L3 Lead Examiner Report 1801

January 2018

Level 3 National in

Unit 5: Principles and Applications of Science II

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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.

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

Grade	Unclassified	Level 3		
		P	M	D
Boundary Mark	0	30	52	74

Introduction

This unit builds on and extends the range of key science concepts in biology, chemistry and physics that were covered in Unit 1: Principles and Applications of Science I.

A strong grasp of these concepts will enable you to use and apply this knowledge and understanding in vocational contexts when studying other units in this specification.
This unit includes: properties, uses and production of some inorganic compounds; structures, reactions and properties of commercially important organic compounds; enthalpy changes; the cardiovascular system; ventilation and gas exchange in the lungs; urinary system structure and function; cell transport mechanisms; thermal physics; physical properties of materials; and fluids in motion.

Individual Questions

Examiner Report for 31627H, Unit 5: Principles and Applications of Science II

Biology – Organs and systems

General comments

Many learners were well prepared for the examination and were able to read the questions carefully and select relevant and pertinent information to give their responses.

Question involving calculations were not generally so well answered and learners need to practise relevant calculations, particularly percentages.

Some learners need more practice at interpreting information given in graphs.

Question 1 (a) (i)

Nearly all learners correctly identified structure A as the trachea.

Question 1 (a) (ii)

Most learners incorrectly identified structure B as a bronchus and not as a bronchiole.

Question 1 (b)

The majority of learners correctly deduced that during expiration the external intercostals muscles relax, the volume decreases and the pressure inside the thorax increases. A small percentage gave the response that suggested they had misread expiration and were describing what happens at inspiration.

Question 1 (c) (i)

The majority of learners correctly identified day 6 as the time the treatment started as after that day the person's peak flow rate improved. Some chose day 2. Learners should be aware that peak flow rates naturally fluctuate but that treatment for asthma gives a noticeable increase in peak flow rate.

Question 1 (c) (ii)

Only the most able learners could correctly calculate the percentage increase in peak flow rate between day 1 and day 14. Few seemed to know that percentage increase is calculated by the formula

Percentage increase = increase/original x 100

Some learners incorrectly divided the start value by the end value.

Some learners calculated the difference but then divided it by the end value.

Many learners divided the peak flow rate at day 14 (450) by the PFR on day 1 (150) and then multiplied this by 100, instead of subtracting 150 from 450 and then dividing 300 by 150 and multiplying by 100.

This is an example of a correct calculation

(ii) Calculate the percentage increase in peak flow rate between day 1 and day 14.

(2)

Show your working.

$$\frac{\text{new} - \text{old}}{\text{origional}}$$

$$450 - 150 = \frac{300}{150} \times 100 = 200\%$$

200

Question 2 (a)

Most learners used the stimulus material in the diagram to help them answer this question. Most referred to protein channel s or carriers and also correctly named the process involved as facilitated diffusion. Some learners lost this mark by referring just to diffusion or by describing the movement as active transport. Many correctly said that facilitated diffusion requires no ATP/energy and takes place down a concentration gradient.

The response below gained full marks

Describe, using information from Figure 1.4, how the amino acids enter the cell.

(2)

Facilitated diffusion. Channel proteins form pores which are shaped to allow molecules and ions to pass across the phospholipid bilayer. Carriers proteins are shaped for specific molecules such as amino acids. The proteins binds to amino acid and changes shape. to allow the molecule to pass across the phospholipid bilayer

Question 2 (b) (i) and (ii)

Most learners did not appreciate that, for a question where the command verb is 'explain', they need to give a reason. Most correctly described the head as hydrophilic but then did not explain that the head/phosphate in the head is hydrophilic because it has a charge/is polar.

Most learners described the tail as hydrophobic but did not explain that this is because the tail does not have a charge.

These responses gain both marks:

(b) (i) Explain how the properties of the phosphate head cause it to face the watery exterior and interior areas.

(2)

Phospate head is hydrophilic so it ~~has the tendency to be~~ attracted to water. This is why you can see them of the fluid mosaic model at the top. It is negative ~~at~~ charge

(ii) Explain how the properties of the fatty acid tails cause them to face away from the watery exterior and interior areas.

(2)

The fatty acid tails are non-polar and Hydrophobic. Because it is Hydrophobic, the fatty acid tails are repelled away from the water. As they are ~~at~~ repelled away from water this will cause the ~~tails~~ fatty acid tails to face away from the watery exterior and interior areas.

(Total for Question 2 = 6 marks)

Question 3 (a) (i)

Many learners correctly identified the valves X and Y. Some learners incorrectly identified X as the tricuspid valve, possibly not being aware that on anatomical diagrams viewed from the front, the left side of the organ is on the right side of the page. Some learners did not appreciate that valve Y is at the entrance to an artery and is, therefore, a semi lunar valve.

Question 3 (a) (ii)

Nearly all learners stated correctly that valves prevent backflow of blood. Fewer went on to describe where this backflow was prevented – for example, from ventricles back to atria (for X) or from aorta back to ventricle (for Y). Many stated that valves allow blood to pass from one correctly named part of the heart to another and then shut to prevent backflow, and these valid responses were fully credited.

Question 3 (b)

A significant proportion of learners do not appreciate that during cardiac diastole, both atria and ventricles relax. A few learners, on seeing the word 'systole', said that both atria and ventricles contract during ventricular systole or said that the atria contract and the ventricle relax. They had possibly not read the contents of the table carefully enough. The most able learners gained both marks on this question.

This response gains both marks:

Complete Table 1.1 by stating whether the atria and ventricles are contracted or relaxed in each of these phases.

(2)

Phase of cardiac cycle	atria	ventricles
ventricular systole	relaxed	contract
cardiac diastole	~~contract~~ relaxed	relaxed.

Table 1.1

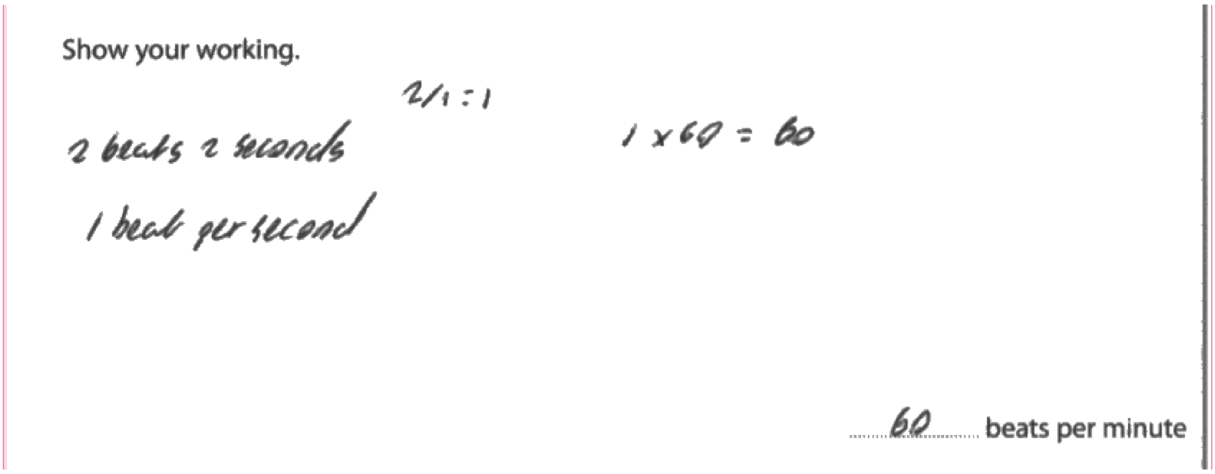
Question 3 (c)

Only the most able learners answered this question correctly. Many appeared not to be able to interpret information from the graph and deduce that two cardiac cycles were shown in a time period of 2 seconds. Those who did scored all 3 marks, as they correctly deduced that 1 cycle takes 1 second, therefore in one minute there are 60 heartbeats. Many tried to use the formula:

cardiac output = stroke volume x heart rate

to calculate the heart rate, despite the fact that neither stroke volume or cardiac output were shown in this graph.

These calculations are correct and gain full marks:

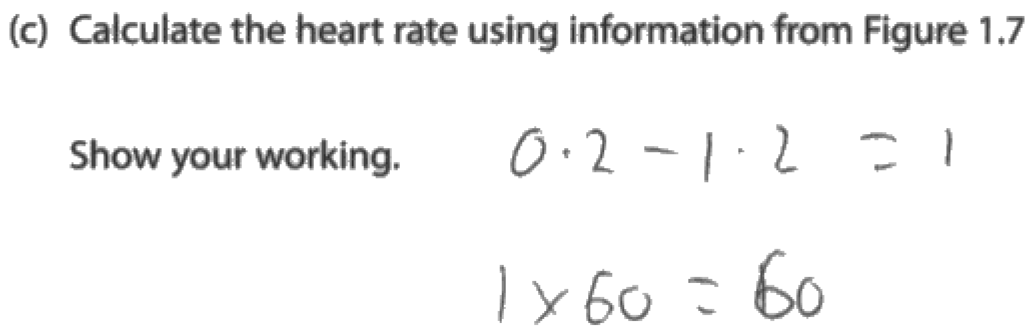

Show your working.

