CARIBBEAN EXAMINATIONS COUNCIL

REPORT ON CANDIDATES' WORK IN THE CARIBBEAN ADVANCED PROFICIENCY EXAMINATION MAY/JUNE 2009

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

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CARIBBEAN ADVANCED PROFICIENCY EXAMINATIONS

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UNIT 1

GENERAL COMMENTS

Three hundred and eighty-six (386) candidates were entered for the 2009 examinations in Unit 1 and two hundred and thirty-four (234) for examinations in Unit 2. In Unit 1, 72 per cent of candidates earned Grade V and above. In Unit 2, 82 per cent of the candidates earned Grade V and above.

Candidates performed poorly in Unit 1 Paper 01 and particularly in Module 3 of Unit 1. Candidates' performance in all three modules of Unit 2 was good. The performance on the Internal Assessment for both units continues to be very good. A large number of candidates continue to display poor drawing skills, limited design ability and a poor knowledge of ISO convention. Candidates need to improve their knowledge of engineering components, materials and manufacturing processes.

DETAILED COMMENTS

UNIT 1

Paper 1

Module 1

Question 1

This question tested candidates' knowledge of the principle of an archimedian. The majority of candidates that attempted the question were able to identify the curve with some candidates drawing the shape without construction. Most candidates had difficulty applying the data given to solve the problem. Generally the question was well done, with approximately 60 per cent of the candidates being able to solve the problem.

Question 2

This question tested candidates' ability to reproduce a quadrilateral and subsequently find the centroid. There was more than one method of finding the solution, and all of these methods were employed by the candidates who attempted this question.

The methods used in order of popularity were:

1. Re-entrant quadrilateral
2. Resolve into composites
3. Funicular or link polygon
4. Determination of centroid using first and second derived areas and the formula.

Over 90 per cent of the candidates attempted this question with 40 per cent giving a satisfactory performance.

Method 1

Candidates who used this method were generally able to divide the sides into 3 equal parts and from that create the re-entrant quadrilateral and finally the centroid from the mid-point of the intersecting diagonals. The only difficulty was misinterpretation of the continuous dimensions in the base of the figure which rendered the shape incorrect.

Method 2

This method was employed by 45 per cent of the candidates. Candidates were generally able to divide the quadrilateral into two triangles and find their respective centroids. However, in the determination of the areas, and finding the ratio to divide the line joining the centroids of the two now existing triangles to find the centroid of the quadrilateral, proved to be their common downfall. Most of them were awarded marks up to this point only.

Method 3

The candidates who used this method had difficulties with accuracy. Weaknesses in drawing skills were readily noted.

Method 4

Of the 2 per cent that attempted this method none of them were able to eventually find the centroid, and in a few cases no data was shown to support what was drawn. The candidates who used AUTOCAD to complete their drawings had difficulty in reproducing the drawing to the correct size, and in general did not provide any supporting evidence as to how the final results were obtained.

Question 3

This question tested candidates' knowledge and ability to construct a cam displacement diagram. The question was attempted by virtually all candidates and 60 per cent gave satisfactory responses. Most candidates constructed the simple harmonic motion curve properly, while 88 per cent failed to interpret the uniform acceleration and retardation curve.

Module 2

Question 4

This question tested candidates' ability to construct the curve of interpenetration. This question was attempted by approximately 90 per cent of the candidates. The majority of the candidates were unable to perform the necessary construction for the intersection. Most candidates used the construction for the intersecting of two pipes of different diameters.

Question 5

This question tested candidates' knowledge of oblique cabinet projection and ability to draw curves of the front face and the extension of those curves in the oblique plane. It was attempted by approximately 97 per cent of the candidates, however, only approximately 55 per cent were able to produce the correct solution required whilst approximately 25 per cent were able to produce the object in the oblique plane, but failed to show the correct outline of a tapered edge and the reduced rear (cabinet) view. The final 10 per cent reproduced the given figure and were only able to gain marks on the front face.

The 25 per cent of the candidates who were able to produce the oblique object seemed to have found difficulty in being able to construct the tapered outline. Moreover, the same candidates failed to produce the figure in cabinet view. However, construction of the oblique object was well done without the above mentioned requirements. This clearly indicates that candidates generally have a basic understanding of how to construct oblique drawings correctly, but need to have a greater understanding of how to apply a taper and cabinet view to an oblique drawing. Teachers should place more emphasis on teaching these two aspects to the students.

