L3 Lead Examiner Report 1806

BTEC

June 2018

Level 3 National in Engineering

Unit 1: Engineering Principles (31706H)

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Grade Boundaries

What is a grade boundary?

A grade boundary is where we set the level of achievement required to obtain a certain grade for the externally assessed unit. We set grade boundaries for each grade, 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 should be 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 test, because then it would not take into account that a test might be slightly easier or more difficult than any other.

Grade boundaries for this, and all other papers, are on the website via this link:
http://www.edexcel.com/iwantto/Pages/grade-boundaries.aspx

Unit 1: Engineering Principles

Grade	Unclassified	Level 3			
		P	M	D	N
Boundary Mark	0	62	41	21	11

Introduction

This was the second series for the new style of examination for Unit 1 Engineering Principles examination, with this mandatory unit being assessed in the same format as in January 2018, which is a traditional paper-based examination with a number of different styles of question.

The question paper followed the format identified in both January 1801 and the revised sample assessment materials and additional sample assessment materials published on the Pearson website. The focus of the paper being on a range of questions that assess applied mathematics, along with mechanical, and electrical and electronic principles. The range of questions will vary for each examination series with the aim of covering all of the topics listed within the specification. As noted in previous reports, it is important for centres to remember that, due to nature of the specification, they will need to ensure that learners are given the opportunity to become familiar with the processes of solving problems, and the mathematical skills required to arrive at solutions, including situations where multiple topics from the specification are drawn together in the form of synoptic questions. Furthermore, learners should be able to identify and use the appropriate units that relate to the engineering principles being assessed.

The paper had 20 questions. Each question was based on an engineering concept, with some questions having multiple parts. Learners were required to demonstrate knowledge and understanding of a range of specification topics and to apply this knowledge to the specific question scenario. The intention was to offer as broad a coverage as possible for all areas of the unit content. Questions had varying weightings attached to them, with 1 to 4 marks for the lower demand questions and up to 9 marks for questions where an extended response was required, such as calculation that were synoptic in their assessment of either mechanical or electrical and electronic principles.

Each of the questions that involved calculations was marked using both method (M) marks and accuracy (A) marks, as shown in the mark scheme, although in a small number of cases some independent accuracy (B) marks were awarded where alternative approaches were taken when answering questions. The short-written response questions were point marked against mark schemes with linked responses being required for explain questions. A small number of questions were multiple choice for which learners had to select the correct answer from four alternative options.

Introduction to the Overall Performance of the Unit

Learner performance was generally consistent across the paper, with some questions proving much more challenging than others due to their synoptic nature. Overall, there was evidence of learners having been taught well across the range of unit content, with the extended calculations allowing for differentiation across learner abilities. It was positive to see that across the cohort of learners there were examples of full marks being awarded for every question on the paper, with a very small number of learners achieving full marks on the examination.

It continues to be important that learners are given the opportunity to practice responding to shorter and/or lower demand questions as well as extended calculation questions. As with the January 2018 series there were a small number of occasions where learners did not present any working to support a numerical value that they gave as an answer. It is important to show working as this allows access to 'method marks' should the solution be incorrect.

Learners responded well and provided more clear responses to most of the questions in the examination with many being able to achieve some of the marks that were available for the various extended calculations even when the correct solution was not found or only a partial answer provided. It was again noted that a number of learners were less comfortable with the written answers than the calculations, although there was evidence that some learners were able to provide linked responses to the question that required an explanation. As noted in the previous series it is important that learners are prepared fully for the examination and have the opportunity to practice short-open response questions of the form that were included in both this paper, previous examinations and also both of the sample assessment materials.

Individual Questions

The following section considers each question on the paper, providing examples of learner responses and a brief commentary of why the responses gained the marks they did. This section should be considered with the live external assessment and corresponding mark scheme.

Question 1

This question was in two parts and was generally answered well by a large proportion of learners. In most cases learners could calculate the gradient of the straight-line graph for part (i) and then interpret the graph correctly for part (ii) to initially identify the intercept and then state the equation of the straight-line graph in the correct format.

Where learners did not achieve full marks the reasons for this tended to be either failure to calculate the correct gradient, generally as a result of inverting the values and dividing the difference in x-values by the difference in y-values, or by omitting the intercept when stating the equation of the line.

Part (i)This response gained 2 marks

1 (i) Calculate the gradient of the straight line. **(2)**

$$\text{gradient} = \frac{\text{change in } y}{\text{change in } x}$$

$$\frac{5-1}{2-0} = \frac{4}{2} = \underline{2}$$

In this response the learner has shown their working in full, and has identified a suitably wide range of values to use for the differences in both y and x. The value arrived at for the gradient is correct.

