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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T190(E)(A1)T
APRIL EXAMINATION
NATIONAL CERTIFICATE
BUILDING SCIENCE N2

(15070012)

1 April 2014 (Y-Paper)
13:00–16:00

Calculators may be used.

This question paper consists of 5 pages, 2 diagram sheets and 1 formula sheet.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
NATIONAL CERTIFICATE
BUILDING SCIENCE N2
TIME: 3 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer ALL the questions.
 2. Read ALL the questions carefully.
 3. Number the answers according to the numbering system used in this question paper.
 4. Write down the formula BEFORE you start your calculations.
 5. ALL sketches and/or diagrams must be done in pencil.
 6. The sketches and/or diagrams must be reasonably large and fully labelled.
 7. Assume that 1 kg of mass exerts a force of 10 N.
 8. Write neatly and legibly.
-

QUESTION 1

Define the following terms as found in building science:

- 1.1. Relative density of a material (specific gravity) (3)
 - 1.2 Capillary action (2)
 - 1.3 Thermal capacity of a material (3)
 - 1.4 Torque (2)
- [10]**

QUESTION 2

- 2.1 Describe the working principles of a hydrometer: (3)
 - 2.2 Study the statement below and answer the questions.

If we place a brick in a container full of water, hundreds of tiny bubbles come to the surface. We say that the brick is porous.

 - 2.2.1 What causes the air bubbles to appear? (2)
 - 2.2.2 Describe how the manufacturing process of bricks makes them porous. (2)
 - 2.2.3 Describe how timber (wood) becomes porous. (2)
 - 2.3 The bulk volume of a material is $5,46 \text{ cm}^3$ and its solid volume is $4,02 \text{ cm}^3$. The material absorbed $1,30 \text{ cm}^3$ of water.

Calculate the saturation coefficient of the material. (6)
- [15]**

QUESTION 3

- 3.1 Describe TWO precautions that one would take to avoid frost damage to exposed building components. (2)
 - 3.2 Explain the working of a domestic hot-water heating cylinder. (4)
 - 3.3 Calculate the mass of water required if 700 kJ of heat is given out when the temperature of the water drops from 90°C to 60°C . The specific heat capacity of water is $4,2 \text{ kJ/kg}^\circ\text{C}$. (4)
- [10]**

QUESTION 4

- 4.1 Explain what is meant by the term *permeability* with reference to roofing materials. (1)
- 4.2 Will corrugated iron sheeting be a suitable roof cover for coastal areas? Motivate your answer. (3)
- 4.3 Copy the following table in your ANSWER BOOK and complete it by writing YES, NO or FAIR in the spaces provided. (6)

ROOF COVERING	DURABLE	HAIL RESISTANT	HEAVY
Clay tiles			
Glass fibre sheets			
Slate tiles			
Thatch			

(12 x ½)

(6)
[10]**QUESTION 5**

Figure 1 (DIAGRAM SHEET 1) shows a beam X-Z which is 13 meters long and simply supported at L and R. The beam is loaded as indicated in the sketch and has a weight of 8 kN.

- 5.1 Calculate the reactions at L and R by taking moments about any suitable point. Control/Test your answer. (10)
- 5.2 Calculate the reactions at L and R if the point loads on this beam are replaced by an evenly distributed load of 10 kN per metre length over the whole length of the beam. Control/Test your answer. (8)

[18]

QUESTION 6

Figure 2 (DIAGRAM SHEET 1) shows the dimensions of a thin metal plate of uniform thickness.

Determine the position of the centroid from side AB by calculation only.

NB: NO MARKS will be allocated for a graphical solution.

