GAUTENG DEPARTMENT OF EDUCATION

SENIOR CERTIFICATE EXAMINATION

WELDING AND METALWORKING SG

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

- Answer book
- Drawing answer book
- Drawing instruments and an 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 the answer in your answer book, e.g. 1.1.16 – True.

1.1.1 A template loft should be equipped with a wooden floor with a matt finish.

1.1.2 With girders and roof trusses that are symmetrical it will be necessary to set out one half of each member.

1.1.3 Angle iron templates are cut to the lengths obtained from the lines but with 3 mm to 6 mm clearance allowed between the ends of the struts and the toes of the rafters and bottom ties.

1.1.4 The centre distances between the rivets or bolts should be between 3 d and 5 d.

1.1.5 If carbon from the filler material is introduced into the weld, it will oxidize into carbon monoxide, leaving a porous deposit behind.

1.1.6 Oxygen absorbed in a weld will increase the tensile strength and ductility and increase its resistance to corrosion.

1.1.7 The purpose of the annealing process is to harden carbon steels.

1.1.8 Quenching heat treated steel in brine or oil will cause the steel to normalize.

1.1.9 Tempering will reduce brittleness of hardened steels.

1.1.10 All steels will lose their magnetic properties at the AC_2.

1.1.11 Chromium forms chromium carbide in steel and increases the hardening power and ability to deep harden carbon steels.

1.1.12 Manganese will give steel the ability to resist wear and shock.

1.1.13 The most important alloying element in steel is carbon.

1.1.14 Ductility is the ability of a metal to become permanently flattened or stretched by hammering.

1.1.15 Malleability is the ability of a metal to stretch and become permanently deformed without breaking or cracking. (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	Scaffolds should	A	correct electrode, current setting and polarity is used.
1.2.2	During the calculation of bending moments.	B	that is supported at one end and the other end is free to move.
1.2.3	When carbon is added to iron	C	forces acting upwards are positive and forces acting downwards are negative.
1.2.4	Steel ropes should not	D	maximum stress divided by the safety factor.
1.2.5	A template loft should have	E	are of the utmost importance during heat treatment of steel.
1.2.6	Landing	F	by means of the ultra-sonic test.
1.2.7	Tungsten, chrome and nickel	G	by using the dye-penetrate test.
1.2.8	Presetting will	H	a few elements of a welding symbol.
1.2.9	Ladders should be	I	minimize distortion.

1.2.10	Templates are used to	J	oil is used on the acetylene equipment.
1.2.11	A chemical reaction will cause an explosion if	K	is equal to 1,5 times the diameter of the rivets.
1.2.12	The oxygen gas bottle is	L	left-hand thread.
1.2.13	Tail, arrow and reference lines are	M	placed at the correct angle before use.
1.2.14	Spatter will be eliminated if the	N	be inspected at regular intervals.
1.2.15	A cantilever is a beam	O	be allowed to rust.
1.2.16	Surface defects can easily be detected	P	thin, long and black in colour.
1.2.17	Safe stress is the	Q	avoid repetitive making off and ensure accuracy.
1.2.18	The acetylene gas bottle has a	R	good lighting, adequate space and black floors.
1.2.19	Internal defects can be examined	S	steel is formed.
1.2.20	Factors such as carbon content, time and speed of cooling	T	are some of the elements that are added to steel.

(20)

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

1.3.1 A carburizing flame is obtained by _____.

(a) using equal amounts of oxygen and acetylene
(b) using excess oxygen
(c) using excess acetylene
(d) using excess oxygen and excess acetylene

1.3.2 Factors influencing the welding process are _____.

(a) size of the electrode
(b) size of the run
(c) the sequence in which the runs are made
(d) All of the above.

1.3.3 Slag inclusions can be defined as _____.

(a) metallic, solid material trapped in the welded metal
(b) non-metallic, solid material trapped in the welded metal
(c) magnetic, solid material trapped in the welded metal
(d) any metallic or magnetic material trapped in the welded metal

1.3.4 To avoid cracks in alloys or high-carbon steels these metals should be _____.

(a) clamped prior to the welding process
(b) peened prior to the welding process
(c) preheated prior to the welding process
(d) welded with a high hydrogen electrode

1.3.5 To minimise distortion in a weld use _____.

(a) more runs with a thin electrode
(b) more runs with a thick electrode
(c) fewer runs with a thick electrode
(d) fewer runs with a thin electrode. (5)

[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 roof truss is subjected to two vertical point loads. Draw the space diagram to a scale of 10 mm : 1 000 mm and complete the questions below.

