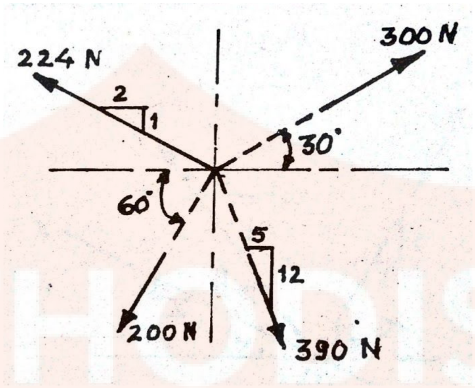
Engineering Mechanics

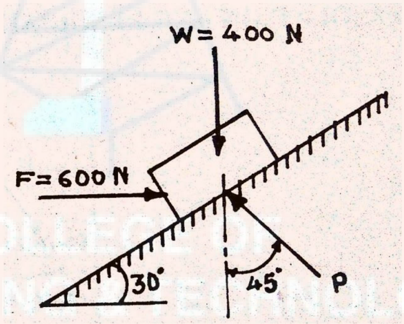
Unit 1:

1. Find the resultant of the 4 forces acting as shown in the diagram.

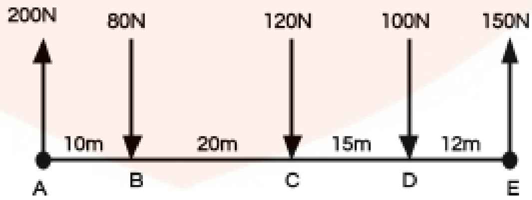


2. The resultant of 4 forces, which are acting at a point is along Y axis. The magnitudes of Forces F_1, F_3 & F_4 are 10kN, 20kN & 40N respectively & the angles made by them with positive x axis are 30°, 90° & 120° respectively. Find the magnitude & direction of force F_2, if resultant is 72 kN. (Ans F_2 = 16.77kN & theta = 47.46)

3. The block shown is acted upon by its weight W = 400N, a horizontal force F = 600N and the pressure P exerted by the inclined plane. The resultant R of these forces is parallel to the incline. Determine P and R. Does the block move up or down the incline?

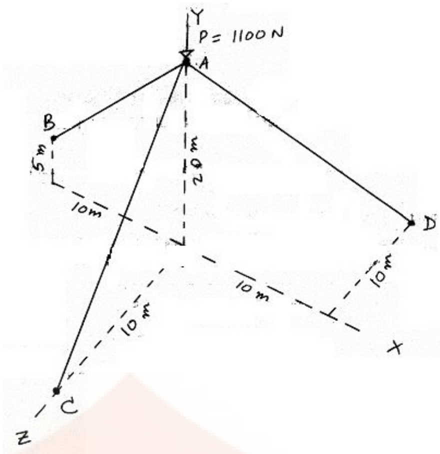


4. Find the resultant & its point of action in the following beam.

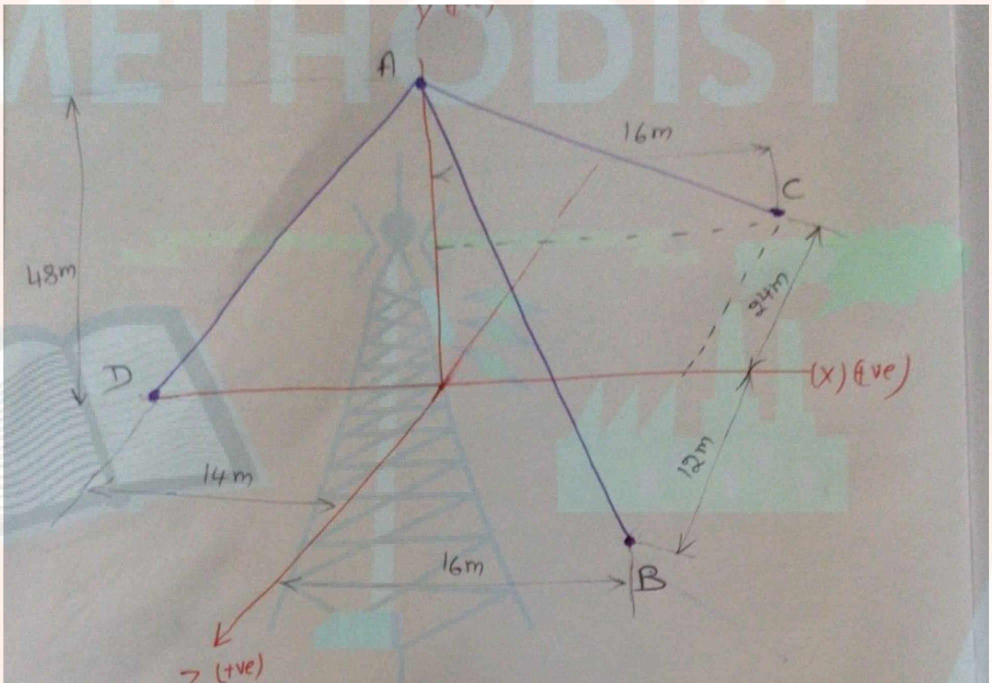


Ans 50 x= -7

5. A vertical load of 1100N is supported by the three bars as shown in figure 2. Points O, C and D are on the horizontal plane (i.e., XZ plane) while point B is 5m above the XZ plane. Point A is along the Y axis, at a height of 20m from the XZ plane.



