L3 Lead Examiner Report 2001

January 2020

L3 Qualification in Applied Science

Unit 5: Principles and Applications of Science II (31627H)

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications come from Pearson, the world's leading learning company. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications website at http://qualifications.pearson.com/en/home.html for our BTEC qualifications.

Alternatively, you can get in touch with us using the details on our contact us page at http://qualifications.pearson.com/en/contact-us.html

If you have any subject specific questions about this specification that require the help of a subject specialist, you can speak directly to the subject team at Pearson. Their contact details can be found on this link:
http://qualifications.pearson.com/en/support/support-for-you/teachers.html

You can also use our online Ask the Expert service at https://www.edexcelonline.com
You will need an Edexcel Online username and password to access this service.

Pearson: helping people progress, everywhere

Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your learners at: www.pearson.com/uk

January 2020
Publications Code 31627H_2001_ER

Grade Boundaries

What is a grade boundary?

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

Setting grade boundaries

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

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

Variations in external assessments

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

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

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

Unit 5 Principles and Applications of Science II (31627H)

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	0	16	33	54	75

Introduction

Biology - Organs and Systems

31627_H1B is the biology section of the externally assessed unit, unit 5. This unit, Organs and Systems, covers the cardiovascular system (B.1), the respiratory system (ventilation and gas exchange in the lungs) (B.2), the structure and functions of the urinary system (B.3), and cell transport mechanisms (B.4).

This was the sixth series of the new specification. It was the third time that learners had sat the Biology, Physics and Chemistry sections as individual papers.

The question paper followed the same format as for the previous papers and for the sample assessment material. It consisted of five questions, four of which consisted of smaller items; there were 18 items in total. These included four multiple choice items and three other single-mark questions testing mainly recall of knowledge. There were some 2, 3 and 4 mark items, each carrying a greater cognitive demand, where learners had to analyse or interpret information or apply their knowledge to a new scenario. These questions were marked using a points-based mark scheme.

The last question carried 6 marks and was marked using a levels-based approach that considered the overall quality of the response and not just the amount of correct and relevant facts presented by the learner. More detail can be found below, in the individual question section of the report.

Introduction to the Overall Performance of the Unit

Many learners were well prepared for the examination; they read the questions carefully with due consideration of the command word used and subsequently selected relevant and appropriate information to use in their responses.

However, a significant number, for some questions, did not sensibly use the information in the question stem. This type of omission was seen particularly in responses to questions 1 b, 1 c iii and 1d.

Some of the responses to very straightforward questions, such as identifying the

process of removing metabolic waste from the body were disappointing, especially as this was a multiple choice item and the correct response, excretion, was therefore one of the options; Some learners were not able, in question 2 c, to identify one of the heart chambers (right atrium) and the blood vessel, vena cava, associated with that chamber. Many candidates are not able to calculate percentage change (question 2 a ii) and, whilst many could correctly interpret information shown on a graph (question 4 a), it is clear that some learners need more practice at these particular skills.

- You can access the specification and/or sample assessment materials (SAMs) located on the BTEC First qualification webpage located here.

Chemistry - Properties and Uses of Substances

This is the fifth examination series for the Unit 5 (Principles and Applications of Science) Chemistry section A: Properties and uses of substances. The following topics were covered:

- Question 1: a property and use of calcium hydroxide (A1); the energetics involved in hydration of ions (A3)
- Question 2: the equation for combustion of an alkane and recall of the standard enthalpy change of combustion (A3); naming an organic molecule and the effect chain length on boiling point (A2)
- Question 3: free radical addition mechanism for the polymerisation of ethene (A2); the formula of titanium(IV) oxide; identifying a titanium species as a complex and the representation of bond within it; the use of the titanium complex in catalysis (A1)
- Question 4: the bonding between carbon atoms within an alkene; differences in bond angle for different carbon atoms; addition of bromine to an alkene and the skeletal formula of the product (A2)
- Question 5: extraction of aluminium and of chlorine by electrolysis (A1)

Introduction to the Overall Performance of the Unit

In general, learners performed similarly on this paper by comparison to recent series.

Areas where learners performed well were:

- Being able to convert and calculate temperature differences, substitution and

evaluation of an equation to solve a problem - Question 1(c)
- Balancing chemical equations - Question 2(a)(i)
- Naming organic molecules - Question 2(b)(i)
- Interpretation of images and diagrams, such as recognising the presence of double and single bonds - Question 4(a)
- Basic comparison (ie similarities, differences) and identifying lowest / highest in a group (Questions 2, 4 and 5)

Areas where learners did not perform as well were:

- Recall of specific details in properties and uses of substances – Question 1
- Expanding upon identification points to give a sustained line of reasoning - Questions 1(d), 2(b), 3(b)(iv), 4(b) and 5
- Understanding and completion of hydrocarbon mechanisms - Question 3(a)
- Understanding of naming conventions for inorganic compounds and writing formulae – Question 3(b)(i)
- Understanding and explanation of the reasons behind a molecular shape, bond angle or representation of a bond – Questions 4(b) and 3(b)(iii).

Physics – Thermal Physics, Materials and Fluids

Compared to the January 2019 series, learners performed slightly better on the Physics paper. Learners were able to show a range of skills and knowledge across a wide variety of specification points. This is very good to see.
Learners grow increasingly confident in using some mathematical skills to answer questions. There is still a good way to go before this becomes generally the case, but clear improvements in algebraic skills graphical interpretation, and evaluating answers has been seen. There are some aspects that remain problematic. For example, converting between units or handling standard form in calculations correctly.
Learners were able to show noticeable improvements in the use of command words. For example, in Q4a which was a describe question, learners gave a logical sequence and did not offer an explanation in their answer, which has happened before and wasted time that learners could have spent in answering another question.
The examination covered a wide range of topics from the specification and also included some areas that were identified in the additional guidance for Unit 5.
Areas where learners showed good knowledge and understanding, were in section C2 'Materials in domestic and industrial applications' and some parts of C1 'Thermal physics in domestic and industrial applications.' Particularly the section on engine cycles and related calculations. Areas where learners struggled to

provide answers were in sections C1 'Thermal physics in domestic and industrial applications' sections relating to the behavior of gasses and section C3, Fluids in motion.
As in previous series a number of misconceptions relating to physical laws and principles remain. For instance, many learners thought that as a water pipe narrows, the water pressure within the pipe increases, when in reality the opposite happens. The kinetic theory, (Q3ai and ii) and (5aii), covering section C1 of the specification, remains challenging to many learners and misconceptions regarding the difference between heat and temperature as well as the concept of conservation of energy remain.

Biology

Individual Questions

Question 1(a) 1 mark

For this question learners were told that the kidneys remove metabolic waste, such as urea, from the body and they were then asked to identify the name of the process of removing metabolic waste from the body. This was a multiple choice item and the options were: excretion, selective reabsorption, tubular absorption and ultrafiltration. The majority answered correctly, excretion, but some chose selective reabsorption or ultrafiltration. Both of these processes occur in the kidney and are part of the process but learners should know the meaning of the term 'excretion'. They should also appreciate that ultrafiltration and selective reabsorption, whilst involved in excretion carried out by the kidneys, are distinct processes. Excretion is a general term for removal of (toxic) metabolic waste, including urea and carbon dioxide.

Question 1 (b) 2 marks

In this question learners were presented with information, mainly as a flow diagram, detailing how water is reabsorbed in the kidney nephrons. They were told that 80% of water reabsorption occurs in the distal convoluted tubules and

the other 20% is reabsorbed from the loop of Henle and structure A under the influence of B. They had to identify A and B.

Good responses identified A as the collecting duct and B as ADH/antidiuretic hormone.

Some learners appeared not to have noted the information in the flow diagram and gave DCT as their choice for A. Others appeared to not know this topic and gave any random part of the kidney nephron, or 'nephron' as their response.

This response gained two marks.

(b) The kidneys also regulate the salt and water content of the blood.

Water is filtered from the blood and then the water that the body needs is reabsorbed.

Figure 1 shows how water is reabsorbed in the kidneys.

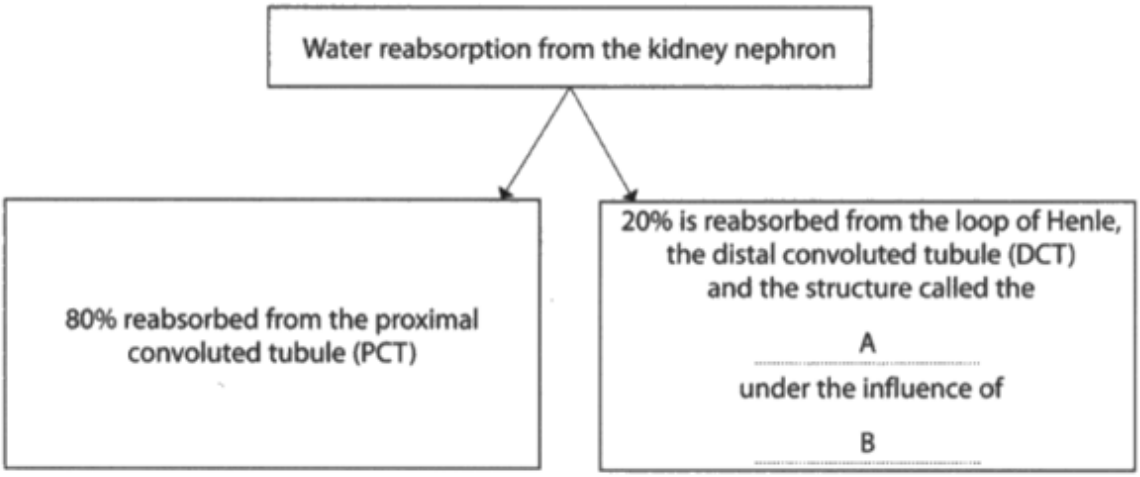


Figure 1

Identify the missing words, A and B, to complete Figure 1.

(2)

collecting duct.
ADH (Antidiuretic hormones)

The learner has correctly identified the collecting duct and ADH.

Some learners gave osmosis, diffusion, osmoregulation or aquaporins for B. If they gave these as well as ADH, they were not penalised as these terms were considered neutral and did not contradict ADH.

Question 1 (c)

In this question learners were given some information about a patient with kidney failure receiving treatment by renal dialysis. They were given information about the quantities of urea and glucose in the blood and in the dialysis fluid before dialysis and were asked about the levels of urea and glucose in the blood after dialysis.

1 (c) (i) 1 mark

This was a multiple choice question and having been told that the concentration of glucose in both the dialysis fluid and the blood before dialysis was 7.5 mmol dm^{-3}, learners were asked to identify the concentration of glucose in the blood after dialysis. The options given were 0.0, 7.5, 26.5 and 34.0 mmol dm^{-3}. Most learners realised that as there was no concentration gradient for glucose between the blood and dialysis fluid then no glucose would leave the blood during dialysis and its glucose concentration after dialysis would be the same as it was before dialysis, at 7.5 mmol dm^{-3}. Some learners seemed not to reason this and made a guess, choosing one of the incorrect distracters.

1 (c) (ii) 1 mark

This was a short open response and asked learners to give a reason why there was no urea in the dialysis fluid before dialysis began. This question was designed to test learners' understanding of how renal dialysis works and the importance of a concentration gradient across the dialysis membrane as, unlike in a kidney glomerulus where urea is removed by ultrafiltration, renal dialysis depends upon diffusion for removing urea from the patient's blood. Urea has to diffuse from blood to dialysis fluid.

This response gained one mark

(ii) There is no urea in the dialysis fluid before dialysis begins.

Give a reason why this is important.

(1)

This is because the urea will diffuse from the blood to the fluid as there is a very big concentration gradient

The learner has correctly shown that if there is no urea in the dialysis fluid there will be a concentration gradient between the blood and dialysis fluid. They have also indicated that urea will therefore diffuse from blood to fluid, which is another way that the mark could be gained.

This is also a good response, gaining one mark

(ii) There is no urea in the dialysis fluid before dialysis begins.

Give a reason why this is important.

(1)

To maintain a concentration gradient so the urea diffuses from the blood to the dialysis fluid as it is toxic & needs to be removed

This response gained one mark.

(ii) There is no urea in the dialysis fluid before dialysis begins.

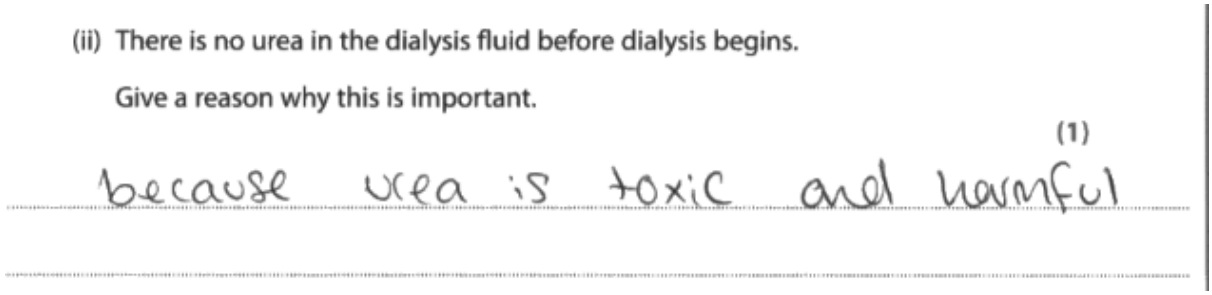
Give a reason why this is important.

(1)

so non of the urea will enter the blood

This response tackles the question from a different angle, namely so that urea will not diffuse from the dialysis fluid into the blood and that is also credit worthy.

This response gained no marks


(ii) There is no urea in the dialysis fluid before dialysis begins.

Give a reason why this is important.

(1)

because urea is toxic and harmful

The statement is true but, on its own, is not answering the question. Had the learner gone on to say that because urea is toxic it has to be removed from blood they would have gained the mark.

Question 1 (c) (iii) 1 mark

Learners were asked to predict the concentration of urea in the blood after dialysis. Responses were a little disappointing as many learners gave the value 0.0 or 34.0 mmol dm^{-3} whereas any number between these two values would have been credited. Many learners therefore appeared not to appreciate that as one of the functions of renal dialysis is to remove urea from the blood, the concentration of urea in the blood after the procedure would be less than 34.0 mmol dm^{-3} (the concentration of urea in the blood before dialysis) but, as urea is always being made (in the liver by deamination of excess amino acids) and taken to the kidneys for removal, or, as not all of the urea is likely to diffuse out of the blood, the blood concentration after dialysis is unlikely to be 0.0 mmol dm^{-3}.

This response gained one mark


(iii) Predict K in Table 1.

(1)

17 mmol dm^{-3}

The learner has correctly offered a numerical value between 0.0 and 34.0 mmol dm^{-3}

Question 1 (d) 3 marks

This question asked learners about another function of the kidneys, which is to help adjust blood pressure, via the renin-angiotensin-aldosterone system.

Learners were given information about this in a paragraph and asked to identify three missing words, denoted X, Y and Z, namely angiotensin II, ACE or angiotensin converting enzyme, and water.

Some learners knew this and also used the information given. They were told that angiotensinogen was converted to angiotensin I and that angiotensin I was converted to X by an enzyme Y. They were told that aldosterone was then released which causes sodium ions to enter the blood, and then (as a result) Z entered the blood causing blood pressure to increase. A reasonable number of learners could work out that angiotensin I is converted to angiotensin II and if they did not know the name of the enzyme that catalysed this change they could deduce that after sodium ions entered blood (lowering the water potential) water would follow.

Some learners also knew the name of the enzyme although some confused ACE with ATP or ADH.

A few learners seemed to have no idea and made random guesses or left the answer lines blank.

This response gained three marks

(d) When the kidneys detect a fall in blood pressure they secrete renin.

Paragraph 1 shows the renin-angiotensin-aldosterone mechanism.

When blood pressure drops, some cells in the kidney produce renin.

Renin converts angiotensinogen to angiotensin I.

Angiotensin I is converted to ..... X ..... by the enzyme

..... Y ..... ACE .

The hormone aldosterone is then released.

More sodium ions are reabsorbed into the blood.

..... Z ..... enters the blood.

Blood pressure increases.

Paragraph 1

Identify the missing words, X, Y and Z, to complete Paragraph 1.

(3)

X angiotensin II

Y Angiotension converting enzyme.

Z Water.

(Total for Question 1 = 9 marks)

The learner has correctly identifies, X, Y and Z

This response gained two marks

Identify the missing words, X, Y and Z, to complete Paragraph 1.

(3)

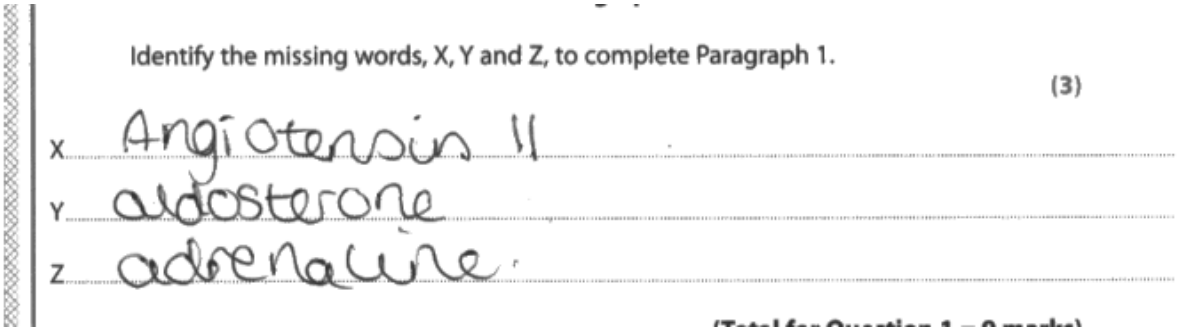
X angiotensin II

Y ACE

Z ADH

The learner has correctly identified X and Y

This response gained one mark


Identify the missing words, X, Y and Z, to complete Paragraph 1.

