

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions.

Marks for each question are shown in brackets.

Section A

1.

Simplify EACH of the following and rearrange to make  $x$  the subject of the expression:

(a)

$$y = \frac{bx^3}{x^2} + \frac{x^4}{4b} \quad (4)$$

(b)

$$y = \frac{x^2 \times z^3}{z^2} \times \frac{2x^5 \times z}{x^2} \quad (4)$$

2.

A cable stretched between two fixings sags under its own weight. The amount to which it sags is given by the approximate expression;

$$S = \sqrt{\left(\frac{3d(L-d)}{8}\right)}$$

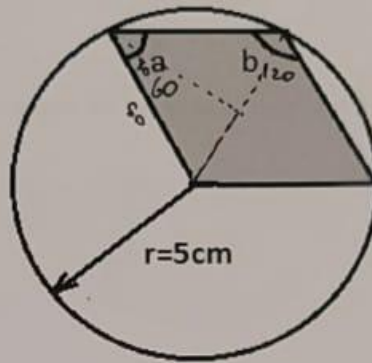
Determine the value for  $L$  to 2 decimal places when  $S = 3.25$  and  $d = 50$ . (8)

*Note: Units can be ignored.*

3. ✓ Determine the area of the shaded sector shown in Fig Q3 for the angles given.

$$\text{Angle, } a = \frac{\pi}{3} \text{ rads}$$

$$\text{Angle, } b = \frac{2\pi}{3} \text{ rads}$$



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Fig Q3

(8)

4. ✓ (a) Plot the following (x,y) data on a graph.

(4)

x	3	2	1	0	-1	-2
y	-9.4	-6.6	-3.8	-1	1.8	4.6

(b) Determine an expression relating the x and y coordinates.

(4)

(c) Determine the value of y when x = 1.5.

(2)

5. ✓ A concrete beam is shown in Fig Q5.

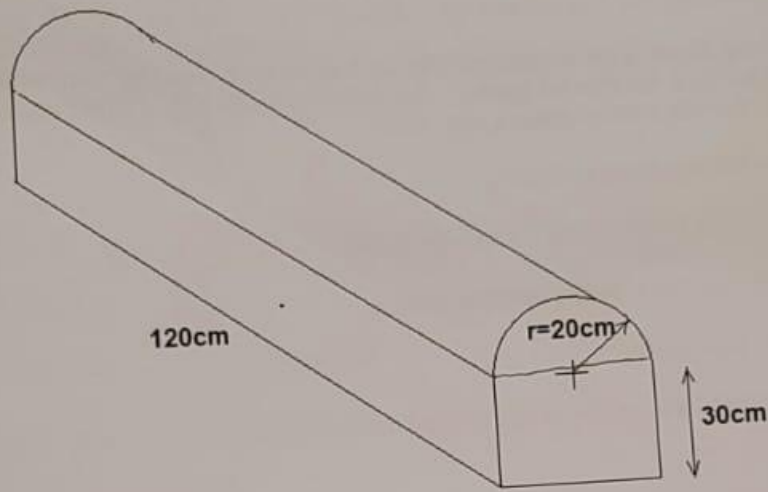


Fig Q5

Determine EACH of the following:

(a) the volume of the beam;

(b) the total surface area of the beam.

(3)

(5)

6. A sphere and a cone have the same volumes. The radius of the sphere is the same as the radius of the cone base.

Determine EACH of the following:

(a) the ratio of cone height to sphere radius;

(b) check your answer to Q6(a) by calculation for a sphere of radius 2 cm.

(4)

(4)

Section B

7. A stationary block with a mass of 150 kg has a force applied to it which causes acceleration in a horizontal plane. The force of 1950 N is applied at an angle of  $15^\circ$  below the horizontal pulling the block.

Determine EACH of the following:

- (a) the applied force in the horizontal plane; (1)
- (b) the applied force in the vertical plane; (1)
- (c) the net normal force; (2)
- (d) the acceleration of the block if the coefficient of friction is 0.2. (4)

8. Fig Q8 shows a cross section of a wind turbine support column. The turbine rotor assembly has an effective mass of 30 tonnes on top of the column. The column has a rectangular central section of length 1 m joined by semi-circular ends.