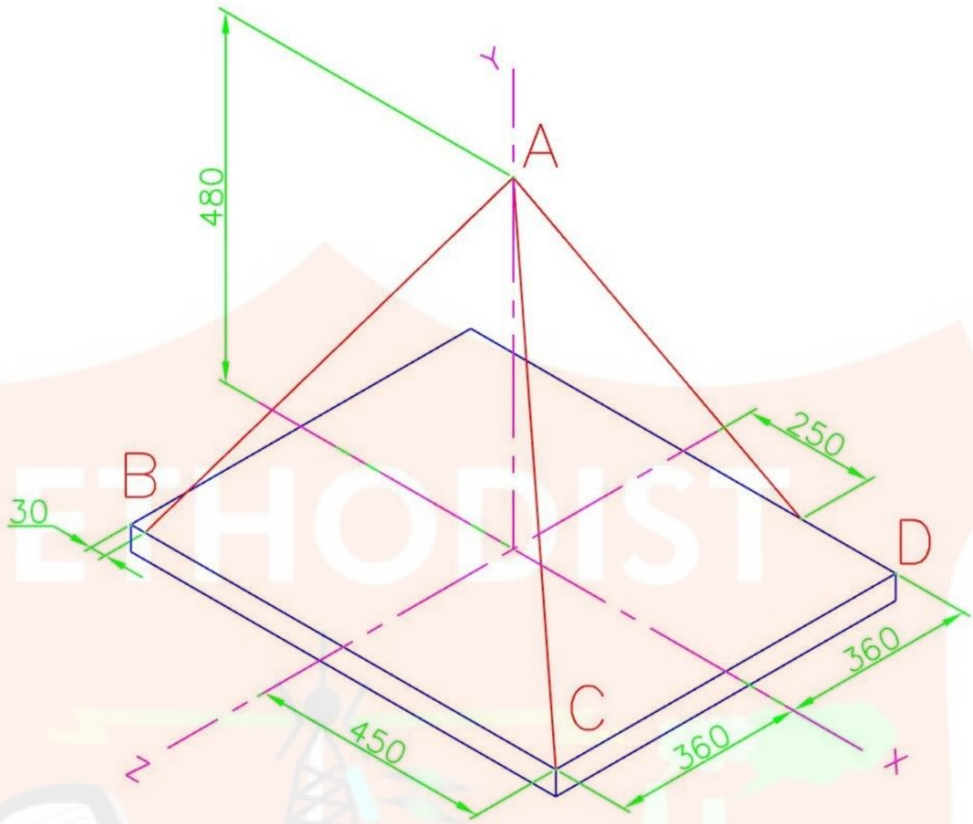
6. a)



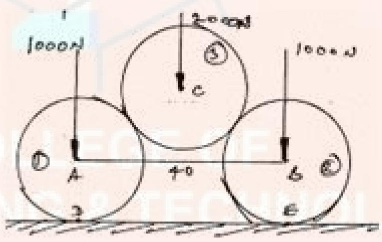
Q) Knowing that the tension AC is $T_{AC} = 20\,kN$ Determine the required values of Tension T_{AB} and T_{AD} so that the resultant of the three forces applied at A is vertical and Calculate resultant.

b)

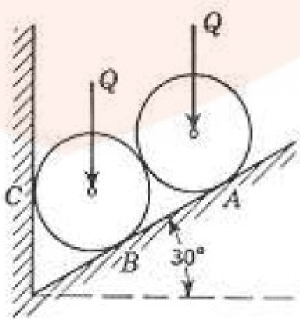
10.A rectangular plate is supported by 3 cables as shown in below figure. Knowing that tension in cable AD is 520N. find the components of force at point D.



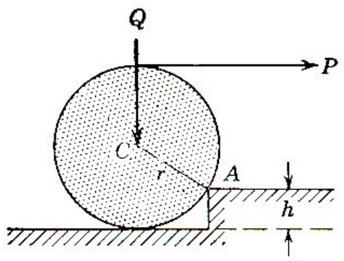
7. Two smooth cylinders, each of weight W=1000N and radius 15 cm, are connected at their centers by a string AB of length 40 cm; and rest up on a horizontal plane, supporting above them a third cylinder of weight 2000N and radius 15 cm as shown in the figure below. Find the force in the string AB and the pressure produced on the floor at the points of contact D and E.



