JAIPUR ENGINEERING COLLEGE AND RESEARCH CENTRE

Department of Mechanical Engineering

Engineering Mechanics

Assingment 1

Q.1 State and Prove Parallelogram law of forces.

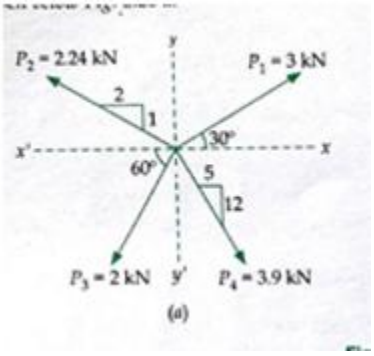
Q.2 Explain Lami's Theorem.

Q.3 Explain perfect, deficient and redundant frame in trusses.

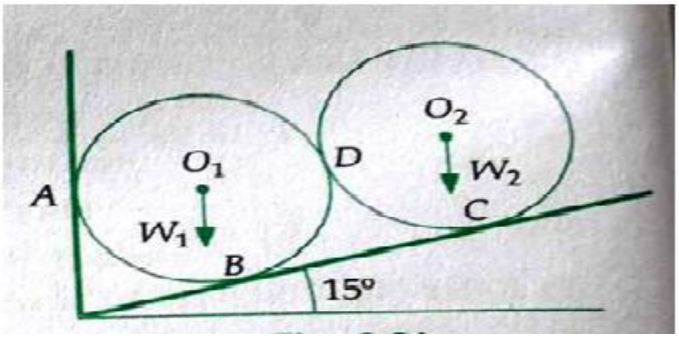
Q.4 State the principal of virtual work with example.

Q.5 Two forces one of which is double the other has resultant of 260N. If the direction of the larger force is reversed and the other remains unaltered, the resultant reduces to 180N. Determine the magnitude of the force and the angle between the forces.

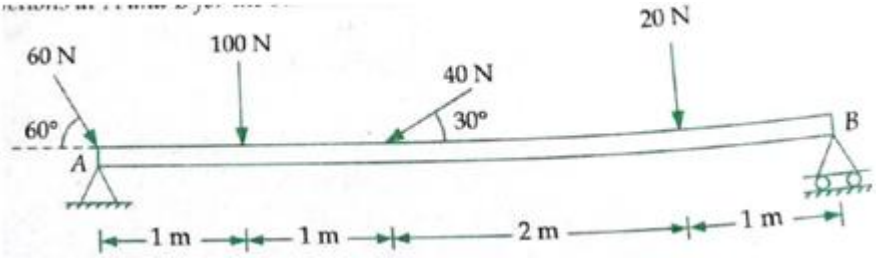
Q.6 Determine the resultant, both in magnitude and direction, of the four forces acting on the body as shown in the figure given below



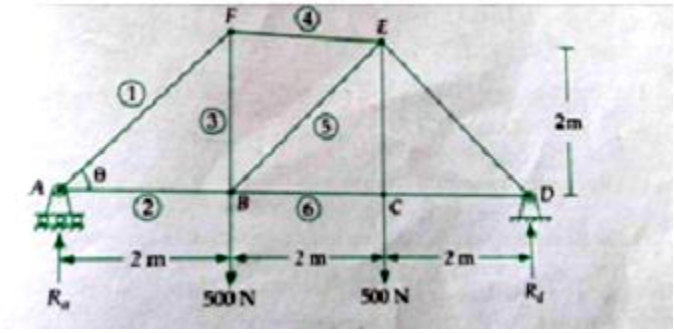
Q.7 Two rollers of the same diameter are supported by an inclined plane and a vertical wall as shown in the figure. The upper and the lower rollers are respectively 200N and 250N in weight. Assuming smooth surfaces, find the reaction induced at the points of support A, B, C and D.



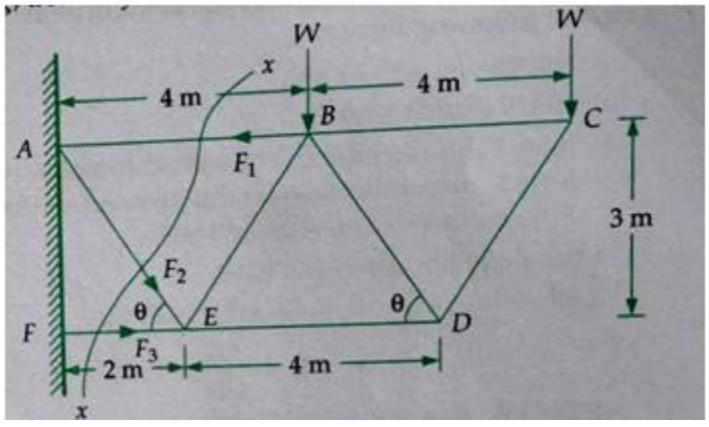
Q.8 Determine reaction at A and B for the beam loaded as shown in fig.