Question 6

This question tested candidates' analytical and graphical skills of auxiliary view. This question was compulsory and was attempted by 99 per cent of the candidates, 35 per cent gave satisfactory responses. It was well noted that most candidates constructed the two given views, but most failed to produce the true face of A.

Module 3

Question 7

This question tested candidates understanding and interpretation of the projection used and candidates' ability to produce a free hand isometric sketch in good proportion. It was compulsory and was attempted by just over 70 per cent of the candidates with the majority giving satisfactory responses.

Some candidates displayed an inability to draw in good proportion and with neat clear linework. Misinterpretation of some features of the projection shown led to the omission of simple isometric structures and form.

Question 8

This question tested candidates' knowledge of locking devices, manufacturing processes and materials. It was compulsory and was attempted by approximately 65 per cent of the candidates with about 40 per cent giving satisfactory responses. Some candidates displayed an inability to design a simple device to lock and swivel two tubes. They were unable to identify the manufacturing process necessary, and the material to be used.

Question 9

This question tested candidate's knowledge of limits and fits. It was compulsory and 97 per cent of the candidates responded. Many of the candidates demonstrated that they have knowledge of what tolerance is and were able to explain the two types of tolerancing. However, they seemed to have had difficulty in demonstrating the application through their drawing skill. Part (b) of the question was fairly well done with candidates providing reasonably good responses, demonstrating a full knowledge of the terms clearance and interference fit. Approximately 70 per cent of the candidates were able to successfully produce graphical demonstrations to further describe the two terms.

Paper 2

Module 1

Question 1

This question tested candidates' ability to construct cam displacement diagrams and cam profile to produce simple harmonic motion (SHM), dwell and uniform velocity (UV), using an in-line follower. The motion being anti-clockwise.

In this section of the paper, this question was optional but proved to be popular as it was attempted by approximately 85 per cent of the candidates. Eighty per cent (80 per cent) of these gave satisfactory responses.

Many candidates were aware of the cam displacement diagram and its function and relationship in terms of producing the cam profile. They were also aware of the importance of the follower motion. The weaker candidates confused the type of follower motion and some even ignored the type of follower as stated in the question. Most of the weaker candidates left out the roller center. Some of the candidates had difficulty in terms of plotting in an anti-clockwise direction.

In the classroom attention must be given to the accuracy and completion of different types of cam examples.

Question 2

This question tested candidates' knowledge of a simple crank mechanism and their ability to plot the locus of a point on a movable arm.

It was attempted by approximately 68 per cent of the candidates. 60 per cent of them gave an excellent response and received marks of 20 and above out of 25 marks. Approximately 25 per cent gave moderate responses and received scores ranging from12 to 19 out of a possible 25 marks. What was alarming was the number of candidates who offered poor responses to the question. About 15 per cent of the candidates scored less than 10 out of 25, with a high ratio scoring only 4 out of 25. This is an indication that some students had very little knowledge of this aspect of the syllabus. What is of even greater concern is the fact that this identical objective is covered at the CSEC level. Students at this level are expected to show mastery of this particular objective.

Question 3

This question tested candidates' ability to graphically locate the centroid of a figure. It was not very popular and was attempted by approximately 150 candidates, 35 per cent of whom scored less than 11 out of 25. About 10 per cent of the candidates scored 20 or above out of 25 and approximately 55 per cent scored between 12 and 19 out of 25.

All candidates were able to accurately reproduce the given figure. About 65 per cent of them were able to derive the first and second moment of area, however, many were not able to calculate the actual area of the given figure and the first and second derived figures. The calculation of the areas and the first and second moment using the formulae was the most poorly done part of the question. Many of the candidates did not attempt this part of the question. Lack of knowledge of the formulae proved to be the downfall of many candidates.

Module 2

Question 4

This question tested candidates' knowledge and ability to draw the development of a truncated oblique cone. Many candidates used the construction method used in the development of a regular cone. This question was attempted by just over half of the candidates and 50 per cent gave satisfactory responses.

In Part (A), the candidates were able to correctly reproduce the diagram as given.

