GAUTENG DEPARTMENT OF EDUCATION
SENIOR CERTIFICATE EXAMINATION

WELDING AND METALWORKING SG

OCTOBER / NOVEMBER 2005
OKTOBER / NOVEMBER 2005

TIME: 3 hours

MARKS: 200

REQUIREMENTS:

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

INSTRUCTIONS:

- Answer all questions in the drawing answer book 716-2/X.
- Answer only FIVE questions.
- Section A is COMPULSORY.
- Answer only 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 making an (**X**) in the appropriate block on the answer sheet.

1.1.1 With reference to the iron-carbon equilibrium diagram, carbon steel that is heated to above the upper critical point consists mainly of austenite.

1.1.2 A characteristic of case hardening is that the core remains soft whilst the outer core is hard.

1.1.3 Normalising is applied to steel that is subjected to internal stresses.

1.1.4 The tensile test, the bend test and the nick break test are known as destructive tests.

1.1.5 Poor root penetration in a weld is caused by no or insufficient bevelling.

1.1.6 Electrodes are more effective if they are kept cool.

1.1.7 The metric unit for Tera is $x10^9$.

1.1.8 Carbon does not play an important role during the heat treatment process.

1.1.9 A large weld will shrink more than a small weld.

1.1.10 Tungsten is added to steel to improve heat and shock resistance. (10)

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

1.2.1 A bleeding wound in the workshop is life-threatening to other learners when the _____.

A. blood pours onto the work surface
B. blood is infected with the HI virus and other learners make contact with the blood without taking the proper precautions
C. wound is not treated immediately
D. patient is not taken to hospital as soon as possible

1.2.2 Castellated beams are used to increase the depth of a beam by 50%, thereby increasing the _____.

A. maintenance of the beam
B. welding surface of the beam
C. cost of the beam
D. load-carrying capacity without increasing the weight

1.2.3 The main purpose of heat treatment of steel is to _____.

A. reduce the effective shrinkage force
B. make shrinkage forces work to reduce distortion
C. give steel specific mechanical and physical properties
D. increase the effectiveness of the deposited slag

1.2.4 The ultrasonic test is used to detect weld defects by means of _____.

A. high frequency sound waves
B. a cathode-ray probe, emitting sound waves to detect the internal flaws
C. applying dye to the surface of the weld to detect the internal flaws
D. the bend test to detect the internal flaws

1.2.5 Surface hardening is carried out on steel with _____.

A. a low carbon content
B. no carbon content
C. a high carbon content
D. a high ferrite structure

1.2.6 When the welding process is inspected, one of the following should be observed:

A. amount of penetration and fusion
B. that good lighting is available
C. that the parent metal is clamped
D. that edge preparation is carried out

1.2.7 Tensile testing is known to be a/an _____.

A. inexpensive way of testing welds
B. accurate way of testing welds
C. destructive test that destroys the sample
D. very quick method for performing a test

1.2.8 Overhead costs can be charged against _____.

A. the labour cost only
B. the total cost
C. the material cost only
D. the labour cost or the material cost

1.2.9 Distortion of a weld can be decreased by _____.

A. using the correct parent metal
B. pre-clamping the parent metal
C. using a thinner welding rod and a higher current
D. using bigger welding electrodes

1.2.10 The safety factor applied to scaffolding is _____.

A. 2
B. 4
C. 8
D. 10 (10)

1.3 Choose the correct answer in **Column B** to match the information supplied in **Column A** by writing only the letter of your choice next to the corresponding question number, e.g. 1.3.21 – R in the drawing answer book.

