GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

WELDING AND METALWORKING SG

FEB / MAR 2006

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Drawing answer book 716-2X
- Drawing instruments and approved pocket calculator

INSTRUCTIONS:

- Answer all questions in the drawing answer book 716-2X.
- Answer only FIVE questions.
- Section A is COMPULSORY.
- Answer any FOUR questions from Section B.
- Only the first FIVE questions will be marked.

SECTION A
COMPULSORY

QUESTION 1

1.1 Indicate whether the following statements are TRUE or FALSE by marking an (**X**) in the appropriate block on the answer sheet.

1.1.1 High-carbon steels can be case hardened.

1.1.2 Ladders must be neatly painted at all times.

1.1.3 During the hardening of steels, the steel is cooled down as slowly as possible.

1.1.4 The carbon content of steels does not play a major role during the heat-treatment process and can be ignored.

1.1.5 Files are made of low-carbon steel.

1.1.6 Templates are used because they are accurate and save time and money.

1.1.7 The floor boards of the template loft should be laid diagonally across the floor.

1.1.8 Overhead costs can only be charged from the labour cost.

1.1.9 Pitches used on templates are between 6-8 d.

1.1.10 Acetylene bottles have a clockwise thread. (10)

1.2 Each of the following questions has four possible answers ONLY ONE of which is correct. Indicate your answer by marking an (**X**) in the appropriate block on the answer sheet.

1.2.1 Distortion in a weld will reduce _____.

A. if fewer runs are welded with a thicker electrode
B. if more runs are welded with a thinner electrode
C. by only welding fewer runs with a higher current
D. by only welding more runs with a higher current

1.2.2 Root cracks and other cracks can be reduced by _____.

A. clamping the parent metal
B. preheating the parent metal
C. using a stronger current
D. welding more runs

1.2.3 Stress relieving is applied to _____.

A. change the granular structure of the metal
B. obtain the maximum hardness in a metal
C. reduce internal stresses in welded metals
D. increase the ductility in steel

1.2.4 The unit for Tera is _____.

A. 10^3
B. 10^6
C. 10^9
D. 10^{12}

1.2.5 Steels are classified according to their _____.

A. granular structure
B. carbon content
C. weight
D. hardness

1.2.6 Elasticity is the ability of a metal _____.

A. to return to its original size and measurements
B. to be permanently deformed
C. to be drawn into wire
D. not to be unnecessarily deformed if it is hammered

1.2.7 Chromium is added to steel to _____.

A. improve brittleness
B. improve shock and corrosion resistance
C. improve ductility
D. improve elasticity

1.2.8 All steels lose their magnetic properties at the _____.

A. AC_1
B. AC_2
C. AC_3
D. AR_3

1.2.9 Steels that are heated to above the AC_3 consist mainly of _____.

A. ferrite and austenite
B. pearlite and cementite
C. ferrite and pearlite
D. austenite

1.2.10 Oxygen trapped in a weld will _____.

A. have no bad effect on the weld
B. improve ductility
C. decrease the granular structure
D. increase the corrosion resistance (10)

1.3 Choose the correct answer in **Column B** to match the information given in **Column A** by indicating the letter of your choice next to the relevant question number, in the drawing answer book e.g. 1.3.11 – R.

