29-4-16

INDIAN INSTITUTE OF ENGINEERING SCIENCE AND TECHNOLOGY, SHIBPUR
B.TECH-M.TECH DUAL DEGREE 2nd SEMESTER (AE, CE, ME, Met, Min) FINAL EXAMINATION, 2016

MECHANICS (AM 1201)

FULL MARKS: 70 TIME: 3 Hrs

i) Answer any Seven questions
ii) Each question carries equal marks.
iii) Notations used carry their conventional senses.

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1. Determine the moments of inertia and product of inertia of the Z-section about its centroidal x_0- and y_0-axes (Fig. Q1).

2. Calculate the forces in members CG and CF for the truss loaded (Fig. Q2).

3. The Fig. Q3 shows a wheel puller which is designed to remove a *V*-belt pulley *P* from its tight-fitting shaft *S* by tightening the central screw. If the pulley starts to slide off the shaft when the compression in the screw has reached 1.2 kN, calculate the magnitude of the force supported by each jaw at *A*. The adjusting screws *D* support horizontal force and keep the side arms parallel with the central screw.

4. A former student of mechanics wishes to weigh himself but has access only to a scale *A* with capacity limited to 400 N and a small 80-N spring dynamometer *B*. With the rig shown in Fig. Q4 he discovers that when he exerts a pull on the rope so that *B* registers 76 N, the scale *A* reads 268 N. What is his correct weight?

5. In Fig. Q65, the body falling with speed v_0 strikes and maintains contact with the platform supported by a nest of springs. The acceleration of the body after impact is $a = g - cy$, where c is a positive constant and y is measured from the original platform position. If the maximum compression of the springs is observed to be y_m, determine the constant c.

6. In the design of a timing mechanism (Fig. Q6), the motion of the pin *A* in the fixed circular slot is controlled by the guide *B*, which is being elevated by its lead screw with a constant upward velocity v_0 = 2 m/s for an interval of its motion. Calculate both the normal and tangential components of acceleration of pin *A* as it passes the position for which $\theta = 30°$.

7. The small object of mass m is placed on the rotating conical surface at the radius shown in Fig. Q7. If the coefficient of static friction between the object and the rotating surface is 0.8, calculate the maximum angular velocity ω of the cone about the vertical axis for which the object will not slip. Assume very gradual angular velocity changes.

8. The 1.8 kg collar is released from rest against the light elastic spring, which has a stiffness of 1750 N/m and has been compressed a distance of 150 mm (Fig. Q8). Determine the acceleration a of the collar as a function of the vertical displacement x of the collar measured in meters from the point of release. Find the velocity v of the collar when x = 0.15 m. Friction is negligible.

9. A tennis player strikes the tennis ball with her racket while the ball is still rising (Fig. Q9). The ball speed before impact with the racket is $v_1 = 15$ m/s and after impact is speed is $v_2 = 22$ m/s, with directions as shown in the figure. If the 60 gram ball is in contact with the racket for 0.05 s, determine the magnitude of the average force R exerted by the racket on the ball. Find the angle β made by R with the horizontal.

10. The Fig. Q10 shows n spheres of equal mass m suspended in a line by wire of equal length so that the spheres are almost touching each other. If sphere 1 is released from the dashed position and strikes sphere 2 with a velocity v_1, write an expression for the velocity v_n of the nth sphere immediately after being struck by the one adjacent to it. The common coefficient of restitution is e.