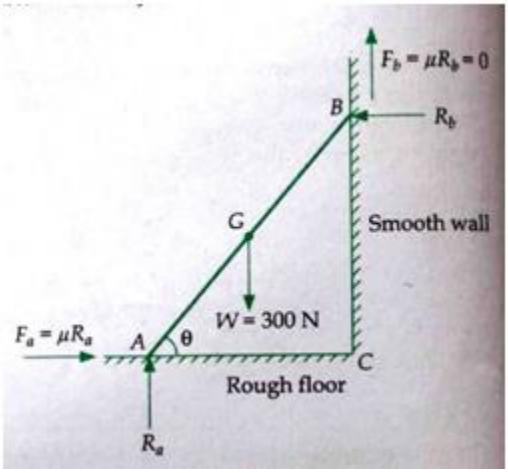
Q.9 Determine the reaction and the forces in each members of truss supporting two loads as shown in fig.



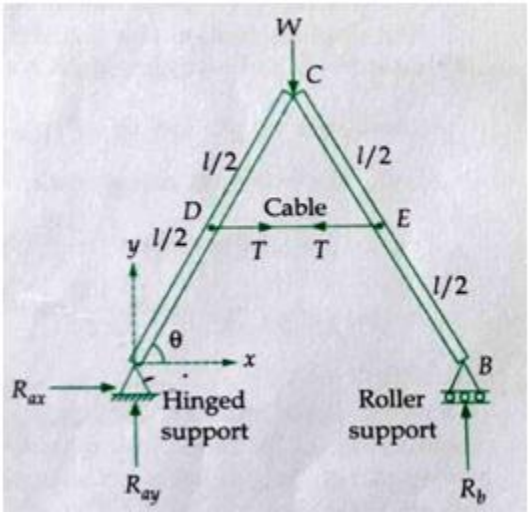
Q.10 Make calculations for the load W that would produce a force of magnitude 160kN in the AB member of the cantilever truss shown in fig. Fir this loading , workout forces in members AE and FE of the truss.



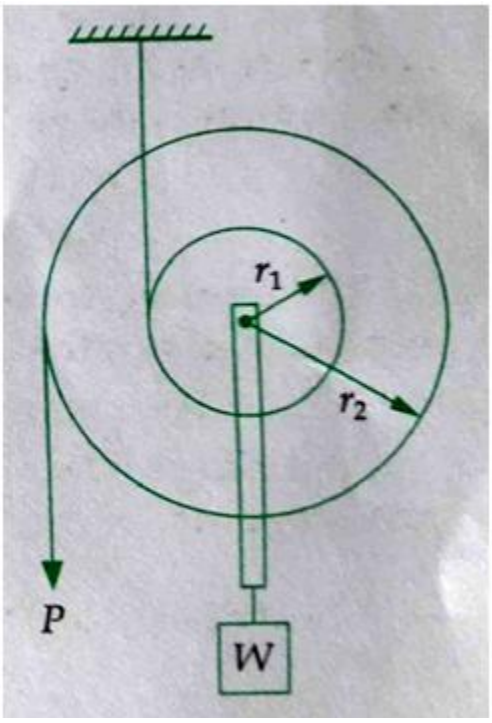
Q.11 A uniform ladder of 300 N weight rest against a smooth vertical wall and a rough horizontal floor making an angle of 60^0 with the horizontal. Use the method of vertical work to find the frictional force between the foot of ladder and the rough horizontal floor.



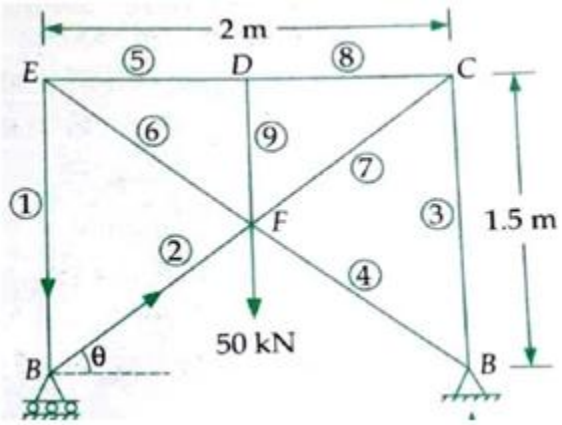
Q.12 The arrangement shown in Fig.12.13 is required to remain in state of equilibrium. Set up an expression for tension in the cable in terms of θ and load W. Use the method of virtual work.



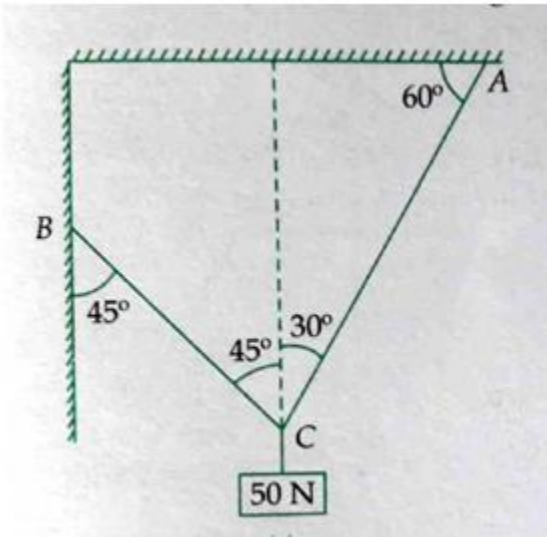
Q.13 The pulley arrangement shown in Fig.12.9 is used for hosting a load W. Find the applied force P in terms of load W for equilibrium of the system. The radii of the two steps of the pulley are r_1 and r_2. Neglect friction and use the virtual work principle.