8. Two identical rollers, each of weight 100 N, are supported by an inclined plane and a vertical wall as shown in Figure 1b. Assuming smooth surfaces, find the reactions induced at the points of support A, B and C.



9. A roller of radius r = 0.3 m. and weight Q = 2000N is to be pulled over a curb of height h = 0.15 m, by a horizontal force P applied to the end of a string wound around the circumference of the roller. Find the magnitude of P required to start the roller over the curb.



10. The the figure 2 cylinders, A of weight 400N & B of weight 200N, rest on smooth inclines. They are connected by a bar of negligible weight hinged to each cylinder at its geometric center by smooth pins. Find the force P acting as shown that will hold the system in the given position.

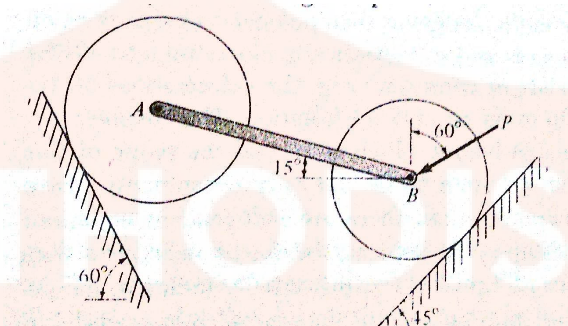


Figure 3-4.1

Unit 2:

Friction

1.

Example 8.3. *Two blocks A and B of weights 1 kN and 2 kN respectively are in equilibrium position as shown in Fig. 8.4.*

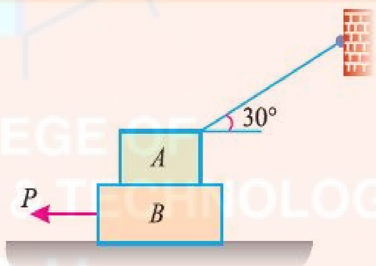


Fig. 8.4.

If the coefficient of friction between the two blocks as well as the block B and the floor is 0.3, find the force (P) required to move the block B.

2. The ladder is 6m long and is supported by a horizontal floor (point A) and vertical wall (point B) . the coefficient of friction between the floor and the ladder is 0.25 and between wall and the ladder is 0.4. The self weight of the ladder is 200N and may be considered as concentrated at G. The ladder also supports a vertical load of 900N at C which is at a distance of 1m from B. Determine the least value of θ at which the ladder may be placed without slipping. Determine the reactions developed at that stage.

3.

Example 8.5. *A body of weight 500 N is lying on a rough plane inclined at an angle of 25° with the horizontal. It is supported by an effort (P) parallel to the plane as shown in Fig. 8.9.*

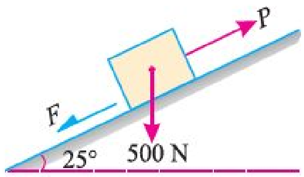


Fig. 8.9.

Determine the minimum and maximum values of P, for which the equilibrium can exist, if the angle of friction is 20°.

4.

