Dec 2008

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets.

1. (a) State the Theorem of Pythagoras. (3)

   (b) A ladder is 8.66m long and is positioned against a vertical wall such that the foot of the ladder is 4.065m from the wall.

   Calculate the perpendicular height to the top of the ladder. (5)

2. (a) Draw the graph of $y = x^2$ for values of x between $x = -1$ and $x = +2$. (4)

   (b) Using the same axes draw the graph of:

   $y = x + 1.5$ for values of x between $x = -1$ and $x = +2$. (4)

   (c) Determine the co-ordinates of the points of intersection of the graphs. (2)

   Note: suggested scales 1 unit x = 4cm
   1 unit y = 4cm

3. A right angled triangle has an area of 2.8m². The sides are in the ratio of 5:12:13 and the triangle stands on the shortest side.

   Calculate EACH of the following:

   (a) the perpendicular height; (5)

   (b) the hypotenuse. (3)

4. A solid hemisphere has a diameter of 21cm.

   Calculate the <u>total</u> surface area in m². (8)

5. The following formula may be used to determine torque in shaft transmission systems.

$$T = \frac{\pi D^3 \tau}{16}$$

(a) Transpose the formula to make D the subject. (5)

(b) Calculate the shear stress τ when $T = 6350\text{Nm}$ and $D = 0.0974\text{m}$. (3)

6. (a) Multiply $2x + 4$ by $3x - 5$ (3)

(b) Simplify $\frac{4a}{3b} + \frac{5b}{2a}$ (5)

7. An electric motor comes to rest from running speed in 1 minute 7 seconds and turns through 1018 revolutions before coming to rest.

Calculate EACH of the following:

(a) the running speed in rev/min; (4)

(b) the retardation in rad/s². (4)

8. Calculate EACH of the following:

(a) the coefficient of friction between a machine having a mass of 462kg and a horizontal surface if it takes 2.7kN applied parallel to the horizontal surface to just cause motion; (4)

(b) the force applied parallel to the horizontal surface to just cause motion if rollers are introduced under the load reducing the coefficient of friction by 73%. (4)

9. (a) Produce a simple diagrammatic sketch of a double purchase (double reduction) crab winch. (4)

(b) Using the sketch in Q9(a) prove that the movement ratio is equal to

$$\frac{L}{r} \times \frac{product\ of\ followers}{product\ of\ drivers}$$ (6)

where L = effort arm length and r = load shaft radius.

10. (a) Indicate on a simple transverse sketch of a box barge the position of EACH of the following:

(i) centre of gravity G; (1)

(ii) centre of buoyancy B; (1)

(iii) metacentre M. (1)

(b) Calculate the value of GM for a box barge floating at a draught of 4.7m given that KG = 3.95m and BM = 2.83m. (5)

11. A vessel has an underwater volume of 2927m³ in water of density 1025kg/m³. A mass of 40 tonne is loaded on the centreline, then moved 2.48m to port, and in this condition KG = 4.95m and KM = 5.88m.

Calculate EACH of the following:

(a) the displacement in tonnes; (3)

(b) the angle of heel generated to the nearest whole degree, given that

$$GM = \frac{m \times d}{\Delta \tan \theta}$$

(5)

12. A drydock gate is 42m wide and has water of density 1018kg/m³ on one side only to a depth of 14.8m.

Calculate EACH of the following:

(a) the hydrostatic gauge pressure, in bar, at a point 2m up from the bottom of the gate; (3)

(b) the hydrostatic load on the gate. (5)