Q.14 A truss has been loaded and supported as shown in Fig.5.15. Make calculation for the reactions at the support and the forces in the member of the truss.



Q.15 An electric light fixture weighing 50 N hangs from point C by two strings AC and BC as shown in Fig.2.71 a. The string ACis inclined at 60^0 to the horizontal and string BC is 45^0 to the vertical. Using Lami's theorem or otherwise determine the forces in the strings AC and BC.



Q.16 Two locomotives on opposite banks of a canal pull a vessel moving parallel to the banks by means of two horizontal ropes. The tension in these ropes have been measured to be 20 kN and 24 kN while the angle between them is 60^0. Find the resultant pull on the vessel and the angle between each of the ropes and the sides of the canal.

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Assingment 2

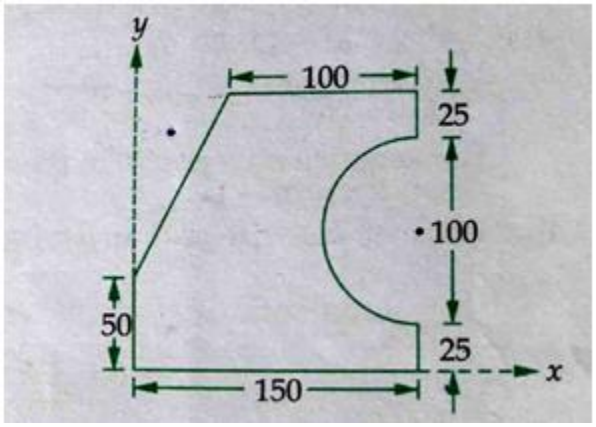
Q.1 Define the term centroid, centre of gravity and centre of mass.

Q.2 State and explain
- **a)** Parallel axis theorem
- **b)** Perpendicular axis theorem

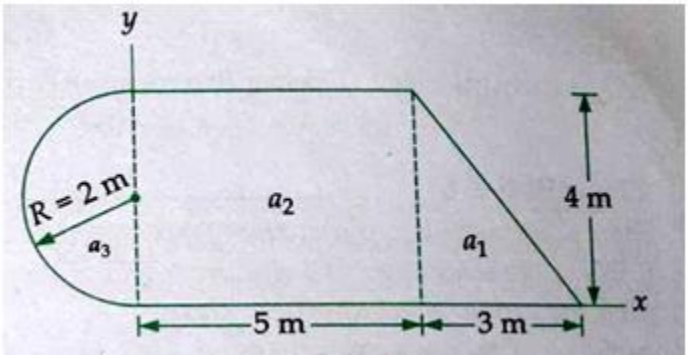
Q.3 State the condition for reversibility and self locking of machine.

Q.4 What are winch crabs? Sketch the single winch crab and setup expression for its velocity ratio and mechanical advantage.

Q.5 Locate the centroid of the area shown in Figure. All the dimensions are in mm.

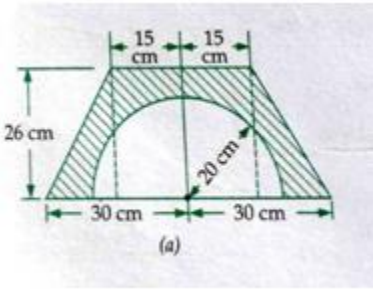


Q.6 Locate the centroid of the area shown in Figure with respect to the axes indicates in the figure.

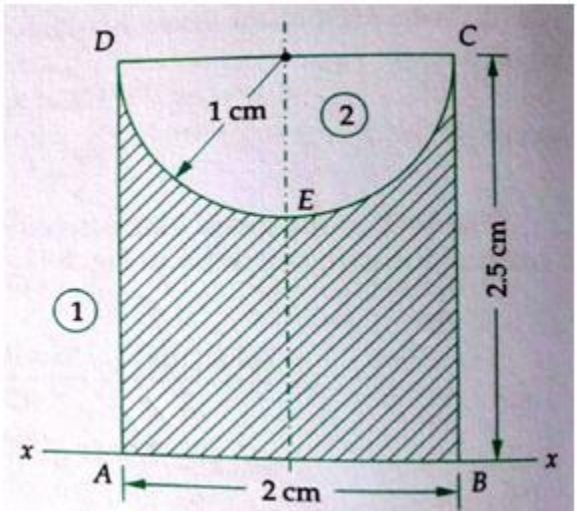


Q.7 From a rectangle plate whose cross-section is 8 cm * 6 cm, a circular disc of 3 cm^2 in area is removed. If CG of the rectangular plate, work out the distance of the centre of disc from the centre of rectangular plate.