$\Sigma F_x = 0$; $\Sigma F_y = 0$ and $\Sigma M = 0$

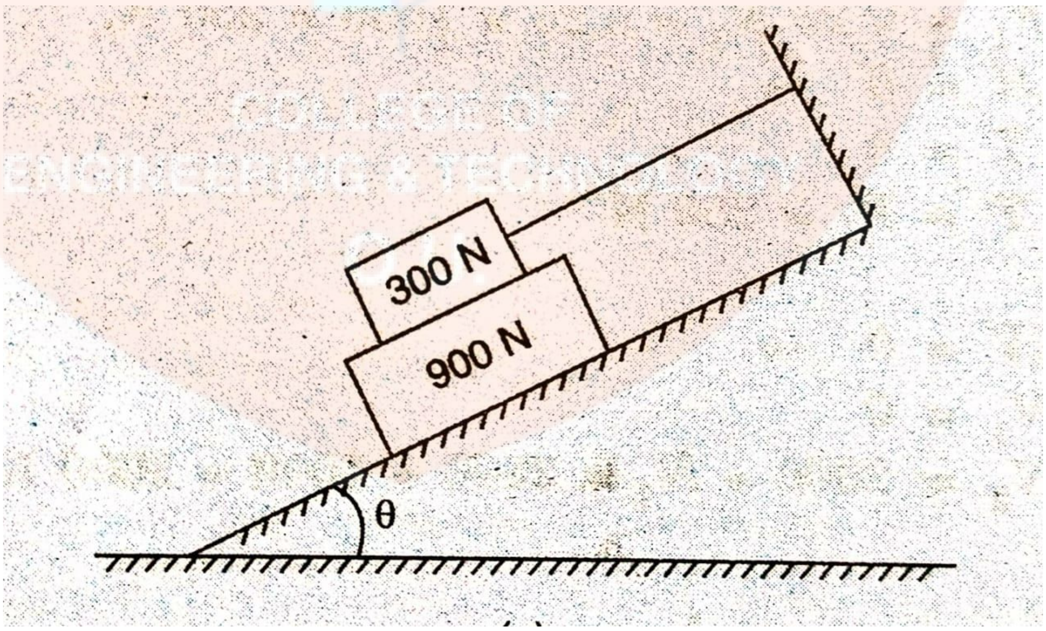
Problem 25

A uniform ladder weighing 100 N and 5 meters long has lower end *B* resting on the ground and upper end *A* resting against a vertical wall as shown in Fig. 8.25. The inclination of the ladder with horizontal is 60°. If the coefficient of friction at all surfaces of contact is 0.25, determine how much distance up along the ladder a man weighing 600 N can ascent without causing it to slip.

Fig. 8.25

Solution

5. What should be the value of θ in the below figure that will make the motion of 900N block down the plane to impend? The coefficient of friction for all the contact surfaces is 1/3.

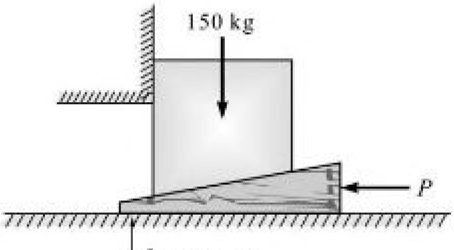


6.

Problem 21

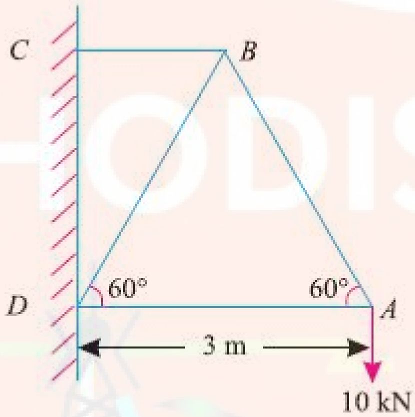
A block of mass 150 kg is raised by a 10° wedge weighing 50 kg under it and by applying a horizontal force at it as shown in Fig. 8.21. Taking coefficient of friction between all surfaces of contact as 0.3, find what minimum force should be applied to raise the block.

Solution

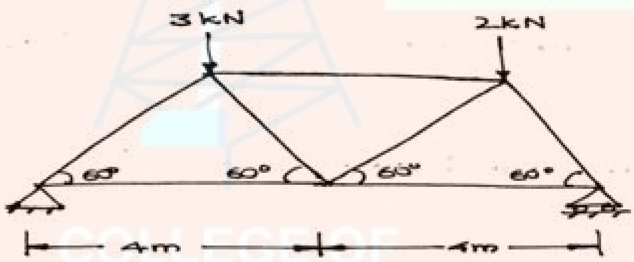


10° Fig. 8.21

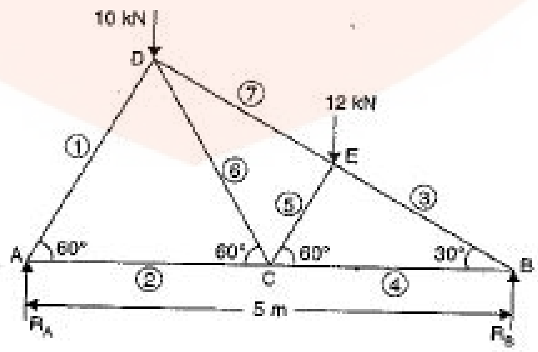
7. A cantilever truss of 3 m span is loaded as shown in the figure. Solve the forces in the various members of the framed truss, and tabulate the results.



8. Identify the forces in members by method of joints and method of sections.



9. A truss of span 5 m is loaded as shown in the figure. Identify the reactions and force in the members of the truss.



10.

Problem 11

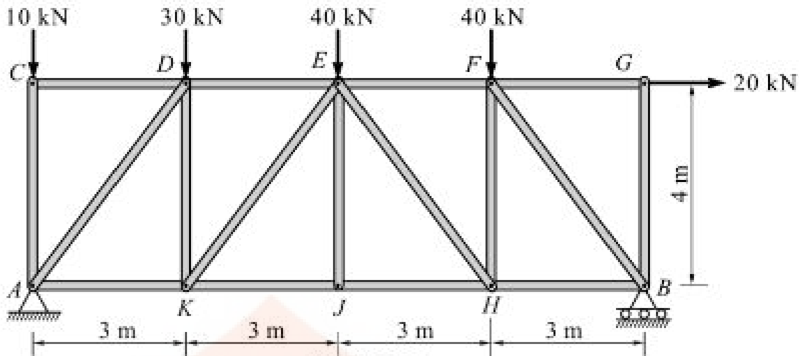


Fig. 7.11(a)

A truss is located as shown in Fig. 7.11(a).

