L3 Lead Examiner Report 1906

June 2019

L3 Qualification 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, at Distinction, Merit and Pass.

Setting grade boundaries

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

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

Variations in external assessments

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

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

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

Unit 1: Engineering Principles

Grade	Unclassified	Level 3			
		N	P	M	D
Boundary Mark	**0**	**10**	**21**	**42**	**64**

Introduction

This was the fifth 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 the previous series, which is a traditional paper-based examination with a number of different styles of question including multiple choice, short written responses and calculations. 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 continues to change for each examination series, with new topics being assessed along with others which have been assessed previously.

As noted in previous reports, it is important for centres to remember that, due to nature of the specification, they should continue 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 that can be found towards the end of both Section B and Section C. Furthermore, learners should be able to identify and use the appropriate units that relate to the engineering principles being assessed; credit is awarded for these in some question as it is for identifying appropriate approaches in other questions.

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 related to a range of specification topics and apply this to arrive at solutions to the different questions in the examination. The paper is written in such a way as to provide as broad a coverage as possible for each area 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 the synoptic calculations towards the end of Section B and Section C for 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. In a small number of instances, the 'correct answer only' was required; in these situations the follow through rule for 'error carried forward' was not applicable. The short written response questions were point marked against mark schemes with linked responses being required for the explain question. 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 much of unit content, although some topic areas performed less well than expected. This included, but was not limited to, drawing sine waves and factorising. The extended calculations allowed for differentiation across learner abilities. It was again positive to see that across the cohort of learners there were examples of full marks being awarded for every question on the paper, with some 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 previous series there were again a small number of occasions where learners did not present any working to support a numerical value that they stated as their answer to calculations. It is important to show working as this allows access to ‘method marks’ should the solution be incorrect or only partial working presented.

Learners responded well to the questions in the examination and in many cases provided clear responses to the majority of the questions. A significant proportion of learners were able to achieve some marks that were available for the various extended calculations even when the correct solution was not found or only a partial answer provided as a result of showing their working clearly and logically. A number of learners annotated their working; this is good practice as it allows the examiner to identify the process being taken to find a solution to problems.

Learners responded better to the written questions in comparison to previous examinations, with the majority of learners providing an answer and demonstrating an understanding of the concepts involved. As noted previously 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 in both examples of 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 examination paper and the corresponding mark scheme.

Question 1

This question was a single part question and was answered with varying success by learners. Only a small proportion of learners achieved full marks, mostly due to a lack of labels on axes. Most learners were able to sketch a sine wave, and to identify appropriate values for both the angle and sin θ. Where learners did not achieve full marks the reasons were the omission of labels or values, both of which were asked for in the question. A small proportion of learners did not seem to be aware of the form of a sine wave and presented either a straight line graph or a 'saw tooth' form.

This response gained 4 marks

Engineers use the sine function when plotting AC waveforms.