COLUMN A		COLUMN B	
1.3.1	Some of the elements that are added to steel are	A	kept dry.
1.3.2	Gloves should be used when	B	the cold-working process.
1.3.3	At the AC2	C	repeatedly hammered during the cold working of steel.
1.3.4	The smallest grain structure is obtained when steel reaches the	D	carbon content of the steel.
1.3.5	Slings should never be	E	methods used for cooling during the heat-treatment process.
1.3.6	Scaffold planks should have a factor of safety of at least	F	nick-break test.
1.3.7	Electrodes are more effective if they are	G	deformation and the original length.
1.3.8	Scaffolding must be	H	will cause an undercut.
1.3.9	Elongated grains are the result of	I	1,5 times the diameter of the rivets or bolts used.
1.3.10	Cold air, oil, water or brine are	J	zinc, chromium or tungsten.
1.3.11	Carbon steels will work harden if they are	K	inspected at various intervals by a competent person.
1.3.12	Strain is the ratio between the	L	all steels lose their magnetic properties.
1.3.13	Ladders must never be in contact with	M	dragged against a floor.
1.3.14	One destructive test used is known as the	N	electricity.
1.3.15	Excessive heat during the welding process	O	heavy plates are rolled or pressed.
1.3.16	Iron is formed in a	P	iron oxide in steel.
1.3.17	Oxygen forms	Q	AC3.
1.3.18	During the hardening process the final temperature will depend on the	R	6 times its strength.
1.3.19	Back marks are	S	weld away from the gas bottles.
1.3.20	During gas welding	T	blast furnace.

(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 10 metres long and the angles BJA and HJA are 45°.

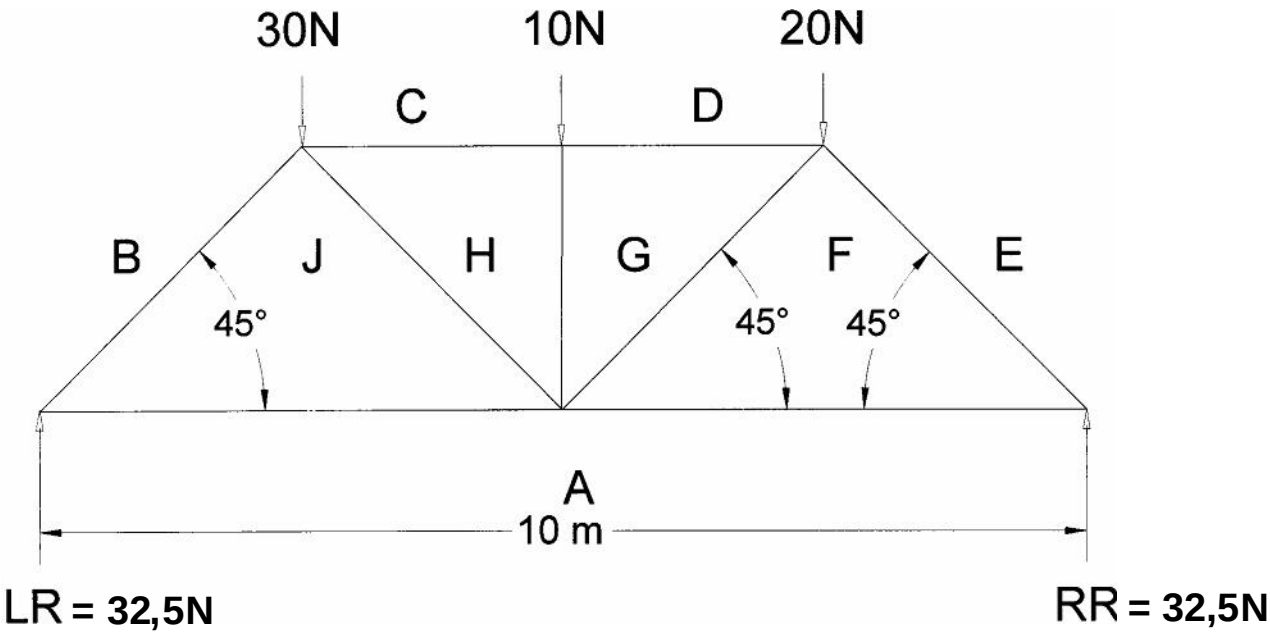

Figure 1

2.1.1 Indicate by means of calculation that the left and right reaction forces are 32,5 N and 27,5 N respectively. (6)

2.1.2 Draw the force diagram by using a scale of 2 mm: 1 N. (12)

2.1.3 Indicate the nature of the forces on the given diagram. (10)

2.1.4 Determine graphically by means of the vector diagram the magnitude and nature of the forces in each member of the framework. Complete the table below in the drawing answer book.