(i) Find the reactions at the supports.

(ii) By method of joints, solve joints *A*, *C*, *D* and *K*.

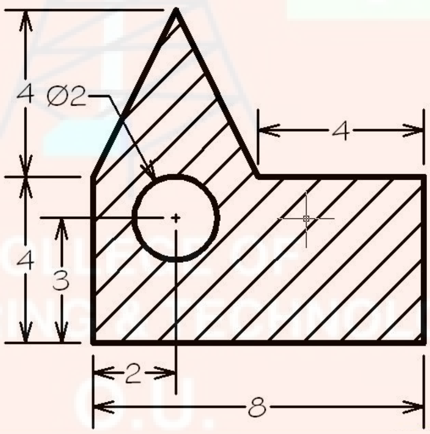
(iii) By inspection find forces in the members having zero axial force in them.

(iv) Find forces in member *JH*, *FH* and *BF* by method of section.

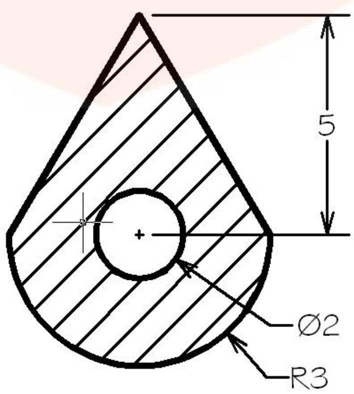
Unit 3:

Centroid & Area Moment of Inertia

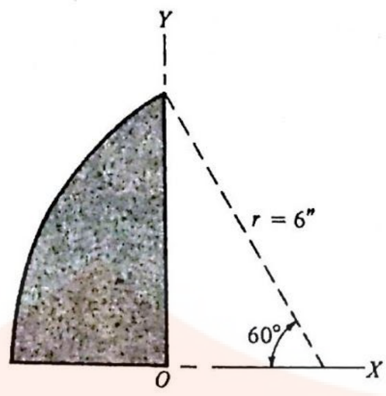
1. Find the moment of inertia about centroidal axis. (all dimensions are in cm)



2. Find the moment of inertia about centroidal axis. (all dimensions are in cm)

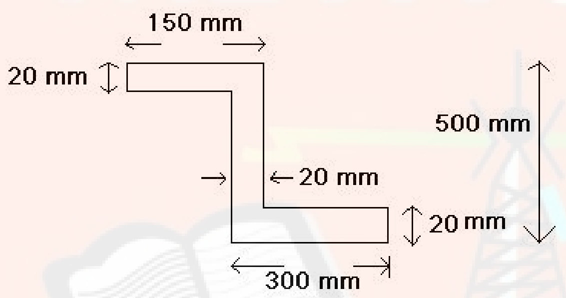


3. Find the moment of inertia about centroidal axis. (all dimensions are in inches)

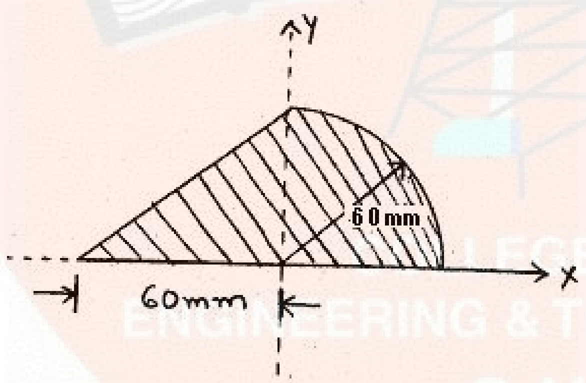


Ans: x=-12.30. y=20.36

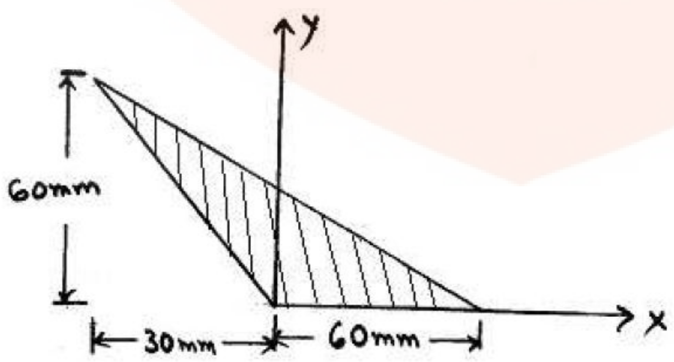
4. Find the moment of inertia about centroidal axis. (all dimensions are in mm)