2 beats 2 seconds 2/1 = 1 1 x 60 = 60

1 beat per second

60 beats per minute

[NJ1]


(c) Calculate the heart rate using information from Figure 1.7

Show your working. 0·2 − 1·2 = 1

1 x 60 = 60

Learners would also have scored full marks if they had carefully measured the duration of a beat as 0.96 seconds and divided 60 by that number, arriving at a value of 62.5 beats per minute. As some leeway is often allowed when learners read from a graph, the time of one beat could have been read as 0.9 s or any value between 0.9 s and 1 s, so a response with a number between 60 and 67 beats per minute was given full credit.

Question 3 (d)

Many learners appreciated that the pressure in the left side of the heart is greater than that of the right side as the left side sends blood around the body, whereas the right side sends blood only to the lungs, a shorter distance and/or the lungs are delicate and unable to withstand a high pressure. Fewer linked this to greater the thickness/amount of muscle in the left ventricle wall. Some learners confused the left and right sides of the heart and a small number think that blood goes from the left to the right side of the heart.

This response gained full marks:

(d) Explain why during ventricular systole, the pressure in the right ventricle is different from the pressure in the left ventricle.

(3)

- right ventricle walls are thinner than the left one.
- less pressure because there is more volume
- blood only travels to the lungs from the right ventricle, where as blood will go to the rest of the body from the left ventricle which means more pressure is needed

(Total for Question 3 = 13 marks)

Question 4 (a)

Many learners understand that there should not be a concentration gradient across the partially permeable membrane that separates the dialysis fluid from the patient's blood, as otherwise sodium ions would pass out of or into the patient's blood and disrupt the normal electrolyte balance of the blood. Many learners then correctly described and explained the subsequent effect on red blood cells and this, originally unexpected, slant on answering the question was credited as it showed good scientific understanding and good linking of knowledge and concepts. Many learners understood that only excess sodium ions in the blood should be diffusing into the dialysis fluid. A small minority think that the patient's blood flows through the dialysis fluid, not appreciating why the partially permeable membrane is there. Less able learners wrote about the workings of the kidney rather than focussing on the information given in the stem.

This response gains marking points 1,2 and 3

(3)

Because sodium regulates blood pressure. ~~If it is there~~ when concentration is the same no net movement happens unless sodium is too high. This ~~is~~ because there is no concentration gradient. This mantains the concentration in the body.

Question 4 (b)

The quality of responses here was generally impressive and showed good understanding of the effects and mode of action of ADH. However, some learners spent too much time describing where ADH is made and how it is released. Many learners understand well the effect of ADH on permeability of the collecting ducts. Many gave good detail of how aquaporins are inserted into the membranes of cells making up the collecting duct walls and then described how and when water is reabsorbed into the blood. Unfortunately some learners were confused and thought that ADH is released when we have too much water in the blood and need to remove water from blood, rather than when we have too little water in the blood and need to reabsorb water. A consideration of what 'anti-diuretic' means would help them get this right. Very few learners qualified their description of water reabsorption by using the word 'osmosis'.

An example of a response scoring 3 marks:

ADH is a hormone produced by the hypothalemus and secreted by the pituitary gland when there is a low wate potential in the blood. Low wate potential shows not enough wate is being absorbed from the fluids, in the descending limb of the Loop of Henle or the Collecting Duct. ADH increases number of aquaporins in collecting duct. Aquaporins are small wate channels which helps absorb wate from urine. ADH increases number of aquaporins, so more wate is absorbed, and the volume of ~~that~~ urine decreases. When more water is absorbed, wate potential increases, so then the secretion of ADH is stopped.

This response gets 4 marks

Explain how ADH is involved in osmoregulation in the kidneys.

(4)

When there is less water in the glomerulus filtrate, osmo receptors in the hypothalamus detect this change in Ψ. The ADH attaches to the collecting duct and opens aquaporins, which allows the water to move ~~to~~ by osmosis into the medulla that has low Ψ. This causes a concentrated small amount of urine to be produced. The ions move in the duct and to the bladder at the end.

Question 5

Few learners reached level 3 for this question. Many learners appeared not to have carefully read the stem and the question. They saw that the question was about CVD and reiterated the mark scheme from the SAM material, referring to anti-hypertensives, beta blockers and heart transplants, instead of statins. These comments were not, in themselves, wrong but are totally irrelevant so not creditworthy and learners including irrelevant detail penalise themselves as they then have no time or space to write about statins. Many learners also restricted the level they could attain by not appreciating that the command verb was 'discuss' and they failed to give some disadvantages/cons, as well as advantages/pros.

This response is level 2 as it discusses some disadvantages as well as advantages. More detail about how statins work and a little more about side effects would have taken it to level 3

Discuss the use of statins to treat CVD.

Statins lower the blood pressure ~~[illegible]~~ and also lowers the levels of lipoprotein in the blood, preventing the build up of them causing blood clots.

The negative about using statins to ~~the~~ treat CVD is that they can become adictive as the pacient is dependent on taking statins rather than healthy treatment, and they also can cause nausea on the pacient also preventing them from exercizing

This response is also in level 2

Statins is used to treat CVD because it lowers the levels of low density lipoprotein but there are risks using statins.

The risks are that some people might become dependent on statins & then not eat a balanced diet & as a cause of this, they start getting headaches.

Another risk is ~~ne nau~~ sickness which could lead to people not wanting to have the treatment because it's making them feel sick.

Chemistry
Section B – Properties and Uses of Substances

General comments

Learners in this section of the paper generally did well where questions required answers needing basic facts or straight recall (eg Q6b, Q7c) but where a context was supplied to test understanding, some learners were unable to apply what they knew (Q6c).

Longer questions proved challenging for learners where they were required to make links and explain statements in more depth (eg Q6d, Q7d), and more probing of understanding is needed in preparing learners. The extended response question (Q9b) provided a good showcase for many learners to demonstrate what they knew but they must write fluently, and use terminology and equations accurately.

Key areas which learners do not seem to understand or apply fully are standard enthalpy change of formation (Q8a) and polymerisation (Q9a). Simple recall of definitions is not sufficient. Learners need to be taught how to represent both in equations for different situations and understand what both processes represent.

Basic calculations are being performed well and in organic chemistry, structures and naming are generally good. Simple mistakes such as rounding, evaluation and omitting bonds in drawing were preventing full marks, and learners should be coached to work carefully and check thoroughly.

Question 6 (a)

Whilst the correct response (pH 10) was known by a large number of learners to be the pH of a base, more selected one of the other options available. Learners should know the pH ranges for acidic and basic substances.

Question 6 (b)

A definition of "amphoteric" (or a description of the term) was well known by the majority of learners.

(b) Aluminium oxide is an amphoteric metal oxide.

State what is meant by the term amphoteric. **(1)**

It can act as an acid or a base.

Incorrect responses were typically based upon incorrect chemistry or mistakenly substituting acid with alkali or base in their definition.

(b) Aluminium oxide is an amphoteric metal oxide.

State what is meant by the term amphoteric. **(1)**

Amphoteric is a metal oxide that can act as both an alkali or a base

Question 6 (c)

Most learners did not recognise that the difference between an alkali and a base is that an alkali is a soluble base, and struggled to provide a convincing reason why sodium hydroxide is an alkali but copper hydroxide is not.

(c) Sodium hydroxide is a base and an alkali.

Copper hydroxide is a base but not an alkali.

Give the reason why sodium hydroxide is an alkali but copper hydroxide is not. **(1)**

sodium hydroxide is soluble in water and can form aqueous solution but copper hydroxide is not soluble in water

Many learners placed the focus on the substances for the basis of their answer, which often concerned the differences between sodium and copper.

> Because Copper is less reactive.

> sodium is from group one which are alkali metals and copper is a tranisition metal.

Where learners did focus on the nature of alkalinity, responses tended to show misconceptions.

> One contain hydrogen$^+$ ion the other doesn't

> Because sodium hydroxide is amphoteric and can be used as an acid and base

Question 6 (d)

Although learners could have provided several points regarding how a catalyst works, it was rare to see responses that could be credited with more than 2 marks. Good responses tended to give a relevant characteristic of a transition metal, such as incomplete d subshells or variable oxidation state, and then explain how this allowed it to act as a catalyst.

(d) Manganese (IV) oxide is a transition metal compound.

It can be used as a catalyst to speed up reactions.

Explain why manganese (IV) oxide can act as a catalyst.