[12]

QUESTION 7

7.1 Figure 3 (DIAGRAM SHEET 1) shows a pin-jointed frame in equilibrium.

Use a suitable scale and draw the force diagram and determine the magnitude of the forces in the members. (15)

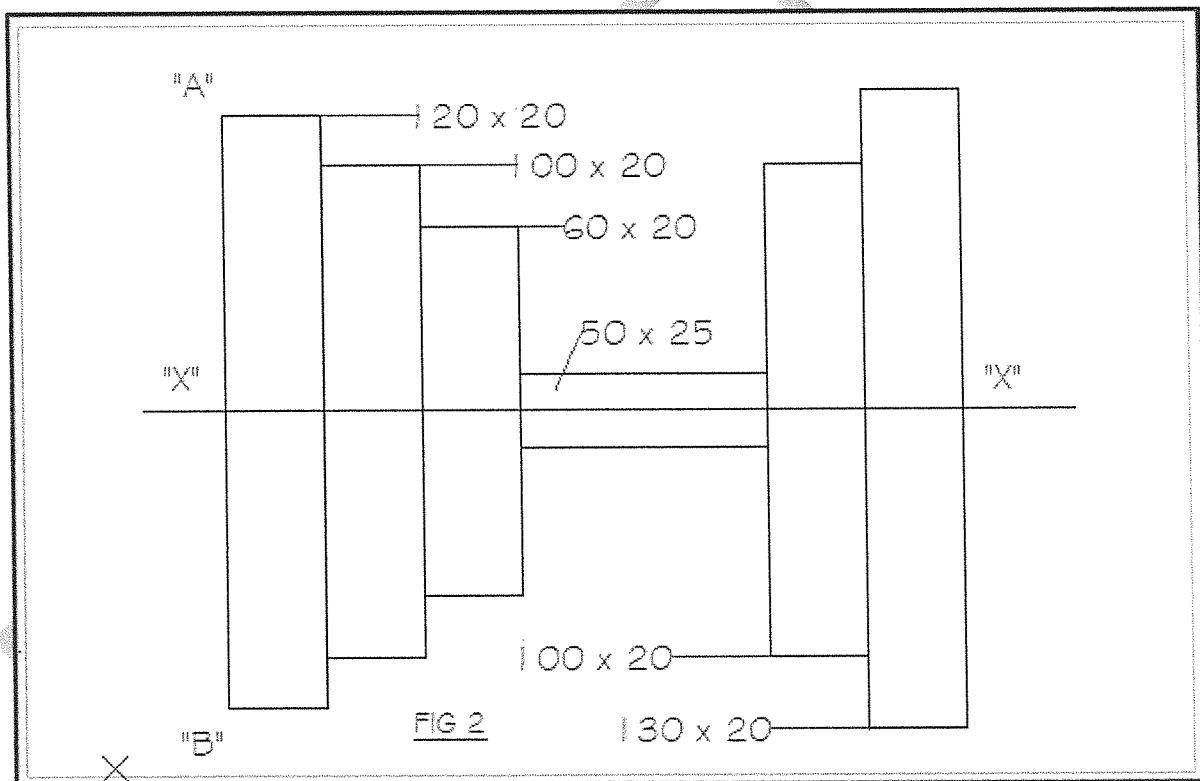
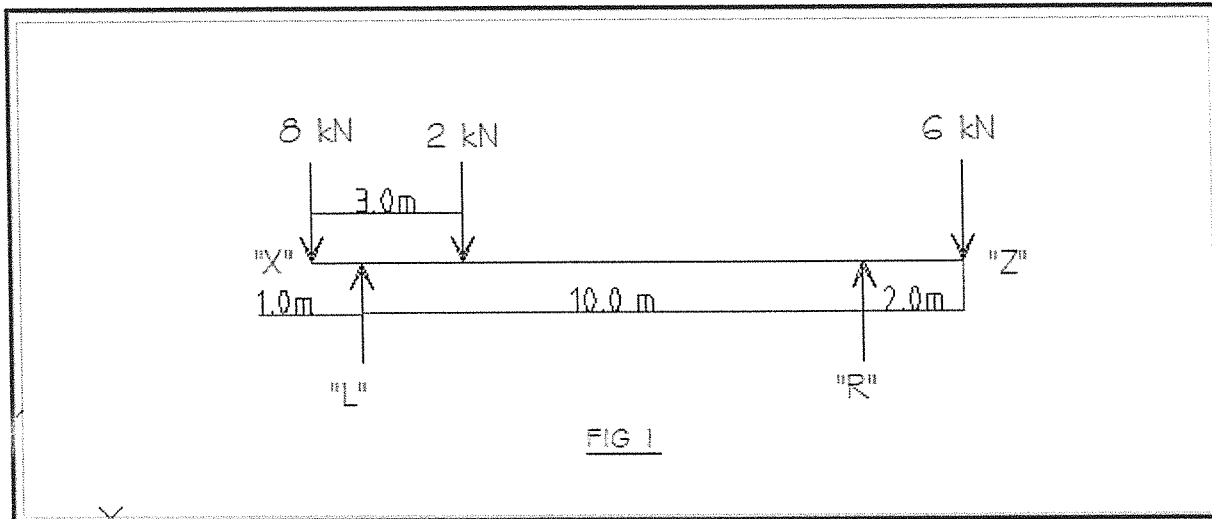
7.2 Neatly tabulate your answers from QUESTION 7.1 in the ANSWER BOOK according to the following TABLE.

