# SENIOR CERTIFICATE EXAMINATION

# FEBRUARY / MARCH

# 2007

## WELDING AND METALWORKING

**SG**

**716-2/0 E**

WELDING & METALWORKING SG
Question Paper & Answer Book

716 2 0E SG

11 pages

X05

**GAUTENG DEPARTMENT OF EDUCATION**
**SENIOR CERTIFICATE EXAMINATION**

**WELDING AND METALWORKING SG**

**TIME: 3 hours**

**MARKS: 200**

**REQUIREMENTS**:

- Answer book
- A3 drawing answer book
- Drawing instruments and approved pocket calculator

**INSTRUCTIONS**:

- You must answer FIVE questions.
- Section A is COMPULSORY.
- Number your answers in accordance with the question paper.
- Only the first five questions will be marked. Cancel all questions that should not be marked.

## SECTION A
## COMPULSORY

### QUESTION 1

1.1 Indicate whether the statements below are TRUE or FALSE. Write down only the question number and next to it TRUE or FALSE in your answer book.

1.1.1 Use gloves when heavy steel plates are rolled and pressed.

1.1.2 Silicon is added to steel to control the oxygen content.

1.1.3 High-frequency sound waves are used to detect flaws in a weld during the ultrasonic test.

1.1.4 Place ladders at the correct angle before use.

1.1.5 Flux covering of electrodes flux away impurities present on the surface of the metal being welded.

1.1.6 The carbon content of cast iron is very low.

1.1.7 Cast iron is very ductile.

1.1.8 An undercut is considered a minor weld defect.

1.1.9 The purpose of the slag covering is to slow down the rate of cooling of a weld.

1.1.10 Distortion can be reduced by pre-setting the plates.

1.1.11 The leftward and rightward methods are two types of welding techniques used for oxy-acetylene welding.

1.1.12 The three basic flames used are carburizing, neutral and oxidizing flames.

1.1.13 Porosity is when small pinholes are formed in a metal which tends to weaken the weld.

1.1.14 Elasticity is the ability of a metal to be permanently deformed by hammering or the rolling process.

1.1.15 Austenite is an element that is added to iron to form steel. (15)

1.2 Choose the correct answer in **COLUMN B** to fit the information given in **COLUMN A** by writing only the letter of your choice next to the corresponding question number, e.g. 1.2.21 U.

| | COLUMN A | | COLUMN B |
|---|---|---|---|
| 1.2.1 | Chromium, Nickel, Manganese, Tungsten and Silicon | A | all carbon steels loses its magnetic properties. |
| 1.2.2 | At the $AC_2$ | B | resistance a metal has against denting, wear and scratching. |
| 1.2.3 | Heat treatment is carried out to | C | some of the elements that may be observed in a weld. |
| 1.2.4 | Factors of great importance when heat treating are | D | possibilities of misunderstanding between the engineer, draughtsman and journeyman. |
| 1.2.5 | Annealing, normalizing, hardening, tempering, stress relieving are | E | distorted or lengthened. |
| 1.2.6 | Oxygen, Nitrogen and Hydrogen | F | to shock. |
| 1.2.7 | Pre-setting and back-step method of welding is used to | G | during the inspection of a welding process. |
| 1.2.8 | Insufficient penetration, weld craters, undercut and slag inclusions are | H | weld spatter, arc blow, undercut and poor fusion. |
| 1.2.9 | Properties of cast iron is that it is | I | some of the conventional methods of heat treatment. |
| 1.2.10 | Hardness is the | J | non-metallic, solid material trapped in a weld joint. |

| | | | |
|---|---|---|---|
| 1.2.11 | Toughness is the metal's resistance | K | template loft. |
| 1.2.12 | During the cold working process the structure of the steel is | L | known as weld defects. |
| 1.2.13 | Arc current, arc length, arc speed are some of the factors to be observed | M | no lack of penetration. It must be free from cavities, cracks and slag inclusion. |
| 1.2.14 | Items to consider after the welding process are | N | used in dry, well ventilated areas. |
| 1.2.15 | Slag inclusion are | O | minimise distortion of a weld. |
| 1.2.16 | The fractured surface of a test specimen of a nick break test should show: | P | are elements that are added to plain carbon steels to improve its qualities. |
| 1.2.17 | Arc welding machines should be | Q | at the base. |
| 1.2.18 | Ladders must be firmly supported | R | give steel specific mechanical and physical properties. |
| 1.2.19 | Welding symbols eliminate | S | brittle, strong in compression and snaps before it will break. |
| 1.2.20 | Template making is performed in a | T | the carbon content, the final temperature, the length of time and the speed of cooling. |

(20)

1.3 Choose the correct answer. Write down only the question number and your choice. e.g. 1.3.6 - C.

1.3.1 The effect of tungsten added to steel will _____.

(a) increase wear resistance
(b) increase heat resistance
(c) increase tensile strength and shock resistance
(d) All of the above.

