BTEC

L3 Lead Examiner Report 2001

January 2020

L3 Qualification in Engineering

Unit 1: Engineering Principles

31706H

Pearson

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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			
		N	P	M	D
Boundary Mark	0	9	18	38	59

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Introduction

This was the sixth 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.
Centres are reminded that although the paper is always of the same structure, the nature of questions in each section will differ from one series to the next. It is important therefore 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 electrical/electronic and mechanical principles being assessed; credit is awarded for the correct unit in some question in a similar way that identifying appropriate approaches is rewarded 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 a linked response being required for the explain question. A small number of questions were multiple choice for which learners had to select the correct answer from a range of four alternative options.

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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, applying the laws of logarithms, producing vector diagrams and capacitors in series. 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 very high marks overall 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 was stated in isolation as their answer to a question - an incorrect answer in this situation would achieve zero marks. 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 presented, this was a result of learners showing their working clearly and logically. A number of learners annotated their working to explain what each stage was; 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 answers 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 the sample assessment materials.

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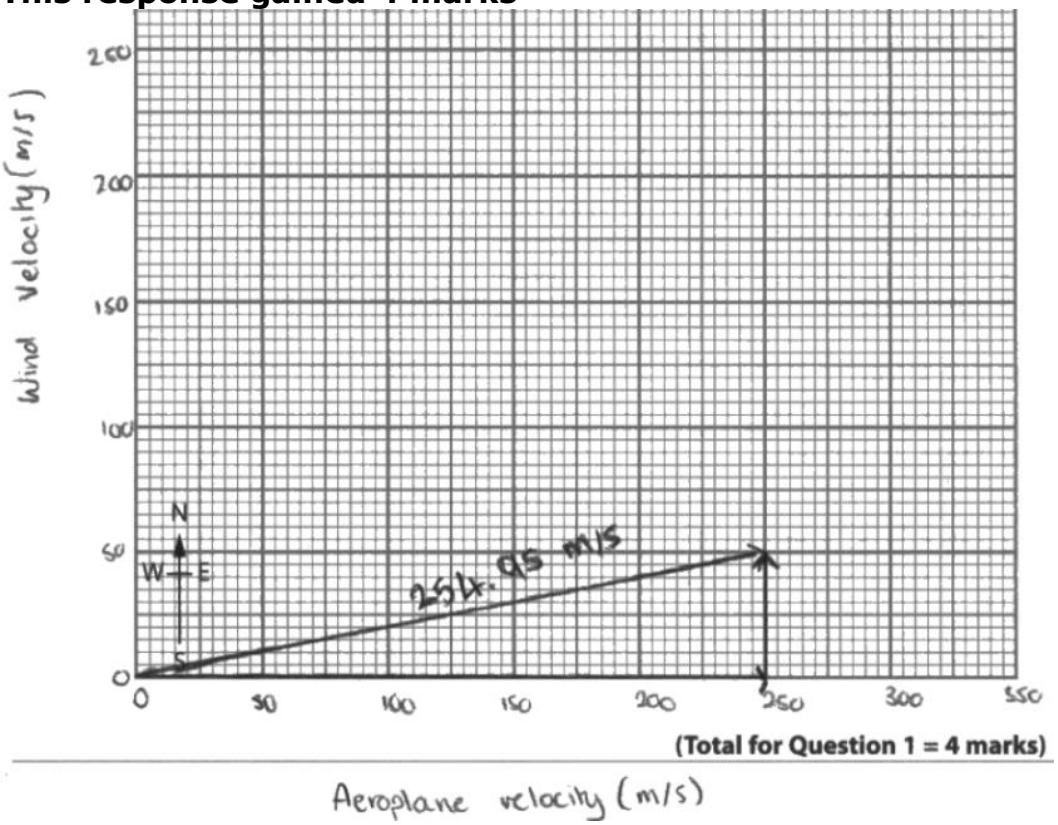
Individual Questions

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 understanding of how to construct vector diagrams. Most learners were able to plot the two vectors and identify their magnitude on the diagram. Where learners did not achieve full marks, the reasons were the omission of labels for the two vectors, one or both of the vectors being plotted inaccurately or the resultant velocity vector being omitted. A significant number of learners plotted diagrams that were very small, rather than making best use of the space available.

This response gained 4 marks



(Total for Question 1 = 4 marks)

In this response the learner has included both axes with appropriate values to the same scale, both of which are labelled (note that wind velocity and aeroplane velocity are acceptable as they are in context). Both of the North and East vectors have been plotted accurately to scale, and there is also accurate plotting of the resultant velocity. The scale used is appropriate for the magnitude of the two vectors.

`

Question 2

This question was a single part question where learners needed to perform a calculation to determine the volume of a cone. On the whole, learners performed well on this question, and tended to show working in full. Some learners converted the dimensions into centimetres, whilst others calculated the volume using metres; both were accepted. Where learners made errors, this was either due to not converting the diameter into a radius or incorrect substitution of values.

This response gained 2 marks

2 The diagram shows a cone that is used to provide a reference line.

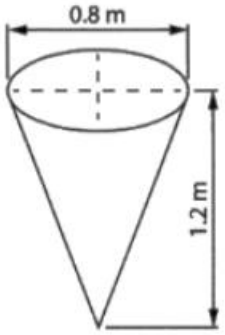


Diagram not to scale

Calculate the volume of the cone.

$V = \frac{1}{3}\pi r^2 h$

$\frac{1}{3} \times \pi \times 0.4 \times 1.2$

$V = 0.5026$

This response achieves two marks. The learner has correctly converted the diameter into a radius. No mark can be awarded for the substitution of values as the radius (0.4m) has not been squared. The final mark for the answer for V can however be awarded allowing follow through from the incorrect substitution of values in the previous step.

Question 3

This question was answered well by a large proportion of learners, however there was a significant minority that were unable to identify that the question could be answered using the tangent ratio. A range of approaches were seen, including the use of the sine rule which was applied with some success, or calculating the length of the hypotenuse of the triangle using either sine or cosine and then attempting to use Pythagoras' Theorem to calculate the height. The latter approaches were often unsuccessful as learners made errors in rearranging expressions and inaccurate substitution. Where learners had made some progress, method marks were often awarded.

