C A R I B B E A N E X A M I N A T I O N S C O U N C I L

REPORT ON CANDIDATES' WORK IN THE SECONDARY EDUCATION CERTIFICATE EXAMINATION MAY/JUNE 2007

MECHANICAL ENGINEERING TECHNOLOGY

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TECHNICAL PROFICIENCY EXAMINATION
MAY/JUNE 2007

GENERAL COMMENTS

1 475 candidates entered for the 2007 examination compared with 1316 for the 2006 examination. This represented an increase of 12.08%.

Of the 1 475 candidates entered for the examination 58.1% of the candidates earned Grade III and above.

Candidates did well on the practical project for the Internal Assessment component (SBA) but there is need for improvement on the written project. Question 1 on Paper 02 continued to be a major challenge to many of the candidates.

DETAILED COMMENTS

Paper 01 – Multiple Choice

This paper consists of 60 items testing the theoretical aspects of the Unit. There were 30 items testing the Knowledge profile and 30 items on the Application profile. The topics that most candidates found difficult were:

1. Items that are essential for carrying out a brazing operation
2. Reasons for annealing metal
3. Current setting of arc-welding machines
4. Factors affecting life of grinding wheels
5. What causes high speed steel to retain its hardness at high temperatures

PAPER 02 – Essay/Structured Response Questions

Section A

Question 1

Candidates were required to complete the design for a drilling jig. The frame of the jig was to be made of two pieces of mild steel bars (vertical and horizontal supports) joined together at right angles.

For each operation the piece of pipe should be firmly clamped to the horizontal support by the movable jaw in order to drill the hole. A bushing was to be fixed to the movable jaw to guide the drill and prevent it from drifting off to the side of the pipe.

The movable jaw was to be operated by a quick-locking and upward-releasing mechanism to allow the easy loading and removal of pipe from the jig.

A removable stop guide was put in place to locate the position of the hole to be drilled.

The jig, when installed, was to be firmly attached to the base of the drilling machine table.

The major design considerations were:

(a) A method of joining the vertical and horizontal supports.

This could have been done by using machine or cap screws for the attachment or they could have been welded together.

Most of the candidates that attempted the question indicated that they would weld the pieces together. Some suggested bolting together, riveting, etc. Some of these solutions could work effectively depending on how they were done.

(b) The locking mechanism used to secure the pipe for drilling.

This could have been done by using a cam lock system which would allow quick locking and release. However, most candidates used threads in one form or another to secure the pipe, but these solutions did not really offer a means of quickly locking and releasing the pipe. Some candidates used G-clamps to hold the pipe while others used bolts that went through the pipe. On the whole this aspect of the question was not well done and it would appear that more time needs to be spent looking at locking mechanisms during the course.

(c) A bushing for guiding the drill during the drilling process

This aspect of the question was not handled well as some of the candidates did not seem to know what a bushing was. Instead of securing the bushing in the movable jaw as was suggested some candidates had their bushing suspended in the air without any support. Some candidates used arrows to indicate where the bushing should be located but could not make sketches to represent the bushing. Here a sectional view could have been used to show clearly the bushing in place in the movable jaw.

(d) The mechanism in place for lifting the movable jaw each time the lock is released.

The most common means of lifting the jaw that was used by the candidates was a rack and pinion. This was not a very appropriate solution as most of them attempted to attach the rack and pinion to the column of the drill press. Some candidates hinged the movable jaw to the upright, which would create a problem each time it is raised as it would be forced to hit against the drill.

Here simple springs could be used to raise the jaw each time the lock is released. The springs could be placed between the movable jaw and the horizontal support on guide rods fitted to the horizontal support and passing through the movable jaw.

(e) A method of securing the stop guide to the frame.

This could have been done by using counter sunk or cap screws to secure the guide without causing any interference to the pipe. Some candidates welded the guide in place, which would make it permanent. This was not a very good solution as one should be able to replace a guide if changes are to be made to the location of the hole being drilled. Some candidates used hexagonal head bolts which would interfere with the pipe being drilled.

(f) The frame of the jig attached to the machine table.

This section of the problem was dealt with fairly well even though a large number of the candidates threaded bolts directly into the machine table. This solution would work but it was thought that it was not very appropriate to drill and tap the machine table; bolts and nuts

would have been more appropriate since there are usually slots on the drill press table for accommodating such fasteners.

This compulsory question was again a problem for quite a number of candidates. The ability to interpret the drawing and provide suitable sketches of the solution seemed to be beyond a number of these candidates. It appeared as if they were not given enough exposure to the area and this needs to be addressed if there is going to be any improvement to the performance of candidates on the question. Some candidates reproduced the given drawings without doing anything with respect to a solution.

Candidates should be encouraged to include footnotes along with their sketches, and use localized sections of areas that need to be made clear for proper interpretation. They should also be advised to use more than one view of the completed component to add to the clarity of the solution.

Section B

Question 2

The objective of this question was to test the candidates' knowledge of:

(a) How to determine the tap drill for a particular thread size.