1 Draw the waveform to represent the function:

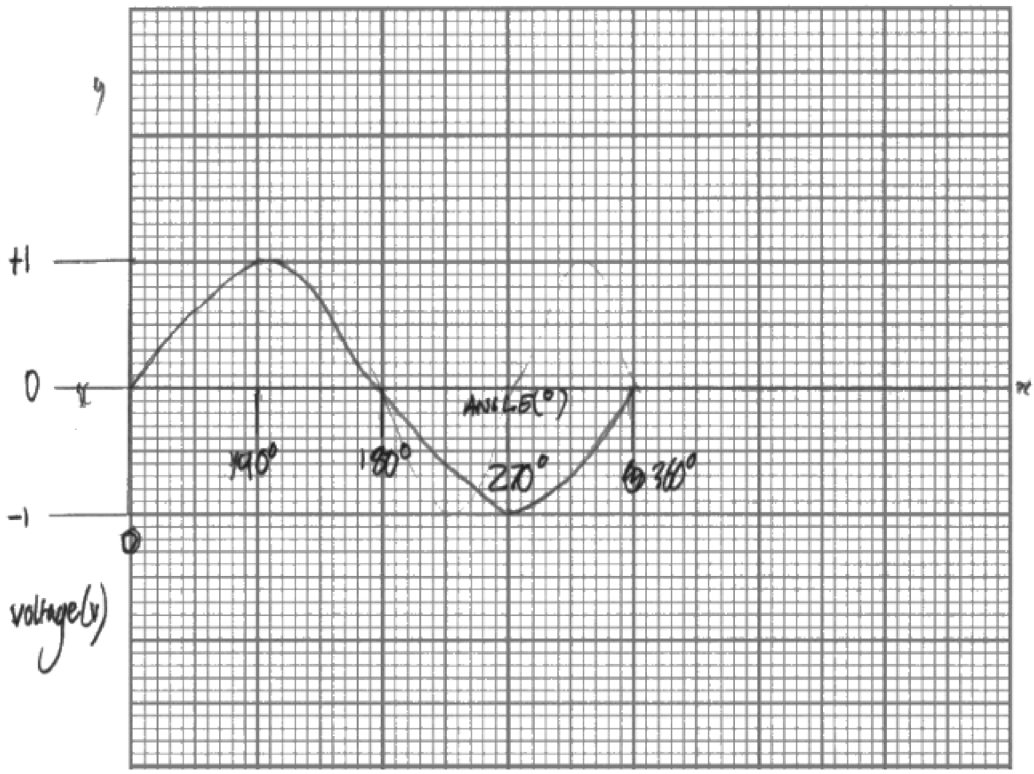
$y = \sin\theta$

where θ is an angle between 0° to 360°.

You should include labels and axis values on your graph.

sin θ

x	0	90	180	270	360
y	0	1	0	-1	0



In this response the learner has drawn a sine wave in the correct form, with values plotted with accuracy. Labels are present and the values shown on axes are correct.

Question 2

This question was a single part question where learners needed to perform a calculation to determine the area of an extrusion. Although a compound shape, the solution could be arrived at using areas of rectangles. Two approaches were seen, one that subtracted that are of the channel from the overall square section, and another where the cross section was broken down into three constituent parts. The latter approach however often resulted in errors being made, with some learners not recognising the overlap of the rectangles in each of the lower corners.

On the whole, learners performed well on this question, and tended to show working in full. This was particularly beneficial for those learners who made arithmetic errors.

This response gained 3 marks

The diagram shows the cross section of an extrusion with a uniform thickness of 4 mm.

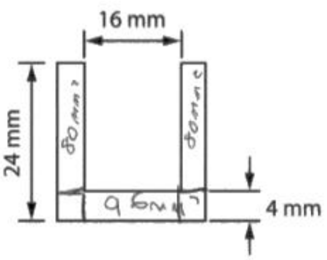


Diagram not to scale

2 Calculate the area of the extrusion.

$20 \times 4 = 80$

$16 + 4 + 4 = 24$

$24 \times 4 = 96$

$96 + 80 + 80 = 256$

This response achieves three marks. The learner has broken the extrusion down in to three rectangles. The areas of each have been calculated accurately, and the final stage of adding the three areas together is also correct. This approach was relatively common, although the division of the rectangles was not always the same. Irrespective of which approach was taken, a correct answer achieved three marks.

Question 3

This was the first two part question on the examination and was answered with variable success by learners. Part (a) tended to be less well answered, with learners demonstrating a lack of knowledge of the laws of indices. A significant proportion of learners were able to correctly arrive at the answer, however some learners added the two values (2 and 3) together to present a solution of $l = n^5$, or placed the numbers in order and gave $l = n^{23}$. As with many questions, an incorrect answer for part (a) could be carried forward to part (b) and if the correct substitutions were made and a numerically correct answer given, the one mark available for part (b) was awarded. In a small number of cases, learners used the correct approach for part (b) despite getting part (a) wrong.

Part (a) response has gained 2 marks.

The length of time an alarm sounds is represented by the formula:

$l = (n^2)^3$

Where l is the length of time (in milliseconds) and n is the number of activations.

3 (a) Simplify the formula using **one** law of indices.

(2)

$(n^2)^3 = n^6$

The learner has selected and applied the correct law of indices and has given their answer in simplified form. Both marks can be awarded despite the lack of the intermediate stage of showing $n^{(2x3)}$.

(b) Calculate the value of l when n = 4.

(1)

$4^6 = 4096$

The learner has shown the correct substitution, using their answer from part (a). The answer is accurate and has been awarded one mark.