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This response has gained 4 marks.

3 A helicopter takes off vertically from the ground and is stationary at point A.

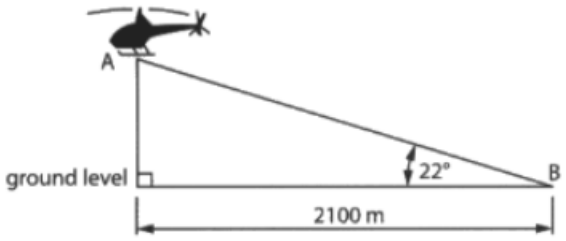
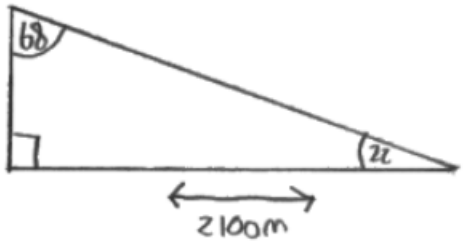


Diagram not to scale

The helicopter is observed from point B.

Calculate the height above ground level of the helicopter at point A.



$\frac{c}{\sin C} = \frac{a}{\sin A}$

$\frac{2100}{\sin 68} = \frac{a}{\sin 22} = 2264.92$

$\frac{a}{\sin 22} = 2264$

$a = \sin 22 \times$

$= 848.465$

Answer: 848.46 m

The learner has recognising the sine rule can be used to answer the question and has also included a diagram showing all known information. The correct substitution of values has been completed, and then the expressions corrected rearranged in terms of 'a'. The answer for 'a' is correct, therefore full marks are awarded,

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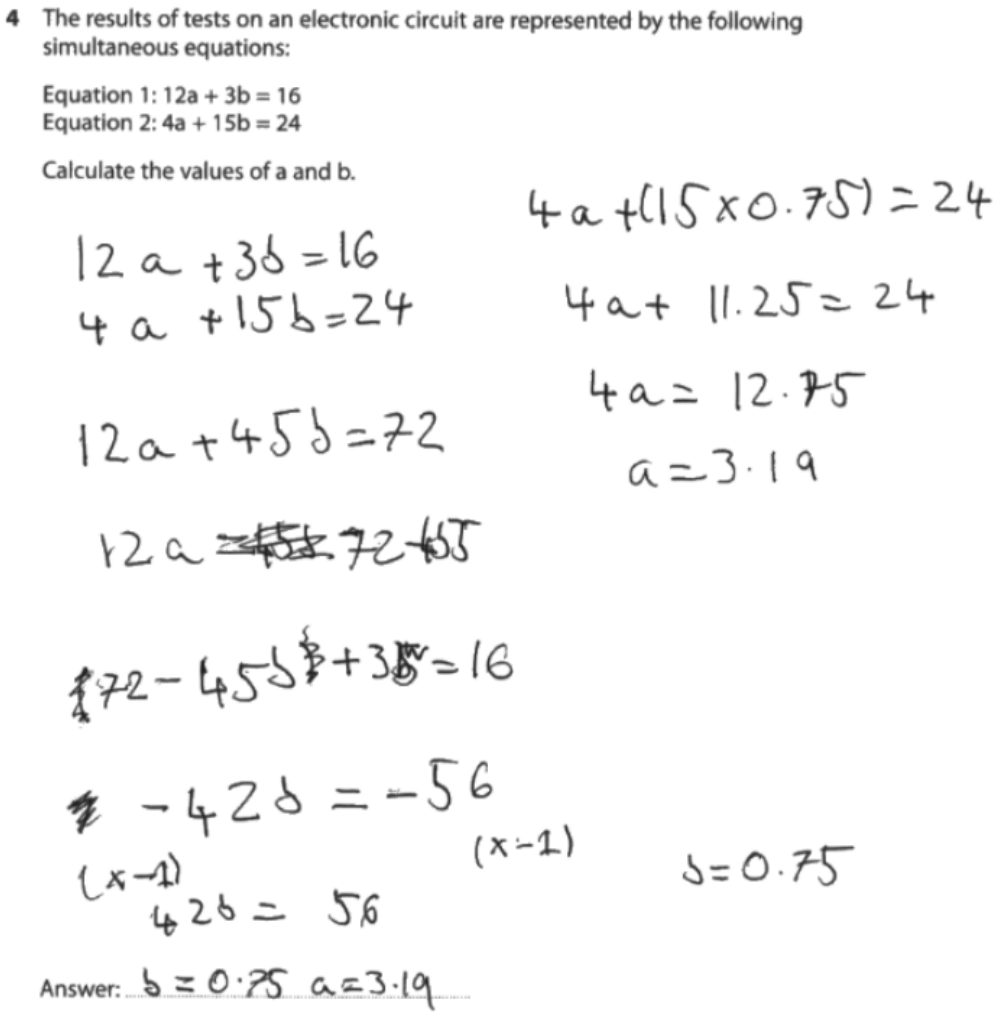
Question 4

Learners performed with varying degrees of success on this question with a large proportion of learners being able achieve some marks for multiplying one or both of the equations by appropriate values. In many cases learners selected and used an elimination method, although a small number of candidates followed a substitution approach. Where learners did not achieve full marks this was often due to arithmetic errors when multiplying equations, rearranging errors or arithmetic errors when working through the various stages of the calculations.

This response gained 3 marks.



The learner has been awarded one mark for multiplying the equation 2 by 3, and a further mark for the subtraction of equation 1 from equation 3. The working is then inaccurate; therefore no mark can be awarded for the value for 'b'. One mark can however be awarded for the value for 'a' allowing follow through when the calculated value of 'b' is substituted into equation 2.