1.3.2 The landing used during template making is equal to _____.

(a) 3d
(b) 4d
(c) between 3 – 5 d
(d) 1,5d

1.3.3 The pitches used for template making should be between _____.

(a) 2 – 5d
(b) 3 – 5d
(c) 4 – 5d
(d) 5d

1.3.4 The clearance between the ends of the struts and the toes of the rafter must be _____.

(a) 2 – 4 mm
(b) 3 – 5 mm
(c) 3 – 6 mm
(d) 2 – 5 mm

1.3.5 Malleability is the ability of a metal to _____.

(a) return to its original shape and size

(b) become permanently flattened or stretched by hammering or rolling

(c) stretch and become permanently deformed without breaking

(d) withstand indentation, wear and abrasion (5)

**TOTAL FOR SECTION A: [40]**

## SECTION B

Answer any FOUR questions from this section.

### QUESTION 2

2.1 **Figure 1** shows a line diagram of a cantilever roof truss. The truss is subjected to two vertical point loads.

2.1.1 Draw the forces diagram for the roof truss by using a scale of 10 mm : 10 N. (8)

2.1.2 Copy and complete the given table in your answer book. (18)

2.1.3 Draw the space diagram to a scale of 1 cm : 1 m and indicate the nature of the forces. (6)

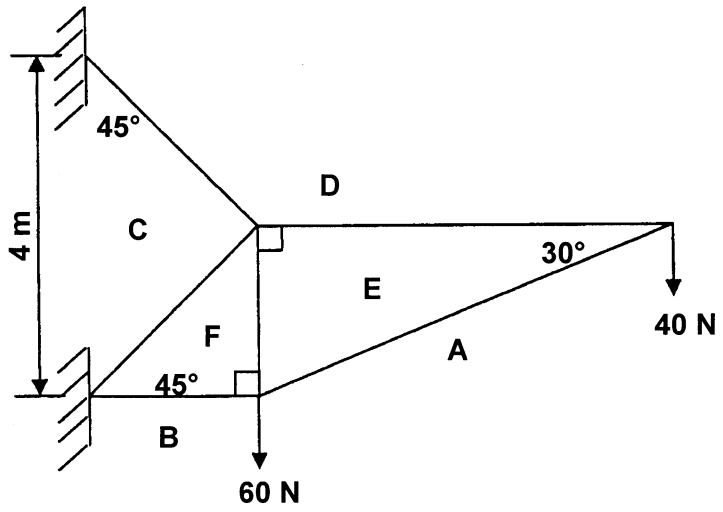


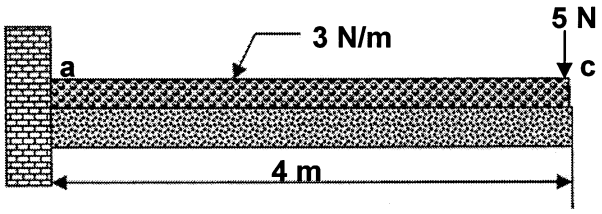

**Figure 1**

| MEMBER | MEASUREMENT mm | FORCE N | NATURE |
|---|---|---|---|
| AE | | | |
| DE | | | |
| FE | | | |
| FB | | | |
| FC | | | |
| DC | | | |

2.2 **Figure 2** shows a cantilever which is 4 metres long. The cantilever carries a 5 N force at the free end. A distributed load of 3 N/m, is distributed between the force at the free end and the fixed end.

2.2.1 Convert the distributed load to a point load and indicate it as point **b**. (2)

2.2.2 Calculate the bending moments for the cantilever at points **a**, **b** and **c**. (6)




**[40]**

**Figure 2**

## QUESTION 3

**Figure 3** shows a simple supported beam of 12 metres long. The beam carries two point loads.

3.1 Prove by means of calculation the left reaction force (LR) is 10 N and the right reaction force (RR) is 20 N. (4)

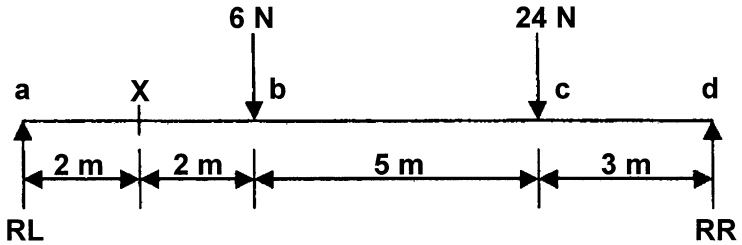
3.2 Calculate the bending moments at points **a**, **b**, **c**, **d** and **X**. (8)