Question 4

Learners performed with varying degrees of success on this question with a large proportion of learners being able calculate the required slope length. In many cases learners selected and used the correct formula from the information - the cosine rule, however a number of learners attempted to solve the problem using either the sine rule or Pythagoras' Theorem. As with other questions on the paper, learners were able to achieve some method marks where they provided sufficient evidence of correct working which for this question was often the correct population of the sine rule formula.

Where learners did not achieve full marks, having selected the correct approach, this was the result of incorrect rearranging or errors when working with the value of cos25.

This response gained 4 marks.

The diagram shows a triangular ledge on a building.

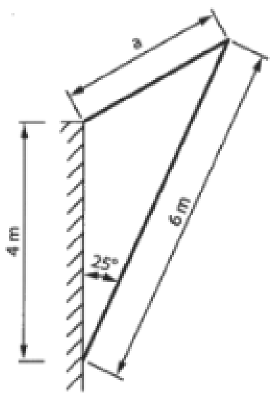


Diagram not to scale

4 Calculate the length of side a.

$a^2 = b^2 + c^2 - 2bc\cos A$

$a^2 = 4^2 + 6^2 - 2 \times 4 \times 6 \times \cos 25$

$a^2 = 8.5$ (1dp)

$a = \sqrt{8.5} = 2.92$m (2dp)

This response has been awarded four marks. The working is clear, although the learner has omitted one step of the calculation. One method mark has been awarded for recognising the need to use the cosine rule, one method mark for the correct substitution of values, a further method mark for rearranging in terms of 'a' and an accuracy mark for the correct answer. Note that although some steps are not shown, all method and accuracy marks can be awarded.

Question 5

Learners performed with variable success on this question with marks being awarded across the full range available. In a significant number of cases used the quadratic formula to determine the two required values. As the question required evidence of factorising, learners who took this approach were limited to two marks for correctly substituting values in to the given expression and rearranging.

A range of approaches to factorising was noted during marking, with a large number of learners extracting a common factor as an initial stage. Learners made a number of mistakes when trying the find the required factors, often as a result of arithmetic errors when simplifying or manipulating the expression.

This response gained 6 marks.

A rocket follows a path represented by the equation:

$h = -4t^2 + 24t$

Where t = time in seconds and h = height above ground.

5 Find **by factorisation** the **two** times when the rocket is at a height of 32 m.

$-4t^2 + 24t = 32$

$-4t^2 + 24t - 32 = 0$

$\div 4$

$-t^2 + 6t - 8 = 0$

$(t - 2)(t + 4)$ $\quad t - 2 = 0 \quad -t + 4 = 0$

$t = 2 \quad t = 4$

$-t^2 + 4t + 2t - 8$

$-t^2 + 6t - 8$

$t = 2 \quad t = 4$

This learner has correctly substituted the value of ‘h’ into the expression, and then rearranged appropriately. A common factor of 4 has been extracted (at the division stage) and the quadratic correctly factorised. The two values of ‘t’ have been correctly determined.

The learner has then checked their answer by expanding the brackets. Where possible it is good practice to check that answers are correct by substituting back in and verifying the answer.

Question 6

Question 6 was the first of the questions that assessed learners’ understanding of mechanical principles. As is the format of the paper, this was the first multiple choice question on the paper that requires learners to select the correct answer from a range of options.

This question asked learners to identify the output motion from a scissor jack this is one of the lifting machines in the unit content, and a significant proportion of learners correctly identified linear motion.

Question 7

Learner performance on this multiple choice question was better when compared to that seen for question 6. A significant proportion of learners identified radians per second as the unit of measure for angular velocity. A small proportion stated metres per second in error.

Question 8

Question 8 was the first calculation in Section B and was related to a simply supported beam in equilibrium about a single support. Questions related to simply supported beams and the application of turning moments have been a common feature of previous examinations. It was therefore somewhat surprising that a significant number of learners made errors in their calculations. Often this was not taking moments about the support, or the incorrect application of moments. A minority of learners calculated the support reaction, which was not required.

Where learners were familiar with the concepts and their application, performance was much improved and many learners were able to achieve full marks.

This response gained 5 marks

A beam supporting three loads is in static equilibrium.