(b) The steps of procedure to be followed to reduce the risk of tap breakage while threading a blind hole in a component.

(c) Methods that could be used to remove a broken tap from a hole.

(d) The use of sketches to show the THREE types of cold chisels used in the workshop.

(e) The use of sketches to assist in explaining the procedures for using various chisels in the workshop.

(f) Precautions that should be observed while using a chisel in the workshop.

This question was attempted by 82% of the candidates.

Aspects of the question that were well done include the following:

- Steps of procedure for threading the component
- Safety precautions to be observed while using a chisel

Aspects of the question that were not well done include the following:

- How to determine the tap drill size for a hole
- How to extract a broken tap from a hole

Most candidates felt that a drill would be most effective in drilling out the broken tap. Some attempted to break up the tap with a chisel and remove it. This could be done if there was enough space in the hole for the operation.

– The sketches used to display the types and uses of chisels were very poor in most cases, and this is an area that should be improved as a lot of sketching is required in the examination.

Question 3

The objective of this question was to test candidates' knowledge of:

(a) (i) The steps of procedure for marking out a template on sheet metal.

(ii) Naming the tools to be used in the marking out process.

(b) The procedure for cutting out a slot with a large radius in sheet metal

(c) The tools to be used in the cutting out process

(d) Precautions that should be observed while marking out sheet metal to ensure that accuracy is maintained.

(e) Safety precautions that should be observed while cutting out slots in sheet metal.

This question was attempted by 86% of the candidates.

Aspects of the question that were well done included the following:

– Naming the tools to be used in the layout process
– Precautions to be observed while marking out to ensure accuracy is maintained
– Precautions to be observed while cutting out the slot

Aspects of the question that were not well done include the following:

– Steps of procedure for marking out the template.

  Here most candidates did not indicate the various areas of the template that they were marking out. For example: Some candidates simply said "mark horizontal lines, mark vertical lines", but they did not indicate where the lines should be marked. The measurements indicated on the given drawing should be used as the guide for listing the steps for marking out. A statement should therefore indicate for example, "Using the given base as datum, mark horizontal lines at 15 mm, 45 mm and 85 mm on the template". They could then go on to mark vertical lines in a similar manner.

– Procedure for cutting out the required slot.

  Some candidates attempted to use a 50 mm diameter drill to drill out the slot, which was not a good idea, considering the thickness and size of the material.

Question 4

The objective of this question was to test the candidates' knowledge of the process of producing a component on the centre lathe from a piece of mild steel stock. The challenges included:

(a) Using sketches to assist in outlining the steps of procedure for making component.

(b) Knowledge of the tools to be used in the procedure.

(c) Understanding the procedure required to produce a knurled section on a component.

(d) Knowledge of precautions to be observed while producing a knurl on a component.

(e) Calculating the spindle speed that is required to produce a specific size given the cutting speed of the material.

(e) Knowledge of safety precautions that should be observed while working on the centre lathe.

This question was attempted by 45% of the candidates.

Aspects of the question that were well done included the following:

- Safety precautions to be observed while working on the lathe
- Tools to be used to produce the component

Aspects of the question that were not well done include the following:

- Using sketches to assist in listing the sequence of operations for producing the component
- Calculating the spindle speed for the operation
- Steps of procedure for producing the knurled section of the component

Question 5

This question tested the candidates' knowledge of the process of sheet metal work. The challenges included:

(a) Making a well proportioned labelled sketch of the development of a funnel indicating allowances for the following:

(i) Hem

(ii) Groove seam

(iii) Lap joint

(b) The steps of procedure for sweat soldering the spout to the top of a funnel.

(c) The steps of procedure for producing a folded and grooved seam.

(d) (i) How to determine size of a tin man's snip.

(ii) Methods of producing small holes in tinplate.

(e) Safety precautions that should be observed when working with sheet metal.

This was not a popular question. It was attempted by only 18% of the candidates.

The question was very poorly done. It would appear that more time needs to be spent on this section of the syllabus. The only section of the question that was well done was the section requiring candidates to state safety precautions. Most of the candidates were not familiar with "sweat soldering" so they could not list the steps required for carrying out the process.

Question 6

This question tested the candidates' knowledge of milling operations. The challenges included:

(a) The cutting tools that should be used to produce a dovetail slot on the vertical milling machine.

(b) The steps of procedure for producing the slot on the vertical milling machine.

(c) Factors that could negatively affect the life of a cutting tool.

(d) The primary purpose of the dividing head used in gear cutting operations on the milling machine.

(e) How to calculate simple indexing for various numbers of divisions given the desired hole circles.

(f) Safety precautions to be observed while using the milling machine.

This was not a popular question. It was attempted by only 32% of the candidates.

This question was also very poorly done. Some of the candidates who attempted the question did not seem to be familiar with the milling machine. They attempted to use a hacksaw and chisel to produce the groove in the component.

Only a few of the candidates were able to calculate the indexing required for producing the number of divisions indicated.

The candidates were not familiar with factors that could negatively affect the life of the cutting tool.