MEMBER	MAGNITUDE (KN)	NATURE	
		TIE	STRUT
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			

(10)
[25]

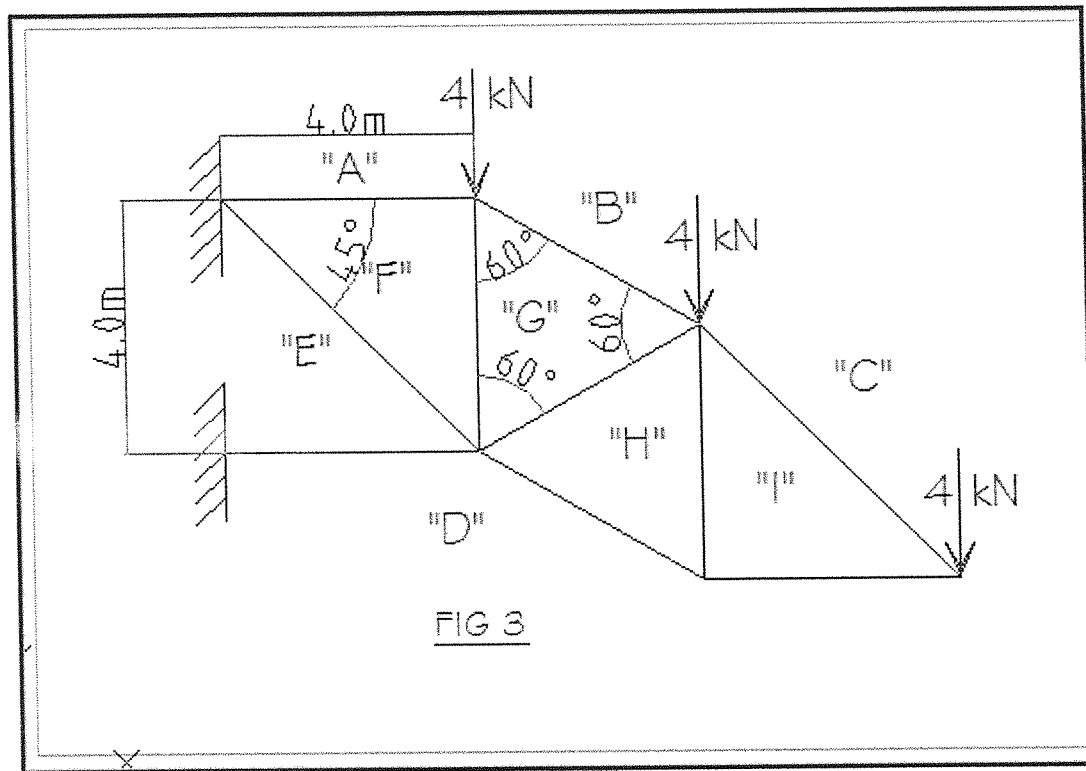
TOTAL: 100

DIAGRAM SHEET 1



NB: FIGURE 1 should be showing 8 kN at the centre of the beam (per statement given)

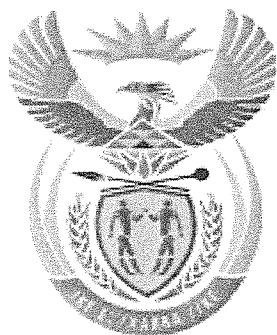
DIAGRAM SHEET 2



FORMULA SHEET

Any applicable formula may be used.

