Code No: R050210804 **Set No. 1**

II B.Tech I Semester Regular Examinations, November 2006
ENGINEERING MECHANICS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Determine the tensions in wires AB, AC and AD.
{As shown in the Figure1}

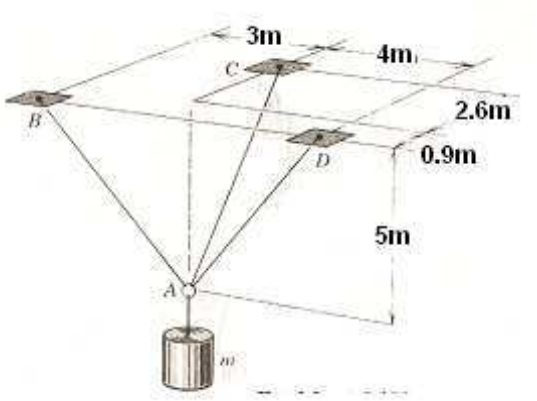

Figure 1

2. (a) The homogeneous rectangular block of mass m, width b, and height H is placed on the horizontal surface and subjected to a horizontal force P which moves the block along the surface with a constant velocity. The coefficient of kinetic friction between the block and the surface is μ_k. Determine
   i. The greatest value that h may have so that the block will slide without tipping over, and
   ii. The location of point C on the bottom face of the block through which the resultant of the friction and normal forces acts if h = H/2.
   {As shown in the Figure2a}

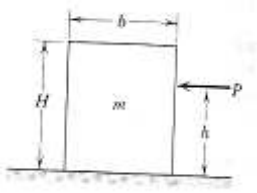

Figure 2a

   (b) Determine the distance s to which the 90-kg painter can climb without causing the 4-m ladder to slip at its lower end A. The top of the 15-kg ladder has a small roller, and at the ground the coefficient of static friction is 0.25. The mass center of the painter is directly above his feet.
   {As shown in the Figure2b}

Figure 2b

3. (a) Deduce an expression for centrifugal tension of belt drive.
   (b) The maximum allowed tension in a belt is 1500N. The angle of lap is 170^0 and coefficient of friction between the belt and material of the pulley is 0.27. Neglecting the effect of centrifugal tension, calculate the net driving tension and power transmitted if the belt speed is 2m/s.

4. (a) Explain the terms:
      i. Moment of inertia
      ii. Polar moment of inertia
      iii. Product of inertia
   (b) Locate the centroid of the shaded area
   {As shown in the Figure4b}

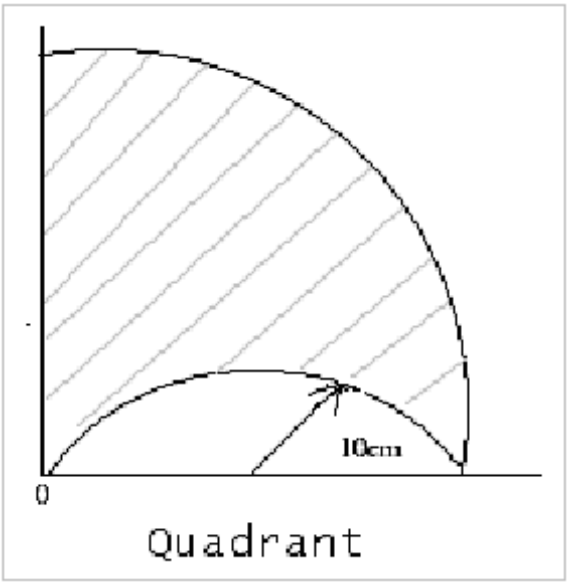

Figure 4b

5. Determine the mass moment of inertia of a thin equilateral triangular plate of mass 'm' and thickness 't' about the axis perpendicular to the plane of the plate and passing through the mass center. Base width= 'b' and height of vertex above base= 'h'. Density of material is 'w'.

