form of mechanical energy in order to do work. Marks were available for the energy conversion and then for the final idea of work. Some learners answered by considering what happens in a steam engine in terms of steam being raided by heating water, then going on to saying what the steam did, e.g. pushing a piston, moving wheels, etc. If the learner then went on to state that work was done, the final mark could be scored. Many learners were abler to score one or two marks, but frequently missed the last marking point.

Some learners answered by describing a heat pump and gained no credit.

This response gained two marks.

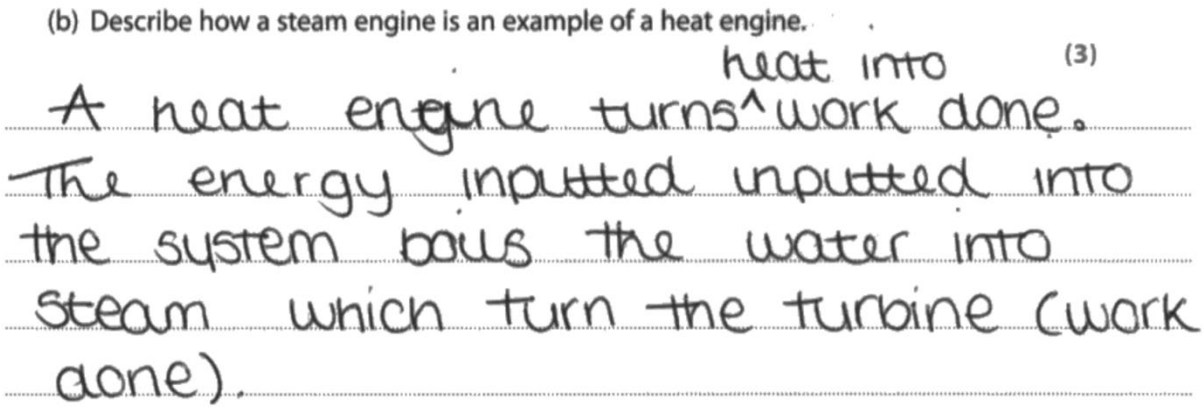

(b) Describe how a steam engine is an example of a heat engine.

(3)

This is because it uses friction which creates heat to move the ~~over~~ moving parts in the engine. This is because heat energy is turned into mechanical energy therefore allowing the engine to move.

This gains the first two marking points on the third line. There is no mention of work done. This response was typical of many that gained marks.

A full three mark response is given here.


(b) Describe how a steam engine is an example of a heat engine.

(3)

A heat engine turns heat into work done. The energy inputted ~~inputted~~ into the system boils the water into steam which turn the turbine (work done).

The learner has written about a turbine which moving which was an acceptable response for the second marking point in the additional guidance. Some learners tried to describe what happened to pressure and volume or considered temperature changes in their answers and drifted away from what the question was asking about.

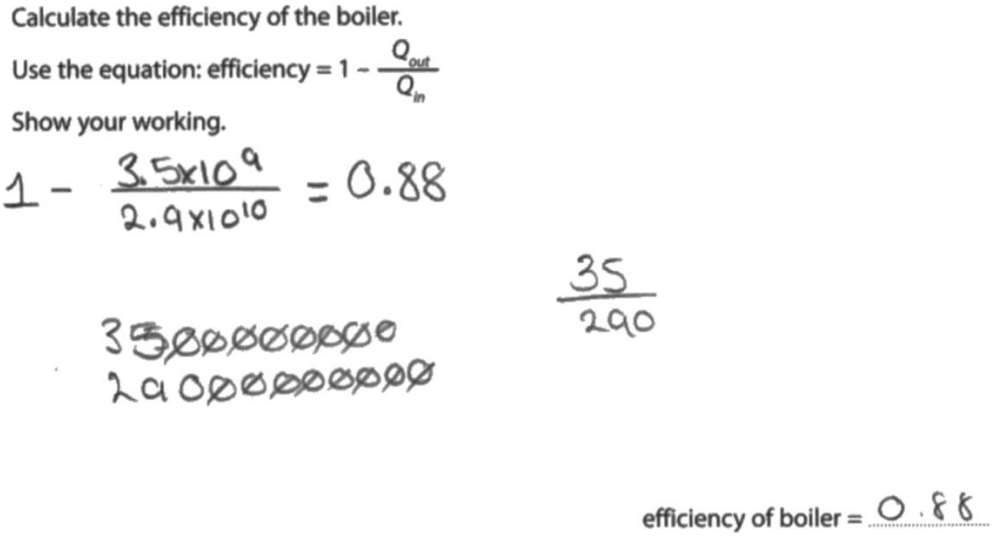
Q3c (ii)

This was a calculation that was well answered by learners.

