L3 Lead Examiner Report 1901

January 2019

L3 Qualification in Engineering

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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	63

Introduction

This was the third 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 two series, which is a traditional paper-based examination with a number of different styles of question.

The question paper followed the format identified in the two previous versions and also 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 continues to change for each examination series with the aim of covering all of the topics listed within the specification in due course.

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 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 as credit is awarded for these in some question.

The paper had 21 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 to arrive at solutions to the specific questions in the paper. 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 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 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. The extended calculations allowed 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 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.

Learners responded well to the questions in the examination and in many cases provided clear responses to the majority of the questions. A large number of learners were 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 the case that some learners were less comfortable with the written answers than the calculations. It was encouraging that learners were able to give linked responses to the question that required an explanation. 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 both of the sample assessment materials.

Individual Questions

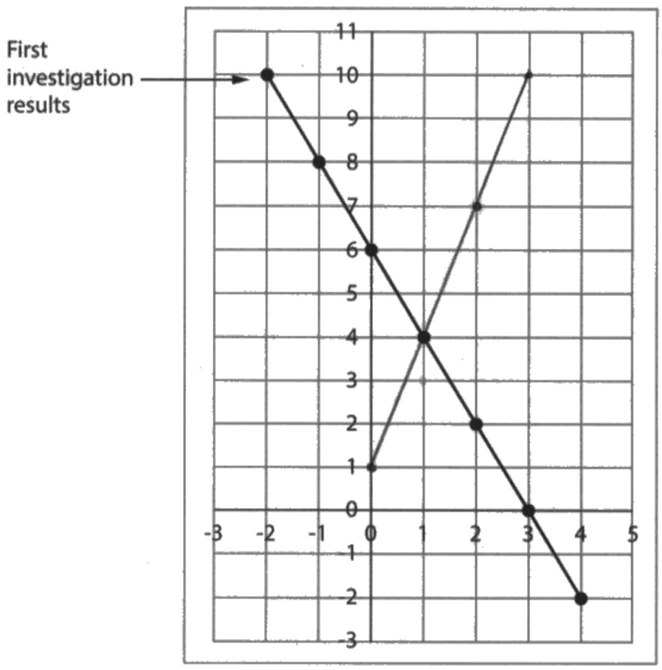
The following section considers each question on the paper, providing examples of learner responses and a brief commentary of why the responses gained the marks they did. This section should be considered with the examination paper and the corresponding mark scheme.

Question 1

This question was in two parts and was generally answered well by a large proportion of learners. In the majority of cases learners were able to plot the correct straight line to represent the results of the second investigation for part (a). Learners performed less well with part (b) where they needed to identify the intercept of the two straight lines. Where learners did not achieve full marks the reasons for this tended to be either failing to plot the line with accuracy, or misinterpreting the co-ordinates of the intercept of the two lines.

Part (a) This response gained 3 marks

An engineer has plotted a straight line graph based on the results of an investigation.



The results of a second investigation are represented by the expression:

$y = 3x + 1$

1 (a) Draw a straight line onto the graph paper to show the results of the **second** investigation.

In this response the learner has achieved 1 mark for their y intercept at y=1, 1 mark for the correct gradient of 3 and 1 further mark for accurately plotting the straight line.

The line is drawn with accuracy, with points clearly plotted on the graph.

Part (b) This response gained 2 marks

(b) Find the coordinates of the intercept for the lines plotted for the first and second investigations.

(2)

Answer (1, 4)

The learner has correctly read the coordinates from their graph (above) and presented these as their answer to achieve 2 marks.

In cases where the learner has plotted the line incorrectly, follow through marks were awarded for part (b) providing the coordinates stated were accurate with respect to the intercept shown on their graph.

Question 2

This question was a single part question where learners needed to perform a calculation to determine the number of revolutions per minute from given information. It was somewhat disappointing that some learners performed a number of operations to arrive at a solution for a question that should have been a single stage operation.

In a number of cases learners who did not achieve both of the marks completed only a partial calculation, for example converting the time, in minutes, into seconds and then dividing the total number of revolutions by this value.

In most cases learners also presented their working in full which allowed some partial credit for some of the more unconventional methods seen.

This response gained 2 marks

A milling machine cutter completes 1750 revolutions in 3 minutes 30 seconds.

2 Calculate how many revolutions are completed in 1 minute.

3 mins 30 secs = 210 sec

1750 ÷ 210 = 8.3̇

8.3̇ x 60 = 500

Answer 500 revolutions per minute

This response achieves both of the marks available. The learner has initially converted the time into seconds and given their answer with accuracy. They have then multiplied this answer by 60 to reach the correct final answer of 500 revolutions per minute.

A large proportion of learners took this approach rather than the straight forward method of dividing 1750 by 3.5 to reach the final answer. Irrespective of which approach was taken, a correct answer achieved both marks available.

