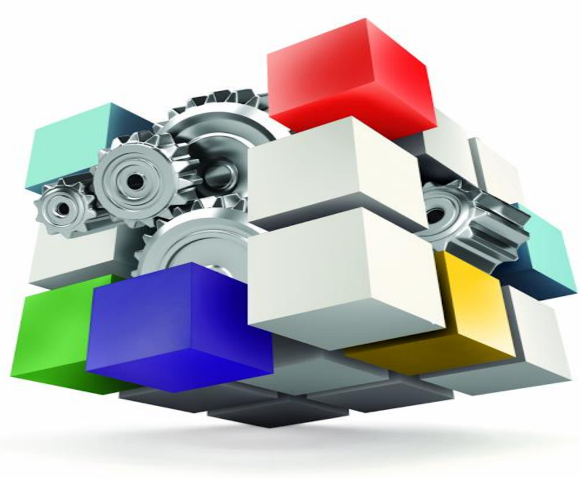
Examiners' Report/
Lead Examiner Feedback
Summer 2017

BTEC Level 3 Nationals in Engineering
Unit 1: Engineering Principles (31706H)



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August 2017
Publications Code 31706H_1706_ER

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, Pass and Near 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	36	55

Introduction

This was the first series of the new specification for Engineering and as such, the first time that this mandatory unit has been assessed via an external assessment rather than via centre based internal assessment across a number of assignments. This unit has been assessed through a traditional paper-based examination.

The question paper followed the format identified in the additional sample assessment materials published on the Pearson website. The focus of the paper being on a range of questions that assess mechanical, electrical and electronic principles along with a synoptic question. The range of questions will change each examination series with the aim of covering all of the topics listed within the specification. 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.

The paper had 18 questions. Each question was based on an engineering concept, with some questions having multiple parts. Learners were required to demonstrate knowledge and understanding of a range of specification topics and to apply this knowledge to the specific question scenario. The intention was to offer as broad coverage as possible for all areas of the unit content. Questions had varying weightings attached to them, with 1 to 4 marks for the lower demand questions and up to 8 marks for questions where an extended response was required, such as calculation that required analysis of information.

Each of the questions that involved calculations was marked using both method (M) marks and accuracy (A) marks, as shown in the mark scheme. The short written response questions were point marked against mark schemes with linked responses being required for explain questions

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. Overall, there was evidence of learners having been taught well across the range of unit content, with the extended calculations allowing for differentiation across learner abilities. It was positive to see that across the cohort of learners there were examples of full marks being awarded for every question on the paper.

It is extremely important that learners are given the opportunity to practice responding to shorter and/or lower demand questions as well as extended synoptic questions. There were a number of occasions where learners did not present any working to support a numerical value given as an answer. It is important to show working as this allows access to 'method marks' should the solution be incorrect.

Although it may seem like an obvious comment, it is extremely important that learners read the questions carefully and identify what is being asked of them. This is especially important in questions where information needs to be interpreted in order to arrive at a solution; diagrams are generally included to support learners and to assist with clarifying questions. Some learners made effective use of such diagrams by adding annotations to them to indicate values or directions of motion.

Learners responded well and provided more clear responses to aspects of the synoptic question with many being able to achieve some of the marks that were available for the three parts. It was however noted that a number of learners were less comfortable with the written answers than the calculations; it is important that learners are prepared fully for the examination and have the opportunity to practice short-open response questions as featured both in this paper and both of the sample assessment materials.

Individual Questions

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

Q1

This question was generally answered accurately by those learners who had knowledge and understanding of the use of circular measure and were able to perform the appropriate conversion to radians. Some learners attempted to answer the question using degrees and arrived at an incorrect answer.

It is important that all learners are aware of the correct techniques to perform conversions between degrees and radians and vice versa as such operations are routine in engineering.

This response gained 2 marks.

1 Calculate the length of the curved side of the plate.

$$s = r\theta$$
$$= 52 \times \left(66 \times \frac{\pi}{180}\right)$$
$$= 52 \times 1.15$$
$$= 59.8\text{mm}$$

Answer 59.8mm

Whilst this response is concise and correct. The learner has converted the angle from degrees to radians and has shown each stage of the calculation which is good practice.

Q2

This question required learners to factorise an equation to arrive at values of t. A minority of learners used the quadratic equation to arrive at the two roots of the equation; this approach did not gain any credit. Where a question asks for a certain process to be followed, in this case factorization, other methods are not acceptable.
A large proportion of learners did not achieve marks for a number of reasons, the most significant being their lack of understanding of the approach to factorization. It was positive however to see learners being able to adopt the correct approach and arrive at the required values. Where learners only achieved one mark this tended to be as a result of factorizing but not then finding the roots of the equation.

This response gained 2 marks.