(4)

Manganese (IV) oxide is a transitional metal; which has an incomplete d-sub shells which able it to make a variable oxidation state and also accept lone pair of electron which able it to reduce and oxidize to facilitate a reaction with out being used as It can reform its original state.

It was more common for learners to provide a single statement or fact about a catalyst that was relevant, often based upon a level 2 understanding of the subject.

• It speeds up the reaction by reducing the activation energy without being chemically changed.

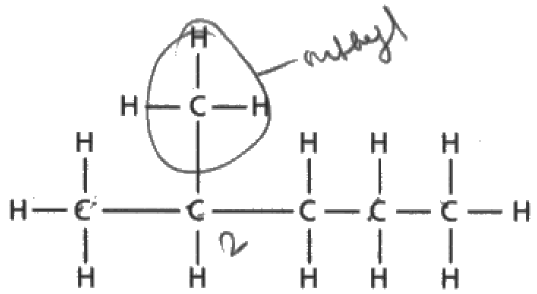
However, a majority of learners simply described what a catalyst does rather than explain underlying theories of catalysis, which was not credit worthy.

It can be used as a catalyst to speed a reaction and not be used up.

Question 7 (a)

About half of learners were able to correctly name the displayed formula as 2-methylpentane. There was often evidence to demonstrate that learners were applying their understanding of IUPAC rules in arriving at their answer.

7 The properties of organic compounds depend on their structure and bonding.



(a) Name this compound using IUPAC convention.

(1)

2, methyl pentane

Incorrect answers were very varied but included:

- mis-naming the structure as hexane or another hydrocarbon
- mis-naming the structure as an alkene
- omitting the number of the methyl group or incorrectly giving it as 4

Whilst small errors involving commas, gaps and dashes were overlooked, learners need to be encouraged to use these with greater accuracy.

Learners should not be deterred from attempting questions asking for the naming of organic compounds if IUPAC convention is referred to.

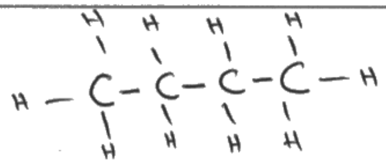
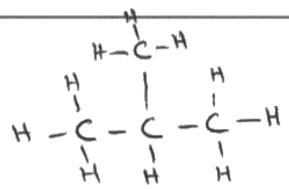
Question 7 (b)

Most learners were able to achieve at least one mark on this question and accurate drawings and naming were often seen.

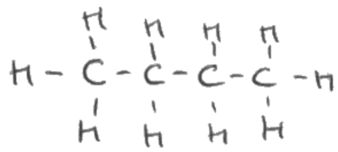
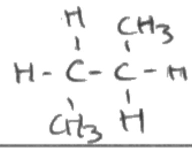
(b) C_4H_{10} has two structural isomers.

Complete the table to show the name and displayed formula of each isomer using IUPAC convention.

(4)

Name of isomer	Displayed formula
Butane	
2-Methyl Propane	

Most common errors observed were atoms or bonds being omitted in displayed structural formulae. These are vital to demonstrate understanding of the question. Other errors involving diagrams were shortened structural formulae being drawn, too many carbon atoms included, or the same structural formulae being drawn twice but in a different orientation.

Name of isomer	Displayed formula
Butane	
~~Trou... 2eth...~~ ~~...~~ 1,2-methyl-ethane	

Question 7 (c)

The majority of learners were easily able to give one reason why hexane has a higher boiling point than methane and some answers went into good detail.

(c) State why hexane has a higher boiling point than methane. **(1)**

Hexane has more carbon atoms and has a longer chain making the boiling point higher.

Answers that were not credit worthy tended to be for answers that were ambiguous, such as “greater number of bonds to break”, or lacked clarity.

Hexane has higher boiling point than methane because it has straight chain of carbon

Question 7 (d)(i)

The majority of learners were able to correctly identify the general formula of an alkene from the available options.

Question 7 (d)(ii)

A significant number of learners were able to correctly complete the equation for the cracking of decane. Key to this was recall of the molecular formula of propene and from this, to work out the formula of the other product.

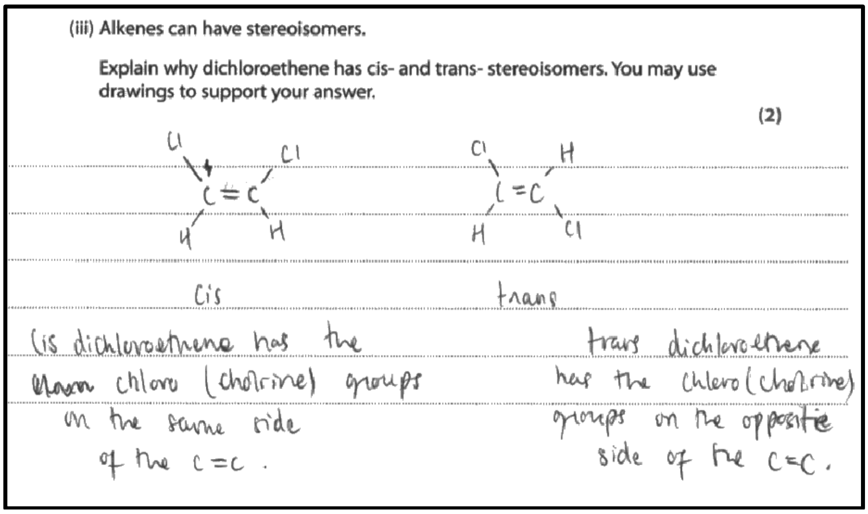
> (ii) Complete the equation for the cracking of decane to form **one** molecule of propene and one other organic molecule.
>
> **(2)**
>
> $C_{10}H_{22} \longrightarrow C_3H_6 + C_7H_{16}$

Learners that only scored 1 mark did so because they did not correctly provide a second formula which add up with C_3H_6 to equal $C_{10}H_{22}$. Occasionally, this was not even a hydrocarbon (eg H_2O) which indicated that some learners did not understand what cracking was or possibly the meaning of "organic molecule". Answers that failed to score at all were often rooted in poor recall and careless equation balancing.

> $C_{10}H_{22} \longrightarrow C_3H_8 + C_6H_{14}$

Question 7 (d)(iii)

About half of learners managed to score at least 1 mark for their response to this question. Many learners managed to identify that the structure had a double bond and that there were different atoms upon each carbon that could be positioned differently. It was very common for learners to demonstrate their understanding of the features needed for cis and trans stereoisomerism using well drawn diagrams.



(iii) Alkenes can have stereoisomers.

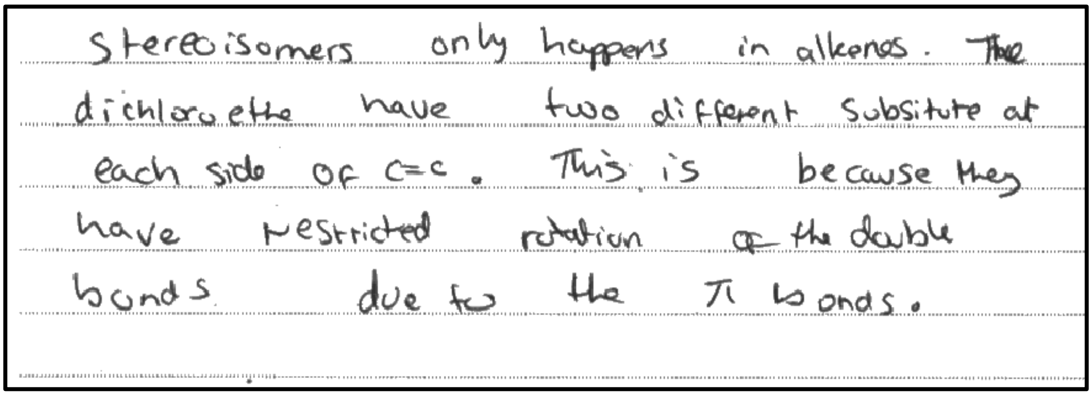
Explain why dichloroethene has cis- and trans- stereoisomers. You may use drawings to support your answer.

(2)

cis dichloroethene has the ~~chloro~~ chloro (chlorine) groups on the same side of the C=C.

trans dichloroethene has the chloro (chlorine) groups on the opposite side of the C=C.

Responses achieving the full two marks were rare. Learners that did attempt to explain the restricted rotation around the double bond tended to show reasonable understanding.



Stereoisomers only happens in alkenes. ~~The~~ dichloroethe have two different subsitute at each side of C=C. This is because they have restricted rotation ~~of~~ the double bonds due to the π bonds.

Question 7 (d)(iv)

This question was poorly answered in general.

