March 1999

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each part question are shown in brackets

1. Evaluate the following expressions, using fractions and showing ALL working:

   (a) $7\frac{1}{3} - 2\frac{1}{4} + 3\frac{3}{5} - 2\frac{5}{6}$ (4)

   (b) $\frac{1}{5} \div \left(\frac{1}{3} \div \frac{1}{2}\right)$ (4)

2. A gear wheel having 40 teeth revolves at 130 rev/min.
   This wheel meshes with another wheel which has 28 teeth.

   Calculate the speed of the 28 tooth wheel. (6)

3. A triangle ABC has side AB = 70mm, side BC = 60mm and angle ABC =60°.

   (a) Construct the triangle, full scale, and determine the length of side AC. (3)

   (b) Calculate the area of the triangle in Q.3(a) in cm^2. (5)

4. The final length of a metal bar subjected to heat is given by the formula:

   $$l = l_0(1 + \alpha t)$$

   (a) Transpose the formula to make α the subject (4)

   (b) Determine the value of t when l = 30.0144, l_0 = 30 and α = 1.2 x 10^{-5}. (4)

5. *(a)* (i) Plot the graph of y = 2x + 2 between the limits of x = 0 and x = 3. (4)

   (ii) Plot the graph of $y = x^2$ between the same limits, on the same axes. (4)

   (b) State the ordinates where graphs Q.5(a) (i) and (ii) intersect. (2)

   Note: Suggested Scales:
   x axis 1 unit = 4cm
   y axis I unit = 2cm

6 Fig. Q 6 shows a solid right cone.

Determine the TOTAL surface area in m^2. (10)

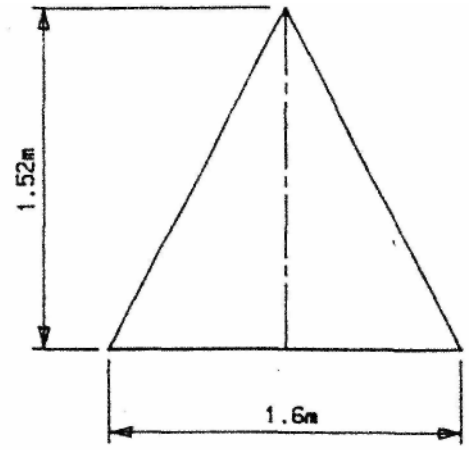

Fig. Q.6

7. A screwjack is operated by an effort lever 160 mm long and has a screw pitch of 4 mm.

An effort of 39.25N applied to the effort lever will just lift a load of 200 kg.

Determine:

(a) the mechanical advantage; (3)

(b) the velocity ratio; (3)

(c) the efficiency, as a percentage. (2)

8. A vertical hollow support column has an outside diameter of 150 mm and a wall thickness of 14 mm. A vertical load of 4.3 tonne is applied at the top of the column.

Calculate:

(a) the stress in the column in N/mm^2; (5)

(b) the value of E for the material in GN/m^2 given that the strain is not to exceed 3.525×10^{-5}. (5)

9. *(a)* Define *power* and state its unit (2)

(b) A pump transfers water from one tank to another through an effective height of 19 metres.

Determine the power of the pump when the discharge flow rate is 95 tonne/hour. (6)

10. Determine, by any suitable means, the force in the jib and tie of the wall crane shown in Fig. Q.10. (8)

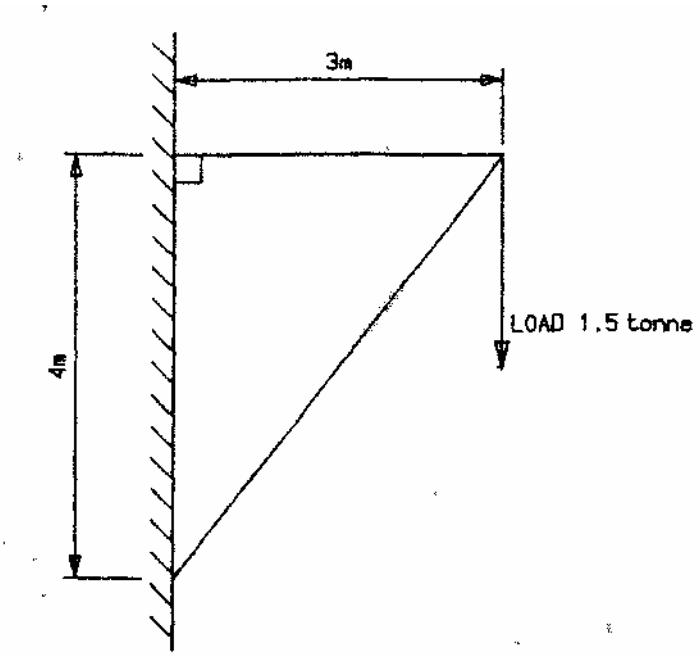

Fig. Q. 10

11. A ship has a displacement of 2 370 tonne with a centre of gravity G positioned 4.1 metres above the keel.

Determine the new position of the centre of gravity above the keel when a mass of 90 tonne is loaded on the centre line as deck cargo at 6.3 metres above the keel. (8)

12. A plank of wood is 2.1 metre long, 203 mm wide and 102 mm deep and floats in water of density 1020kg/m^3.

Calculate the height of wood above the water surface given that the wood has a density of 780kg/m^3 and floats horizontally. (8)