(3)

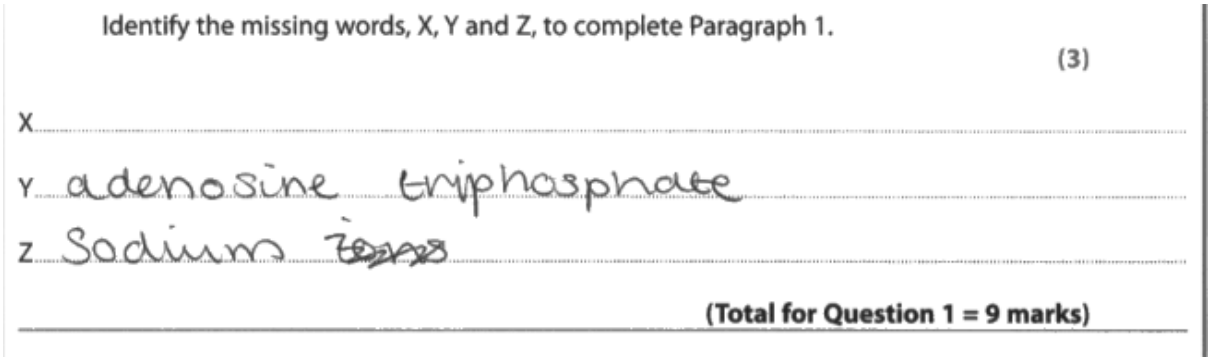
X Angiotensin II

Y aldosterone

Z adrenaline.

The learner has correctly identified X

This response gained no marks


Identify the missing words, X, Y and Z, to complete Paragraph 1.

(3)

X

Y adenosine triphosphate

Z Sodium ~~ions~~

(Total for Question 1 = 9 marks)

The learner has not correctly identified X, Y or Z

Question 2

This question focussed on the effect of caffeine on heart rate in *Daphnia* and extended into questions about the structure of the human heart and associated blood vessels.

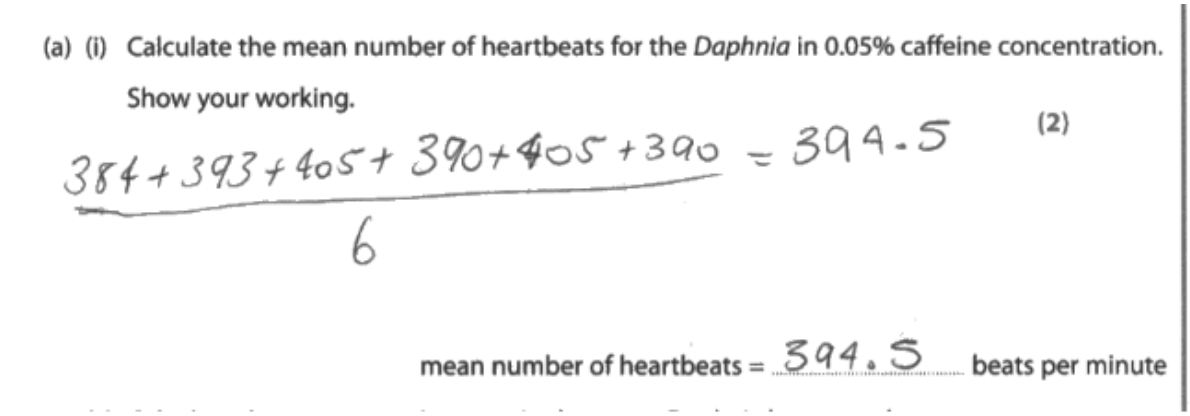
Learners were given information about an investigation into the effect of caffeine on heart rate in *Daphnia*, together with a table of data.

Question 2 (a) (i) 2 marks

Learners were asked to calculate the mean value of the *Daphnia* heart rate when exposed to 0.05% caffeine solution. They had six trial values and were expected to add these and divide by 6. Most learners did just that and obtained the correct answer of 394.5/395 and gained 2 marks. Some learners decided that one value was anomalous and discarded it, but as this seemed not unreasonable and the

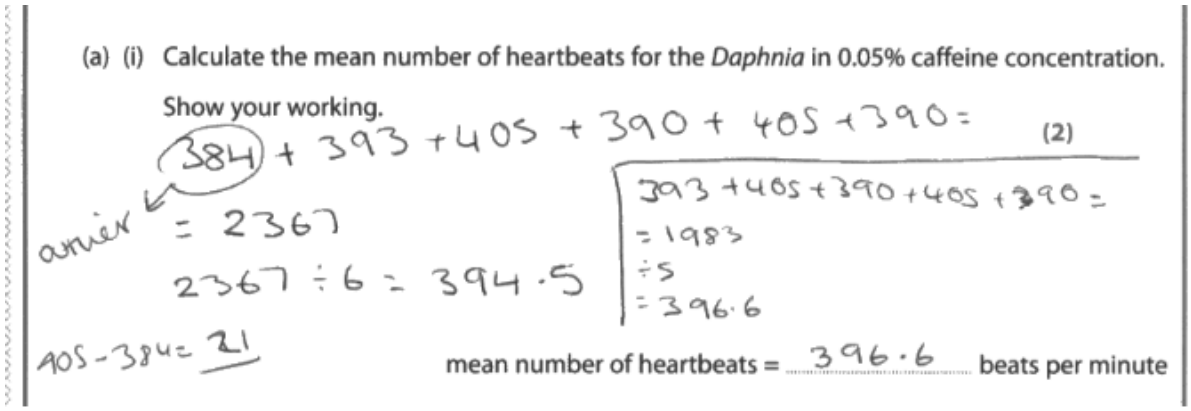
marks were being awarded for process, they also gained 2 marks, provided that their addition of the five numbers and subsequent division by 5 was carried out correctly.

This response gained two marks


(a) (i) Calculate the mean number of heartbeats for the *Daphnia* in 0.05% caffeine concentration.
Show your working.
$\frac{384+393+405+390+405+390}{6} = 394.5$ (2)
mean number of heartbeats = 394.5 beats per minute

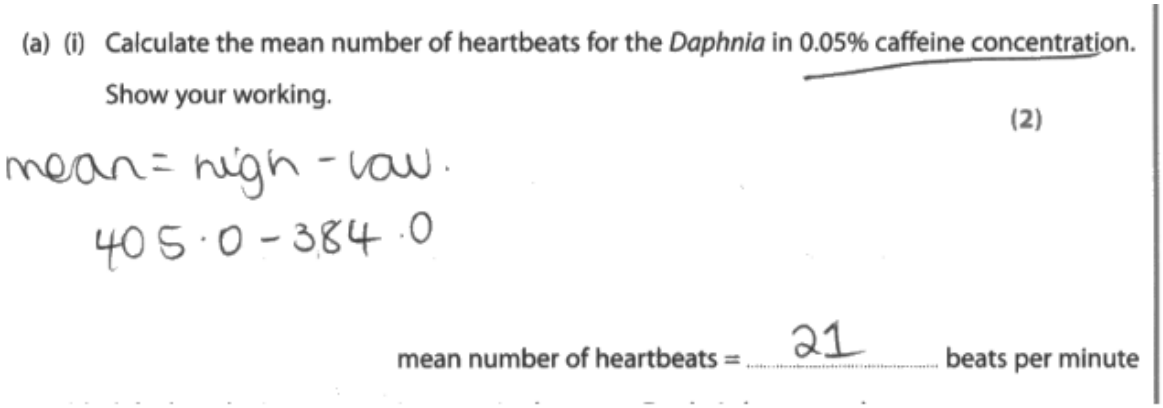
The learner has correctly added all six values and divided by 6.

This response also gained two marks


(a) (i) Calculate the mean number of heartbeats for the *Daphnia* in 0.05% caffeine concentration.
Show your working.
384 + 393 + 405 + 390 + 405 + 390 = (2)
anwer = 2367
2367 ÷ 6 = 394.5
405 - 384 = 21
393 + 405 + 390 + 405 + 390 =
= 1983
÷ 5
= 396.6
mean number of heartbeats = 396.6 beats per minute

The learner has discarded 384 as an anomaly and then correctly added the remaining five values and divided by 5.

This response gained no marks

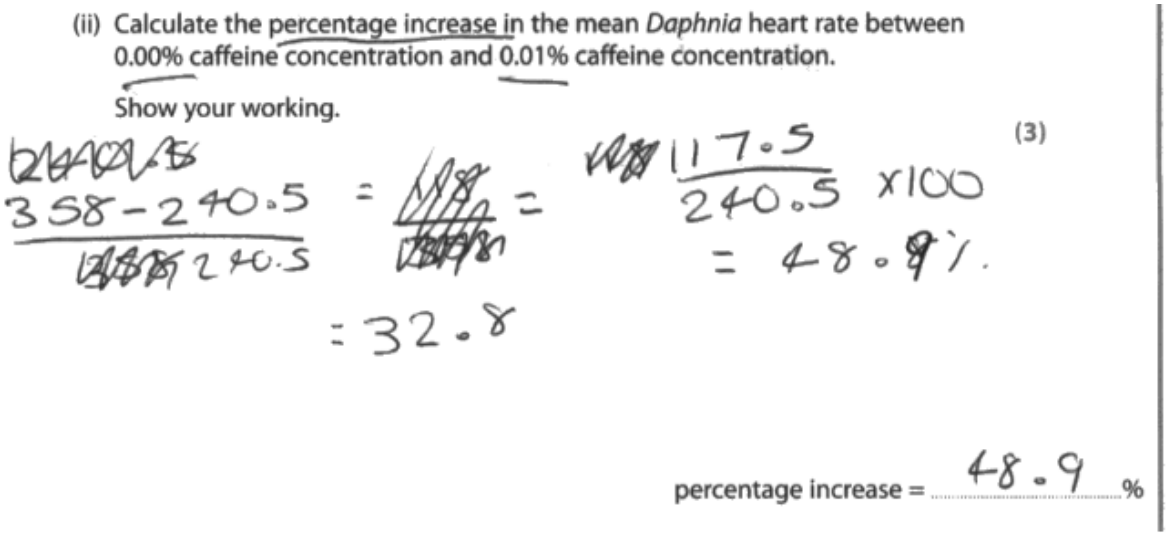

(a) (i) Calculate the mean number of heartbeats for the *Daphnia* in 0.05% caffeine concentration.
Show your working.
(2)
mean = high - low.
405.0 - 384.0
mean number of heartbeats = 21 beats per minute

The learner has not carried out an appropriate calculation but found the difference between two values

Question 2 (a) (ii) 3 marks

In this question learners were asked to calculate the percentage change in *Daphnia* heart rate between 0.00 and 0.01 caffeine concentrations. Most learners correctly calculated the difference, although a few used 240 instead of 240.5 for the normal *Daphnia* heart rate, in order to make the calculation easier. Learners should always have a calculator with them in these exams. Some learners were able to use the difference in a calculation and work out the percentage change using either (difference ÷ original x 100) or [(final ÷ original x 100) - 100]. However a significant number of learners divided original by the difference in the first method or divided original by final in the second method. Some used the second method and then forgot to subtract 100 from 148.9. A quick common sense check should have told them that the increase of 117.5 is just short of half of 240 so the answer should be just under 50% and they could then see if their calculated answer is in the right area. It is clear that many learners would benefit from more practice at calculating percentage changes.

This response gained three marks


(ii) Calculate the percentage increase in the mean *Daphnia* heart rate between 0.00% caffeine concentration and 0.01% caffeine concentration.

Show your working.

$\frac{358 - 240.5}{240.5} = \frac{117.5}{240.5} \times 100$

$= 48.9\%$

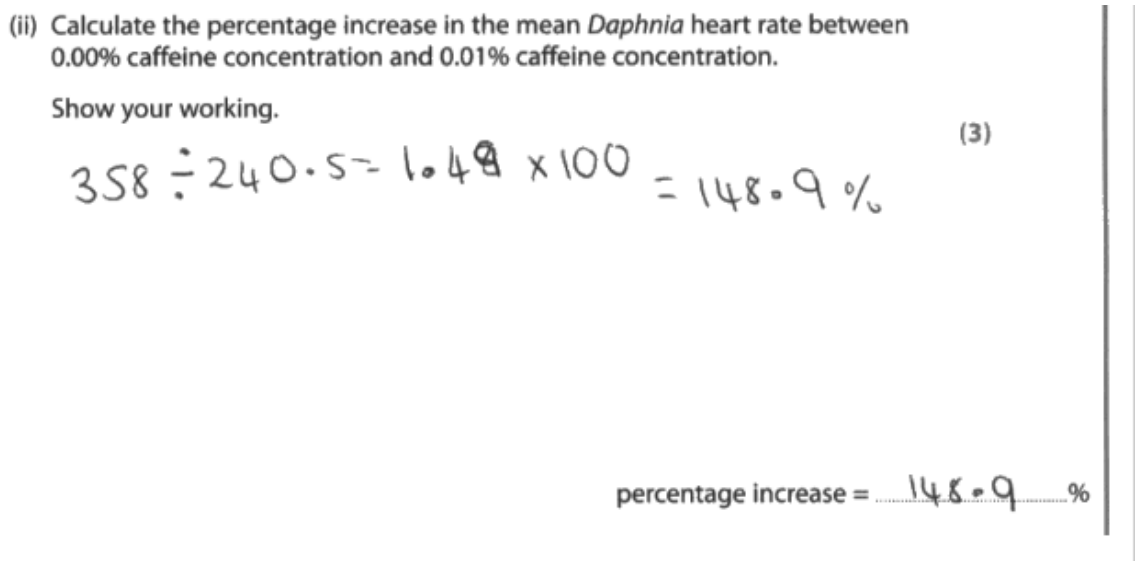
$= 32.8$

(3)

percentage increase = 48.9 %

The learner has first of all calculated the difference and divided that by the final heart rate. They have seen the error of their ways and then crossed out 358 and substituted 240.5. They have rewritten this sum more clearly, this time arriving at the correct answer. Fortunately they wrote the correct answer on the answer line so that answer was accepted. Had they not done so they would have been offering a list and leaving the examiner to choose, and would not have achieved full marks.

This response gained two marks


(ii) Calculate the percentage increase in the mean *Daphnia* heart rate between 0.00% caffeine concentration and 0.01% caffeine concentration.

Show your working.

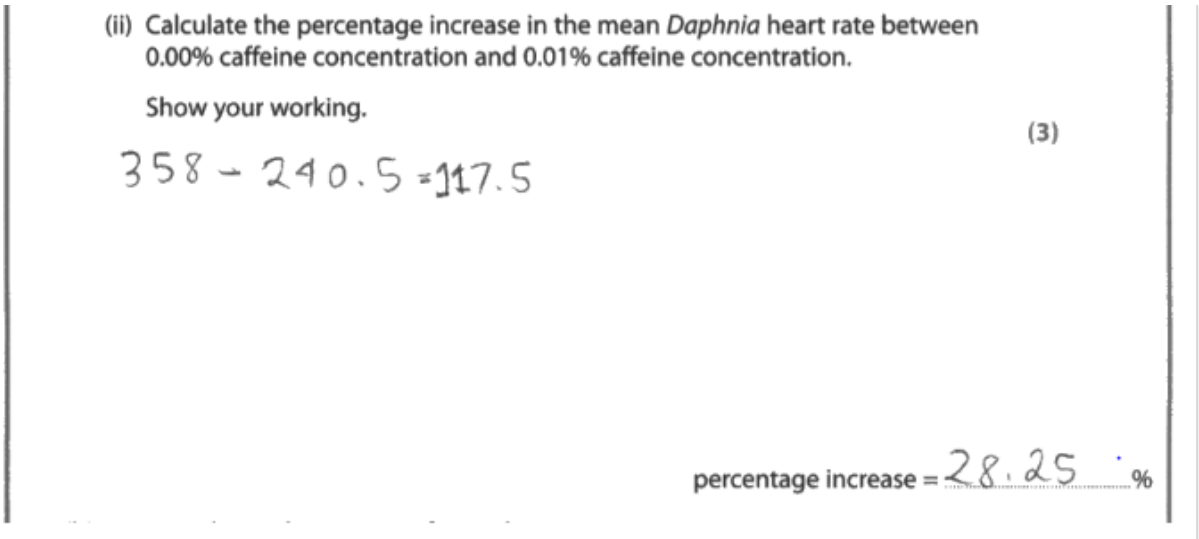
(3)

358 ÷ 240.5 = 1.489 x 100 = 148.9 %

percentage increase = 148.9 %

The learner has correctly carried out two stages of the calculation but omitted to subtract 100.

This response gained one mark


(ii) Calculate the percentage increase in the mean *Daphnia* heart rate between 0.00% caffeine concentration and 0.01% caffeine concentration.

Show your working.