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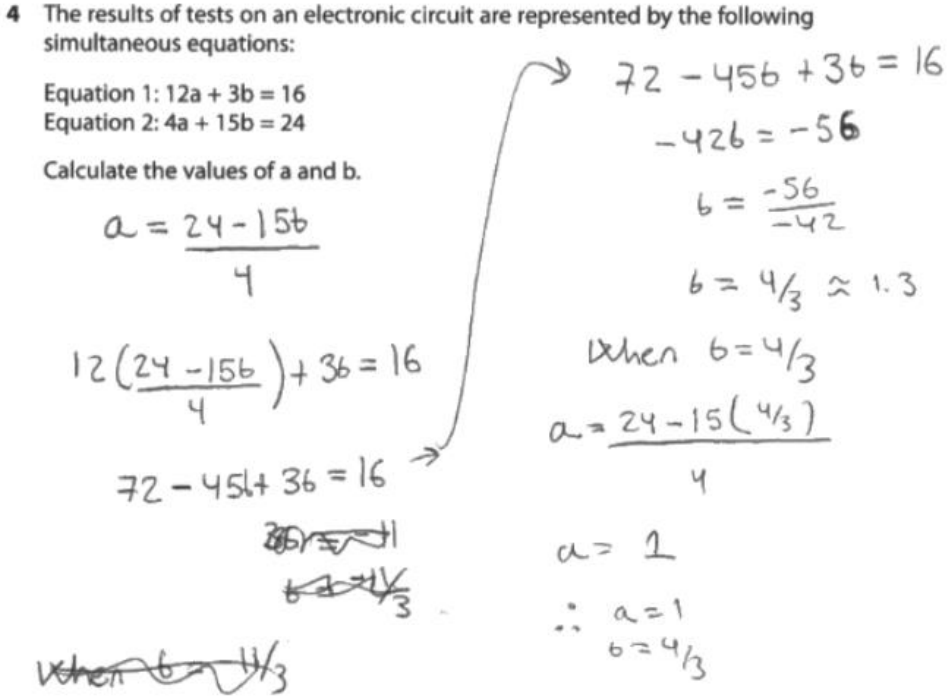
This response gained 4 marks.



The learner has used the alternative approach that involves substituting an expression for 'a' into the first equation. This is a viable alternative approach and has resulted in both values for 'a' and 'b' being correct, therefore full marks can be awarded. Note that answers in the form of fractions are acceptable.

Question 5

Learners performed with limited success on this question with marks being awarded mostly at the lower end of the range, although a number of learners achieved full marks. Learners often did not rearrange the expression algebraically at the first stage, or they did not apply laws of logarithms with accuracy. A limited number of learners recognised that ln'e'=0. As a two part question, learners needed to take forward the expression for 'h' and substitute values in to arrive at the answer for part (b). Part (b) was 'correct answer only' therefore an incorrect expression from (a) could not be carried forward to achieve marks.

This response gained 3 marks for part (a) and 1 mark for part (b)

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5 Air pressure is represented by the formula:

$$P = P_0 e^{\frac{h}{k}}$$

where P is the pressure at height h and P_0 is the air pressure at sea level.

(a) Simplify the formula using logarithms and make h the subject of the formula. **(4)**

$\log P = \log P_0 + \log e^{\frac{h}{k}}$

$\log P = \log P_0 + \frac{h}{k}\log e$

$\log P - \log P_0 = \frac{h}{k}\log e$

$\log \frac{P}{P_0} = \frac{h}{k}\log e$

$\frac{h}{k} = \frac{\log \frac{P}{P_0}}{\log e}$

$h = \left(\frac{\log \frac{P}{P_0}}{\log e}\right)k \quad h = \frac{\log \frac{P}{P_0}}{\log e}k$

Answer: $h = \left(\frac{\log \frac{P}{P_0}}{\log e}\right)k$

(b) Calculate the value of h when $P = 70 \times 10^3$ Pa, $P_0 = 100 \times 10^3$ Pa, and $k = -8150$ **(1)**

$h = \frac{\log \frac{70 \times 10^3}{100 \times 10^3}}{\log e} \times -8150$

$h = 2906.9$

This learner has correctly rearranged the expression in terms of 'e', and has then correctly applied the laws of logarithms throughout - both ln or log being acceptable at this stage. The learner has not recognised that ln(e)=1, therefore no mark is awarded for this, however they have correctly rearranged in terms of h; the final mark can be awarded allowing follow through for not recognising ln(e) = 1. For part (b) the correct answer for 'h' has been stated to achieve 1 mark.

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 one method that can be used to find the density of a material. A significant proportion of learners correctly identified Archimedes' Principle.

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Question 7
Learner performance on this multiple choice question was similar when compared to that seen for question 6. A significant proportion of learners identified Newtons per metre squared as the unit of measure for shear stress.

Question 8

Question 8 was the first calculation in Section B and was related to linear motion. Questions that have included some aspects of linear motion or constant acceleration have been a common feature of previous examinations. It was therefore somewhat surprising that a significant number of learners made errors in their calculations either for part (a) or part (b). Often this due to assuming values from the question in part (b), such as the time was again 8 seconds, or incorrectly substituting values, for example taking 'u' as 4 m/s in part (a) rather than zero. One mark was available in part (b) for the correct unit, this being dependent on the correct numerical answer being stated.

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 2 marks for part (a) and 4 mark for part (b)

8 A car is on a road with a set of traffic lights ahead.

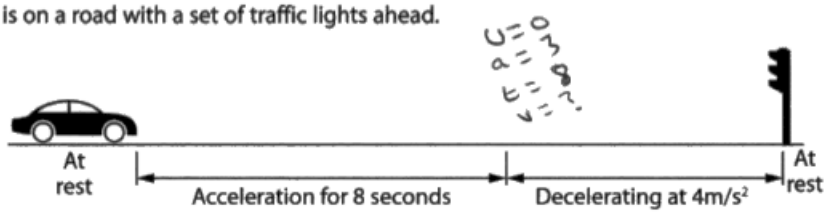


Diagram not to scale

The car starts from rest. The car then accelerates at a constant rate of 3 m/s² for 8 seconds.

(a) Calculate the velocity of the car after 8 seconds.