6. (a) A small grinding wheel is attached to the shaft of an electric motor which has a rated speed of 3000r.p.m . When the power is turned on, the unit reaches

its rated speed in 5secs and when the power is turned off, the unit comes to rest in 60secs. Assuming the acceleration to be uniform, find the number of revolutions that the motor executes

i. in reaching its rated speed and

ii. to come to rest.

(b) A cord is wrapped around a wheel which is initially at rest as shown in (figure6b)
force is applied to the cord and is gives an acceleration a=6t $m/s^2$where t is in seconds. Determine

i. The angular velocities of the wheel

ii. The angular position of radial line OP as a function of time.

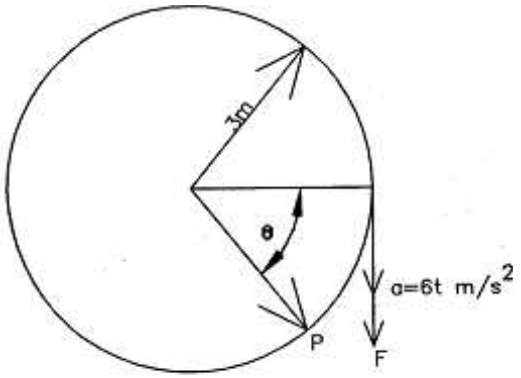

Figure 6b

7. (a) A homogeneous solid cylinder of weight 100 N whose axis is horizontal rotates about its axis, in frictionless bearings under the action of the weight of a 10N block which is carried by a rope wrapped around the cylinder. What will be angular velocity of cylinder two seconds after the motion starts? Assume the diameter of cylinder as 100cm.

(b) A block of mass 5Kg resting on a 30^0 inclined plane is released. The block after travelling a distance of 0.5m along the inclined plane hits a spring of stiffness 15N/cm. Find the maximum compression of spring. Assume coefficient of friction between the block and the inclined plane is 0.2.
{As shown in the Figure7b}

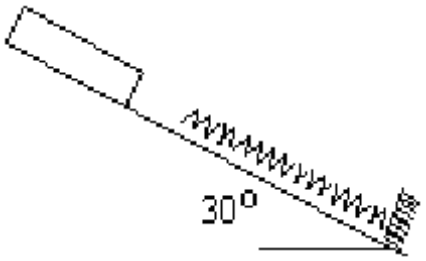

Figure 7b

8. In a mechanism, a cross-head moves in straight guide with simple harmonic motion. At distances of 125mm and 200mm from its mean position, it has velocities of

6m/sec and 3m/sec respectively. Find the amplitude, maximum velocity and period of vibration. If the cross-head weighs 2N, calculate the maximum force on it in the direction of motion.

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Code No: R050210804 **Set No. 2**

II B.Tech I Semester Regular Examinations, November 2006
ENGINEERING MECHANICS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A system of forces consists of
   i. Force P_1 = 3i + 5j – 6k acting through point (2,1,-3)
   ii. Force P_2 = 5i – 4j + 3k acting through point (1,4,2) and a moment

   M = 20i – 35j + 60k. The forces are in Newton (N) units, distances in 'm' units and the moment in 'N-m' units. Calculate
   i. The component of the resultant forces and its magnitude
   ii. The total moment of the system about the origin 'O'.
   iii. The moment of the system about the line through 'O' drawn in the 1^{st}octant which makes angles of 65^0 and 75^0 with X and Y axes respectively.

