Cambridge Technicals

Engineering

Level 3 Cambridge Technical Certificates in Engineering **05822, 05823**

Level 3 Cambridge Technical Diplomas in Engineering **05824, 05825**

OCR Report to Centres June 2017

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This report on the examination provides information on the performance of candidates which it is hoped will be useful to teachers in their preparation of candidates for future examinations. It is intended to be constructive and informative and to promote better understanding of the specification content, of the operation of the scheme of assessment and of the application of assessment criteria.

Reports should be read in conjunction with the published question papers and mark schemes for the examination.

OCR will not enter into any discussion or correspondence in connection with this report.

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Unit 1 - Mathematics for engineering

General Comments:

This is a mandatory unit across all qualifications in the Cambridge Technicals in Engineering suite.

It is hoped that the following points may help centres to prepare future cohorts of learners for this unit.

The expected norm for decimal answers is 3 significant figures. Sometimes fewer (e.g. 2) were accepted. However, in following through a calculation to a further answer, learners should use the best answer they have. Failure to do so results in an error that is compounded to the extent that the further answer becomes incorrect to 3 significant figures. For instance, in Question 4(b), providing the response given demonstrates the use of Pythagoras, 2.2 was an accepted answer. However, using the value 2.2 in part (iii) rather than the correct value yields an answer that does not round to 2.1 and so the final mark is lost.

Learners should generally show working for full marks. For instance, in question 5(i) the question asked for integration. If the final answer was given with no working then no marks could be earned. The answer might come from the use of an advanced calculator that is not specified in the rubric, which states only a scientific calculator is allowed, in which case no integration has been done.

Additionally, many candidates do not understand what is required when the question says 'show that....'. A 'Show that …' question is usually asked when the answer is required in a later part – by giving the answer, the later part can be done using a correct value instead of a possibly incorrect value that the candidate found in the earlier part. In a question asking for a 'Show that' it is required that candidates do show their working in such a way that they demonstrate to the examiner that they have followed a correct process. An example of this is question 3 where, without the correct expression for the area of the green carpet a candidate is unable to do part (ii), or with an incorrect quadratic expression might create a lot of extra work to produce an incorrect answer. But many candidates failed to convince examiners of the process used, it is important therefore that all workings are shown even if some might be easily done in the learners head.

It is important for answers to be written clearly, some scripts this series contained text and working that was difficult to read or understand.

While candidates generally performed to expectation, there seemed to be, as in January 2017, a number of gaps in their knowledge please refer to the comments that follow on individual questions.

Comments on Individual Questions:

Question 1 (Algebra)
Part (a) was generally well answered. In part (b) most candidates obtained a common denominator (though the use of 18 rather than 6 demonstrated a general lack of understanding of what they were doing) but many did not obtain correct numerators.

In part(c) there were numerous errors seen, usually caused by the square root and the failure to square the whole of the function

In part (d)(i) many failed to answer the question properly, quoting the remainder theorem to (correctly) demonstrate that f(1) = 0 and hence (x – 1) was a factor of f(x). The question, however, was to do with finding the other, quadratic factor. Multiplying out the given factorised expression was acceptable; long division often caused problems because of the lack of a squared term in f(x). This caused problems particularly for those candidates who drew up a 2 × 3 table.

Many candidates failed to answer part (ii) properly. Some wrote (x – 3)(x + 4), omitting the (x – 1) already found. Others gave an answer x = 1, 3, - 4 answering the question "Solve f(x) = 0".

Question 2 (Exponential decay)
As in previous series this question was not well answered.

The value of k is the initial value or the value of V when t = 0 but this was rarely given. In part (ii) the substitution was also quite poorly done with an inability to solve the resulting equation using logs.

In part (b) the context caused difficulty, for the question merely asked for a sketch of F = kx which is a straight line through the origin.

In part (c)(i) it was expected that candidates would find the mean of coordinates; many seemed to need the opportunity to plot the points on a graph that was not given to them. Some did sketch small diagrams in the space available; others used the extra space at the end of the paper or even additional answer books. Unfortunately some used the graph of the previous part, thus making the answer to part (i) difficult to understand.

There are various ways to find the equation of the line AB and all were of course acceptable. The use of the gradient is the most popular and so in part (ii) this value was required. Using the gradient in part (iii) was generally well done.