(2)

$v = u + at$

~~$v = 0$~~ $v = 0 + 3 \times 8$

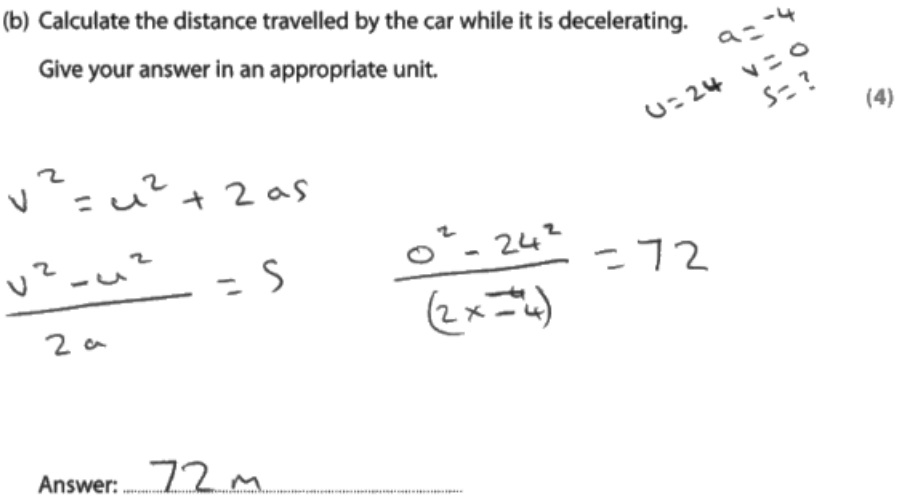
Answer: ~~24 m/s~~ 24 m/s

`

The car then decelerates at a constant rate of 4 m/s² and stops at the traffic lights.

(b) Calculate the distance travelled by the car while it is decelerating.

Give your answer in an appropriate unit. (4)



Answer: 72 m

In this example the learner has identified the correct approach in both parts of the question. The correct values have been used by the learner for both part (a) and part (b) of the question, with the value from (a) being used correctly for part (b). The learner has correctly calculated the time taken to decelerate and has used this to determine the distance travelled whilst decelerating. The correct unit has been stated, hence full marks are awarded.

Question 9

This question was another multi-part calculation in the mechanical principles section of the paper. The question assesses an aspect of the specification that has not been covered previously, namely angular velocity. The first part focussed on calculating the angular velocity of the bicycle wheel, with Part (b) then required learners to apply this value to calculate the centripetal acceleration of the wheel.

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 angular velocity as a common error amongst learners was to calculate the tangential velocity of the wheel. In some instances this was applied appropriately in part (b) to calculate the correct value of centripetal acceleration. A common mistake amongst learners was to not convert from revolutions per minute to revolutions per second, and to misinterpret the radius of the wheel.

For part (b) some learners used the correct approach but with incorrect values from part (a). This resulted in follow through marks being available, although a large number of learners used v^2/r which achieved no marks.

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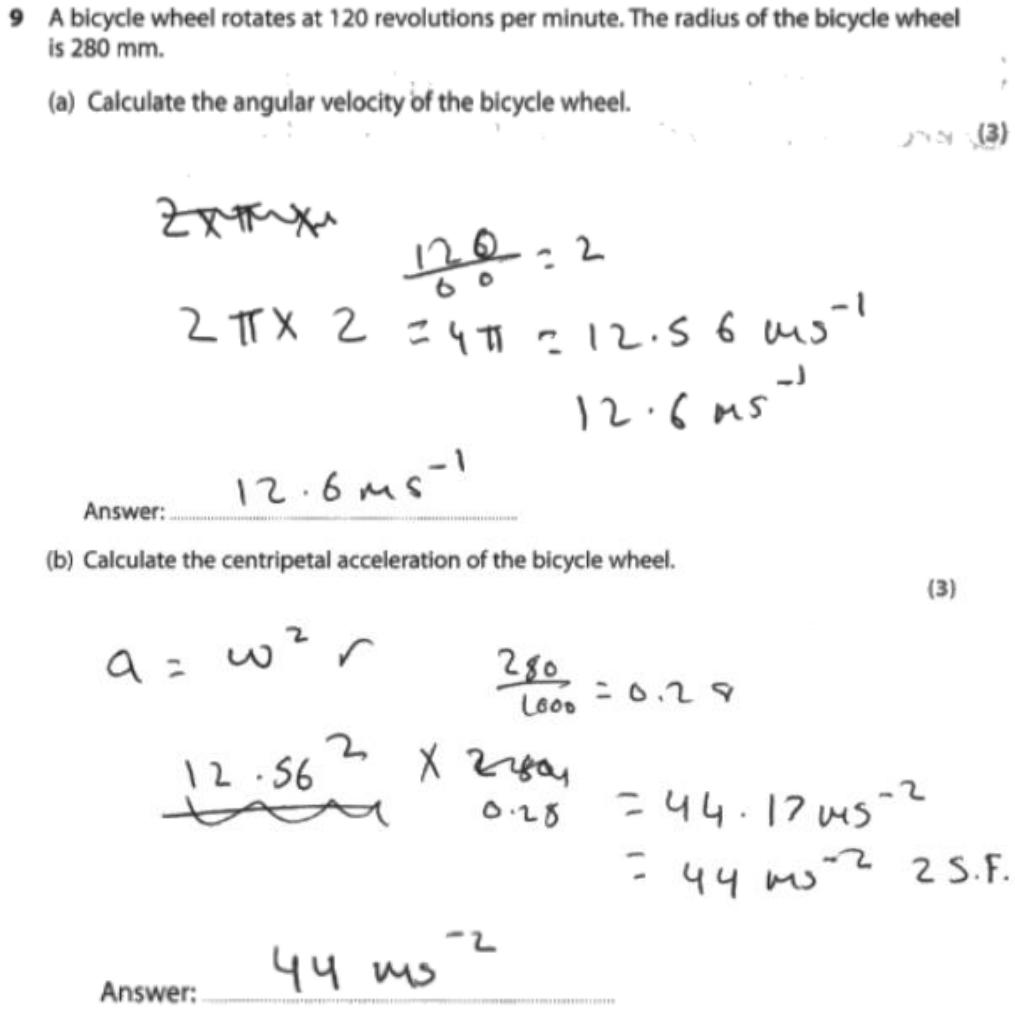
This response gained 3 marks for part (a) and 3 mark for part (b)



9 A bicycle wheel rotates at 120 revolutions per minute. The radius of the bicycle wheel is 280 mm.

(a) Calculate the angular velocity of the bicycle wheel.