	COLUMN A		COLUMN B
1.3.1	The carbon content in steel	A	between 3-5 d.
1.3.2	High carbon steel can	B	using the back-step method.
1.3.3	Low carbon steel can be	C	peening the weld.
1.3.4	Steel that is hardened is	D	overhead cost.
1.3.5	Copper is a	E	cause blow holes.
1.3.6	Cast-iron is	F	act as a melting agent and to remove impurities from the surface of a weld.
1.3.7	Internal stresses in a weld can be reduced by	G	is the internal force in a material that counters the load.
1.3.8	Standard pitches on templates are	H	N/m^2.
1.3.9	Cost encountered such as petrol, repairs and bonuses form part of the	I	ductile metal.
1.3.10	Oxygen absorbed in a weld will	J	at just above the re-crystallization temperature.
1.3.11	Brittleness in hardened steel can be reduced by	K	case hardened.
1.3.12	Distortion in a weld can be prevented by	L	brittle and can withstand shocks.
1.3.13	Hot-working of steel is done	M	brittle and can break easily.
1.3.14	The function of flux is to	N	must be inspected at regular intervals.
1.3.15	Stress	O	determines the final temperature during the heat-treatment process.
1.3.16	The unit for Pascal is	P	undergo surface hardening.
1.3.17	Scaffolding	Q	using a thicker electrode and by using fewer runs.
1.3.18	The effective shrinkage force will reduce if	R	tempering.
1.3.19	At 720°C (lower critical point)	S	all steels lose their magnetic properties.
1.3.20	Undercutting is the result of	T	too high current.

(20)

TOTAL FOR SECTION A: [40]

SECTION B

Answer any FOUR questions from this section.

QUESTION 2

2.1 **Figure 1** shows a space diagram of a framework with three vertical loads. The beam is 8 metres long.

Figure 1

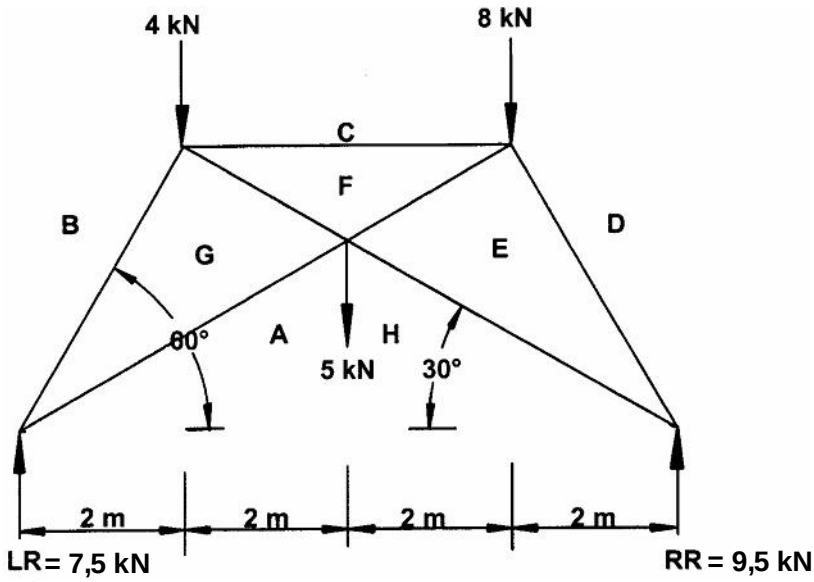


Figure 1

2.1.1 Indicate by means of calculation that the left and right reactions are 7,5 kN and 9,5 kN respectively. (4)

2.1.2 Draw the forces diagram by using a scale of **8 mm : 1 kN**. (8)

2.1.3 Indicate the nature of the forces in the drawing answer book. (7)

2.1.4 Determine the magnitude and nature of the forces in each member of the framework. Complete the given table in the drawing answer book.

MEMBER	MEASUREMENT	FORCE	NATURE
AG			
BG			
CF			
FG			
DE			
EF			
EH			

(21)
[40]

QUESTION 3

3.1 **Figure 2** represents a cantilever with a span of 10 metres. The cantilever is subjected to three vertical point loads. Draw the space diagram to the given scale and do the following:

Calculate

3.1.1 the bending moments at points **A**, **B**, **C** and **D**. (8)

3.1.2 all the shear forces for the lever **A**, **B**, **C** and **D**. (8)

Draw the

3.1.3 bending moment diagram to the given scale. (6)

3.1.4 shear force diagram to the given scale. (6)