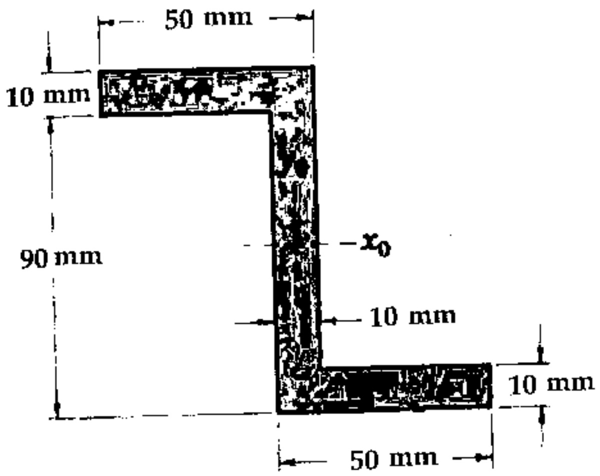

Fig. Q1

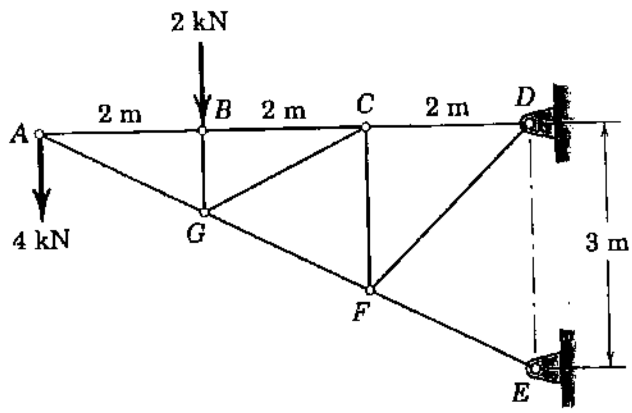

Fig. Q2

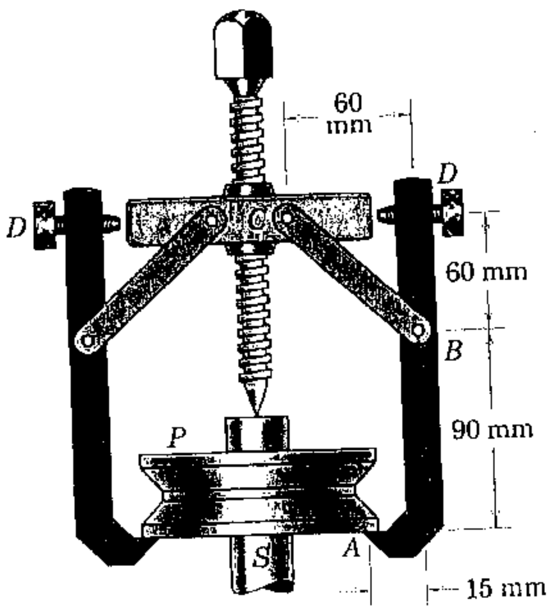

Fig. Q3

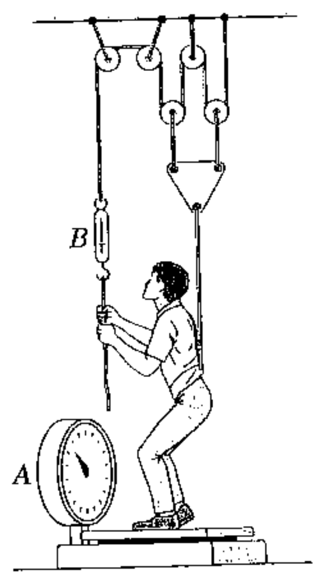

Fig. Q4

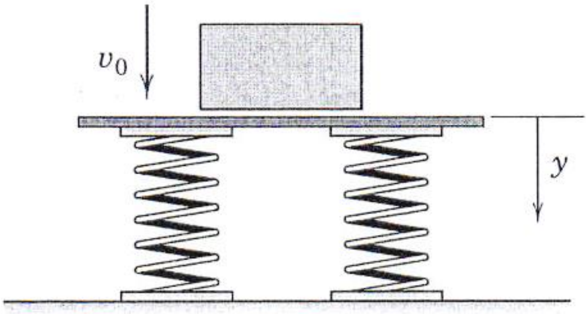

Fig. Q5

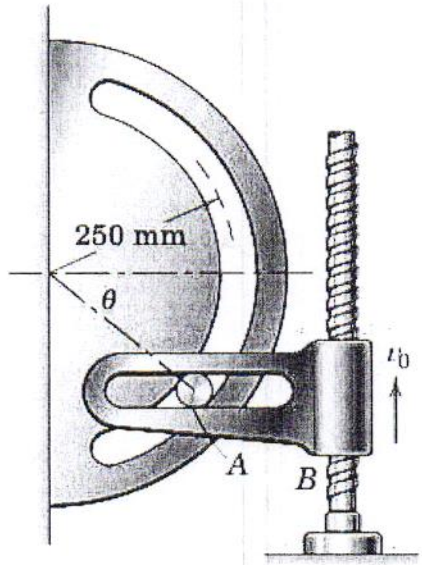

Fig. Q6

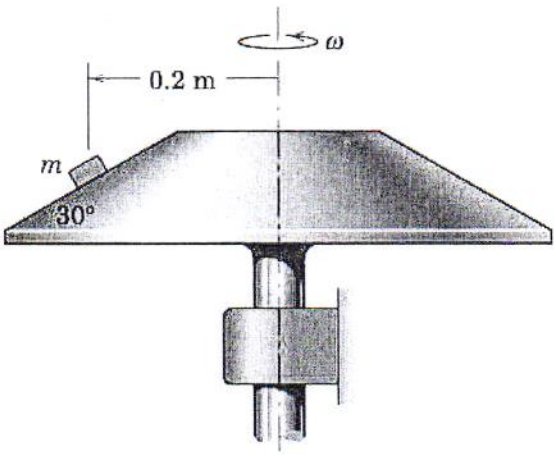

Fig. Q7

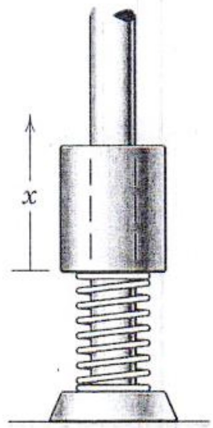

Fig. Q8

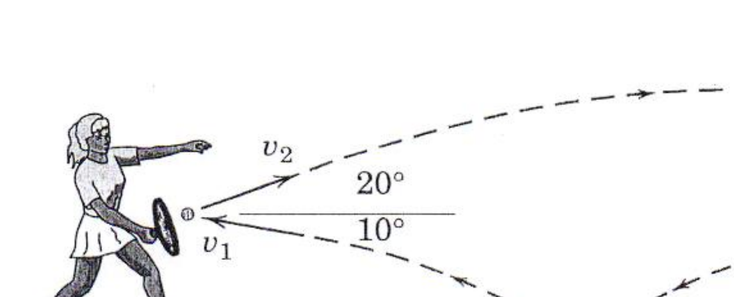

Fig. Q9

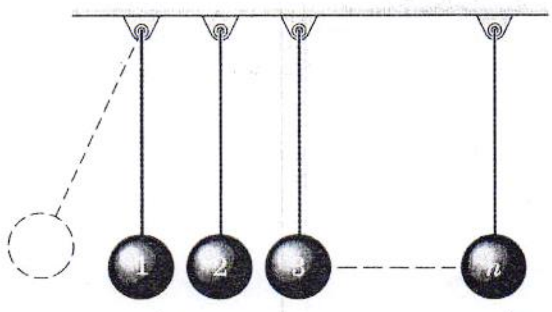

Fig. Q10