Responses in which learners provided some detail but only scored 1 or no marks tended to be because the explanation:

- repeated the context that alkenes had pi bonds or double bonds whereas alkanes did not
- indicated that more energy was required to break the pi bond than a sigma bond
- indicated that the double bond was weaker than a single bond (or stronger – whilst correct this does not explain its reactivity)

(iv) Alkanes contain sigma (σ) bonds.

Alkenes contain both sigma (σ) and pi (π) bonds.

Explain, in terms of sigma and pi bonds, why alkenes are more reactive than alkanes.

(4)

Alkenes has a sigma and pi bond and it is more reactive than an alkane which has a sigma bond. This is because the ~~two bonds~~ sigma & pi bonds that the alkene has, ~~gives~~ means that it's got a double ~~rather th~~ whereas the alkane has a single bond. The double bond means that the alkene is more reactive.

Alkenes have π bonds and σ bonds which are harder to break because of the double bond present.
They are more reactive as it takes more energy to break the bonds and also because they have π bonds surrounding the alkene and they form sp^3 hybrid stereoisomers.

The credit of 2 marks was typically for a comparison of the strength of sigma and pi bonds, and noting that the latter required less energy to break and react. The strongest answers built upon this by attributing the weakness of the pi bond to the partial or sideways overlap of p orbitals.

Alkenes have a sidewards overlap of P orbitals that are weaker than the σ bonds. Alkenes have both where as alkanes only have the σ bond which require lots of energy to break. π bond don't need alot of energy to break.

Only occasionally did a learner refer to the ability of an alkene to attract species to react with.

A pi bond is formed when two adjacent p orbitals overlap above and below the carbon atoms. They can ~~at~~ only form when sigma bonds are present. They are the reactive part of the molecule since they have a high electron density (they have more electrons than sigma bonds). This pi is high in electron density and attracts electrophiles.

Question 8 (a)(i)

This question was usually attempted but rarely had credit worthy responses. Whilst learners did understand that the equation involved ethanol, they did not fully understand that the equation needed to show the formation of ethanol **from its elements in their standard states**. This is an essential part of the definition of standard enthalpy change of formation. It was extremely rare to see this written correctly.

8 Ethanol, C_2H_5OH, is often used as a biofuel.

It is a liquid at room temperature.

(a) (i) Write the balanced equation for the standard molar enthalpy change of formation of ethanol.

(3)

$2C_{(s)} + 3H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow C_2H_5OH_{(l)}$

Incorrect answers that scored no marks included:

- The equation for the hydration of ethene to form ethanol
- The combustion of ethanol to form carbon dioxide and water
- Carbon reacting with water to form ethanol

$C_2H_4{}_{(aq)} + H_2O_{(l)} \longrightarrow C_2H_5OH_{(l)}$

$2C_{(s)} + 3H_2O_{(l)} \rightarrow C_2H_5OH_{(l)}$

Where learners did understand that elements were the reactants, recall of formulae was not always correct (eg diatomic carbon molecules or monoatomic oxygen or hydrogen were used), or the balancing of the equation was incorrect (this should be for the formation of 1 mole of ethanol), and often restricted answers to 1 mark.

> $2C + 3H_2 + \frac{1}{2}O \rightarrow C_2H_5OH$

Finally, state symbols are necessary for any equation that represents a standard enthalpy change. This was a standalone mark so learners that realised that this needed to be included in the equation were credited if they were included and applied correctly even if the reactants were incorrect.

> $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

Question 8 (a)(ii)

This question was very poorly answered. This revealed that many learners did not appreciate that the equation for many standard enthalpy changes of formation was not a viable reaction. There were a number of ways to respond to this question that are credit worthy:

> (ii) Give **one** reason why the standard molar enthalpy change of formation of ethanol cannot be measured directly.
>
> **(1)**
>
> takes several steps to gain final product.

> It is not formed from its pure elements.

> Because during the formation some other molecules will be produced as well.

Some learners seemed to recognise that standard conditions might have some bearing on the reaction but gave statements that did not give a cogent reason for why the reaction could not occur.

Because it is not done in standard conditions. It is also, too dangerous.

The majority of incorrect responses generally tended to focus on practical or experimental error, in likely response to the mention of "measurement" in the question.

Energy can be lost to the surrounding

the change happens too fast

IT EVAPOURATES

Question 8 (b)(i)

The calculation was very well answered by learners, with most getting the full 3 marks. Many calculations showed full working that was clear, with some relating their answer back to the question by confirming that their answer was indeed approximately 10970J.

(i) Show that the heat energy produced by burning 0.016 moles of ethanol is approximately 10970 J.

Heat energy produced = mass of water × specific heat capacity × change in temperature.

Show your working.

(3)

Mass of H_2O = 250g
Ethanol burnt = 0.016moles
temperature change = 293.0 = 20, 303.5 = 30.5 } 10.5°C
SHC = 4.18

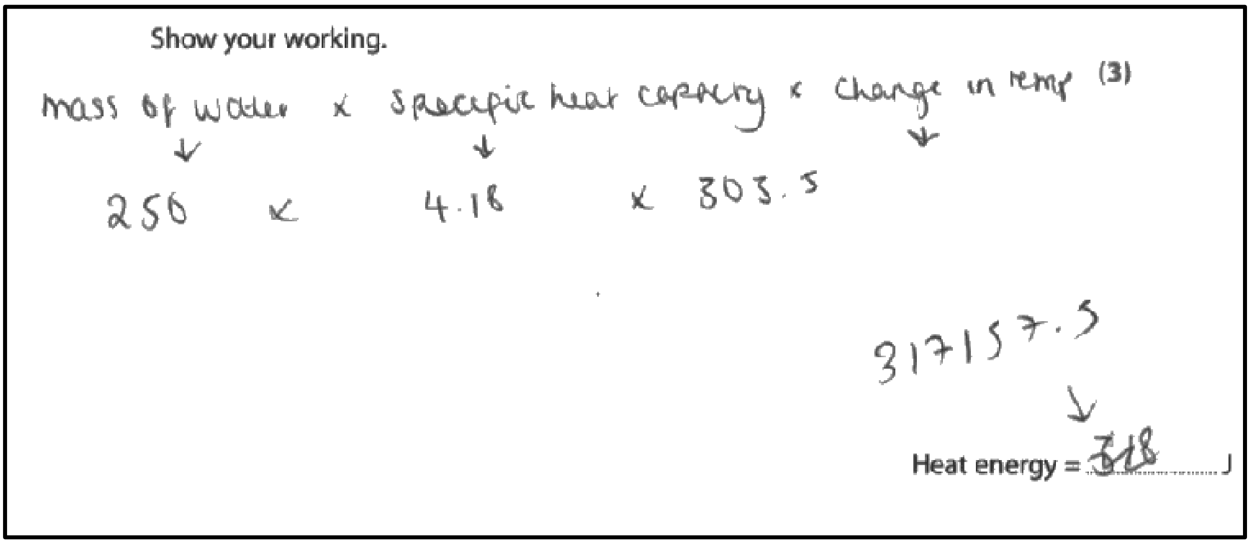
Mass of H2O × SHC × Δt = 10972.5
250g × 4.18 × 10.5

Heat energy = 10972.5 J

250g × 4.18 × 10.5 = 10972.5J

Apporx = 10970J
Answer = 10972.5J ✓

Where errors occurred it was often at the evaluation stage where the working had been shown correctly but an incorrect final answer was presented. Occasionally, learners would perform a random process involving the 0.016 moles of ethanol or using 303.5 instead of the temperature change when substituting into the equation.


Show your working.

mass of water × specific heat capacity × change in temp **(3)**

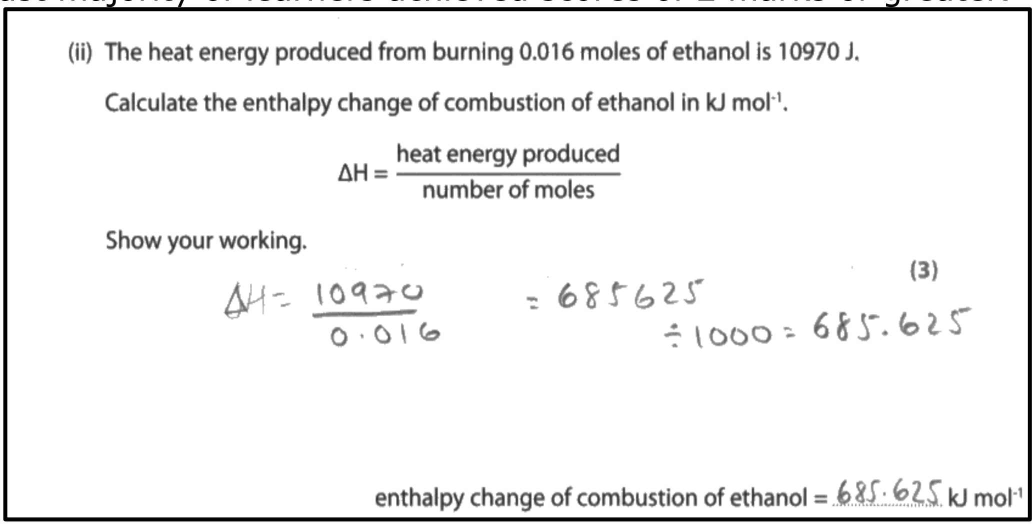
250 × 4.18 × 303.5

317157.5

Heat energy = 318 J

Question 8 (b)(ii)

This calculation was not as well answered as Q8(b)(i) but nevertheless the vast majority of learners achieved scores of 2 marks or greater.


