

CARIBBEAN EXAMINATIONS COUNCIL

**REPORT ON CANDIDATES' WORK IN THE
CARIBBEAN ADVANCED PROFICIENCY EXAMINATION®**

MAY/JUNE 2012

GEOMETRICAL & MECHANICAL ENGINEERING DRAWING

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GENERAL COMMENTS

This subject consists of two units — Unit 1 and Unit 2. Unit 1 comprises two papers and so does Unit 2.

Papers 01 and 02 in Unit 1 each comprise three sections: Section A (Module 1), Plane Geometry; Section B (Module 2), Solid Geometry; Section C (Module 3), Mechanical Engineering Drawing.

In Unit 2, Papers 01 and 02 also consist of three sections: Section A (Module 1), Mechanics of Machines; Section B (Module 2), Engineering Materials and Processes; Section C (Module 3), Engineering Design Elements.

Paper 01 in each unit consists of nine compulsory questions each worth 10 marks, making a total of 90 marks for each paper.

Paper 02 in each unit consists of nine questions each worth 25 marks. Candidates are expected to answer six questions (two of three from each section) for a total of 150 marks.

In 2012, the mean mark on Unit 1, Paper 01 was 43.20 per cent which was in excess of the 2011 figure by approximately 6.5 per cent but lower than the 2010 figure by about 7 per cent, while the Unit 1, Paper 02 mean was 23.14 per cent which was lower than the 2011 figure by 11 per cent and smaller than the 2010 figure by 10 per cent.

In 2011, the mean mark on Unit 2, Paper 01 was 29.31 per cent which was 13 per cent lower than the 2011 figure and 11.5 per cent lower than the 2010 figure, while the Unit 2, Paper 02 mean was 43.31 per cent which was 1.5 per cent lower than in 2011, but almost 4 per cent larger than in 2010.

Overall, on Unit 1 there was a slight reduction of about four per cent in the mean when compared with 2011 and a decline of about 8 per cent when compared with that of 2010. Overall, on Unit 2, the 2012 mean declined by about 6 per cent when compared with 2011 and about 2 per cent when compared with 2010. With respect to grade levels, the percentage of candidates receiving Grades I–V was 61.30 while on Unit 2 the corresponding percentage was 74.90.

According to the examiners, the standard of work in Unit 1 was satisfactory for Modules 1 and 2; the majority of candidates did not perform well on the design question in Module 3.

On Unit 2, the standard of work produced was moderate, with only about 7 per cent of candidates obtaining Grades I and II and 17 per cent being awarded Grades I–III.

DETAILED COMMENTS

UNIT 1

Paper 01 – Short-Answer Questions

Module 1 – Plane Geometry

Question 1

This question tested candidates' knowledge, ability and drawing skills. In particular, it tested the ability of candidates to project an auxiliary view from a cutting plane and so construct a parabola.

The question was very popular with candidates. Across the region, there were many different approaches. Approximately 80 per cent of the candidates reproduced the diagram but were unable to produce various aspects for the solution such as projecting a line downwards from the lines going to the apex, and connecting at the inclined line to plot the points at the plane.

Added to this, candidates were heavily challenged in attempting to create the true shape formed by plotting the points on the right angle to the plane.

Candidates would do well to pay more attention to the points of intersection through extended practice.

Question 2

This question tested candidates' knowledge and ability to determine graphically the centroid of a lamina.

Many candidates (approximately 80 per cent) did a very good job of this question. Candidates managed to reproduce the diagram which included semicircles, rectangles and triangles. However, there were challenges such as finding the centre of the triangle and determining the ratio line; thus the centroid was not located. Many candidates guessed where the centroid of the figure would be located.

Question 3

This question tested candidates' ability to construct the profile of a plate cam given the performance graph and identify the type of motion imparted to a follower.

The majority of candidates answered this question and approximately 80 per cent of them gave satisfactory responses. Many were successful in reproducing the performance graph, and were able to accurately divide the base and to project the points in order to create it. However, about 50 per cent of the candidates had difficulty producing the cam diameter to the required measurements and below the base line of the cam graph as expected. Nevertheless, the majority of candidates successfully plotted the points, and joined them with a relatively smooth curve in order to complete the drawing. It should be noted that approximately 40 per cent of the candidates either did not remember to specify the type of motion or it was incorrectly stated. Specific instructions must be given to all candidates using Auto Cad to include the scale used as well as *all* construction lines, since many candidates submitted responses of completed drawings without construction lines.

Module 2 – Solid Geometry

Question 4

This question tested candidates' knowledge, ability and drawing skills in producing the orthographic projection with hidden details of a component in first angle projection.

This was a very popular question. Approximately 90 per cent of the candidates gave satisfactory to excellent responses. Approximately 25 per cent of the candidates were not able to position the projections correctly; in addition, a few candidates lost marks for producing a third angle projection instead of a first angle.

It is recommended that teachers emphasize the importance of sketching and that greater attention be paid to the variation in projection method for orthographic projection.