1. $F = m \times g$
2. $\sin \theta = O/H$
3. $\cos \theta = A/H$
4. $\tan \theta = O/A$
5. $A = \pi \frac{D^2}{4} = \pi r^2$
6. $A = \frac{1}{2}(B \times H)$
B)
7. $V = \pi \frac{D^2}{4} \times H$
8. $\sum CM = \sum ACM$
9. $\sum \uparrow F = \sum \downarrow F$
10. $V = L \times B \times H$
11. $M = F \times s$
12. $K = C + 273$
13. Moment of area = area x distance from axis
14. $VC = W \cdot \sin \theta$
15. $HC = W \cdot \cos \theta$
16. $y = \frac{\sum My}{\sum A}$
17. $D = \frac{M}{V}$
18. $RD = \frac{D \times S}{D \times W} = RD = \frac{M \times S}{M \times W}$
19. $\Delta L = L_o \times \Delta T \times \alpha$
20. Heat required = $m \times \Delta t \times SHC$
21. $\% \text{ porosity} = \frac{\text{Bulk volume} - \text{Solid volume}}{\text{Bulk volume}} \times 100\%$
22. $\text{saturation coefficient} = \frac{\text{volume of water absorbed}}{\text{bulk volume} - \text{solid volume}}$



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MARKING GUIDELINE

NATIONAL CERTIFICATE

APRIL EXAMINATION

BUILDING SCIENCE N2

1 APRIL 2014

This marking guideline consists of 7 pages.

QUESTION 1

- 1.1. Ratio between the density of the specific substance✓ and the density of pure water✓ at 4 °C✓ (3)
- 1.2 Capillary action is the rising of liquids✓ such as water and oil that can wet the surfaces (extra bonus mark if added✓) through the fine pores of certain solid substances✓ (2)
- 1.3 Thermal/Heat capacity of a material is the quantity of heat energy✓ required to raise the temperature✓ of the body by 1°C or 1 K✓ (3)
- 1.4 Torque is the effect of a force on an object fixed at a turning point✓ that will produce rotation movement about that fixed point.✓ (2)
- [10]**

QUESTION 2

- 2.1 The working principles of a hydrometer is that all floating objects will displace its own weight in a liquid.✓
Hydrometers will therefore float at different levels in different fluids.✓
This variety in depth of floating can be celebrated to indicate the density of a specific fluid.✓ (3)
- 2.2 The bubbles are caused by water penetrating the pores in the brick✓ and displacing the air inside the pores. ✓ (2)
- 2.2.1 Bricks are baked and during this process heat drives the moisture out.✓
This leaves hollows (pores) behind.✓ (2)
- 2.2.2 Shrinking wood cells leave vacuums✓ when the sap in the wood dries out.✓ (2)
- 2.3 First determine volume of pores
 $\text{volume} = \text{Bulk volume} - \text{Solid volume}✓$
 $v = 5,46 \text{ cm}^3 - 4,02 \text{ cm}^3 \checkmark$
 $v = 1,44 \text{ cm}^3✓$
- Now determine saturation coefficient
 $\text{saturation coefficient} = \frac{\text{volume of water absorbed}}{\text{bulk volume} - \text{solid volume}}✓$
 $s co = \frac{1,30 \text{ cm}^3}{1,44 \text{ cm}^3} \checkmark$
- $\text{saturation coefficient} = 0,903✓$ (6)
- [15]**