   (b) Write the Equilibrium equations for concurrent force system in space

2. (a) Calculate the force P required to initiate motion of the 24-kg block up the 10^0 incine. The coefficient of static friction for each pair of surfaces is 0.30.
   {As shown in the Figure2a}

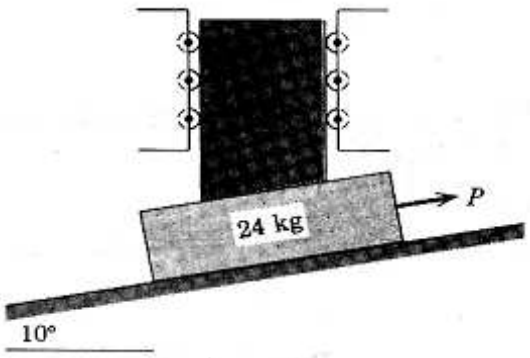

Figure 2a

   (b) Two men are sliding a 100-kg crate up an incline. If the lower man pushes horizontally with a force of 500 N and if the coefficient of kinetic friction is 0.40, determine the tension T which the upper man must exert in the rope to maintain motion of the crate.
   {As shown in the Figure2b}

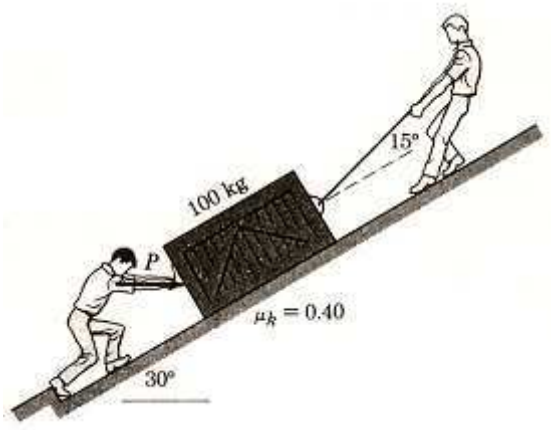

Figure 2b

3. (a) Define the terms pertaining to belt drives : Creep, Slip and initial tension.

   (b) A shaft which rotates at a constant speed of 150 r.p.m is connected by belting to a parallel shaft 720mm apart which has to run at 60,80 and 100 r.p.m. The smallest pulley on the driver shafts is 40mm in radius. Determine the remaining radii of the two stepped pulleys for

   i. A crossed belt and

   ii. An open belt.

4. (a) Explain the transfer formula for product of inertia

   (b) Find the moment of inertia about shaded are parallel to x – axis. {As shown in the Figure4b}

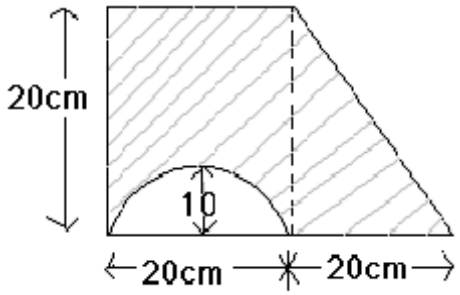

Figure 4b

5. Derive the expression for the moment of inertia of a cylinder length 'l', radius 'r' and density 'w' about longitudinal centroidal axis and about the centroidal transverse axis.

6. (a) A body moves along a straight line and its acceleration 'a' which varies with time 't' is given by a =2-3t. Five seconds after the start of observation, the velocity is 20m/s. The distance moved by the body 10sec after the start of observation of motion from origin is 85m
   Determine

   i. the acceleration, velocity and distance from the origin at the start of observation.

ii. the time after the start of observation at which the velocity becomes zero and the distance travelled from the origin.

(b) A car is uniformly accelerated and passes sucessive kilometre-stones with velocities of 20km/hour and 30km/hour respectively. Calculate its velocity when it passes the next kilometre stone and the time taken for each of these two intervals of one kilometre.

7. (a) A body weighing 20N is projected up a 20^0 inclined plane with a velocity of 12m/s, coefficient of friction is 0.15. Find

i. The maximum distance S, that the body will move up the inclined plane

ii. Velocity of the body when it returns to it original position.

(b) Find the acceleration of the moving loads as shown in figure7b. Take mass of P=120kg and that of Q=80Kg and coefficient of friction between surfaces of contact is 0.3 .Also find the tension in the connecting string.