Question 3 (Algebra)
Part (i) demonstrated the problems that candidates have when they are given the answer and told to "show that...". There are two ways to obtain the result. The first is to take the smaller area from the larger, and this was done by many candidates. The other is to split the border into a set of squares and rectangles. It was this method that was not clearly explained by candidates and many gave way to temptation and wrote down the answer at the end (which was given in the question) instead of following through their working carefully to ensure that it was correct.

In part (ii) most were able to obtain the quadratic equation that had to be solved. Many solved using the formula, others were able to factorise correctly. However, the process of solving the quadratic equation yields two answers and it was necessary to acknowledge that there were two answers, one of which was practically impossible being a negative number. The rejection of x = -7 was explicitly stated by many candidates but others "lost" it on the way. Those that solved the quadratic by trial and error all failed to find and reject this value; their working therefore resulted in the first value found without any recognition that there was another possible value which might have been a solution to the problem.

Question 4 (Trigonometry)
In part (a), many incorrect graphs were seen including incorrect amplitude, frequency or phase. Most graphs were labelled as requested. It was not always clear however which label was attached to which graph.

In part (b)(i), most candidates were able to give the correct answer from Pythagoras, but some rounded this to 2.2. In this part this was accepted but the use of this rounded value created larger errors later on. There were many correct answers to part (ii) with a variety of methods to

get there. Working backwards from the given answer always failed, and this is because the angle BMC was not 53º but only approximately this value.

Finding the sector of the circle in part (iii) was usually well done.

Question 5 (Calculus)
There were many correct answers here, though calculus is a topic that is not understood well by some candidates. In part (i) an answer with no working got no credit and without differentiation and appreciation that the turning point of the curve occurred where the tangent had zero gradient, part (ii) received few marks also. Some did gain a mark by correct differentiation but did not know what to do next.

Question 6 (Statistics and probability)
Those candidates who understood the difference in the two probabilistic situations in part (a), where replacement did and did not occur, scored well. Many candidates however did not understand the process of multiplying probabilities and so the difference in the two parts caused confusion.

In part (b) (i) and (ii) many candidates seemed to be unaware of the different averages used in different circumstances.

In part (iii) a wide range of answers were seen including left skew, right skew, negative skew, positive skew, skewed to the left, skewed to the right and several others. Candidates should have used the correct wording (positive skew), though in this instance other answers were accepted if they meant the same thing. It seemed as if candidates had an understanding of skew and its statistical implications but were unable to express themselves well.

Unit 2 - Science for engineering

General Comments:

In some of the calculation questions it can be difficult to follow the candidate's working which makes it more difficult to give credit where there is more than one mark available. It was good to see improvements from previous series in the use of units in numerical questions, but candidates still need to show more awareness with powers of ten. Both question 3 and 4 were well answered showing that many candidates had good understanding of both the electricity and material properties sections of the specification.

Comments on Individual Questions:

Question 1:
Q1 (a). Many candidates did not understand what was meant by conversion to base SI units. Some weaker candidates wrote down the property measured by each unit, and some did make an attempt to convert to equivalent units, but not necessarily the base SI units.
Q1 (b). Candidates found it difficult to explain in words what is meant by error and uncertainty. More candidates were able to explain error.
Q1(c). Several candidates did not know that a barometer is used to measure pressure; a common incorrect answer was viscosity, and there were a number of responses which did not refer to a measured property such as 'water'.
Q1 (d). Most candidates showed understanding of how to calculate the mean, but a common error was to ignore the frequency column in the table and just add the four values of current and then divide by 4. Finding the standard deviation seemed to be more difficult and some candidates who attempted the correct calculation, made arithmetic errors. Some candidates showed no working so may have used a scientific calculator to work out both mean and standard deviation.
Q1 (e). This was difficult for most candidates, many of whom thought that this part carried on from part (d) and used the values calculated earlier in a calculation. Very few candidates answered this part correctly.

Question 2:
Q2 (a)(i). Whilst most candidates used the correct equation to calculate kinetic energy, many of them did not convert the speed in km h^{-1} to m s^{-1}, before carrying out the calculation. Another reasonably common error was to forget to square the speed.
Q2 (a)(ii). It was good to see that most candidates attempted to use the correct equation to calculate power, and many of them included the units in the final answer.
Q2 (a)(iii). This calculation proved difficult for many candidates. There was more than one way to work out this problem and there were a variety of attempts. This question in particular is one where candidates need to take care with their presentation, so that intermediate marking points can be gained.
Q2 (b)(i). Most candidates realised how to calculate weight, but many did not include the unit or incurred a power of ten error.
Q2 (b)(ii). Many candidates struggled with this calculation, and again if working was shown clearly candidates were able to gain credit for showing an intermediate step in their calculation.