Question 5

This question tested candidates' knowledge and ability to produce orthographic projection and isometric drawings. It was the most popular question done as almost all candidates attempted it. Generally, candidates made strong responses to the reproduction of the given views and scales were good. The general weakness was seen in their interpretation of the views given. The candidates often confused the plan for the front view. This led to an often incorrect position and projection of the end view. A further weakness was noted in the creation of the isometric view. There was a fair split in candidates providing the correct solution; a solution inverted, that is, Top down, and a solution with the top facing the right and the bottom facing the left. There also seemed to be a deficiency in their understanding of first and third angle projections.

Question 6

This question tested candidates' knowledge of auxiliary projection. The question was attempted by about 30 per cent of the candidates with about 25 per cent of them giving satisfactory answers.

Parts (a) and (b) of the question tested the candidates' knowledge of orthographic projection. This was fairly well done with some inadequacy in response to Part (b). Only few candidates gave satisfactory responses to Part (c) which indicated a lack of knowledge of **auxiliary** projection. The question asked for an auxiliary front elevation, however, some candidates attempted an auxiliary plan, while most candidates did not attempt this part of the question.

Module 3

Question 7

This question tested candidates' knowledge and ability to produce working drawings. It was very popular, with approximately 75 per cent of the candidates attempting it. The general level of performance was moderate and most candidates showed that they understood what working drawings were. The accuracy of views, when done, was good. The general area of weakness was seen in the placing of machine symbols. Less than 10 candidates placed any machine symbols at all. Candidates had some challenges in presenting well dimensioned drawings; arrow heads, leader lines and the like were below standard. Some candidates provided assembled isometric drawings.

Question 8

This question tested candidates' knowledge and ability to design a crank handle. Candidates did not fully understand the operation of the crank handle capable of driving a shaft in one direction and slipping in the other. Candidates were handicapped in producing neat labelled sketches of the components of the crankhandle and cross-sectional views.

Question 9

This question tested the candidates' knowledge of the design process and the use of engineering materials. It was attempted by just over half the candidates and about 70 per cent of them gave satisfactory answers.

Part (a) of the question was generally well done with candidates giving reasonable answers.

Part (b) of the question tested candidates' ability to explain their design. This was well done.

Part (c) of the question tested candidates' knowledge of manufacturing processes. This part of the question was misinterpreted by most candidates as they stated the design of the product without stating how the product would be manufactured.

Part (d) tested the candidates' knowledge of engineering materials. This part of the question was generally well done as they identified the relevant material for the specific application. However, some candidates used the words iron and steel interchangeably, which indicates a lack of knowledge of the difference between them. In some cases, even though the design was good in itself, it was ineffective for the application to the question.

UNIT 2

Paper 1

Module 1

Question 1

This question tested candidates' ability to determine graphically the reactions on a simply supported loaded beam. Candidates were to draw a load (force diagram) line to scale, complete the polar diagram, plot the link polygon and transfer the closing line to load diagram.

Most candidates attempted this question. A significant number performed mathematical calculations rather than the graphical approach to determine the reactions on the beam. About 30 per cent of the candidates did not apply BOW's notation and a few applied scales incorrectly.
Teachers are reminded that mathematical solutions are not allowed.

Question 2

This question tested candidates' knowledge and ability to sketch a gear wheel and label the different parameters. Approximately 95 per cent of candidates attempted it. Approximately 40 per cent of those who attempted this question showed some knowledge of the definitions, but were not too clear in their expressions. As for the sketch, about 60 per cent of the candidates who attempted the question were familiar with the diagram, but failed in proper labelling with arrow indicators.

Question 3

This question tested candidates' ability to reverse first and second auxiliary orientation. After reproducing the given drawing, they were to plot the plan and then project the front elevation of the lamina. Most candidates drew the figure as given but a few changed the general orientation. This may have affected them when it came time to plotting the plan and elevation. A significant number of candidates projected the first auxiliary (a2 b2) parallel to itself, rather than perpendicular to x1 y1 as required. Some candidates projected the plan at right angle to the right as opposed to vertically upwards as required. Obviously they are not used to reversing the auxiliary operations.

