GENERAL ENGINEERING SCIENCE I

Attempt ALL questions.

Marks for each question are shown in brackets.

Section A

1. (a) Express the fraction $\frac{26}{11}$ as a decimal correct to 4 decimal places. (2)

(b) Express the value 0.0034 as a percentage. (2)

(c) Write the number 0.00784 in standard form. (2)

(d) Simplify the following expression into a single fraction:

$$\frac{27}{13} \div \frac{9}{4}$$

2. The time period of a pendulum is given by:

$$T = 2 \times \pi \sqrt{\frac{L}{g}}$$

(a) Rearrange the equation to make L the subject. (4)

(b) Evaluate T, when L is 1.3 m and g is 9.81 m/s^2 giving you answer to 2 decimal places. (4)

3. Data collected from an experiment is shown in Table Q3.

X	-5	-1	2	9
Y	-16	-6	1.5	19

Table Q3

(a) Plot the points shown in Table Q3 using an appropriate scale and draw the best fit line of a straight line graph of the form y = mx+c. (2)

(b) Determine the values of *m* and *c* from your graph. (3)

(c) Determine the relationship of the variable x in terms of Y. (3)

4. A tourist is admiring the view from the top of a building giving them a viewpoint of 100 m elevation above level ground. The tourist can see a second building 150 m away that is 70 m high and remembers their car is parked some distance beyond the second building. The car is 1.7 m high and is parked 325 m beyond the second building, in a straight line of sight.

Provide working to demonstrate whether the tourist will be able to see their car. (8)

5. Fig Q5 shows a square constructed within a square. Determine an expression for the area of the inner square in terms of the dimensions x and y shown. (8)

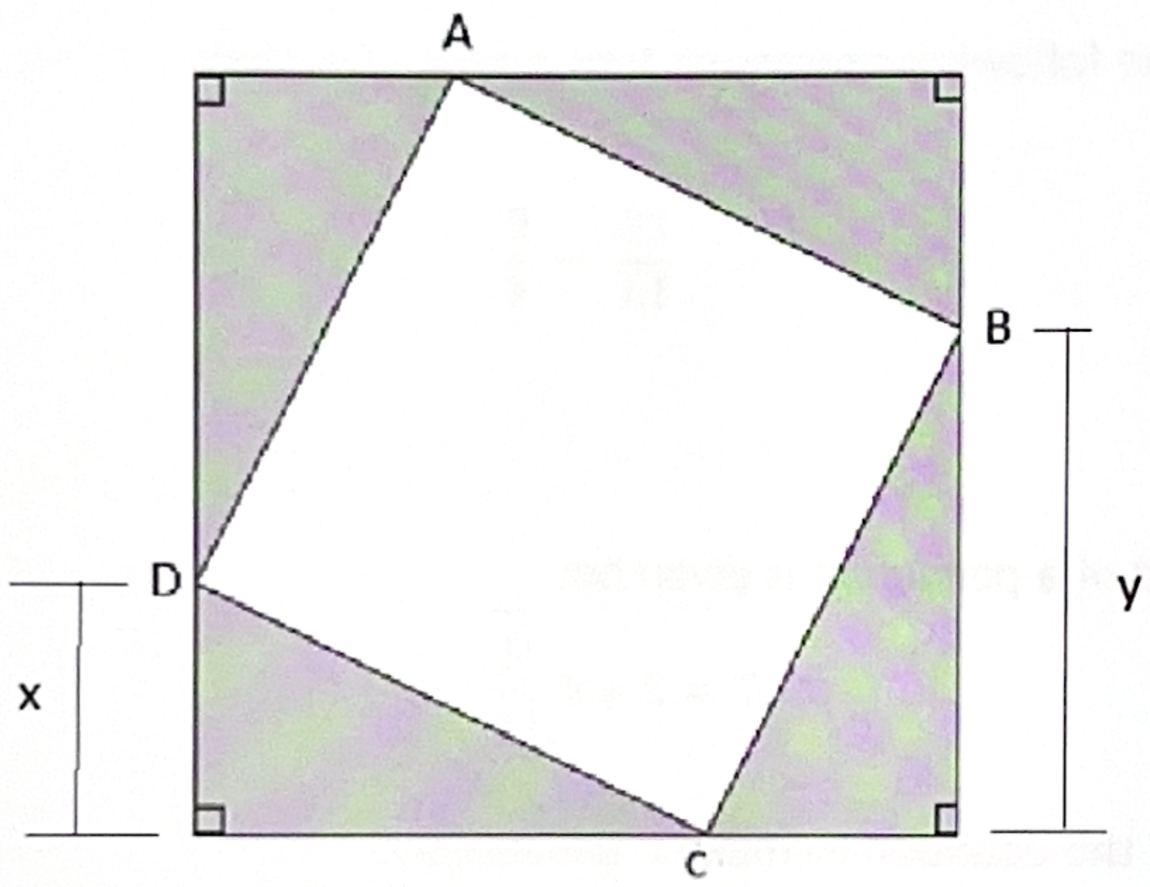


Fig Q5

6. Fig Q6 shows a cross section of a cone with a sphere inside it. The sphere contacts the cone surface tangentially. If the cone has a height of 26.7 cm, and a base radius of 16.5 cm.