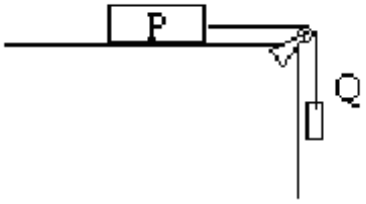

Figure 7b

8. The shaft shown in the (figure8) carries two masses. The mass A is 300Kg with radius of gyration of 0.75m and the mass B is 500Kg with radius of gyration of 0.9m. Determine the frequency of torsional vibrations. It is desired to have the node at the mid-section of the shaft of 120mm diameter by changing the diameter of the section having a 90mm diameter. What will be the new diameter?

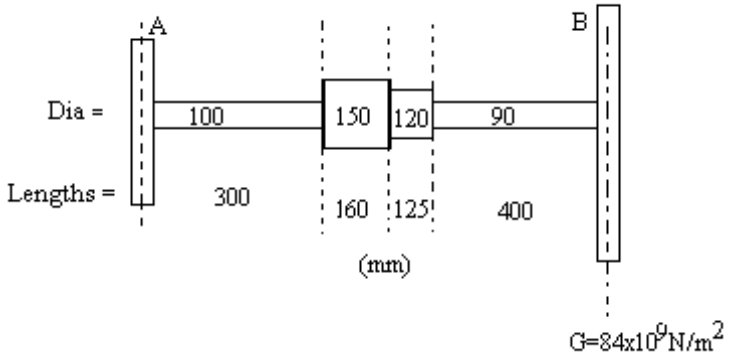

Figure 8

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Code No: R050210804 **Set No. 3**

II B.Tech I Semester Regular Examinations, November 2006
ENGINEERING MECHANICS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. Determine the tensions in wires AB, AC and AD.
{As shown in the Figure1}

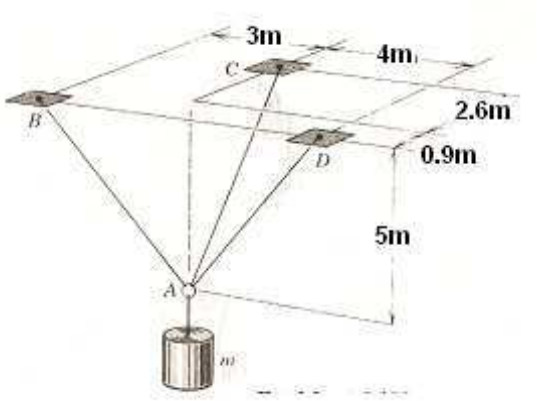

Figure 1

2. (a) A short right circular cylinder of weight W rests in a horizontal V-notch having the angle 2θ as shown in figure2a. If the coefficient of friction is μ, find the horizontal force 'P' necessary to cause slipping to impend.

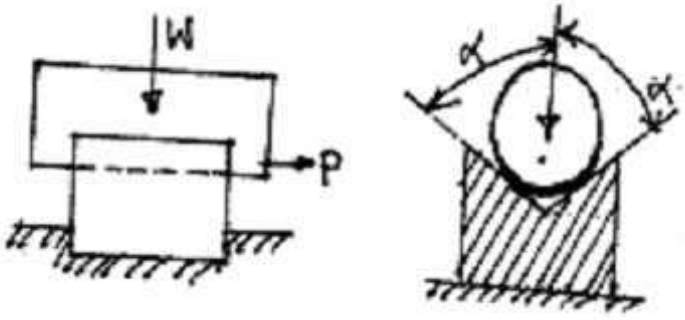

Figure 2a

(b) A 15^0 wedge of negligible weight is to be driven to tighten a body B which is supporting a vertical load of 1000N. If the coefficient of friction for all contacting surfaces be 0.25, find the minimum force 'P' required to drive the wedge. Assume the reaction of the surface y-y as zero.
{As shown in the Figure2b}