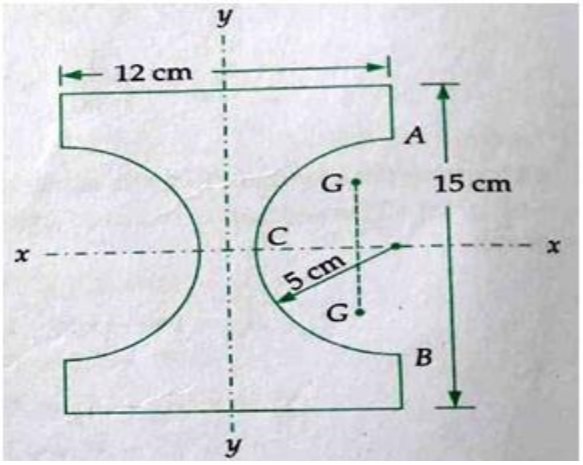
Q.8 Locate the position of the centroid of the plane shaded area depicted in Figure given below:



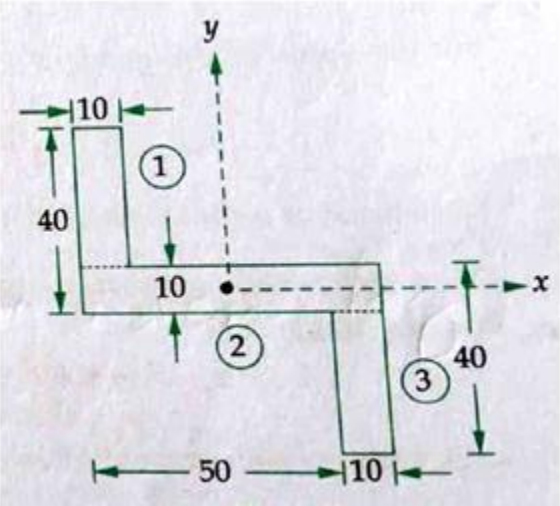
Q.9 Determine the moment of inertia of the area shown shaded in Figure about axis xx which coincides with the base edge AB.



Q.10 Determine I_{xx} and I_{yy} of the cross-Section of a cast iron beam shown in Figure.



Q.11 Determine the moments of inertia the x and y centroids axis of a beam whose cross-sectional area as shown in Figure. All dimensions are in cm.



Q.12 Determine the efforts required to lift a load of 150 N if the lifting machine is stated to have velocity ratio 15 and efficiency 60 percent. Also set up an equation prescribing the law of machine if the frictional resistance of the machine is constant. Proceed to find the effort to run this machine at :

- **i.** no load,
- **ii.** a load of 100 N.

Q.13 In a wheel and axle arrangement, the diameter of the wheel is 600 mm and that of the axel drum is 200 mm. The thickness of cord on the wheel is 5 mm and that on the axis is 10 mm.

(a) What is the velocity ratio of the machine?

(b) This machine is required to lift 1500 N load with a velocity of 20 m/min. If the machine has an efficiency of 75 percent, estimate the work that needs to be supplied to the machine to perform the task.

Q.14 The following data refers to a double purchase winch crab :

- Length of the lever (crank) arm = 400 mm
- Diameter of the drum = 128mm
- Number of teeth for the pinion on effort axel = 15
- Number of teeth for the spur wheel on intermediate axel = 80
- Number of teeth for the pinion on intermediate axel = 20
- Number of teeth for the spur wheel on load axel = 75

This machine can lift loads of 100 N and 150 N by applying efforts of 1.75 N and 2.5 N respectively. Determine:

(a) Law of the machine,
(b) Effort required to lift a load 200 N and efficiency at this load, and
(c) Maximum efficiency of the machine.

Q.15 A load of 500 N is required be lifted by a screw jack whose spindle has the square threads with the following specifications:

- Outer diameter = 8 cm; threads in 1.6 cm = 2
- Thread thickness = half the pitch
- Coefficient of friction between nut and screw = 0.1

What force needs to be applied at the end of the handle of 50 cm length?

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Assignment 3

Q.1 Define the following terms

- **a)** Coefficient of friction
- **b)** Angle of friction
- **c)** Angle of repose

Q.2 Define the following terms

- **a)** Velocity Ratio
- **b)** Crowning of pulley
- **c)** Creep

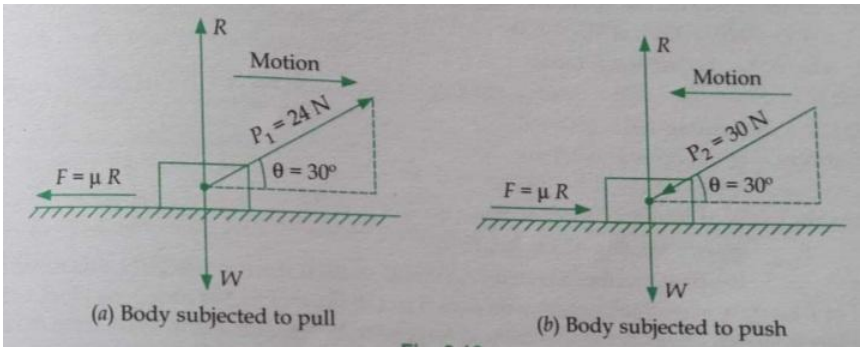
Q.3 Setup the following expression for the flat belt drive