(3)

358 – 240.5 = 117.5

percentage increase = 28.25 %

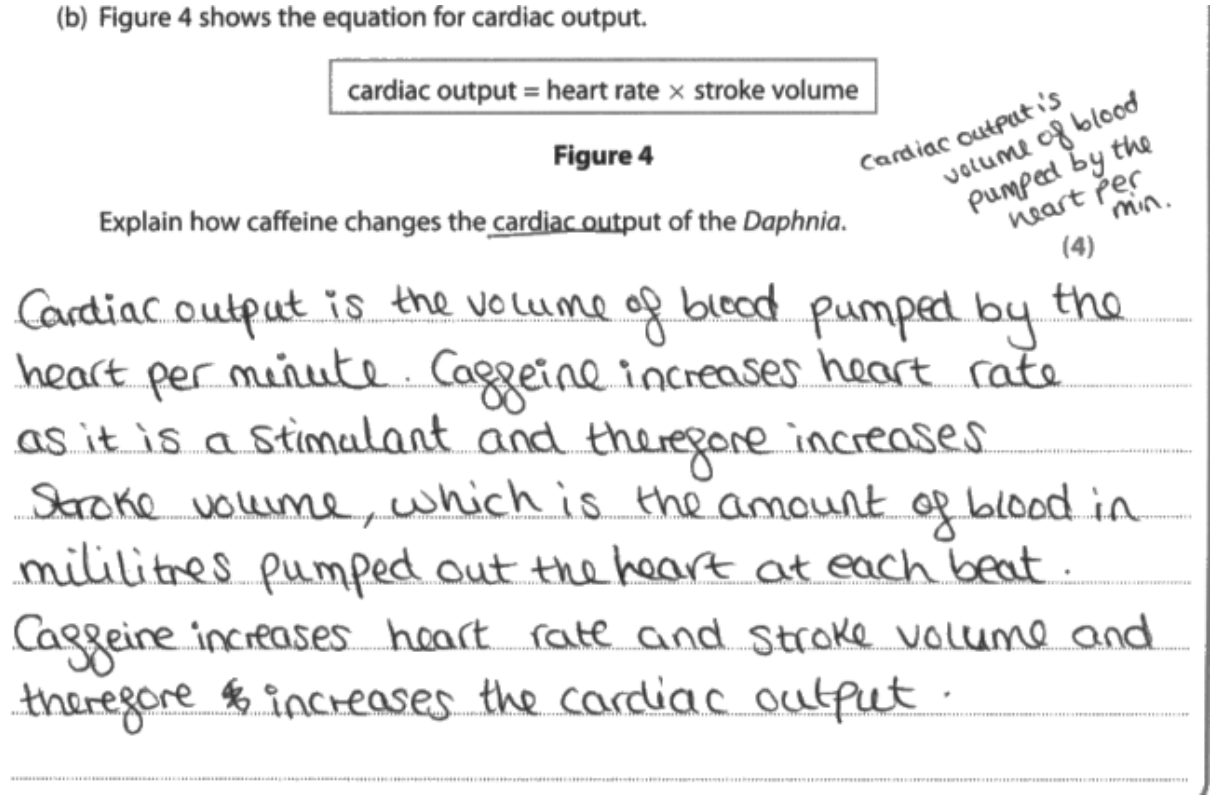
The learner has calculated the difference but not used it in an appropriate calculation.

Learners are asked to show their working and nearly all of them do so. This benefits them because if their final answer is incorrect, examiners can see which stages have been correctly completed and award marks accordingly. An incorrect answer with no working shown gains 0 marks.

Question 2b 4 marks

In this question learners were asked to explain how caffeine changes the cardiac output of the *Daphnia*. In order to help them, they were given the equation that shows the relationship between heart rate, stroke volume and cardiac output. They were expected to recall that stroke volume is the volume of blood leaving the ventricles in one beat and cardiac output is the volume of blood leaving the heart in one minute. However, without recalling this, and by using the equation given (cardiac output = heart rate x stroke volume) they could see that if heart rate increased then cardiac output will also increase. Most learners obtained these two marks. Many also stated that stroke volume also increases. Some learners also stated that caffeine is a stimulant and that it affects the SAN or increases electrical activity in the heart or increases the strength of the ventricle contractions, thus applying what they have learnt about the human heart to this new situation.

This response gained four marks



(b) Figure 4 shows the equation for cardiac output.

cardiac output = heart rate × stroke volume

Figure 4

Cardiac output is volume of blood pumped by the heart per min.

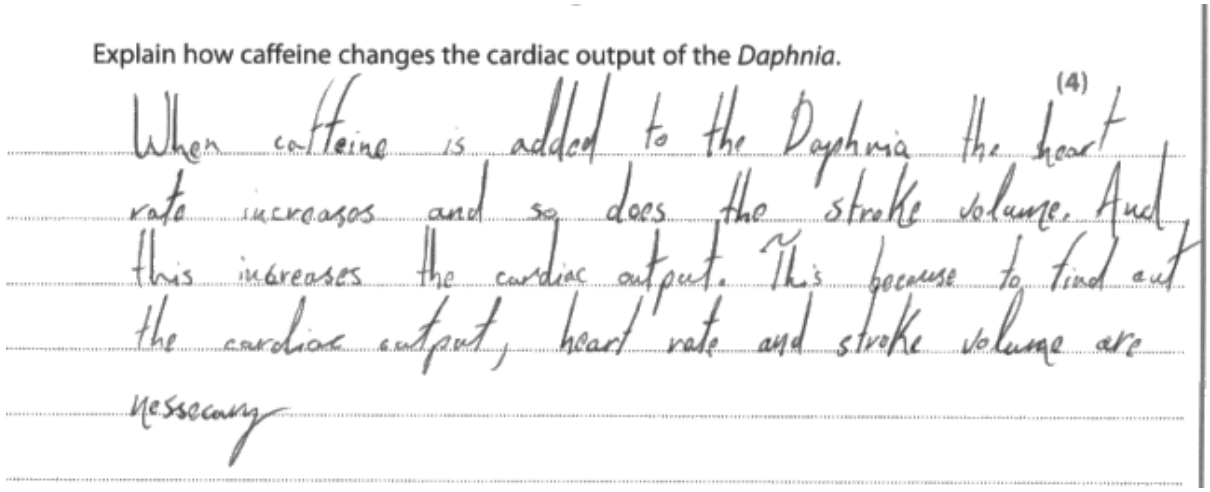
Explain how caffeine changes the cardiac output of the *Daphnia*.

(4)

Cardiac output is the volume of blood pumped by the heart per minute. Caffeine increases heart rate as it is a stimulant and therefore increases stroke volume, which is the amount of blood in mililitres pumped out the heart at each beat. Caffeine increases heart rate and stroke volume and therefore & increases the cardiac output.

The learner gains marking points 2 (increases heart rate),3 (caffeine is a stimulant), 7 (increases stroke volume) and 1 (increase cardiac output). The explanation is clear and unambiguous and indicates that the learner understands how caffeine affects cardiac output.

This response gained three marks



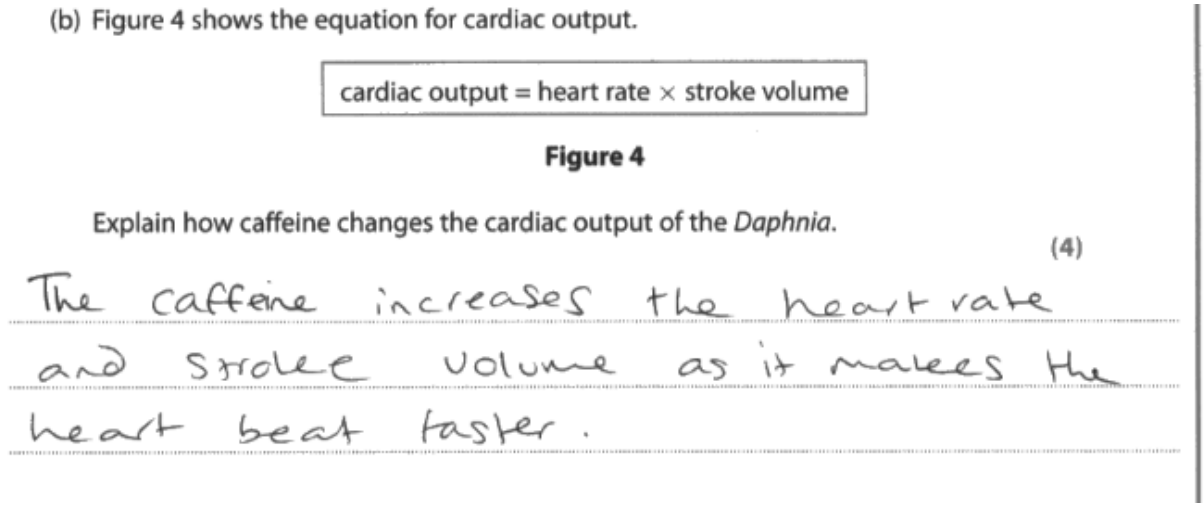
Explain how caffeine changes the cardiac output of the *Daphnia*.

(4)

When caffeine is added to the Daphnia the heart rate increases and so does the stroke volume. And this increases the cardiac output. This because to find out the cardiac output, heart rate and stroke volume are nessecary

The learner has gained marking points 2,7 and 1. They have not said *how* the caffeine exerts if effect.

This response gained two marks



(b) Figure 4 shows the equation for cardiac output.

cardiac output = heart rate × stroke volume

Figure 4

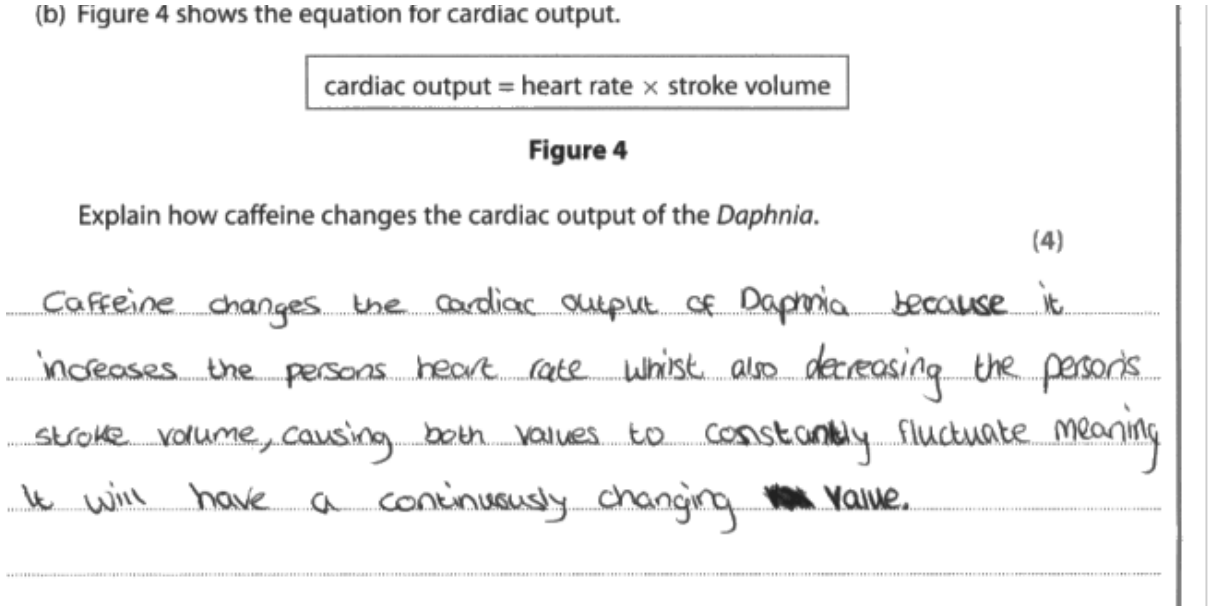
Explain how caffeine changes the cardiac output of the *Daphnia*.

(4)

The caffeine increases the heart rate and stroke volume as it makes the heart beat faster.

The learner has achieved marking pints 1 and 7 and then repeated marking point 1.

This response gained one mark



(b) Figure 4 shows the equation for cardiac output.

cardiac output = heart rate × stroke volume

Figure 4

Explain how caffeine changes the cardiac output of the *Daphnia*.

(4)

Caffeine changes the cardiac output of Daphnia because it increases the persons heart rate whilst also decreasing the persons stroke volume, causing both values to constantly fluctuate meaning it will have a continuously changing [redacted] value.

The learner has not gained marking point 1 because a reference to changing the cardiac output is too vague. The words 'affecting' or 'changing' unqualified do not indicate whether the change/effect is an increase or a decrease. They have gained marking point 2 for using the data provided and saying that the heart rate increased. The statement about decreasing stroke volume is incorrect and prevents them from gaining marking point 7 but does not negate marking point 2 that they have already gained.

Question 2 (c) 2 marks

This was a very straightforward question asking learners to identify the right atrium of the heart and the vena cava (the blood vessel that delivers blood to that chamber).

The majority of learners could identify these structures but some forgot that for anatomical diagrams where we are looking at the front (ventral surface) of the heart, the right side of the heart is on the left side of the page and they incorrectly identified the left atrium. Some appeared to be guessing at the name of the blood vessel and incorrect responses included aorta, pulmonary vein and pulmonary artery

This response gained two marks

(c) Figure 5 shows the human heart in longitudinal section, together with some of the main blood vessels.

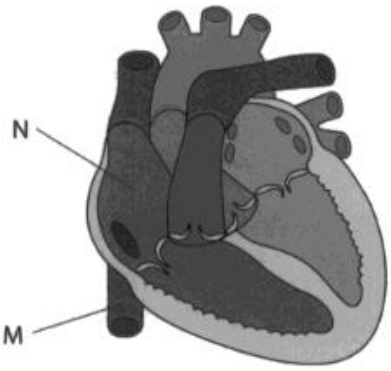


Figure 5

Identify the structures labelled M and N in Figure 5.

(2)

M W trachea Aorta. ~~M~~ vena cava.

N ~~vena~~ cava right atrium

The learner has made incorrect identifications but then thought again and crossed out those, substituting the correct responses.

This response gained one mark

(c) Figure 5 shows the human heart in longitudinal section, together with some of the main blood vessels.

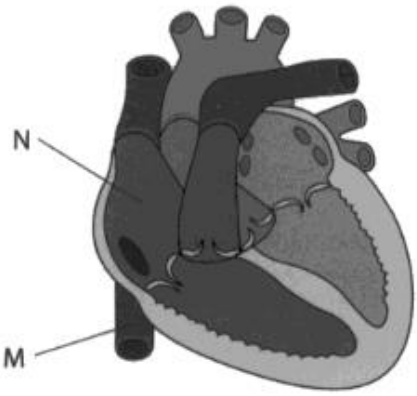


Figure 5

Identify the structures labelled M and N in Figure 5.

(2)

M Right Ventricle

N Right Atria

The learner has correctly identified N as the right atrium. Although they have used the plural 'atria' they have not been penalised for an error of Latin.

Question 2d 1 mark

This was a multiple choice question asking learners to identify characteristics of the main artery, the aorta, with respect to wall thickness, size of lumen and pressure of blood in the vessel.

Most learners correctly identified that the wall is thick, the lumen relatively small and the pressure of blood is high.

Question 3

Question 3 was all about blood groups and blood transfusions.

Learners were told that the question focussed on the ABO blood grouping system and the rhesus system.

Question 3 (a) 4 marks

In this part of the question learners were given an incomplete table showing the antigens on erythrocytes and antibodies in the plasma for four blood groups, A, B, AB and O, and were asked to complete the table for blood groups A and AB.

Many learners knew this and completed the table correctly. However, some lost a mark by not indicating that the erythrocytes of blood group AB have two different types of antigens, A **and** B, and not a single antigen called AB. Some also incorrectly indicated that group O had anti O antibodies, as opposed to no antibodies, in the plasma.

This response gained four marks

3 The two most important blood grouping systems for humans are the:

- ABO system
- rhesus system.

Table 4 lists the antigens and antibodies present in people of different ABO blood groups.

(a) Complete Table 4 for blood groups A and AB.

(4)

blood group	antigens on erythrocytes	antibodies in blood plasma
A	A	anti B
B	B	anti A
AB	A and B	none
O	none	anti A and anti B

Table 4

All four blank boxes have been correctly completed. The learner changed their mind about the antibodies for group A and crossed out their first idea and then substituted a correct response.

This response gained two marks

3 The two most important blood grouping systems for humans are the:

- ABO system
- rhesus system.

Table 4 lists the antigens and antibodies present in people of different ABO blood groups.

(a) Complete Table 4 for blood groups A and AB.

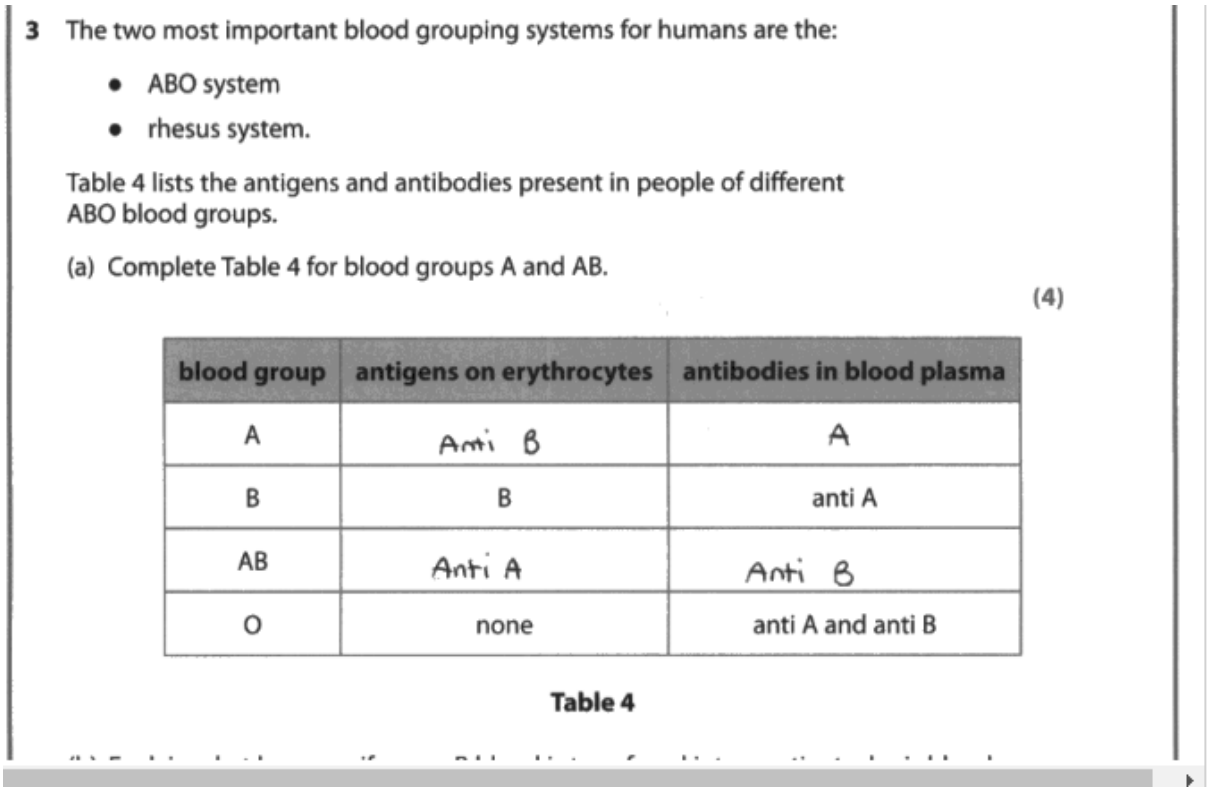
(4)

blood group	antigens on erythrocytes	antibodies in blood plasma
A	A	anti B
B	B	anti A
AB	AB	Anti A + anti B.
O	none	anti A and anti B

Table 4

The learner has correctly identified the antigens and antibodies for group A blood but has not clearly indicated that blood group AB has two distinct antigens and has incorrectly stated that group AB blood has antibodies against its own antigens.