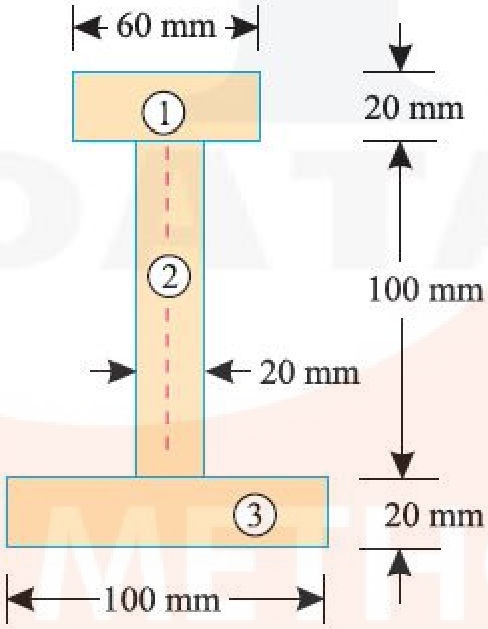
5. Find the moment of inertia about centroidal axis. (all dimensions are in mm)



6. Find the moment of inertia about centroidal axis. (all dimensions are in mm)



7. Find the moment of inertia about centroidal axis. (all dimensions are in mm)



8.

Problem 24

Show that the coordinates of the centroid G of the area between the parabola $y = \frac{x^2}{a}$ and the straight line $y = x$ are $\overline{x} = \frac{a}{2}$, $\overline{y} = \frac{2a}{5}$.

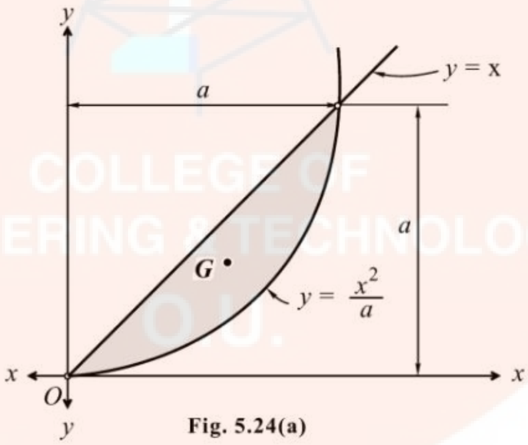
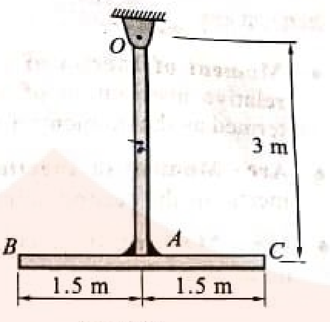


Fig. 5.24(a)

9.

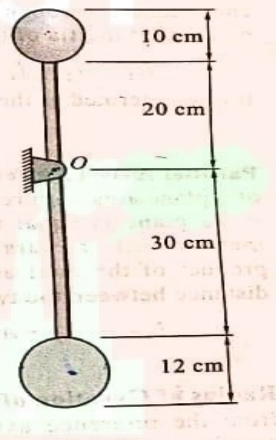
Two uniform rods, each of mass 40 kg and length 3 m are welded together to form a T shape assembly, which is pin suspended at O as shown in Fig. 6.16. Determine the mass moment of inertia of the assembly about pin axis at O.



10.

Problem 17

A uniform rod of mass 10 kg pinned at O and its ends are welded by sphere of mass 20 kg at upper end and circular disc of mass 15 kg at lower end as shown in Fig. 6.17. Find M.I. about pinned axis.



Unit 4:

(Kinematics & Kinetics)

1. Stone is dropped into a well without initial velocity it's splash is heard after 3.5 seconds. Another stone is dropped with some initial velocity and its / splash is heard after 3 seconds find the initial velocity of the second stone if velocity of sound is 335 metre per second.
2. A Train covers a distance of 1.60 metres between two stations a and b in 2 minutes starting from rest. In The first minute of its motion it accelerates uniformly and in the last 30 seconds it retards uniformly and comes to rest. it moves with uniform velocity during the rest of the period. find:
   a. its acceleration in the first minute
   b. its retardation in the last 30 seconds
   c. constant velocity reached by the train

(a) 0.3555 m/see, (b) 0.711 m/see; (c) 213383

3. The elevator in an office building starts from ground floor with acceleration of 0.6 m/sec2 for 4 seconds. During the next 8 seconds, it travels with uniform velocity. Then suddenly power fails and elevator stops after 3 seconds. If floors are 3.5 m apart, find the floor near which the elevator stops. Assume the retardation is uniform. [Ans. near eighth floor, h=216.