$(6t - 10)(t - 1)$

$6t^2 - 6t - 10t + 10$

$= 6t^2 - 16t + 10$

So $t = 1$ and $t = \frac{10}{6} = 1.67$

Answer 1

t = 1 second

Answer 2

t = 1.67 seconds

This response achieves both of the marks available. The learner has factorised the expression (although not fully) and has then checked their factorisation, which is good practice. The values of ‘t’ have been expressed both as fractions and decimals to an appropriate degree of accuracy.

Q3

This question was generally well answered, with the full range of marks being given. A large number of learners achieving full marks. Where marks were lost, this tended to result from learners taking the height of the cylinder section of the silo as 7m rather than this being the overall height and subtracting 2.3 to arrive at 4.7m for the height of the cylinder. It was positive to note that the majority of learners showed their working in full which allowed them to access method marks where arithmetic errors had been made.

This response gained 4 marks.

$7 - 2.3 = 4.7m.$ $SA_{cone} = 2r\pi h.$

$4.6 \times \pi \times 4.7 = 67.92\ m^2.$ (Area of the cylinder.)

$SA = 4\pi r^2$

semicircle = $\boxed{2\pi r^2}$ base: $\pi r^2 = 16.62\ m^2$

$2 \times \pi \times 2.3^2 = 33.24\ m^2$

$Tot = 33.24 + 67.92 + 16.62 = 117.8\ m^2$

Answer

$117.8\ m^2.$

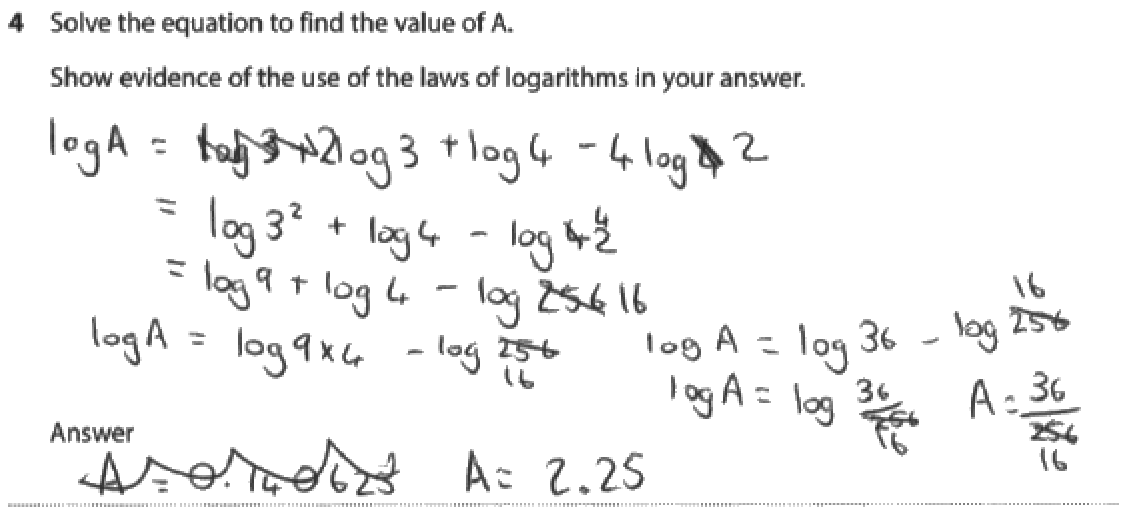
The learner has demonstrated good practice by breaking down the calculation into the various stages, the cylinder, the base and the hemisphere. Working is shown for each, with the correct values being entered into formulae from the diagram.

The learner has also shown the areas at each intermediate stage before adding them together to find the total surface area of the silo.

Q4

Learners performed with some success on this question. Where learners had an understanding of the laws of logarithms they often achieved full marks. In the majority of cases learners showed their working stage-by-stage and showed that they could apply each of the laws of logarithms appropriately. Where learners did not achieve marks the reasons for this tended to be either they calculated the value of LogA rather than giving the value of A, or they used a calculator to solve the equation. As with question 2, learners were required to show evidence of the use of the laws of logarithms, therefore answers derived using a calculator attracted no marks.

This response gained 3 marks.



4 Solve the equation to find the value of A.

Show evidence of the use of the laws of logarithms in your answer.