Question 5

This question tested candidates' knowledge, ability and drawing skills in producing an auxiliary view of a component by projecting from an elevation onto a plane. Most candidates were able to project the auxiliary elevation.

Of the approximate 93 per cent of candidates who attempted this question, 24 per cent completed the auxiliary view correctly; 49 per cent misinterpreted the question and produced the incorrect view.

Common errors included:

- Incorrect angle of the inclined plane
- Incorrect view chosen for the projection of the line to the given plane
- Incorrect angle used in the projection of the line to the given plane
- Incorrect plotting of the points in relation to the view
- Joining of points to achieve the desired view

Question 6

This question tested candidates' knowledge, ability and drawing skills in constructing the development of a truncated cylinder and projecting an auxiliary view to obtain the true shape of one of the cut ends of the cylinder.

Although most candidates drew the given views accurately, it was surprising that many either were unable to construct the development of the cylinder or produce the true shape of the cylinder. Of the approximate 93 per cent of candidates who attempted the question, 25 per cent did the development and true shape correctly; 49 per cent did the development alone and 24 per cent attempted the question but could not complete it.

Candidates should pay particular attention to the following:

- Projected lines to generate the true shape must be at right angle to the cutting plane.
- The development must be plotted in relation to the seam that is chosen.
- The points must be connected using a smooth continuous curve.
- The development must be clearly labelled.

Module 3 – Mechanical Engineering Drawing

Question 7

This question tested candidates' knowledge and skills in the isometric sketching of keys used in various power transmission situations.

Candidates were required to recall the rectangular, gib-head, feather and Woodruff keys. Approximately 44 per cent of the candidates attempted this question and roughly 30 per cent of

them gave satisfactory responses. Many of the candidates did not describe the keys or give their uses as required by the question. Furthermore, the majority of responses contained isometric sketches of the keys only, with very few candidates drawing each key and required shaft. In addition, over 80 per cent of the responses did not contain the feather-head key.

It is recommended that more emphasis be placed on the design section of Unit 1, Module 3.

Question 8

This question tested candidates' knowledge of the components inside an automobile engine, their relative motion, and candidates' ability and drawing skills in producing an assembly drawing of the components.

It was attempted by about 52 per cent of the candidates of which only 35 per cent gave satisfactory to excellent responses.

Part (a) was poorly attempted since most candidates misinterpreted what a line diagram is. Part (b) was also poorly done.

Part (c) had maximum response, however, some candidates had difficulty assembling the components and thus lost marks for application.

It is recommended that more emphasis be placed on assembly and working drawings and the importance of freehand sketching.

Question 9

This question tested candidates' knowledge and ability in the redesigning of a shaft bracket to accommodate a shaft with a larger diameter.

It was attempted by 66 per cent of the candidates. Although the question had asked for a redesign of the bracket via freehand sketch in good proportion, quite a number of candidates reproduced the sketch with no modification. Most sketches were not of good proportion.

It is recommended that emphasis be placed on well-defined freehand sketches. Design modification must be evident in the sketches and explanatory notation must synthesize with drawing changes.

Paper 02 – Essay Questions

Module 1 – Plane Geometry

Question 1

This question tested candidates' ability to plot the locus of a point on a circular lamina rolling along a horizontal surface and changing direction up an inclined surface. This question, although optional, was very popular. It was attempted by approximately 83 per cent of the candidates with more than 50 per cent giving satisfactory responses. The first part of the response showed that a majority of the candidates were aware of the topic and some of its requirements. The second part of the construction proved to be difficult for some as the line changed direction.

Generally, candidates demonstrated a grasp of copying the given diagram and plotting the locus of a point on the rolling lamina. However, some candidates experienced difficulty plotting the path of the points when the line changed direction.

Only six candidates received full marks. Most candidates did not locate the common centre for the two surfaces and assumed that the lamina would have reached the eighth position before reaching the inclined surface when in fact it was in between the seventh and eighth positions. Many candidates divided the length of the surface into 12 divisions rather than marking off the arc of the divided circle on the circumference. The horizontal line was not the length of the circumference of the given circle.

Question 2

This question tested candidates' ability to determine the centroid of an irregularly shaped lamina using graphical integration and to calculate the second moment of area. A large number of candidates attempted this question but the majority only reproduced the drawing. About five per cent of the candidates scored between 19 and 25 marks. A large number of candidates had difficulty constructing the derived curve correctly. These candidates determined that the centroid was to be found in the vertical line through the centre line of the figure and not through the point of the base. Some candidates erred when determining the areas by graphical means. They did not use the midpoints between the main divisions to connect to the pole. A few candidates did not transform the given figure to a common horizontal base before applying graphical integration to find the area of the given figure as required.

Question 3

This question tested candidates' knowledge, ability and drawing skills in constructing the profile of a plate cam given the motion imparted to a roller follower oscillating at the end of a lever. About 54 per cent of the candidates attempted this question, 40 per cent of whom were able to give reasonable responses.

Of those candidates who answered poorly, many did not use the correct cam follower; using instead a knife edge or an offset roller follower.

