6.1 Kinetics of a Particle (KNP) - Class Work Questions

6.1.1 KNP-Force and Acceleration (D'Alembert and Newton Principles)

1. An elevator has a downward acceleration of 1 m/s^2, What pressure will be transmitted to the floor of the elevator by a man weighing 500N travelling in the lift? **[449 N]**
2. A 50 kg block is kept on the top of a 15° sloping surface is pushed down the plane with an initial velocity of 20m/s. If $\mu_k = 0.4$, determine the acceleration of the block. **[a = - 1.25 m/s^2]**
3. Two blocks A and B are separated by 10 m as shown in Figure 6.1-1 .on a 20^0 incline plane. If the blocks start moving, find the time t when the blocks collide and distance travelled by each block. Assume $\mu_k = 0.3$ for block A and plane and $\mu_k = 0.10$ for block B and plane. **[t=3.29 sec, S_A=3.18 m, S_B=13.18 m]**

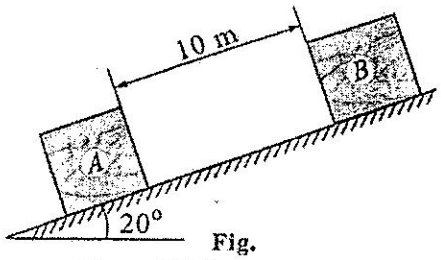

Fig.
Figure 6.1-1

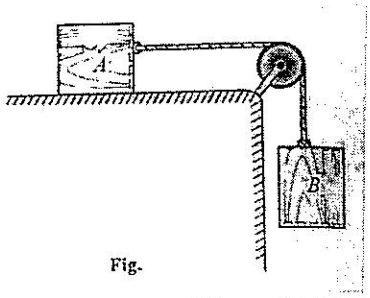

Fig.
Figure 6.1-2

4. Two blocks A and B of masses M_A= 280 Kg and M_B = 420 Kg are joined by an inextensible cable as shown in Figure 6.1-2. Assume that the pulley is frictionless and μ= 0.3 between block A and the surface. The system is initially at rest. Determine (a) acceleration of block A, (b) Velocity after it has moved 3.5m and (c) velocity after 1.5 sec. **[a=4.71 m/s^2, V after 3.5m = 5.74 m/s, V after 1.5 sec = 7.06 m/s]**
5. A horizontal force P = 600 N is exerted on block A of mass 120 kg as shown in Figure 6.1-3. The μ between block A and the horizontal plane is 0.25. Block B has a mass of 30 kg and μ between it and the plane is 0.4. The wire between the two blocks makes 30^0 with horizontal. Calculate the tension in the wire. **[T= 147.78 N]**
6. The 550 N box rest on a horizontal plane for which the coefficient of kinetic friction μ_k= 0.32. If the box is subjected to a 400 N towing force as shown Figure 6.1-4, find the velocity of the box in 4 seconds starting from the rest. **[v=16.724 m/s]**

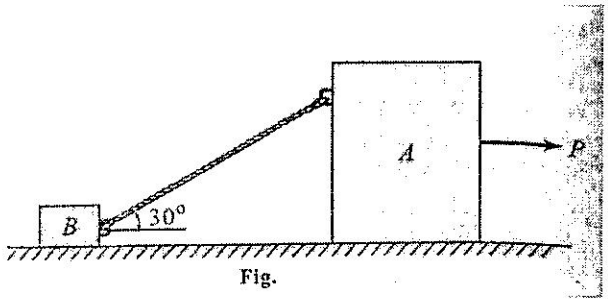

Fig.

Figure 6.1-3

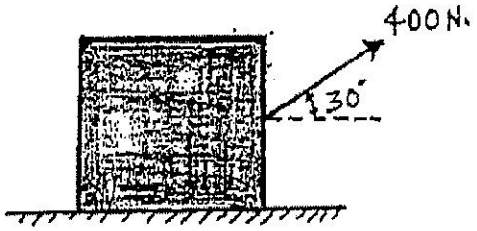

Figure 6.1-4

6.1.2 KNP - Work Energy Principle

1. A 3000N block shown in Figure 6.1-5 slide down a 50° incline. It starts from rest. After moving 2m it strikes a spring whose modulus is 20N/mm. If the co – efficient of friction between block and incline is 0.2, Determine the maximum deformation of the spring.