$$\frac{T1}{T2} = e^{\mu\theta}$$

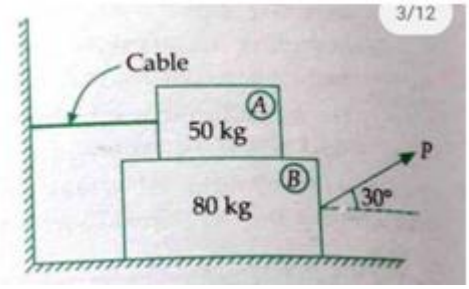
Where T_1 and T_2 are the tension on tight and slack side of belt. And θ is angle of contact and μ is the coefficient of friction between belt and pulley rim.

Q.4 Show that for maximum power transmission, the centrifugal tension should not exceed one third of total tension.

Q.5 A body resting on a rough horizontal plane required a pull of 24N inclined at an 30˚ to the plane just to move it. It was also found that a push of 30N at 30˚ to the plane was just enough to cause motion to impend .Make a calculations for the weight of the body and the coefficient of the friction.

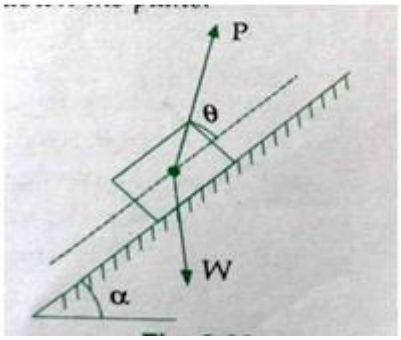


Q.6 Two blocks A and B weighing 50kg and 80kg respectively are in the equilibrium in the position shown in the fig. Calculate the force P required to move the lower block B and tension in the cable .take coefficient of friction at all contact surfaces to be 0.3 .

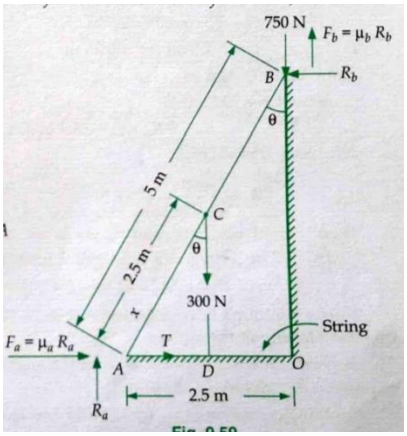


Q.7 Find the least forces required to drag a block of weight W placed on a rough inclined plane having inclination a with the horizontal. The tractive force applied to the block makes an angle Θ to the inclined plane. Consider the following cases:-

1. The block is to move up the plane
2. The block is to move down the plane .



Q.8 A ladder 5m long and weighting 300N is placed against a vertical wall with its lower end 2.5m from the wall. A man weighing 750N climbs the ladder and sits at its top. To avoid slipping of ladder, its bottom is held by a string tied to the wall. If the coefficient of friction for both the contact surfaces is 0.2, what tension would be induced in the string?

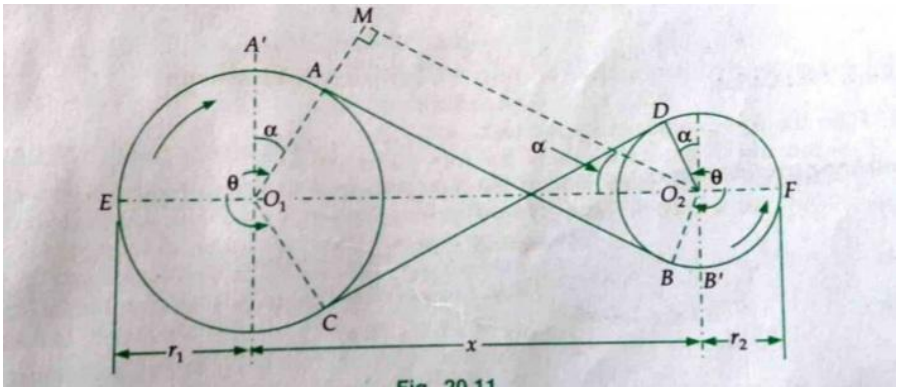


Q.9 A block weighing 2500N , overlying a 10-degree wedge on a horizontal floor and leaning against a vertical wall is to be raised by applying a horizontal force to the wedge. The coefficient of friction between all the surfaces in contact is 0.3 . make calculations for the minimum horizontal force to be applied to raise the block .

Q.10 Two parallel shafts 5m apart are provided with 600 mm and 400 mm diameter pulleys which are connected by a cross belt. It is desired to reverse the direction of rotation of the driven of rotation of the driven pulley by a changing over to an open bet drive belt system. Calculate the reduction in the length of the belt required.