The question required candidates to apply a pivoting arm roller follower to construct the cam profile, in which case the rotating centre of the pivot would be used to draw the arc representing the movement of the roller centre. On this arc, the rise and fall would be marked off.

Candidates should pay attention to this topic and they should note that different types of cam followers and their position influence the construction of the cam's profile.

Module 2 – Solid Geometry

Question 4

This question tested candidates' knowledge, ability and drawing skills in producing an auxiliary view of an octahedron looking in the given direction. Very few candidates attempted this question and those who did clearly demonstrated a lack of knowledge regarding the construction of first and second auxiliary projection.

The difficulty candidates encountered in their attempt at this question was knowing how to produce a plan and elevation to establish true lengths and auxiliary planes. Most candidates simply reproduced the given pictorial drawing and attempted to project lines from it.

Question 5

This question tested candidates' knowledge, ability and drawing skills in constructing the development of a truncated oblique cone. Candidates were required to reproduce the given figure and draw the development of the truncated cone with the joint as specified. It was a very popular question and was attempted by just over 91 per cent of the candidates.

Generally, candidates demonstrated good understanding of the given elevation and they divided the base circle and projected those divisions to the apex of the cone to commence the process of the development. However, the majority of candidates displayed a lack of knowledge in

determining the true lengths. They also rotated one side of the elevation as given in their attempt to generate the development. They treated the oblique cone as a right cone and did not demonstrate an understanding of the difference.

Question 6

This question tested candidates' knowledge, ability and drawing skills in producing the plan from the front elevation of a cylinder passing through a sphere, and constructing the curves of interpenetration in the plan.

Seventy-one per cent of the candidates attempted this question.

Part (a) required candidates to draw the front elevation and plan of the sphere with the intersecting cylinder. Of the 363 candidates who attempted this question, 87 per cent scored less than 10 marks out of the allotted 25 marks.

In Part (b), candidates were required to construct the curve of intersection in the plan. As noted in Part (a) above, candidates were not able to perform the constructions necessary to obtain the correct curve of intersection. Quite a few did not show the cutting plane lines in addition to not projecting those lines from the sphere's circumference. The response of candidates indicates that many of them were not exposed to this method of construction to determine the curve of intersection.

It is recommended that candidates be exposed to the different methods of construction in determining the curve of intersection and when they should be applied.

Module 3 – Mechanical Engineering Drawing

Question 7

This question tested candidates' knowledge and drawing skills in producing a detailed working drawing of a shaft support, and determining the limits of the bore and shaft, and the type of fit. It also tested candidates' ability to understand and calculate tolerances, insert welding and machining symbols and produce working drawings. The question was attempted by over half of the candidates with under a third of them giving satisfactory responses.

Most candidates reproduced the given isometric, not giving working drawings of any type. Welding and machining symbols were left out of most answers. Dimensions were left off of some of the orthographic views drawn as working drawings, making them ineligible for maximum marks.

Most candidates read the inserted sheet and copied the correct figures but did not use the information to calculate the upper and lower limits correctly.

Greater emphasis should be placed on teaching the topic of tolerances and students should be reminded of what constitutes a working drawing.

Question 8

This question tested candidates' knowledge and ability to design a seat belt system for an automobile seat, give details as to how it is latched shut, opened, anchored, how it retracts when released and suggest suitable materials for each component.

Forty-three per cent of candidates attempted this question. The majority of them simply drew the given diagram or their version of an existing seat belt. No attempt was made to show how the mechanism worked.

Candidates seemed not to be aware of the design process and the importance of clear diagrams with labels.

The importance of clear, appropriately scaled sketches using orthographic principles was not demonstrated.

Question 9

This question tested candidates' knowledge and sketching ability in producing a neat, labelled isometric sketch of a metal machining lathe. Forty per cent of the candidates attempted the question. The majority of them answered the question satisfactorily, showing important details of the metal lathe, labelling correctly and drawing freehand in isometric projection.

Candidates who scored poorly did not correctly distinguish between a metal lathe and a wood turning lathe, and had poorly sketched drawings with few details.

UNIT 2**Paper 01 – Short-Answer Questions****Module 1 – Mechanics of Machines**Question 1

This question was designed to test candidates' knowledge, application and drawing skills of gears. It was divided into three parts.

Candidates who attempted Part (a) gave satisfactory responses. Most candidates could not produce suitable sketches for the gears, especially for worm and worm wheel gears. Since three-dimensional figures would give more clarity to sketches that were required, some candidates who attempted this approach lost marks because of their poor drawing techniques. Some of these candidates also failed to describe the gears in writing.

Part (b) was generally well done by candidates who attempted Part (a), in that they could easily indicate the direction of movement on the gears.

Part (c) was also well done. The majority of candidates could give an example of a practical application of each gear drawn. However, a few candidates gave some vague responses.

Question 2

This question tested candidates' ability to understand and apply principles as they relate to graphically determining the magnitude of a force using their respective drafting skills. The underlying concepts of Bow's notation and the resolution of forces were the underpinning concepts/principles for mastery of this question.

