NATIONAL INSTITUTE OF TECHNOLOGY CALICUT

ZZ102 T ENGINEERING MECHANICS II--DYNAMICS

Test 2 (Module # 2) – 13 March 2006

Time: 9:00 – 11:00am Marks: 20

Important Instructions: READ THESE BEFORE ANYTHING ELSE!

- Answer **all** questions. Read questions carefully before attempting to answer.
- Use the concepts from Module 2 to solve the problems.
- Each question carries 4 marks.

1 Blocks *A* and *B* weighing 2 kN each are connected by an inextensible flexible cable, with the block *A* being attached to the wall by a spring having a spring constant of K = 50 N/m as depicted in Fig. 1. The blocks are released from a rest configuration with the cable being taut. If block *B* can only fall by 50 mm, what is the velocity of block *A* after it has moved a distance of 75 mm? The coefficient of dynamic friction between block *A* and the floor is 0.2.

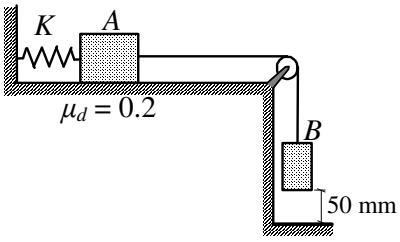

Figure 1

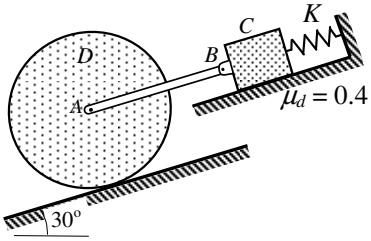

Figure 2

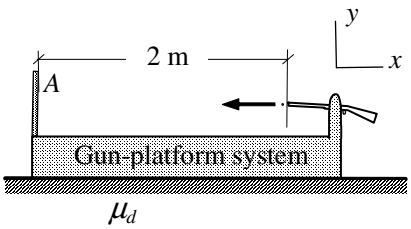

Figure 3

2 The system shown in Fig. 2 is released from rest where the cylinder *D* rolls without slipping. What is the speed of the system after moving 0.2 m down the incline? Also ascertain the frictional force between the ground and the cylinder. Neglect the weight of rod *AB*. The spring is originally unstretched. Data: m_D = 50 kg, m_C = 20 kg, K = 100 N/m, and μ_d between block *C* and the ground is 0.4.

3 A ballistic test consists of the setup shown in Fig. 3. The coefficient of friction between the 100 kg gun-platform system and the ground is μ_d = 0.7. Determine (a) the speed of the platform (V_{p1}) just after the gun fires a 0.05 kg bullet at a muzzle velocity of 1000 m/s, and (b) the distance Δx_p travelled by the platform before the bullet strikes the target screen at *A*.

4 A small sphere *A* attached to a cord *AC* is released from rest in the position shown in Fig. 4 and hits an identical sphere *B* hanging from a vertical cord *BD*. If the maximum angle θ_B formed by cord *BD* with the vertical in the subsequent motion of sphere *B* is to be equal to the angle θ_A, determine the required value of the ratio l_B / l_A of the lengths of the two cords in terms of the coefficient of restitution *e* between the two spheres.

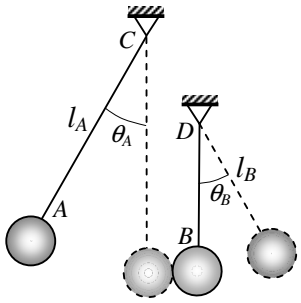

Figure 4

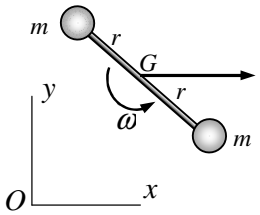

Figure 5a

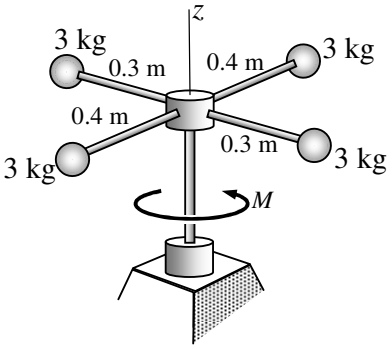

Figure 5b

5 (a) The two small spheres each of mass *m* and the connecting rod of negligible mass are lying in the *xy*-plane, and are rotating about their mass centre *G* with an angular velocity of ω, as shown in Fig. 5a. At the same instant of time the mass centre has a velocity of **V** in the *x*-direction. Determine the moment of momentum $\mathbf{H}_o$ of the assembly at the instant about the origin *O* when *G* has coordinates *x* and *y*.

(b) The four 3 kg balls shown in Fig. 5b are rigidly mounted to the rotating frame and shaft which are initially rotating freely about the vertical *z*-axis at the angular speed of 20 rad/s clockwise when viewed from above. If a constant torque M = 30 Nm is applied to the shaft, calculate the time *t* needed to reverse the direction of rotation and reach the angular speed of 20 rad/s in the same sense as *M*.