MEMBER	MEASUREMENT	FORCE	NATURE
GF			
HJ			
FE			
FA			

(12)
[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 in the drawing answer book and do the following:

Calculate the

3.1.1 bending moments at points **A**, **B**, **C** and **D**. (8)
3.1.2 shear forces for the beam at points **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 (1 mm = 3 kNm)
Shear force diagram	2 mm = 1 kN

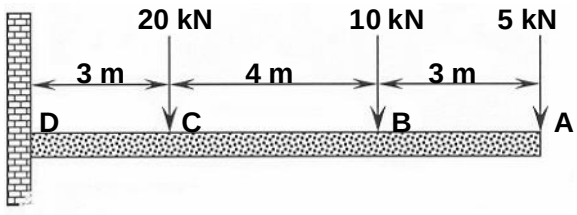

Figure 2

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 over the indicated 5 metre section of the beam.

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)

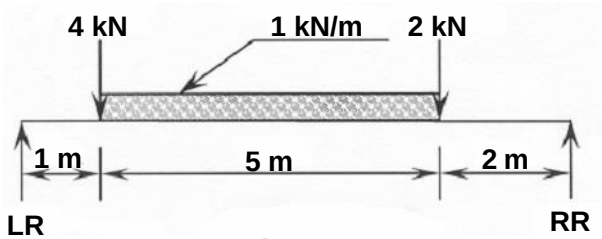

Figure 3

[40]

QUESTION 4

4.1 A tensile force of 120 kN causes a steel bar with a length of 300 mm and a diameter of 12 mm to stretch 15 mm.

4.1.1 Prove by means of calculation that the stress in the bar is 1,06 GPa. (8)

4.1.2 Prove by means of calculation that the strain in the bar is 50 x 10^{-3}. (4)

4.1.3 Calculate the value of Young's Modulus. (4)

4.2 A steel bar was subjected to a tensile test and the force needed for the test was recorded as 40 kN. The internal stresses during the test were 127,32 MPa.

Calculate the

4.2.1 cross-sectional area of the bar. (5)

4.2.2 diameter of the bar. (6)

4.3 Name any FOUR non-destructive tests. (4)

4.4 Name any TWO destructive tests. (2)

4.5 Briefly describe the dye-penetrant test. (7)

Formulas

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

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

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

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

[40]

QUESTION 5

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

Calculate the

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

5.1.2 true length of BF^1. (10)