Candidates' responses to the question were relatively low with most candidates not attempting the question. However, candidates who attempted this question generally reproduced the given figure. Candidates in general lacked the ability to apply the principles of Bow's notation and also found it quite difficult to apply the principles to resolve the forces acting in the cables as a result of the imposed load.

Candidates who did well on this question correctly applied the principle involved in graphically determining the magnitude of forces using the principles of Bow's notation and force diagrams. It is necessary for the concept of force diagrams and Bow's notation to be reinforced with

candidates while allowing them to have the requisite amount of practice in order for the concepts to be entrenched using wide variables.

Question 3

This question required candidates to produce orthographic views (plan and front elevation) of two lines, and then project any auxiliary view from them.

The question tested candidates' knowledge and application of orthographic projection where a line in space is represented by a line drawn on a principal plane of projection, and is represented using the faces of the box which is positioned perpendicular to the parallel projector in order to obtain the views. Candidates were given the option to produce views using either first or third angle projection. Candidates were also tested on their ability to project an auxiliary view using any plane other than the principal plane of projection.

The question was a popular one, as 89 per cent of the candidates attempted it. Unfortunately, the responses to this question indicated a lack of understanding of the fundamentals of orthographic projection. Seventy-five per cent of the candidates who attempted the question failed to draw the correct orthographic views for the lines in Figure 2 (the given figure). Candidates demonstrated a lack of ability to make that transitional process from a three dimensional to a two dimensional space. Those who produced the orthographic views lacked the basic fundamental principles of obtaining an auxiliary view. Thirty per cent of the candidates scored at least 50 per cent of the total mark because they produced the plan and elevation but did not project the auxiliary view; other candidates who scored 61 per cent and above were able to project the correct auxiliary view.

Overall, performance on this question showed a deficiency in the amount of practice candidates received in producing orthographic drawings.

Module 2 – Engineering Materials and Process

Question 4

Part (a) tested candidates' ability to sketch two types of internal lubrication systems; (i) bath lubrication and (ii) splash lubrication. Part (b) asked candidates to sketch the O ring, V ring and U cup in operation with shaft and housing.

Part (a) was satisfactorily done by most candidates. However, candidates demonstrated a lack of ability in interpreting the splash lubrication system. As a result, over 65 per cent of them were reluctant to sketch a diagram that showed how the mechanism of the system would splash the

lubricant. A significant number of candidates were able to sketch the bath lubrication system. Weaker candidates drew diagrams with only one gear.

Part (b) was generally well done by approximately 75 per cent of the candidates. The general concerns were either the space between the shaft and seal or the seal not in contact with the shaft. Additionally, sketches showed the seal positioned incorrectly in relation to the direction of the shaft.

Question 5

This question tested candidates' knowledge of the use of an appropriate material for the manufacturing of the stabilizer bushings. It also required candidates to show an application of the bushing.

Approximately 80 per cent of the candidates failed to select the material most suitable for making the stabilizing bushing. Most candidates selected a metal which was inappropriate for the component. However, candidates described the manufacturing process for the metal they selected. Less than 50 per cent of candidates gave a satisfactory response to the manufacturing process of the material.

Approximately 90 per cent of the candidates selected a lubricant when none was required for the given bushing.

Approximately 67 per cent of the candidates who drew a freehand sketch to illustrate a typical application of the stabilizer bushing lacked the basic knowledge of sketching in either pictorial or orthographic format. In addition, candidates could not show or demonstrate how the bushing could be applied. It is recommended that teachers increase the amount of time students spend in problem-solving exercises involving freehand sketching using both formats.

Question 6

This question was designed to test candidates' knowledge of a connecting rod with numbered parts. The question was divided into four parts. Part (a) required candidates to identify the bearings and bushings in the diagram showing a connecting rod with its parts numbered. Part (b) required candidates to identify two materials each, suitable for producing a bearing and a bushing respectively. Part (c) required candidates to explain the purpose of both bearings and bushings and Part (d) required them to explain why an interference fit should not be specified for the bearings.

Part (a) posed a great deal of difficulty. Candidates were unable to identify the proper location of the bearing to that of the bushing. They were also unaware of the correct name for the lower and upper bearings and some went as far as to label the entire diagram unnecessarily.

Part (b) was generally well done. Weaker candidates were reluctant to give more than one required material in the manufacturing of bearings and bushings. Some gave materials that were considered substandard.

Part (c) was generally well done with over 70 per cent of the candidates giving satisfactory responses. However, weaker candidates were not able to give adequate explanations of bearings and bushing as used in the connecting rod mechanism.

Part (d) was well done by candidates as 85 per cent of them demonstrated knowledge of why an interference fit should not be used for bearings. They were also able to explain the impact of interference fits as it relates to space and moving parts, but a large number of them made no mention of the impact of hydrodynamic pressure in lubricating the bearings.