Part (ii) This response gained 2 marks

(ii) Find the equation of the straight line.

$y = mx + c$ $\quad\quad$ $m=2$

$y = 2x + c$

$c =$ y intercept

$y = 2x + 1$

The learner has again shown their working in full, and has identified that ‘c’ is the y intercept which they have correctly read from the graph. They have stated their answer from part (i) ‘m=2’ which has been correctly applied to arrive at the correct answer for the equation of the line.

Question 2

This question had three parts, part (i) where learners needed to calculate the internal angle of a sector of a circle in radians, part (ii) where they needed to calculate the area of the sector of the circle, and part (iii) which required learners to calculate the volume of the storage tank with a base shaped like the sector of the circle previously calculated.

It was somewhat disappointing that a significant minority of learners failed to calculate either the area of the base or the volume of the container correctly. In a number of cases they calculated the area of a square base, whilst some learners calculated the volume of a cylinder which did attract a method mark for part (iii).
In a number of cases learners who did not achieve the marks available for part (i) were able to access the marks for parts (ii) and (iii) through the application of the ‘follow through’ approach where incorrect previous working did not result in a further loss of marks. In most cases learners also presented their working in full which allowed some partial credit for the method used even where the final answer provided was incorrect.

Part (i) This response gained 2 marks

2 (i) Convert 60° into radians.

$$\frac{2\pi(60)}{360} = \frac{1}{3}\pi$$

$$= 1.047$$

Answer $\frac{\pi}{3}$ rads or 1.047

This response achieves both marks available. The learner has clearly substituted the correct values in the equation for converting degrees to radian measure to be awarded one method mark. An accuracy mark has also been awarded for the correct solution. In questions such as this learner will be given full credit for answers in a range of formats including answers presented in terms of Pi.

Part (ii)This response gained 2 marks.

(ii) Calculate the area of the base (sector of a circle).

$$\tfrac{1}{2} r^2\theta = \tfrac{1}{2} \times 2^2 \times 1.05$$

$$= 2.1\,m^2$$

The various two- and three-part questions were designed for learners to 'take forward' their response from part (i) and then use this in their working for subsequent parts of the question. In this example the learner has done this, although for this question a minority took a different approach and calculated the area of the circle which they then divided by 6 to arrive at the correct answer. In this example the learner has rounded their answer for part (i) and has used this value correctly in part (ii) to access both of the marks that were available.

Part (iii)This response gained 2 marks.

(iii) Calculate the volume of the steel storage tank.

Area = 2.094

volume = Area × height

volume = 2.1 × 3m

volume = 6.28318 m^3

This response again shows each stage of the calculation clearly, with the learner presenting a final answer that is correct. Centres are reminded that learners should be encouraged to present their answers to an appropriate degree of precision, and the number of significant figures used when stating an answer should be appropriate for the situation. In this case, answers that were rounded to 2 or 3 decimal places were acceptable.

Question 3

This question was well answered by many candidates with a large proportion of learners achieving full marks. Many different approaches were seen, with many learners using either the sine or cosine ratio to calculate the missing dimension. A significant proportion of learners attempted to answer the question using the Sine Rule, or more complex approaches using a combination of trigonometry and Pythagoras' Theorem. Where learners did not achieve all of the marks that were available the causes of this was generally arithmetic errors when following one of the more complex routes to a solution, or by attempting to solve the problem using an inappropriate approach such as the Tan identity. Centres are reminded that it is important that learners are provided with the skills needed to be able to rearrange equations so that they can answer the broad range of questions on the paper that involve the use of rearranging and similar arithmetic and algebraic skills.

This response gained 4 marks

3 Calculate the length of side AC.

$S\frac{O}{H}\ C\frac{A}{H}\ T\frac{O}{A}$

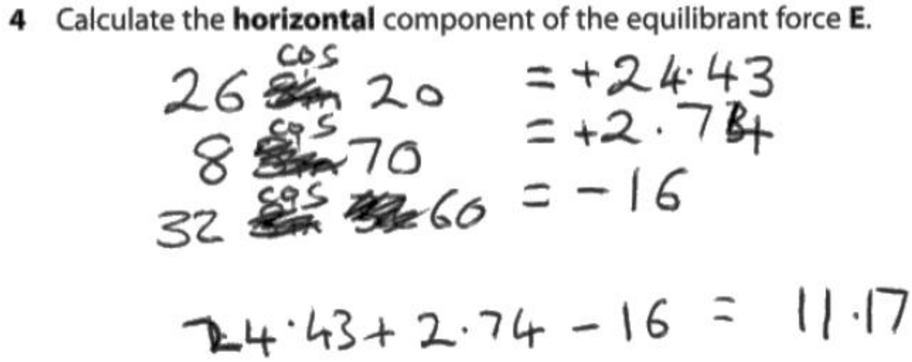
$\cos\theta = \frac{Adj}{Hyp}$ $\qquad\qquad$ $\cos 75 = \frac{50}{H}$