It would appear as if a vast number of the candidates were not exposed to the various machines and their operation in the workshop.

Question 7

This question tested the candidates' knowledge of either the oxyacetylene or the arc welding process. The challenges include:

(a) (i) How to sketch and name the sooty flame produced when the oxyacetylene torch is lit.

(ii) The reason for the particles of soot produced by the flame.

(b) Copying and completing the welding and brazing columns of the given table to match the factors column.

Factors		Welding	Brazing
1.	Filler rod material		
2.	Type of flame		Carburizing
4.	Fusion of work pieces		

(c) The steps of procedure to be followed in using oxyacetylene welding to join two pieces of 15 mm diameter steel bars end to end, ensuring strength and dimensional accuracy of the finished product.

(d) The procedure for lighting an oxyacetylene torch and adjusting it to create an oxidizing flame after both valves on the cylinders have been opened.

(e) Safety precautions to be observed when using oxyacetylene welding equipment.

OR

Candidates were required to demonstrate knowledge of:

(a) Possible reasons why an arc did not occur when the tip of an electrode was scratched on a work-piece at the beginning of an arc welding operation.

(b) The steps of procedure to be followed in using electric arc welding to join two pieces of 20 mm diameter steel bars end to end, ensuring strength and dimensional accuracy of the finished product.

(c) Pieces of safety equipment commonly used in the arc welding process.

(d) Using sketch/sketches to illustrate the set-up to perform an arc welding process using reverse polarity, and identifying the position of the following:

(i) Work

(ii) Ground connection

(iii) Direction of current

(iv) Electrode

(e) Using sketches to explain the TWO methods of starting an arc.

(f) The functions of the coating on the arc welding electrode.

This question on welding was attempted by 51% of the candidates.

However, it was not well done as most of the candidates were unable to outline procedures clearly, and where sketches were required these were very poor.

Aspects of the question that were well done included the following:

– Setup for reverse polarity

– Procedure for lighting the oxyacetylene torch

Question 8

This question tested candidates' knowledge of materials and how they are processed. The challenges included:

(a) (i) The approximate carbon content of high carbon steel

(ii) The minimum temperature to which high carbon steel should be heated for hardening.

(iii) The steps of procedure required to harden a cutting tool.

(iv) The changes that occur to a material when it is tempered.

(b) (i) The difference between thermoplastics and thermosetting plastics.

(ii) Different types thermoplastic and thermosetting plastic materials.

(iii) The uses of various thermoplastic and thermosetting plastic materials.

(c) (i) The use of sketches to list the steps of procedure for producing an eye on a piece of 8 mm diameter mild steel.

(ii) The use of sketches to list the steps of procedure for drawing down a piece of 8 mm diameter mild steel bar to a point.

This was not a popular question as it was attempted by only 15% of the candidates.

It would appear as if this section of the syllabus was not covered adequately by teachers in the various schools. This question was very poorly done by the candidates who attempted it.

Aspects of the question that were not well done included the following:

- Giving the approximate carbon content of high carbon steel
- Steps of procedure required to harden a tool
- Changes that occur in a material that has been tempered
- Explaining the difference between thermoplastic and thermosetting plastic materials
- Stating the uses of thermoplastic and thermosetting plastic materials
- Producing an eye in forging and drawing down a piece of round stock to a point.

Question 9

The objective of this question was to test the candidates' knowledge of bearings, gears and motions. The challenges included:

(a) (i) Friction and antifriction bearings.

(ii) The use of sketches to show applications friction and antifriction bearings.

(iii) Naming the various parts of an antifriction bearing.

(b) (i) The use of sketches to indicate the driven gears in a mechanism and explanation of how the gears could be used to reduce speed in the mechanism while maintaining the same direction.

(ii) The use of sketches to show how rotary motion can be changed to lateral motion.

(c) The properties of lubricants.

This was not a very popular question as it was attempted by only 6.29% of the candidates.

The question was also very poorly done.

Aspects of the question that were not well done included the following:

- Naming friction and antifriction bearings
- Sketching to show applications of the various bearings
- Naming parts of and antifriction bearing
- Explaining how gears can be used to reduce speed while maintaining direction in a mechanism
- Showing how rotary motion can be changed to lateral motion
- Stating the properties of lubricants

Notes to Teachers

1. The written report is an individual assignment and should be treated as such by students.

2. More attention needs to be paid to Unit B8 of the syllabus which addresses Question 1 on Paper 02. This could be achieved by addressing the following suggestions:

    - Students should be given exercises in designing which involve sketching and making models.
    - Students can be taken on field trips to various industries where aspects of mechanical devices/mechanisms not seen in the school workshop can be seen.
    - Teachers should assist students in examining and reporting on mechanisms relating to machines in the school's workshop.
    - This process might involve the taking down of machine guards etc. It is important to remember however that machines should be shut down before these operations can be carried out.

3. When schools do not have the machines required for the programme, students can be taken to centres where these are available and have suitable persons giving demonstrations of the uses of these machines.

4. Students should be encouraged to provide sketches to assist with their explanations in answering various questions.