Question 3

This question was well answered by a large number of candidates with a significant proportion of learners achieving full marks. A number of different and somewhat unconventional approaches were seen, with many learners using a combination of methods such as Pythagoras' Theorem to initially find the length of the hypotenuse and then either the sine or cosine ratio to calculate the missing angle.

A significant number of learners however did recognise that the tangent ratio was required to find the angle and populated the equation correctly to find tanθ before continuing to find the value for the angle.

Where learners did not achieve full marks, this was often as a result of following a more complex approaches using a combination of trigonometry and Pythagoras' Theorem. Arithmetic errors when often the reason for learners not achieving full marks as when taking one of the more unconventional approaches.

Centres are reminded that it is important that learners are provided with the skills needed to be able to identify the most appropriate method to use to answer questions, for instance being able to identify the most appropriate trigonometric identity to use to solve problems associated with right angles triangles.

This response gained 3 marks

A communications tower has a cable attached as shown.

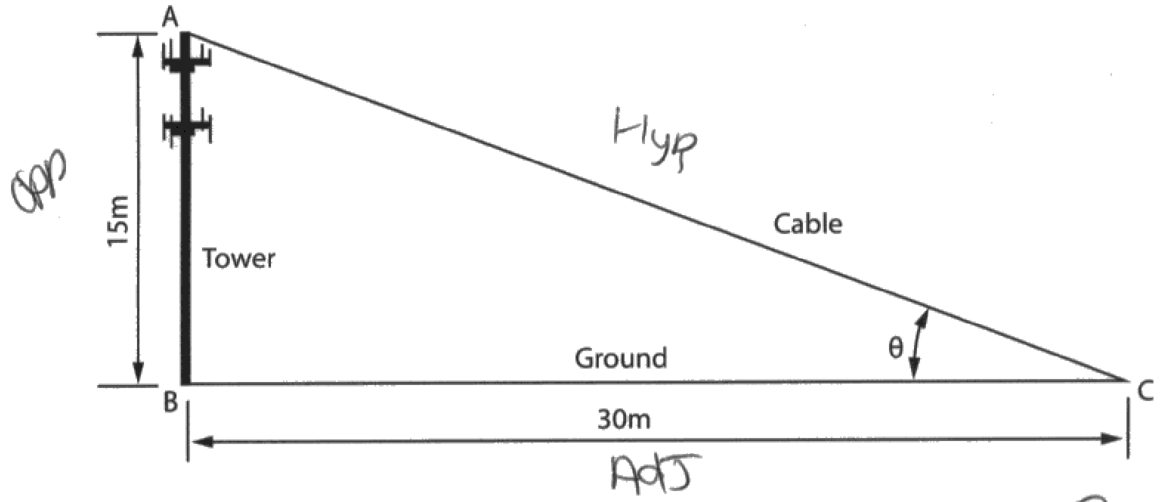


Diagram not to scale

3 Calculate the angle θ.

SOH CAH TOA

$\tan^{-1}(15 \div 30) = 26.6^\circ$ (1DP)

Answer Angle $\theta = 26.6^\circ$ (1DP)

The learner has demonstrated good practice by showing their working clearly and concisely. The learner has clearly identified the correct trigonometric identity to use and has substituted values correctly to be awarded one mark. A further method mark has been awarded for correctly rearranging to make the missing angle the subject of the equation. Finally, an accuracy mark has been awarded for the correct solution for the missing angle.

Question 4

Learners performed with varying degrees of success on this question with a large proportion of learners being able calculate both the slope length of the cone and the curved surface area. In many cases learners selected and used the correct formulae from the information booklet, however where learners did not achieve higher marks the reasons for this tended to be because of selecting an incorrect approach to find the length of the slope.

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 from part (a) into part (b), the final 'accuracy' mark could often also be awarded,

A small number of learners also included the area of the base of the cone in addition to the curved surface area; where this the case learners received appropriate credit.

Part (a) This response gained 3 marks.

The diagram represents a cone that covers a satellite receiver.

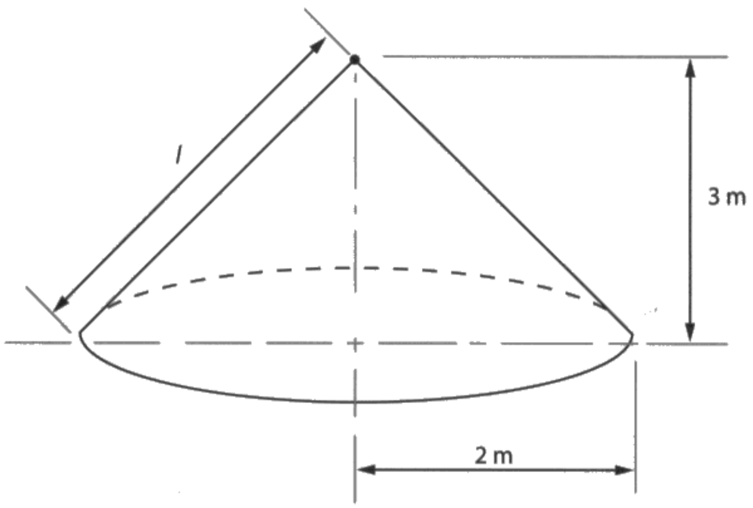


Diagram not to scale

4 (a) Calculate the length of the slope *l*.