Q.11 A crossed belt running over two pulleys 500 mm and 250 mm diameter, connects two parallel shafts 3m apart.The larger pulley rotates at 300 rev/min, the coefficient of friction between the belt and pulley rim is 0.2 and the maximum permissible tension is 1.2kN. determine

1. Length of the belt required
2. Angle of contact between the belt and pulley and
3. Power transmitted by the belt.



Q.12 Following data is given for a rope pulley transmitting 60kW power:-

Dia of pulley=1.25m; angle of grooves =45˚

Speed of the pulley =180rpm; coefficient of friction=0.3

Angle of contact/lap=160˚;mass of rope =0.5kg/m length

Maximum permissible tension=750N

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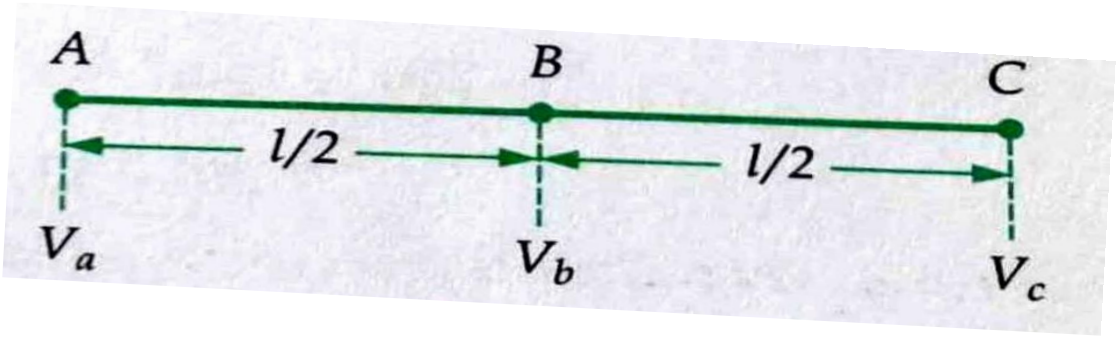
Assignment 4

Q.1 what is projectile motion? Derive the expression for the horizontal range, maximum height and time of flight.

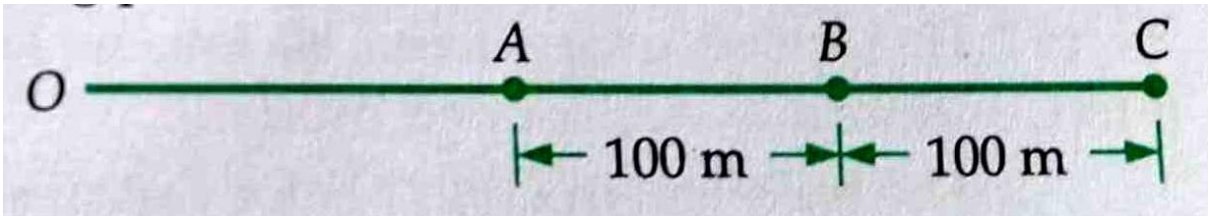
Q.2 State D'alembert's principle.

Q.3 A particle moves with uniform acceleration along a straight line ABC. The speeds of the particle at positions A and C are 5 cm/s and 25 cm/s respectively. If the point B lies midway between A and C, what will be the ratio of times taken by the particle to travel distances AB and BC?



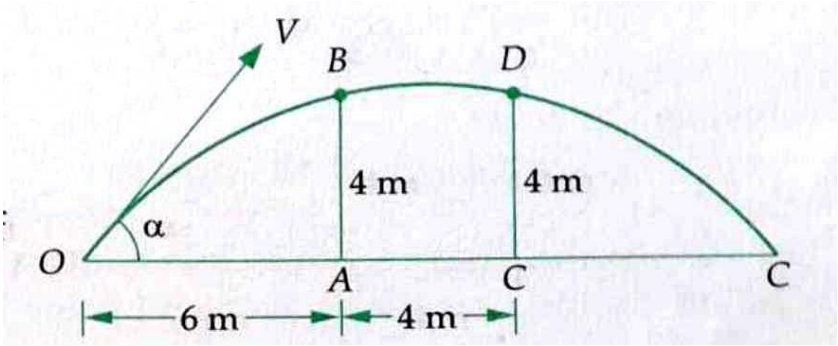
Q.4 Three marks A,B and C spaced at a distance of 100m are made along a straight road. A car starting from rest and accelerating uniformly passes the mark A and takes 10 seconds to reach the mark B, and further 8 seconds to reach the mark C. Make accelerations for

a) The magnitude of the acceleration of the car,
b) The velocity of the car at A,
c) The velocity of the car at B, nad
d) The distance of the mark A from the starting point.