Module 3 – Engineering Design Elements

Question 7

This question examined the following general objectives of Unit 2, Module 3:

- Understanding of the different methods of producing engineering components
- Knowledge of the materials for the production of engineering components
- Design principles with respect to ergonomics and aesthetics.

The question tested candidates' knowledge and understanding of engineering materials and processes in terms of the production of engineering components and the manufacturing process applied to specific components. There was investigation of candidates understanding of the role of specific factors related to the engineering design process with special emphasis on ergonomics and aesthetics. The drawing skills of candidates were not tested in this question.

This question was very popular and was attempted by about 92 per cent of the candidates; it was however not well done by candidates. Weaker responses gave the manufacturing processes to which the components can be applied instead of those processes which were carried out in the manufacture of the components. Indeed, fewer than 80 per cent of the candidates responded closely to the desired solution set.

Candidates were also required to match specific engineering processes with the engineering materials. They were required to identify a material on which the application of the specific process yields a good result. Weaker candidates failed to identify any such material but stronger candidates were able to correctly match process to material. This aspect of the question was not very well done; in most responses, materials were ill-matched to processes.

Although many candidates displayed knowledge of ergonomics and aesthetics as general terms, several failed to apply these terms to the actual design/manufacturing process. There was an observed challenge for several candidates to link these concepts in the factors of consideration within the manufacturing process especially where aesthetics was concerned.

Many candidates did not use technical script but preferred to present responses in cursive writing. A few examples of pen and ink presentations were also observed. This style of presentation was often visually unclear and untidy in the case of weaker candidates. It must be noted also that there seems to be a general trend to avoid the use of the drawing paper and to defer to the use of guided script and/or answer booklets in the presentation of answers.

The mean score of this question was below 51 per cent, with fewer than 33 per cent of candidates scoring seven marks or more. Candidates seemed to have the required knowledge but organized their responses poorly.

Question 8

This question tested candidates' knowledge and application of the design process. Part (a) was fairly well done. Most candidates outlined, briefly, the roles of the given stages in the design process. However, quite a few candidates had knowledge of the design process but failed to express them effectively. Some candidates also misinterpreted the various components of the design process. They confused the *analysis* stage with the *evaluation* stage.

Part (b) was also fairly well done. The majority of candidates knew various methods of presenting a design. However, some of these candidates gave responses that overlapped with each other, for example, pictorial drawings, detail drawings, working drawings, blueprint and AutoCAD presentations would have fallen under the same drawing method.

Part (c) was satisfactorily done. The majority of candidates could not apply concepts of the design process to define the design problem effectively. Candidates should be introduced to various scenarios from which they would be required to practise defining the engineering problem.

Question 9

This question tested candidates' knowledge and understanding of automobile braking systems. The diagram for this question was an excellent illustration of an exploded 3D view of a disassembled, part-numbered rear braking system for a vehicle.

Part (a) required candidates to identify any three parts of the labelled diagram and provide its name. A large percentage of candidates were successful in providing the correct name for the parts they chose. Many candidates incorrectly labelled Part 2 as the brake drum. Some candidates confused brake disk and brake shoes. Additionally, there was some misunderstanding in being able to identify the parts labelled 8, 6 and 5.

Part (b) required candidates to describe the functions of each part chosen in Part (a). A high percentage of the candidates provided suitable responses to this part, particularly in the function of the brake shoes and how the braking process is accomplished.

Candidates were asked in Part (c) to state three purposes for brakes. Nearly all the candidates who responded to this section gave correct responses. Some of them, however, repeated a previously stated function.

Part (d) required candidates to explain why it is not good to oil brakes. A very high percentage of them provided appropriate responses to this question.

Paper 02 – Essay Questions

Module 1 – Mechanics of Machines

Question 1

This question tested candidates' ability to use their drawing skills to construct three gear teeth using a given set of parameters. About 56 per cent of the candidates attempted this question. The scores ranged from 0 to 25 with most scores ranging from about 7 to 18 and a few in the range of 0–7 and 19–25.

Overall, there were signs that this topic was covered but the problem was to accurately construct the gear teeth and label them. Candidates who did this item in AutoCAD failed to turn on certain layers as well as to scale the drawing when printing. Most candidates displayed evidence of knowledge of where to draw the pressure line, but failed to make it tangential to the base circle

as to the inner circle. Some candidates preferred the conventional method (approximate circle) over the involute method. All in all, a fair attempt was made by most candidates at this question but they could have done better if these points were addressed.

Question 2

This question tested candidates' knowledge and ability to determine graphically the reactions of a simply supported beam, draw the shear force and bending moment diagrams, and also find graphically the magnitude and position of the resultant.

This question was attempted by 84 per cent of the candidates; over 70 per cent of them were able to give better than satisfactory responses.

Candidates who did not give satisfactory responses were incorrect in their dimensioning and the placement of their load line, and were lacking in their ability to draw the horizontal lines to attain the required diagrams.

For improved performance, candidates need to spend more time on this topic, paying additional attention to the proper attainment of bending moment and shear force diagrams as this topic continues to form part of the required syllabus.