(3)

$3^2 + 2^2 = 13^2$

$\sqrt{13} = 3.61$

Answer 3.61m

This response has been awarded three marks. The working is clear, with the learner demonstrating each step of the calculation clearly. One method mark has been awarded for recognising the need to apply Pythagoras' Theorem, a further method mark for the correct substitution of values and an accuracy mark for the correct answer.

Part (b) This response gained 2 marks.

(b) Calculate the surface area of the cone.

(2)

$\pi \times r \times L$

$\pi \times 2 \times \sqrt{13} = 22.65$

Answer 22.65m

In this example the learner has shown their value for the slope length as the square root of 13. Where irrational numbers form part of a calculation this can often lead to higher degrees of accuracy as there is less scope for rounding errors. The learner has correctly substituted the slope length into the correct formula and has arrived at the correct answer.

Question 5

Learners performed with variable success on this question with marks being awarded across the full range available, although these were often limited to one or two marks for the initial stages of the process, or by finding the two values of ‘x’ by factorising. A number of learners made errors when substituting values into the quadratic formula, with many omitting the ‘-’ from the value of ‘b’ (-24) which resulted in incorrect roots being calculated. This often resulted in a maximum of four marks being awarded.

Some learners correctly substituted all values, however then made a series of errors in their working which reduced the overall mark awardable. In cases where learners used alternative approaches, then a maximum of two marks were awarded for each of the correct answers for ‘x’.

This response gained 5 marks.

The results of a test on an electronic circuit are represented by the expression:

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

Where x represents the times when two LEDs light up on a display.

5 Calculate, using the quadratic formula, the **two** values of x when the LEDs light up.

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

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

∴ placing the equation into this formula will provide the answers

$$\frac{-(-24) \pm \sqrt{(-24)^2 - 4 \times 32 \times 4}}{2 \times 32} = \begin{cases} + \rightarrow \frac{1}{2} \\ - \rightarrow \frac{1}{4} \end{cases}$$

Answer

$x = \frac{1}{2}$ or $x = \frac{1}{4}$

This learner has correctly and fully substituted all values into the quadratic formula. Although some stages shown in the mark scheme are implied, for example the simplification of the formula, the correct values of 'x' have both been stated. The learner has therefore achieved full marks for the question, and has shown how the values have been arrived at.

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 unit of measure for hydrostatic pressure. A large proportion of learners correctly selected pascal from the four options available. As stated in previous reports 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 lower when compared to that seen for question 6. A significant proportion of learners identified inertia for their answer, with a relatively small proportion of learners correctly identifying torque as the turning moment that causes rotation about an axis.

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 as well as being able to carry out calculations where these principles are applied.

Question 8

Question 8 was the first short open written response question on the examination and was worth one mark. A large proportion of learners performed with success on this question with typical responses often referring to the load on the cable or similar.

There were some common errors, for example stating that strain or length impacts on the stress in the cable, however correct answers reflected all of those listed in the mark scheme.

This response gained 1 mark

8 State **one** factor that affects stress in a cable supporting an object.

The thickness of the cable.

Many alternative ways of considering the thickness of the cable were accounted for in the mark scheme, such as the area or diameter. Where responses linked to the cross-sectional area of the cable marks were awarded to learners, as in this example where they have stated thickness.

Question 9

This question was the first calculation in the mechanical principles section of the paper. The question assesses an aspect of the specification that has been covered previously in the sample assessment materials and in January 2018 therefore it was disappointing that a large proportion of learners followed inappropriate approaches to arrive at solutions.

The question assesses understanding of volumetric flow rates, although some learners followed methods such as applying various SUVAT equations to attempt to calculate the outlet flow velocity from the pipe. It is important that learners have familiarity with the correct approaches to answer problems related to each of the principles listed in the specification.

A common mistake amongst learners was to incorrectly rearrange the equation; when this occurred, the learner could be awarded one mark for the substitution of values but no further credit given as this was one example of a question where only the correct answer achieved the final accuracy mark, therefore only answers of 25 m/s were credited.

This response gained 3 marks.

A pipe tapers from an area of 0.5 m² to 0.3 m².

Assume that the pipe runs full and contains an incompressible fluid.

The inlet flow velocity is 15 m/s.

