April 2008

GENERAL ENGINEERING SCIENCE I

Attempt ALL questions

Marks for each question are shown in brackets.

1. Simplify EACH of the following:

(a) $\dfrac{x^2 \times x^3 \times x^5}{x^3 \times x^4}$ (4)

(b) $\dfrac{x}{3} + \dfrac{3x}{2} - \dfrac{5x}{4}$ (4)

2. Table Q2 gives the mass W (kg) and the corresponding effort E newton for a simple lifting machine.

W (kg)	3	8.8	15.2	18
E (N)	45	72	105	118

Table Q2

(a) Plot the graph from the tabular values. (6)

(b) Determine, from the graph produced in Q2(a), the effort needed to just lift a mass of 12kg. (2)

(c) The significance of the origin of the graph in Q2(a). (2)

Note: suggested scales: W axis 1 cm = 2kg
E axis 1 cm = 5N

3. Calculate the area of an equilateral triangle having sides of length 13cm. (8)

4. A right pyramid is 78cm high and stands on a hexagonal base having sides of 21cm.

Calculate the volume of the pyramid in m^3. (8)

5. The total surface area of a solid cylinder is given by the formula:

$$S = 2\pi r^2 + 2\pi rh$$

(a) Transpose the formula to make ***h*** the subject. (5)

(b) Calculate the total surface area of a solid cylinder having the following dimensions: diameter 18cm; height 15cm. (5)

6. Calculate the mass of a piece of steel tube 2.85m long having an inside diameter of 25mm and a tube wall thickness of 6mm. (8)

Note: Steel is 7.6 times heavier than an equal volume of fresh water.

7. A body of mass 25kg is moving at a uniform velocity of 29m/s when it is retarded to 11 m/s in 5 seconds.

Calculate EACH of the following:

(a) the retardation in m/s^2; (3)

(b) the retarding force necessary; (2)

(c) the distance travelled during the 5 second retardation period. (3)

8. A uniform simply supported beam AB is 5m long and has a mass of 1.8 tonne. Point loads of 0.9 tonne and 1.3 tonne are applied at 1.3m and 4.1m from the left hand end A.

(a) Sketch the beam AB, showing ALL relevant loads and dimensions. (2)

(b) Calculate EACH of the following:

(i) the vertical reaction R_A at the left hand end A; (3)

(ii) the vertical reaction R_B at the right hand end B. (3)

9. A steel rod of diameter 2.5cm is subjected to an axial tensile load of 517kg and extends by 0.08mm. On removal of the load the rod assumes its normal length of 95cm.

Calculate EACH of the following:

(a) the direct stress in the rod when loaded; (4)

(b) the direct strain in the rod when loaded; (3)

(c) the value of the Modulus of Elasticity, E, for the material. (3)

10. A rectangular bulkhead is 15m wide and is flooded on one side only with water of density 1019kg/m^3.

Calculate EACH of the following:

(a) the depth of flooding if the pressure at the bottom of the bulkhead is 120kN/m^2; (4)

(b) the hydrostatic load on the bulkhead when flooded to the depth determined in Q 10(a). (4)

11. A vessel has an underwater volume of 1039m^3 in water of density 1023kg/m^3.

Calculate EACH of the following:

(a) the displacement of the vessel; (3)

(b) the distance a mass of 1.06 tonne, already on board, must be moved athwartships to correct a list of 0.4°. (5)

$$Given \quad GM = \frac{m \times d}{\Delta \tan \theta}$$ KM = 4.23m KG = 3.97m.

12. A vessel has a displacement of 5750 tonne. A cargo mass of *m* tonne is now loaded on the centreline at a position 4.1m above the keel causing ship's G to rise by 0.13m.

Calculate the final displacement of the vessel given that the original KG is 2.8m. (8)