Many were able to calculate the value and gain both marks. In some cases, learners gave their answer of 0.88 as 0.88% and therefore lost a mark. In this particular calculation the value obtained is without a unit, hence the lack of a unit on the answer line. In every other case where these was a calculation, the unit is given on the answer line. It should be noted that unless the unit is specifically asked for then the learners should not add their own unit. This can

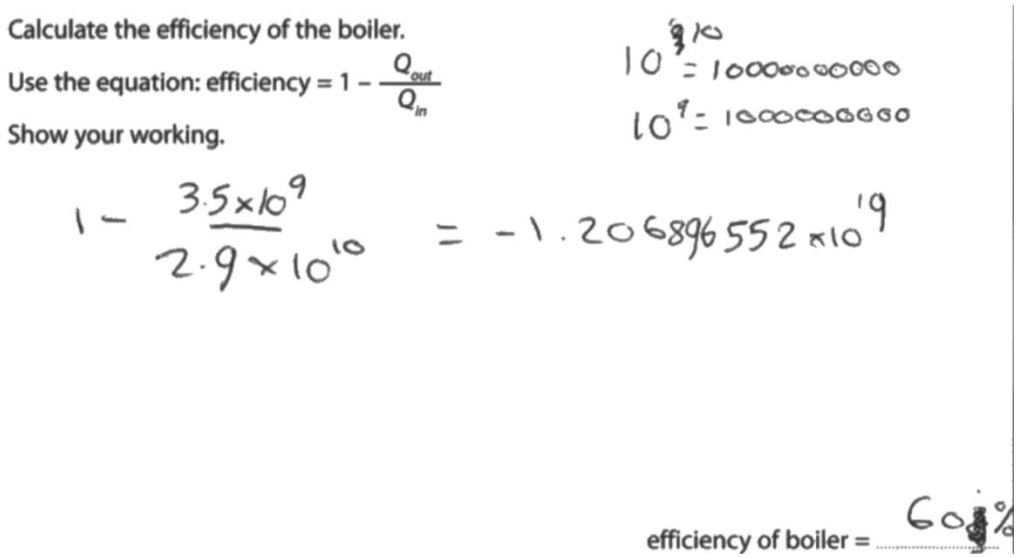
lead to the loss of marks if it is incorrect. The question asked for the efficiency, not the percentage efficiency so the number had to be a value less than 1 or in this series we allowed a correct percentage efficiency. Some learners were aware that an efficiency of 0.88 was the equivalent of a percentage efficiency of 88% and were therefore not penalised as they had an answer correct in terms of the value quoted.

This is an example of a correct two mark calculation.



The answer on the answer line is correct. Had the learner just given the answer without the working both marks would have bee scored.

This response gained one mark



The substitution is correct, but the value has not been correctly evaluated. Had the working not been shown and there was just the answer on the answer line, then no mark would have been scored.

These two examples show the importance of showing working. Intermediate marks can be scored even if the final answer is wrong, if working is shown.

Q4a (i)

Q4a and b related to graph of length of spring and force applied. There was an easy start to the question in the form of a 'state' question. In this case the learners were expected to state how the graph showed Hooke's law. In previous series, similar types of question asked for 'why' rather than 'how'. Learners were expected to indicate that the line was straight or linear or had a constant gradient. Many learners attempted to quote Hooke's law for the answer, which was not asked for. In addition, in attempting to quote Hooke's Law the learner considered length and force and not extension. Many learners did not gain this mark as a result. Comments about proportionality were ignored, apart from the specific case where there was a correct comment on force and extension.

This answer scored the mark

graph line ~~goes~~ increases at a constant gradient
directly proportional

The comment on 'a constant gradient' scored. The part about proportionality was ignored.

This response scored no marks.

(1)

As the force is increased, the length of the spring increases, until the elastic potential is exceeded.

Many learners quoted energy conversions between GPE and KE as an answer. It was clear from responses that learners were not able to use the graph to state that a straight line relationship is what would be expected to be seen.