This response gained no marks



3 The two most important blood grouping systems for humans are the:

- ABO system
- rhesus system.

Table 4 lists the antigens and antibodies present in people of different ABO blood groups.

(a) Complete Table 4 for blood groups A and AB.

(4)

blood group	antigens on erythrocytes	antibodies in blood plasma
A	Anti B	A
B	B	anti A
AB	Anti A	Anti B
O	none	anti A and anti B

Table 4

The learner has confused antigens and antibodies for blood group A and has given incorrect information for blood group AB.

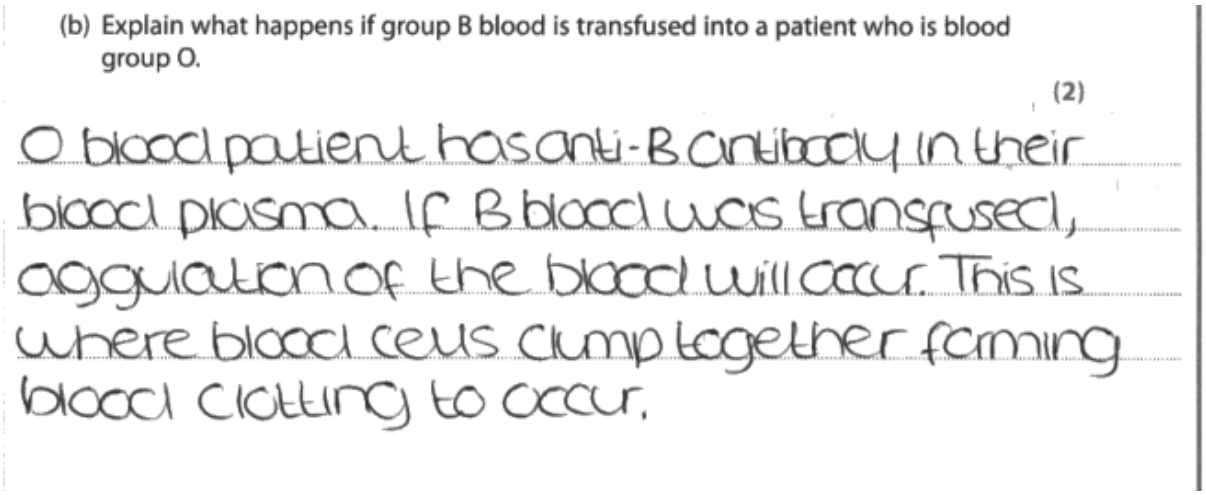
Question 3 (b) 2 marks

In this part of the question learners were asked to explain what would happen if group B blood were to be transfused into a patient who is blood group O.

Even if they had not gained any marks for 3 (a) learners could still use information given in Table 4 to help them answer this question.

Most learners used the information and realised that it was the presence of anti B antibodies in the patient's blood that would react somehow with the donor blood; some learners correctly stated that these antibodies would bind to the B antigens on the donor's erythrocytes and most learners referred to the subsequent agglutination (clumping) of blood. Some learners also explained that blood would not circulate or flow properly and that tissues would be deprived of oxygen.

This response gained two marks



(b) Explain what happens if group B blood is transfused into a patient who is blood group O.

(2)

O blood patient has anti-B antibody in their blood plasma. If B blood was transfused, agglutination of the blood will occur. This is where blood cells clump together forming blood clotting to occur.

This response gained marking points 1 (correct reference to the type of antibodies) and 3 (agglutination). Although agglutination is mis-spelt it is unlikely to mean anything else and the learner has also mentioned clotting and clumping.

This response gained one mark

(b) Explain what happens if group B blood is transfused into a patient who is blood group O.

(2)

~~The grou The~~ The group B blood will have B antigens and the bodies plasma will have anti B anti bodies, so the blood will be fought off by the antibodies

The learner has correctly identified that group B's B antigens would be involved but has not said how – that they would be bound to or fit to antibodies; 'being fought off by' is too vague at this level and suggests that the antibodies are somehow involved in dealing with an infection. The learner has correctly stated that it is anti B antibodies that will be involved and so gained marking point 1.

The idea that these antibodies deal with infections caused by blood transfusions was a fairly common misconception although many learners under this misapprehension still gained full marks as they had also given two correct and credit worthy statements.

This response gained one mark

(b) Explain what happens if group B blood is transfused into a patient who is blood group O.

(2)

~~this~~ will result to different types of blood ~~mixture~~ which could lead to clotting of the blood. This could increase the risk of infection ~~to the blood~~ of disease in the blood.

This response indicates some lack of understanding but gets a mark for saying that the blood would clot.

Question 3 (c) 3 marks

This question informed learners that the rhesus system referred to whether erythrocytes had or did not have D antigens on their surface and then asked learners to explain why, in an emergency, anyone could be given a transfusion of blood of group O rhesus negative.

Most learners used information in Table 4 and said that there were no antigens in group O blood so therefore any antibodies in the recipient's plasma would not react to the donated erythrocytes and no coagulation of blood would occur. Some learners also stated that there would be no D antigens in the donated blood and so no formation of, or reaction by, anti D antibodies in the recipient's blood. Very few learners appreciated that the donated blood would be diluted by the recipient's blood and so the antibodies in the donated blood would not be sufficient to cause coagulation by reacting with recipient's antigens. However, they could achieve full marks without alluding to this.

Some learners did not give an explanation in their response, merely repeating the question by saying that group O rhesus negative was the universal donor; a response that, although a true statement, was not offering any explanation and therefore not answering the question and not credit worthy.

This response gained three marks

(c) The rhesus system relates to the presence or absence of D antigens on the surface of the erythrocytes.

Explain why, in an emergency, anyone can be given a transfusion with blood of type O rhesus negative.

(3)

O rhesus negative contains no D antigens as well as no A or B ones. This means that even if a persons plasma contained any of the respected antibodies, they would not attach to the O negative blood. Therefore, there would not be any blood clots caused.

The learner has clearly indicated that there are no A,B or D antigens in the donor blood, gaining marking points 1 and 4. They have then implied that there is no reaction with the recipient antibodies (marking point 2) and also said that there will be no clotting, which is marking point 3 so they have achieved maximum marks.

This response gained no marks

(c) The rhesus system relates to the presence or absence of D antigens on the surface of the erythrocytes.

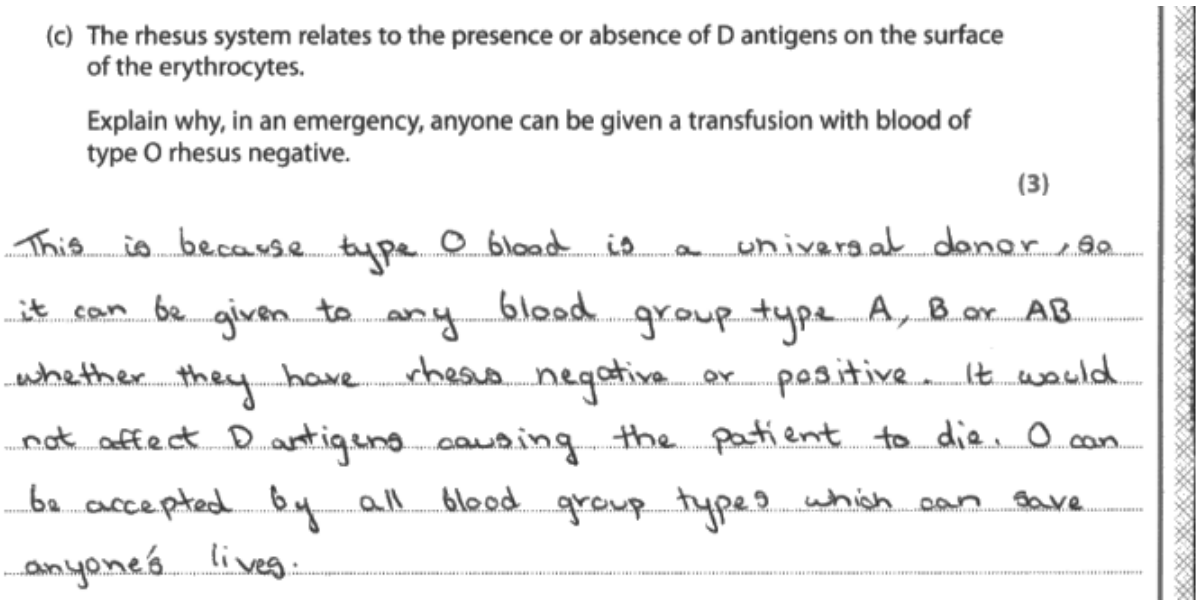
Explain why, in an emergency, anyone can be given a transfusion with blood of type O rhesus negative.

(3)

~~[illegible]~~ Because everyones bodies can accept type O rhesus negative. It is only given in an emergency though as it isnt the safest blood to use. Type O rhesus negative can work with everyones blood types

This response repeats, in slightly different wording, what is in the question and does not offer any explanation as to *why* group O rhesus negative blood can be safely given to anyone.

This response gained no marks



(c) The rhesus system relates to the presence or absence of D antigens on the surface of the erythrocytes.

Explain why, in an emergency, anyone can be given a transfusion with blood of type O rhesus negative.

(3)

This is because type O blood is a universal donor, so it can be given to any blood group type A, B or AB whether they have rhesus negative or positive. It would not affect D antigens causing the patient to die. O can be accepted by all blood group types which can save anyone's lives.

The learner's first statement is a correct statement. However, it is not answering the question but is merely repeating information in the question. In their second sentence they refer to D antigens but they have not clearly stated that O Rhesus negative blood does not contain these antigens. It is true that such a transfusion will not cause the patient to die but learners need to give a reason why death will not occur – i.e. that the blood will not coagulate or red blood cells will not be destroyed.

Question 4

Question 4 was about some aspects of the respiratory system:- alveoli and gaseous exchange.

Question 4 (a) 1 mark

Learners were told that pulmonary disease destroys alveoli and they were then presented with a graph showing the total surface area of lungs against number of alveoli destroyed. They were asked to describe the relationship between number of alveoli destroyed and total surface area of the lungs.

A great many learners appreciated that there was a negative correlation between the two features and some stated just that and others described it in a variety of acceptable ways, for example: as more alveoli are destroyed the surface area reduces or 'as surface area reduces more alveoli are destroyed' or 'as less alveoli are destroyed the total surface area is increased'. However, a significant few learners misinterpreted the data and said that as more alveoli are destroyed the surface area increases. Some said that as the number of alveoli decreased the surface area decreased which, although a true statement, did not answer the question, which was about the relationship between number of alveoli *destroyed* and surface area, not about the relationship between the number of alveoli and surface area.

This response gained one mark

4 Pulmonary disease destroys alveoli.

Figure 6 shows the effect of destroying alveoli on the total surface area of the lungs.

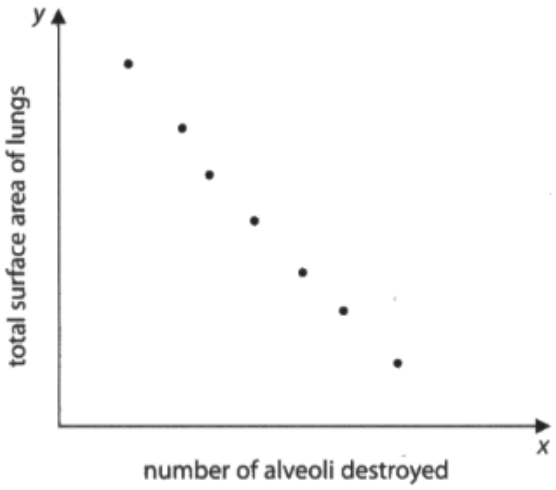


Figure 6

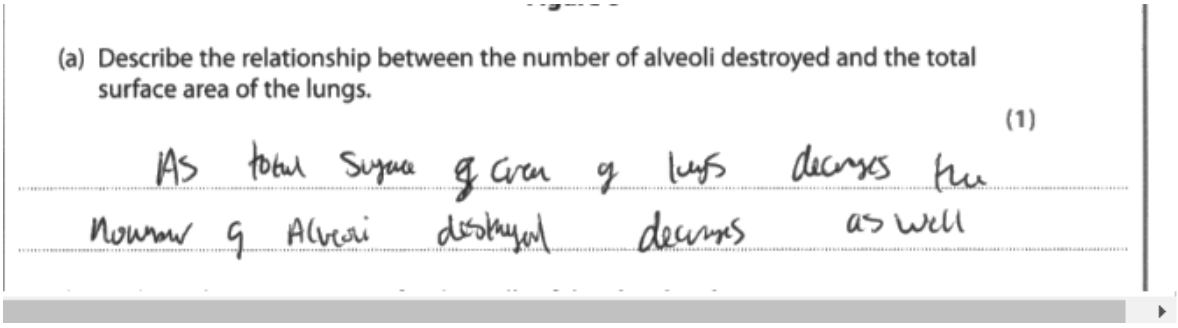
(a) Describe the relationship between the number of alveoli destroyed and the total surface area of the lungs.

(1)

as the number of alveoli destroyed ~~decreases~~ increases the total surface area of the lungs decreases.

The learner has correctly described the relationship between number of alveoli destroyed and total surface area of the lungs.

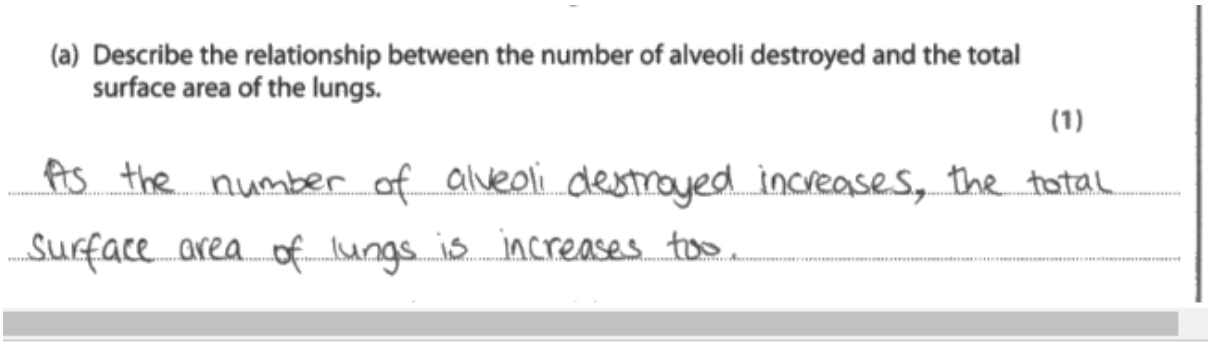
The following responses gained no marks and illustrate some common misinterpretations



(a) Describe the relationship between the number of alveoli destroyed and the total surface area of the lungs.

(1)

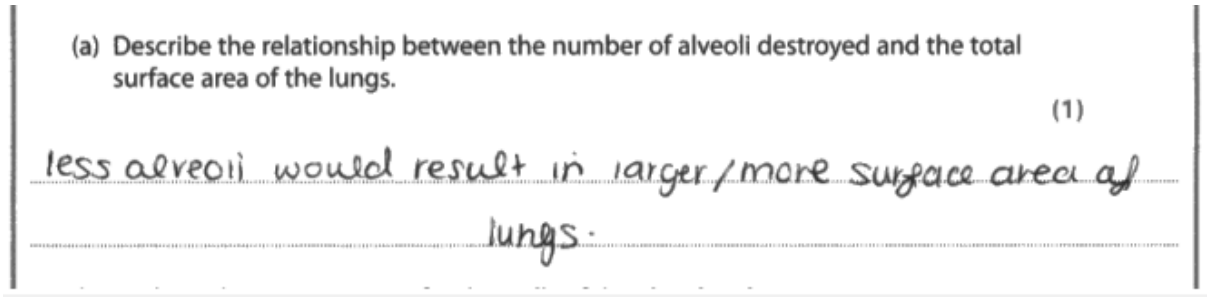
As total surface area of lungs decreases the number of alveoli destroyed decreases as well



(a) Describe the relationship between the number of alveoli destroyed and the total surface area of the lungs.

(1)

As the number of alveoli destroyed increases, the total surface area of lungs is increases too.

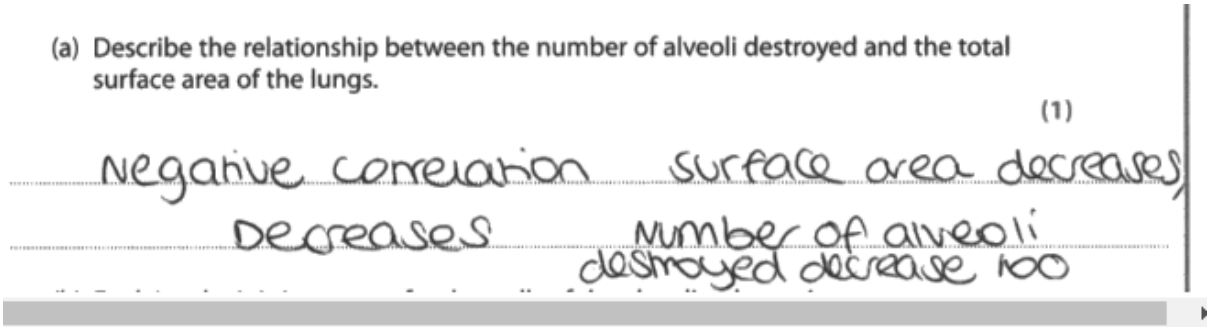


(a) Describe the relationship between the number of alveoli destroyed and the total surface area of the lungs.