$\frac{50}{\cos 75} = 193.1851653$

The learner has demonstrated good practice by showing their working clearly and concisely. One method mark has been awarded for identifying and using an appropriate trigonometric identity. A further two method marks have been awarded for correctly subtracting values into formula and rearranging to make the missing dimension the subject of the equation. Finally, an accuracy mark has been awarded for the correct solution.

Question 4

Learners performed with varying degrees of success on this question with a large proportion of learners being able calculate the horizontal component of the equilibriant force. Where learners did not achieve marks the reasons for this tended to be either they selected an incorrect approach to resolve the forces, often calculating vertical components, or they made arithmetic mistakes in their working.
As with other questions on the paper, learners were able to achieve some method marks where they provided sufficient evidence of correct working, and where errors had been followed through to the solution, the final ‘accuracy’ mark could often also be awarded. A number of alternative approaches were used by learners, with a small number of learners going beyond what was asked of them in the question, calculating both the magnitude and the direction of the equilibriant force.



4 Calculate the **horizontal** component of the equilibrant force **E**.

$26 \cos 20 = +24.43$

$8 \cos 70 = +2.74$

$32 \cos 60 = -16$

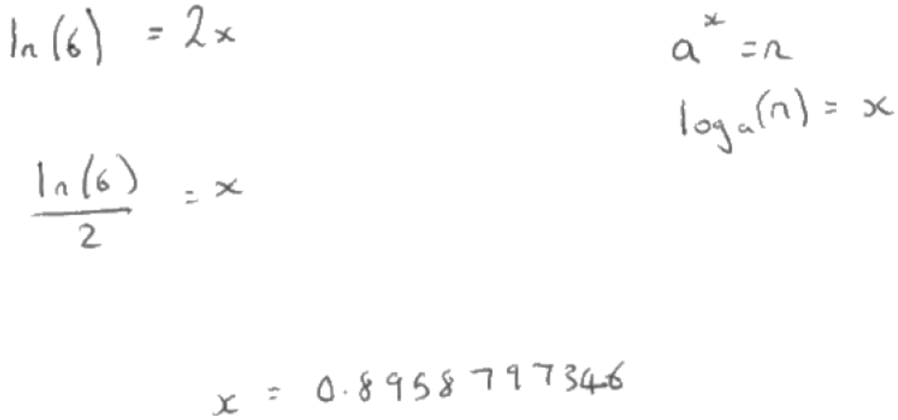
$24.43 + 2.74 - 16 = 11.17$

This response has been awarded four marks. The working is clear, with the learner demonstrating how they arrived at the value for the horizontal component of each of the forces. It is important that learners consider the direction of each of the forces, as demonstrated in this example, as one of reasons why learners often made mistakes when answering this question was that they used a value of ‘16’ rather than ‘-16’ for the value of the horizontal component of the 32N force.

Question 5

Learners performed with limited success on this question with marks being awarded across the full range available, although these were often limited to one mark. Learners seemed to be unclear with regards to the application of the rules of logarithms and the difference between natural logarithms to base-e and logarithms to base-10. In many cases working followed a base-10 approach which resulted in an incorrect final answer, although some method marks could often be awarded for a correct application of one of the laws of logarithms.

This response gained 3 marks.



$\ln(6) = 2x$

$\frac{\ln(6)}{2} = x$

$a^x = n$

$\log_a(n) = x$

$x = 0.8958797346$

This learner has correctly identified the correct approach to solving the problem involving natural logarithms, and although all stages of the working have not been shown in this case, the learner has correctly recognised that ‘ln e’ = 1 and has subsequently rearranged the equation correctly to then arrive at a value for x.

As noted above, learners should be encouraged to present their answers to an appropriate degree of precision rather than include all the digits shown on their calculator.

Question 6

Question 6 was the first of the questions that assessed learners' understanding of mechanical principles. This was the first of four multiple choice questions on the paper that are intended to allow learners to select the correct answer from a range of options.
This question asked learners to identify the unit of measure for mechanical energy. A large proportion of learners correctly selected joule, although a significant proportion of those who did not get the answer correct chose watt.
It is important that learners are familiar with the units that are used for the various quantities that are included in the unit content.