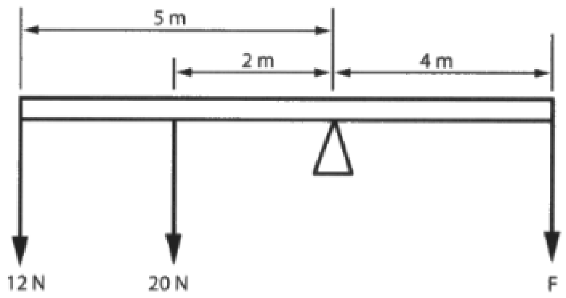


Diagram not to scale

8 Calculate the force F needed to keep the beam in static equilibrium.

12 × 5 + 20 × 2 = 100N

$\frac{100}{4m}$ = 25

25 × 4 = 100N

In this example the learner has identified the correct approach, and has been rewarded for this, despite not being explicitly shown in the working. The correct values have been used by the learner for both sides of the beam, and the values ‘balanced’ appropriately. This has been correctly rearranged in terms of ‘F’ in the second line of the working. The correct answer has been presented. Note that again the learner has checked their answer for accuracy by substituting back in to the calculation.

Question 9

This question was the first multi-part calculation in the mechanical principles section of the paper. The question assesses an aspect of the specification that has been covered previously, although in this case in two parts. The first part focussed on potential energy and was a part question where the ‘correct answer only’ was rewarded. Part (b) then required learners to apply the principles of conservation of energy to calculate a velocity.

As reported on previously, it is important that learners have familiarity with the correct approaches to answer problems related to each of the principles listed in the specification such as conservation of energy, and that they are equipped with the skills to make these decisions.

A common mistake amongst learners was to consider the height of the car at point B as being 5m rather than 25m, however in the majority of cases part (a) was answered correctly.

For part (b) some learners did not consider the potential energy at point (b) and used the initial kinetic energy from the car passing point A. This restricted the marks available, although some credit was given for rearranging in terms of velocity and an answer being provided that was arithmetically correct. This was also an example of a question where a mark was available for the units, which was given by a significant proportion of learners.

Part (a) response has gained 2 marks.

A 500 kg car on a theme park ride is shown below.

As the car passes point A, the total energy in the system is 154 000 J.

Total energy = potential energy + kinetic energy.

Assume the car is rolling freely, the track is frictionless and there is no wind resistance.

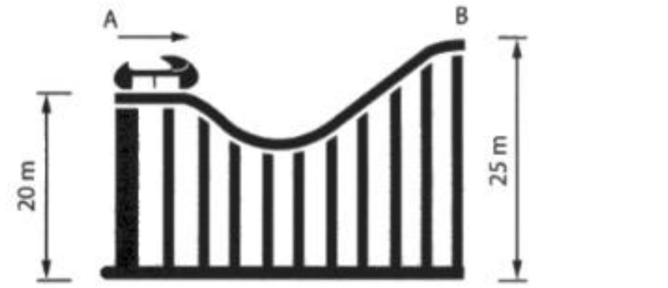


Diagram not to scale

9 (i) Calculate the potential energy of the car at point B on the ride. **(2)**

~~KE = ½mv² = ½ x 500x10³ x~~

PE = mgh

PE = 500 x 9.81 x 25

Answer: PE = 122625

The learner has interpreted the written information and that shown in the diagram with accuracy. The correct values have been substituted in to the correct formula, and an accurate answer given.

Part (a) response has gained 4 marks.

(ii) Calculate the velocity of the car as it passes point B on the ride.

Give your answer in an appropriate unit.

TE = PE + KE : 154000 − 122625 = KE **(4)**

KE = 31375 = ½ m v²

$\frac{31375}{\frac{1}{2} \times 500} = v^2$

125.5 = v²

v = √125.5

Answer: V = 11.20 m/s

The learner has correctly applied the principle of conservation of energy, as shown in the first line of working. A correct substitution of values has been made, and the rearrangement in terms of ‘v’ is accurate. The final answer is correct, and an appropriate unit has been given. The learner has achieved full marks as a result.

Question 10

Question 10 is a short open written response question with learner being asked to state one factor that affects flow rate in a gradually tapering pipe.

The majority of learners who attempted this question performed well, identifying a suitable factor. In some cases learners explained how the flow rate was affected; this was not required. It is acceptable to provide one or two word answers when the command verb is ‘state’ as was the case with this question.