$\log A = 2\log 3 + \log 4 - 4\log 2$

$= \log 3^2 + \log 4 - \log 2^4$

$= \log 9 + \log 4 - \log 16$

$\log A = \log 9 \times 4 - \log 16$

$\log A = \log 36 - \log 16$

$\log A = \log \frac{36}{16}$

$A = \frac{36}{16}$

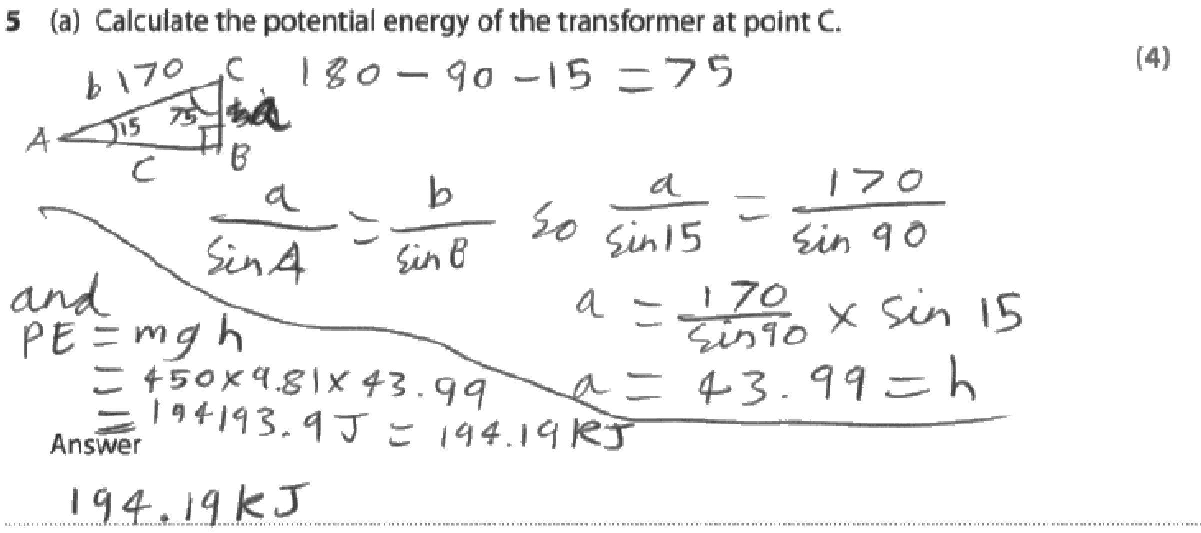
Answer ~~A = 0.140625~~ A = 2.25

This response has been awarded three marks. The working is clear, with each of the laws of logarithms being evident in the answer. Intermediate stages have been shown in full, and the learner has provided a value of A, as required, rather than a value of log A.

Q5(a)

Learners performed with variable performance for this question. Learners tended to achieve either 2 marks or 4 marks, with the cause of the difference being the value of ‘h’ that learners calculated. A range of approaches were seen to determine ‘h’ including using trigonometry (sine), the sine rule and the cosine rule. In some instances learners derived a value of ‘h’ using other methods, however often the value was incorrect. Where an incorrect value of ‘h’ had been calculated, a ‘follow through’ approach was taken for the value of the potential energy which allowed learners to achieve 2 marks for this part of the response.

This response gained 4 marks.


5 (a) Calculate the potential energy of the transformer at point C. **(4)**

$180 - 90 - 15 = 75$

$\frac{a}{\sin A} = \frac{b}{\sin B}$ so $\frac{a}{\sin 15} = \frac{170}{\sin 90}$

$a = \frac{170}{\sin 90} \times \sin 15$

$a = 43.99 = h$

and

$PE = mgh$

$= 450 \times 9.81 \times 43.99$

$= 194193.9\text{ J} = 194.19\text{ kJ}$

Answer 194.19 kJ

This learner has used a combination of methods to arrive at a value of ‘h’, which has been calculated with accuracy and has therefore attracted one method mark and one accuracy mark.
This value of ‘h’ has then been imputed into the correct formula to calculate the potential energy; this has also been calculated accurately and to an appropriate degree of precision.

Q5(b)

Although learners had some understanding of the purpose of a ramp or inclined plane, many learners failed to achieve marks for this question due to a lack of understanding of the differences between force and energy. Many learners stated that less energy was needed to raise the load using a ramp which indicated a lack of understanding of the concepts involved.

This response gained 1 mark.

(b) Explain **one** advantage of using a ramp for moving the transformer compared to lifting the transformer vertically.

(2)

The resultant opposing force, due to gravity, acting against the lifter is at a fraction when pushing up a slope, as oppose to lifting straight up, because the ramp is opposing the downward force due to gravity.

This learner has achieved one mark. There is some understanding that the force that needs to be overcome is reduced due to the slope. However, there is some misunderstanding and the learner has not provided a linked response.

Q6

Learner performance on this question was variable, with a range of marks being awarded. Some learners only achieved one or two marks for resolving forces horizontally and/or vertically. Those learners who progressed with their answers were able to find the horizontal and vertical components of the force and then apply Pythagoras' Theorem and trigonometry to arrive at the magnitude and direction of the force.

This response gained 5 marks.