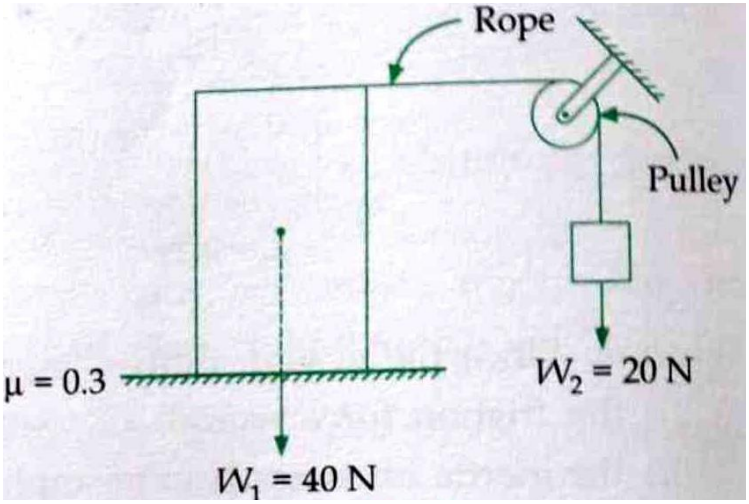


Q.5 Two adjacent guns having the muzzle velocity of 400 m/s fire simultaneously at angles α_1 and α_2 for the same target at a range 4800m. Calculate the time difference between the hits. Assume gravitational acceleration g=9.80 m/s^2.

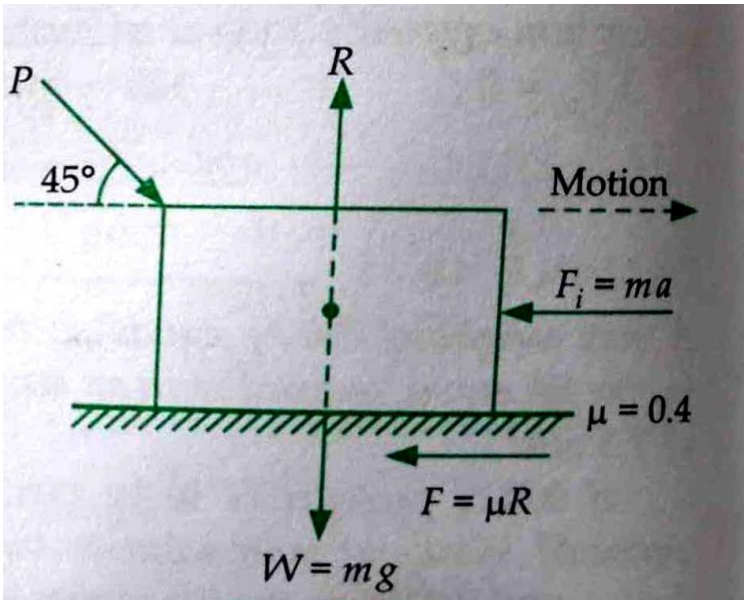
Q.6 A jet water discharging from a nozzle hits a vertical screen placed at a distance of 6m from the nozzle at a height of 4m. When the screen is shifted 4m away from its initial position, the jet hits the screen again at the same point. Determine the angle and celocity with which the jet issues from the nozzle.



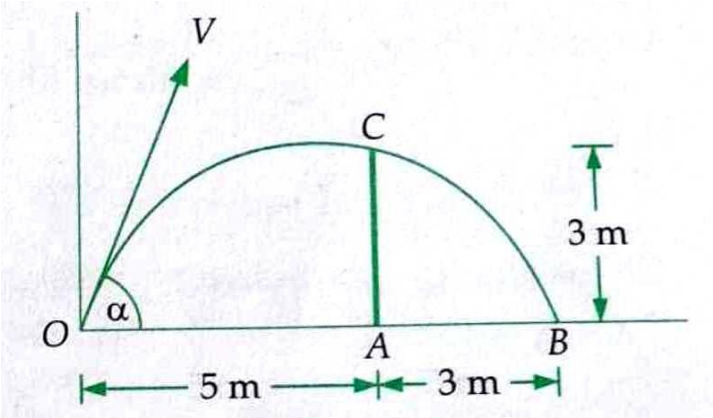
Q.7 A block weighing 40N accelerated along the horizontal plane by means of a 20N weight attached to it through flexible, inextensible and weightless rope passing over a smooth pulley as shown in figure. Using D'alembert's principle, determine the acceleration of the system and the tension in the rope. Take coefficient of friction between the 40N weight block and the horizontal plane as 0.3.



Q.8 A block of mass 50 kg, resting on a horizontal plane, is required to be given an acceleration of 2m/s towards right by applying a push P at an angle of 45 degree with the horizontal. Assuming that coefficient of friction between the block and plane is 0.4, work-out the magnitude of push P. Obtain your solution by applying D'alembert's principle.



Q.9 There is a 3m high wall 3m in front of ememy target. If the gunman is 5m away from the wall on the opposite of the target and on the same horizontal plane as the target , find the angle of projection and the least velocity of projection so that the shell strikes the target.