USE THE FOLLOWING SCALES

Space diagram	1 cm = 1 m
Bending moment diagram	5 mm = 15 kNm
Shear force diagram	2 mm = 1 kN

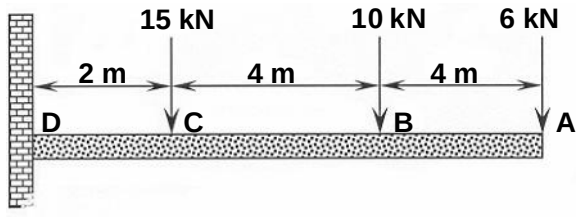
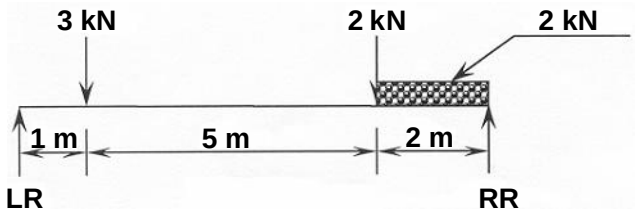


Figure 2

3.2 **Figure 3** shows a simple supported beam that is 8 metres long. The beam carries two vertical point loads as well as a distributed load of 1 kN/m on the 2 metre section of the beam as indicated.

3.2.1 Convert the distributed load to a point load. (2)

3.2.2 Calculate the left and right reaction forces of the beam. (10)



[40]

Figure 3

QUESTION 4

4.1 A steel bar with an original length of 300 mm is used for a tensile test. The strain of the bar is 53,33 x 10^{-3} and Young's Modulus for the bar is 12,73 GPa. The force used was 120 kN.

4.1.1 Prove by calculation that the bar stretched 16 mm (changed in length). (4)

4.1.2 Prove by calculation that the stress in the bar was 679 MPa (round off). (4)

4.1.3 Calculate the sectional area of the bar. (4)

4.1.4 Calculate the diameter of the bar in mm. (6)

4.2 Calculate the stress in a round bar if the force is 80 kN and the cross-sectional area is 2 300 mm^2. (6)

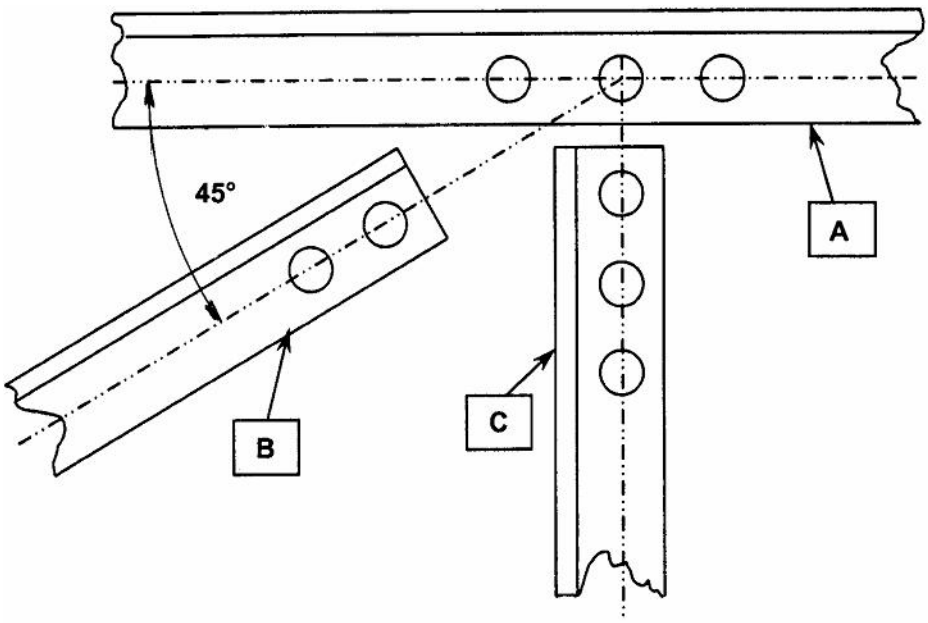
$$Cross\text{-}sectional\ area\ (m^2) = \frac{\pi (D)^2}{4}$$