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

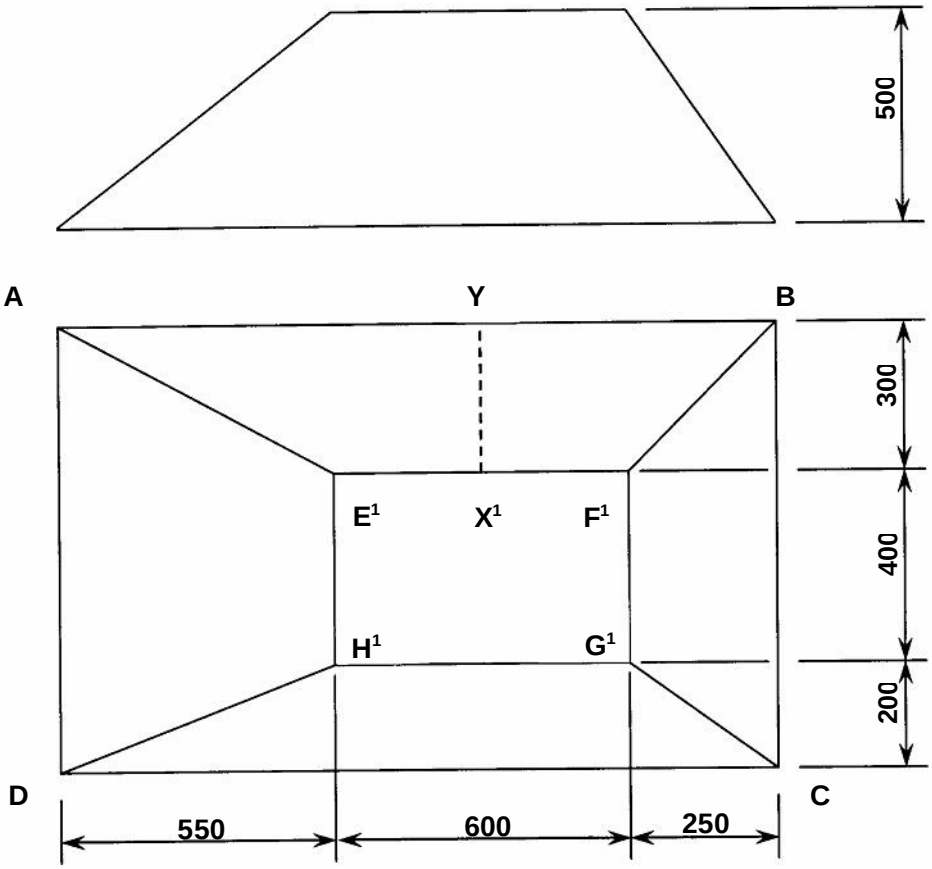

Figure 4

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 of a template loft. (2)

[40]

QUESTION 6

6.1 **Figure 5** shows a line diagram of a welded roof truss. The truss consists of 32,6 metre single angles which are made of 76 x 76 x 8 mm angle iron. The cost of the angle iron with a mass of 8,2 kg/m length is R4,30 per kilogram. The total time taken for carrying out the task was 15 hours at a tariff of R72,00 per hour. The overheads are calculated at 120% of the total material cost.

Calculate the

6.1.1 labour cost of the task. (4)
6.1.2 cost of the material used. (5)
6.1.3 overhead expenses incurred. (4)
6.1.4 total cost of the completed roof truss. (5)

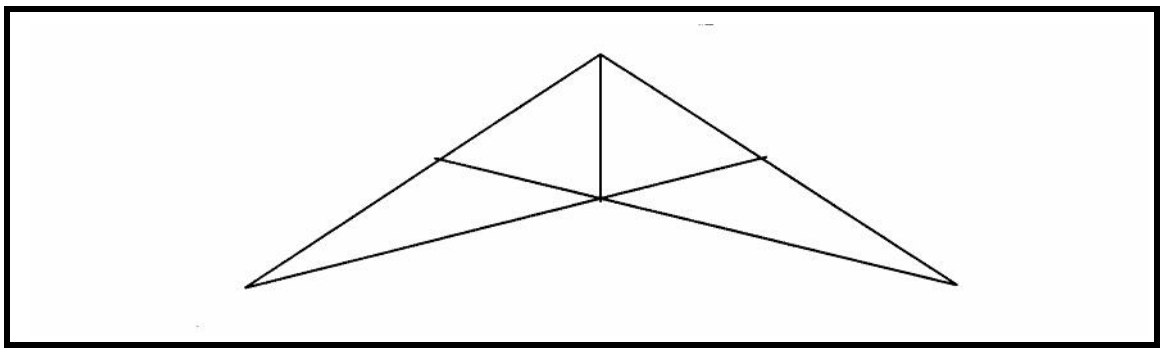

Figure 5

6.2 **Figure 6** shows a layout of a simple riveted lattice girder joint. Use a scale of 1:1 to draw the joint and insert the gusset plate. Show only the position of the rivets. The pitch used for the bracing and for the tie beams is 5 d. The landing is 1½ d. The diameters of the rivets are 8 mm. The back mark is 16 mm. (12)