This response gained 1 mark

10 State **one** factor affecting the flow rate of a liquid in a section of a gradually tapering pipe.

Assume that the pipe is rigid and the fluid is incompressible.

The temperature.

In this response the learner has identified one of the factors from the extensive list in the mark scheme to achieve one mark.

Question 11

This was another example of a question that had a number of stages for learners to complete in order to reach the correct answer. Although a large proportion of learners were able to gain full marks, a significant proportion made errors at the first stage of the calculation. The main cause of this was not recognising that the cutting area was the circumference of the circle multiplied by the thickness of the material. A large proportion of learners considered the area of the circle, with this being accounted for with the application of the follow through rule. Other aspects where learners made mistakes included not completing unit conversions with accuracy, such as not recognising the relationship between MN and N, or inaccurate substitutions of values into equations.

This response gained 7 marks

A punch will be used to produce a hole through a sheet of aluminium.

The diameter of the hole is 0.2 m and the thickness of the aluminium sheet is 0.004 m.

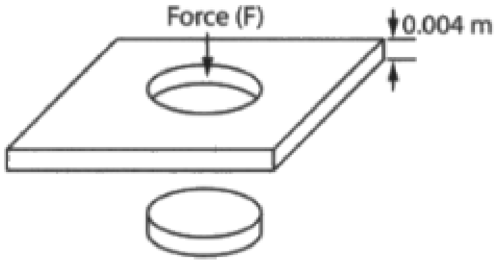


Diagram not to scale

The ultimate shear stress of the aluminium sheet is 50 MPa.

11 Calculate the force (F) needed to punch the hole through the aluminium sheet.

$50 MPa = 50 \times 10^6 N/m^2$

$0.2 \times \pi = \frac{1}{5}\pi m$

$\frac{1}{5}\pi \times 0.004 = 2.513 \times 10^{-3} m^2$

$\tau = \frac{F}{A}$ $\quad F = 50 \times 10^6 \times 2.513 \times 10^{-3}$

$\tau \times A = F$ $\quad F = 125663.7061 N$

The learner has shown their working clearly and fully, with some stages being represented in terms of pi - this is an appropriate and acceptable approach to take where circular measure is involved. The cutting area has been presented to a suitable degree of precision. The formula for shear stress has been rearranged correctly to make the force the subject, and values substituted accurately. The final answer has been presented in Newtons. Note that correct answers given in N, kN or MN would be rewarded fully.

Question 12

As the final question in Section B, Question 12 draws together a number of concepts. In this example this included the volume of a cylinder, the relationship between weight and mass, and Archimedes' Principle. A significant number of learners correctly calculated the volume of the cylinder, although a minority calculated the surface area in error.

The intermediate stage proved to be more troublesome for learners, with many simply not completing the calculation to change the weight of water in to the mass. The final step, where learners applied the relationship between density, volume and mass, tended to be completed with some accuracy. Where learners substituted the value of the weight in error, marks were still awarded for the final stage if the substituted values were correct with respect to other parts of the working.

This response gained 3 marks

12 Calculate the density of the solid cylinder using Archimedes' principle.

~~0.3 4x πr²~~ ~~πr² = π × 0.3×2 = 1.89m~~

1.89 x 0.7 = 6.465397681 m³

$\pi \times r^2 \times h$

$\pi \times 0.3^2 \times 0.7 = 0.19\ m^3$

$\rho = \frac{m}{V} = \frac{22}{0.19} = 115$

Answer: 115 n/m³

In this example, the learner has not converted the weight of the water into the mass. They have however calculated the volume of the cylinder using the correct values, however the answer has been rounded incorrectly. 1 mark is awarded for this stage. No calculation of the mass of the water has been done, as noted previously, however the correct value of 22 (for the weight) and 0.19 (volume) have been substituted in the formula and the answer presented is arithmetically correct. The final method mark and accuracy mark can thus be awarded.

This response achieves 9 marks

A solid cylinder is fully submerged in a tank of water and is in static equilibrium.

Assume the cylinder is made from an unknown material.

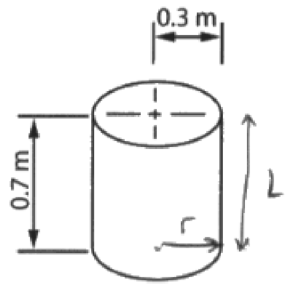


Diagram not to scale

The weight of water displaced by the cylinder is 22 N.