(ii) The heat energy produced from burning 0.016 moles of ethanol is 10970 J.

Calculate the enthalpy change of combustion of ethanol in kJ mol^{-1}.

$$\Delta H = \frac{\text{heat energy produced}}{\text{number of moles}}$$

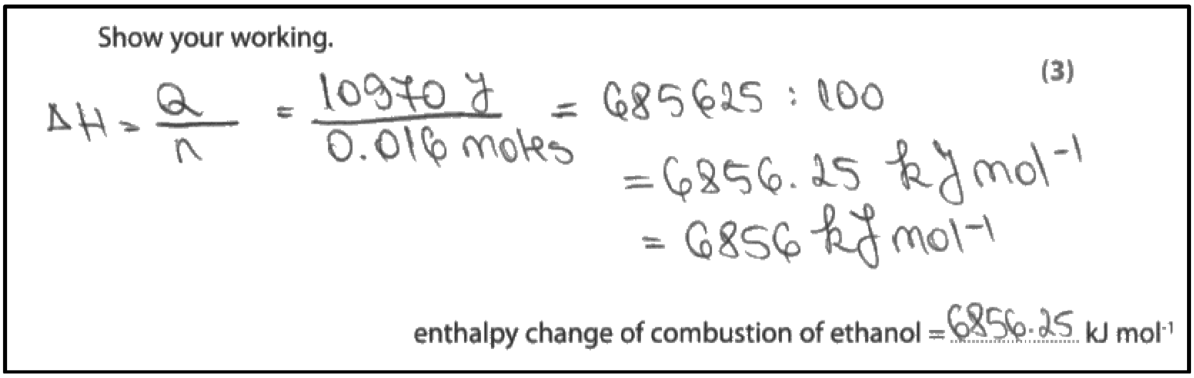
Show your working. **(3)**

$\Delta H = \frac{10970}{0.016} = 685625$

$\div 1000 = 685.625$

enthalpy change of combustion of ethanol = 685.625 kJ mol^{-1}

When learners lost a mark it tended to be for incorrect conversion of the value to kJ mol^{-1} (or completely omitting this stage entirely). Some issues with rounding up were seen but these were in the minority where students rounded to 685 rather than 686.



Show your working.

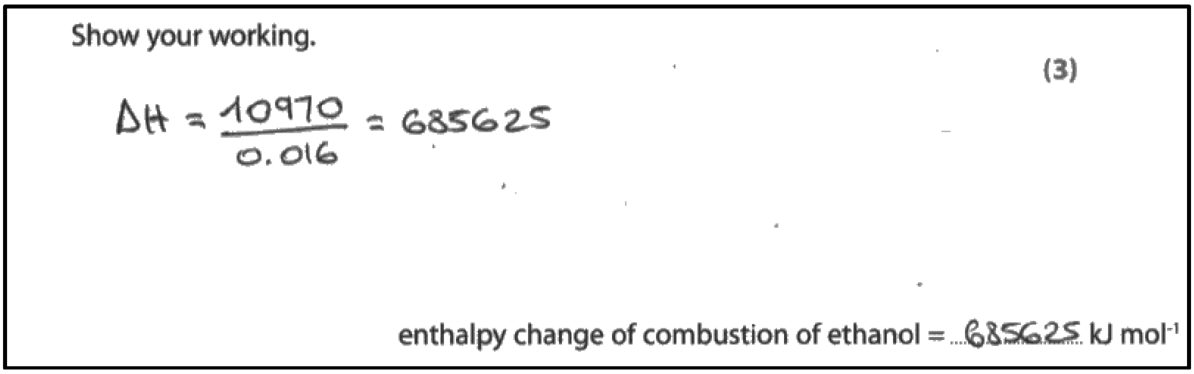
(3)

$\Delta H = \frac{Q}{n} = \frac{10970\ J}{0.016\ moles} = 685625 \div 100$

$= 6856.25\ kJ\ mol^{-1}$

$= 6856\ kJ\ mol^{-1}$

enthalpy change of combustion of ethanol = 6856.25 kJ mol^{-1}

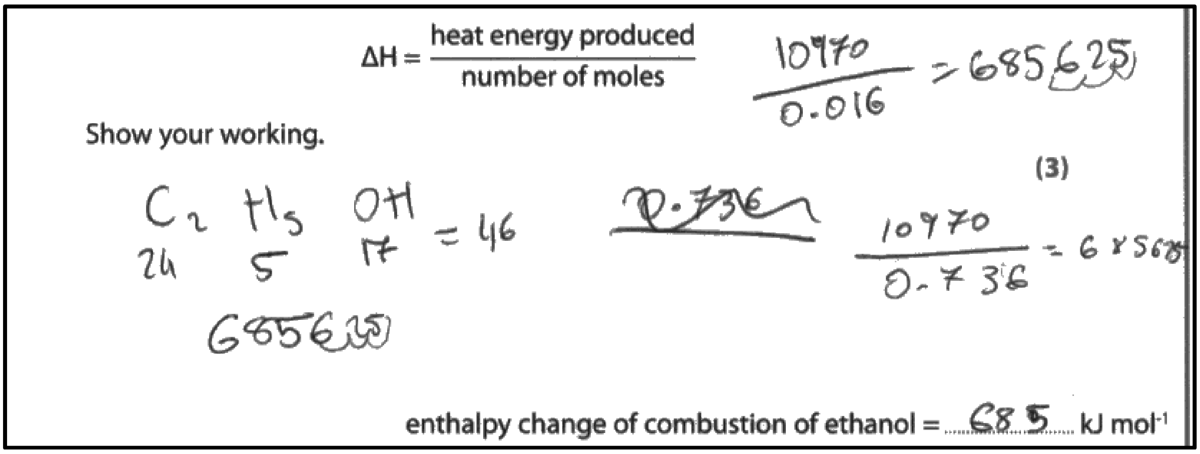


Show your working.

(3)

$\Delta H = \frac{10970}{0.016} = 685625$

enthalpy change of combustion of ethanol = 685625 kJ mol^{-1}



$\Delta H = \frac{\text{heat energy produced}}{\text{number of moles}}$ $\frac{10970}{0.016} = 685625$

Show your working.

(3)

$C_2\ H_5\ OH$
24 5 17 = 46

~~0.736~~

$\frac{10970}{0.736} = 68565$

685625

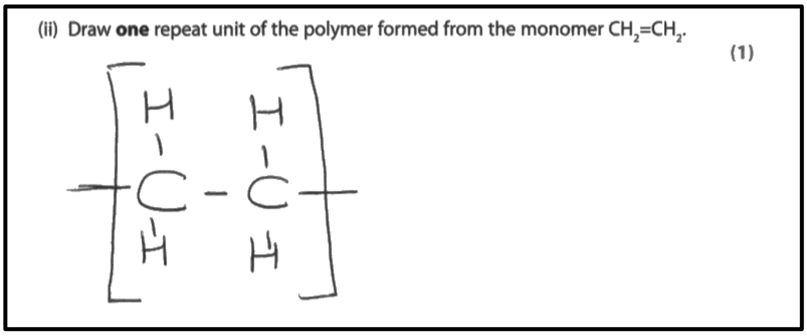
enthalpy change of combustion of ethanol = 685 kJ mol^{-1}

Question 9 (a)(i)

Although “Addition” was frequently identified as the correct answer by learners, most did not select this. Therefore, details of the polymerisation of alkenes may not be well known or recalled by learners.

Question 9 (a)(ii)

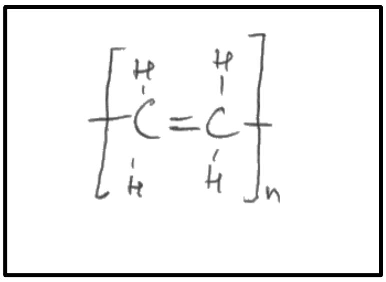
This question continued on the theme of polymerisation and required learners to draw a single unit of poly(ethene) from the given formula of ethene. This is a fairly routine and basic example of polymerisation but very few learners were actually able to provide the correct answer, even after allowances for reaction equations, brackets and “n” which were unnecessary.