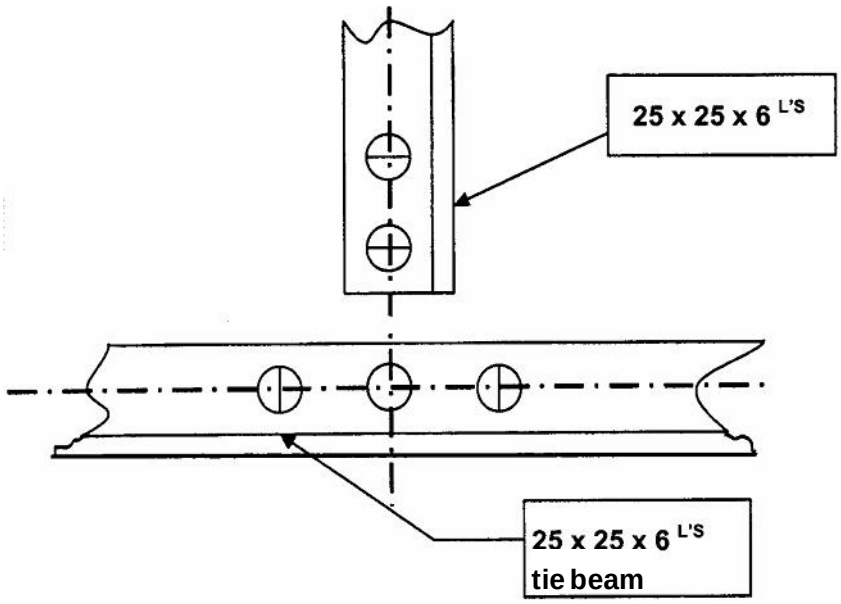

Figure 6

6.3 Name the information that must appear on a template. (5)

6.4 Name THREE safety measures for the use of scaffolding. (3)

6.5 Name TWO advantages of the use of templates. (2)
[40]

QUESTION 7

7.1 Name FIVE welding defects. (5)

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

7.3 Name any FIVE elements that are added to steel to alter its properties. (5)

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

7.5 Make a full detailed sketch of the carbon equilibrium diagram according to the given scales and answer the following questions: (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 At what temperature do all steels undergo a crystal structure change? (1)

7.5.2 To what temperature would you heat steel with a 1% carbon content during the hardening process? (1)

7.5.3 Which cooling method must be used during the hardening process? (1)

7.5.4 Which cooling method is used during normalising?

7.5.5 At which temperature do we find the AC_2? (1)

7.5.6 What determines the final temperature during heat treatment? (1)

7.5.7 Name THREE liquids used for quenching. (3)
[40]

TOTAL FOR SECTION B: [160]

TOTAL: 200

END

CANDIDATE'S NUMBER / *KANDIDAAT SE NOMMER*

SENIOR CERTIFICATE EXAMINATION
SENIORSERTIFIKAAT-EKSAMEN

OCTOBER / NOVEMBER
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2005

WELDING AND METALWORKING
SWEIS EN METAALBEWERKING

SG

ANSWER BOOK
ANTWOORDBOEK

716-2/x

Cover + 7 pages / *Voorblad + 7 bladsye*

QUESTION / VRAAG 1.1

Indicate your choice with a X Dui jou keuse aan met 'n X		
	TRUE WAAR	FALSE ONWAAR
1.1.1		
1.1.2		
1.1.3		
1.1.4		
1.1.5		
1.1.6		
1.1.7		
1.1.8		
1.1.9		
1.1.10		

QUESTION / VRAAG 1.2

Indicate your choice with a X Dui jou keuse aan met 'n X				
	A	B	C	D
1.2.1				
1.2.2				
1.2.3				
1.2.4				
1.2.5				
1.2.6				
1.2.7				
1.2.8				
1.2.9				
1.2.10				

QUESTION / VRAAG 1.3

Indicate your choice
Dui jou keuse aan

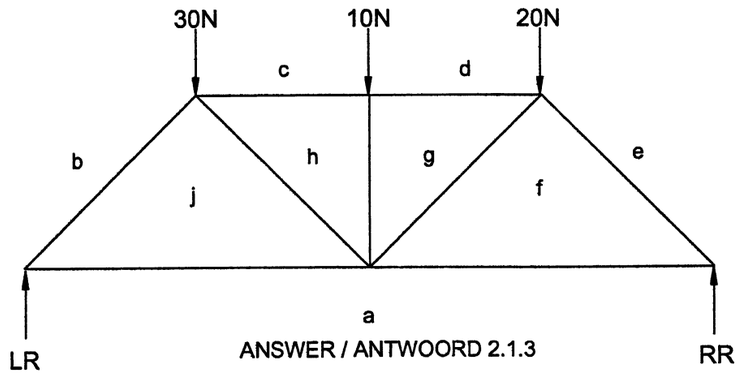
1.3.1	
1.3.2	
1.3.3	
1.3.4	
1.3.5	
1.3.6	
1.3.7	
1.3.8	
1.3.9	
1.3.10	
1.3.11	
1.3.12	
1.3.13	
1.3.14	
1.3.15	
1.3.16	
1.3.17	
1.3.18	
1.3.19	
1.3.20	