(3)

$\frac{120}{60} = 2$

$2\pi \times 2 = 4\pi = 12.56 \text{ ms}^{-1}$

12.6 ms^{-1}

Answer: 12.6 ms^{-1}

(b) Calculate the centripetal acceleration of the bicycle wheel.

(3)

$a = \omega^2 r$ $\frac{280}{1000} = 0.28$

$\frac{12.56^2}{0.28} \times$ $= 44.17 \text{ ms}^{-2}$

$= 44 \text{ ms}^{-2}$ 2 S.F.

Answer: 44 ms^{-2}

In part (a) the learner has interpreted the written information and the correct values have been substituted in to the correct formula, and an accurate answer given. They have correctly converted from RPM to RPS and then converted revolutions per second into radians.
In part (b) they have correctly converted from mm to m and then substituted values. The answer is correct, therefore full marks are awardable.

This response gained 0 marks for part (a) and 3 mark for part (b)

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9 A bicycle wheel rotates at 120 revolutions per minute. The radius of the bicycle wheel is 280 mm.

(a) Calculate the angular velocity of the bicycle wheel.

(3)

Circumference x revolutions x time.

$2\pi r \times 120 \times 1\text{min}(60\text{sec})^2$.

(πd).

$r = 280\text{mm}$

$d = 280 \times 2 = 560\text{mm}$.

$\pi 560 \times 120 \times 1^2$.

$560\text{mm} = 0.56\text{m}$.

$= 67200\pi\ \text{mm}/1\text{min}^2(60\text{sec})$.

$= 211115.0263\ \text{mm}/60\text{sec}^2$.

$\times 1000$.

Or. $211\text{m}/60\text{s}^2$

$\div 60 = 3.52\ 2\text{dp}\ \text{m/s}^2$

Answer: 3.52 m/s².

(b) Calculate the centripetal acceleration of the bicycle wheel.

(3)

$a = \omega^2 r$ OR $a = \frac{v^2}{r}$

$a = 94.25\ (2\text{dp})$

44.25m/s^2.

$v = 3.52\text{m/s}^2$.

$r = 280\text{mm}$ or 0.28m.

have to use as velocity in meters.

$a = \frac{3.52^2}{0.28}$

$a = \frac{12.3904}{0.28}$

Answer: 44.25 m/s².

The learner has calculated the tangential velocity in part (a). Although the value is correct, no marks are awarded. This value is then used in an appropriate formula in part (b) to correctly determine the centripetal acceleration. This can be awarded three marks as the answer is correct. The learner has provided some annotations on their work to explain stages, which is good practice.

`

Question 10

Question 10 is a short open written response question with learner being asked to explain what is meant by the term 'non-concurrent forces. The majority of learners who attempted this question could identify a factor, generally that they do not act on the same point. There were however many misconceptions, and answers were often not expanded on with an extension or justification.

This response gained 1 mark.

10 Explain what is meant by the term non-concurrent forces.

Forces that do not all occur from the same point. So they are not in equilibrium

In this response the learner has identified that the forces do not all occur from the same point, however the expansion lacks accuracy as non-concurrent forces may be in equilibrium.

Question 11

This was another example of a question that had more than one stage 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 early stages, often not recognising the correct angle to use when dividing the force in to its two components. the first stage of the calculation. Other aspects where learners made mistakes included multiplying the given force by 9.81, assuming that the given value was a mass, or selecting an inappropriate trigonometric function.

This response gained 5 marks

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11 A packing crate is placed onto an inclined plane. The inclined plane is friction free.

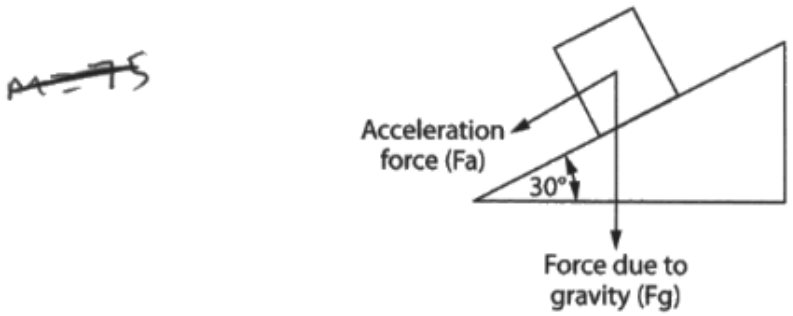

Diagram not to scale

The force due to gravity (Fg) acting on the crate is 75 N.

Calculate the acceleration force (Fa) acting to move the crate down the slope.

force on incline = mg Sin θ

75 x Sin30 = 37.5 N

The learner has shown their working clearly and concisely, with some stages being omitted or implied in the working. The final answer is correct, hence full marks can be awarded.

`

Question 12

As the final question in Section B, Question 12 draws together a number of concepts. In this example this included areas of circles and continuity of flow. A significant number of learners correctly calculated the inlet area of the pipe, although some assumed the value in the question was the area and carried this value forward in calculations. As is often the case, learners did not convert from millimetres to metres in a large number of cases.

A range of approaches were taken to calculate the volumetric flow rate, often using incorrect values or ones drawn directly from the stem of the question. The final step, where learners applied the relationship the capacity of the container and the volumetric flow rate. A number of learners cubed the volume of the container, however some marks could often be awarded by applying a follow through approach for errors in working.

This response gained 9 marks

12 A storage tank has a capacity of 18 m^3.

The tank is filled with water through a gradually tapering pipe that runs full.

The inlet diameter of the pipe is 50 mm and the outlet diameter is 30 mm.

Assume the water enters the pipe with a velocity of 2 m/s and that the tank is empty.

Calculate the time taken (in seconds) for the tank to fill.