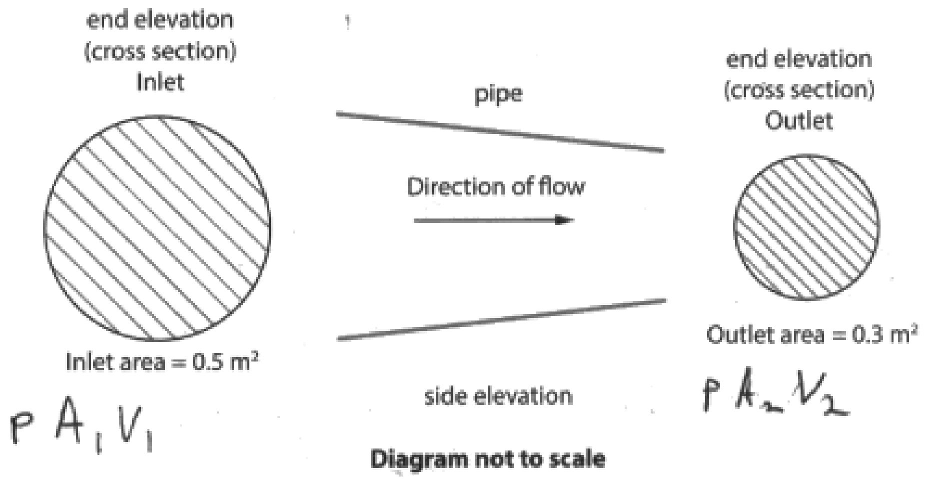


Diagram not to scale

9 Calculate the outlet flow velocity.

$A_1 = 0.5 m^2$

$A_2 = 0.3 m^2$

$V_1 = 15 m/s$

$V_2 = ? m/s$

$0.5 \times 15 = 0.3 \times ?$ $\quad ? = 25 m/s$

$7.5 = 0.3?$ $\quad 7.5 \div 0.3 = 25$

Answer $V_2 = 25 m/s$

The learner has correctly rearranged the formula in terms of the outlet velocity for 1 method mark. A second method mark is awardable for the correct substitution of values. The final answer is correct, therefore the final accuracy mark, for 'correct answer only' is awarded for the outlet velocity.

Question 10

Question 10 is a single part question in which learners need to calculate the direct strain in a cable from given data. The majority of learners who attempted this question performed well although some errors occurred as a result of the lack of accurate conversion of values. Learners who performed less well-made errors when populating the given formula, often transposing values. In some cases, learners did not recognise the meaning of 'delta L' as being the extension of the cable and used a value of 5003 or 5.003 on the top line of the equation.

This response gained 3 marks.

A steel cable of uniform diameter has a length of 5 m.

The cable extends by 3 mm when a load is applied.

10 Calculate the direct strain in the cable.

direct strain $= \varepsilon = \frac{\Delta L}{L}$

~~3mm ÷ 1000 = 0.03 m~~

$3\,mm = 3 \times 10^{-3}\,m$

$\varepsilon = \frac{3 \times 10^{-3}}{5}$

$= 6 \times 10^{-4}$

Answer 6×10^{-4}

In this response the learner has initially converted the extension of the cable into metres. This is shown as an intermediate stage in the working and achieves 1 merit mark. The learner has then substituted values correctly to be awarded the second method mark. The answer is accurate and is awarded the accuracy mark for the final answer.

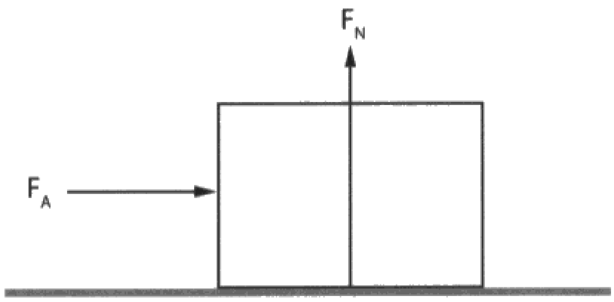
Question 11

This was another example of a question that had two parts, with part (a) requiring learners to calculate the normal reaction force for a load on a horizontal surface, and part (b) the force required to overcome the effects of friction. It was somewhat unexpected that a large proportion of learners made errors with part (a) of the calculation. There appeared to be some misunderstanding amongst learners between mass and weight, with some simply stating a value of 50 as the reaction force, this being the mass of the crate. Credit was also given for the use of the correct unit, although a significant number of learners failed to state the unit in their answer.

For part (b), providing that learners brought forward their answer from part (a), learners were often able to achieve the two marks available if they substituted values correctly and carried out their calculation with accuracy.

Part (a) This response gained 4 marks

A 50 kg packing crate is being pushed along a horizontal surface.



11 (a) Calculate the normal reaction force F_N.

Give your answer in an appropriate unit.

(4)

Force = mass x velocity.

f = 50 x 9.81 = 490.5

Fn = 4905 N

Answer 490. 5 N

Although the learner has stated 'velocity' in their notes as opposed to 'gravity' the correct value has been used in the substitution of values and the calculation completed with accuracy. This allows access to two method marks and one accuracy mark. The learner has also stated their answer with the correct unit, to be awarded a further accuracy mark that is dependent on the numerical answer being given.

Part (b) This response gained 2 marks

50 newtons

(b) Calculate the force (F_A) needed to overcome the effects of friction.