3.3 Calculate the shear forces at points **a**, **b, c, d** and **X**. (8)

3.4 Draw the space diagram to a scale of 10 mm : 1 m. (2)

3.5 Draw the bending moments diagram to a scale of 10 mm : 10 Nm and also indicate **X**. (9)

3.6 Draw the shear force diagram to a scale of 2 mm : 1 N. (9)




**[40]**

**Figure 3**

## QUESTION 4

4.1 A rectangular bar with a length of 300 mm stretches by 15 mm if a load of 120 kN is applied during a tensile test. Young's Modulus for the bar is 40 GPa.

Prove by calculation that

4.1.1 the strain in the bar was 0,05 ($50 \times 10^{-3}$). (3)

4.1.2 the stress in the bar was 2 GPa. (5)

4.1.3 the area of the bar was 60 $mm^2$ ($60 \times 10^{-6}$ $m^2$). (6)

4.1.4 the breadth of the sectional area of the bar is 5 mm if the length is 12 mm. (3)

4.2 A steel bar with a cross-sectional diameter of 1 800 $mm^2$ is subjected to a force of 144 MN.
Change the area from $mm^2$ to $m^2$ and calculate the stress in the bar. (6)

4.3 A round bar with a length of 150 mm measured 164 mm after a tensile test was performed. Calculate the strain of the bar. (5)

4.4 Define the term **elasticity**. (3)

4.5 Name THREE destructive tests. (3)

4.6 Name THREE non-destructive tests. (3)

4.7 Name THREE types of defects that we search for during the nick-break test. (3)

Formulae:

$$\text{Stress (Pa)} = \frac{\text{Load (N)}}{\text{Cross-sectional area } (m^2)}$$

$$\text{Strain} = \frac{\text{Deformation (mm) or (m)}}{\text{Original length (mm) or (m)}}$$

$$\text{Young's Modulus (E) (Pa)} = \frac{\text{Stress (Pa)}}{\text{Strain}}$$

**[40]**

## QUESTION 5

5.1 **Figure 4** shows a line diagram of a steel framework. The framework is welded and consists of single-angle profiles without gusset plates. The total time taken to manufacture one framework is 9 hours, at a tariff of R280,00 per hour, while the overhead costs are calculated 95% of the material cost. The cost of the 80 x 80 x 8 mm angle profiles marked **A** and **B** with a mass of 8,8 kg/m length is R5,70 per kilogram and the 60 x 60 x6 mm profiles marked **C** and **D** with a mass of 6,49 kg/m length is R4,35 per kilogram. An amount of R250,00 is allocated for welding material per framework.

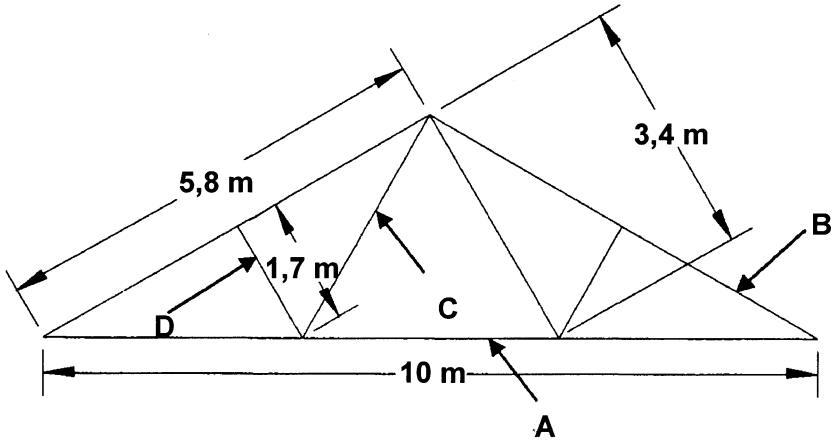



**Figure 4**

| Mark | Quantity needed | Material needed (m) | Mass kg/m | Total mass per kg | TARIFF /kg | Amount |
|---|---|---|---|---|---|---|
| A | | | 8,8 | | R5,70 | |
| B | | | 8,8 | | R5,70 | |
| C | | | 6,49 | | R4,35 | |
| D | | | 6,49 | | R4,35 | |
| | | | | Welding material | | |
| | | | | Total cost | | |