- (a) If the compressive stress limit is  $350 \text{ MN/m}^2$  determine whether the column can withstand the load; (4)
- (b) Calculate the strain in the column given that the Modulus of Elasticity  $E$  for the material is  $196 \text{ GN/m}^2$ .

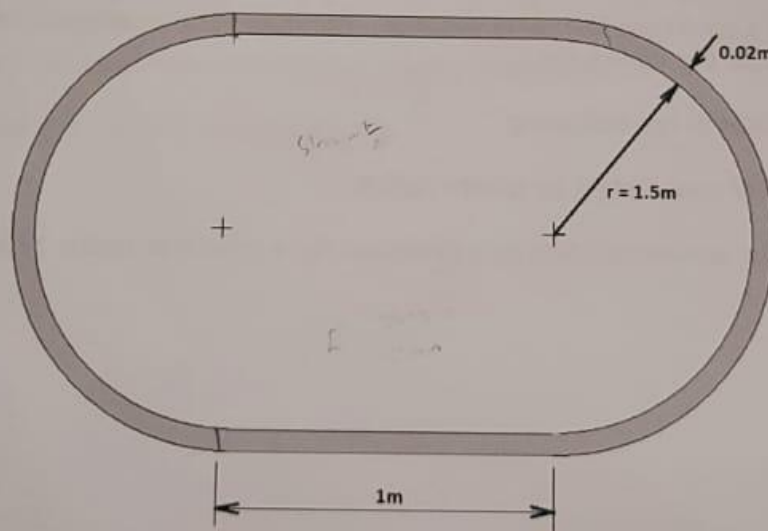


Fig Q8 (not to scale)

(4)

- ✓ 9. (a) Define density and use the definition to derive the units for density. (2)
- (b) Define work (work done) as it is used in engineering and use the definition to derive the units for work done. (4)
- (c) State the law of conservation of energy. (2)

- ✓ 10. A pump on a water main discharges through a pipe of 100 mm diameter against a head of 32 m at a constant velocity of 3.5 m/s. You can ignore the effects of friction in the pump and pipe-work.

Note: Density of seawater  $1025 \text{ kg/m}^3$

Determine EACH of the following:

- (a) the power of the pump;
- (b) the motor power to drive the pump if the combined electrical and mechanical efficiency is 88%.
11. (a) Explain what is meant by the term centroid.
- (b) For the shape shown in Fig Q11, determine the position of the centre of area.

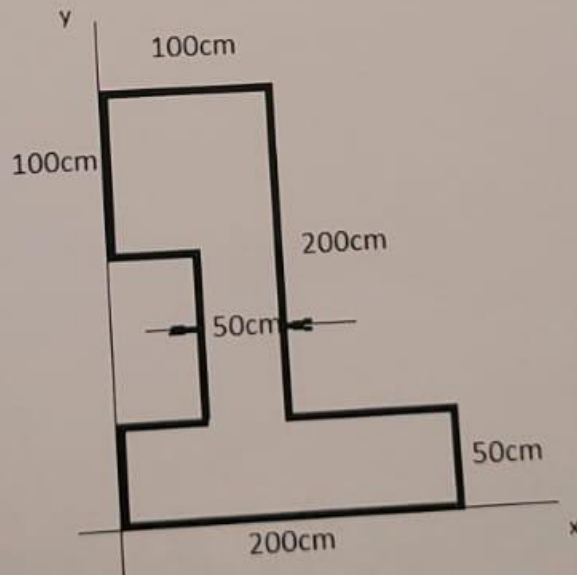


Fig Q11

12. A winch raises a mass of 500 kg through a distance of 12 m in 10 seconds. The power input to the system is measured at 7.5 kW.

Determine EACH of the following:

- (a) the work done in lifting the load;  
(b) the system efficiency.

$$W = F \times d$$
$$= 500 \times 9.81 \times 12$$