[0.72m]

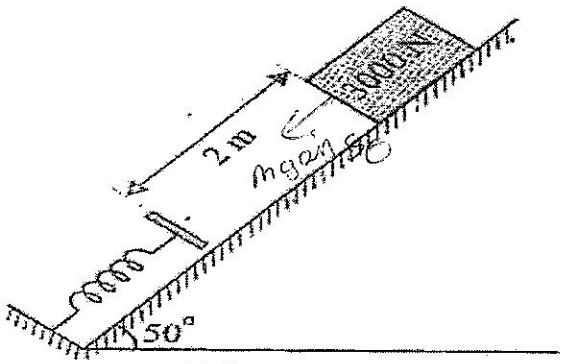

Figure 6.1-5

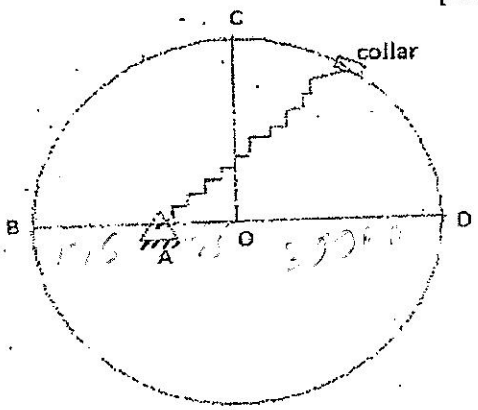

Figure 6.1-6

2. A 1 Kg collar is attached to a spring and slides without friction along a circular rod which lies in a horizontal plane as shown in Figure 6.1-6. The spring has a constant K=250N/m and is undeformed when collar is at B. knowing the collar passes through point D with a speed of 1.6 m/s, determine the speed of the collar when it passes through point C and point B. Radius of circular path=300mm and distance OA=125 mm. **[V_B=4.343 m/s, V_C=3.638 m/s]**

3. Figure 6.1-7 shows a collar of mass 20kg which is supported on the smooth rod. The attached springs are undeformed when d=0.5m. Determine the speed of the collar after the applied force of 1000N causes it to displace so that d=0.3m. The collar is at rest when d= 0.5m.

[4.6m/s] {MU, May 2018, 6 Marks}

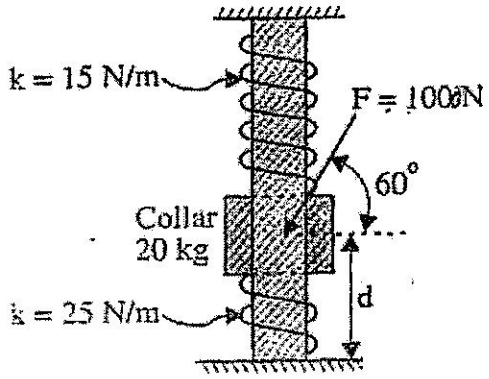

Figure 6.1-7

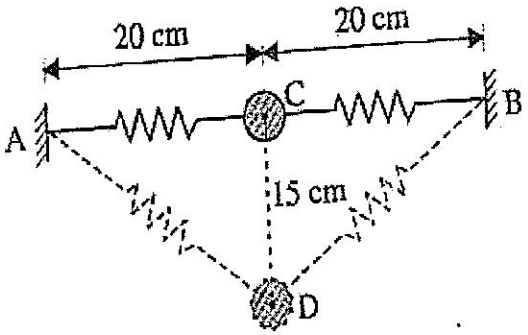

Figure 6.1-8

4. Two springs each having stiffness of 0.5N/cm are connected a ball B having a mass of 5kg in horizontal position producing initial tension of 1.5N in each spring. If the ball is allowed to fall from rest. What will be its velocity after it has fallen through a height of 15 cm. Refer Figure 6.1-8. **[1.683m/s]**

5. A 2kg collar M is attached to a spring and slides without friction in a vertical plane along the curved rod ABC as shown in Figure 6.1-9. The spring has an undeformed length of 100mm and its constant is 800 N/m. If the collar is released from rest at A. Determine its velocity (i) as it passes through B (ii) as it reaches C. **[2.3332, 1.414m/s]**