In this example, the learner has completed each stage of the calculation. They have used the correct values for areas, and calculated the outlet velocity. This has been used to then calculate the volumetric flow rate and this the time to fill the container. The working is concise, but shows all stages.

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This response achieves 5 marks

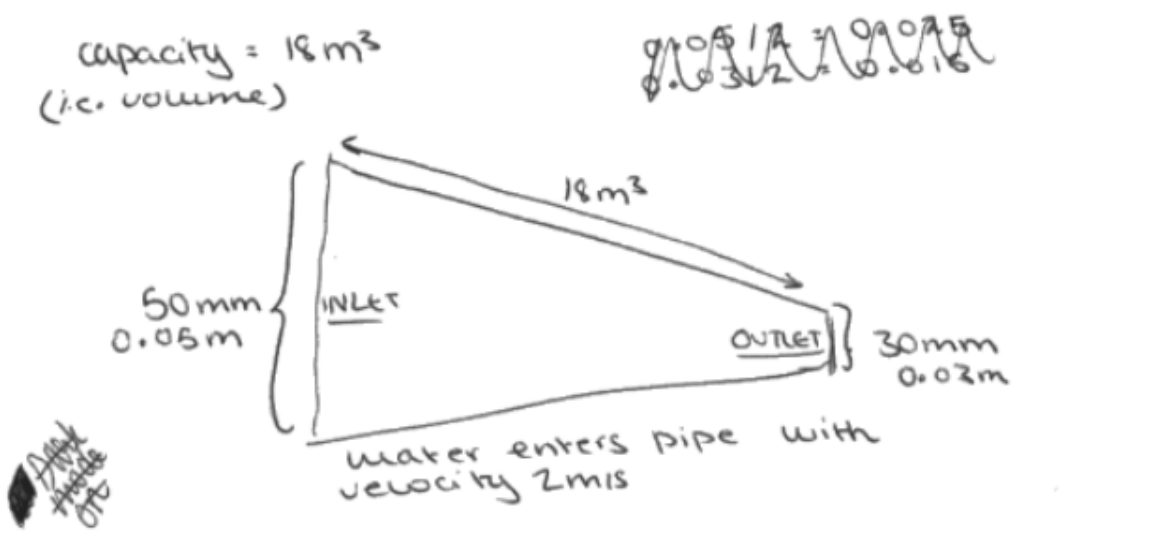
12 A storage tank has a capacity of 18 m³.

The tank is filled with water through a gradually tapering pipe that runs full.

The inlet diameter of the pipe is 50 mm and the outlet diameter is 30 mm.

Assume the water enters the pipe with a velocity of 2 m/s and that the tank is empty.

Calculate the time taken (in seconds) for the tank to fill. distance / time



INLET AREA = $\pi(50 \div 2)^2 = 625\pi$ mm² = 0.001963 m²

OUTLET AREA = $\pi(30 \div 2)^2 = 225\pi$ mm² = 0.000 7069 m²

$A_1V_1 = A_2V_2$

$\frac{0.001963 \times 2}{0.000707} = V^2 \rightarrow V_2 = 5.55$ m/s

water starts moving at 2 m/s
then ends up moving at 5.55 m/s

$s = ?$
$u = 2$
$v = 5.5$
$a = 11$
$t = ?$

$v = u + at$
$5.5 = 2 + (11)t$
$5.5 - 2 = 11t \rightarrow \frac{5.5 - 2}{11} = 0.318$

Answer: 0.318 seconds

In this example the learner has correctly calculated the inlet area, allowing three marks to be awarded. The second part of the working includes recognition of flow rate and correct substitution of values, however no value has been stated for the flow rate. Two further marks are awarded. Further working then uses an inappropriate approach (linear motion), therefore no additional marks can be awarded.

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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 the unit of electrical power is Watt.

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 that capacitance is the property of a material that allows it to store electrical energy in an electric field, a large proportion stated permittivity as their answer.

Question15

Learners responded well to this open response question. Many correctly identified a suitable use of a circuit that uses a variable resistor, with dimmer switches, volume controllers and motor controls being common answers.

Question16

The majority of learners found question 16 to be accessible with a large proportion being able to achieve at least one mark. Learners again often tended to treat the series capacitors in the same was as they would resistors and simply added values together. s. Where learners did not achieve full marks this was often as a result of not taking the inverse of the value of 0.138 to calculate the correct value of total capacitance. This is a type of question that has been asked previously, and it is unfortunate that learners are still making errors with regards to concepts that should be familiar and where the formulae needed is listed in the information booklet.

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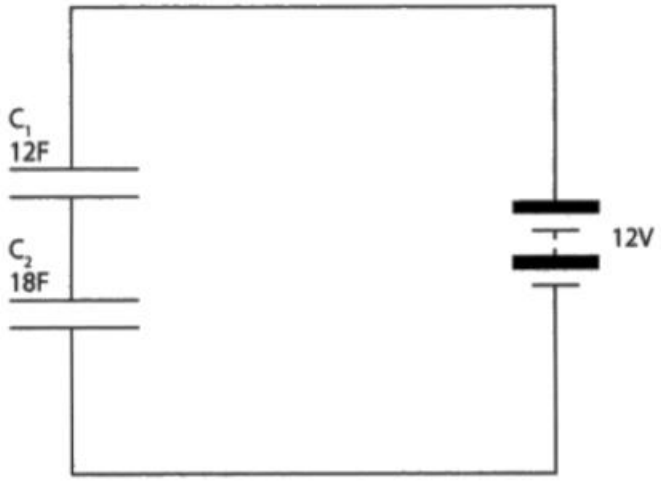
This response has gained 1 mark.

16 A DC power source is connected to two capacitors in a series network.



Calculate the total capacitance of the two capacitors.

$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$

$\frac{1}{12} + \frac{1}{18} = \frac{36}{5} = 0.138$

Answer: 0.138

The learner identified the correct formula to use and has populated this correctly. They have also stated the correct answer for 1/Ct. They have not however rearranged the answer or given the correct answer for total capacitance. This limits their achievement to 1 mark.