12 Calculate the density of the solid cylinder using Archimedes' principle.

Weight = Mass × gravity

m / d | v

$\frac{22}{g}$ = Mass

$\frac{22}{9.81} = 2.24$ Kg

density = $\frac{\text{Mass}}{\text{Vol}}$

$\frac{2.24}{\pi r^2 L} = \frac{2.24}{0.3^2 \times 0.7 \times \pi} = 11.32$ Kg/m^3

In this example the learner has not presented each stage of the working; instead they have calculated the mass of the water as a first stage. This value has then been substituted into a combined formula for the density of the liquid, with the correct values needed for the volume being shown on the bottom line of the formula. The learner has presented the correct final answer for the density of the liquid. Had the learner made an error at the final stage of the calculation with respect to the volume of the cylinder there is a potential that method marks and accuracy marks may have been lost. As has been reported previously, learners are encouraged to show all stages of their working.

Question 13

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 the majority of learners were able to identify that the circuit symbol represented an inductor.

Question 14

This was a further multiple choice question although learners performed less well on this particular question. Although a significant number of learners identified the correct answer of Coulombs per second, a large proportion were unaware of the correct unit for charge flow. Learners should be familiar with the units for each of the principles included in the specification.

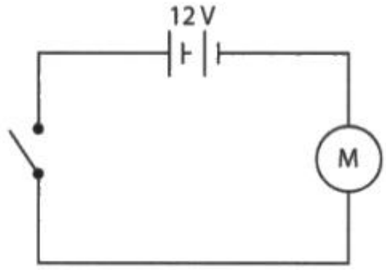
Question15

Learners responded well to this open response question. Many correctly identified that a rectifier circuit is used to change an AC supply in to a DC output. A small number of learners gave specific applications, such as mobile phone chargers. Where these applications were correct, the learner was rewarded with the mark available.

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 arithmetic errors or performing an incorrect transposition of the formula. These are skills that learners should be able to apply to a range of different types of questions in the examination; centres are once again encouraged to make sure that learners are able to perform algebraic manipulations with accuracy.

A DC electric motor has an output power of 50 W.



The current flowing in the circuit is 5.5 A.

16 Calculate the input power to the electric motor.

Power = 50
current = 5.5
voltage = 12

P = IV
P = 5.5 x 12 = 66

Answer: 66 W

The learner identified the pieces of information they are likely to need to use to answer the question and have also written out the formula they intend to use before populating it. The learner has correctly used the aforesaid values when populating the formula and has given the correct answer. Both of the available marks can be awarded.

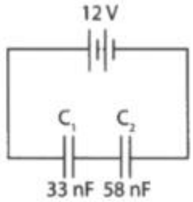
Question17

Question 17 was a two part calculation which assessed learners understanding of processes and procedures related to capacitors. It was encouraging to note that more learners had success with capacitors in a series arrangement than previously, however there remains a significant number of learners who apply series resistor theory to problems such as this. Many learners correctly populated the formula for capacitors in series, but failed to find the inverse of the answer in order to state the overall capacitance of the arrangement. As with other multipart questions, answers from part (a) were carried forward in to part (b), so an incorrect answer in the first part that was correctly applied in part (b) was still able to access full marks for part (b).

As with other questions in the examination, a significant proportion of learners did not perform the unit conversion from picofarads to farads, which had an impact on their final answers. Somewhat surprisingly a significant minority of learners were not able to correct an appropriate unit for energy stored in the capacitors.

Part (a) example gained 3 marks

Two capacitors are connected in a series circuit to a 12 volt DC power supply.



17 (a) Calculate the total capacitance in the circuit.

(3)

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2}$$

$$\frac{1}{C_T} = \frac{1}{33} + \frac{1}{58}$$

$$= \frac{91}{1914}$$

$$= \frac{1914}{91}$$

$$= 21.032967$$

$$= 21.03 \text{ (2dp)}$$

Answer: 21.03 (2dp)

The learner has identified and populated the correct formula. The value for 1/Ct has been calculated with accuracy and then inverted to achieve a method mark for rearranging. The answer stated for Ct is accurate which allows the final accuracy mark to be awarded.