Q4a (ii)

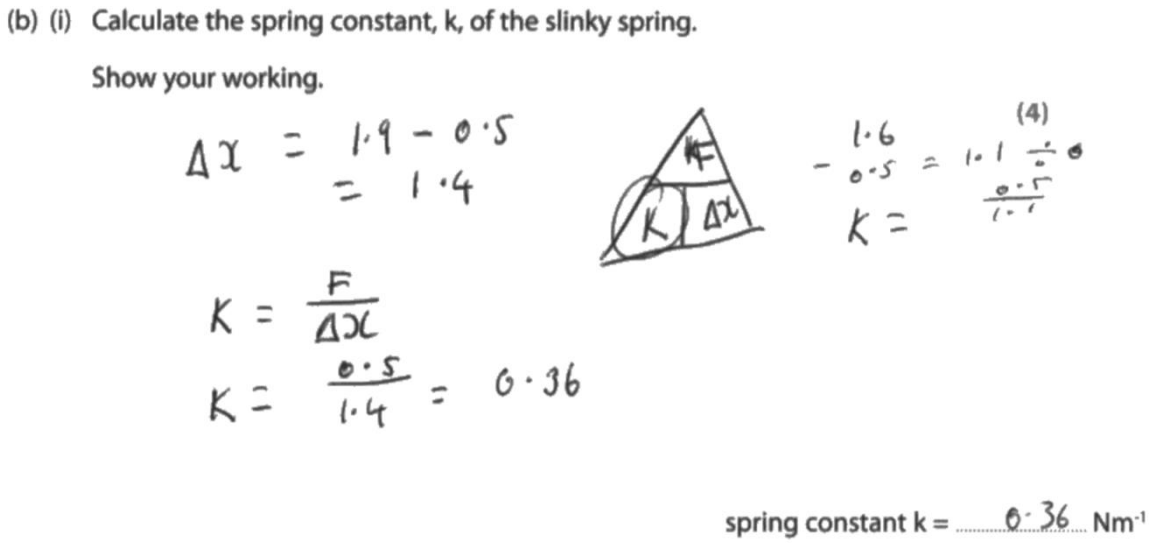
This was answered very well and in the aspect of graphical interpretation requiring reading an intercept, learners were able to show a good level of competency.

Q4b (i)

Learners were able to show a range of performance on this question. Learners were expected to take data from the graph and use it in one of the equations given on the formula sheet to find the spring constant of the spring.

Many learners were able to select and use the correct equation, however some were not able to take the data from the graph to find the extension of the spring. In the cases where the incorrect extension was used in a correct calculation, the remaining marks were awarded as an error carried forward. A large number of learners scored three marks as a consequence, or two marks in the final evaluation from that error carried forward was incorrect.

This response gained all four marks.



(b) (i) Calculate the spring constant, k, of the slinky spring.

Show your working.

$\Delta x = 1.9 - 0.5$

$= 1.4$

F

K Δx

$1.6 - 0.5 = 1.1$ (4)