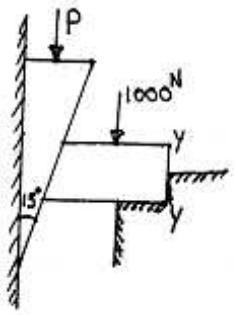

Figure 2b

3. An open belt running over two pulleys 1500 mm and 1000 mm diameters connects two parallel shafts 48000 mm apart. The initial tension in the belt when stationary is 3000N. If the smaller pulley is rotating at 600 r.p.m and coefficient of friction between the belt and pulley is 0.3. Determine the power transmitted taking centrifugal tension into account. The mass of belt is given as 0.6703 kg/meter length.

4. (a) Calculate the moment of inertia of the shaded area about the x – axis {As shown in the Figure4a}

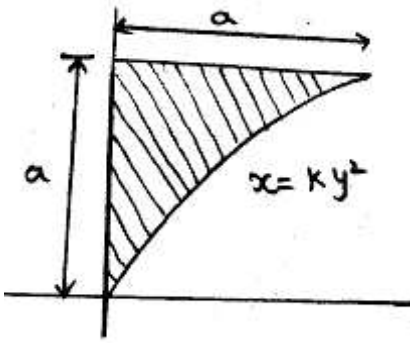

Figure 4a

(b) Determine the moment of inertia of a hallow circular section about its centroidal axes as shown in figure4b.

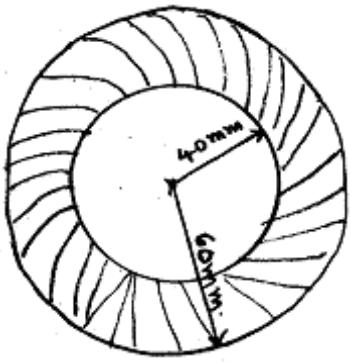

Figure 4b

5. Determine the mass moment of Inertia of the cast iron flywheel as shown in (figure5). (cross section) with respect to the axis of rotation. The flywheel has six elliptical spokes 30 × 40 mm in cross section. Cost iron weighs 7200 kg/m^3.

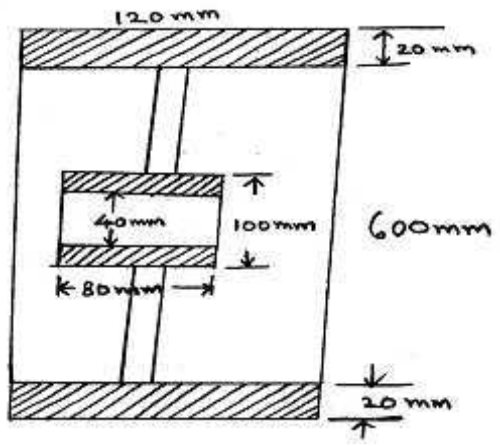

Figure 5

6. (a) A train is traveling at a speed of 60km/hr. It has to slow down due to certain repair work on the track. Hence, it moves with a constant retardation of 1km/hrper second until its speed is reduced to 15km/hr. It then travels at a constant speed of for 0.25km/hr and accelerates at 0.5km/hr per second until its speed once more reaches 60km/hr. Find the delay caused.

   (b) The motion of a particle in rectilinear motion is defined by the relation $s = 2t^3 - 9t^2 + 12t - 10$ where s is expressed in metres and t in seconds. Find

      i. the acceleration of the particle when the velocity is zero

      ii. the position and the total distance traveled when the acceleration is zero.

7. (a) A homogeneous sphere of radius of a=100mm and weight W=100N can rotate freely about a diameter. If it starts from rest and gains, with constant angular acceleration, an angular speed n=180rpm, in 12 revolutions, find the acting moment. .