Question 3

This question tested candidates' knowledge, ability and drawing skills in constructing lines representing the shortest distance between two skew lines and correctly labelling the diagram. Generally this question was well done. Over 90 per cent of the candidates who attempted this question were able to reproduce the given views with correct dimensions. The production of the first auxiliary view was not too great a challenge and the majority of candidates were successful in doing so. The second auxiliary view was a little more challenging and about 60 per cent of the candidates successfully reached this stage. However, only about half of them were able to demonstrate any knowledge of the transfer of the shortest distance to the original elevation and plan.

The importance of neat labelling must be emphasized as too many candidates who otherwise gave a reasonable response were unable to get maximum marks because of poor labelling.

Module 2 – Engineering Materials and Processes

Question 4

This question tested candidates' knowledge of materials, their properties and uses. It required candidates to describe, give properties, uses and examples of the listed materials. Sixty-eight per cent of the candidates answered this question. Most candidates described ferrous metals and distinguished between the two types of plastics successfully. A large number of candidates were unsure of the description of grey cast iron. The area offering the greatest challenge was Part (c) which required candidates to give the properties and uses of the three alloying elements to steel namely molybdenum, chromium and chromium-vanadium. The part requiring candidates to describe and give one example of thermoplastics and thermosetting plastics was fully answered correctly by most candidates. Most candidates were satisfactory in their responses to the question.

Question 5

This question tested candidates' knowledge, design ability and drawing skills in the design of a shaft and housing assembly in which they were required to design suitable end covers, providing a means of lubricating and sealing the bearing, and securing the bearing in place using a collar and tab washer. This question was attempted by just over 57 per cent of the candidates, with just over 35 per cent giving satisfactory answers.

Most candidates reproduced the drawing but had difficulty correctly placing the bearing, tab washer and collar. The majority drew a ball bearing as opposed to a roller bearing even though the question stated that a heavy-duty roller bearing was to be used. The means of supplying lubricant to the bearing presented a challenge.

Candidates also opted to write about a method of sealing the assembly as opposed to incorporating it into the drawing. Greater emphasis should be placed on these types of sub-assemblies and their components.

Question 6

This question tested candidates' knowledge, ability and drawing skills in sketching the cross-sectional view of an automobile engine, and indicating the forward and return path of the lubricant. They were also required to state the type of lubricant used and the method of lubrication, while also listing the difference between oils and greases. Candidates were then

required to state how the sump and engine is sealed and explain what damages may occur to an engine that runs out of lubricant.

Approximately half of the candidates attempted this question and approximately six per cent gained a mark of 18 and above. Points of note are as follows:

- Candidates continue to demonstrate poor standards with respect to technical sketching. Neat, well-proportioned and clear diagrams are required. Accuracy and good draughtsmanship is essential for GMED.
- Most candidates understood that liquid lubrication was required; the majority of them suggested oil.
- Most candidates had no knowledge regarding the lubrication of combustion engine.
- The interpretation of the problem posed a challenge to some. When asked about the difference between oil and grease about 90 per cent of the answers referred to the use of oil and grease in the engine.
- A large number of candidates (about 50 per cent) suggested welding the sump pan to the engine block, displaying a lack of knowledge of the inner working of a combustion engine.
- An absence of clear and concise technical terms when writing about the lack of lubrication in the engine was apparent. The topic was not well done.

Module 3 – Engineering Design Elements

Question 7

This question tested candidates' knowledge of the parts and workings of a braking system and their drawing skills. It required candidates to label an automotive brake system and complete a cross-sectional view of where the wheel is situated. Candidates' performance on labelling the given diagram was average and they showed a fair understanding of how the disc brake works.

Given the sketches of the cross-sectional view where the wheel is positioned, candidates showed a lack of knowledge in this area; very few were able to show some kind of sketch and these attempts were weak. In preparing for the examination, a car specimen could be used to explain the disc brake system and explain its function. Also, allowing candidates to sketch and label what they see before relating it to a diagram could be useful.

Question 8

This question tested candidates' knowledge of the design process and their sketching ability. Candidates were required to suggest three possible solutions to a rigid stool which was to be

redesigned so that it would be able to swivel. They were further asked to outline a detailed reference of this mechanism as it applied to one of their possible solutions.

Part (a) was not done well. More than 85 per cent of the candidates were not able to clearly define the problem. In quite a few instances they just restated the problem that was already given.

For Part (b), the majority of the candidates were able to sketch three possible solutions and explain some aspects of them.

Part (c) was also well done. The majority of candidates suggested some kind of bearing mechanism in their design of the stool swivel. Approximately 76 per cent of the candidates scored 13 or more marks out of 25.

In Part (d), the total marks allotted for choice of materials was received by the majority of candidates. They selected an appropriate material and gave the properties.

Overall, responses to this question were above average with 88 per cent of the candidates attempting the question.

Question 9

This question required candidates to make a well-proportioned, labelled, cutaway freehand sketch of a motor and centrifugal pump directly coupled.