5.1.1 Copy the above table in your answer book and calculate the total material cost. (18)

5.1.2 Calculate the labour cost. (3)

5.1.3 Calculate the overhead cost. (3)

5.1.4 Calculate the total cost. (4)

5.2 Make a neat, labelled sketch of a shielded arc. (12)
**[40]**

## QUESTION 6

6.1 **Figure 5** shows a simple joint of a riveted Queen truss. Use a scale of 1 : 1 to lay out the joint and draw the gusset plate. Show only the position of the rivets. The purlin marked (A) consists of 40 x 40 x 5 Ls with a back mark of 23 mm and pitches of 3d. Both the main girder marked (C) and the collar beam marked (B) are made from 30 x 30 x 3 Ls with a back mark of 17 mm and pitches of 3d. The rivets used on the girder and collar beam are 12 mm in diameter. (17)

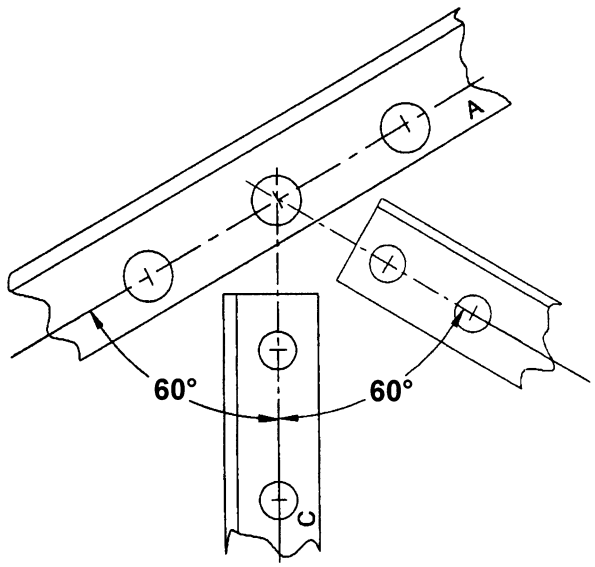



**Figure 5**

6.2 **Figure 6** shows a cone frustum with a height of 600 mm. The large diameter is 900 mm while the small opening has a diameter of 400 mm.

Prove by calculation that

6.2.1 the distance EC is 250 mm. (3)

6.2.2 the true length of the plate (BC) is 650 mm. (5)

6.2.3 the large radius (GC) is 1 170 mm. (7)

6.2.4 the small radius (GB) is 520 mm. (5)

6.2.5 $\frac{1}{12}$ of the large diameter is 306,3 mm. (3)

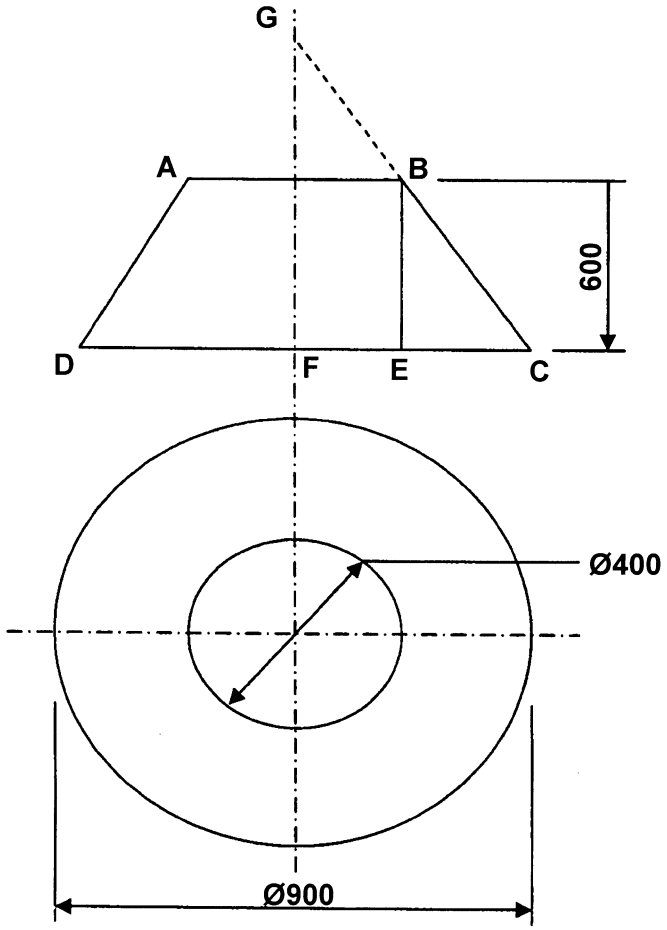



Figure 6

[40]

TOTAL: 200

END