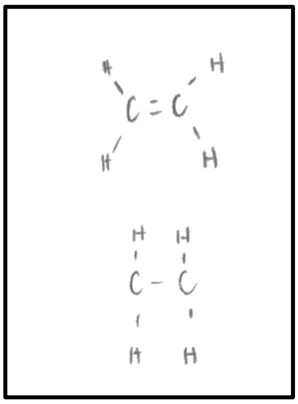


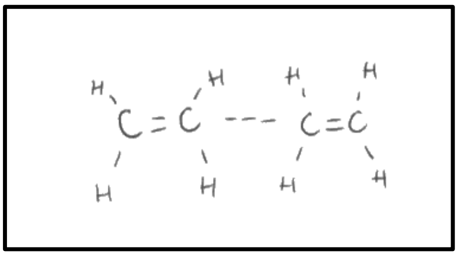
Some responses often seemed to be over complicated and learners should be reassured that sometimes the most obvious answers are the correct ones.

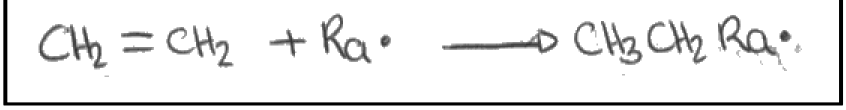
Incorrect responses included:

- carbons with the wrong number of bonds or double bonds
- displayed structures of ethene or other hydrocarbons
- two structures drawn but no arrows to identify that a change takes place
- structures with free radicals or other structures reacting









Question 9 (b)

The extended response question offered opportunity for learners to demonstrate their understanding of the free radical mechanism for the reaction of methane with chlorine. The majority of learners were able to provide credit worthy answers to this question but it still proved challenging for a number of learners.

Some confused the question with polymerisation – much was not relevant, but aspects are similar and could be credited.

Level 1 responses tended to simply list the three stages and provide a brief statement (eg initiation is the start of the reaction when free radicals form). Occasionally equations would be provided but were variable in accuracy.

Level 2 responses built upon basic points by providing further detail and description of the process. Generally, initiation and termination stages were well described, but propagation was often skirted over, inaccurate or confused with the other two stages. It was common for learners to provide the six equations associated with this free radical mechanism, and was variably done. However, whilst this can provide a good account of the process, it does not alone demonstrate understanding and learners could not simply expect to move into Level 3.

Level 3 responses were typified by giving a complete overview of the three stages. Propagation tended to be well understood and the two step process well explained, with close reference to the equations. Accurate terminology and detail such as the role of UV light, homolytic bond fission, methyl radicals, etc was common and demonstrated a deeper understanding than simple recall of equations. Where learners did not score the full 6 marks at this level was frequently because of weaker or inaccurate statements which had no place in the answer and undermined the piece eg carbocations, electrophiles, longer chains forming, etc.

Level 1 (1-2 marks) example

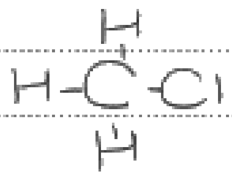
(b) Chloromethane is produced when chlorine reacts with methane.

Explain the **three** stages of the free radical mechanism involved in the formation of chloromethane.

(6)

$CH_4 + Cl\cdot \rightarrow CH_3Cl + H$

chloromethane =



Initiction - where the free radical (Cl) is added to the area where methane is to start the formation.

Propogation - the step where chloromethane is being formed

Termination - where the free radical is removed to prevent any more chloromethane from being formed.

Level 2 (3-4 marks) example

(b) Chloromethane is produced when chlorine reacts with methane.

Explain the **three** stages of the free radical mechanism involved in the formation of chloromethane.

(6)

First initiation will take place and a UV light is required for this reaction. During the initiation step the diatomic reactant will be broken down into 2 radicals. for example "$Cl_2 \rightarrow \bullet Cl + \bullet Cl$"

Next is the propagation step where one of the radicals will be reacted with a product and the product in this case chloromethane will become a radical. This step is done twice with another product.

The last step is termination where ~~any~~ all radicals produced are reacted together to form new products for example. "$\bullet Cl + \bullet Cl$" will go back to being "Cl_2"

Level 3 (5-6 marks) example

Initiation

$Cl_2 \xrightarrow[light]{UV} 2Cl\bullet$ chlorine molecule breaks down to form 2 chlorine free radicals

Propergation

$CH_4 + Cl\bullet \longrightarrow CH_3\bullet + HCl$ methane reacts with a chlorine free radical to form a methane free radical and a molecule of HCl.*

$CH_3\bullet + Cl_2 \longrightarrow CH_3Cl + Cl\bullet$ methane free radical reacts with chlorine molecule to form chloromethane and another chlorine free radical

Termination

$Cl\bullet + Cl\bullet \longrightarrow Cl_2$

$CH_3\bullet + CH_3\bullet \longrightarrow C_2H_6$

$CH_3\bullet + Cl\bullet \longrightarrow CH_3Cl$

free radicals react together thus stopping the process

* It reacts with the hydrogen as it is the easiest to react with.

Physics
Section C – Thermal Physics, Materials and Fluids

Learners found many of the Physics items a challenge; this could have been due to a number of factors including basic understanding of physical concepts, recall of basic definitions or the use of appropriate scientific language when describing or explaining ideas. Those with good mathematical skills were able to access many of the marks associated with the skills, those with weaker skills found great difficulty with the calculations, particularly with rearranging equations. Centres should ensure that learners have the practice required to enable them to use simple algebra, rearrange equations, use powers of ten and read data with confidence from graphs. The specification requirements mean that learners have to use very big and very small numbers in this part of the paper. Centres should devote time in preparation of learners by giving them practice in standard form as being the best way to handle such numbers. The Physics section was at the end of the paper, it was evident that some learners did not complete all the questions due to running out of time. Learners should be encouraged to devote sufficient time to a section, so that they have a chance of completing it and then checking what they have written. In many cases learners' appear not to have covered the specification areas tested in the section, it was evident that key words and concepts were not understood by many attempting the questions. In some cases learners did not read the questions carefully, and provided general answers that did not fit the question that was set. Questions set in this section required not only written answers, but the need to add to diagrams and interpret graphical data.

Question 10 dealt with the stretching of an elastic band, as an example of a material that does not obey Hooke's law.

Q10a

This multiple choice question was designed to be an easy entry into the question and was based on recall of information from a graph. The correct answer C was given by 18% of the learners. Many thought that answer D was correct, but this answer would have been related to the area under the line to the x axis and not the area between the two lines, which represented the energy lost to the surroundings.

Q10b

This single mark answer gave learners more opportunity to show understanding; approximately 50% of learners were able to say that the band had been permanently deformed, or that its shape had changed, so scoring the mark. Some learners who did not score the mark repeated parts of the stem of the question or described aspects of elastic limit, such as in this non scoring answer.

because it might have reached it's elastic limit
so it cannot go back to it's origin.

A good answer to this question is to be found below.

Because the band is now deformed and has passed the elastic limit.

The comment regarding elastic limit was ignored as indicated in the mark scheme.

Q10c

Few learners were able to provide a complete answer to this question. More were able to identify that the graph was not a straight line **OR** that the graph showed that the force was not proportional to the extension, but most did not give both parts.

A good answer is shown here that gives a good explanation.

Because the force is not directly proportional to the extention. For example ~~the~~ when the extention is 10 cm the Force is 4.4 N and when the extension is 20cm the force is 8.3 if it was directly proportional the force for 20cm should be 8.8. It isn't a straight line

(Total for Question 10 = 4 marks)

Many learners did not read the question carefully enough and failed to see that the answer had to relate to the graph. Some learners quoted formulae or explained features such as yield point that were not relevant to the graph shown.

Question 11 related to fluid flow in a pipe. It required learners to utilise several skills, including drawing flow lines on a diagram and explaining factors affecting fluid flow.

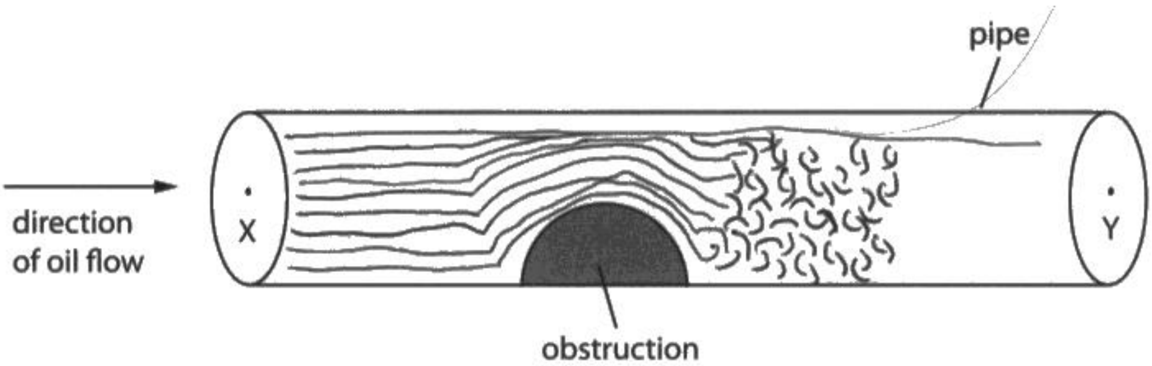
Q11a

This multiple choice question was well answered. 65% of learners scored this mark for giving answer B, the diameter of the pipe. A common incorrect answer was C indicating a misunderstanding in how pressure acts in pipes.