REMARK ONLY / SLEGS HERMERK						Question Vraag	*NORMAL MARKING / NORMALE MERK*					
Marks / Punte			Initials / Paraaf				Marks / Punte			Initials / Paraaf		
H	T	U	Mark	Mod	Cont		H	T	U	Mark	Mod	Cont
						1						
						2						
						3						
						4						
						5						
						6						
						7						
						Total Totaal						

DISTRICT
DISTRIK

ANSWER / ANTWOORD 2.1.1
MOMENTE OM RR / MOMENTS AROUND RR

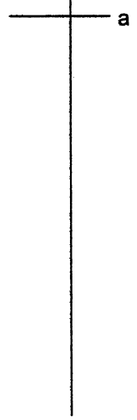
ANSWER / ANTWOORD 2.1.1
MOMENTE OM LR / MOMENTS AROUND LR



ANSWER / ANTWOORD 2.1.3

ANSWER / ANTWOORD 2.1.4

MEMBER ONDERDEEL	MEASUREMENT AFMETING	FORCE KRAG	NATURE AARD
GF			
HJ			
FE			
FA			



FORCE DIAGRAM / KRAGTEDIAGRAM
SCALE / SKAAL 2 mm : 1 N

ANSWER / ANTWOORD 2.1.2

DISTRICT
DISTRIK

3.1.1 BENDING MOMENT / BUIGMOMENTE

BM (A) = _____

BM (B) = _____

BM(C) = _____

_____

BM(D) = _____

_____

_____

3.1.2 SHEAR FORCES / SKUIFKRAGTE

SF /SK (D) = _____

SF /SK (C) = _____

SF / SK (B) _____

SF/SK (A) _____

QUESTION / VRAAG 3.2

3.2.1 CONVERSION / OMSKAKELING