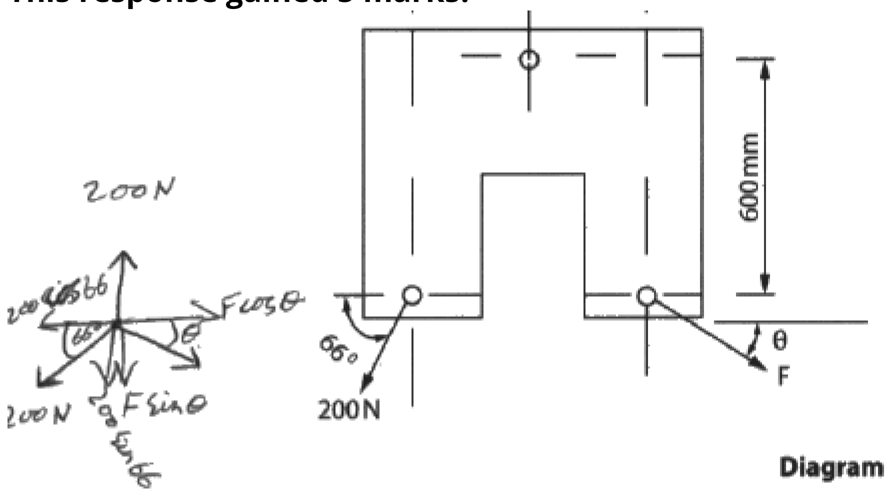


Diagram not to scale

6 Calculate the magnitude and direction of the force F from the horizontal.

resolve vertically:

$200 = 200\sin 66 + F\sin\theta$

$200 - 200\sin 66 = F\sin\theta$

resolve horizontaly:

$200\cos 66 = F\cos\theta$

so $F\cos\theta = 81.35N$

and $F\sin\theta = 17.29N$

so magnitude $= \sqrt{81.35^2 + 17.29^2}$

$= 83.17N$

and $\theta = \tan^{-1}\left(\frac{17.29}{81.35}\right)$

$= 11.99°$

Magnitude

83.17N

Direction

11.99°

The learner has produced a force diagram to support their working, This has been used to then resolve forces vertically and horizontally. The learner has used good practice to show their working in full so as to access any method marks if any mistakes had been made. The learner has shown how they arrived at the magnitude of the force and the direction, and has presented these to an appropriate level of accuracy.

Q7

This question proved to be a challenge for many learners, with only a small proportion achieving full marks. Learners had an understanding of the approach to finding the forces due to the sea water and fresh water but in many cases this is where the answers stopped. Common errors included only considering a unit width of the wall, rather than the full width of 10m. Some learners were able to calculate the moment due to one or other of the bodies of water, however only a small proportion of all learners achieved full marks for finding the overturning moment and the direction of the overturning moment; the latter mark being only awardable if a value for the overturning moment had been given.

This response gained 6 marks.

7 Calculate the resultant turning moment of the wall about the base.

$F_1 = \rho g A x = 1000 \times 9.81 \times (10 \times 4) \times 2 = 784800\,N$

$M_1 = 784800 \times \frac{4}{3} = 1046400\,Nm$

$F_2 = 1030 \times 9.81 \times (1.5 \times 10) \times 0.75 = 113673.375$.

$M_2 = 113673.375 \times \frac{1.5}{3} = -56836.7$

$1046400 - 56836.7 = 989563.3\,Nm$ to the right.

Answer

989563.3 Nm to the right.

The learner has correctly calculated the forces due to both sea water and fresh water which attracts one method mark each. They have then found the overturning moment for each, gaining two further method marks.

The learner has then continued to find the resultant turning moment for the wall and has indicated the direction. Although the learner has stated ‘to the right’ rather than clockwise, the mark has been awarded.

Q8

As section B progresses, the complexity of the questions increases for the mechanical principles aspect of the specification. This question proved to be challenging for many learners, although a large proportion were able to achieve marks for the impact velocity of the hammer either using conservation energy or laws of linear motion.

Where a large number of learners failed to achieve marks was as a result of not considering conservation of momentum and the combined mass of the hammer and the pile. Learners should be aware of the how to use both conservation of energy and conservation of momentum to solve problems.

This response gained 4 marks.

8 Calculate the average resistance force exerted by the ground in bringing the pile and hammer to rest.

~~F=ma~~
~~F=700x9.81~~
~~F=6867N~~

F=ma
F=700x9.81
F=6867N

F=ma
F=200x0
F=0

S=3.2
u=0
v=?
A=9.81
T=x

$v^2=u^2+2as$
$v^2=0^2+2\times9.81\times3.2$
$v^2=62.784$
$v=7.924\ ms^{-1}$

$(m_1u_1)+(m_2u_2)=(m_1v_1)+(m_2v_2)$
~~(m200x0)+(200x0)~~ =
$(700\times7.924)+(200\times0)=(700\times v_1)+(200\times v_1)$
$5546.8=900v_1$
$v=6.1631\ ms^{-1}$

S=0.176m
u=6.1631
v=0
A=?
T=x

$v^2=u^2+2as$
$0^2=(6.1631)^2+2\times a\times0.175$
$0=37.984+0.35a$
$-37.984=0.35a$
$a=-108.526\ ms^{-2}$

F=ma
F=900x-108.526
F=-97673.14N

Answer

97673.14N

In this response the learner has firstly calculated the impact velocity of the hammer. They have then used this value and applied the law of conservation of momentum to determine the initial velocity of the combined pile and hammer. This achieves 2 method marks and one accuracy mark.