(1)

less alveoli would result in larger / more surface area of lungs.

The following response gained no marks.


(a) Describe the relationship between the number of alveoli destroyed and the total surface area of the lungs.

(1)

negative correlation surface area decreases
decreases number of alveoli
destroyed decrease too

Had this learner just left the response as 'negative correlation' they would have gained the mark. However by further elaboration and getting it wrong, they have contradicted themselves and, unfortunately, lost the mark.

Question 4 (b) 2 marks

This question asked learners to explain why it is important for the walls of the alveoli to be moist. Some learners said that gases have to be in solution in order to diffuse. This is not correct and gases diffuse faster when not in solution than when in solution. The reason alveoli need to be kept moist is so that they do not collapse and adhere, which would reduce the surface area for gaseous exchange. Some learners answered correctly. Some of them also referred to reducing surface tension. Some learners wrote that gases have to be in solution to diffuse and some learners confused the moisture in alveoli with pleural fluid that is between the pleural membranes and talked, incorrectly, of reducing friction.

This response gained 2 marks

(b) Explain why it is important for the walls of the alveoli to be moist.

(2)

The walls of the alveoli must be moist to ensure easy gas exchange. Also the moist walls allow the alveoli to expand easier, which increases the surface area of the lungs during inhalation.

The learner has made the points in converse. By saying it allows the alveoli to expand easier is equivalent to saying it prevents their collapse/sticking together and by saying that this increases the surface area is equivalent to saying prevents reduction in surface area. This is a clear response indicating good understanding.

This response gained 1 mark

(b) Explain why it is important for the walls of the alveoli to be moist.

(2)

This is important as the water will stop it from collapsing which is surfaca Suffactant. It withsh also prevents tension

The learner has correctly stated that the moisture prevents alveoli from collapsing (it here refers to the subject in the question which is alveoli) but has not gained marking point 3 as they have not clearly stated that the reduction is in *surface* tension.

Question 4 (c) 1 mark

This was a multiple choice question asking learners to identify an adaptation that directly enables efficient gaseous exchange in human lungs. Most learners

correctly identified this as the fact that capillary walls consist of one layer of endothelial cells, rather than any of the distracters: bronchioles not containing cilia, internal intercostal muscles only contracting during forced expiration and the lungs being protected by the rib cage; all of these are correct statements but do not directly contribute to efficient gaseous exchange.

Question 5 6 marks

This question asked learners to compare how substances moved into and out of cells by active and passive transport mechanisms.

Good responses showed some similarities between active and passive transport processes, such as that both facilitated diffusion and active transport use protein carriers or channels in the cell membrane; or that bulk transport (exo-and endo-cytosis) and active transport both use ATP. Few learners mentioned that transport across cell membranes depends upon surface area or surface area to volume ratio and therefore certain cell shapes or projections, such as microvilli, increase the rate of transport; few mentioned that temperature increases the rate of transport as diffusion, facilitated diffusion and osmosis all depend on the kinetic energy of the molecules or that if temperatures increases too much then membrane structure loses its integrity and protein carriers would denature and the lipids in the phospholipid bilayer would melt.

More learners focussed on the differences and some gave very good accounts of bulk transport, active transport, facilitated diffusion, diffusion and osmosis. Some learners also included references to co-transporters and gave clear explanations about the specificity of protein channels used in facilitated diffusion and channel and carrier proteins used in active transport. Many used annotated diagrams to help illustrate their answers, particularly when referring to endo- and exo- cytosis.

However, some learners were confused about the significance of the size of molecules passing across cell membranes and thought that all molecules passing by diffusion had to be small; this is not always the case as large fat-soluble molecules can pass through the lipid bilayer of membranes. Some learners thought that active transport was only for large molecules; this is the case for bulk transport but many learners did not link active transport using protein carriers or pumps to the movement of molecules against the concentration gradient; or they did not link the need for protein channels or carriers to the fact that ions or polar molecules cannot pass directly through the hydrophobic part

of the lipid bilayer. Some learners thought that active transport was simply for faster transfer.

A small number of learners were very confused and thought that active transport did not use ATP whereas diffusion and osmosis did use ATP. Some thought, wrongly, that active transport carried molecules down the concentration gradient and passive carried molecules against the gradient. Some learners thought, incorrectly, that facilitated diffusion uses ATP, presumably because it , like active transport, uses protein channels. A few learners had probably not read the question carefully and talked about cells moving into and out of blood, which was not at all relevant.

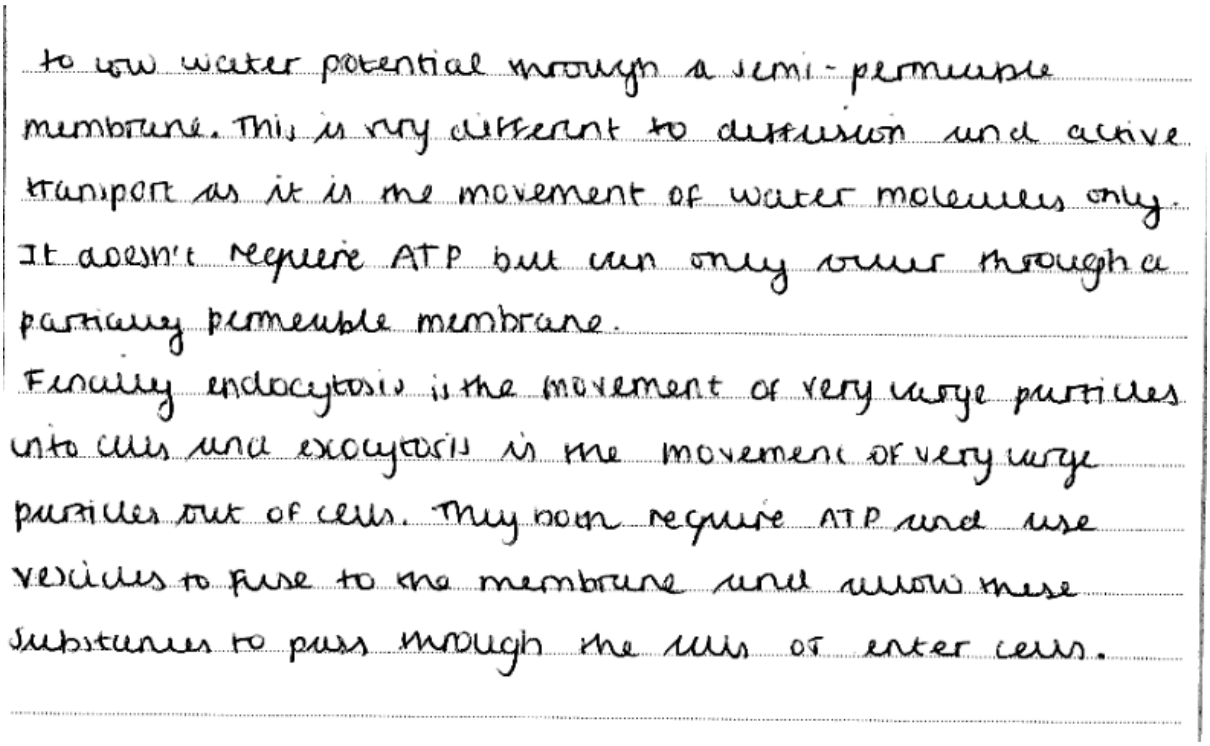
Many learners refer to the cell membrane as 'semi-permeable', rather than the more accurate description of 'partially permeable', however they were not penalised for this.

The following response is worthy of top level 3 with 6 marks

Active transport is the movement of charged and large particles via channel / carrier proteins. This movement is against the concentration gradient from a low to high concentration. It's an active process that requires ATP (energy) produced in aerobic respiration. This mechanism can also be affected by respiratory inhibitors as they stop the production of ATP needed for the process to take place. A limiting factor includes that when all the channel / carrier proteins are used up, active transport can't take place anymore.

In comparison, diffusion is a passive process. Simple diffusion transports small particles and facilitated diffusion transports larger, charged particles. These mechanisms don't require ATP like active transport so therefore aren't affected by respiratory inhibitors. The particles in this process move with the concentration gradient from a high to low concentration which is the opposite to active transport. Furthermore, facilitated diffusion also uses carrier / channel proteins which is also a limiting factor as when they're used up, the process can't take place anymore.

Another method of transport that is passive is osmosis, this is the net movement of water molecules from a high


to low water potential through a semi-permeable membrane. This is very different to diffusion and active transport as it is the movement of water molecules only. It doesn't require ATP but can only occur through a partially permeable membrane.
Finally endocytosis is the movement of very large particles into cells and exocytosis is the movement of very large particles out of cells. They both require ATP and use vesicles to fuse to the membrane and allow these substances to pass through the cells or enter cells.

Learners do not have to cover all the indicative content as given on the mark scheme. They will also be credited for other valid points, such as the excellent reference here to the effect on active transport of respiratory inhibitors and the limiting effect of the number of available carriers.

The learner has given a lot of detail and discussed the points they have made. There is nothing inaccurate here and correct technical terms are used throughout. The response is well synthesised, concise and coherent. The learner has not included a diagram but this is not needed to gain full marks although relevant annotated diagrams may help learners to achieve marks. The response has selected relevant information and shows comprehensive knowledge and understanding about similarities and differences, producing an account with a clear, coherent and logical structure.

This response reached the top end of level 2 and gained 4 marks

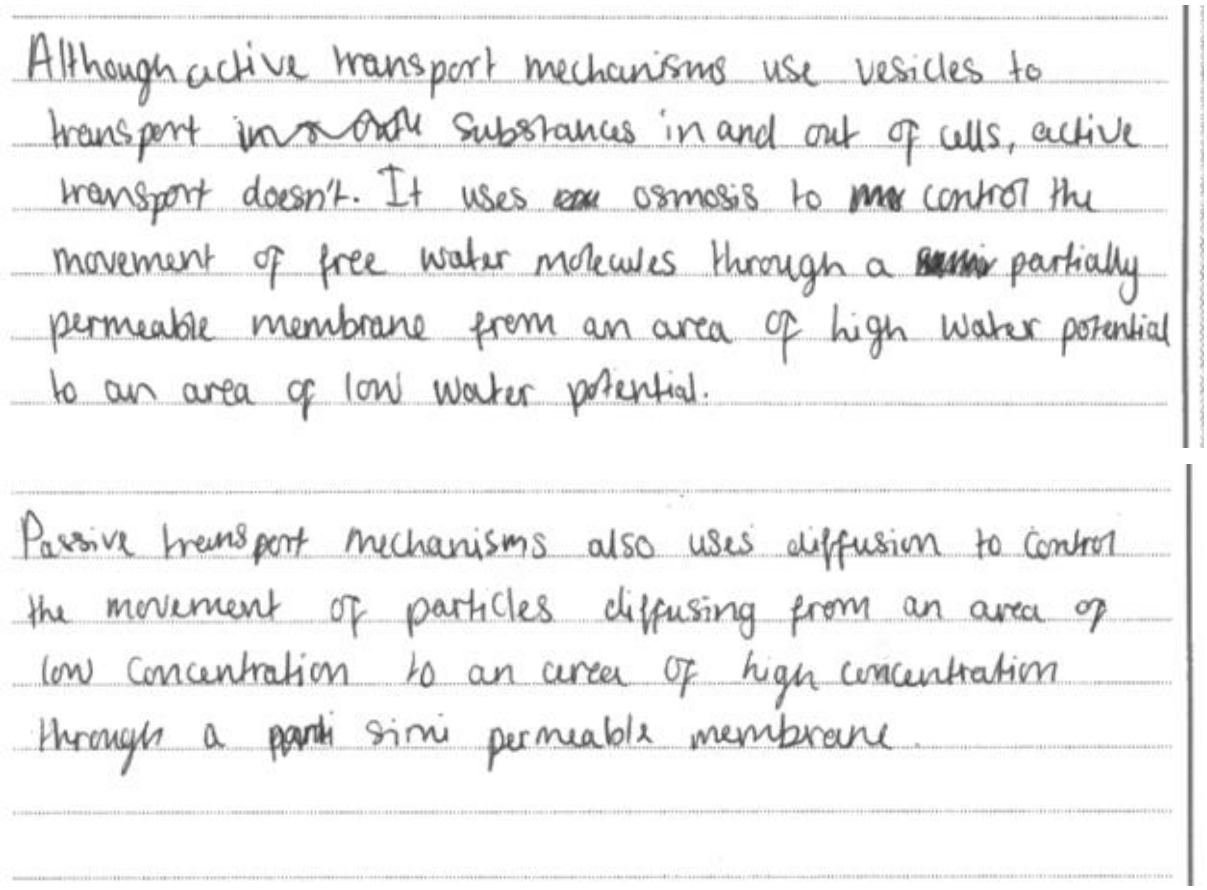
5 Substances may enter or leave cells by active transport and passive transport mechanisms.

Compare how substances move into and out of cells by both active and passive transport mechanisms.

You may include diagrams to support your answer.

(6)

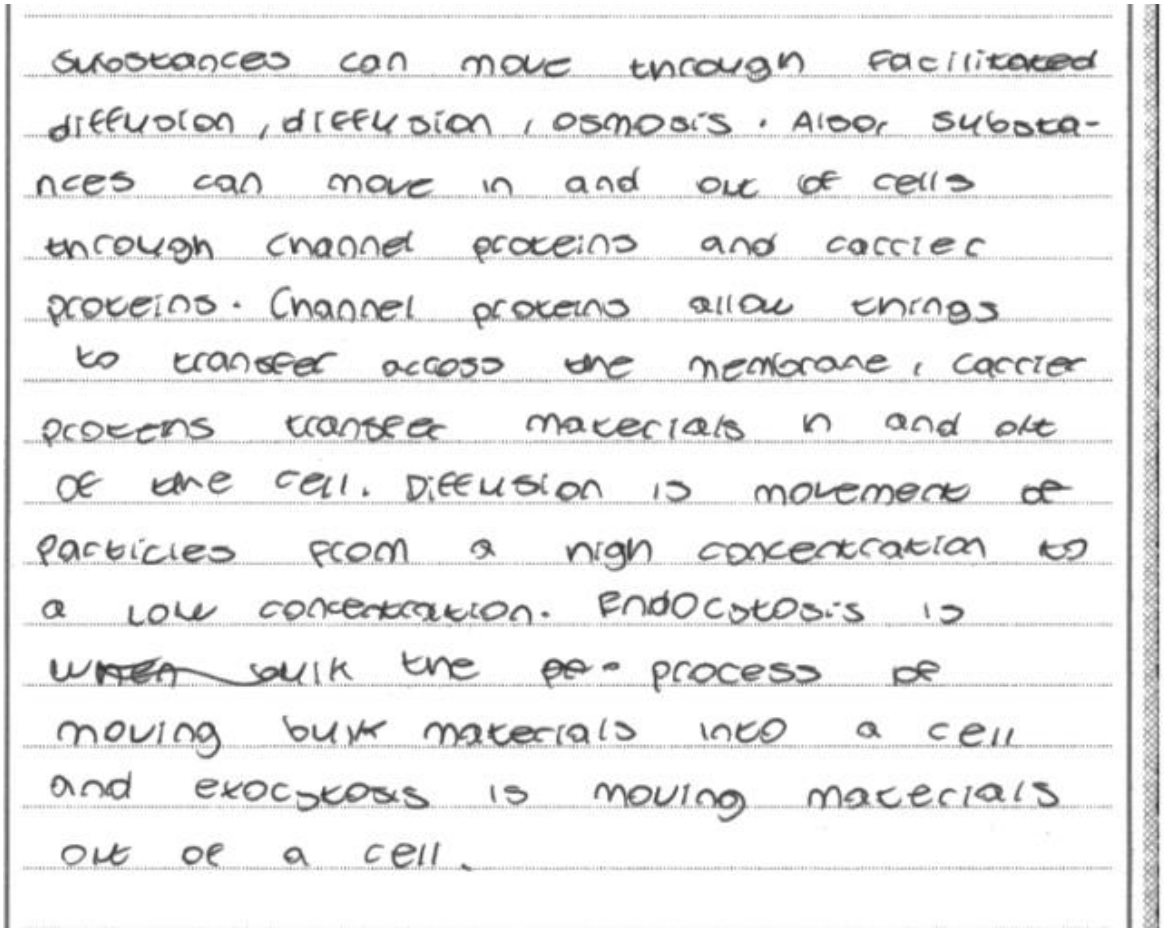
Substances can actively move in and out of cells through vesicles, while during passive transport mechanisms they move out there and in through diffusion and osmosis. Active transport also move substances against the direction of the concentration gradient.
During active transport mechanisms substances move in and out of cells in vesicles through 2 processes called endocytosis (moving into cells) and through exocytosis (moving out of cells). During endocytosis, a molecule gets surrounded by the membrane and then absorbed by the vesicle. The vesicle then transports that molecule inside cells. During exocytation the vesicle carries the large molecule towards the membrane of the cell, where it fuses with it. Allowing the molecule to escape out of the cell.


Although active transport mechanisms use vesicles to transport substances in and out of cells, active transport doesn't. It uses osmosis to control the movement of free water molecules through a partially permeable membrane from an area of high water potential to an area of low water potential.

Passive transport mechanisms also uses diffusion to control the movement of particles diffusing from an area of low concentration to an area of high concentration through a semi permeable membrane.

The response covers active and passive methods of transport but does not link them to ATP, which is a key factor. Overall the response is fairly coherent but lacks some details in places.