Question17

Question 17 was a two part calculation which assessed learners understanding of processes and procedures related to charge flow and resistance of materials. The first part of the question was an area of the specification that had not previously been assessed, and learners had some success in calculating the current in the conductor.. 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). It was however somewhat disappointing that a large number of learners were not familiar with Ohm's Law, or that they were unable to correctly manipulate the given formula to make resistance the subject of the formula.

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This response gained 0 marks for part (a) and 3 mark for part (b)

17 A conductor is connected to a 12V DC supply. A charge of 36 coulombs (C) passes along the conductor in 24 seconds.

(a) Calculate the current in the conductor.

(2)

$Q = V I t$

$I = \frac{Q}{V \times t}$

$\frac{36}{12 \times 24} = \frac{1}{8} = 0.125$

$I = 0.125$

Answer: 0.125

(b) Calculate the resistance of the conductor.

(3)

$V = I \times R$

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

$\frac{12}{0.125} = R$

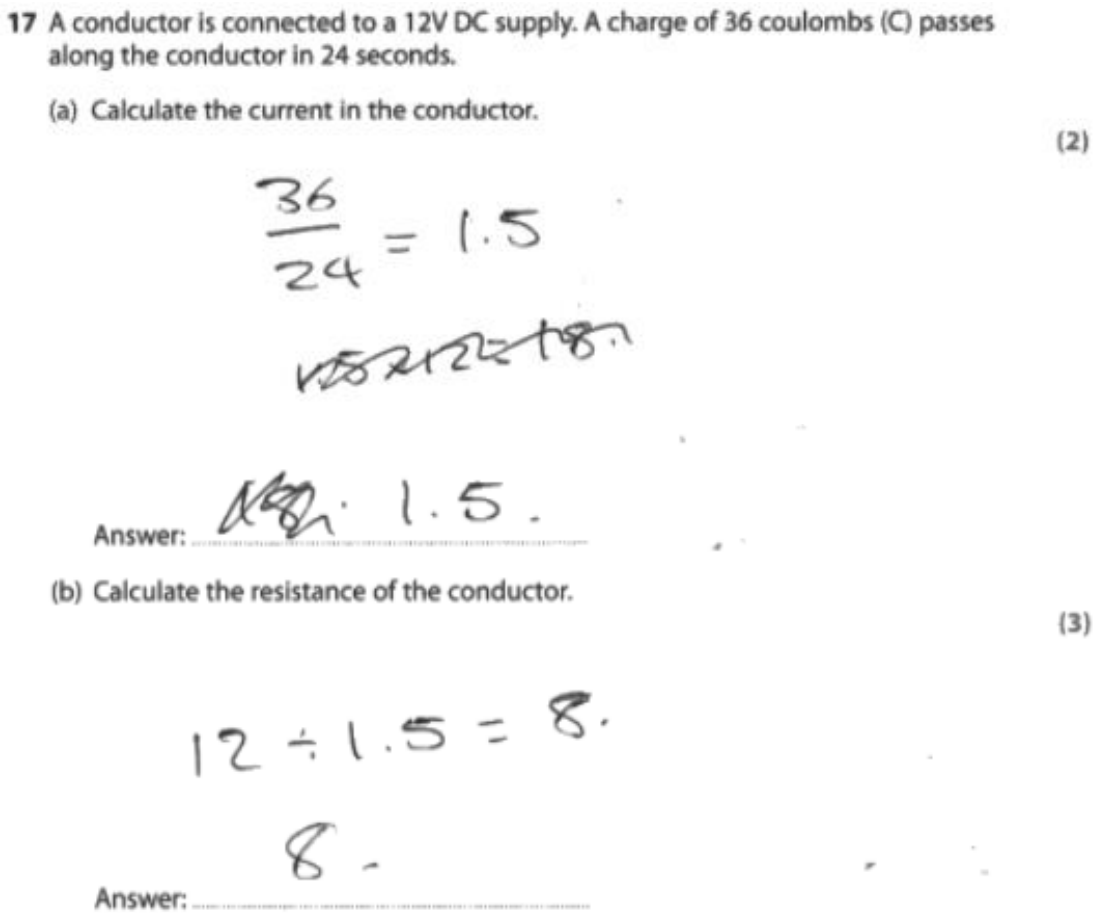
$\frac{12}{0.125} = 96$ $R = 96$

Answer: 96 Ω

`

For part (a) the learner has used an incorrect formula and approach, therefore no marks can be awarded. In part (b) however they have correctly rearranged the formula and populated it with suitable values, allowing follow through from part (a). The answer is arithmetically correct, therefore this also gains credit - again allowing for follow through.

This response gained 2 marks for part (a) and 3 marks for part (b)



17 A conductor is connected to a 12V DC supply. A charge of 36 coulombs (C) passes along the conductor in 24 seconds.

(a) Calculate the current in the conductor.

(2)

$\frac{36}{24} = 1.5$

Answer: 1.5.

(b) Calculate the resistance of the conductor.

(3)

$12 \div 1.5 = 8.$

8.

Answer:

This example follows the correct process in both part (a) and part (b). As a result, all marks can be awarded. The learner has not shown some of the stages, such as rearranging in terms of resistance, however this is implied by the values stated and the form they are in. Learners are encouraged to show all rearranging algebraically before substituting values as this allows examiners to note if an incorrect rearrangement has been completed or if incorrect values have been substituted.

`

Question 18

This was a further calculation that assessed a topic area that has been covered to an extent in previous series. 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 select the appropriate formula to use when calculating values. Where learners achieved only partial marks this tended to be fas a result of not converting units or not stating the correct unit for the value.

This response gained 3 marks.

18 A conductor with a length of 250 mm is moving at right angles through a magnetic field of flux 2.2 T. The conductor is moving at a velocity of 8 m/s.

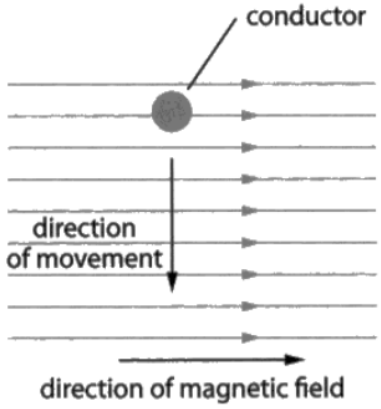


Diagram not to scale

Calculate the induced EMF.