   (b) A block starts from rest from'A' . If the coefficient of friction between all surfaces of contact is 0.3, find the distance at which the block stop on the horizontal plane. Assume the magnitude of velocity at the end of slope is same as that at the beginning of the horizontal plane.
   {As shown in the Figure7b}

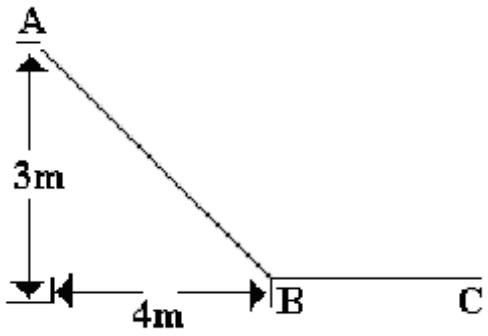

Figure 7b

8. The vertical shaft shown in the (figure8) is fixed at the top and carries a flywheel of weight 5000N welded at its bottom. The radius of gyration of flywheel is 250mm.

The diameter of the shaft is 100mm and its length is 1000mm. The modulus of elasticity E=2x10^5N/mm^2.and the modulus of rigidity is 8.16x10^5N/m^2. Determine the frequencies for free torsional vibrations and longitudinal vibrations.

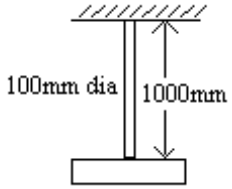

Figure 8

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Code No: R050210804 **Set No. 4**

II B.Tech I Semester Regular Examinations, November 2006
ENGINEERING MECHANICS
(Chemical Engineering)

Time: 3 hours **Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

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1. (a) A cylinder of weight 'W' and radius 'r' is supported in horizontal position against a vertical wall by a bar AB of negligible weight . The bar is hinged to the wall at 'A' and supported at 'B' by a horizontal rope BC. Find the value of the angle 'θ' that the bar should make with the wall so that the tension in the rope is minimum. Assume frictionless conditions. figure1a.

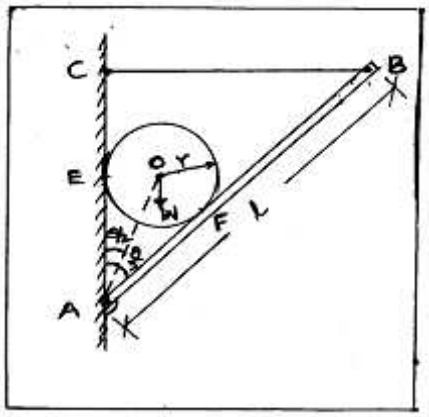

Figure 1a

(b) Determine the magnitude and direction of the smallest force 'P' required to start the wheel figure over the block.
{As shown in the Figure1b}

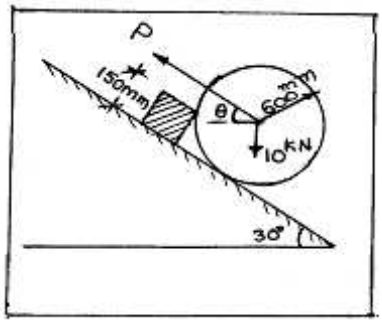

Figure 1b

2. (a) A block of weight $W_1 = 200$ N rests on a horizontal surface and supports on top of it another block of weight $W_2 = 50$ N . The block W_2 is attached to a vertical wall by the inclined string AB. Find the magnitude of the horizontal force P, applied to the lower block as shown, that will be necessary to cause slipping to impend. The coefficient of static friction for all contiguous surfaces is $\mu = 0.3$.
{As shown in the Figure2a}

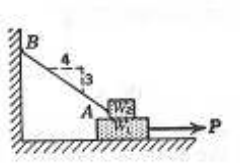

Figure 2a

(b) Two rectangular blocks of weights W_1 and W_2 are connected by a flexible cord and rest upon a horizontal and an inclined plane, respectively, with the cord passing over a pulley as shown in Figure2b. In the particular case where $W_1 = W_2$ and the coefficient of static friction μ is the same for all contiguous surfaces, find the angle α of inclination of the inclined plane at which motion of the system will impend. Neglect friction in the pulley.