Module 2

Question 4

This question tested candidates' knowledge of engineering materials and their application. It was a two-part question which asked for recalling definitions and giving examples. It was a very popular question with approximately 98 per cent of the candidates attempting it. Candidates' responses were a little vague and for some the responses were mixed up. Overall, candidates showed a fair knowledge of the question, but failed at times to mention terms in defining an item. As for Section 2 of this question, there were overlapping responses and some candidates were a little off target in terms of materials relating to engineering. Exposing students to samples of these materials and their properties along with demonstrations would be of benefit to the student.

Question 5

This question tested candidates' knowledge of seals. It was attempted by more than 75 per cent of the candidates.

Part (a), requiring candidates to name the two basic seals, was not well done. In most of the responses, candidates could name the static seal only, with few being able to name both. In giving the examples, few of the candidates who were able to name both seals, incorrectly gave the O-ring seal as a static seal or the gasket as a dynamic seal.

Part (b), which required candidates to name the given seals that were shown, was not generally well done. Most of the responses showed candidates only able to name the split – ring and /or the gasket. In few of the responses candidates referred to the O–ring as a "ball" and the gasket as a "plate". Some candidates classified the given seals as either static or dynamic instead of giving the name. It is necessary to illustrate to students the seals in application and not just a pictorial representation.

Question 6

This question tested candidates' ability to produce freehand sketches. Approximately 90 per cent of the candidates attempted this question. Although the question stated that candidates should only sketch the rolling or sliding element, most of them went on to sketch a large portion of the entire bearing. Candidates should be instructed to read the question carefully. It is recommended that greater emphasis be placed on 3-dimensional sketches. Approximately 85 per cent of the candidates attempting this question failed to score a mark on Part (a), however, the question was fairly well done.

Module 3

Question 7

This question tested candidates' knowledge of the pulley system, and required candidates to describe how the tensioning of a belt drive could be achieved by (a) an idler pulley, and (b) a hinged mount.

This question was attempted by approximately 75 per cent of the candidates and was generally not well done. Only a few of the responses showed candidates ability to accurately sketch and describe the idler pulley and hinged mount tensioning the belt drive. Many of the responses showed candidates only had some knowledge of an idler pulley but could not clearly show or describe how the belt drive is tensioned. Many of the responses showed candidates having a weak or no knowledge of a hinged mount.

Question 8

This question tested candidates' knowledge and understanding of the stages in the design process. Approximately 90 per cent of the candidates attempted it.

Part (a) of the question required candidates to list the design stages in their correct order, while Part (b) required candidates to match each stage with its correct explanation. Although this question was fairly well done, Part (a) posed some difficulty, in that some candidates did not know the correct order. However, the candidates were more aware of the explanation for the different stages.

Question 9

This question tested candidates' knowledge and understanding of ergonomics in engineering design. Candidates were required to define the term ergonomics and describe four factors to consider in designing an instrument console. It was attempted by almost 90 per cent of the candidates and showed most candidates as having some understanding of ergonomics by giving a correct definition. Many of the candidates scored full marks on this question, which showed candidates stating the correct ergonomic factors. However, some responses showed candidates listing only aesthetic factors. This showed that candidates do not know the difference between ergonomics and aesthetics. In a few of the responses candidates incorrectly listed the steps in design process as ergonomic factors. Few of the weaker responses also showed candidates not having any knowledge of what a console was. It is important to emphasize and show how ergonomics is a part of the design process and not interchangeable with the design process.

Paper 2

Module 1

Question 1

This question tested candidates' ability to determine graphically the magnitude and type of forces for each member of a roof framing truss and to indicate the reactions. Many candidates attempted this question. The majority of them were able to determine the reaction of R1 and R2 graphically.

However, the second part of this question appeared to be more difficult, with less than 40 per cent of those who attempted the question being able to complete and indentify the forces and magnitude of each member of the framing truss.

Question 2

This question tested candidates' ability to calculate the various parameters of the involute gear and to construct a gear tooth profile. It was attempted by 42 per cent of the candidates with over 75 per cent giving satisfactory responses.

Many students were aware of the definitions and calculations pertaining to the involute gear terms. Many candidates were able to apply this information to the construction of the gear profile.

The weaker candidates confused the definition of terms and were unable to construct the gear profile accurately. Some candidates did the calculations accurately but were unable to produce the gear profile.

Attention in the classroom must be given to accuracy, completion and presentation of solutions for different examples.