Question 7

Learner performance on this multiple-choice question was comparable to that seen for question 6, with a large proportion of learners correctly identifying mechanical advantage as the ratio of output force to input force. It is important that learners are familiar with the various principles listed in the unit content and understand the concepts on which they are founded.

Question 8

Question 8 was the first short open written response question on the examination and was worth one mark. Somewhat disappointingly only a relatively small proportion of learners were able to identify once condition for static equilibrium. Common errors often involved stating that 'forces need to be equal' or similar. Answers such as this did not attract the mark as this is not true in all situations with learners needing to make reference to opposite directions to achieve the mark available.

Question 9

This question was another that had two parts, with part (i) requiring learners to calculate the area of a vertical dam wall that was in contact with water, and part (ii) which tasked learners with calculating the hydrostatic thrust on the aforesaid dam wall. In general, the two parts of the question proved to be accessible for many learners, with a significant proportion achieving full marks. Learners had a good understanding of the approach to take to find the contact area of the water, although some errors were apparent such as considering the area to be square rather than rectangular. As with other two-part questions in the examination credit was given in part (ii) for the correct working and arithmetic answer derived from an incorrect value from part (i).

Part (i) This response gained 2 marks.

9 (i) Calculate the area of the water against the dam wall.

$A = H \times W$

$= 8 \times 6$

$= 48 m^2$

The learner has correctly calculated the area of the contact area of the water. They have shown their working in full, which is to be commended. It is important that learners are familiar with methods of calculating regular shapes such as rectangles and squares.

Part (ii) This response has gained 3 marks.

(ii) Calculate the hydrostatic thrust on the dam wall.

Assume the density of water is 1000 kg/m^3.

Hydrostatic thrust = $F = \rho g A x$

$x = \frac{\text{height}}{2} = 3$

$A = 48 m^2$

$\rho = 1000$

$g = 9.81$

$F = 1000 \times 9.81 \times 48 \times 3$

Answer 1412640 Newtons or 1.4126 MNewtons

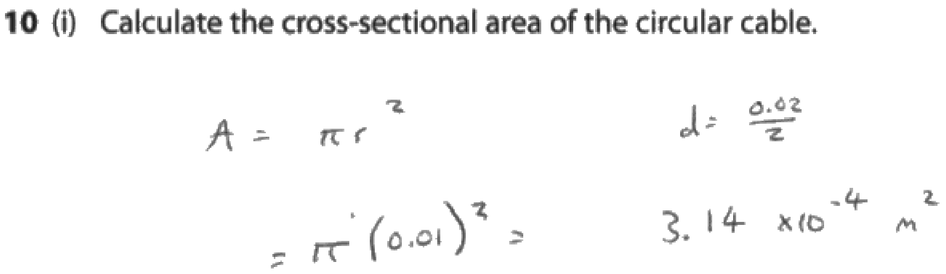
In this response the learner has correctly substituted their answer from part (i) into the given equation for hydrostatic thrust. The learner has correctly calculated the value of ‘x’ which was often omitted from learners’ working and resulted in at least one mark not being awarded. In this example the learner has given their answer initially in newtons and then converted to meganewtons. In a significant number of cases such conversions were not shown as part of the working and learners made errors related to magnitude; again, this was the cause of marks not being awarded.

Question 10

Question 10 is a further two-part question in which learners need to calculate the cross-sectional area of a circular cable in part (i) and the direct stress in the cable in part (ii). The majority of learners who attempted this question performed well for part (i) although some errors occurred as a result of either using the diameter rather than radius for calculating area, or though converting values.

Learners performed less well when answering part (ii) with a significant proportion being unable to correctly transpose the given formula, or they made errors related to converting from one form of unit to another. Somewhat disappointing was the limited number of learners who could correctly state the unit for direct stress.

Part (i) This response gained 2 marks.