They have then found the deceleration of the pile due to the ground to gain a further method mark.

The learner has unfortunately omitted the force due to gravity on the combined pile and hammer from the final stage of the working, thereby not achieving the final method mark and accuracy mark

Q9

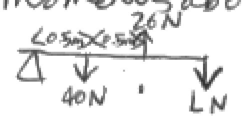
Many learners were able to attempt this question and show some understanding of the processes involved, however it was clear from responses that awareness of methods of solving problems that involve a uniformly distributed load were somewhat limited. A significant proportion of learners interpreted the diagram as if the UDL spanned the entire width of the beam, whilst others considered that the UDL acted at the midpoint of the beam as opposed to the midpoint of the loading.
Most learners were able to carry forward their value of L to determine the reaction force accurately, with follow through being applied if an incorrect value of L had been presented.

This response gained 4 marks.

9 Calculate:

- the maximum load (L) that can be supported at point C
- the reaction force at point A when L is applied.

moments about point A:



$(26 \times 1) = (40 \times 0.5) + (L \times 1.25)$

$26 = 20 + 1.25L$

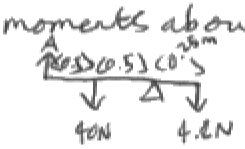
$6 = 1.25L$

$L = 4.8N$

Maximum load (L)

4.8N

moments about point B:



$(A \times 1) + (4.8 \times 0.25) = (40 \times 0.5)$

$A + 1.2 = 20$

$A = 18.8N$

Reaction force (R_A)

18.8N

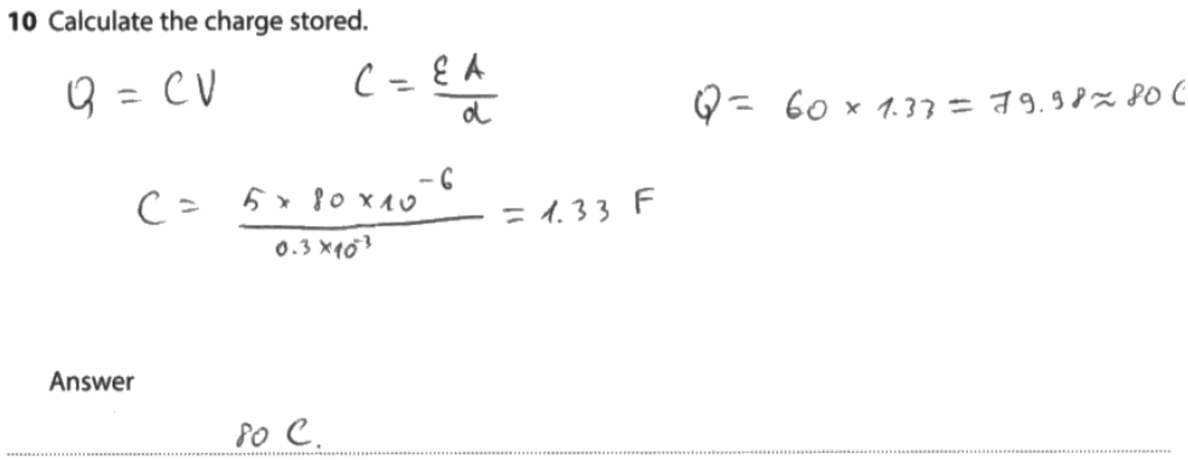
The learner has correctly interpreted the diagram to find the equivalent point load for the UDL and the location where it acts.

They have taken moments around point A to determine the load at L. They have then taken moments at point B to determine the reaction at A; an alternative approach would have been to resolve forces vertically which would have gained the same credit.

Q10

Question 10 is the first of the electrical and electronic principals questions on the paper and required learners to interpret information to calculate the charge stored in a capacitor. A large proportion of learners achieved at least two marks for this question; where marks were lost this was as a result of not converting the thickness of the dielectric into metres from millimetres. The majority of learners selected the correct formulae from the information booklet to firstly find the capacitance of the capacitor and then the charge.

This response gained 3 marks.


10 Calculate the charge stored.

$Q = CV$ $\qquad$ $C = \frac{\varepsilon A}{d}$ $\qquad$ $Q = 60 \times 1.33 = 79.98 \approx 80\ C$

$C = \frac{5 \times 80 \times 10^{-6}}{0.3 \times 10^{-3}} = 1.33\ F$

Answer 80 C.