The question was not very popular, with just over 25 per cent of the candidates attempting it. Showing an appropriate means of coupling the shaft of the motor onto the pump was the difficulty encountered by most candidates; a small percentage of candidates also did not show the pump and motor coupled, while some only drew either the pump or the motor. Most candidates were able to give an appropriate application of the centrifugal pump.

Paper 03 – School-Based Assessment (SBA)

In 2012, the SBAs showed marginal improvement as teachers and students alike are becoming more familiar with the contents of the syllabus and what is required by CXC. We expect this trend to continue and that a good standard across the Caribbean is achieved in the very near future.

Both Units 1 and 2 produced work of a very high standard. That being said, it seemed some schools were not too familiar with the contents of the syllabus and what was required. This was revealed during moderation of the SBAs. This occurrence must be eradicated.

UNIT 1

As with last year, the standard of work produced in Modules 1 and 2 continue to grow with time but Module 3 seems to receive less attention in the development of skills, especially in the area of design. Assignment 5 was only satisfactorily done.

In this session of moderation, 61 centres were registered and six of these did not submit any SBA samples for moderation. Most centres (60 per cent of them) submitted the requested five samples per centre with the majority of the remaining 40 per cent submitting only one sample, mostly due to the fact that only one student was registered for the subject.

The quality of the folders presented was generally good with only a few centres producing work below the CAPE standard. However, it must be noted that not all students or entire folders were guilty of this.

Of the 55 centres that submitted folders, only three schools submitted both the GMED 1-1 and the GMED 1-3 forms. Of those two forms, only one was helpful in that it provided a breakdown indicating how the teachers marked each student. The GMED 1-1 form was revised in 2004 and, with minor adjustments to the Assignment 5 criteria, would be preferred. That being said, about 65 per cent of the schools printed out the schemes and submitted them with marks. These scores are important during the moderation process as they provide the moderator with information regarding how the teacher would have graded the student and then the appropriate recommendation can be made if necessary.

When submitting work in AutoCAD, students are encouraged to save the file as an “***AutoCAD 2004 Drawing (*.dwg)***” file type, simply for compatibility reasons. Also AutoCAD drawings should be printed in the event that the floppy, CD or flash drive gets damaged in transit, as has happened before. If there is an issue with printing from AutoCAD, then simply export/copy the drawing into Microsoft Word and print it from there.

A much larger percentage of schools submitted the questions given to the students for the SBA and this was pleasing to see. Thus, it should be reiterated that all schools submitting SBA samples should submit the assignment questions as well. This would be very useful during the moderation process.

In terms of grading, 51 per cent of grades were acceptable this year when compared to grades that were unacceptable (lenient, severe or inconsistent) which shows that though improvement is evident, there is still some distance to go.

It should be noted that students are only required to submit one drawing per assignment and each on its own sheet of drawing paper, except for Assignment 4 which is done on A4 paper. Too many drawings on one sheet create confusion at times. Teachers are reminded that they are required to submit six original drawings for the Unit 1 SBA.

Brief Summary of Each Assignment

Assignment 1 – Centroids

There was much improvement in this area, falling only by misunderstanding of the calculations required to find the centroid especially using first and second moments or lack of knowledge of how to find the centroid from calculations. In this session, using the first and second moment method was very popular. However, many solutions came directly from the textbook. Approximately 70 per cent of the centroids were very well done.

Assignment 2 – Cams

Once again, this topic was very well done with only cam centres and directions of rotation missing. The cam displacement diagrams and their profiles were generally well labelled. There were some students who did not align the graph to the profile and provided little or no construction. Teachers must ensure that in the SBA, attention is paid by students to detail and to correctness.

Assignment 3 – Development and Interpenetration

Approximately 85 per cent of the work done was satisfactory. However, the use of straight lines to build/produce a curve must be discouraged. Some students have been using curve drawing apparatus (French and Flexi curves) to obtain a smooth curve. But if this method is used, the resulting curve must be seamless and very smooth.

If students use CAD software to produce this assignment, they should have a good understanding of line weights, line types and layers (if they intend to use layers).

Assignment 4 – CAD

Drawing using CAD software is very popular now, with a growing number of schools submitting all of their work in AutoCAD. However, it was noted that the level of the CAD drawings were too low albeit recognizing that the syllabus just states *Use of CAD software to produce solid geometry drawings*.

Many of the CDs or flash drives submitted did not open due to the fact that versions older than AutoCAD 2006 are not currently supported by the computer used during marking.

Assignment 5 – Design

The design process continues to be challenging for most students. The basic steps of the design process needs to be adhered to even though what is required is not as in-depth as Unit 2.

The design needs to be coherent, flowing from point/stage to point/stage with justification of the best design chosen, final sketches and final drawings.

Too many folders lacked good organization. Some designs seem to have been thrown together. A write-up must be included in the design in order to convey what the design is all about. This was lacking in many cases.

Assignment 6 – Assembly/Engineering Drawing

This assignment was generally well done (about 90 per cent of the time). Some drawings were very impressive in terms of the attention to detail and layout.