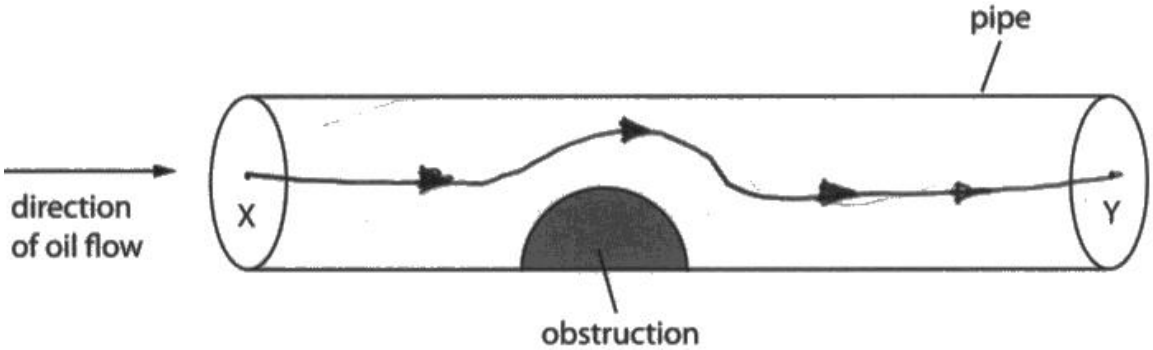
Q11b

This question was designed to test the understanding of the difference in the flow lines in streamline and turbulent flow. In order to do this learners should have drawn at least two lines to show how the flow changed, however many learners simply drew a single line, so could not show the parallel nature of the lines before the obstruction and lines crossing/curling over each other after the obstruction.

A good answer that gained two marks is shown below. Less than 10% of learners were able to give a fully correct answer worth 2 marks. The initial lines were clearly sufficiently parallel to score the first mark point on the mark scheme.



This was a more typical response that many learners gave that scored no marks as there were insufficient lines on the diagram.



Q11c

This question was answered well across the mark range. Over 70% of learners scored at least one mark, with nearly 50 % scoring two marks.

Weaker learners were confused and wrote that higher temperatures gave higher values of viscosity, but then correctly related higher temperature to an increase in speed. The weakest learners scored no marks by simply repeating the stem of the question. The hardest mark to score was the explanation relating to the particles/molecules of the oil. Many learners did not link the change in speed/fall in viscosity to particles having more energy or that the forces between the particles were less.

A good three mark answer is shown here.

When the oil's viscosity decrease due to the ~~change~~ increase in temperature, the velocity increases, as the intermolecular forces are broken and some of the bonds are broken, due to the energy causing the particles to collide more, therefore increasing the movement and velocity

The learner has correctly related rise in temperature to fall in viscosity and increase in velocity and given an explanation in terms of forces. Less than 10% of learners were able to give a full explanation.

Question 12 related to the ideas of latent heat and the theoretical efficiency of thermal systems.

Q12a

This multiple choice question was based on the standard cooling curve graph for water. It was evident that some learners did not look at the y axis of the graphs, which showed values of temperature that related to the ice and steam points. The correct answer was graph D, which was identified by fewer than 20% of learners.

Many gave answer C, which would have indicated a change of phase to ice at a temperature well above zero.

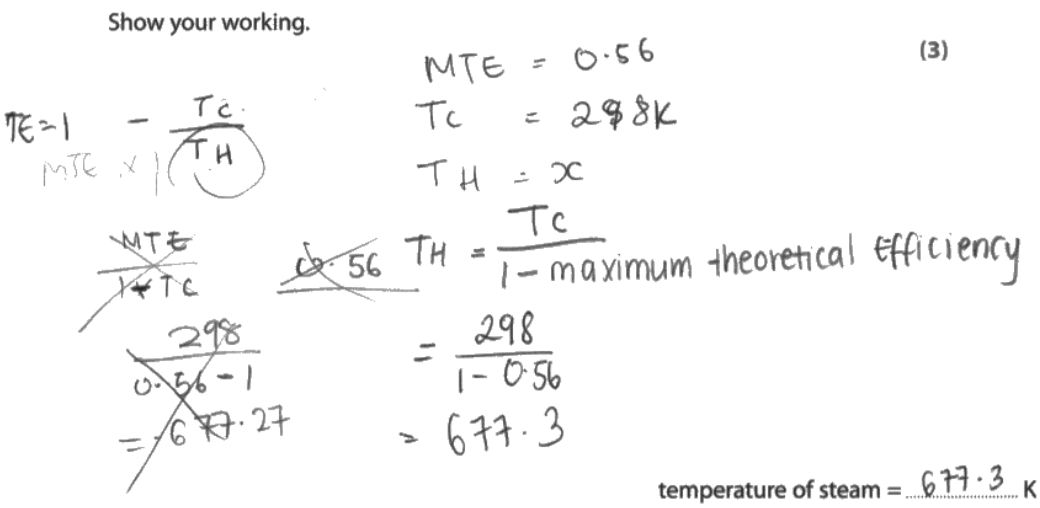
Q12bi

A calculation was required for this question. Many learners were able to score at least one mark, with over 67% scoring at least one mark. The correct answer of 2500kg was scored by nearly 50% of learners. Those that were not able to do the calculation were unable to rearrange the formula correctly. Some learners were not able to correctly convert or work in standard form and so lost a mark for providing an answer that was a power of ten error of the correct answer. The learners in this case were credited with correct substitution and rearrangement, but then gave an incorrect evaluation.

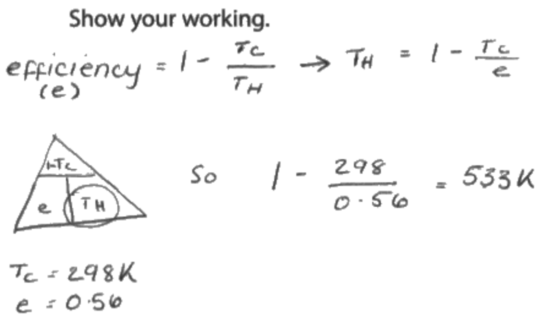
Q12bii

The second calculation was more challenging. The formula to be used, (which was provided at the end of the paper on the formula sheet) was challenging as it required an algebraic manipulation involving a subtraction from 1. Learners should have rearranged the equation to subtract 0.56 from 1 to give 0.44 and then divide this into 298. In many cases learners evaluated 298 divided by 0.56 and then subtracted or in some cases added 1 to the whole fraction. Less than 10% of learners score full marks on this question. Over 30% were able to score at least one mark for showing a correct substitution into the correct equation, but then not being able to progress further with the rearrangement correctly.

A correct calculation showing all the steps is shown in this learners answer. The part crossed out was ignored. The learner has given all steps and has shown their working, which is good practice. All calculation questions have a reminder to do this given in the question.



This response shows a typical 1 mark response where the learner has evaluated the wrong fraction and then subtracted it from 1.



Q12c

The final part of Q12 was an explain question that required learners to explain the difference between the energy needed to heat water and boil water in terms of molecules/particles. This was a challenging question. Very few learners scored full marks for this question. Nearly 40% of learners did not score on this question. The answer below score three marks.

(4)

This is because the process of turning the boiling water to steam is called vapourisation. In order for this to occur the water needs to be at a very high temperature as the steam needs to be let off. Water molecules in water are still packed together but have more movement and chance of successful collisions. This meaning the bonds can be easily broken when heated but it requires a lot of energy to turn into a gas. Hence the reason 200 times more energy is needed to break the intermolecular forces

The learner has given an answer for the first marking point, where they state 'molecules in water are still packed together' this is the same as 'molecules close together'. The learner goes on to say that the molecules have 'more movement' on fifth line, this is the equivalent to 'move faster', which is the second marking point. There is therefore a statement related to particle separation and another relating to movement. Finally the learner states that 'the bonds can easily be broken' and in last line that intermolecular forces can be broken, this is the last marking point twice, so only one mark is awarded. There is no mention about particles/molecules being able to escape or break free from the liquid; this would have scored the fourth point had it been present.

The learner mentions 'successful collisions' this not the equivalent to 'collide more frequently'. Many learners used incorrect terminology in describing this process that were more related to explaining a chemical reaction.