Question 3

This question required candidates to reproduce the given parallelogram-shaped lamina with a vertical pole mounted in the centre. They had to determine the true angle between the pole and the lamina, the true shape of the lamina and label the true shape.

About 30 per cent of the candidates made errors reproducing the drawings. About 50 per cent of the candidates were able to successfully determine the angle between the pole and the lamina and a slightly larger number were able to project the true shape. Candidates who used the AUTOCAD program generally completed the question successfully. However, some printers (or plotting devices) were not able to print these drawings to a precise scale (e.g.1:1; 1:2; 1:5 etc). This presented a difficulty in verifying the accuracy of the drawings. Most candidates who determined the true angle between the pole and the lamina also found the true shape of the lamina.

Recommendations

Some candidates using the AUTOCAD program appear to produce similar results. Though it was doubtful that there was cheating on this question, as was evident on others, strict supervision is needed where AUTOCAD is used by candidates.

Module 2

Question 4

This question was a popular one, with approximately 95 per cent of the candidates attempting it. There were four parts to this question that asked for definition, application properties and samples of materials.

Part (a) was well done, as most candidates answered correctly. In Part (d) candidates were able to score well, as most had knowledge of the difference between Thermoplastic and Thermosetting plastic. This gave the candidates the edge for Part II of (d) by giving examples and uses from an easy recall.

As for Parts (b) and (c), candidates were weak in giving or identifying the properties, but the uses, candidates could give fairly well.

Perhaps, if instructors gave candidates research on these materials, the newly found knowledge would be recalled easily and accurately. These are materials that candidates see and feel, perhaps, everyday. Therefore researching them may enhance their ability to know them well.

Question 5

This question tested candidates' knowledge and application of the casting and moulding processes. They were required to give advantages and disadvantages of some processes. Candidates were also required to sketch two methods of manufacture.

Many candidates that attempted this question were unable to complete what was required or give clear reasons for each process stated.

Question 6

This question tested the candidates' knowledge and application of bearings and their ability to differentiate between journal and ball bearings.

This question attracted sixty-four responses many of which were poorly done. The marks ranged from zero to seventeen out of twenty-five. Sixteen (25 per cent) candidates scored 10 or more out of 25 with the marks clustering around 10, 11, 12, and 13.75 per cent of the candidates scored under 10 marks. This is cause for concern as the deficiencies were mainly in the same areas, function and application of journal bearing.

It is suggested that instructors pay more attention to this area as it is a critical area of the design of moving components.

Module 3

Question 7

This was not a popular question. The few students who answered it were able to describe the operation of a centrifugal clutch giving one example of its application. In regards to the sketching and labelling of the centrifugal clutch, few students were able to attempt the section with great success. The majority of candidates were able to state one main use and name two classes of couplings asked for.

The candidates performed reasonably well in describing the operation of the Oldham flexible coupling by the application of neatly labelled sketches.

Question 8

This question tested candidates' knowledge and understanding of designing, engineering materials, and methods of manufacturing, and applying these to the designing of an industrial wheelbarrow. It was attempted by over 90 per cent of the candidates, and was fairly well done. In most of the responses candidates were able to sketch a wheelbarrow and indicate the required components in Part (a).

Part (b) of the question, which required candidates to give details of how the wheel may be attached to the frame, was generally not well done. Only a few of the responses showed candidates being able to give appropriate details.

Part (c) was generally well done, with most candidates correctly explaining two ergonomic reasons.

Part (d) posed the greatest challenge, which required candidates to complete a table. Candidates were able to indicate the correct quantities of each component. Few were able to indicate correctly whether the component part was to be made or bought. Some candidates misinterpreted this part of the table by indicating a dollar figure (estimated price) in the make/buy column. Most candidates were unable to identify appropriate material and/or manufacturing methods for the component parts. Many candidates incorrectly named cast iron (material) and forging/casting (manufacturing method) for the handle/frame and the tray/bed.

Candidates should be able to select appropriate materials and manufacturing methods for various engineering components. This will require candidates' exposure to various engineering materials, their applications and limitations.

Question 9

This question tested candidates' ability to interpret design specifications. It was attempted by almost all candidates. Candidates considered the interpretation of the special feature to be optional while it was compulsory to the question. Candidates found Part (d) of the question to be difficult to answer.