Assume the coefficient of friction μ= 0.3.

(2)

F = μ N

F = 50 × 0.3 = 15 [crossed out]

Answer [crossed out] 15 newtons

The learner has carried forward their incorrect answer from part (a) but has then used this correctly within the formula to calculate the force required to overcome friction. The answer is correct allowing for these incorrect values, therefore both available marks can be awarded to the learner.

Question 12

Question 12 was a further two-part question that in this case assessed understanding and application of conservation of momentum. Part (a) of the question required learners to calculate the time taken for an engine to travel a specified distance at a constant velocity. In many cases learners were correctly able to apply either SUVAT equations or recognise the relationship between time, distance and velocity to arrive at the correct answer and gain all three marks available.

Part (b) proved to be challenging for a large number of learners who attempted to use a range of approaches to complete the calculation. Only a relatively small proportion of learners were able to correctly apply conservation of momentum to the problem, with others trying to arrive at an answer using either conservation of energy or considering ratios of engine and truck involved.

Part (a) This response has gained 3 marks.

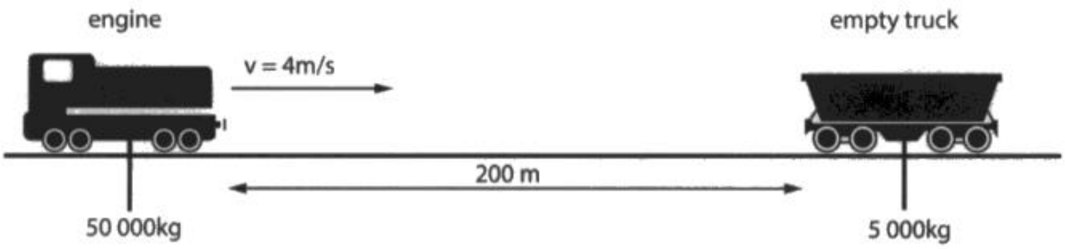

A railway engine travels on a level track at a constant velocity of 4 m/s.
Ignore the effects of friction and wind resistance.

Diagram not to scale

12 (a) Calculate the time taken for the engine to travel 200 m.

(3)

$s = 200m$
$u = 4$
$v = 4$
$a = x$
$t = x$

$200 = \left(\frac{4+4}{2}\right)t$

$200 = 4t$

Answer $t = 50$ secs

The learner has initially written down the values for all the known variables associated with problems involving linear motion. This is good practice as it allows the learner to identify those variables they know and those that they need to determine.

The learner has recognised that the initial and final velocities are the same and has populated the formula to reflect this. Working has been shown in full, and the learner has stated the correct answer for the time taken. The working is clear and concise.

Part (b) This response has gained 5 marks

The engine collides with and couples to the stationary empty truck and continues moving.

(b) Calculate the velocity of the coupled engine and truck just after the collision.

(5)

u = 4 m/s
a = ?
s = 200 m
t = 50 s
v = ?

$(m_1 v_1) + (m_2 v_2) = (m_1 v_1) + (m_c v_1)$

$50000(4) + 5000(0) = 55000 V_1$

$200000 = 55000 V_1$

$\frac{200000}{55000} = V_1$

$3.\dot{6}\dot{3} = V_1 = 3.64 ms^{-1}$

Answer $3.64 ms^{-1}$ (3sf)

The learner has recognised momentum = mass x velocity and the principle of conservation of momentum in the first line of their working. This allows the first two method marks to be awarded. The learner has then substituted the values correctly for the third method mark. The learner has then rearranged the formula in terms of the required velocity which they have identified as V1. The final answer is correct, allowing the final A1 mark to be awarded to the learner. Each stage of the working has been shown in full, this allows access to method marks where arithmetic errors are made at an intermediate stage of the calculation.

Part (b) This response has gained 0 marks

The engine collides with and couples to the stationary empty truck and continues moving.

(b) Calculate the velocity of the coupled engine and truck just after the collision.

(5)

50 000kg = 4m/s

+10% = 55000kg   −10% = 3.6 m/s

Answer 3.6 m/s

This example was typical of a large proportion of learners who followed an inaccurate and unsuitable approach to solving the problem. The learner has recognised that the final mass of the truck and engine is 55 000kg, however considering this to simply be a 10% increase in mass therefore the combined velocity would be reduced by 10% is an over simplification that is not only inaccurate, but also does not reflect the principles of conservation of momentum. No credit can be given for approaches such as this one.

Question 13

As both sections B and C progress, the complexity and demand 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 in order to be able to calculate the work done in raising a mass.

Many learners made errors at various stages of the process, or only provided partial answers. In some cases, learners only calculated the acceleration of the load as it was being raised, or they ignored the effects of gravity when calculating the work done in raising the load. In most cases where learners had a reasonable attempt at the question learners were able to access some of the marks available depending on the stages completed and the accuracy of their working.