This learner has indicated the formulae that they will use before populating them with values; this is good practice and allows the examiners to confirm that the correct calculation is being performed. The learner has performed the conversion from millimetres to meters when calculating the capacitance and has used the value arrived at (1.33F) to calculate the charge and has presented this to an appropriate level of precision.

Q11

Those learners that did not achieve the one mark available tended to either select the wrong formula to solve the problem or entered values incorrectly. Learners did however tend to populate the formula correctly when selected and showed the values entered in their working.

This response gained 1 mark.

Two parallel plates are connected across a battery. The distance between the conductors is 3.5 mm, and each is fed from the same 20 V DC power supply.

11 Calculate the uniform electric field strength generated by the plates.

$$E = \frac{V}{d} = \frac{20}{3.5 \times 10^{-3}} = 5714.3$$

Answer 5714.3

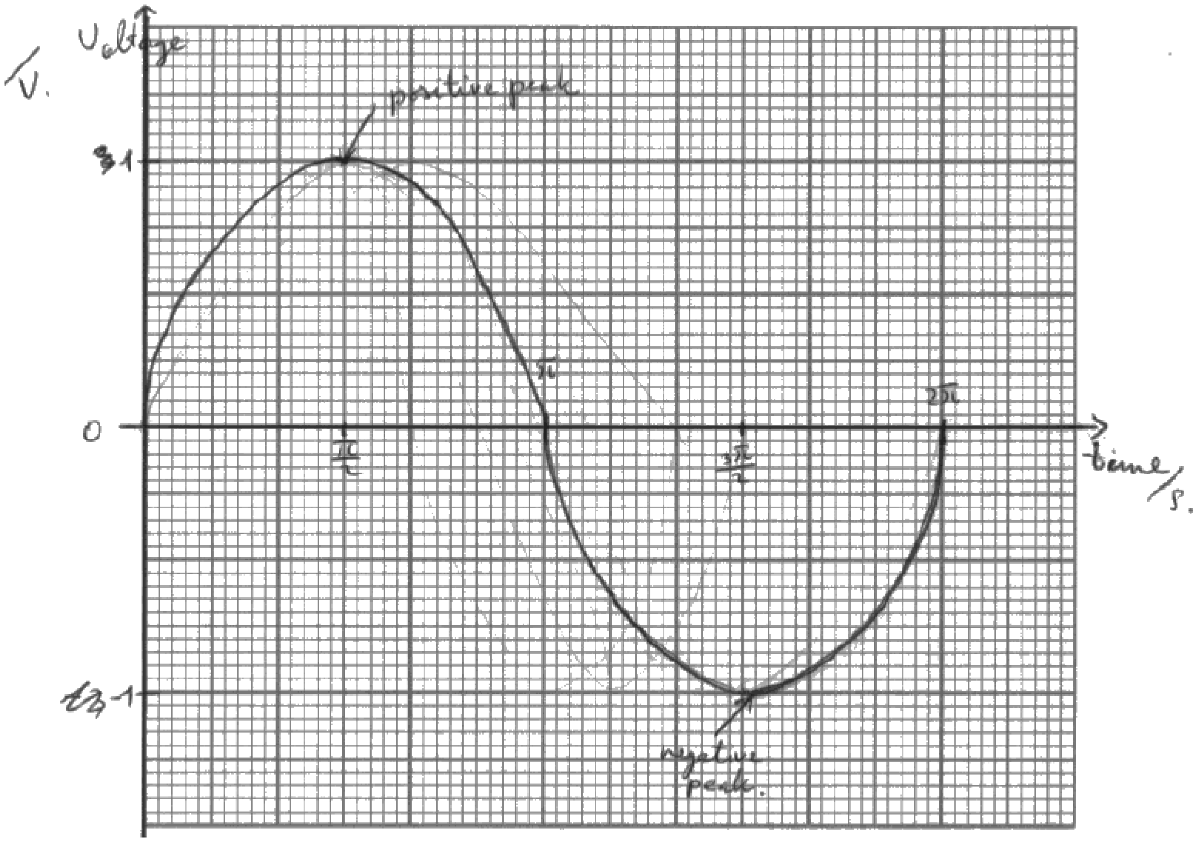
The learner has correctly populated the appropriate formula and has presented their answer to 1 decimal place which is suitable in this situation.

Q12

Learners generally performed well on this question, with marks being awarded across the entire mark range. Responses gaining lower marks often presented only a basic sine wave, although there were numerous responses that included the full range of features listed in the mark scheme. Some learners included alternative waveforms that attracted no marks. Where learners did not achieve marks, this was often as a result of failing to indicate the amplitude, time period or peak values. A large proportion of learners did not provide labels on the axes.

This response gained 4 marks.