Part (a) example gained 3 marks

17 (a) Calculate the total capacitance in the circuit.

(3)

$$\frac{1}{33} + \frac{1}{58} = \frac{91}{1914} = 0.0475$$

This answer was typical of many learners who substituted values in to the formula and found the correct answer for 1/Ct. This achieved one method mark. The learner has not however inverted this expression so no further marks can be awarded in part (a).

Part (b) example gained 4 marks

Answer:

$C_T = 21.1nF$

(b) Calculate the total energy stored in the capacitors.

Give your answer in an appropriate unit.

(4)

$W = \frac{1}{2} \times C^2 \times V^2$

$W = \frac{1}{2} \times 21.1 \times 12^2$

$W = 1519.2 \times 10^{-9}$

$= 1.5192 \times 10^{-6}\ J$

Answer:

$W = 1.5192 \times 10^{-6}\ J$

The learner has carried their answer (21.1nF) through from part (a) and correctly substituted this in to the formula for energy stored. Each stage of the working has been shown, which allows the learner access to the two method marks available, including the one for recognising the relationship between pF and F (implied in the third line of working). The answer for 'W' is arithmetically correct, and the unit stated is appropriate for these values. Both of the accuracy marks available can be awarded.

Part (b) example gained 2 marks

Answer: $C_T = 21.1nF$

(b) Calculate the total energy stored in the capacitors.

Give your answer in an appropriate unit.

(4)

$W = \frac{1}{2} C V^2$

$W = 0.5 \times 21.1 \times 12^2$

$W = 1519.2$

Answer: 1519.2Wh

This example, which is similar to the previous one, has omitted the conversion of pF to F. As a result only one method mark can be awarded. The answer is arithmetically correct, therefore one accuracy mark can also be awarded. The unit is however not appropriate and therefore cannot be rewarded.

Question 18

This was a further calculation that assessed a topic area covered in the additional sample assessment materials. Although a proportion of learners achieved full marks, it was clear that this was a topic area that they were less familiar with and often struggled to interpret the data that was presented to them in the table. Where learners achieved only partial marks this tended to be for identifying the change in resistance for the conductor. Often this was applied incorrectly, with learners either substituting this value in to the wrong part of the formula, or they did not apply the temperature change from the written information. Learners should be able to interpret data presented in a number of formats, and be able to apply this data where appropriate to solve problems.

This response gained 4 marks

A technician carried out an investigation into the temperature coefficient of a conductor.
The following measurements were recorded:

Temperature	Resistance
T1	12 Ohms
T2	15 Ohms

The difference in temperature between T1 and T2 was 17°C, and the value of R_0 = 12 Ohms.

18 Calculate the temperature co-efficient (α) of the conductor.

$$\frac{\Delta R}{R_0} = \alpha \Delta T$$

$$\frac{3}{12} = \alpha\ 17$$

$$0.25 = 17\alpha$$

$$\frac{0.25}{17} = \alpha = 0.0147058....$$

The learner has identified the correct values from the table and written information and substituted these with accuracy. The formula has been rearranged to make the temperature co-efficient the subject and the final answer stated to an appropriate degree of precision to be able to achieve the accuracy mark available.

This response gained 2 marks

18 Calculate the temperature co-efficient (α) of the conductor.

$$\frac{\Delta R}{R_0} = \alpha \Delta T$$

$$\frac{3}{12} = \alpha \times \Delta T$$

$$0.25 = \alpha \times \Delta T$$

$$0.25 = \alpha \times 17$$

$$\alpha = \frac{17}{0.25} = 68$$

The correct value for the difference in temperature has been stated (3) and the equation has been populated correctly (4th line of the working). The manipulation of the formula is however incorrect which prevents the third method mark from being awarded and the associated accuracy mark for the final answer. As stated earlier in the report, it is important that learners are able to perform routine rearrangements of algebraic expressions.