Question 3:
Q3 (a). Many candidates showed some understanding of how to calculate total resistance for multiple resistors in parallel, but there were some mathematical errors. Nearly all the candidates were able to gain some marks for calculating current and power correctly in parts (ii) to (iv).
Q3 (b). Many candidates were able to correctly use the equation, but there were some power of ten errors.

Question 4:
Q4 (a). Some candidates found it difficult to extract the correct data from the information given on the diagram. Also, many candidates did not ensure that all the length measurements were in consistent units before tackling the calculations in parts (i) and (ii). However, most were able to distinguish stress from strain and go on to calculate Young Modulus in part (iv).
Q4 (b). This question was well answered on the whole.

Question 5:
Q5 (a). There were a variety of responses to this question.
Q5 (b). Most candidates were able to gain one mark here for understanding the relationship between gauge pressure and absolute pressure, but few were able to explain what is meant by the term gauge pressure.
Q5 (c). Many candidates showed good understanding in this question, and were able to correctly calculate both volume and density of the cube. There were some errors with powers of ten or omitted units. Some candidates used the incorrect value of force. Common incorrect answers were 'downwards' or 'upwards', showing that there may have been some confusion between upthrust and pressure.

Question 6:
Q6 (a). Most candidates were aware that latent heat was involved with the changing state of a material but many omitted to include reference to constant temperature, so were not awarded the mark in part (i). Nearly all the candidates identified the correct section of the graph.
Q6 (ii). Parts (i) and (ii) were generally well answered and it was good to see most candidates using temperature change in part (ii) and not temperature in Kelvin. Part (iii) was challenging so it was good to see many candidates making attempts at the calculation which gained them some of the marks. Again, this is another question where candidates who show their working carefully are able to gain credit.

Unit 3 - Principles of mechanical engineering

General Comments:

Many candidates show room for improvement in their presentation of answers to calculation questions. Such candidates would benefit from showing evidence of; the equation (or principle) used; rearranging; substituting; stating clearly their answer to an appropriate number of significant figures; including appropriate units. There were a number of missing or incorrect units being used for numerical answers and candidates need to ensure that they convert values to consistent powers of ten before carrying out any calculation.

Candidates' responses to questions 5(b) and 6(b) indicate that understanding of learning objective 4 is relatively weak.

Comments on Individual Questions:

Question 1:
Q1 (a). Most Centres had clearly given candidates good preparation in how to determine the coordinates of the centroid of a flat plate. Candidates lost marks mainly due to careless errors. Many candidates used a tabular approach to show workings for the individual parts that the plate is broken down into and this good practice. The best candidates also included summary equations before clearly stating their computed coordinates.
Q1 (b). It is worth noting that Factor of Safety is dimensionless. Many candidates made good use of the terms "plastic deformation" and/or "permanent deformation" in explaining what happens when the elastic limit is exceeded. Many candidates failed to score full marks for calculating shear stress because they omitted to include appropriate units. In this case this was explicitly required in the question, but it is good practice always to include appropriate units even when not explicitly required; sometimes candidates may "get away" without losing marks by not including units, but sometimes they will not – so it is strongly recommend that appropriate units are always included.

Question 2:
Q2 (a). Correct answers gave specific reasons for selecting "wormgear and wormwheels" rather than other types of gear arrangement. For example "high gear ratio" was not credited as it is too general (and can be achieved by many alternative arrangements).
Q2 (b).Most candidates correctly identified a class 1 lever.
Q2 (c).The best responses clearly stated the relevant basic formula used, showed rearrangement and substituted values, and then stated the calculated answer to an appropriate number of significant figures together with the appropriate unit. It would benefit all candidates to follow this approach.
Q2 (d).Most candidates were able to successfully apply their knowledge of gears to the situation involving 2 spur gears although most were unable to deal with calculations when an idler gear was introduced. It was pleasing though that most used the correct technical term for this 3rd gear.

Question 3:
Q3 (a). Most candidates were able to apply basic formulae to calculate power and kinetic energy. However very few candidates were able to deal with a simple conservation of energy calculation involving a collision between a moving and a stationary object.
Q3 (b). It was disappointing that so many candidates use the term "gravity" when they mean "weight" or "force due to gravity". There was good evidence that Centres had given candidates good preparation in the calculation a resultant forces by resolving into vertical and horizontal components. In most cases where marks were lost, this was due to careless mistakes by

candidates. Most candidates were able to calculate acceleration using their calculated resultant force and the mass of the object.