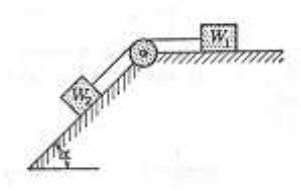

Figure 2b

3. A belt transmits 15 kW from a pulley of 900mm diameter running at 300r.p.m. The angle of lap is 160^0 and coefficient of friction is 0.25, thickness of the belt is 6mm and its density is $1000kg/m^3$. Determine minimum width of the belt required if stress in belt is limited to 2 N/mm^2

4. (a) Differentiate between 'polar moment of inertia' and 'product of inertia'

   (b) Find the moment of inertia and radius of gyration about the horizontal centroidal axis.
   {As shown in the Figure4b}

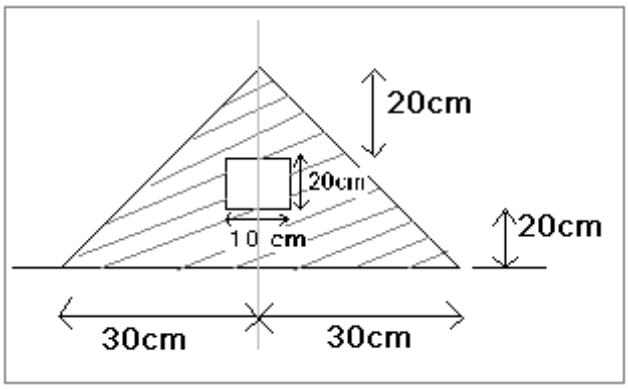

Figure 4b

5. A cylinder of diameter 400mm and height 1000mm rests vertically. Over this, a cone of base diameter 400mm and height 500mm is placed such that the axis of the cone coincides with the axis of the cylinder. Find out the mass moment of inertia of this composite solid about a line which passes through the vertex of the cone and which is parallel to the base of the cylinder if the mass density is $4000kg/m^3$.

6. (a) A car starts from the rest on a straight road and travels with uniform acceleration of 0.8m/s^2 for the first 10sec and then travels with uniform velocity for the next 30 sec. It then decelerates at the rate of 0.5m/s^2 and comes to rest. Determine
   i. Total time taken to complete the trip
   ii. Total distance travelled and

   (b) A fighter plane is directly over an antiaircraft gun at time t=0 and at an altitude of 1800m. The plane is moving with a speed of 600 km/hour. A shell is fired at time t=0 in an attempt to hit the plane. If the muzzle velocity is 1000m/sec, find out the angle at which the gun should be held.

7. If W_a:W_b:W_c is in the ratio of 3:2:1 , find the accelerations of the blocks A, B, and C. Assume that the pulleys are weightless.
   {As shown in the Figure7}

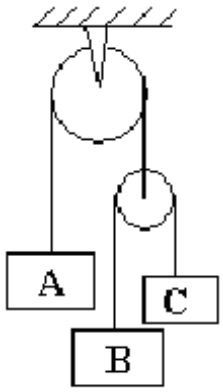

Figure 7

8. (a) A homogeneous circular disk of radius 'r' and weight 'W' hangs in a vertical plane from a pin 'O' at its circumference. Find the period τ for small angles of swing in the plane of the disk

   (b) A slender wire 0.90m long is bent in the form of a equilateral triangle and hangs from a pin at 'O' as shown in the (figure8b). Determine the period τ for small amplitudes of swing in the plane of the figure.

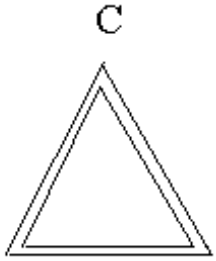

Figure 8b

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