$K =$

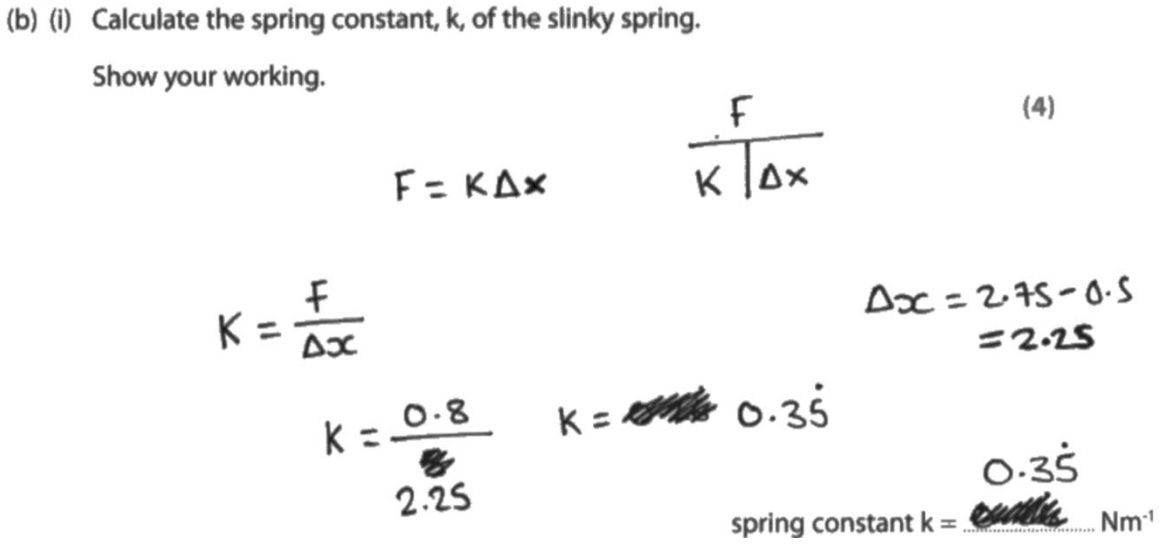
$K = \frac{F}{\Delta x}$

$K = \frac{0.5}{1.4} = 0.36$

spring constant k = 0.36 Nm^{-1}

The answer on the answer line is correct and, in this example, full working is shown. It should be noted that the learner has not found the extension for the whole force applied, but instead for a limited region of the line. This is perfectly acceptable, and the correct answer obtained.

This response gained full marks


(b) (i) Calculate the spring constant, k, of the slinky spring.

Show your working.

(4)

$F = K\Delta x$

$K = \frac{F}{\Delta x}$

$K = \frac{0.8}{2.25}$

$K = 0.3\dot{5}$

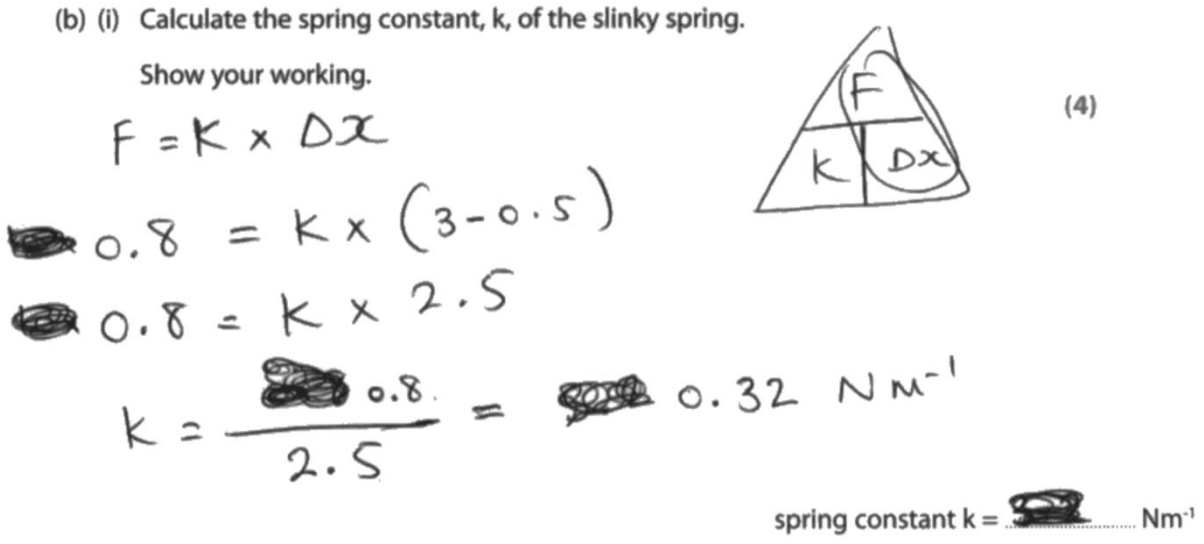
$\Delta x = 2.75 - 0.5 = 2.25$

$0.3\dot{5}$

spring constant k = ... Nm^{-1}

The learner has used a dot above the last decimal figure to indicate a recurring decimal. The calculation is fully correct and uses the whole range of date presented.

For this calculation answers rounding to 0.4 were accepted as there was the possibility of some variation in answers due to reading data from the graph.


(b) (i) Calculate the spring constant, k, of the slinky spring.

Show your working.

(4)

$F = K \times \Delta x$

$0.8 = K \times (3 - 0.5)$

$0.8 = K \times 2.5$

$K = \frac{0.8}{2.5} = 0.32\ N\,M^{-1}$

spring constant k = ... Nm^{-1}

In this example the learner has incorrectly calculated the extension, as the line does not go to 3m., however, beyond that first error, the rest of the calculation is correct and so the remaining marks were scored as an error carried forward.