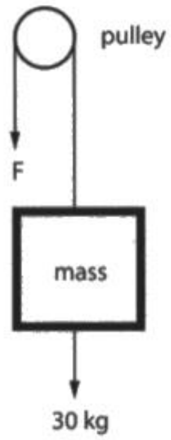
As question 13 is the final question that assesses mechanical principles and is synoptic across the various mechanical topics in the unit content, the question is not scaffolded and learners need to be able to identify and make connections themselves.

This response gained 3 marks

A mass of 30 kg is hoisted vertically by a rope running over a pulley.

The mass accelerates with an initial velocity of 2 m/s to a final velocity of 3 m/s when travelling through a distance of 5 m.

Ignore the effects of friction.



↑ $a = 0{\cdot}5ms^{-2}$

13 Calculate the work done in raising the mass.

$s = 5m$

$u = 2ms^{-1}$

$v = 3ms^{-1}$

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

$3^2 = 2^2 + 10a$

$9 = 4 + 10a$

$5 = 10a$

$a = \frac{1}{2}$

$F = ma$

$F = 30 \times 0{\cdot}5$

$F = 15N$

The learner has correctly calculated the acceleration of the mass by applying the correct SUVAT equation. This stage of the calculation has been awarded 3 marks. The learner has recognised that the force due to acceleration for the mass needs to be considered, however they have not included the force required to overcome the effects of gravity. No working has been presented with regards to calculating work done, therefore the learner cannot be awarded any further marks.

This response gained 8 marks.

13 Calculate the work done in raising the mass.

$W = Fs$

$u = 2$
$v = 3$
$s = 5$

$v^2 = u^2 + 2as$
$3^2 = 2^2 + 10a$
$a = \frac{1}{2}\ ms^{-2}$

$W = mg$
$30 \times 9.81 = 294.3N$

$F = ma = 30 \times \frac{1}{2} = 15N$

$W = 15 \times 5 = 75J$

$294.3 \times 5 = 1471.5J$

$1471.5 + 75 = 1546.5J$

Answer

1546.5J

This learner has indicated each of the various formulae that they will use within their working before populating them with values; this is good practice and allows the examiners to confirm that the correct calculation is being performed at each stage.

The learner has correctly calculated the acceleration of the load as it is being raised and has stated the answer with accuracy. The learner has recognised that the work done relates to both the weight of the mass and also the force due to acceleration. The learner has calculated the work done with respect to each of these forces and has added these together to reach the total. All working is accurate, and the correct unit stated. The learner has achieved full marks for this question.

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 able to interpret the waveform and recognise that the feature labelled was the amplitude.

Question 15

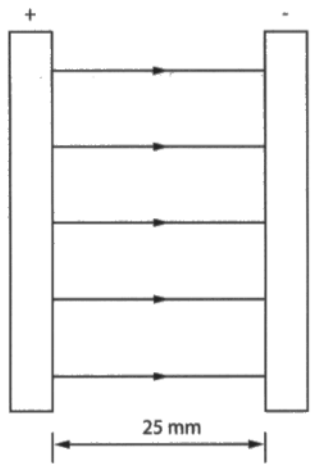
This was a further multiple choice question although learners performed less well on this particular question. Although a significant number of learners identified reluctance as the correct answer, it is clear that the other options were plausible for many learners who selected alternative options.

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 not completing the required unit conversions. 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 to convert between units.

This response has gained 2 marks.

The potential difference between two parallel plates is 75 kV.



16 Calculate the uniform electric field strength between the two plates.

Give your answer in an appropriate unit.

$E = \frac{F}{q}$ or $E = \frac{V}{d}$

$\frac{75}{25} = 3$

The learner has written out the formula they intend to use before populating it. As indicated above, this is good practice and allows the examiner to understand where values have come from. The learner has not completed unit conversions for either the plate spacing or the potential difference. They have however populated the formula using the values given in the question and arrived at a numerically correct answer. This allows one method and one accuracy mark to be awarded. No unit has been stated in the answer, therefore the final accuracy mark for the unit is not awarded.

Question 17

Question 17 was a short written question where learners needed to state one factor that affects the electrical resistance of a conductor. Factors that affect resistance are listed in the specification under topic E1, and many learners were able recall one of these and present these as their answer. A range of other appropriate factors were stated by learners such as the purity of the metal, however many stated incorrect answers that related to external factors such as the amount of power supplied to the circuit.

This example gained 0 marks

17 State **one** factor that affects the electrical resistance of a conductor.

The amount of voltage or current going through a circuit.

This answer was typical of many learners who stated external factors. Although increased current could cause a temperature change in the conductor and then potentially affect the resistance, it is the change in temperature that is the factor rather than the increasing current. As such, answers linking current or voltage to the resistance achieved no marks.

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 ect... 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.