QUESTION 3

- 3.1 Only very durable materials are selected for use in exposed areas.✓
All possible precautions are taken to reduce absorption of water by any exposed features.✓ (2)
- 3.2 A heat source will raise temperature of the water at the bottom of the cylinder.✓
Convection current will circulate the hot water to the top.✓
Cold water will replace the raised hot water.✓
A thermostat would control the temperature levels in the cylinder.✓ (4)
- 3.3 Heat required = $m \times \Delta t \times SHC$ ✓
 $700\text{kJ} = m \times (90 - 60) \times 4,2\text{kJ/kg}^\circ\text{C}$ ✓
 $m = 700$ ✓
 $30 \times 4,2$
 Mass of water = 5,56kg✓ (4)
- [10]**

QUESTION 4

- 4.1 The extent to which a roofing material allows water to pass through it is called its permeability.✓ (1)
- 4.2 No – corrugated iron will not be suitable.✓
It rusts easily✓ and the maintenance is high.✓ (3)
- 4.3
- | ROOF COVERING | DURABLE | HAIL RESISTANT | HEAVY |
|--------------------|---------|----------------|-------|
| Clay tiles | Yes✓ | Fair✓ | Yes✓ |
| Glass fibre sheets | Yes✓ | Fair✓ | No✓ |
| Slate tiles | Yes✓ | Fair✓ | Yes✓ |
| Thatch | No✓ | Yes✓ | No✓ |

(12 x ½)

(6)
[10]

QUESTION 5

5.1 Take moments about R
 $\sum CM = \sum ACM$ ✓
 $(L \times 10) + (6 \times 2) = (2 \times 8) + (8 \times 11)$
 ✓✓✓✓
 $10L = 16 + 88 - 12$ ✓
 $L = 92/10$ ✓
 $L = 9,2$ ✓

Control:
 $\sum \uparrow F = \sum \downarrow F$ ✓
 $9,2 + 6,8 = 8 + 2 + 6$ ✓✓
 $16 = 16$ ✓

Take moments about R
 $\sum CM = \sum ACM$ ✓
 $(R \times 10) + (8 \times 1) = (2 \times 2) + (6 \times 12)$ ✓✓✓✓
 $10R = 4 + 72 - 8$ ✓
 $R = 68/10$ ✓
 $R = 6,8$ ✓

(20 x ½) (10)

5.2 Add mass of beam to UDL✓
 $8 + (10 \times 13) = 138 \text{ kN}$ ✓✓

Take moments about R
 $\sum CM = \sum ACM$ ✓
 $(L \times 10) = (138 \times 4.5)$ ✓✓
 $L = 621/10$ ✓
 $L = 62.1$ ✓

Control:
 $\sum \uparrow F = \sum \downarrow F$ ✓
 $962.1 + 75.9 = 138$ ✓✓

Take moments about R
 $\sum CM = \sum ACM$ ✓
 $(R \times 10) = (138 \times 5.5)$ ✓✓
 $R = 759/10$ ✓
 $R = 75.9$ ✓

(16 x ½) (8)
[18]**QUESTION 6**

6.1 Area of section:

$A = l \times b = 120 \times 20 = 2\,400 \text{ units}^2$ ✓
 $B = l \times b = 100 \times 20 = 2\,000 \text{ units}^2$ ✓
 $C = l \times b = 60 \times 20 = 1\,200 \text{ units}^2$ ✓
 $D = l \times b = 50 \times 25 = 1\,250 \text{ units}^2$ ✓
 $E = l \times b = 100 \times 20 = 2\,000 \text{ units}^2$ ✓
 $F = l \times b = 130 \times 20 = 2\,600 \text{ units}^2$ ✓

True area of section = \sum of areas = 11 450 units²✓
 ONLY CALCULATED RESULT WILL BE CONSIDERED