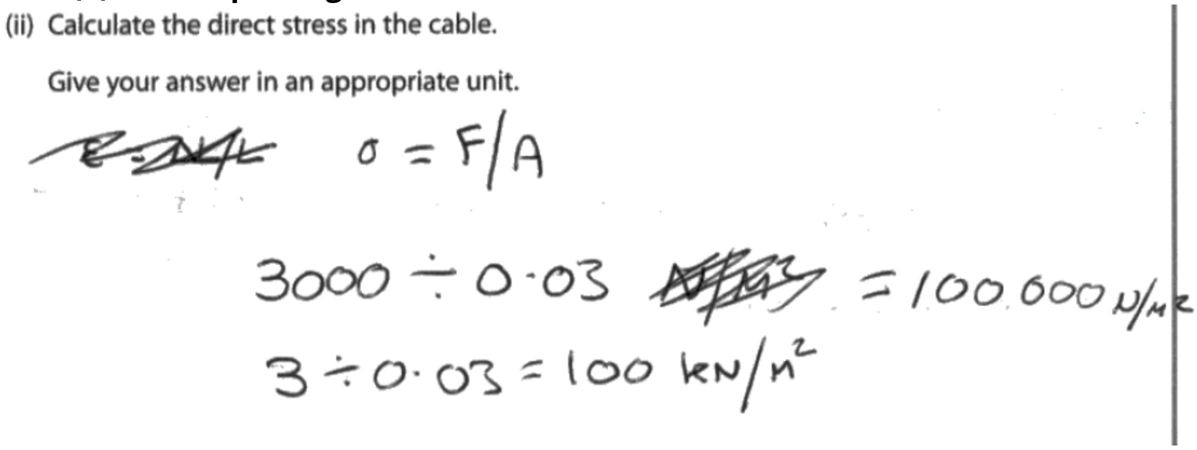

10 (i) Calculate the cross-sectional area of the circular cable.

$A = \pi r^2$ $\quad d = \frac{0.02}{2}$

$= \pi (0.01)^2 = 3.14 \times 10^{-4}\ m^2$

In this response the learner initially calculated the radius of the cable and has then substituted this value correctly to determine the area of the cable. The answer has been presented in standard form which is appropriate and reduces the chances of errors being made when converting between units.

Part (ii) This response gained 3 marks.


(ii) Calculate the direct stress in the cable.

Give your answer in an appropriate unit.

$\sigma = F/A$

$3000 \div 0.03 = 100.000\ N/m^2$

$3 \div 0.03 = 100\ kN/m^2$

The learner incorrectly calculated the area of the cable as 0.03mm^2 in part (i) of the question. They have however correctly substituted this value correctly into the formula for direct stress and have arrived at an answer that is arithmetically correct for the values that they have used. Furthermore, they have stated the answer with a unit that is appropriate for the numerical value given, thereby achieving the dependent unit mark available for this question. It should be noted that where marks for units are awarded, these are dependent on an appropriate numerical answer also being provided, and the unit must be suitable for the numerical value.

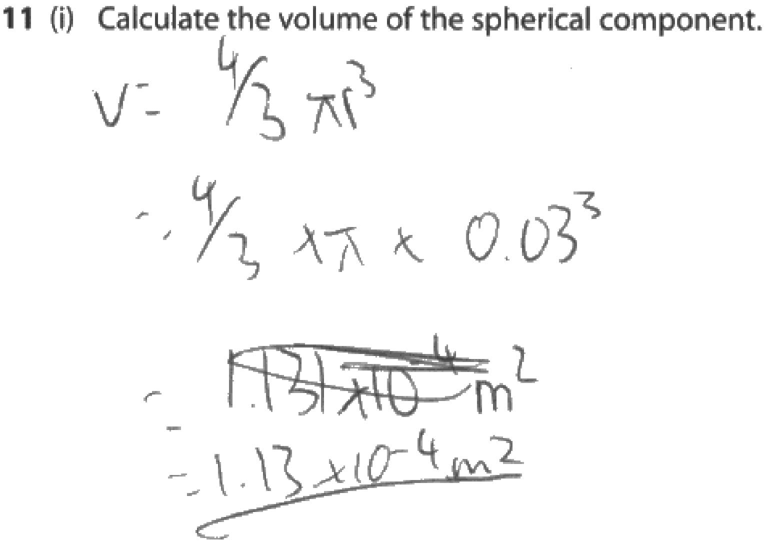
Question 11

This was another example of a question that had two parts, with part (i) requiring learners to calculate the volume of a sphere, and part (ii) the density of a material using given values and the calculated volume.

As with question 10 learners made some errors when converting a diameter into a radius, with this often resulting in an incorrect volume being stated for part (i). In a significant number of cases learners stated the correct formula, populated it correctly and then made errors in their calculation. In cases such as these, learners were able to access the method marks awardable.

Learners tended to perform less well for part (ii) where a common mistake was to multiply the mass by the volume as opposed to dividing. In some cases, learners converted the mass into grammes which was not required and therefore arrived at a solution that was incorrect.

Part (i) This response gained 3 marks


11 (i) Calculate the volume of the spherical component.