Scales:

Space diagram 10 mm : 1 000 mm
Forces diagram 10 mm : 200 N

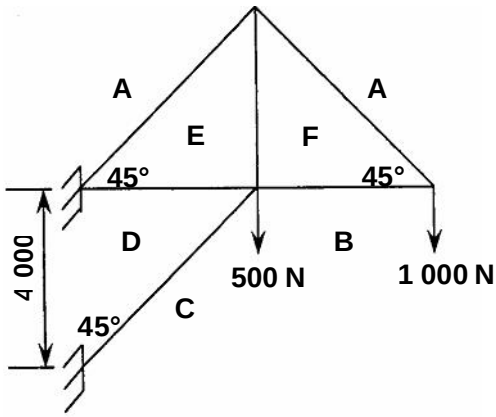

Figure 1

2.1.1 Draw the forces diagram to the given scale and determine the magnitude of the forces in each member. (8)

2.1.2 Determine and indicate the nature of the forces on the space diagram. (6)

2.1.3 Copy and complete the table below in your answer book. (18)

Member	Measurement (mm)	Force (N)	Nature (tie or strut)
AF			
BF			
EF			
EA			
ED			
DC			
	(6)	(6)	(6)

2.2 The following line diagram (**Figure 2**) represents a cantilever with two point loads as well as a distributed load of 2 N/m between the 3 N and 2 N forces.

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

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

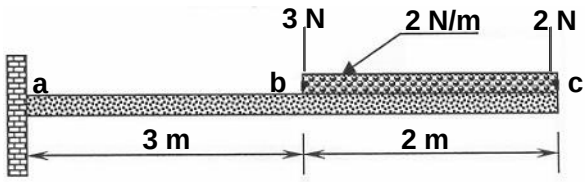

Figure 2

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QUESTION 3

Figure 3 shows a simple supported beam of 10 metres long. The beam is supported at the free ends and carries two vertical point loads. Draw the space diagram to a scale of 10 mm : 1 m and answer the questions listed below.

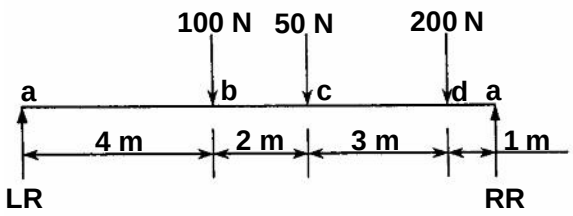

Figure 3

3.1 Prove by means of calculation that the left reaction force is 100 N and the right reaction force is equal to 250 N. (8)

3.2 Calculate the bending moments at points **b**, **c** and **d**. (6)

3.3 Calculate the shear forces at each of points **a**, **b**, **c**, **d** and **e**. (10)

3.4 Draw the bending moment diagram to a scale of 10 mm : 100 Nm. (8)

3.5 Draw the shear force diagram to a scale of 5 mm : 20 N. (8)
[40]

QUESTION 4

4.1 A test piece with a cross-sectional area of 132,73 mm^2 (132,73 x 10^{-6} m^2) was used during a tensile test and the force recorded during the test was 120 MN. Show by calculation

4.1.1 that the internal stress of the test piece is 904,09 GPa. (5)

4.1.2 the strain would be 50 x 10^{-3} if Young's Modulus is 18,08 TPa. (5)

4.1.3 what the original length was prior to the test if the change in length was 7 mm. (5)

4.2 A force of 100 kN was used to perform a compression test on a rectangular bar and the internal stress during the test was 2 GPa.

4.2.1 Prove by means of calculation that the cross-sectional area was 50 mm^2 (50 x 10^{-6} m^2). (5)

4.2.2 Calculate the length of the rectangular bar if the breadth was 5 mm. (5)

4.3 Calculate the diameter of a bar if the force recorded during the test was 40 kN and the bar has an internal stress of 226,36 MPa. (15)

Formulae:

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

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

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

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QUESTION 5

5.1 **Figure 4** shows a line diagram of a steel framework. The framework is welded and consists of single-angle profiles with gusset plates. The total time taken to manufacture one framework is 9 hours, at a tariff of R75,00 per hour while the overhead costs are calculated at 95% of the labour cost. The cost of the angle profiles 70 x 70 x 8 marked AA and AB with a mass of 5,8 kg/m length is R8,95 per kilogram, and the profiles of 60 x 60 x 5 marked D and C with a mass of 4,47 kg/m length is R7,80 per kilogram. An amount of R225,00 is allocated for welding material.