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

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

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

4.3 The following figure shows the top section of a bolted roof truss. Use a scale of 1:1 to draw the given section and indicate the position of the gusset plate. Indicate only the positions of the bolts. The pitches used on the angle iron marked **A** are 5 d, while for the angle irons marked **B** and **C** are 3 d. The angle iron used for **A**, **B** and **C** is 40 x 40 x 6 mm with back marks of 23 mm. The diameter of the bolts used is 12 mm. The angle formed between angle iron **A** and **B** is 45°.



(16)
[40]

QUESTION 5

5.1 **Figure 4** shows the front and top views of a hopper.

Calculate

5.1.1 the true length of plate YX^1. (5)

5.1.2 the true length of DH^1. (10)

5.1.3 Construct the dihedral angle on the joint AE^1. Use a scale of 1:10 for the construction. (10)

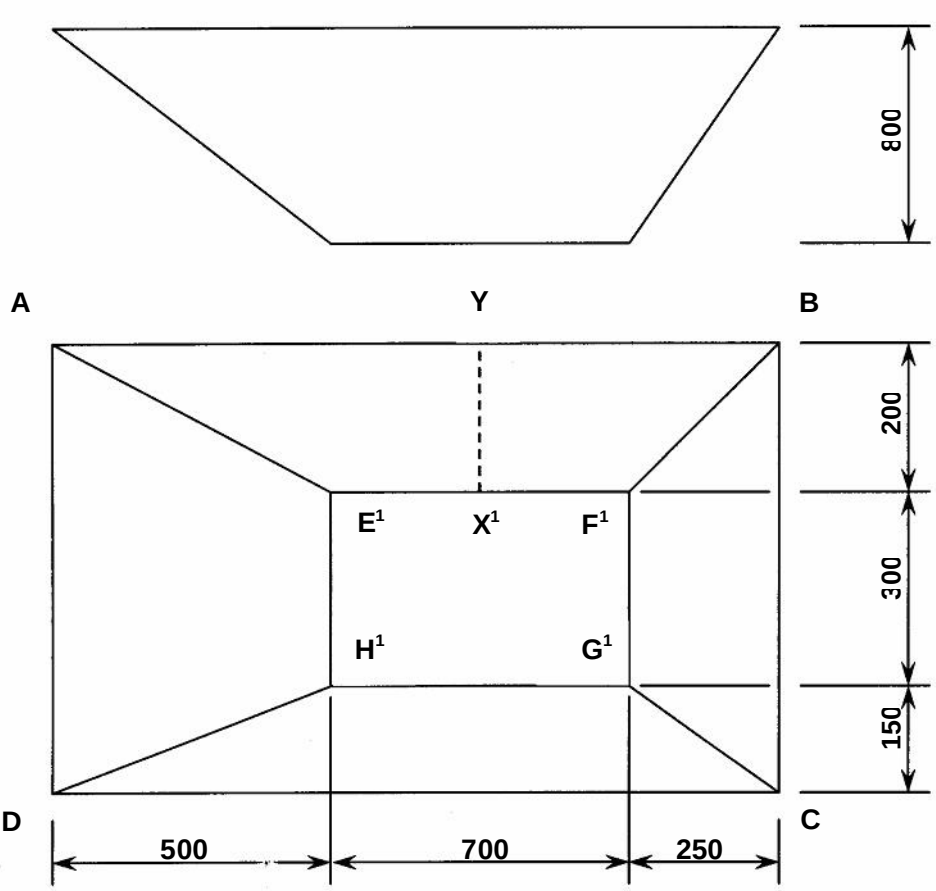


Figure 4

5.2 Name FIVE reasons why templates are used. (5)

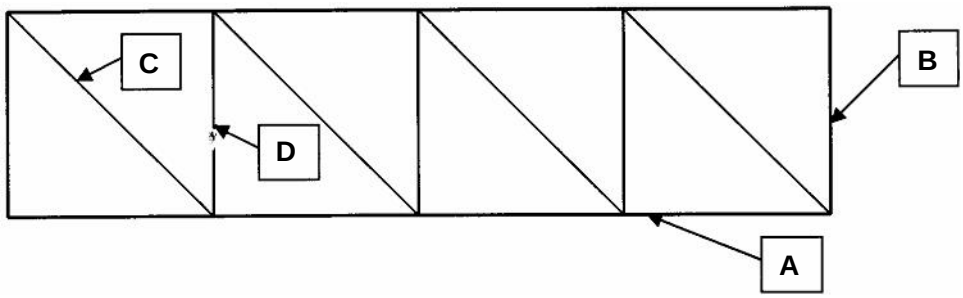
5.3 Name FIVE tools used in the template loft. (5)

5.4 Name THREE materials used for template making. (3)

5.5 Name TWO requirements for a template loft. (2)

[40]

QUESTION 6



Item A = 100 x 100 x 6L = 3,1 m
Item B = 100 x 100 x 6L = 0,7 m
Item C = 50 x 50 x 6L = 0,95 m
Item D = 50 x 50 x 6L = 0,7 m

6.1 The above figure shows a line diagram of a lattice girder. The lattice girder is welded and consists of single-angle profiles without gusset plates. The total time taken to manufacture one framework is 6 hours, at a tariff or R120,00 per hour. The overhead costs are calculated at 85% of the labour cost. The cost of the angle profiles of 100 x 100 x 6 mm with a mass of 9 kg/m length is R3,60 per kilogram and the profiles of 50 x 50 x 6 mm with a mass of 4,5 kg/m length is R3,80 per kilogram. An amount of R90,00 is allocated to the framework for welding material.