$V = \frac{4}{3}\pi r^3$

$= \frac{4}{3} \times \pi \times 0.03^3$

$= \sout{1.131 \times 10^{-4}}\ m^2$

$= 1.13 \times 10^{-4}\ m^2$

The learner has presented their working in full, except for the conversion of the diameter to a radius. The learner has also presented their answer in standard form which allows for the value to be carried forward to part (ii) of the question with a reduced opportunity for errors to creep in.

Part (ii) This response gained 3 marks

density: $\rho = \frac{m}{V}$

$\rho = \frac{0.35\,kg}{0.113 \times 10^{-3}\,m^3}$

Answer

3094.7 kg/m^3

Whilst marks are generally not awarded for the selection of a formula from the information booklet it is nonetheless good practice to copy the formulae that are to be used to answer a question into the examination paper. This reduces the opportunity for errors when populating the formula. The learner has transposed the formula and then written this as part of their answer. They have then correctly populated the formula with the value for volume brought forward from part (i), with the answer being correct and presented to a suitable degree of accuracy.

Question 12

As both sections B and C progress, the complexity of the questions increases with relation to the nature of the problems that need to be solved or the procedures that need to be followed. In this case learners needed to be able to interpret the information that they had been provided with, to be able to calculate the deceleration of a car.

Many learners made errors in their approach, for example calculating the time taken or the average speed between the two give points. In many cases learners selected the correct SUVAT equation and populated it with the correct values. Where the correct equation was populated with accuracy learners tended to achieve full marks. In the majority of cases learners were able to rearrange equations correctly which was positive.

This response has gained 4 marks.

12 Calculate the rate of deceleration of the racing car.

$s = 270$

$u = 75$

$v = 15$

$a = ?$

$t = /$

$$v^2 = u^2 + 2as$$

$$\frac{v^2 - u^2}{2s} = a$$

$$\frac{15^2 - 75^2}{2(270)} = -10 \text{ ms}^{-2}$$

The learner has initially written down the values for all the known variables associated with problems involving linear motion. They have then correctly rearranged and subsequently populated their selected formula to arrive at the correct answer for the deceleration of the car.

The working is concise yet still has sufficient stages shown to allow for method marks to be awarded if the final answer had been incorrect.

Question 13

Question 13 is the final question that assesses mechanical principles and is synoptic across the various mechanical topics in the unit content. A large proportion of learners achieved between four and six marks for this question; where marks were lost this was as a result of not calculating the angular velocity of the thin walled rotating cylinder or applying the correct formula for inertia, In some cases learners struggled with the approach needed to be taken to convert from RPM to radians per second, although even in these cases up to four marks was often awarded for calculating inertia.

This response gained 8 marks

radius = 0.3m

13 Calculate the rotational kinetic energy of the cylinder when it rotates at 60 revolutions per minute (RPM). 60 rev/min 1 / second.

(8)

Rotational kinetic energy = $KE = \frac{1}{2} I \omega^2$

check
$\frac{1}{2}((1 \times 10 \times (\frac{0.6}{2})^2) \times (2\pi \times 1)^2) = 17.77$

$\omega = 2\pi f$

$f = \frac{1}{time}$ frequency = 1 Hz $\omega = 2\pi \times 1 = 6.2831$

$I = k m r^2$ $k = 1$ as thin walled $m = 10kg$ $r = \frac{0.6}{2}$

$I = 1 \times 10 \times (\frac{0.6}{2})^2 = 0.9$

$I = 0.9, \omega = 2\pi$ $KE = \frac{1}{2}(0.9 \times 2\pi^2) = 17.765$

Answer

17.77 Joules

(Total for Question 13 = 8 marks)

The learner has clearly shown each stage of their working with the angular velocity being calculated along with inertia. The learner has correctly used the radius of the cylinder and has then used their calculated values for inertia and angular velocity to calculate the rotational kinetic energy with accuracy.
The learner has also demonstrated good practice by checking their working using an alternative approach to confirm their answer is correct.

This learner has indicated the various formulae that they will use before populating them with values; this is good practice and allows the examiners to confirm that the correct calculation is being performed. The learner has recognised the pin is in double shear (showing a force of 25 N rather than 50). All stages of the working are shown, and they are accurate. As a result, the full 7 marks can be awarded.

Question 14

This was the first question in section C where knowledge of electrical/electronic principles were assessed. As with section B the first two questions were multiple choice. In this question learners were generally successful and could identify that the unit of measurement for frequency is hertz.

Question 15

Another multiple-choice question in which learners generally performed well. Many learners correctly identified diode as being an electronic component that only allows electricity to flow in one direction in a circuit from the options that they were presented with.

