Examiners' Report

January 2010

Principal Learning

Engineering EG308
Mathematical Techniques and Applications for Engineering

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Introduction

Once again, the score of the candidates ranged from about a dozen to more than fifty, reflecting a broad range of abilities. The paper followed a similar pattern as in previous series and closely reflected the same sort of content as the sample paper which is available on the website. The mark scheme also compared well with previous ones.

Question 1

Question 1a(i) – rearrangement of algebraic equation containing squares and fractions. The majority of candidates completed this or made a good attempt at it. Some had ½ θ on the bottom instead of 2A on the top, which was still the same, but not quite as expected. Several only appeared to be able to consider subtraction and addition as re-arrangement methods, and a few forgot all about the square root.

Question 1a(ii) – substituting values into the result of 1a.
If errors had been made, some allowance was made where basic substitution skills were clearly visible, but with only 1 mark, there is little allowance for error. Again, many didn't complete this because they didn't take the square root.

Question 1b – Using the laws of logs to solve an equation.
Many candidates worked through this correctly and achieved full marks, but those who solved it 'using' logs were awarded only 1 mark. Some got part way there and received some mark, and others introduced errors using 3^2 instead of 2^3 .

Question 1c – using natural logs to solve exponentials.
Very few candidates seemed to understand what to do with this. Those who did provided good answers, but many left it blank and others seem to have been confused by the negative, and fractional, power of 'e'.

Question 2

Question 2a – Plotting a graph, finding its equation and solving values.
Almost everyone plotted the graph, or at least put the 4 points in the right place. A few couldn't do that very accurately and some didn't attempt it.
Some extrapolated the line and estimated the values, and some arrived at the answers and kept going, without making it clear what they were doing. A good number forgot to determine the value at t = 0.
A surprising number had done it correctly, then scribbled all over it. Where it is possible to see through the crossings out, any correct answers are actually given credit.

Question 2b – factorise the equation for the surface area of a cylinder.
Some produced perfect answers, but they were in the minority.
Others multiplied everything out, just deleted numbers or the squared term and many didn't make an attempt. Seeing the word 'factorise' a few candidates drew double brackets (   )(   ) but left it there – probably thinking 'square term, therefore a quadratic, etc'.

Question 2c(i) – factorising a quadratic.
Some used the formula method, and very few completed it, but many candidates provided some good working and answers. A few wrote the answers only – demonstrating well developed 'factorisation by inspection' techniques, perhaps? Others used trial and improvement techniques. A few arrived at one answer and stopped there and a few had the polarity the wrong way round.

Question 2c(ii) – explain how the value of 'd' was identified.
Many candidates wrote an explanation of how they carried out the calculations, when the answer only needed them to say why they had discounted the negative value.
Many arrived at wrong answers, but received some credit for making acceptable comments about real distances being positive.

Question 3
Question 3a – sketch of a sinusoidal function, with offset, and obtain a value from a given point. Most candidates drew a reasonable sine-wave with correct offset and amplitude, then gave the value if 'i' at the prescribed point. Some read the value from the graph, and others calculated it using the original equation – and some did both.
Some had triangle wave-shapes, some were unrecognisable, some were exponential curves. A small number incorrectly drew the offset and amplitude and others extended the grid to make their graph fit. A smaller number of candidates wrote down all the equations they knew with 'sine' in them.

Question 3b – use of SOHCAHTOA to solve a right angle.
Many had the correct solution to this, and many more got close.
Tangent was the obvious correct solution, but candidates used a range of techniques and arrived at the answer, including the use of the cosine ratio to obtain the hypotenuse, then used Pythagoras' theorem. Others tried to solve it using 50 x 29 without using a trig ratio. It seemed that some candidates may have had their calculators in the wrong 'angular mode' because their answers were not the correct ones to the equation they had written down. Where this seemed to have happened, partial credit was normally awarded.

Question 3c – solution of a non-right angles triangle.
Many candidates did a good job with this, using the sine rule as expected, but a few believed the trig ratios for right angled triangles would give them the answer.
Others had the sine rule upside down, and a range of formulae were tried and tested on this problem. Many left it blank.