_____

_____

_____

REDRAW DIAGRAM / HERTEKEN DIE DIAGRAM

3.2.2 MOMENTS AROUND R (FOR L) / MOMENTE OM R (VIR L)

_____

_____

_____

_____

3.2.2 MOMENTS AROUND L (FOR R) / MOMENTE OM R (VIR R)

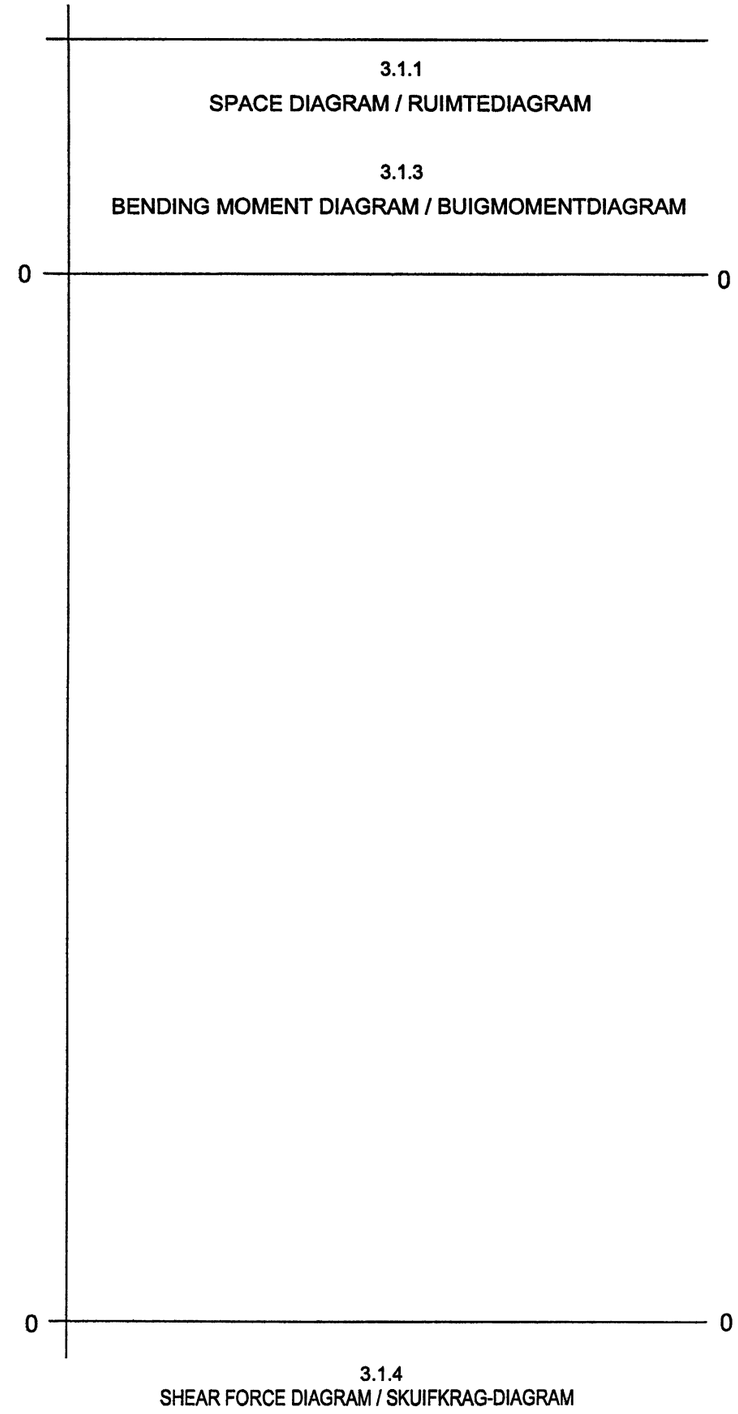
_____

_____

_____

_____

ANSWER FOR QUESTION 3 / ANTWOORD VRAAG 3



3.1.1
SPACE DIAGRAM / RUIMTEDIAGRAM

3.1.3
BENDING MOMENT DIAGRAM / BUIGMOMENTDIAGRAM

3.1.4
SHEAR FORCE DIAGRAM / SKUIFKRAG-DIAGRAM

DISTRICT
DISTRIK

4.1.1

4.1.2 STRAIN / VORMVERANDERING

4.1.3 YOUNG'S MODULUS / YOUNG SE MODULUS

4.2.1 AREA

4.2.2 DIAMETER

4.3

a)

b)

c)

e)

4.4

a)

b)

4.5

DISTRICT
DISTRIK

5.1.1 FOR TL YX[1] / VIR WL YX[1]

5.1.2 FOR TL BF[1] / WARE LENGTE BF[1]

5.1.3 DIHEDRAL ANGLE / TWEEVLAK-HOEK

5.2

A)

B)

C)

D)

E)

5.3

A)

B)

C)

D)

E)

5.4

A)

B)

C)

5.5

A)

B)

DISTRICT
DISTRIK

6.1.1 LABOUR COST / ARBEIDSKOSTE

6.1.2 COST OF MATERIAL / MATERIAALKOSTE

6.1.3 OVERHEAD COST / DRAKOSTE

6.1.4 TOAL COST / TOTALE KOSTE

6.3 a)

b)

c)

d)

e)

6.4 a)

b)

c)

6.5 a)

b)