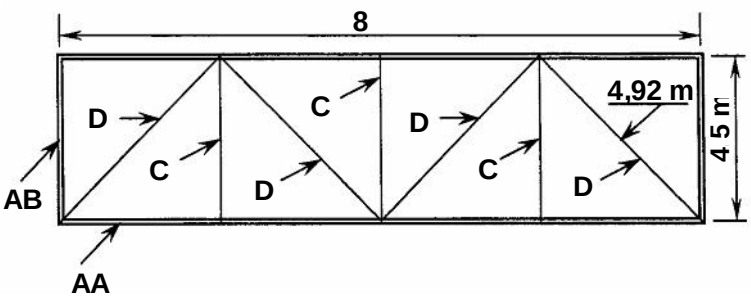

Figure 4

5.1.1 Copy and complete the table below in your answer book then calculate the cost of the material. (18)

Mark	Quantity Needed	Total length needed (m)	Mass per metre	Total mass (kg)	Tariff per kg	Amount
AA			5,8 kg/m		R8,95	
AB			5,8 kg/m		R8,95	
C			4,47 kg/m		R7,80	
D			4,47 kg/m		R7,80	
					Welding material	
					Total material cost	

5.1.2 Calculate the labour cost. (4)

5.1.3 Calculate the overhead cost. (4)

5.1.4 Calculate the total cost of the completed framework. (4)

5.2 Make a neat, labelled sketch of a shielded arc. (10)
[40]

QUESTION 6

6.1 The following drawing (**Figure 5**) indicates a cone. The cone is 900 mm high with a small diameter of 500 mm at the top (AB). Use sin, cos or tan to prove the following calculations:

6.1.1 That the distance EC is 350 mm (5)

6.1.2 That the large diameter (DC) is 1 200 mm (4)

6.1.3 That the true length (BC) is 965,66 mm (5)

6.1.4 That the large radius (GC) is 1 655,46 mm (5)

6.1.5 The small radius (GB) is 689,8 mm (5)

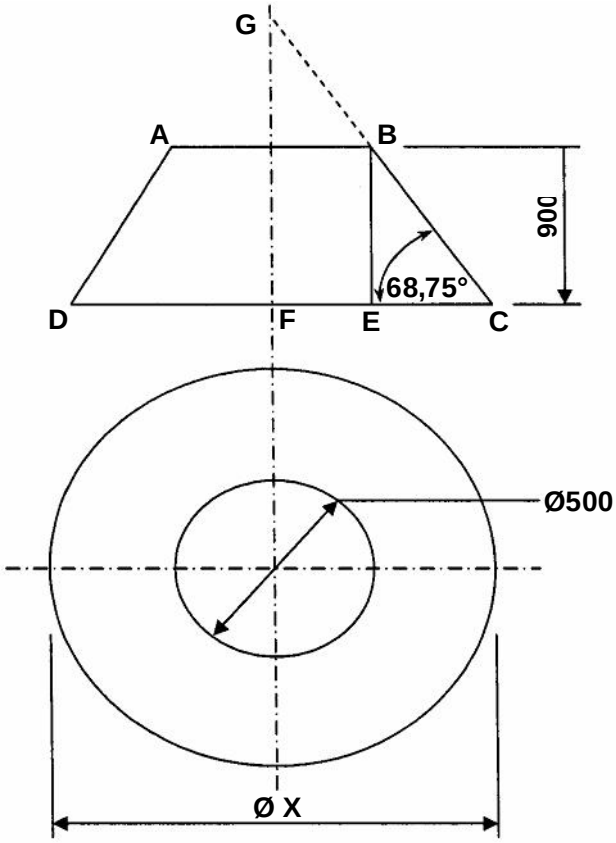

Figure 5

6.2 Draw and design a gusset plate for the given section of a steel construction as indicated by **Figure 6** below. Angle iron marked **A** consists of 50 x 50 x 5 mm Ls with a back mark of 28 mm and pitches of 3d. The rivets used on angle **A** are 12 mm with a landing of 1,5d. Angle irons **B** consist of 30 x 30 x 4 mm Ls with back marks of 17 mm and pitches of 3d. The rivets used are 12 mm and the landing used is 1,5d. (16)

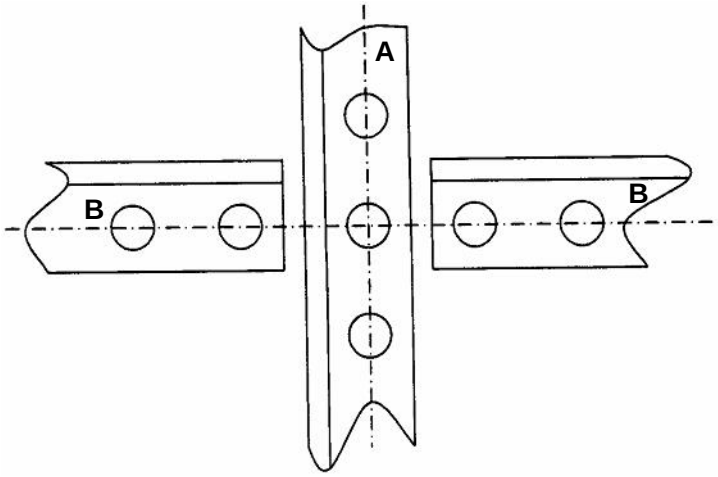

Figure 6

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TOTAL: 200

END