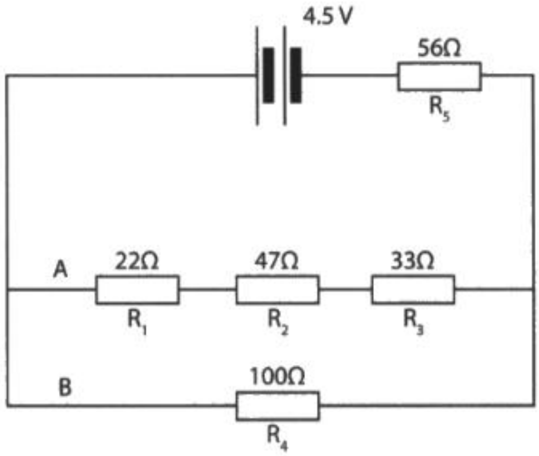
Question 19

Learners performed variably for the two parts of this question. Some learners continue to have difficulties interpreting electronic circuit diagrams or recognising the correct approach to take for resistors in a series or parallel arrangement.

As with other multi-part questions learners were awarded marks in part (b) that took into account incorrect working for part (a). Those learners who failed to score full marks for parts of questions tended to make errors in their working such as using an incorrect approach for the series resistors, incomplete working or making arithmetic errors. For part (a) it was disappointing to see learners add together all of the resistance values shown on the diagram, or to treat them in the same way as parallel resistors. As one of the underpinning principles for electronic circuits, it would be expected that learners would achieve better marks for this part of the question than they did. For part (b) learners often recognised the resistors were in parallel, but did not complete working in full or they made errors such as considering the 56 Ohm resistor as also being on a parallel branch.

Part (a) This response gained 2 marks.

A resistor network has been constructed for testing.



18 (a) Calculate the total resistance of branch A of the circuit.

(2)

$R_T = R_1 + R_2 + R_3$

$= 22\Omega + 47\Omega + 33\Omega$

$= 102\Omega$

Answer $102\ \Omega$

This learner has recognised that the resistors are in series and has correctly substituted values to arrive at the correct answer. The working is shown clearly and the learner has presented each stage of the calculation in full. It is always good practice to show each stage of a calculation, even when the process being followed is a routine operation.

Part (b) This response gained 3 marks.

(b) Calculate the total resistance of the network. **(4)**

$\left(\frac{1}{R_1} + \frac{1}{R_2}\right)$ $\frac{1}{102} + \frac{1}{100} = 0.0198$

$56 + 0.0198$

Answer $50.0198\,\Omega$

The learner has been awarded one method mark for the correct substitution of values for the parallel branches. This has however not been rearranged, hence the mark for this process has not been awarded.

One accuracy mark has been awarded for the final answer for the total resistance in the circuit, considering follow through from not completing the calculation for the parallel branches in full.

Question 19

Question 19 was the final written response on the examination. The focus of the question was to assess learners understanding of one of the theories in topic G1, full wave rectification. As has been indicated above for both questions 8 and 17, learners have generally found these open written response questions to be more challenging than some of the calculations. It is important that learners are able to not only apply concepts to complete calculations, but also demonstrate their understanding of the principles listed in the specification.

Although a proportion of learners were able to achieve marks for their answers to this question, a far greater proportion either did not answer the question or did not understand the concept involved.

This response gained 2 marks.

19 Explain the effects of full wave rectification on an alternating current supply.

Converts an AC supply of current into a single DC current through the use of multiple diodes.

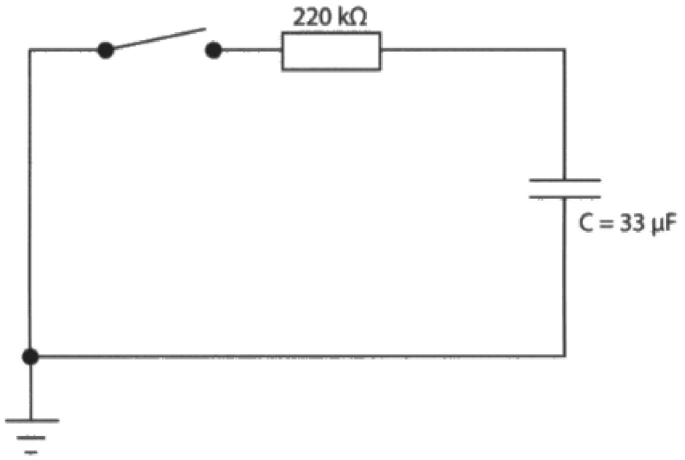
In this response the learner has recognised the effect of full wave rectification, namely the conversion of an alternating supply to direct current. This achieves one mark. A further mark has been awarded for the expansion that makes reference to the use of diodes.

Question 20

Learners generally performed well for the first part of this question, with a large number being able to select the correct formula to calculate the time constant of the capacitor. Where learners failed to achieve the three marks available, this often resulted from the lack of unit conversions for the resistor or capacitor. Answers from part (a) were then carried forward to part (b) and learners often accessed the three marks for part (b) despite making errors in part (a). It was encouraging that learners were able to correctly populate given formulae for both parts of this question.