Give your answer in an appropriate unit.

$E = BlV$

$E = 2.2 \times 0.25 \times 8$

$E = 4.4$ Wb

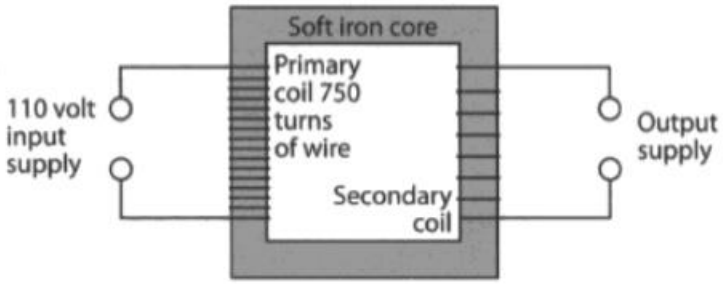
All of the working is correct in this response, however the learner has stated an incorrect unit. This results in three marks being awarded.

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 a stage being omitted In this case, this was often due to not calculating the peak output voltage. Many learners who attempted the question were able to interpret the diagram and populate the correct formula for the transformer, but did not recognise the relationship between peak voltage and RMS voltage. It was at this stage where errors were common, with the value for the output voltage from the question being used in the transformer equation. Providing learners used values appropriately, they were awarded marks for the number of terms being accurate based on their values.

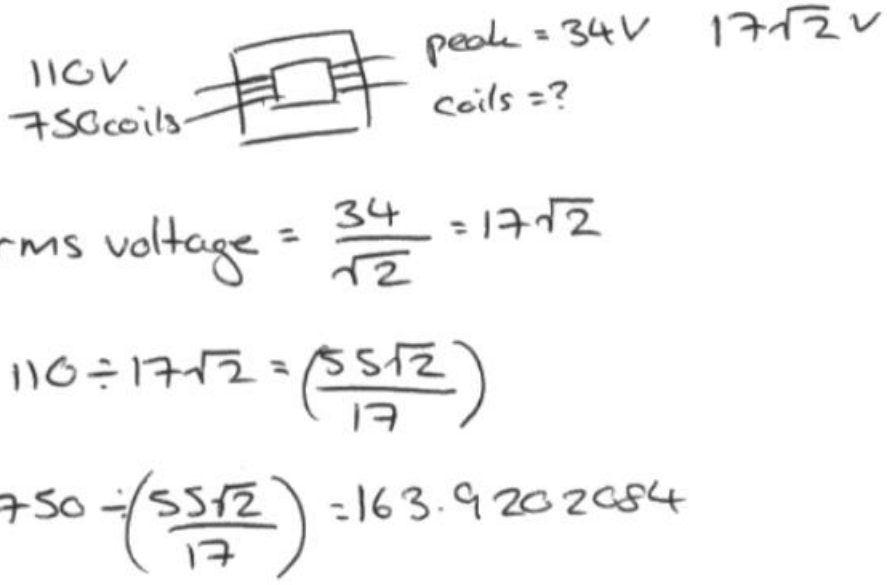
This response gained 6 marks.

19 A transformer has 750 primary turns and is designed to be supplied by a 110 V AC supply.



A peak voltage of 34 V is required as the output from the transformer.

Calculate the number of secondary turns required on the transformer.



Answer: 164 coils (3sf)

The learner has recognised the relationship between peak voltage and RMS voltage. They have substituted values correctly and calculated the RMS voltage with accuracy. This value has then been used to calculate the number of turns in the secondary coil. All working is shown, although some stages are combined. The learner is awarded full marks.

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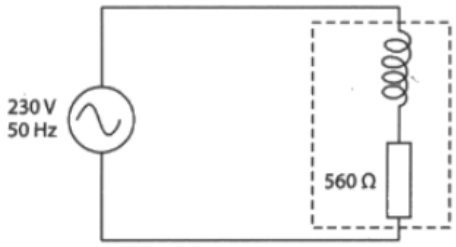
Question 20

Learners often achieved some marks for partial working in this question, although there were a significant number of learners who achieved full marks. Partial working was quite common amongst learners, with some only completing the first stage. It was encouraging that even where learners did not complete the calculations in full, they were able to recognise the relationship between impedance reactance and resistance.
A large proportion of learners were able to substitute values in to the correct formulae but did not rearrange these correctly, thereby restricting achievement.

This response gained 8 marks

20 A coil is connected to a 230 V AC power supply that has frequency of 50 Hz.

The current in the coil is 0.125 A, and the resistance of the coil is 560 Ω.



Calculate the inductance (L) of the coil.

$L = N \frac{\Phi}{I}$

$X_L = 2\pi f L$

$X_L = 2 \times \pi \times 50 \times L$

$Z = \sqrt{X_L^2 + R^2}$

$I = \frac{V}{Z}$, $Z = \frac{V}{I}$, $Z = \frac{230}{0.125}$, $Z = 1840$

$X_L = Z^2 - R^2$

$X_L = 1840^2 - 560^2$

$X_L = 3072000$

$X_L = 2\pi f L$

$\frac{X_L}{2\pi f} = L$

$L = \frac{3072000}{2 \times \pi \times 50}$

$L = 9778.48\ H$

Answer: 9778.48 H

The learner has completed most of the stages of the calculation with some accuracy and has followed the correct process throughout. This allows them access to 'follow through' marks. They have not rearranged the formula in terms of X_L^2 therefore no marks are awarded for this stage. Subsequent working follows the correct process and is accurate with respect to the values used. As such subsequent method and accuracy marks awre awarded to the learner.

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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.
- Rearrange formulae before substituting values in to them.
- 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 situations.
- Avoid excessive rounding at intermediate stages of calculations, or truncating values.
- Provide linked responses for 'explain' questions. An initial lead point should always be expanded upon with either an expansion or a justification.
- Single word, or short answers, are acceptable for 'state' questions.

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