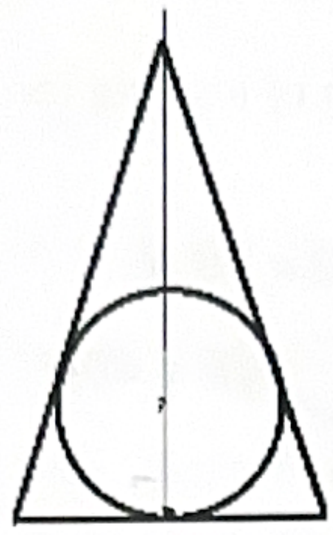


Fig Q6

Determine EACH of the following:

(a) the radius of the inscribed sphere; (5)

(b) the mass of the combined body. (5)

Note: the density of the sphere is 430 kg/m^3 and the density of the remaining cone is 750 kg/m^3

Section B

7. Fig Q7 shows a fastener with two forces, P and Q, acting on it.

Determine the magnitude and direction of a single force having the same effect as P and Q combined. (8)

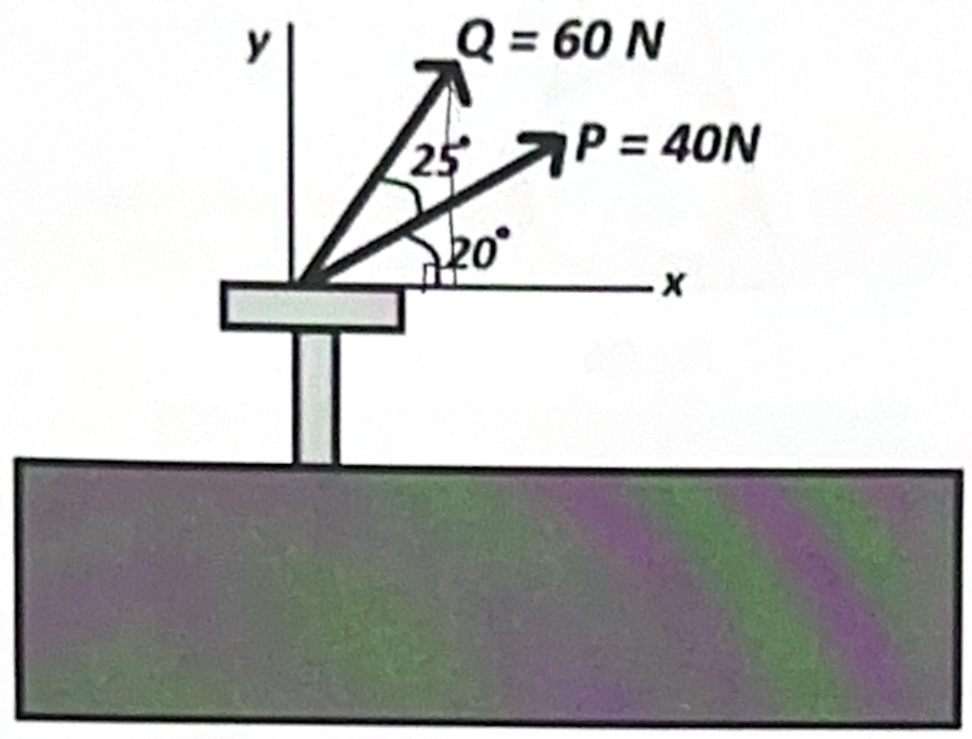


Fig Q7

8. An electric mooring winch is used to tension a rope. The drum has a diameter of 0.8 meters. The winch accelerates its load from rest to a line speed of 1.5 m/s over a period of 4 seconds.

(a) Find the linear acceleration of the mooring line. (3)

(b) Calculate the change in angular velocity per second of the winch drum during this time period. (3)

(c) Determine the number of revolutions the drum makes during this time period. (2)

9. A drum with a mass of 250 kg is being moved manually by sliding it across a steel deck. The coefficient of friction between the drum base and the deck is 0.35. A steady horizontal force of 1 kN is applied to the drum.