Learners who were unable to undertake the calculation but were able to write down the correct equation were able to gain a compensatory mark. This allowed a wide range of learners to access at least one marking point.

Q4b (ii)

In the final part of the questions relating to the graph, learners were asked to find the work done in stretching the spring. For this calculation, the formula to be used was given in the question.

Learners who were able to undertake correctly the calculation in 4bi, were generally able to do this calculation.

This answer was given the full three marks.

(ii) A force of 0.5 N is hung from the slinky spring.

Calculate the work done by this force when stretching the spring.

Use the equation $\Delta E = \frac{1}{2} F \Delta x$

Show your working.

(3)

$\frac{1}{2} \times 0.5 \times 1.4 = 0.35$

$1.9 - 0.5 = \Delta x$

work done = 0.35 J

As for the previous calculation, there was an error carried forward if the incorrect extension was used. In many cases learners were able to gain at least two marks. This question also required learners to read data from the graph, so a tolerance was applied to enable learners to gain full credit even if there were small differences in the values taken from the graph. This would not have applied if this calculation was not based on data from a graph.

Q4c

The last part of Q4 relates to a slinky spring which stretches under its own weight. Many learners were under the impression that the question was based on further masses being added to the spring that them made it stretch. Answers relating to that were limited in marks as the second mark could not be awarded.

This answer scored 2 marks

Explain why the coils are further apart at the top of the slinky spring than at the bottom.

(2)

Because ~~more~~ more forced is applied to the top of the slinky as that is where the weight of the slinky and gravity are combined. The top is ~~not affecting~~ the rest of the slinky's weight.

(Total for Question 4 = 11 marks)

Both the ideas of more force and the weight of the slinky are present in the answer. In many cases learners gained one of these two marks but failed to gain the other. The command was to explain, and there were few instances of a justification.

Many learners thought that the spring was deformed due to the consequences of over stretching the spring.

This answer scored no marks and was typical of many responses trying to explain the situation.

Explain why the coils are further apart at the top of the slinky spring than at the bottom.

(2)

The coils at the top have been through more plastic deformation whereby has exceeded its yield ~~for~~ strength (Ultimate tensile strength and therefore has partially been deformed ~~to~~ due to the fatigue of stretching and unstretching whereas the coils at the bottom haven't gone through this.

(Total for Question 4 = 11 marks)

Q5b

Learners were asked to apply their knowledge and understanding of the Bernoulli effect to a novel situation. The stem of the question made clear that the Bernoulli principle was to be used. Some learners ignored this and considered, (incorrectly), electrostatic effects or ideas relating to pressure differences between the interior and exterior of the balloons.

The answer required learners to link the fast flow of air between the two balloons to a drop in air pressure in that region compared to the pressure elsewhere.

This response gained two marks for a very clear answer.

Explain, using Bernoulli's principle, why the two balloons move towards each other.

(2)

Bernoulli's principle states that as the rate of flow increases the pressure decreases. The air in between the balloons will be moving faster due to the student blowing the air so the pressure between the balloons will be lower than around the balloons causing the two balloons to be pushed together by the surrounding air.

Many answers were not as clear as this.

This response gained one mark as the learner indicates a low pressure area is created.

Explain, using Bernoulli's principle, why the two balloons move towards each other.

(2)