Question 4
Question 4a – volume and surface area of a sphere.
A wide range of levels of attempts were made at this problem, with some candidates actually using the cylindrical volume and surface area equations.
Calculator errors were apparent on occasions, and some took 4/3 to be 1.3, which introduces a large error, beyond the limits of acceptable error in the mark scheme.
Some used the diameter and not the radius, getting a rather large value for both.
A few tried to convert their units from mm^2 to cm^2 or m^2 and none of them did this very well.

Question 4b – angular distance moved.
A large number of candidates successfully used radian calculations to solve this and the answer was accepted in radian or degree format.
Some used both methods and other just drew a circle and an arc or radius.
Some even tried using the formula for the surface area of a sphere.
One wrote down both the given numbers, multiplied them together, then took the tangent of the product. This answer was wrong, by the way.

Question 4c – angular velocity using radians.
A small number obtained a good answer for this problem, whether they had worked in radians or degrees, or both. A few common mistakes were due to having the equations upside down or by taking a radian to equal a full circle, or equal to a degree. Many gave the answer of 80 x 60 = 4800. Some had the right answer, but the decimal point appeared to have been inserted at random positions.

Question 5
Question 5a – defining and obtaining the mode of a set of data.
About half of candidates got this correct, both in explanation or definition and value.
Many put 'C2' as their answer, saying that it had failed most often.
Some gave the range, some gave the mean and a few left it blank.

Question 5b - defining and obtaining the median of a set of data.
Generally well answered by the majority. A few guessed at meanings and gave mean value calculations, some said 'in the middle – so it must be C1' (which is in the middle of the table, but not the data). Quite a large proportion of candidates added up the 63 and divided by 2 to get 31.5, and again selected C2 as the median value.

Question 5c - defining and obtaining the mean of a set of data.
About half of the candidates obtained the correct answer for this, but the number of confusing combinations of numbers was astounding. Around 10 to 15% of candidates added the values up to anything between 39 and 232, making the division by 9 (and occasionally 2, 8 or 63) give a bad range of results.

Question 6
Question 6a – draw a tangent to a curve, determine the equation and two values.
The vast majority drew good tangents, but only about half of them proceeded to solve any of the values.
Some very good answers were provided for this question.
A handful of answers were written down without working, and without the tangent being drawn.
A few drew the tangent, obtained the 'rise' and 'run', then used Pythagoras to obtain the hypotenuse, without answering the task. A few had negative gradients.
Answers were obtained by drawing, or calculation of the gradient, etc, and either was accepted.

Question 6b – differential calculus on a two term expression.
Some very good results were seen for this question, showing that the difficult concepts of differentiation are being grasped and applied, if only by a few candidates.
Many, though, made a range of attempts or left it bank.
Some just wrote the answer down, and others filled the page with several attempts, which did occasionally contain some sections which could be awarded a point or two.
A few attempted to use sines and cosines, to no avail. Others slipped up with basic algebraic rearrangement of equations.

Question 6c – integration. There were some good and full answers to this, but the majority were either blank returns or imaginative attempts.
Newton's laws of motion equations were used by at least one, and some went round in circles looking for inspiration, perhaps.

Overall, a paper which allowed the higher ability candidate to obtain a high score, at or around the A* boundary, and a small number who can expect to be awarded a U grade. Overall advice to centres and candidates is to refer to past papers and mark schemes, and the examiner reports, and practice. Before that, of course, they need time to learn and assimilate the ideas and concepts, preferably with some application to the solution of engineering problems.

Statistics

Level 3 Unit 8 Mathematical Techniques and Applications for Engineers

	Max. Mark	A*	A	B	C	D	E
Raw boundary mark	60	53	47	41	35	30	25
Points Score	14	12	10	8	6	4	2

Notes
Maximum Mark (raw): the mark corresponding to the sum total of the marks shown on the Mark Scheme or Marking Grids.

Raw boundary mark: the minimum mark required by a learner to qualify for a given grade.

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