Determine EACH of the following:

(a) the normal force acting on the deck; (2)

(b) the frictional force resisting motion; (2)

(c) the acceleration of the drum when the horizontal force is applied; (2)

(d) the angle of deck that would cause the drum to start moving if the horizontal force is removed (ignoring dynamic forces). (4)

10. A service vessel of 3500 tonnes accelerates from rest under a constant propulsive force of 140 kN. The total drag forces acting against motion are 40 kN.

Determine EACH of the following:

(a) the acceleration of the vessel; (2)

(b) the vessel's velocity after 3 minutes; (2)

(c) the power used. (4)

11. A load of 500 kg is to be lifted using a screwjack. The jack has a single start square thread with a 6 mm pitch on an effective diameter of 120mm. The effective effort applied to make the lift is 100 N.

Determine EACH of the following:

(a) the force ratio; (2)

(b) the movement ratio; (3)

(c) the mechanical efficiency. (3)

12. A yoke joint shown in FIG Q12 is held together by a steel pin. It is to be made of steel throughout with an ultimate shear strength of 260 MPa and an ultimate tensile strength of 350 MPa. The key dimensions are given in the different views of the joint. The joint is in tension as shown by the arrows.

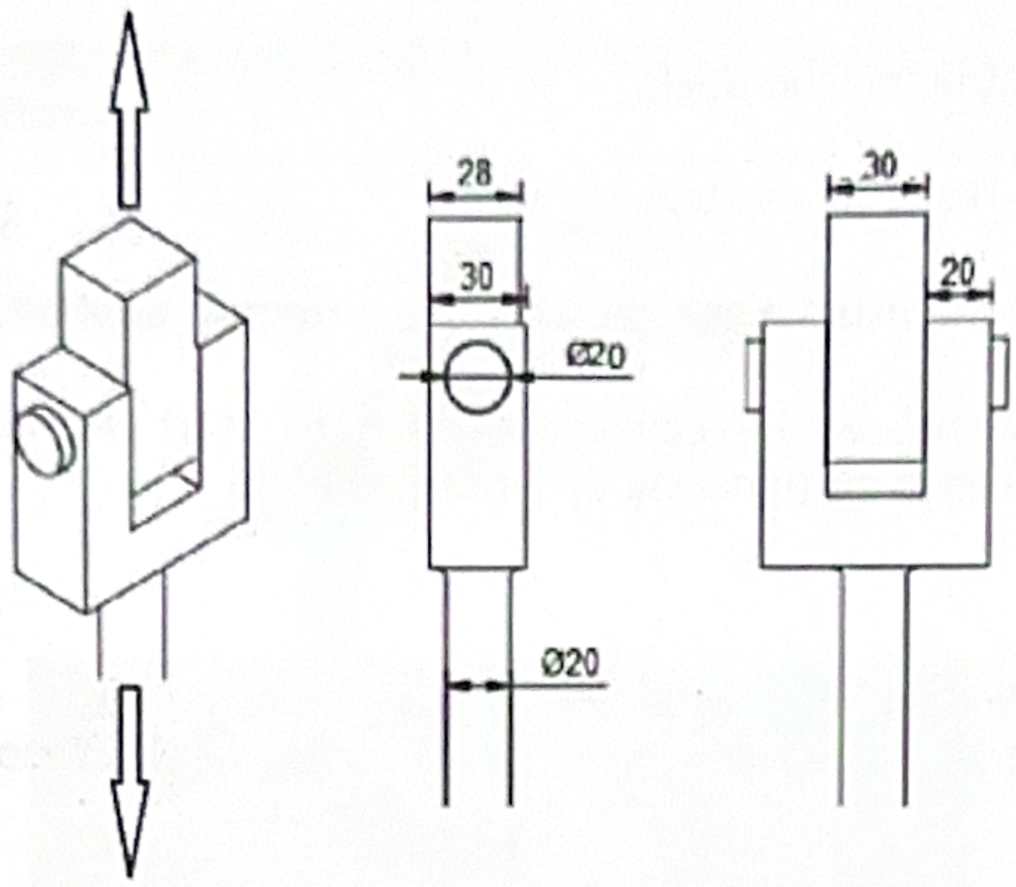


FIG Q12 (dimensions in mm)

Determine EACH of the following:

(a) the maximum force that could be applied before the pin fails under shear if no other failure occurs; (3)

(b) considering the whole joint, what is the maximum load that could be applied before failure occurs. (5)