4. A train, starting from rest, is uniformly accelerated during the first 250 m of its run, next 750 m at uniform speed. It is then brought in 50 seconds under uniform retardation to rest. If the time taken for the entire journey is 5 minutes. find the acceleration in minutes,
[Ans. 0.05 m/sec]
which the train started

5. Ball is thrown vertically upwards with an initial velocity of 36 m/s. After 2 seconds another ball is thrown vertically upwards. what should be its initial velocity so that it crosses the first ball at a height of the 30 metres? *(Ans: 28.33m/s they'd meet after 6.38 seconds)*

6. Train covers distance of 1.6 kilometres between two stations A and B in 2 minutes starting from rest. in the first minute of its motion it accelerates uniformly & in the last 30 seconds it retards uniformly and comes to rest. it moves with uniform velocity during the rest of the period. find
   a. its acceleration in the first minute
   b. retardation in the last 30 seconds
   c. constant velocity reached by the train

7. Particle moving along a straight line its motion represented by the equation
   $s = 16t + 4t^2 - 3t^3$
   Where, s is in metre t is in seconds. Find
   a. displacement velocity and acceleration 2 seconds after the start
   b. displacement and acceleration when velocity is zero
   c. displacement and velocity when acceleration is zero

8.

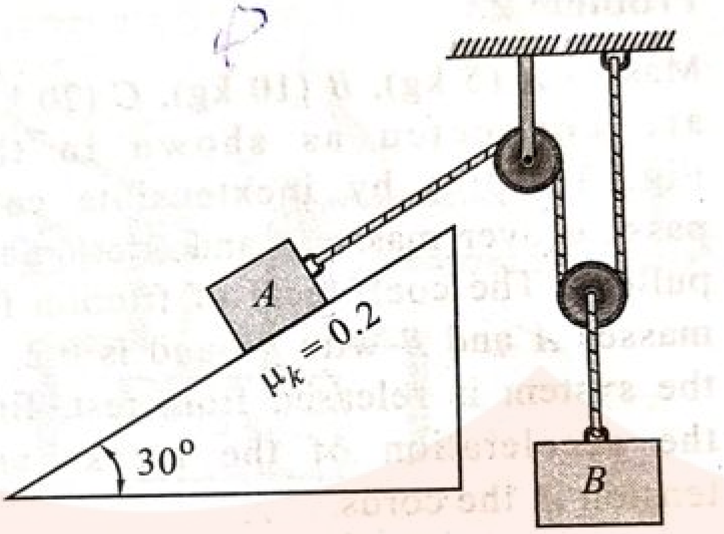
Example 21.13. *The equation for angular displacement of a particle, moving in a circular path (radius 200 m) is given by :*

$$\theta = 18t + 3t^2 - 2t^3$$

where θ is the angular displacement at the end of t sec. Find (i) angular velocity and acceleration at start, (ii) time when the particle reaches its maximum angular velocity; and (iii) maximum angular velocity of the particle.

9. A Stone is dropped from a balloon at an altitude of 600m. How much time is required for the stone to reach the ground if the balloon is
i). Ascending with a velocity of 10m/s
ii). Descending with a velocity of 10m/s
iii). Stationary and
iv). Ascending with a velocity of 10m/s and an acceleration of $1 m/s^2$ (neglect the air resistance).

10. Block A of mass 400kg is being pulled up the inclined plane by using another block B of mass 800kg as shown in below figure. Determine the acceleration of block B and tension in rope pulling the block A. Take $\mu_k = 0.2$. Assume ropes are inextensible and pulleys are small, frictionless and massless.



Unit 5

Work energy and Impulse Momentum Method

1. Two blocks of weights 400 N and 500 N are connected by inextensible flexible wire running around a smooth pulley as shown in Fig. 13.29. Find what will be the velocity of the system if the distance moved by the blocks is 3 m starting from rest. [Ans v=2.557 m/sec]

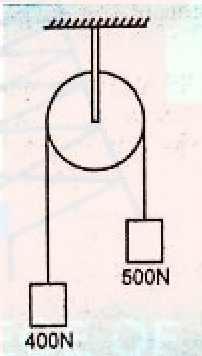


Fig. 13.29

2. Two blocks are connected by inextensible wires as shown in Fig. 13.30. Find by how much distance block 400 N will move in increasing its velocity to 5 m/sec from 2 m/sec. Assume pulleys are frictionless and weightless. [Ans s=5.89]

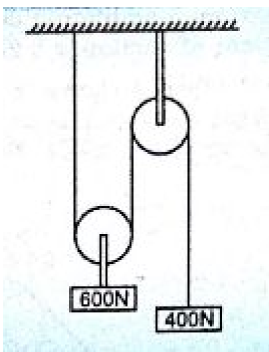


Fig. 13.30

3. By using work energy equation, calculate the velocity and acceleration of the block. A shown in Fig. 13.31 after it has moved 6 m from rest. The coefficient of kinetic friction is 0.3 and the pulleys are considered to be frictionless and weightless. Also calculate, the tension in the string attached to A. [Ans: v=3.544 m/sec; a = 1.046 m/s^2; T = 189.33 /N]