Question 19

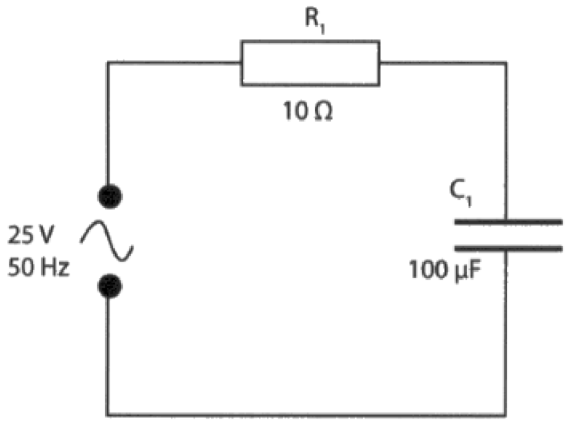
Learners performed variably for this, one of two multistage calculations at the end of Section C. As was common in a number of questions, where learners did not achieve full marks when they had completed the calculation to the end, this was due to the omission of a unit conversion.

Many learners who attempted the question were able to interpret the circuit diagram and populate the correct formula to derive an answer for X_C. It was at this stage where errors were common, with the value for the capacitor being substituted as microfarads rather than being converted to farads. Where this was the case, the learner’s value for X_C, if applied correctly, allowed marks for the total impedance to be awarded.

A significant number of learners however substituted values from the question directly into the formula for impedance and therefore did not achieve marks. To be able to be awarded the marks for this final stage of the calculation learners were required to have made an attempt to calculate X_C.

This response gained 5 marks

The diagram shows an AC circuit that has a resistor and capacitor in series.



19 Calculate the total impedance in the circuit.

$X_c = \frac{1}{2\pi f C}$

$\frac{1}{2 \times \pi \times 50 \times 100 \times 10^{-6}} = 31.83$

$Z = \sqrt{X_c^2 + R^2} = 33.36$

This learner has recognised that the relationship between microfarads and farads and has correctly used this to calculate the capacitive reactance X_C. This has then been substituted to determine the impedance of the RC circuit shown. The answer is given to an appropriate level of precision. Sufficient working has been presented by the learner of the stages of the calculation to identify where key values have been derived from.

Question 20

Learners took one of two approaches to solve this question, although the most popular was to firstly calculate the value of ‘B’, then ‘H’ and finally the flux density. Learners performed with variable success on this the final question which required them to link a number of concepts that were all related to magnetism.

A large proportion of learners were able to recognise the importance of the relationship between B, H and Φ to reach a solution. In many cases this included a rearrangement of the required final formula which achieved limited credit.

This response gained 9 marks

A coil with 200 turns has a current of 3 A flowing through it.

The coil is wrapped around a circular bar with a cross-sectional area of 0.4 m^2 and is 0.25 m in length.

The relative permeability (μ_r) of the circular bar is 150 and the permeability of free space (μ_0) is $4\pi \times 10^{-7}$ H/m.

20 Calculate the magnetic flux (Φ) in the circular bar.

$N = 200$
$I = 3A$
$A = 0.4m^2$
$l = 0.25m$
$\mu_r = 150$
$\mu_0 = 4\pi \times 10^{-7}$ H/m
$\phi = ?$

$H = \frac{NI}{l}$
$H = \frac{200 \times 3}{0.25}$
$H = 2400$ A/m

$\frac{B}{H} = \mu_0 \mu_r$
$\frac{B}{2400} = 150 \times (4\pi \times 10^{-7})$
$\frac{B}{2400} = 1.88495592 \times 10^{-4}$
$B = (1.88 \times 10^{-4}) \times 2400$
$B = 0.4523893421$
$= 0.45$ T

$B = \frac{\phi}{A}$
$\phi = BA$
$\phi = 0.4524 \times 0.4$
$\phi = 0.1809557368$
$\phi = 0.181$ Wb

The learner has extracted all of the variables from the information in the question. They have then used these to calculate the value of H (2400). They have then substituted this value to calculate B (0.45T). The final stage of the calculation is concise and accurate, with the correct answer stated (0.181 Wb). The learner has demonstrated good practice in: a) identifying all the known and unknown variables; b) stating the formulae they will use in full; and c) presenting their working and answer clearly and logically.

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 or partial working.
- Show working in full as again this allows access to method marks. If arithmetic errors are made then marks could still be awarded if an incorrect value has been taken forward.
- Show the formulae that are being used, this can allow examiners to check the correct substitutions have been made.
- Practice rearranging and manipulating algebraic formulae to change the subject of the formula.
- Practice conversions between different units and the application of standard form.
- Use appropriate units where the question asks for them, credit is given in these situation.

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