Part (a) this response gained 2 marks.

A fully charged capacitor is discharged through a resistor when the switch is closed.



20 (a) Calculate the time constant for the capacitor.

(3)

$R = 220 \times 10^3$ $\tau = RC$

$(220 \times 10^3) \times 33$

$\tau = 7260000$

Answer 7.26×10^6

The learner has been awarded both of the method marks available for this question. One mark has been awarded for the unit conversion for the resistance, and the substitution of values in to the correct formula. As with question 9 this was an example of a 'correct answer only' question, therefore the final accuracy mark is not awarded because the learner has not converted the capacitance in to Farads.

Part (b) this response gained 3 marks.

Answer 7260hF

When the switch is closed the capacitor begins to discharge. When t = 0, the voltage across the capacitor is 12 v.

(b) Calculate the voltage across the capacitor after 20 seconds.

(3)

$V_c = V_s e^{(-\frac{t}{T})}$

$V_c = 12 e^{(\frac{-20}{726})} = 12$

Answer 11.97V

In this response the learner has incorrectly calculated the time constant in part (a). The learner has however carried this incorrect value forward and correctly substituted this into the formula for voltage decay. This is awarded one method mark. The learner has then correctly calculated the value of the exponential part of the formula for a further method mark. The final answer is arithmetically correct based on the values used by the learner, therefore the final accuracy mark can be awarded.

Question 21

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 required to create the given magnetic flux.

Many learners were able to achieve the earlier marks in the question by calculating the value of B, the flux density. Where marks were lost at this stage, it was as a result of not converting to webers. Many learners achieved 2 or 3 marks for this part of the calculation.

The next stage involved interpreting the BH chart to read off the value of the magnetic field strength (H). Due to the scale of the chart, a range of values was acceptable here and learners gained credit providing they gave an answer within this range.

The latter stages of the calculation were more complicated and required learners to recognise the relationship between magnetic field strength, the number of turns in the coil and the current. A significant proportion of learners completed the whole of the question to achieve full marks.

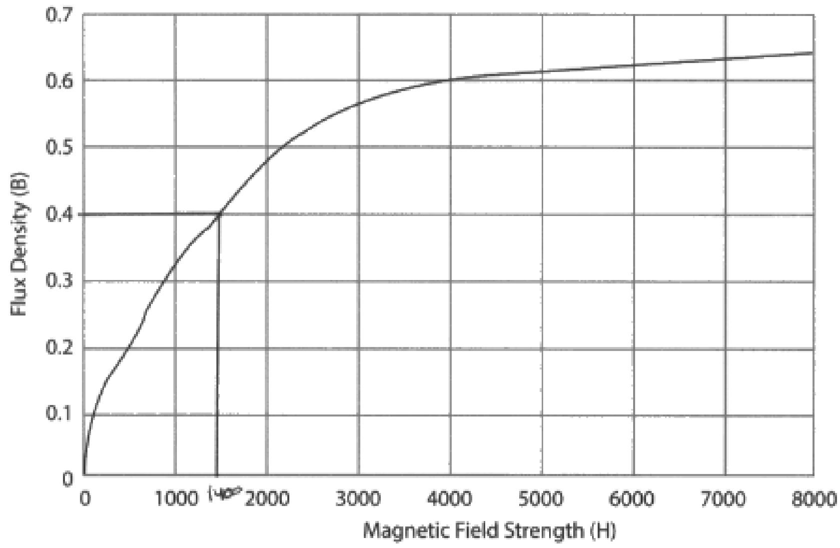
As with other questions, learners were given credit for the stages of the calculation where they performed well, and as with other questions on the paper, a 'follow through' approach was taken to prevent further penalties for errors or omissions in early stages of the calculation.

This response gained 8 marks

A coil of 300 turns is wound around a steel core.

The coil has a length of 0.9 m and a cross sectional area of 250 x 10^{-6} m^2.

A BH curve has been produced using the results from experiments.



21 Calculate the current required to create a magnetic flux (Φ) of 0.1mWb in the core.

$B = \frac{0.1 \times 10^{-3}}{250 \times 10^{-6}}$ $\qquad H = \frac{NI}{L}$

$B = 0.4T$ $\qquad I = \frac{HL}{N}$

$H = 1400$ $\qquad I = \frac{1400 \times 0.4}{300}$

$I = 4.2A$

Answer 4.2 Amps

The learner has achieved all of the marks available for finding the value of B during the first stage of the calculation. The learner has then interpreted the BH curve and arrived at a value of 1400 H for the magnetic field strength. This was within the acceptable range for values, and a further mark has been awarded. The learner has then carried out each of the subsequent stages of the calculation correctly and has arrived at an answer for the current that is correct using their value of H (1400).

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 could still be awarded
- Show the formulae that are being used, this can allow examiners to check the correct substitutions have been made.
- Practice rearranging and manipulating 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 situations.
- 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.

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