6.2 Centroid from A-B :

$$A = \frac{1}{2} \times 20 = 10 \text{ units} \checkmark$$

$$B = \frac{1}{2} \times 20 + 20 = 30 \text{ units} \checkmark$$

$$C = \frac{1}{2} \times 20 + 40 = 50 \text{ units} \checkmark$$

$$D = \frac{1}{2} \times 50 + 60 = 85 \text{ units} \checkmark$$

$$E = \frac{1}{2} \times 20 + 110 = 120 \text{ units} \checkmark$$

$$F = \frac{1}{2} \times 20 + 130 = 140 \text{ units} \checkmark$$

ONLY CALCULATED RESULT WILL BE CONSIDERED

6.3 Moment of area = area x distance from axis ✓

$$A = 2400 \times 10 = 24\,000 \text{ units}^3 \checkmark$$

$$B = 2000 \times 30 = 60\,000 \text{ units}^3 \checkmark$$

$$C = 1200 \times 50 = 60\,000 \text{ units}^3 \checkmark$$

$$D = 1250 \times 85 = 106\,250 \text{ units}^3 \checkmark$$

$$E = 2000 \times 120 = 240\,000 \text{ units}^3 \checkmark$$

$$F = 2600 \times 140 = 364\,000 \text{ units}^3 \checkmark$$

$$\text{True moment of section} = \sum \text{of moments} = 854\,250 \text{ units}^3 \checkmark$$