12 Draw a labelled waveform showing the characteristics of one full cycle of the voltage.



The waveform presented here has achieved full marks. The learner has shown the correct amplitude (+/- 3V) and has labelled the axes appropriately. The waveform is approximately a sine wave and the correct time period is shown as 2π

Q13

Although a large proportion of learners attempted the question, success was limited. This was potentially due to unfamiliarity with the formulae to be used and the values that needed to be entered. A large proportion made an error in the population of the formula because they halved the distance between the two particles and entered r as 0.6m rather than 1.2m. Other values tended to be used correctly; however the aforementioned incorrect value of r resulted in an answer that was inaccurate.

This response gained 2 marks.

13 Calculate the charge on the second particle.

$$F = \frac{q_1 q_2}{4\pi \varepsilon_0 r^2}$$

$$F 4\pi \varepsilon_0 r^2 = q_1 q_2$$

$$\text{so } \frac{F 4\pi \varepsilon_0 r^2}{q_1} = q_2$$

$$\text{so } q_2 = \frac{172 \times 4\pi \times 8.85 \times 10^{-12} \times 1.2^2}{0.3}$$

~~2.68×10^{-8} C~~

$$q_2 = 9.18 \times 10^{-8}\ C$$

Answer

$q_2 = 9.18 \times 10^{-8}$ C

This learner has chosen and re-arranged the correct formula in order to arrive at the charge on the second particle. The appropriate values of each variable have been used and the solution arrived at is accurate.

Q14

Although a significant proportion of learners achieved full marks for this question, it was disappointing to note that a large number of learners did not seem to be aware of how to determine total resistance for parallel resistors.

Many learners were able to find the resistance in the top branch and the lower branch of the circuit, in some cases marking these on the diagram. Whilst this shows understanding, learners are advised that it is important to show working and answers in the answer spaces provided. Common errors tended to include adding all of the resistances together to find a total resistance. Where learners performed the correct operations to find the total resistance they also calculated power with accuracy.

This response achieved 5 marks.

14 Calculate the power dissipated in the circuit.

$560 + \sout{301}\ 330 = 890\ \Omega$

$1000 + 100 = 1100\ \Omega$

$R_{TA} = \dfrac{890 \times 1100}{890 + 1100} = 491.96\ \Omega$

$R_{Tot} = 491.96 + 2200 = 2691.96\ \Omega$

$P = \dfrac{V^2}{R} = \dfrac{\sout{144}\ 144}{2691.96} = 0.053\ W.$

The learner has correctly calculated the resistance in the top and lower branch of the circuit for 2 method marks. A third method mark has been given for the total resistance in the parallel branches along with an accuracy mark for the total resistance in the circuit. The final accuracy mark has been given for the correct value for the power dissipated in the circuit.

Q15(a)

Only a small proportion of responses achieved full marks. Many learners provided descriptions or explanations of what a diode does or how it works as opposed to explaining a forward mode application of diodes. It is important that learners read questions in full in order to maximise their opportunity of achieving marks.

This response gained 2 marks.

15 (a) Explain **one** forward mode application of diodes.

(2)

In a half wave rectifier circuit to convert AC power into DC power, a forward mode Diode is used to remove the negative part of the wave length & only let the positive half through

This learner has provided a linked response where they have stated one forward mode application of a diode for one mark. They have then expanded on their response by stating how the diode is used in a rectifier circuit for a second mark. It is important for explain questions that a lead point is provided which is then expanded upon for a second mark. The expansion could be a justification or further explanation.

Q15(b)

Overall, responses did not achieve high marks. Learners tending to demonstrate a lack of understanding of Zener diodes. Those learners who did show some knowledge and understanding often achieved both of the marks available. Typically learners would refer to breakdown voltages or the smoothing effect of the diodes.

This response gained 2 marks.

(b) Explain **one** reason why Zener diodes are used for voltage regulation.

(2)

Zener diodes are used when the output voltage needs to be controlled. This takes place as Zener diodes will have a breakdown voltage, where current will start to flow ^in the opposite direction. So the output voltage could be controlled between 1V → 1.5V for example.

(Total for Question 15 = 4 marks)

The first two lines of the response attract no marks as they are repetition of the question; learners should avoid doing this as no credit is given for repeating the stem. The remainder of the response however is given two marks, one mark for reference to the breakdown voltage and the second for recognising at this voltage current is able to flow in both directions. Whilst this is not a textbook response, it is clear that the learner understands the operation of Zener diodes.

Q16

A large proportion of learners achieved two marks for the question as a result of calculating the induced EMF in one of the positions, either at the initial angle or the final angle. Some learners calculated both values of the induced EMF but did not find the change therefore full marks could not be awarded. Most learners were able to identify and populate the correct formula from the information booklet.

This response gained 5 marks.

16 Calculate the change in the induced electromotive force if the angle of the conductor is altered to 90°.

$E_1 = BL_1v$

$= 1.3 \times 20 \times 0.45 = 11.7$

$\sin 50 = \frac{opp}{0.45}$

$opp = 0.345$ m.