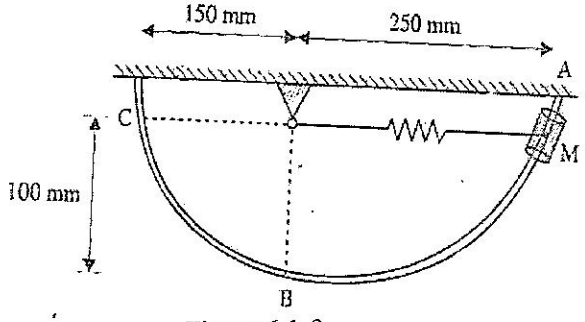

Figure 6.1-9

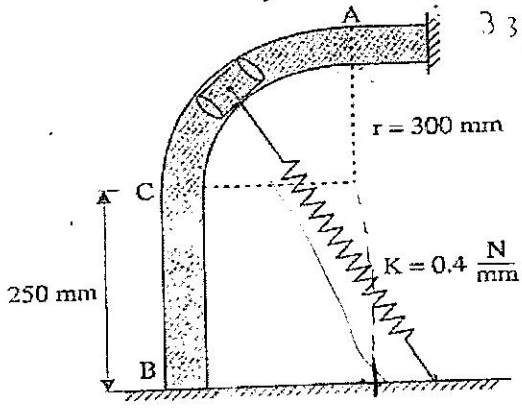

Figure 6.1-10

6. The 25N collar is released from rest at A and travels along the smooth guide. Determine its speed when its centre reaches point 'C'. The spring has an unstretched length of 300mm, and point 'C' is located just before the end of the curved portion of the rod. Refer Figure 6.1-10. **[3.796 m/s]**

6.1.3 KNP - Impulse Momentum Principle and Impact

1. A 2 kg sphere is moving towards left with velocity of 1.8 m/s. It strikes the vertical face of stationary block B of mass 4 kg. A spring K = 5000 N/m is attached to the other face of the block. If e = 0.75. Determine the maximum compression of the spring. Refer Figure 6.1-11. **[26.69 mm]**

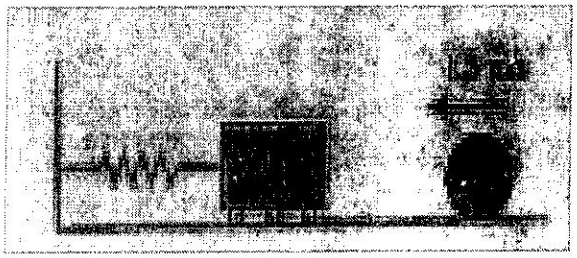

Figure 6.1-11

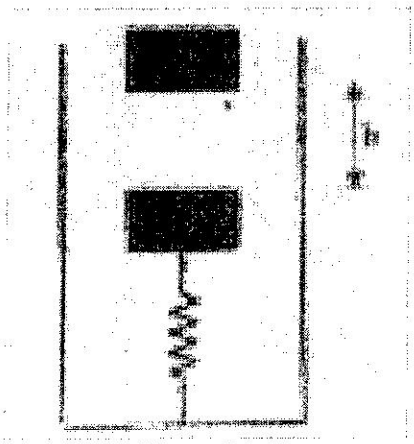

Figure 6.1-12

2. Block A falls through height H onto block B supported on spring of stiffness K. Assuming the impact to be plastic, calculate maximum compression of the spring over and above that due to static action of block A. WA= WB = 20N, K = 20 N/mm, h = 100mm. Refer . Figure 6.1-12 **[10mm]**

3. A bullet of mass 20 gm and moving horizontally with 800 m/s strikes a block of wood of mass 5 kg suspended by a wire 2m long. To what angle with vertical will the block and embedded bullet swing. Refer Figure 6.1-13. **[42.18°]**

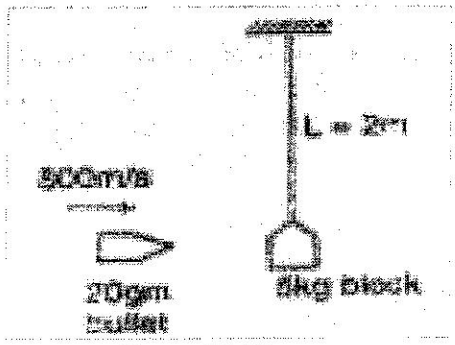

Figure 6.1-13

4. A smooth spherical ball A of mass 120 gms is moving from left to right, with a velocity of 2 m/s in a horizontal plane. Another identical ball B travelling in perpendicular direction with a velocity of 6 m/s collides with ball A as shown in Figure 6.1-14. Determine velocities of A and B after impact. Assume e= 0.8. **[V_A=0.2 m/s (→) and V_B=6.26 m/s (θ°)]**