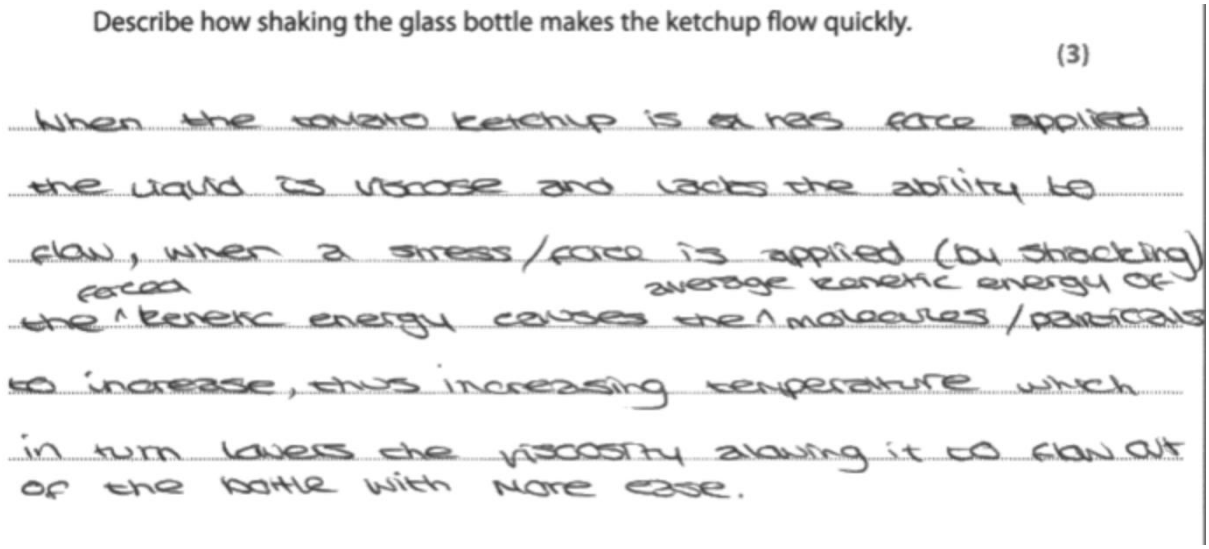
The Air currents are causing a low pressure area which draws the balloons in.

Learners should be made aware that the application of ideas and principals to unfamiliar situations is to be expected in the paper. It was evident that for some learners found it difficult to transfer ideas learnt in one example to a different example.

Q5c

This examination series was the first time that this aspect of the specification was tested. This question was found to be challenging by many learners. In many cases the description provided was about hitting the bottle making the ketchup move rather than considering the effect of providing a force to the ketchup. Learners were expected to focus on the ketchup having a force applied to it, which made the viscosity reduce, so that layers of the ketchup could slide over each other easier. The last point was rarely seen. The idea of a reduction in viscosity was seen more frequently, but it was not often identified as a follow on from a force being applied to the ketchup.

This response gained two marks.



Describe how shaking the glass bottle makes the ketchup flow quickly.

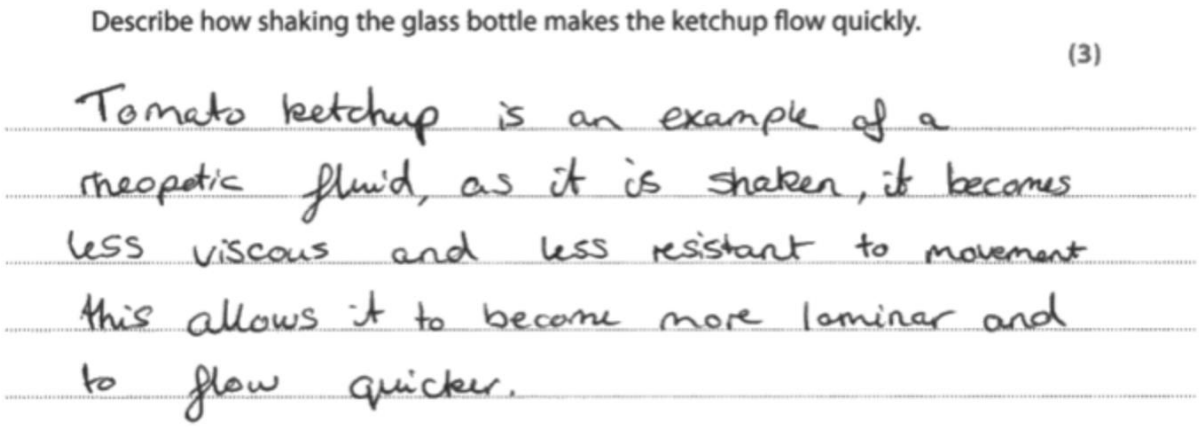
(3)

When the tomato ketchup is ~~a~~ has force applied the liquid is viscose and lacks the ability to flow, when a stress/force is applied (by shacking) forces the ^kenetic energy causes the ^molecules/particals to increase, thus increasing temperature which in turn lowers the viscosity allowing it to flow out of the bottle with more ease. average kenetic energy of

The first two marking points are present. I most cases this was the best answer seen from learners. Very few made the last point, by stating what happened to the ketchup as a result of the viscosity becoming less. The statements regarding to temperature and energy were ignored.

Many learners tried to suggest that shaking the bottle increased the temperature of the ketchup and this caused the contents of the bottle to flow.