6.1.1 Copy and complete the table below in your drawing answer book and calculate the material cost. (18)

6.1.2 Calculate the labour cost. (4)

6.1.3 Calculate the overhead cost. (4)

6.1.4 Calculate the total cost of the framework. (4)

Item	Number required	Material required	Mass/m length	Total Mass	Tariff/kg	R , c
A		100 x 100 x 6mm = _____ m long	9 kg/m		R3,60/kg	R_____
B		100 x 100 x 6 mm = _____ m long	9 kg/m		R3,60/kg	R_____
C		50 x 50 x 6mm = _____ m long	4,5 kg/m		R3,80/kg	R_____
D		50 x 50 x 6mm = _____ m long	4,5 kg/m		R3,80/kg	R _____
				Welding material cost		R _____
				Total material cost		R _____

6.2 Determine graphically the camber in a beam with a span of 10 m and a rise of 1,2 m. Use a scale of 1:50 for the construction. (10)
[40]

QUESTION 7

7.1 Name FIVE welding defects. (5)

7.2 Name FIVE reasons why heat treatment is carried out on carbon steels. (5)

7.3 Name FIVE elements that are added to steel to change the properties of steel. (5)

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

7.5 Make a detailed sketch of the carbon equilibrium diagram. (14)

Scales: temperature scale (y-axis) = 1 cm: 50°C (start at 600°C)
carbon content (x-axis) = 1 cm: 0,1% carbon

7.5.1 To which temperature would you heat a piece of steel with a 1,2% carbon content before it is cooled down for hardening? (1)

7.5.2 Name FIVE methods of cooling. (5)

7.5.3 Which cooling method is used for normalizing? (1)

7.5.4 At which temperature do all steels undergo a crystal structure change? (1)
[40]

TOTAL FOR SECTION B: [160]

TOTAL: 200

END