The following response just got into level 2 with 3 marks



Substances can move through facilitated diffusion, diffusion, osmosis. Also, substances can move in and out of cells through channel proteins and carrier proteins. Channel proteins allow things to transfer across the membrane, carrier proteins transfer materials in and out of the cell. Diffusion is movement of particles from a high concentration to a low concentration. Endocytosis is ~~water~~ bulk the process of moving bulk materials into a cell and exocytosis is moving materials out of a cell.

The account is concise and coherent and demonstrates fairly good knowledge but it lacks some details and has not mentioned ATP or explained why bulk transport is sometimes necessary. However there is nothing inaccurate here.

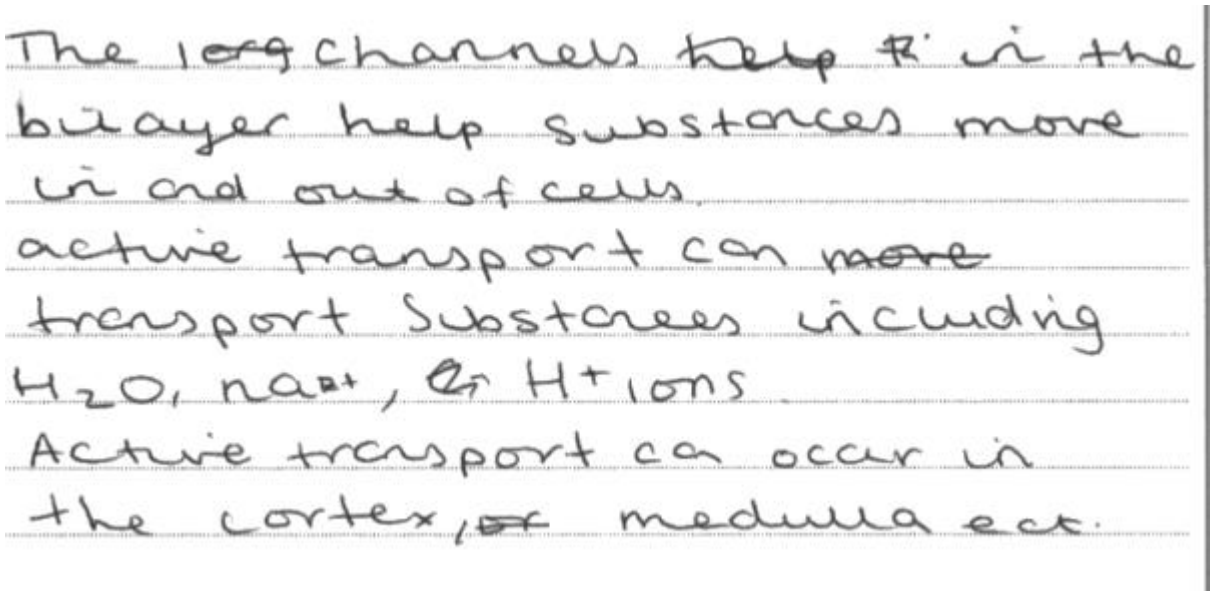
This response was placed at the top of level 1 with 2 marks

You may include diagrams to support your answer.

movement of molecules (6)

active transport is from a high to low concentration a semi-permeable membrane. This can be achieved by the ~~biotayer~~ phosopholid bilayer. active transport uses ATP and ~~carr~~ protein camers to do this. The phosolipid bilayer consists of phospholipids with the head being hydrophillic and tail being hydrophobic. ~~There are many areas~~

Passive transports is the movement of molecules from a high to low concentration across a semi-permeable membrane. passive transport doesn't use ATP ~~or~~ (energy) or protein camers.



There is some comparison and both similarities and differences are included. The response demonstrates adequate knowledge about use of ATP and protein carriers and whether the movement is down or against a concentration gradient. The account lacks coherence in places.

Summary

Based on their performance on this paper, learners should:

- Always read the question carefully and understand which command word is being used and tailor their response accordingly. They should read the information/scenario given in the stem of the question as it will help and guide them towards the appropriate response

- Tailor their response based on the command word in the question; identify does not require any expansion of a point but explain will require a reason for how or why something happens. Describe does not need a reason as to why or how something happens but you need to describe what is happening.

- Use appropriate technical terminology throughout responses. For example when talking about energy for transport across cell membranes, refer to ATP.

- Use the number of marks gained and the space available as a guide to the depth of response required. If the command word is 'identify' or 'name' then usually only a word is needed. Do not waste time writing more; that time can be better used when

answering the longer questions.

- Be clear about the names and functions of all structures and chemicals listed in the specifications.

- Try to spell words correctly**.** We usually accept phonetic spellings but sometimes a mis-spelt word becomes another word and then it cannot be accepted, for example urea and urine.

- Make sure they understand how to calculate percentage changes

- Make sure they can interpret information given in graphs

- Some learners run out of time for the last question. They can answer that question first, before they get too tired, and then answer the shorter questions, but, if they do this, they should not spend too long on the 6 mark question and deny themselves enough time to tackle all the other questions.

Individual Questions

Chemistry

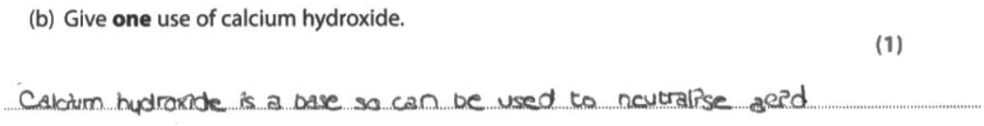
Q1(a)

This multiple-choice question tested whether learners could identify whether calcium hydroxide, as a typical metal hydroxide, was a base.

Just under half of learners did correctly identify this as the property, making it the most popular option of the four presented.

Q1(b)

This question asked learners to give one use of calcium hydroxide but relatively few were actually able to give an appropriate application. Many incorrect responses referred to vague applications in medicine, farming, manufacture of bleach, plastics and toothpaste. One of the most common errors made by learners was to simply reiterate their response from Q1(a). Even if they had selected the correct option in the previous question, this was clearly indicated as a property rather than as an actual use. Some learners were able to extrapolate from calcium hydroxide being a base that it could neutralise acids. This is again simply a chemical property of calcium hydroxide and was not creditworthy as an actual use.

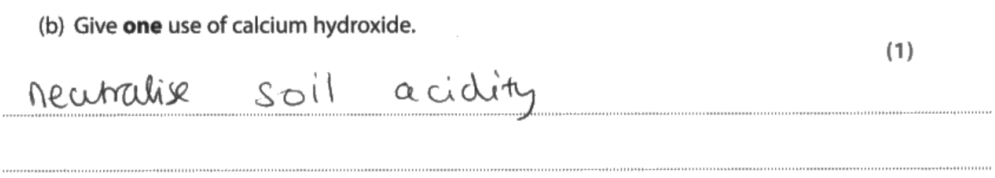

(b) Give **one** use of calcium hydroxide.

(1)

Calcium hydroxide is a base so can be used to neutralise acid

0 marks

Responses that placed this in the context of an everyday use were credited with the mark (eg treatment of acidic soil or waste water).


(b) Give **one** use of calcium hydroxide.

(1)

neutralise soil acidity

1 mark

Attention is drawn to the Essential Content under A1 which covers "Relating properties to uses and production of substances". This specifically identifies

$Ca(OH)_2$ as being used "in acidic effluent treatment" and that learners must know that the "choice of a substance for a use should be in relation to its properties". Please note that the properties and uses of any named substance under section A1 may be questioned in the Unit 5 Chemistry paper and should be included within teaching to learners.

Q1(c)(i)

This question was the first of two calculations related to the temperature / heat energy change that occurred when calcium hydroxide was dissolved in water. In this first part, learners needed to convert the initial temperature of water from Kelvin into Celsius. About three-quarters of the cohort were able to do this successfully.

(c) A technician wants to determine the heat transferred when calcium hydroxide dissolves in water.

The initial temperature of the water was 289.0 K.

(i) On the Kelvin scale of temperature, 0.0 K is –273.2 °C.

Give the initial temperature of the water in °C.

(1)

289 - 273.2 = 15.8

initial temperature of water = 15.8 °C

1 mark

Although a value for absolute zero was provided as part of the question, answers that involved a more accurate or rounded value were credited.

Typical errors preventing the award of the mark tended to involve some other mathematical operation such as addition or multiplication to arrive at an answer.

Q1(c)(ii)

In the second part of the calculation, learners needed to calculate the heat energy transferred when provided with the mass and specific heat capacity of water, as well as its initial and final temperatures. Once again, about three-quarters of the cohort were able to score all of the marks available for this question and it was extremely rare to find a learner that could not score at least 1 mark.

750 x 4.18 x 3.9

289.0 - 292.9 = 3.9

750 x 4.18 x 3.9

= 12226.5

heat transferred = 12226.5 J

3 marks

Generally, learners that only achieved 2 marks did so for one of the following errors:

- The final calculated answer was evaluated incorrectly
- The temperature change calculated had been incorrectly rounded down to 3 instead of 3.9 being used
- A power of ten error had occurred whereby the answer given was too large or small (eg conversion of mass from g to kg)

mass x SHC x TC

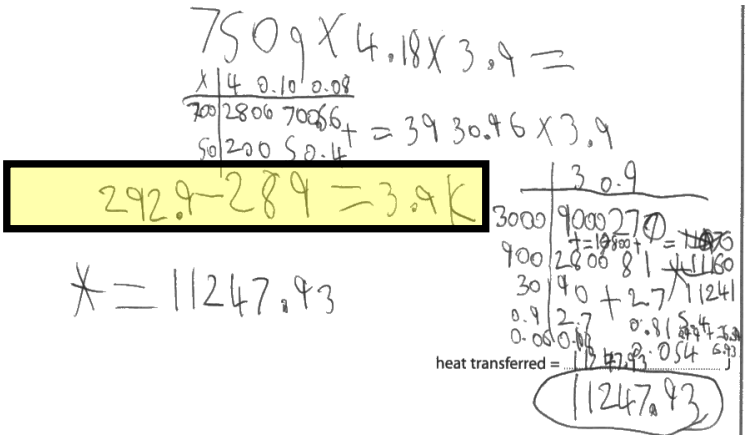
750g x 4.18 x (292.9 - 289.0) = 3.9

0.75 x 4.18 x 3.9 = 12.2265

2 marks

Learners that scored only 1 mark also did so normally for one of three reasons:

- They were able to substitute values into the equation supplied but were unable to calculate the temperature difference or heat transfer correctly
- They selected a temperature rather than the temperature difference to substitute into the equation, and so due to error carried forward were able to score the evaluation mark if correctly calculated
- The temperature change was calculated correctly but subsequent working either did not correctly use the supplied equation, was overly complex or attempted to "test" out at least two different methods



1 mark

In relation to the last of these points, learners need to be reminded to place their final answer on the answer line and cross out any working that does not form part of that answer. Presentation of different methods of working leading to alternate answers elsewhere carries the risk of no marks being awarded at all, irrespective of whether one of the methods is correct and shows the correct answer.

Q1(d)

This question required learners to explain why the enthalpy change of hydration is negative, so answers were required to be scientifically sound and show good reasoning in order to score. Consequently, marks were only awarded to the most able learners and many learners did not score at all.

Some learners confused the images of positively or negatively charged ions with the reference to the negative enthalpy change, which gave rise to answers which did not have any logic.

Explain why the enthalpy change of hydration for **any** ion with water is always negative.

You may use diagrams to support your answer.

(4)

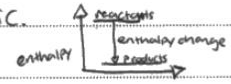
So The enthalpy change of Hydration is the enthalpy change when 1 mole of gaseous ion dissolves in water to make a infinite dilute solution.
So The enthalpy change is negative because there is a δ−, So + and − will make a negative, so that's why its negative.

(Total for Question 1 = 10 marks)

0 marks

1 mark was often achieved by identifying a point relevant to the context (ie negative enthalpy change being exothermic or the water molecule being polar) but learners were then either unable to develop the point further or could not clearly express themselves.

Because the enthalpy change of hydration with water is exothermic.



A positive ion is involved to cancel out the negative ion,

Energy is released into the surroundings from the system, products resulting in a negative change of hydration

1 mark

Generally, learners that scored 2 or 3 marks did so because they were able to link the identification point to the ability of the water molecule to attract ions. Only the very best learners recognised and articulated that because water had a positive and negative end, it could attract negative and positive ions equally well.

enthalphy change of hydration is the measure of energy releesed when attraction form bedween positive or negetive ion and water molecule.

2 marks

Due to the polarity of water molecules negative or positive ions would always be attracted to water molecules, these forces of attraction always releases energy which gives a negative value for enthalpy change.

3 marks

This is due to the dipole the water molecule possesses, where the oxygen is slightly negative and the hydrogen is slightly possitive; the oxygen will attract positive ions ~~Energy~~ and hydrogen will attract the negative ions. Therefore they produce heat when a reaction occurs meaning energy is lost

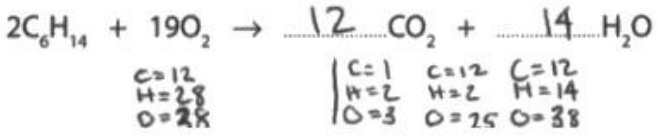
4 marks

Q2(a)(i)

Most learners were able to score one mark if not both marks for balancing the equation showing the combustion of hexane. Although not a requirement, some learners gave working to show how they had arrived at their answer. Centres are strongly advised to provide learners with opportunities to practice their techniques for writing and balancing equations in order to prepare for this fundamental chemistry skill in examinations.

(a) (i) Add numbers to balance the chemical equation for the combustion of hexane.

(2)



2 marks

Most common incorrect answers tended to show 6 for carbon dioxide and/or 7 for water, which would imply that learners had only considered the number of atoms in the molecular formula for the hydrocarbon rather than the stoichiometry shown in the equation.

Q2(a)(ii)

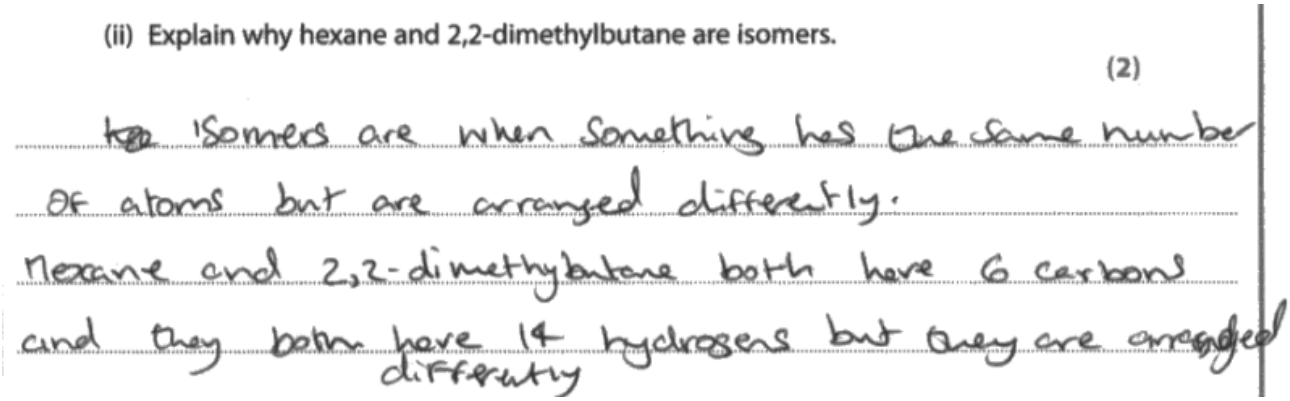
This multiple choice question asked learners to identify the correct statement relating to the standard enthalpy change of combustion. About 40% of the cohort correctly identified that an excess of oxygen was used. It is encouraging to see that an increasing number of learners are able to recall and apply definitions of standard enthalpy change in context.

Q2(b)(i)

Most learners were able to correctly name the isomer as 3-methylpentane, revealing that naming and numbering conventions for organic molecules are generally well known. Learners that did not score were often because of a miscount in number of carbons or inaccurate recall of naming eg 3-methylbutane, 3-methylheptane and 3-dimethylpentane.

Q2(b)(ii)

Approximately half of the learners were able to give some valid comment about why hexane and 2,2-dimethylbutane are isomers. A fair number of responses were able to give a standard definition of isomerism, but it was common to see some excellent answers which did relate to the context achieving full marks.

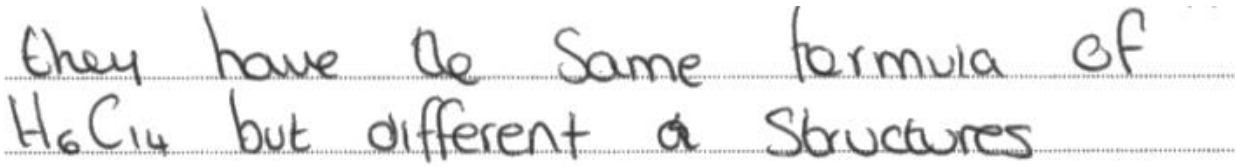

(ii) Explain why hexane and 2,2-dimethylbutane are isomers.

(2)

Isomers are when something has the same number of atoms but are arranged differently. Hexane and 2,2-dimethybutane both have 6 carbons and they both have 14 hydrogens but they are arranged differenty

2 marks

Generally, the key problem with responses that did not score was the presence of vague or irrelevant statements. For example, vague references to different "versions", "orders" or "structures" was not strong enough to meet "different structural formulae / arrangements of the atoms". Equally, "same molecular formula" is insufficiently met by statements that the molecules had the same general formula or had the same number of carbons (with no reference to hydrogen).


They have the same formula of H_6C_{14} but different structures

1 mark

Q2(b)(iii)

Well over half of the learners were able to score at least 1 mark on this question - this was in the main because 2,2-dimethylbutane was correctly identified as the isomer with the lowest boiling point. Generally these learners were able to provide some valid reason to justify their choice (such as it having the shortest

chain length) but only the very best learners were able to expand their justification with reasoning of surface area or intermolecular forces to fully to achieve all of the marks.