What was noted, however, was that many of the questions given were from a popular textbook known for having the solutions to the assembly drawings at the back of the book so a student's true potential at assembling was not always evident.

Some students got very deep into the assignment; going way pass the CAPE level and using 3D modelling.

Recommendations

- For Assignment 4, students should be given a bank of questions to choose from with two students at most doing the same question. This would minimize the likelihood of mass copying.
- Some students handwrote their reports for Assignment 5, but they were not legible (very difficult to read). Thus we suggest that reports be typed in a legible font (Times New Roman, Arial, 12-font, etc.) and submitted.
- Generally, when using CAD software, students should choose line colours and line weights that make the outline of the drawing stand out. Outlines should be thicker.
- Again, AutoCAD Assignment 4 must be prepared in such a way that students' answers are different in each case (because it is easy to copy and paste). For example, a possible

question might be *Draw an isometric from a given orthographic projection with different low points A, B, C and D* for different candidates.

- Finally, teachers of CAPE GMED should meet and discuss questions for the SBA and examinations and generally brainstorm so as to keep that subject and its content relevant and to attain a reasonable standard in delivery across the centres.

UNIT 2

Teachers and students are encouraged to follow the syllabus and the mark scheme in terms of ascertaining what is required and how it should be done. Approximately 75 per cent of students lost marks because they did not follow the guidelines outlined by the syllabus in terms of the layout and content of the portfolios. The standard of the drawings also showed marginal improvement, faltering only in respect of basic alignment and construction techniques.

In moderation for Unit 2, there were 46 centres registered of which 42 centres submitted folders. Approximately 57 per cent of those 42 centres submitted the required five samples with the majority of those remaining submitting only two samples, mostly due to the number of candidates in a particular centre being small.

The quality of the folders presented for moderation was poorer this year when compared to 2011. Once again, the issue of a standard across all centres comes to the fore. Some design projects were very difficult and were graded severely, whilst others were quite simple and almost received full marks. Some portfolios were poorly organized or laid out.

The GMED 2-1 form was not submitted at all; hence a breakdown of teachers' marks was not always forthcoming. However, quite a few schools printed the mark scheme and submitted that along with the portfolio.

When submitting work in AutoCAD, candidates are encouraged to save the file as an "***AutoCAD 2004 Drawing (*.dwg)***" file type, simply for compatibility reasons. Also AutoCAD drawings should be printed in the event that the floppy, CD or flash drive gets damaged in transit, as has happened before. If there is an issue with printing from AutoCAD, then simply export/copy the drawing into Microsoft Word and print it from there.

Over 52 per cent of the grades received were acceptable with most of the others being lenient or severe. Thus, like Unit 1, there is still some distance to go in terms of standards.

Some schools must be commended for the detail they placed in the research phase of the design. However, such elaborate research sometimes borders on irrelevance and must be monitored by the teacher who must keep students focused and on track.

Brief Summary of the Design Phases

In the development of the project (Phases 1, 2 and 3), students generally understood the process involved and supplied moderate to good information regarding their project. Missing, however, were proper work programmes and a good analysis/synthesis of the design of the project.

The use of CAD this year was only satisfactory, with quite a number of schools submitting work that could be described as being poor. Some schools were excellent but it was evident that those schools had a thriving GMED program. Those students who did not submit any CAD either had no CAD software at the school or they had limitations in getting access to the CAD software (mostly due to time allocation).

Most students fell down in the areas of technical and project reporting due to a lack of understanding of what was required for submission. It should be stated that good information was provided during the reporting but oftentimes it was irrelevant and took the reader too long to get to the information actually dealing with the design in question. The communication of the information contained in the report needed to be better organized and more logical, for example, Step 1 should have been followed by Step 2 and so on.

Generally the content of the portfolios was fair and provided enough evidence of a design process and the elements thereof. About 15 per cent of the portfolios received were packed like playing cards held together by paper clips at times. Again, students are encouraged to take pride in the work they do or submit.

In terms of the interactive presentation, about 70 per cent of the schools provided proof of such and showed the breakdown of the marks accordingly.

Recommendations

- Teachers should receive a draft of the report, make corrections if necessary, and send it back to students for final adjustments before final submission. Submission of unfinished reports or reports with errors and corrections should be discouraged.
- Teachers need to ensure that students stay on task and submit all relevant information for the report. Students should be kept focused and gently guided to the completion of their reports.

- Teachers are encouraged to develop a checklist of the item/content of the portfolio needed for submission. Such as:
 - ✓ Phase 1 – Conceptualization
 - ✓ Phase 2 – Design of project
 - ✓ Phase 3 – Work programme
 - ✓ Use of CAD
 - ✓ Project Report:
 - Proposal
 - Scope and specifications
 - Constraints and limitations
 - Final design (sketches, detailed drawing and so on)
 - Logical communication
 - ✓ Good Content
 - ✓ Evidence of an interactive presentation

This information does not necessarily have to be itemized, but it has to be present in the design portfolio.

- Teachers are encouraged to submit the GMED 2-1 form which is very useful during the moderation process.