Question16

The majority of learners found question 16 to be accessible with a large proportion being able to achieve full marks. Where learners did not achieve full marks, this was often as a result of either not including units with the answer, or providing an inappropriate unit for the numerical value given. As with a number of questions in Section B some learners made errors in their transposition of formulae and also with the conversion of units. These are skills that learners should be able to apply to a range of different types of questions in the examination and centres are encouraged to make sure that learners are equipped with the necessary skills to transpose equations and also to convert between units.

This response has gained 5 marks.

16 Calculate the current drawn by the motor.

Give your answer in an appropriate unit.

(5)

$P = IV$

$V = 110$

$P = 2000$

$I = \frac{P}{V}$

$I = \frac{2000}{110}$

$I = 18.\dot{1}\dot{8}$ Ampere

The learner has written out the formula they intend to use in full, and have then populated this correctly. They have correctly converted the value of power from kilowatts to watts and used this appropriately in their answer. Finally, the learner has stated the correct unit for the answer they have provided and have therefore achieved the final accuracy mark for the correct unit.

Question17

A large proportion of learners attempted the question with some limited success, as has been the case in previous series learners have not been as confident with completing problems associated with capacitors, often applying the same rules as they would apply to resistors in parallel. This was again common amongst some of the lower achieving learners. Similarly, learners made some assumptions in their calculations, often omitting microfarads from their calculations. It is important that learners practice calculations using values that are realistic for low voltage situations and are able to recognise the differences between microfards and picofarads for example. In a significant number of cases learners made errors when working in standard form with answers given to varying powers of 10.

Some learners used an alternative approach where they calculated the charge stored on each of the individual capacitors and then found the sum of these. In the majority of cases this approach also achieved full marks, with learners being credited for the individual charges stored and then for the total charge,

This response gained 4 marks.

17 Calculate the total charge stored in the circuit.

(4)

$C_1 + C_2 + C_3 = C_T.$

$68\times10^{-6} + 12\times10^{-6} + 47\times10^{-6} = 127\times10^{-6}$ F

$Q = CV$

$Q = 127\times10^{-6} \times 110$

$Q = 0.01397$ C

This learner has correctly used the formula for capacitors in parallel. They have been consistent with their units and have correctly recognised that in standard form 127 microfarads is 127x10^{-6} F.

The learner has then taken this value forward to calculate the overall charge stored in the circuit. The learner has given their answer in decimal form which is acceptable, with an accurate value being stated.

Question 18

This was a further written open response question which assessed learners understanding of conventional current. It was apparent in a large proportion of cases that learners were unfamiliar with the concept and provided answers that related to direct current in a range of different ways, but did not identify the underlying concept of conventional current flowing from the positive terminal of a power supply to the negative terminal and that this is the opposite direction to electron flow in a circuit.

This response gained 2 marks.

18 Explain the term conventional current flow in a DC electronic circuit.

(2)

Conventional current flow is the direction current is thought of to travel. In a circuit in the UK conventional current flows from the positive terminal of a cell, battery, voltage supply etc to the negative terminal

The learner has identified in their response that conventional current flows from positive to negative and that this is the direction current is 'thought to travel' which shows an amount of deeper understanding. Unfortunately, responses such as 'it flows in one direction' were too common and seem to indicate that in many cases learners are less comfortable with, or prepared for, the written questions on the paper.

Question 19

Learners performed relatively well across the three parts that made up question 19. As with many of the other questions on the examination the root cause of learners failing to score full marks for parts of questions was errors made in their working such as incorrectly rearranging equations or making arithmetic errors. In general, learners performed well for part (i) of the question where they were required to calculate the peak voltage of the supply. Some learners found part (ii) more challenging and did not calculate the average value correctly, simply adding the RMS and peak voltages together and dividing them by 2.

In the main, part (iii) was answered well with learners substituting the correct values into the appropriate formula to calculate the form factor. Where mistakes were made this was often the result of using the peak voltage as opposed to the RMS voltage. As with other questions, where learners had calculated values incorrectly at earlier stages, provided these values were applied appropriately throughout, then subsequent marks were awarded.

Part (i) This response gained 3 marks.

19 (i) Calculate the peak voltage of the supply.

(3)

$V_p = RMS \times \sqrt{2}$

$V_p = 100 \times \sqrt{2}$

$\therefore$ Peak voltage = 141.4 v

Answer 141.4 V

This learner has identified and rearranged the correct formula to achieve one method mark. They have then correctly populated this with the values given in the question and arrived at the correct answer for the peak voltage. This has been stated to an appropriate degree of precision. As with other examples in the report, sufficient working is shown to allow for method marks to be awarded if a numerically incorrect answer had been given.