(iii) Identify and justify which isomer in Table 1 has the lowest boiling point.

(3)

Isomer 2,2-dimethylbutane

Justification This has the shortest chain length out of all three isomers therefore less energy will be needed to break these van der waals bonds so it will have a lower boiling point.

3 marks

Responses which started strongly were often let down by reference to the strength of bonds rather than making clear that it was the strength of the intermolecular forces or the energy needed to separate molecules that was important.

Isomer 2,2-dimethyl butane

Justification has a shorter chain so less energy is need to break the bonds between the carbone atoms.

2 marks

Where learners opted for an incorrect isomer, this was almost always hexane, and the reasons for this were inevitably flawed.

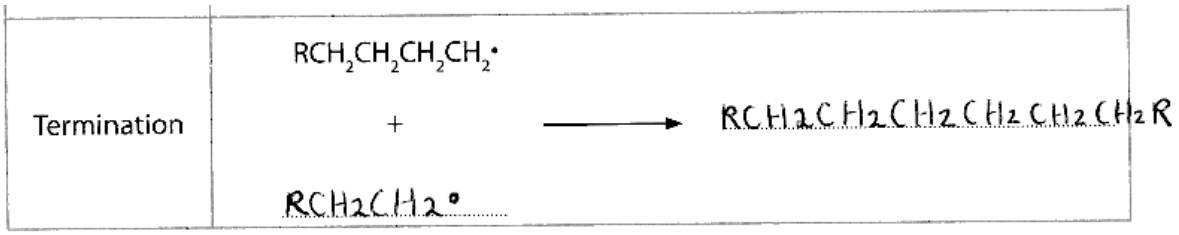
Isomer hexane

Justification It has a symetrical structure and is arranged fairly allthroughout its displayed structure, which will allow heat to reach carbons fairly. Heat can easily reach core.

0 marks

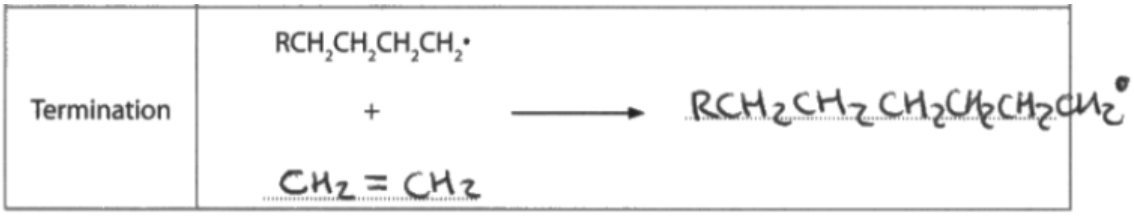
Q3(a)

This question required learners to complete the termination step of the free radical mechanism for the addition polymerisation of ethene. In spite of the preceding steps and part of the termination step being shown, this was still a challenging question for many. Nevertheless, almost half of the learners were able to score at least 1 mark, even if only a few were able to gain both marks.



2 marks

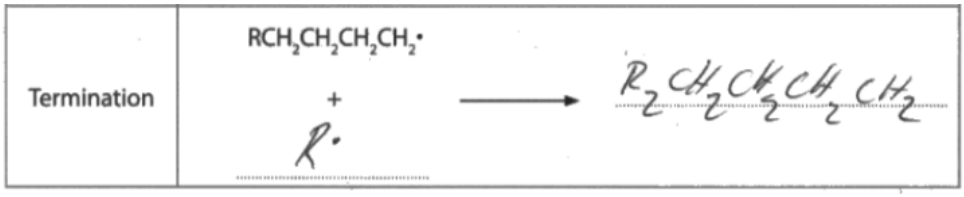
The most common error for learners to make was to treat the final step as propagation and introduce a further ethene molecule to the chain. Although this revealed a misunderstanding of what was required, error carried forward gave an allowance of 1 mark to learners if they were still able to produce the correct product in relation to the reactants – however, many learners either did not give the correct number of carbons or did not show an unpaired electron.



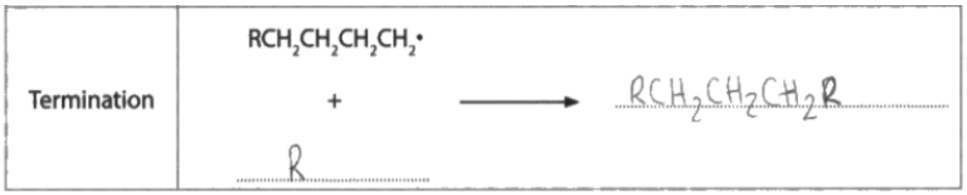
1 mark

Generally where learners did appreciate that this was a termination step, they were able to select an appropriate free radical for their equation. However, achieving the second mark depended heavily upon providing a logical product, with many giving a formula that was a free radical species, possibly mimicking the preceding three steps. Additionally, it was not sufficient to simply show the correct number and type of atom or a "molecular formula" – the correct connection of atoms also needed to be shown. Common errors in the product included:

- A miscount in the number of CH_2 groups
- Showing the R groups at incorrect positions in the chain (eg the same end of the molecule)
- Giving 2 molecules of the product (ie an unbalanced equation)
- Including a unpaired electron in the product or omitting it from the reactant



1 mark



0 marks

Q3(b)(i)

This question asked for the formula of titanium(IV) oxide and could be achieved in a couple of ways by learners:

- Recall of the formula from class notes or own research of the extraction of titanium
- Working out the formula from the systematic name

(i) Give the formula of titanium(IV) oxide.

TiO_2

1 mark

(i) Give the formula of titanium(IV) oxide. $Ti^{4+}O^{2-}$

Ti_2O_4

1 mark

Both recall and worked approaches yielded mixed results as only about 40% of the cohort were able to provide a valid formula. Incorrect attempts included TiO_4 and TiO which showed a misunderstanding (or no knowledge) of naming conventions.

Some learners provided an equation which involved TiO_2 – although not required, this was sometimes an attempt at determining the formula which was valid in this instance.

Again, learners need to be reminded that they must make clear their final answer as multiple attempts which may include the correct response will not be credited.

Q3(b)(ii)

Again about 40% of the learners recognised and identified the diagram as being a "complex". "Free radical" was a commonly selected distractor, most likely as it had been the focus of Q3(a).

Q3(b)(iii)

Approximately a fifth of the cohort were able to provide a correct interpretation of the wedge shaped bond in Figure 2.

(iii) State what the wedge shaped bond indicates about the positions of Ti and the R group in Figure 2.

(1)

R group is in front of Ti

1 mark

Although only a simple statement was required, the accuracy of wording was critical in achieving the mark. Many learners referred to "they" or "it" in their response and so did not make it clear whether Ti, R or indeed both were being referred to.

They are ab the front of the structure

0 marks

Others were simply not able to express the position of R or Ti clearly enough, often resorting to comments such as "it sticks out", "further behind", "face up", etc. Some learners spoke specifically about the bond rather than the atoms which was acceptable if the meaning was clear and correct, but often the possible nature of the bond was identified instead (eg strong, dative, sigma, the angle, etc).

the wedge shaped bonds indicate that it is at a 120° angle to the Ti

0 marks

Q3(b)(iv)

Most learners were unable to provide a creditworthy response to score anything on this question. This was surprising given that the question made clear that $TiCl_4$ was a catalyst and a mark was available for simply stating something about how a catalyst works, such as offering an alternative route or lowering the activation energy – approximately 40% of the cohort were able to provide some credit worthy statement to meet this.

(iv) Explain how the catalyst $TiCl_4$ lowers the amount of energy needed for the addition of $CH_2{=}CH_2$ to the R group.

You may refer to Figure 2 and Table 2 to support your answer.

(3)

~~It~~ It provides an alternative reaction route that has a lower activation energy.

1 mark

Scoring of further marks on this question proved challenging and depended upon learners then relating their initial point to how the catalyst in this situation actually worked (ie Figure 2). A few learners were able to explain that the alternative route or lowering of the activation energy was because the catalyst weakened the double bond. This reasoning could only be credited if the bond being weakened was identified as the double (or pi) bond, however. Occasionally, responses did refer to collisions being easier or being able to happen with less energy.

It lowers the activation energy of $CH_2=CH_2$ by weakening the 'double bonds between $CH_2=CH_2$. So, it doesn't require a lot of heat energy to break the double bonds and so it can be added to the R group since the R group has a lower activation energy. They will both combine **(Total for Question 3 = 8 marks)**

2 marks

Q4(a)

Over two-thirds of learners were able to provide some comment about the bonding between the carbon atoms in propene to be able to score, although some responses were very close to being one word answers rather than descriptions as the question required.

Describe the bonding shown between the carbon atoms in Figure 3.

Bonding between C_1 and C_2

Single bond

Bonding between C_2 and C_3

triple bond

1 mark

The award of 2 or 4 of the 4 marks were the most frequent scores across the cohort, typically because learners were able to identify either single and double bonds, sigma and pi bonds or all four within the diagram. General observations such as that the bonds were covalent or that electrons were being shared were rare. Occasionally, learners would attempt to describe orbital overlap but frequently this was very general without reference to the nature or direction of the overlap.

Bonding between C_1 and C_2

A single bond because the diagram doesn't show p orbitals overlapping therefore there are only sigma bonds which are present in single bonds.

Bonding between C_2 and C_3

This is a double bond as the p orbitals overlap above and below the carbon to create a pi bond. A pi bond is only formed after a sigma bond making it a double bond.

4 marks

Common reasons that learners would lose marks were:

- stating that only a pi bond rather than a pi and a sigma bond was shown between the C_2 and C_3 atoms
- identifying the bonding between C_1 and C_2 atoms as pi rather than sigma (or vice-versa for the C_2 and C_3 atoms)
- identifying the bonding between C_1 and C_2 atoms as double rather than single (or

vice-versa for the C_2 and C_3 atoms)
- not being able to identify the double bond at all

Q4(b)

Well over 85% of learners were able to attribute the larger bond angle at y being due to the presence of the double bond. Where learners failed to score was often due to poor expression (eg y **is** a double bond). Very few were able to explain exactly how the presence of the double bond enabled this, however.

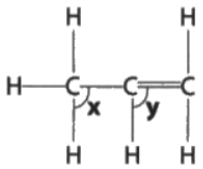


Figure 4

Explain why bond angle **y** is greater than bond angle **x**.

(2)

There is a double bond where y is set and this double bond creates the greater bond angle because although the C atom is sharing 4 bonds it's only attached to 3 other atoms causing a greater angle Whereas angle x is located on an atom with 4 other atoms and 4 bonds plus 4 bonds cause a 109.5° angle Whereas 3 cause 120° therefore x (120) is larger than ~~~~ 109.5°. Angle x is on a tetrahedral shaped Molecule.

2 marks

In general, knowledge of how bond angles are determined by the number of electron pairs around a central atom or the concept of electron pair repulsion is notably absent, and centres are advised to emphasise this within their teaching of Unit 5 and Unit 1 to better prepare learners.

The bond at angle y is a double bond, whereas at x it is a single bond. This is because the double bond takes up more space, causing the remaining 2 hydrogens on the carbon to spread out further, widening the angle.

1 mark

Q4(c)

This multiple choice question asked learners to identify the correct product from the reaction of propene with bromine. Approximately a third of the learners were able to identify the correct response, and it was generally a good discriminator between weak and strong learners. Although learners had 4

options to choose from, the problem was relatively challenging as the chemistry of alkenes had to be understood as well as the use of skeletal formulae – greater practice in both areas should be encouraged as part of preparation of learners.

Q5

This question was attempted by the majority of learners although superficial answers that simply went through the table line by line stating whether each one was a similarity or a difference (or without comment at all) were very common and this approach often yielded 0 marks.

Table 3 shows some key information about the extraction of both elements.

	Extraction of aluminium	Extraction of chlorine
Electrolyte	Alumina	Brine
Chemical formula	Al_2O_3 (l)	NaCl (aq)
Product at anode	Oxygen	Chlorine
Product at cathode	Aluminium	Hydrogen
Other product formed	Carbon dioxide	Sodium hydroxide

Table 3

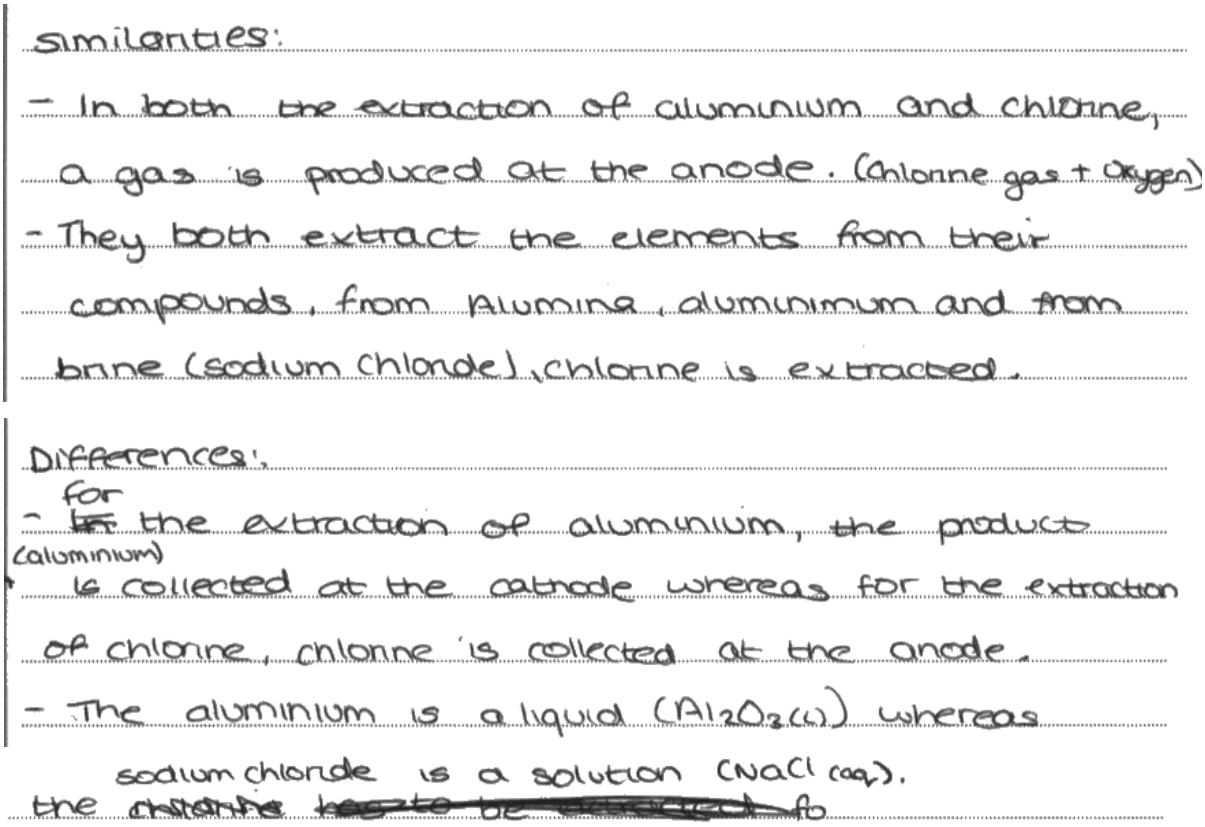
Compare the similarities and differences between the extraction of aluminium and the extraction of chlorine by electrolysis.

(6)

The extraction of aluminium for electrolyte is Alumina. and the product at anode is different then the extraction of chlorine the product at anode is chlorine, whilst at aluminium is oxygen. Another difference extraction of aluminum has is other product formed which is carbon dioxide whilst in extraction of chlorine the otle Product formed is Sodium hydroxide.

0 marks

However, some responses were able to provide more knowledge than this, such as alumina being liquid / molten whilst brine was a solution, and gave access to Level 1. Where the comparison identified similarity as well as difference, a higher placing in Level 1 was achieved eg products at the anode being gases and products at the cathode being metal and non-metal.


Similarities:
- In both the extraction of aluminium and chlorine, a gas is produced at the anode. (chlorine gas + oxygen)
- They both extract the elements from their compounds, from alumina, aluminium and from brine (sodium chloride), chlorine is extracted.

Differences:
- for the extraction of aluminium, the product (aluminium) is collected at the cathode whereas for the extraction of chlorine, chlorine is collected at the anode.
- The aluminium is a liquid ($Al_2O_3(l)$) whereas sodium chloride is a solution ($NaCl(aq)$).
the [illegible] to be [illegible] fo

2 marks

Level 2 answers started to bring in details about the processes involved in the two electrolysis methods, such as problems / uses of the waste product, temperature and energy requirements, recognition of the ions involved, etc. Responses that offered a clear description for both methods scored well but could be flawed or did not develop the reasoning any further. Responses at this level often did not relate this information back to a comparison and so limited the marks awarded. It was also relatively common to see answers which either dwelled too deeply on one aspect (ie the use of the membrane in the electrolysis of brine) or were not directly relevant (ie the extraction of alumina from bauxite).