Question 4:
Most candidates were able to use suvat equations (or just the definition of acceleration) to calculate acceleration. Most were also able to calculate frictional force from the mass and coefficient of friction – although a significant minority omitted "g" from their calculations. Not quite as many candidates – although still a majority – were able to calculate the force required to achieve the acceleration. Learners may find it useful to draw a simple free body diagram in order to better understand situations like this one. Note also that the earlier comments on presentation and units are relevant here too.

Question 5:
Q5 (a).The most pleasing responses avoided examples that were simply too vague by making clear what structure the load specified was acting upon.
Q5 (b).With some notable exceptions, the vast majority of candidates scored very low – often zero – marks for this question. Question 5b is essentially a GCSE level science question although the context may be a slightly unfamiliar one. It seems clear that candidates need more practice and instruction in dealing with these simple moments questions. The parts of the question on bending moments and bending moment diagrams are different in that they would not appear on either GCSE science or A level physics specifications so this clearly represents a greater challenge for learners and Centres alike. However, the principles involved are relatively simple so again this is an area for more time spent in instruction by Centres and practice by learners.

Question 6:
Q6 (a).This question provided more evidence that most Centres had prepared their learners well for questions involving resolution of forces; most learners applied this knowledge successfully in this situation involving static equilibrium.

Q6 (b). This question provided further evidence that the majority of learners were not comfortable dealing with simple moments questions for a body in equilibrium. Candidates where low marks were scored in 5(b)(i) unsurprisingly tended to score low (or no) marks for 6(b).

Unit 4 - Principles of electrical and electronic engineering

General Comments

Questions on the use of the fundamentals (questions1, 2 and 6) were generally answered well. Questions on systems (3, 4 and 5), with a greater reliance on understanding, explanation and recall were not answered so well.

There was widespread misuse of the key words *current, charge, voltage, power, phase*, indicating a less than certain grip on the nature of electricity. It would seem that more time spent early on to embed these ideas would lead to more successful outcomes.

There were a number of missing or incorrect units being used for numerical answers.

A large number of learners were able to correctly substitute values into the appropriate formulas but then calculated the incorrect answer. Usually these candidates were not applying the BODMAS rules when using their calculators.

Comments on Individual Questions

Question 1:
Q1 (a) was a searching question on resistor combination that was usually handled competently provided time was taken to plan the three phases of the calculation. Most candidates recognised the need to use both formulae as appropriate.
Q1 (b) was also handled successfully provided all the data was used correctly.
Q1(c)(i) required recall and few candidates got it right.
Q1 (c)(ii). There appeared to be widespread misunderstanding of the term *'load'* in the context of the question.

Question 2:
Q2 (a)(i). Those candidates who understood to differentiate ***R, C, L, X, Z*** were usually successful.
Q2 (a)(ii). Very few used the correct formula I = V/Z.
Q2 (a)(iii) was not well answered and very few candidates were able to construct all elements of the phasor diagram.
Q2 (b). Recognition of the AC voltage waveform formula usually led to a good score in both parts.

Question 3:
Q3. Most candidates were unable to recall any of the methods of controlling speed. Of those who did very few were able to put together a coherent explanation to gain full marks.

Question 4:
Q4 (a). Many candidates could recall the star formation, many of those also indicating the neutral line. But there was very little evidence of an understanding of the significance of *line* and *phase* voltages.
Q4 (b). Few candidates appreciated that only one complete cycle should be depicted, with 120^0 phase difference between the three waveforms.
Q4 (c). Probably misreading the question, most candidates answered 230V or 240V.
Q4 (d) was generally well answered.

Question 5:
Q5 (a). Few candidates were able to recall all the details of this complex circuit.
Q5 (b). Fewer recalled the correct formula.
Q5 (c). At least one mark could be gained by correct substitution and correct unit.

Question 6:
Q6 (a). Recall of the logic gate symbols was good. Two inputs to the NOT gate and confusion between the AND and OR symbols were the two commonest errors.
Q6 (b)(i). Full mark responses to this question were commonplace.
Q6 (b)(ii). If candidates gave a correct response to 6 (b)(i), a good answer here commonly followed, despite scant evidence of the use of Boolean algebra.

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