Part (ii) This response gained 2 marks.

(ii) Calculate the average value of the supply.

(2)

$\frac{2}{\pi} \times max = avg$

$\frac{2}{\pi} \times 141.42$

$= 90.03$ V

Answer

The learner has brought forward their answer from part (i)and substituted this correctly into the formula for average value. As with the previous example working has been shown in detail and values correctly substituted into the formula. The answer has again been presented with an appropriate degree of precision.

Part (iii) This response achieved 2 marks.

(iii) Calculate the form factor for the supply.

(2)

$$FF = \frac{RMS}{Aver}$$

$$= \frac{100}{90} = 1.1111111$$

Answer 1.1

The learner has correctly identified the formula they need to use and have represented this in their own shorthand version. They have used the value given in the question for the RMS voltage and their calculated average value to determine the form factor of the supply. The answer is accurate based on the value the learner calculated for the average value of the supply. It is important that learners show where values have been derived from when substituting in to a formula as credit is not given if the source of values is not clear.

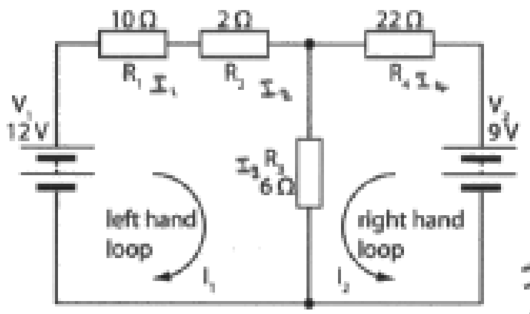
Question 20

As with the mechanical principles questions, the later electrical and electronic principles questions tend to be more demanding. As such, this question proved to be challenging for many learners as a number of stages were required in order to arrive at the solution for the current in the identified resistor.

Many learners were able to achieve at least one mark for recognising that both the left-hand loop and the right-hand loop would need to be considered along with Kirchoff's current law. A number of learners attempted to solve the problem by applying Ohms Law however this approach would not arrive at the correct answer. Where learners achieved some success, they recognised the need to use simultaneous equations for the two loops.

As with other questions, learners were given credit for the stages of the calculation where they performed well, and as with other questions on the paper, a 'follow through' approach was taken to prevent further penalties for errors or omissions in early stages of the calculation.

This response gained 9 marks



$I_1 + I_2 = I_5$

$R_1 + R_2 = 12\Omega$ or R_5

Q20

20 Calculate the current flowing through resistor R_3.

LHL $\quad V = IR \quad V_1 = V_2 + V_3 + V_4 + \ldots + V_n$

$12 = I_5R_5 + I_3R_3 \quad I_3 = I_5 + I_4$

$12 = 12I_5 + 6I_3 \quad \therefore \quad 12 = 12I_5 + 6(I_5 + I_4)$

$\therefore \quad 12 = 18I_5 + 6I_4$ ①

RHL

$9 = I_4R_4 + I_3R_3 \quad \therefore \quad 9 = 22I_4 + 6I_3 \quad \therefore \quad 9 = 22I_4 + 6(I_4 + I_5)$

$\therefore \quad 9 = 28I_4 + 6I_5$ ②

② × 18 : $\quad$ ① × 6 :

$162 = 504I_4 + 108I_5$ ④ $\quad 72 = 108I_5 + 36I_4$ ③

③ − ④

$-90 = -468I_4 \quad \therefore \quad I_4 = 0.19A \quad$ sub I_4 into ①

$12 = 18I_5 + 6(0.19) \quad \therefore \quad I_5 = 0.6A$

Answer $\quad \therefore \quad I_3 = I_4 + I_5 = 0.19 + 0.6$

$I_3 = 0.79A$

The learner has shown each of the stages of the calculation clearly and logically and has shown numerical values where appropriate. It is clear in the working that these values have been arrived at correctly from the two loops, with accurate use of simultaneous equations to arrive at the required current.

Each stage of the calculation has been performed with accuracy, with the final answer being presented to an appropriate degree of precision.

Summary

Based on their performance on this paper, learners should:

- attempt all questions on the paper as method marks are often awarded for partial solutions.
- show working in full as again this allows access to method marks. If arithmetic errors are made then marks can still be awarded
- Avoid excessive rounding at intermediate stages of calculations.
- provide linked responses for ‘explain’ questions. An initial lead point should always be expanded upon with either an expansion or a justification.
- make effective use of space when drawing charts or diagrams
- Practice rearranging and manipulating formulae to change the subject of the formula.
- Practice conversions between different units and the application of standard form.

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