Question 13 related to materials and their properties.

Q13ai

This was a well answered question with nearly 80% of learners scoring the mark. Learners were able to relate what was being measured on the y axis to the property of strength.

Q13aii

This question was designed to test what was meant by a material being ductile. This was quite poorly answered with less than 40% getting this question correct. Many answers did not relate to the graph and learners gave a definition of ductility, rather than relating the reason to the graph.

This was a typical correct response:

Ductile means the ability to be drawn and stretched into wires.
Although glass can withstand more stress the copper can be pulled and stretched more increasing its strain.
∴ Strain is larger then glass.

The learner has correctly referred to the graph axes in the answer.

This was a typical incorrect response:

Copper can be drawn to a thin wire (ductility) due to the molecules being closely bound together.

The learner has not made any mention of the graph or what is measured by the axes in the answer.

Q13b

This question was designed to be challenging to learners and required several steps. Learners had to convert the area from mm^2 to m^2 and also use standard form in the calculation. Some learners did not see that the question gave the area of the wire and attempted to use the area as the radius or even as the diameter to then calculate an area. Many learners found that the very large and very small numbers involved were difficult to handle, and therefore produced answers that were many powers of ten out from the correct answer of 500N. There appeared to be a lack of appreciation in many learners as to the sizes of numbers. Some learners calculated the weight of the light fitting to be 5×10^{15} N and wrote this value down as the answer without appreciating that if this were the case the light fitting would have a mass greater than the great pyramid at Giza. It would help learners a great deal if centres gave learners the opportunity to have an appreciation the mass of everyday objects to a sensible scale. This would then alert learners to having made an error in a calculation.

This is a good example of a well set out answer showing all the steps that gained all 4 marks. Less than 4% of learners gained full marks mainly due to wrong conversion of the area of cross section. 45% of learners gained 3 marks, usually for correct substitution, rearrangement and evaluation, but with the wrong value of cross sectional area being used. This highlights the issues relating to correct use of standard form and an appreciation for the mass of objects quite clearly.

Q13c

The term creep appears as one of the terms that learners are expected to know about in the materials section of the specification for unit 5. The term was also referred to as cold flow by some learners. Very few learners were able to explain creep fully, however nearly 65% of learners were able to score at least one mark out of the four on this question.

(b) A steel wire is used to suspend a light fitting from a ceiling.

The tensile stress in the wire is 1×10^9 Pa.

The wire has a cross sectional area of 0.5 mm² $= 0.5 \times 10^{-6}$ m²

Calculate the weight of the light fitting.

Show your working.

(4)

$Stress = \frac{F}{A}$ $F = (1\times10^9)\times(0.5\times10^{-6}) = 500$ N

100g = 1N

~~500×100~~ = 500N

50000g = 500 N

50kg = 500 N

weight of light fitting = 500 N

Q13c

The term creep appears as one of the terms that learners are expected to know about in the materials section of the specification for unit 5. The term was also referred to as cold flow by some learners. Very few learners were able to explain creep fully, however nearly 65% of learners were able to score at least one mark out of the four on this question.

This response scored three marks.

Creep deformation is when plastic behaviour in a material shows. A force has been applied and over time it has slowly started to change shape. In this case, plastic ~~[struck out]~~ behaviour has started to show in the lead/roofing and the lead is showing cracks or other kinds of damage. An example of a force applied to this is wind/snow.

The learner has identified that a force has been applied over time and so the material cracks. These are two separate points on the mark scheme so this is worth two marks. The learner starts the answer with the idea that the lead is deformed plastically, this sufficient for the first marking point.

The comment on wind and snow is not enough for the third marking point relating to temperature changes.

In many cases learners gave statements that were not justified which are needed to an explanation, so one or at the most two marks could be scored.

Question 14, final question on the paper related to heat engines. This was a challenging question for many learners and for some it was evident that lack of time was a factor in the marks cored in the various parts.

Q14a

Question 14 started with what should have been a straight forward recall question. Less than 33% of learners were able to explain what an isothermal process was. A correct answer scoring the mark is shown here.

It means that the temperature is constant, not changing.

The expectation was that many learners would be able to give this kind of answer in large numbers.

Many learners gave answers which related to controlling the temperature, or situations where the temperature did not change much. Other learners wrote about the heat being constant rather than the temperature. It was evident that many learners are not aware of the difference between heat and temperature.

This was a typical incorrect answer.

Processes where you can control the temperture

Q14b

Many learners scored at least 1 mark on this question, with over 50% scoring 1 and a further 25% scoring 2 marks. Learners were guided to give two reasons for why a heat engine could not be 100% efficient, however many gave just one.

A typical 2 mark answer is given here.

Some efficiency is lost by sound in the heat engine.
Some heat may be lost to the surroundings

This scored first and the fourth marking points.

A typical incorrect answer is given here

because they release harmeful
Substances and give out
carbon dioxide which causes pollution

The answer does not relate to energy loss, many learners who scored no marks attempted to answer this question by using ideas such as seen in this response.

Q14c

This six mark levelled question gave a range of challenges to learners. In many cases learners appeared to rush the answer and failed to score as they had not read the question carefully. The question asked learners to use the graph to support their answer as to how a petrol engine is a form of heat engine. The indicative content provided ideas that were being looked for. It must be emphasised that not all the ideas were needed to gain a level three mark. The factor deciding the level of mark to award was the need to have a range of ideas across the indicative content and then applied to the parts of the graph. Many learners simply described the graph in terms of what was already on the page and added nothing about work done/input energy and change in temperature between the ignition and exhaust phases and finally what happened at the exhaust in terms of being at a lower temperature. Some learners considered parts of the process as isothermal, however given the rapid compressions and expansions involved in such an engine these references were not correct and were ignored. Just over 43% of learners scored at least a level one mark, with a further 15% scoring a level 2 mark and very few a level 3 mark. The level descriptors at the end of the indicative content are used to determine the level and mark, and what is looked for is how the learners' response fits best with these descriptors.

This response gained a level 3 mark and was awarded 5 marks.

A petrol engine allows an air-fuel mixture to enter a cylinder
at Tc, this mixture is then compressed to increase the pressure
which we can see on the graph. This mixture is ignited
by a spark plug this does work on ~~the cylinder~~ a piston which we
can see by the large pressure increase during the ignition
phase, the piston moves downwards, driving a crank shaft
this is the work done, the exhaust fumes are then pushed
out of the cylinder at TH.

The learner has linked the idea of temperature to a change in the pressure/volume of the system and explained where the mixture is ignited so explain where the heat input is in the system. The first three lines link the temperature, and graph well. The learner goes on to say that work is done on the piston that drives the crank shaft. This is little muddled in terms of explanation as it includes the pressure increase in the ignition phase but there is sufficient here for some credit. The final section links the exhaust with an output temperature which is identified as different to the input temperature. Unfortunately, the learner has mixed up the notation that is normally used by reversing the hot and cold temperature notations. They have clearly identified that they are different, so this error was ignored. The fact that there is a difference, and this causes work to be done is the correct. Holistically, the learner has provided a comprehensive analysis of the system using lines of argument that generally correct, but not as logical as what would be needed for full marks. The confusions and notation error gave a mark of5 rather than a mark of 6.

This response was awarded a level 2 at 3 marks.

~~becau~~ p. Petrol engine is a form of heat engine because during ~~ign~~ ignition the pressure increases but the volume stays the same adiabatic, during expansion the ~~k~~ pressure decreases but the volume increases, meaning that heat is lost to its ~~surrounding~~ surroundings. ☆ During compression, the pressure increases ~~but the~~ and the volume decrease, this is isothermal, ~~no heat is~~ there is no change in temperature.

☆ meaning there is work being done.

(Total for Question 14 = 9 marks)

TOTAL FOR SECTION C = 40 MARKS
TOTAL FOR PAPER = 120 MARKS

A – B	P↓	V↑	expansion
B – C	P↓	V –	
C – D	P↑	V↓	compression
D – A	P↑	V –	

The learner has correctly identified what happens to the pressure and volume at various stages in the cycle, this can be seen at the bottom of the page and it is linked to the graph. The use of the term 'adiabatic' is correct that part of the cycle. There are generic statements, with attempted comments relating to heat lost to the surroundings, but these are not clear. The last two lines relating to an isothermal event are not correct and should be ignored. The lack clarity, does not give the logical and coherent structure need for 4 marks.

At level one for 1 or 2 marks, isolated relevant information gained credit.

Summary

- This includes LE recommendations, e.g. Based on their performance on this paper, learners should: (then include between five and ten bullet points)
- If appropriate, refer and link to the specification and/or sample assessment materials (SAMs) located on the BTEC Nationals qualification webpage located here

For more information on Edexcel qualifications, please visit
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