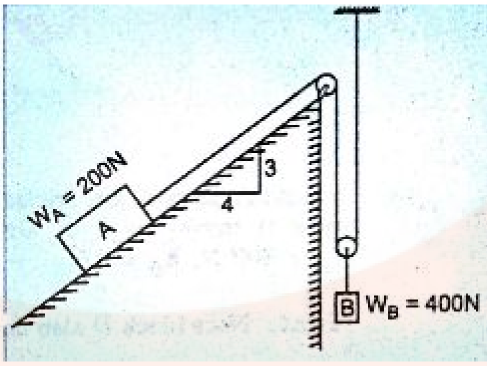
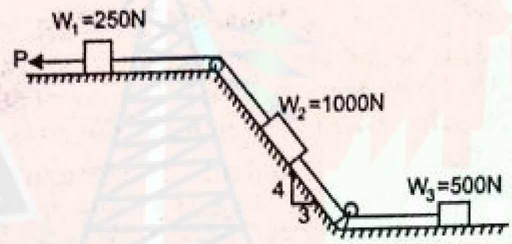


Fig. 13.31

4. Determine the constant force P that will give the system of bodies shown in Figure: a velocity of 3 m/sec after moving a distance of 4.5 m from the position of rest. Coefficient of friction at all contact points is 0.2. Assume pulleys as frictionless.



5. Three perfectly elastic balls *A*, *B* and *C* masses 2 kg, 4 kg and 8 kg move along a line with velocities 4 m/s, 1 m/s and 0.75 m/s respectively as shown in Fig.16.2. If the ball *A* strikes ball *B* which in turn strikes *C*, determine the velocities of the three balls after impact.

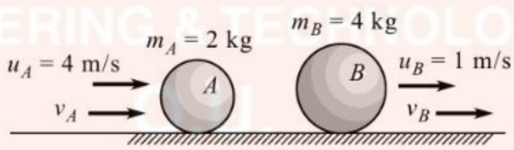


Fig. 16.2(a)

6. A 20 gm bullet is fired with a velocity of magnitude 600 m/s into a 4.5 kg block of wood which is stationary as shown in Fig. 16.24. Knowing that the coefficient of kinetic friction between the block and the floor is 0.4. Determine **(i)** how far the block will move and **(ii)** the percentage of the initial energy lost in friction between the block and the floor.

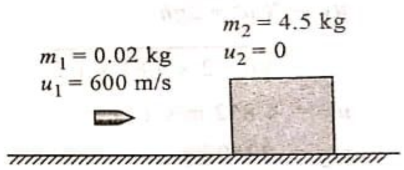
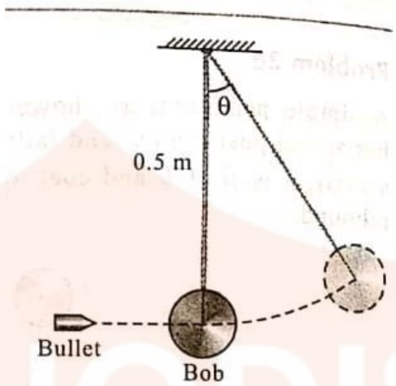


Fig. 16.24(a)

7. A bullet of mass 10 gm is moving with a velocity of 100 m/s and hits a 2 kg bob of a simple pendulum, horizontally as shown in Fig. 16.27(a). Determine the maximum angle θ through which the pendulum string 0.5 m long may swing if **(i)** the bullet gets embedded in the bob and **(ii)** the bullet escapes from the other end of the bob with a velocity 10 m/s.



8.

Problem 3

A mass of 20 kg is projected up an inclined of 26° with velocity of 4 m/s as shown in Fig. 15.E3. If μ = 0.2, **(i)** find maximum distance that the package will move along the plane and **(ii)** What will be the velocity of the package when it comes back to initial position ?

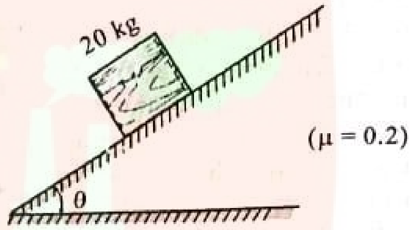
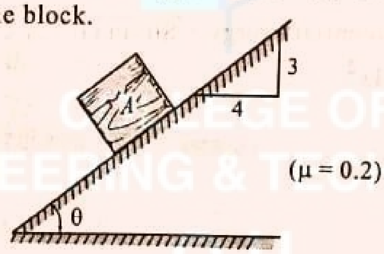


Fig. 15.3(a)

9.

Block *A* has a mass of 2 kg and has a velocity of 5 m/s up the plane shown in Fig. 15.E2. Use the principle of work energy; locate the rest position of the block.



10.

Example 18.51 A body of 5 kg mass is initially at rest on a rough horizontal surface (μ = 0.2) and is acted upon by a 20 N pull applied horizontally. Calculate:

(*a*) the work done by the net force on the body in 5 seconds

(*b*) change in kinetic energy of the body in 5 seconds. Comment on the results.