ONLY CALCULATED RESULT WILL BE CONSIDERED

$$6.4 \quad y = \frac{\sum My}{\sum A} \checkmark$$

$$= 854\,250 \text{ units}^3$$

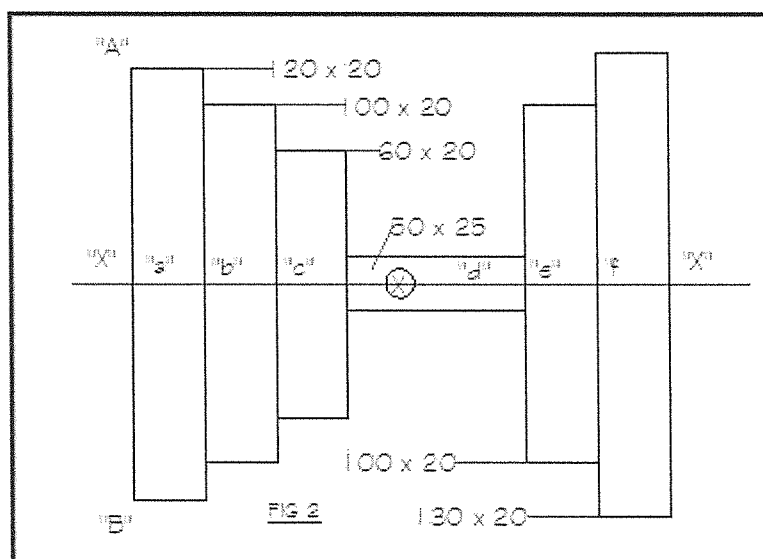
$$11\,450 \text{ units}^2 \checkmark$$

$$= 74,6 \text{ units from A-B} \checkmark$$

ONLY CALCULATED RESULT WILL BE CONSIDERED

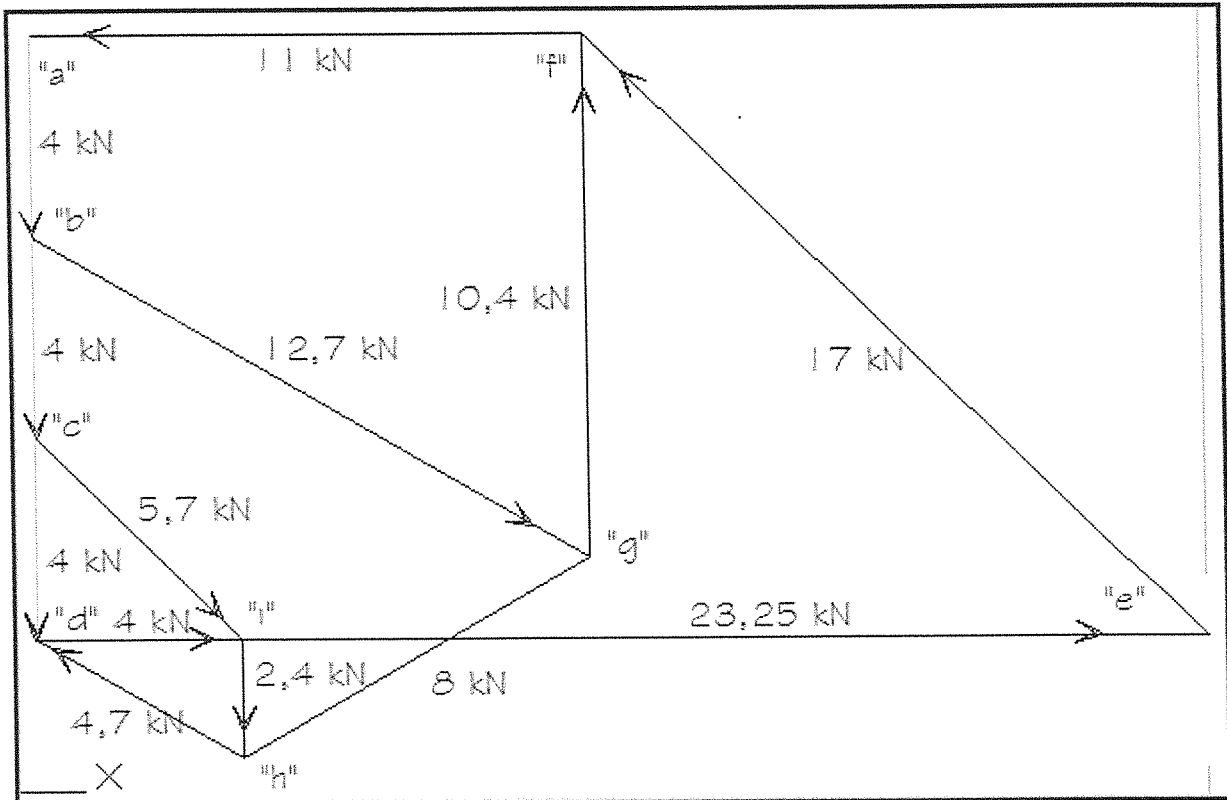
(24 x ½)

(12)
[12]



QUESTION 7

- 7.1 Use a scale of 1 kN = 1cm. Draw and measure – graphical drawing accurate to 5% of memo values will be acceptable.

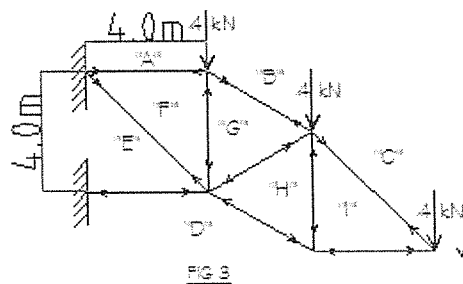
**VECTOR DIAGRAM**

- 10 members drawn in the vector diagram = 1 mark each
- Showing the magnitudes in the vector diagram = $\frac{1}{2}$ mark each x 10 = 5 marks

(15)

7.2 Copy table and populate – loads net required in table

MEMBER	MAGNITUDE (kN)	NATURE	
		TIE	STRUT
a-b	4.0 LOAD		
b-g	12.7	X	
g-f	10.4		X
b-c	4.0 LOAD		
c-i	5.7	X	
i-h	2.4		X
h-g	8.0		X
c-d	4.0 LOAD		
d-h	4.7		X
d-e	23.25		X
e-f	17.0	X	
f-a	11.0	X	
d-i	4.0		X



- Showing the nature of the 10 members in space diagram = $\frac{1}{2}$ mark each x 10 = 5 marks
- Filling in the table showing magnitudes and nature = $\frac{1}{2}$ mark each x 10 = 5 marks

(10)

[25]

TOTAL: 100