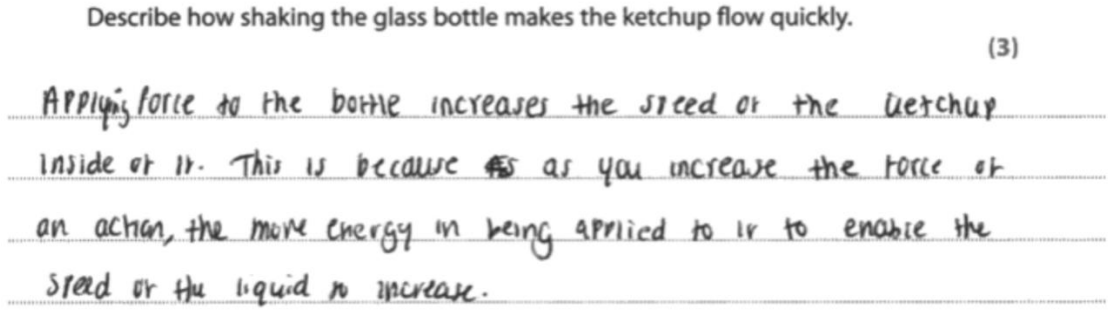
This response scored one mark for the ketchup becoming less viscous when shaken. There is no indication that a force has been applied to the ketchup, or that layers then flow over each other.


Describe how shaking the glass bottle makes the ketchup flow quickly.

(3)

Tomato ketchup is an example of a rheopetic fluid, as it is shaken, it becomes less viscous and less resistant to movement this allows it to become more laminar and to flow quicker.

This response scored no marks


Describe how shaking the glass bottle makes the ketchup flow quickly.

(3)

Applying force to the bottle increases the speed of the ketchup inside of it. This is because as you increase the force of an action, the more energy in being applied to it to enable the speed of the liquid to increase.

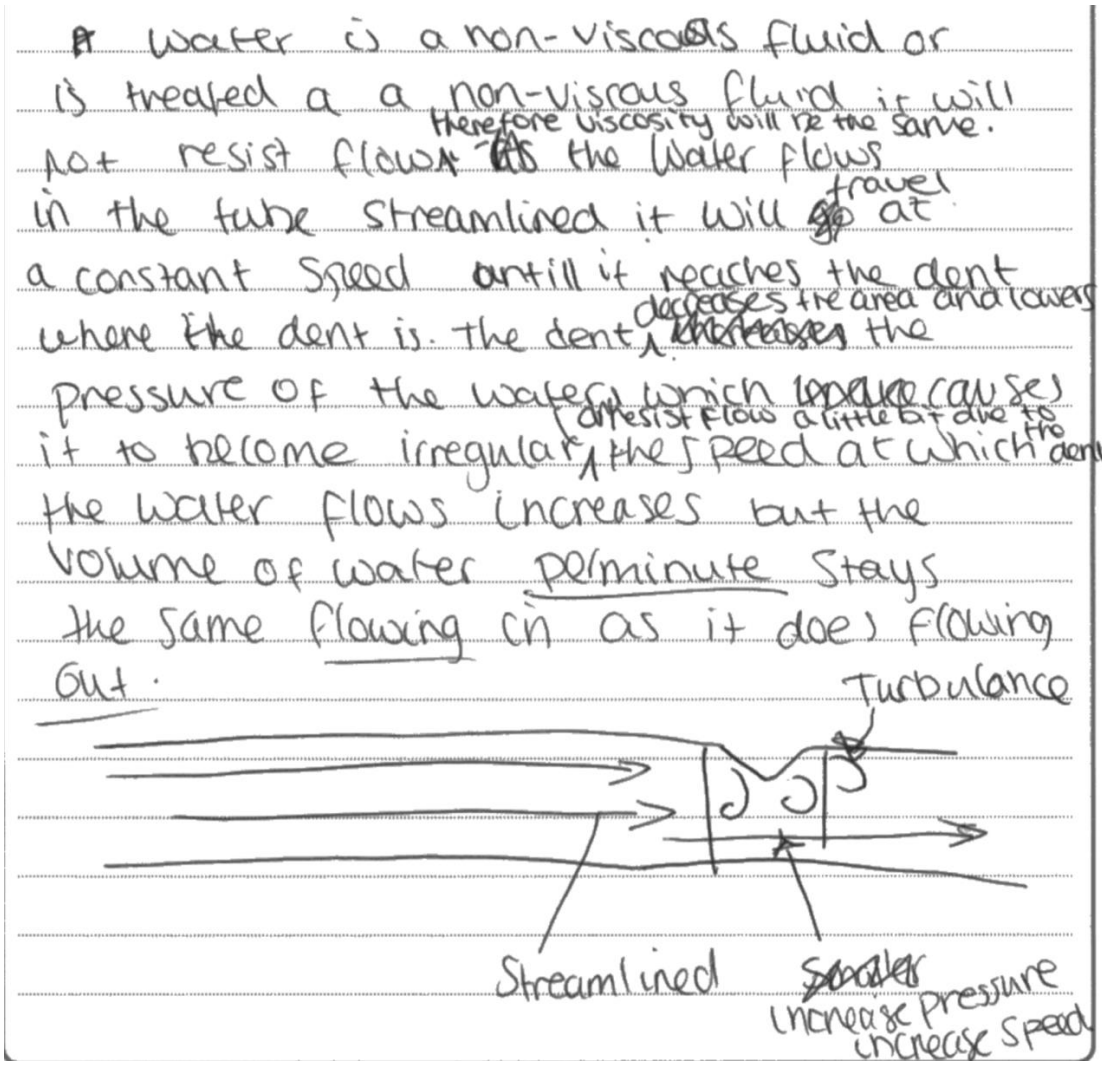
This was a typical response of many learners who focused on the bottle and not the contents and considered speed of shake and energy transfer.