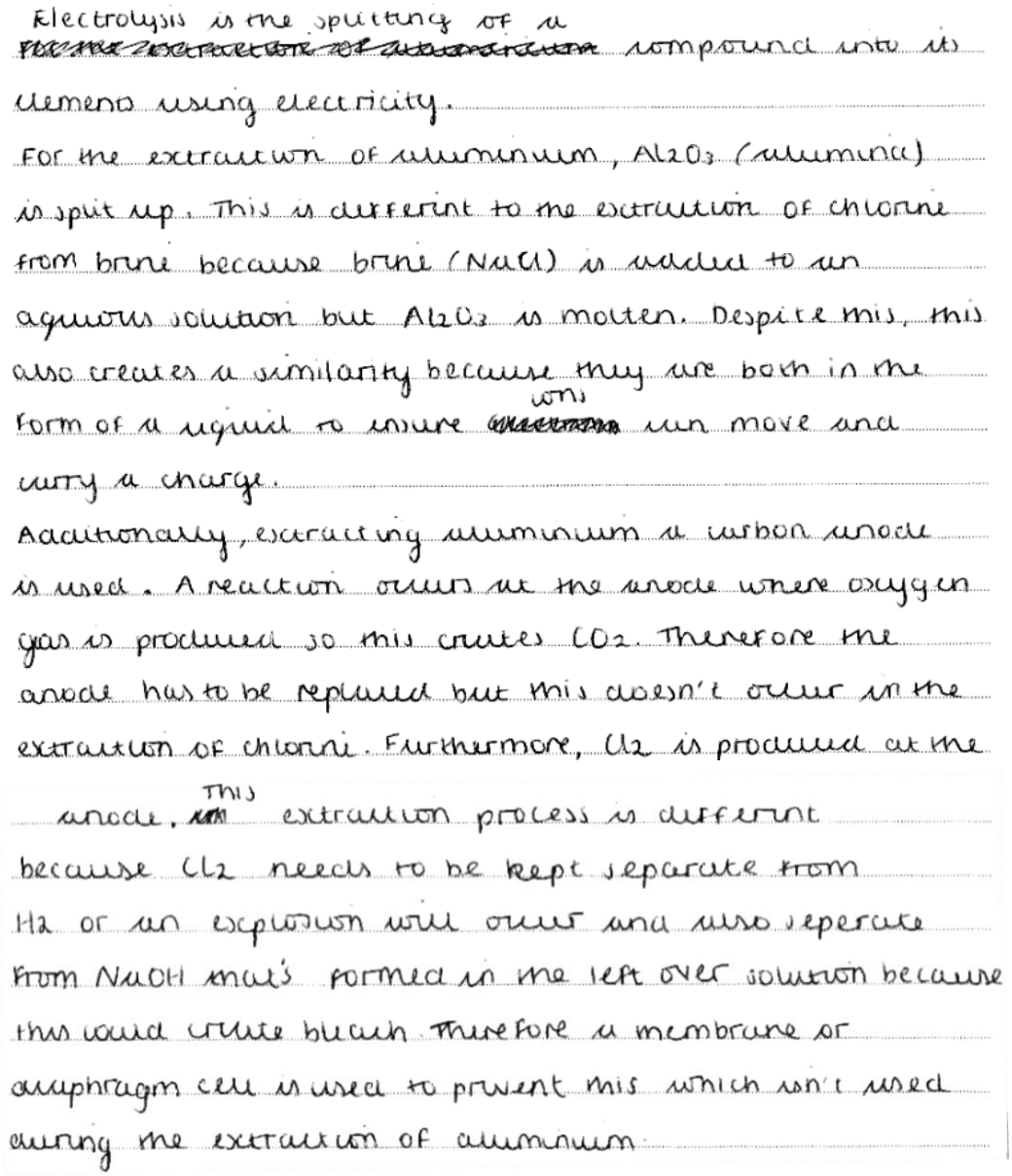
The first difference between the different electrolysis reactions is the products formed as aluminium forms alumina and Chlorine formed brine. The states of the final products are also different as Al_2O_3 is a liquid and NaCl is in aqueous solution.

However the negative electrode (cathode) will ~~attract~~ always form the positive product so this is a similarity between the electrolysis. Al^{3+} is formed for extraction of aluminium and H^+ is formed at the cathode for the chlorine extraction. These are different products but have undergone the same process. Consequently the anode products are always the negative products, with aluminium the product is O^{2-} and for ~~brine~~ Brine the product is Cl^{2-}. Again different products have been formed but they both have a ~~the~~ negative charge.

The left over products formed are different as alumina results in carbon dioxide and brine produces sodium hydroxide. ~~The difference~~ These products also have a difference in state as CO_2 is a gas and NaOH is in solution (aq).

4 marks

Level 3 responses were characterised by comparisons between the two processes but also showed a sustained line of reasoning and understanding. This was often best demonstrated with ideas such as the movement and discharge of ions at the electrodes as links between the substances produced at the electrodes with the underlying chemistry could be made and compared. The best answers then showed a clear understanding of the process of electrolysis or chemistry involved and used knowledge of this to compare the similarities and differences of both processes in detail.



Electrolysis is the splitting of a ~~[illegible]~~ compound into its elements using electricity.

For the extraction of aluminium, Al_2O_3 (alumina) is split up. This is different to the extraction of chlorine from brine because brine ($NaCl$) is added to an aqueous solution but Al_2O_3 is molten. Despite this, this also creates a similarity because they are both in the form of a liquid to ensure ions can move and carry a charge.

Additionally, extracting aluminium a carbon anode is used. A reaction occurs at the anode where oxygen gas is produced so this creates CO_2. Therefore the anode has to be replaced but this doesn't occur in the extraction of chlorine. Furthermore, Cl_2 is produced at the anode. This extraction process is different because Cl_2 needs to be kept separate from H_2 or an explosion will occur and also seperate from NaOH that's formed in the left over solution because this would create bleach therefore a membrane or diaphragm cell is used to prevent this which isn't used during the extraction of aluminium.

Another difference is that during the extraction of aluminium, extremely high temperatures are used to melt alumina and it's also dissolved in cryolite but this doesn't occur in the extraction of chlorine.
At the cathode in the extraction of chlorine, Hydrogen is formed as is higher in the electrochemical series than Na^+ so that forms NaOH in the left over solution.
This is different than the extraction of aluminium because there is no extra solution or other ions competing with eachother to be formed at the electrodes.

6 marks

Summary

Based upon performance within this paper, learners should:

- Be familiar with the properties and uses of substances referred to within section A1 of the Essential Content (eg calcium hydroxide, chlorine, alumina, etc)
- Practice writing techniques for different types of mechanism and of formulae
- Be able to recognise transition metal complexes and describe the bonding and conventions used (such as wedge-shaped bonds)
- Practice questions of 3 or more marks that test understanding and develop reasoning skills. They should try to structure their response to give a clear identification, explanation and further expansion (eg boiling point of an isomer, how a catalyst works).
- Understand that the command verb "compare" requires clear identification of at least one similarity and one difference. However, in the context of an extended response (level based) question, learners need to make several points and be prepared to explore these further in order to achieve maximum marks available.
- Be familiar with molecular shapes and bond angles relevant to organic compounds, and give the reasons for these, such as number of electron pairs and repulsion. Please see the Additional Guidance document for further details: (https://qualifications.pearson.com/en/qualifications/btec-nationals/applied-science-2016.coursematerials.html#filterQuery=category:Pearson-UK:Category%2FExternal-assessments&filterQuery=category:Pearson-UK:Document-Type%2FContent-support)

Individual Questions

Physics

Q1 was based on parts of section C2 'Materials in domestic and industrial applications' of the specification. The question was about the ideas of stress and strain and the concepts of elastic limit and fatigue.
Q1a asked learners to define stress, many learners selected answer C rather than the correct answer D for this multiple choice question. This appears to indicate that learners knew that force and area were associated with stress, but had not understood that it was force divided by area, rather than force multiplied by area.
Q1b was a calculation using a given equation, most learners were able to successfully evaluate the answer, gaining full marks. A significant number did not appear to see that the stem of the question gave the change in length of the spring (0.008m) and proceeded to work out a change in length from the numbers given themselves, this resulted in a compensatory mark being awarded, however it did clearly indicate that learners in the heat of the examination sometimes fail to read carefully enough the question and take note of the information provided.
Q1c required learners to place an X onto a pre-drawn line to show the elastic limit. Many learners gained the mark, however some did not simply because the X drawn was so large, or thickly drawn that it made it difficult to decide where it was supposed to be. The expectation in this question was that learners drew a small x on the line at the point where the line stopped being straight.
Q1d most learners failed to score this mark. Some learners thought that fatigue was defined by B or D. Approximately 45% of learners gave the correct answer A.

Q2 covers aspects of section C3 of the specification 'Fluids in motion'. It covered areas such as factors affecting viscosity, fluid flow and pressure, and the properties of one type of non-Newtonian fluid.
Q2ai frequently gave the wrong response. The factor that affects viscosity of a fluid it the temperature of the fluid. Answer C was the expected response. Just over 25% of the cohort got this multiple choice question correct.
Q2aii asked learners to complete three sentences by adding the missing words. This question did discriminate well between Pass and Merit learners in particular. Pass learners generally correctly gave the last sentence by adding the number '2' in the blank line. Merit learners were also able to score a second mark for getting the middle sentence correct by adding the word, 'same' or 'constant' to the blank line. Nearly 50% of learners scored one mark, 30% scored 2 marks but less than 4% scored 3 marks. In

many cases the first sentence was not attempted or repeated the answer for the second sentence.
Q2aiii nearly two thirds of learners did not score a mark for this question. Those that did tended to gain the mark for writing that the flow rate or velocity of the water increases. The effect on pressure was not well understood, less than 10% were aware that the increase in water speed, reduced the pressure of the water as the pipe narrowed. Most wrote that the pressure increased and left it at that without making any comment about the speed of the water. This is a common misconception, as the correct relationship is counterintuitive. There are some areas of the course where simple classroom experiments can be used to show these effects, it could be a simple as holding up two pieces of paper close together and blowing air between them. The effect is to make the pieces of paper to move inward. This gives an opportunity to then discuss why this happens in terms of the theory for the topic.
Q2b is the second example of a question set on a non-Newtonian fluid. In a previous examination the question centred on tomato ketchup stuck in a bottle and the use of a quick impact to make it less viscous , and so run out of the bottle. Many learners had learnt this and tried to apply the idea to the situation presented in this paper, however it is the opposite of the situation. Learners were expected to explain why jumping rapidly on this fluid made it more resistive to force. Very few learners were able to do this. Over 70% did not score a mark. Those that did score a mark, generally wrote that the viscosity became greater, a very few linked that to the force being applied suddenly to make the viscosity change for the second mark. It was very rare to see the last marking point which needed learners to state what the effect was on the Oobleck in terms of resisting impact. The topic of non-Newtonian fluids is one area of the specification where learners may have had little prior experience from other courses. Centres need to consider providing examples of a range of fluids that change their properties under a range of different physical changes. Centres should look at practical activities that could be used to exemplify these changes.

Q3 covered aspects of section C1 of the specification Thermal physics in domestic and industrial applications'. The question covered the equation of the first law of thermodynamics, the idea of an isothermal expansion, kinetic theory and from the additional guidance document a calculation based on the ideal gas equation. Learners find these ideas conceptually difficult and performance in the paper on these topics was poor.
Q3ai was designed to be a straightforward introduction to the question. The answer expected the phrase 'energy supplied' or equivalents identified in the mark scheme. 'Energy' alone is not sufficient as all the terms in the equation are energy terms of one form or another. The learner was expected to identify this particular energy term, as that needed or supplied or input into the system. Nearly every learner identified the term as energy, however less than 10% could correctly identify the term as energy

supplied or equivalent. It appeared that learners may have not understood the difference.
Q3aii this question was about an isothermal expansion of a gas. Learners were expected to be aware that when a gas expands it does work, so cools. If the expansion is slow, then there is time for helium particles to gain energy from the surroundings so there is no change in temperature. Many learners answered this question in terms of what the balloon did to the gas. Some learners wrote general answers indicating a knowledge of the behaviour of particles, but did not answer the question set. The two marks were awarded for identifying a need for time for energy to transfer and then stating why, i.e., to give an isothermal expansion. A very small number of learners were able to gain a mark for this, and even fewer gained both marks. The common reason for awarding one mark was for identifying the need for an isothermal expansion.

Q3bi was a very well answered question. Learners clearly are aware that heating a gas increases the kinetic energy of the gas. Over 90% of learners scored this mark.
Q3bii was a calculation based on the combined gas law formula in the additional guidance document. Learners with strong skills in algebra did well and scored the full three marks available. The correct answer was scored by third of the learners. In a number of cases learners were not able to convert standard form correctly and so generated a wrong answer for the new pressure, that was a power of ten error, this was awarded 2 marks. Learners that scored 2/3 marks were able to do the necessary algebra. Some learners were able to substitute correctly into the given equation or show what half of the equation would evaluate to (106) and so gain a mark. This allowed around 30% of learners to score a mark from the question. It appears many learners were unfamiliar with manipulating a pair of three term equations used in the question and did not know how to start. Learners need to be given practice in working with this equation and using it to find any one of a pressure, a volume or a temperature. Some learners did put the volume into both sides of the equation but did not notice that these values cancelled out. There still remain a significant number of learners that wrongly rearrange equations.

Q4 was from section C1 of the specification and dealt with heat engines and a calculation on maximum theoretical efficiency. In previous series, both these topics did not generate good answers from learners. It was pleasing to see learners showing good knowledge and understanding and application of the ideas in this question.
Q4a asked learners to describe pressure changes in car engine cylinder, based on information given in the form of a graph. Engine cycles had been asked about in previous series, with varying degrees of success, in this paper the question was more focused on the one idea of pressure. Learners were generally able to identify what was happening to the pressure in the cylinder in sections F and H. More able learners

were able to describe what was happening in all parts of the cycle. In most cases learners did not identify that there was a rapid increase in pressure in part G. Over 75% of learners scored at least 1 mark, with just over 10% scoring 4 marks. Some learners misunderstood the question and tried to explain what was happening in each part of the cycle in terms of the use of fuel or energy conversion. Other learners considered the volume and not the pressure. Centres would do well to ensure that learners understand the command word being used and keep the answer to point. Many wasted a good deal of time offering correct ideas but irrelevant to the question.
Q4b was a calculation using a given formula. Similar calculations have been set in the past with little success because learners seemed to lack the skill in algebra to deal with the 1- part of the equation. It was pleasing to see more successful use of this equation in this series, with more learners being able to manipulate the formula to find the answer. There still remain a significant number of learners who struggle with this kind of formula. Most learners were able to score at last 1 mark from this calculation, with nearly a quarter gaining full marks. Where learners failed to score it was generally because they forgot to consider the 1- term altogether or found difficulty in manipulating the equation.

Q5 The final question on the paper considered the ideas of specific heat capacity and specific latent heat. The question also considered solids, liquids and gases and melting and boiling in a liquid and some ideas on energy transfer. The ideas have been considered in previous papers, in this series, learners seemed better prepared to consider the behaviour of solids liquids and gases at the molecular level.
Q5ai was a 4 mark calculation, where the learner had to select the equation from the given list at the end of the paper. Learners had to find a value of the output water temperature from a shower. Most learners were able to access at least one mark. Many that could not get started with the calculation, could quote the formula to be used. The result was nearly 33% of learners scored a mark on this question. Those that could substitute into the equation generally scored three marks for the evaluation of the temperature rise of 14.9K. This was not the final answer, the question asked for the temperature of the water leaving the shower, not the temperature rise, so the final mark was for either adding 14.9 to 289K or giving an answer of 304K. 16% of learners were able to do this. In some cases, learners were not clear as to the difference between the temperature difference of the water and the final water temperature. Some thought them to be the same. As in the previous calculations, a lack of algebra meant that some learners were disadvantaged. The same is true for this calculation as the others, learners need practice in substitution and rearrangement of terms in equations as part of their preparation for the examination.
Q5aii was a follow on question asking why the temperature of the water was different to that calculated. The question was careful to use the word ‘different’. For a full

answer the learner needed to identify that the water temperature would be lower and that this was due to energy being transferred to the surroundings, the pipes etc. .A little under 50% of learners were able to identify that energy is lost to the surroundings, but rather fewer went on to give the effect of that in terms of a lower water temperature. Learners need practice in answering questions such as this where they have to come to a decision and then support it in an answer. There were some learners who had misconceptions relating to the topic, that thought that the temperature would rise as heat energy is transferred from the surroundings to the water in the shower.

Q5b was the final 6 mark levelled question on the paper. The question was related to a graph that displayed information about the melting of an ice cube right through to the water from the ice cube being boiled to steam. Learners were specifically asked to compare the similarities and differences in terms of two molecular properties. Learners generally did well and were able to access at least one or two marks, stronger learners were able to show a good level of response and scored higher marks. The correct understanding of the command word was key to gaining a good mark in this question. There was an indication as to what was expected in the answer and scaffolding did identify similarities and differences were being looked for. Many learners focused on the differences and gave no similarities, other learners made no comparisons at the molecular level and compared regions of the graph in terms of shape, both this limited the level of achievement. A good answer gaining a top band mark required learners to give both similarities and differences between the water/ice/steam in terms of energy and intermolecular forces in different parts of the graph, about 15% of learners were able to gain a level 3 distinction mark for their answers. Many learners were able to identify differences, but not add much more, this gave Level 2 or Level 1 answers with the relevant marks awarded.

Summary

- Learners need to be given practice in substituting and rearranging values into equations, so that they can develop the skills needed to answer the calculations in this paper.
- Learners should have the opportunity to practice answers to questions with a variety of command words. They should also have the opportunity to learn the meanings of command words. This is particularly the case in questions using commands like compare.
- Learners need to learn the basic definitions of words such as fatigue, and the units associated with quantities such as stress. so that they can recall their meanings and identify their units.
- Learners should be given opportunities to practice answers where a letter needs to be added to a graph to ensure that the examiner is clear as to where the symbol is being place and is confident that this is accurate.
- When answering an explain type question, learners need to make sure that they give a justification to a statement made. In many cases marks were lost in these questions as there was no justification.
- Centers should be aware that additional guidance on the content that is tested is to be found for this unit on the BTEC L3 Applied Science website via this link.https://qualifications.pearson.com/en/qualifications/btec-nationals/applied-science-2016.coursematerials.html#filterQuery=Pearson-UK:Category%2FExternal-assessments

For more information on Pearson qualifications, please visit
http://qualifications.pearson.com/en/home.html

Pearson Education Limited. Registered company number 872828
with its registered office at Edinburgh Gate, Harlow, Essex CM20 2JE