



**GENERAL ENGINEERING SCIENCE I**

Attempt ALL questions.

Marks for each question are shown in brackets.

**Section A**

1. An exhaust gas sample was analysed by volume and was found to be made up of 2 parts Sulphur Dioxide, 40 parts Oxygen, 198 parts Carbon Dioxide and 770 parts Nitrogen.

Calculate the percentage of EACH gas in the exhaust, by volume. (8)

2. Simplify EACH of the following expressions showing working:

(a)  $\frac{2 a b^3}{6 b c} \div \frac{4 a^2 b^2}{c^2}$  (4)

(b)  $\frac{2 a}{6 a b c} \times \left( \frac{2 a}{b} + \frac{a}{b} \right)$  (4)

3. (a) State the law of a straight line graph explaining the terms. (2)  
(b) Plot and join the pairs of points shown in Table Q3. (3)  
(c) From the graph determine the equation linking X and Y. (3)

X	-2	-1	0	1	2	3
Y	-8.5	-5.5	-2.5	0.5	3.5	6.5

Table Q3

4. A ladder 3 m long leans against a perpendicular wall at an angle of  $75^\circ$  to the horizontal.

If the bottom of the ladder is moved 40 cm further away from the wall how far will the top of the ladder move down the wall. (8)

5. An engine cylinder, Fig Q5, can be approximated to a cylinder with flat circular base of radius 20 cm with a hemi-spherical top. The piston sweeps 95% of the cylindrical part of the cylinder.

Determine the clearance volume as a percentage of swept volume. (8)

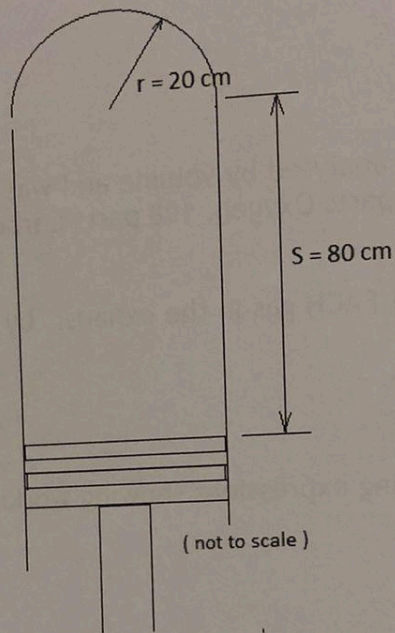


Fig Q5

6. A right cylindrical vessel has a diameter of 20 cm and a height of 30 cm. The vessel contains water to a height of 20 cm. Steel spheres of radius 2 cm are dropped into the vessel raising the water level.

Determine the maximum number of spheres that can be dropped into the vessel without water overflowing. (10)



Section B

7. A simple hoist has a pulley and axle with a pulley diameter of 220 mm on an axle of 55 mm.
- (a) Sketch the basic hoist with dimensions. (2)
- (b) Determine EACH of the following:
- (i) the velocity ratio of the machine; (3)
- (ii) the mechanical advantage of the machine if it requires an effort of 300 N to just lift a mass of 100 kg. (3)

8. Three ships leave the same port at the same time. The first travels due north at a speed of 20 knots, the second travels north east at 9 knots, the third travels due east at 18 knots. After 5 hours they are all instructed to change their plans to travel to a new destination 80 nautical miles north east of the original port which they do immediately.

Calculate which ship will get to the destination first if the speeds remain the same. (8)

9. A mass of 80 kg has a velocity of 1.5 m/s. Its velocity is uniformly increased to 3.0 m/s in 15 seconds. The effects of friction can be ignored.
- (a) Calculate the accelerating force required. (3)
- (b) A brake is applied and the velocity of the mass is now uniformly retarded at  $0.5 \text{ m/s}^2$  from 3.0 m/s until the mass just comes to rest.
- Calculate, for the retardation period, EACH of the following:
- (i) the time taken to come to rest; (4)
- (ii) the distance travelled. (4)

10. A stationary body with a mass of 20 kg has a force of 70 N applied to it which causes acceleration in a horizontal plane.

Calculate EACH of the following:

- (a) the acceleration of the body, ignoring friction; (4)
- (b) the acceleration of the body if the coefficient of friction is 0.25. (4)



11. A steel tie rod 2.2 m long has a diameter of 5 mm and when subjected to an axial pull of 310 kN extends by 1.45 mm.

Determine EACH of the following:

- (a) the direct stress in the rod; (3)
- (b) the direct strain in the rod; (3)
- (c) the Modulus of Elasticity (E) for the steel. (2)
12. Fig Q12 shows a steel beam, of uniform cross section, 2.5 metres long having a mass of 60 kg.
- Determine the value of W to give a balanced equilibrium condition about the fulcrum. (8)

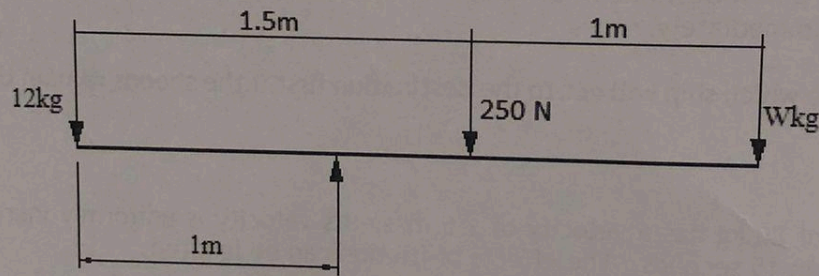


Fig Q12