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Assignment 5

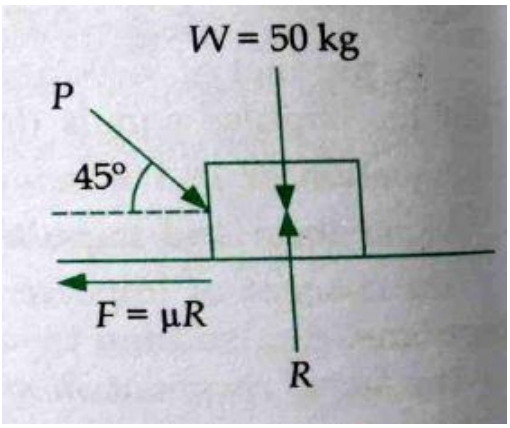
Q.1 Write short notes on following:

a) Principle of work and energy
b) Principle of liner impulse and momentum

Q.2 Write short notes on following:

a) Law of conservation of energy
b) Principal of angular momentum

Q.3 A body of mass 50 Kg rests on a rough horizontal surface (μ=0.4) and is acted upon by a push applied at an angle of 45° to the horizontal. Determine the magnitude of push if it causes the body to move with an acceleration of 2m/s².



Q.4 An automobile is travelling along a straight level highway. When the brakes are applied, the vehicle slides for 2 seconds and covers a distance of 10 m before coming to rest. Assuming that the automobile moves with the constant deceleration during the period, determine the coefficient of friction between the tyres and the road.

Q.5 A train weighing 4000 kN has a frictional resistance of 5N/kN of weight. Determine the steady pull which the locomotive must exert if the speed of the train is to be increased from 30km/hr to 60km/hr within a period of 1.5 minutes.

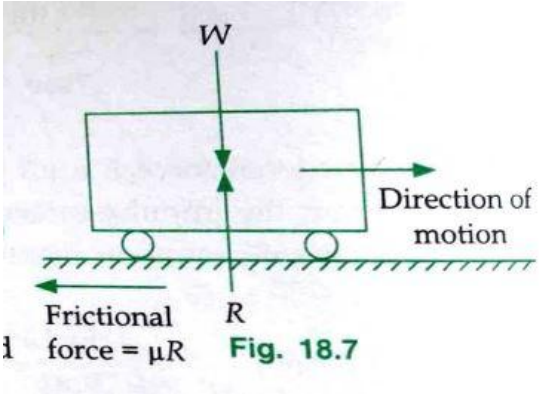
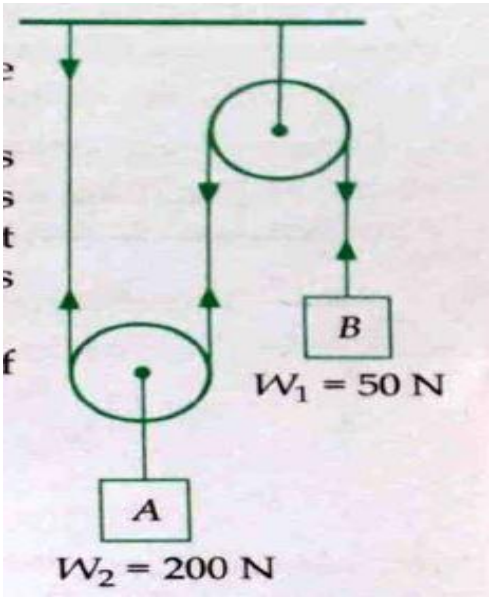


Fig. 18.7

Q.6 A system of frictionless pulleys carries two weights hung by inextensible cords as shown in the figure. Make calculations for the tension in the cords and acceleration of the weights

Proceed to work out the displacement and velocity of weight W_1 after 4 seconds from start. Presume that the system is released from rest.



Q.7 A fire engine lifts 30×10^3 litres of water to a height of 5m and discharges it with a velocity of 8m/s. What is the amount of energy spent during this process?

If the task is accomplished in quarter of an hour, determine input power of the fire engine which has an overall efficiency of 75 percent.

Q.8 A wooden block of 750N weight is placed on an inclined plane which makes an angle of 30° with the horizontal. What work will be done if the block is to be moved upwards the plane for 2.5m distance and the (a) plane is smooth (b) plane is rough with coefficient of friction 0.2.

Q.9 A train weighing 2×10^6 N starts from rest with an acceleration of $0.8 m/s^2$ and acquires a speed of 90km/hr. Determine the kinetic energy corresponding to final speed and average power required.

Subsequently the power is shut off and the train is subjected to a retarding force equal to 8% of the weight of the train. Calculate the distance the train will travel before coming to rest.

Q.10 Wagon A of mass 100 tonnes moving at 5km/hr collides with the back of another wagon B of mass 40 tonnes and moving in the same direction at 1.5km/hr.

After impact, the wagon B sets moving with a velocity of 7.5m/s. determine the velocity of wagon A after the impact and the impulse between the two wagons.

Q.11 A ball of mass 2kg moving with a velocity of 3m/s impinges directly on a ball of mass 4kg at rest. After the impact, the 2kg mass ball comes to rest. Determine the velocity of 4kg ball after striking and the coefficient of restitution between the two balls.

Q.12 In a pile driving equipment, a ram of 800kg mass is released from rest 2.5m above the top of the pile of 2000kg mass. The ram rebounds to a height of 0.15m after hitting the pile. Calculate:

- **(a)** The velocity of pile after the impact,
- **(b)** The coefficient of restitution, and
- **(c)** The percentage of energy loss due to impact.