$E_2 = 1.3 \times 0.345 \times 20 = 8.97$

$11.7 - 8.97 = 2.73$ V

Answer 2.73 V.

The learner has presented their working in full and has broken the calculation down into three stages. One method mark and one accuracy mark have been given for calculating the final value of the induced EMF. A further method and accuracy mark have then been given for calculating the initial value of the induced EMF. The learner has then completed the final stage of the calculation to be awarded the final accuracy mark for the change in induced EMF.

Q17

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 a solution. Although learners were able to identify the information provided in the stem of the question, they often selected an incorrect formula from those available and were unable to reach a solution.

This response achieved 4 marks.

17 Calculate the inductance of the coil.

$X_L = 2\pi f L$

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

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

$Z = \frac{120}{150 \times 10^{-3}}$

$= 800$

$X_L = \sqrt{800^2 - 68^2} = 797.1$

$797.1 = 2\pi \times 50 \times L$

$L = \frac{797.1}{2\pi \times 50} = 2.54$

Answer

2.54

The learner has correctly interpreted the given information to firstly calculate the value of the impedance of the coil (top right hand side of the working) for one method mark. A further method mark has been awarded for determining the value of X, which has then been used to calculate the inductance in the coil. The learner has been given a further method mark for this process and an accuracy mark for the calculated inductance of the coil.

Q18(a)

For the synoptic question in Section C, learners need to be able to synthesise the information they are presented with in order to answer a number of part questions. Learners tended to be able to find the angular velocity of the rotor assembly, however only a limited proportion of these were able to complete the conversion from angular velocity to revolutions per minute (rpm).

This response gained 4 marks.

18 (a) Calculate the speed with which the rotor assembly turns (in rpm).

(4)

$P = T\omega$

$\omega = \frac{P}{T} = \frac{56.5 \times 10^3}{300} = 188.33 \text{ rad/s}$

188.33 rad/s

= 11299.8 rad/min ⤵ ×60

= 1798.42 rpm ⤵ ÷2π

The learner has shown the stages of the calculation clearly and logically and has annotated the steps to indicate that they have done at each stage. The calculations have been performed with accuracy, with the final answer being presented to an appropriate degree of precision.

Q18(b)

The second part of the synoptic question involved a number of steps that needed to be performed in order to achieve the six marks available. Method and accuracy marks were given for both the input and output power for the generator, with the remaining marks being awarded for calculating the efficiency. Some learners carried forward values of power from part (a) which allowed follow through marks to be given for the calculation of the efficiency of the system.

This response gained 6 marks.

(b) Calculate the overall system efficiency. (6)

$E = \frac{P_{out}}{P_{in}}$

So $E = \frac{33.2 \times 10^3}{230 \times 10^3}$

$= 0.144...$

$= 14.43\%$

$P_{out} = P = IV$

$= 80 \times 415$

$= 33.2\text{ kW}$

$P_{in} = 46 \times 10^6 \times 0.005$

~~0.005~~

$= 230{,}000\text{ J/kg}$

$= 230\text{ kJ/kg}$

Answer 14.43%

This response is concise and shows each step of the calculation clearly. The learner has shown how they arrived at the input power and the output power; this is good practice as method marks are given for the process and should the learner have made an arithmetic error than credit could have been given. The value for the overall system efficiency is correct, with both a fraction or percentage value being acceptable.

Q18(c)

Learners tended to perform with reasonable success for this part of the question. In the majority of cases learners were able to identify one effect on the efficiency of adapting the generator to operate at a higher rpm; most commonly this was a simple statement such as ‘the efficiency will increase’. Learners did not, in general, expand upon this although where they did the response tended to state that it caused the power output to increase. Only a small proportion of learners provided two effects.

This response gained 4 marks.

(c) Explain **two** effects on the efficiency of the system if the generator is adapted to operate at 2500 rpm.

(4)

Firstly it would allow the output per unit mass of fuel to increase and you ~~no~~ could generate more energy from the fuel, reducing waste and increasing efficiency. The othe effect is that should you require the same ouput then you would be able to decrease the amount of fuel being put in. This would also help increase the efficiency.

The learner has identified that the output power increases (1 mark) linking this to improved efficiency (1 mark). The second part of the answer is considered to be ‘another appropriate explanation’ as the learner has considered that if the output power is kept constant then the input power could be reduced and has linked this to the possibility of using less fuel. Learners gain credit for answers that are valid, even if they are not included in the mark scheme.

Summary

Based on their performance on this paper, learners should:

- Attempt all questions on the paper as method marks are often awarded for partial solutions.
- Show working in full as again this allows access to method marks. If arithmetic errors are made then marks can still be given.
- Provide linked responses for 'explain' questions. An initial lead point should always be expanded upon with either an expansion or a justification.
- Make effective use of space when drawing charts or diagrams.
- Ensure that axes on graphs or charts are labelled with both titles and values.

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