Q5d

The final question on the paper was the levelled and was designed to assess across the whole range of ability. Learners were asked to water flow and viscosity before and after a dent in a water pipe. Many learners did not do more than repeat statements in the stem of the question, which gained no marks. Many learners stated that the viscosity was different before and after the dent, which was incorrect. In many cases this was due to confusing viscosity with viscous drag.

To achieve a mark in band 3, (the top band), learners had to consider both factors and link there to what happened before and after the dent, (or at the dent). In addition, there were other relevant points that were in the indicative content that could be made, for example linking the difference in speed of flow before and after the dent to the water pressure in the pipe. A similarity and a difference in the comparison was also required.

This response gained a band 3 mark.



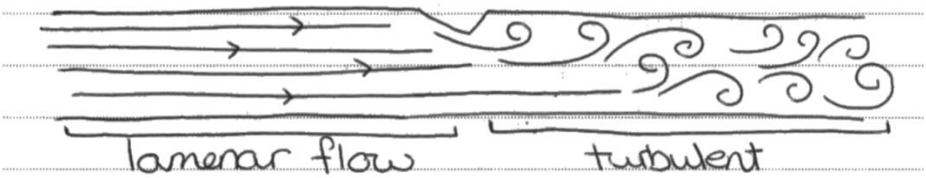
There is a comprehensive discussion using relevant knowledge. Some of the statements are supported, but there are inconsistencies, for example a line showing turbulence before the dent, and the statement about pressure. There is one similarity and a difference, which is sufficient for accessing the top band marks.

This response gained a band 2 mark.

Compare the water flow and water viscosity before and after passing the dent in the water pipe.

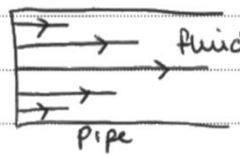
(6)

You may draw diagrams to help your answer.



As a fluid passes through a pipe without interferance the flow is streamline and in continuous one directioned flow. This allows for faster flow / movement of particles. However, interfearence with the pipes smooth edges, such as a dent, causes the flow to become turbulent, which decreases speed and volume of water that can pass through. The viscosity of the now turbulent flow is higher due to

more friction. While the water traveled through lamenar flow ~~no~~ very little energy was lost as the particles in the centre of the pipe had no friction and high gradient of flow. Meaning only particles at the edge were restricted by friction along the edge of the pipe.



Contradictingly, in turbulent flow, the random movement of particles decreases the overall efficience of the movement of fluids.

(Total for Question 5 = 12 marks)

The learner has shown good knowledge with a labelled diagram without error. There is a comment on the rate of flow in different regions of the pipe, supported by the diagram. There are differences, but no similarities. The comment on viscosity is incorrect and ignored.

Responses at level 1 related to one of the factors to be considered and were generally poorly supported with diagrams or test that indicated that the learner understood what happened to the water after the dent, compared to before.