6.2 GUSSET PLATE / KNOOPPLAAT

DISTRICT
DISTRIK

7.1

A) _____

B) _____

C) _____

D) _____

E) _____

7.2

A) _____

B) _____

C) _____

D) _____

7.3

A) _____

B) _____

C) _____

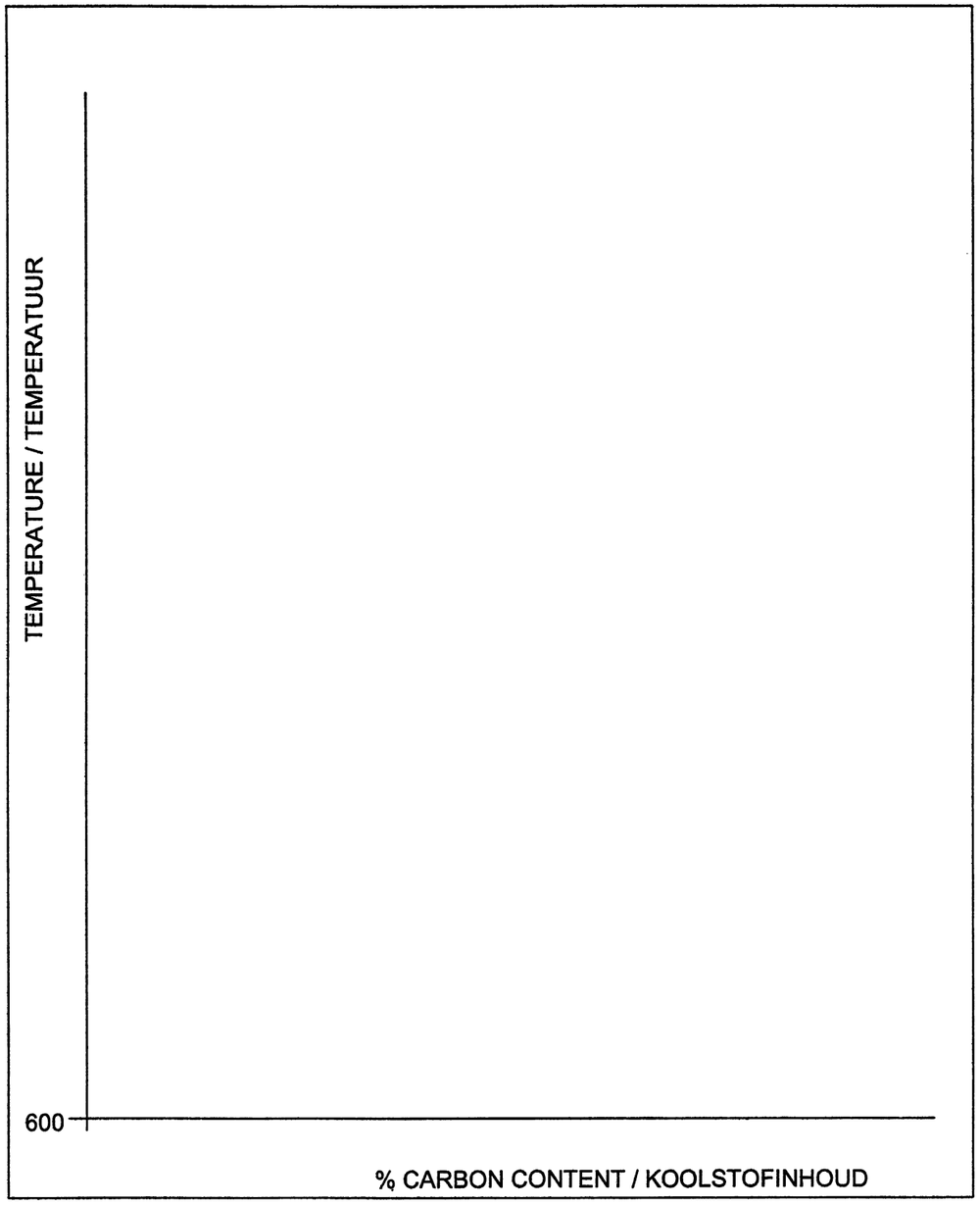
D) _____

E) _____

7.4 _____

_____

7.5



USE THE FOLLOWING SCALES
GEBRUIK DIE VOLGENDE SKALE

1CM : 0.1% CARBON /KOOLSTOF
1CM : 50^{O}C

7.5.1 _____

7.5.2 _____

7.5.3 _____

7.5.4 _____

7.5.5 _____

7.5.6 _____

7.5.7

a) _____

b) _____

c) _____

DISTRICT
DISTRIK