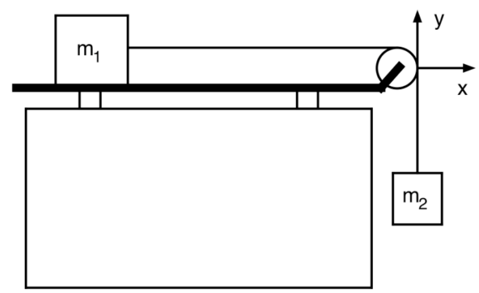
Physics 121H
Fall 2015

Homework #9
14-October-2015
Due Date : 19-October-2015

Reading : Chapter 9

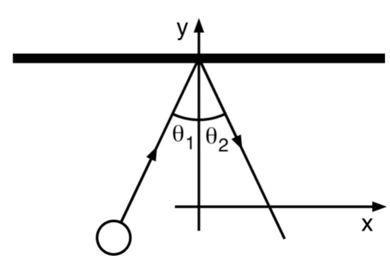
Reminder: The second one-hour exam will be on Friday, 16-Oct-2015. It will cover material from chapters 5-8. You may bring a one-page 'cheat sheet' for use during the exam. You may not use a calculator during the exam.

1. The figure shows an arangement with a frictionless track, in which a cart is connected by a cord to a hanging block. The cart has mass m_1 = 0.600 kg, and its center is initially at *xy* coordinates (-0.500 m, 0 m); the block has mass m_2 = 0.400 kg, and its center is initially at *xy* coordinates (0, -0.100 m). The mass of the cord and pulley are negligible. The cord is stretchless. The cart is released from rest, and both cart and block move until the cart hits the pulley. The friction between the cart and the air track and between the pulley and its axle is negligible. (a) In unit-vector notation, what is the acceleration of the center of mass of the cart-block system? (b) What is the velocity of the center of mass as a function of time *t*? (c) Sketch the path taken by the center of mass. (d) If the path is curved, determine whether it bulges upward to the right or downward to the left, and if it is straight, find the angle between it and the *x* axis.



2. A projectile is shot from the ground with initial speed v_o at an angle θ_o from the horizontal. At the top of its trajectory, it explodes into 2 identical pieces. One of the fragments has zero velocity immediately after the explosion. How far from launch point does the other piece hit the ground?

3. The figure gives an overhead view of the path taken by a 0.165 kg cue ball as it bounces from a rail of a pool table. The ball's initial speed is 2.00 m/s, and the angle θ_1 is 30.0°. The bounce reverses the *y* component of the ball's velocity but does not alter the *x* component. What are (a) the angle θ_2 and (b) the change in the ball's linear momentum in unit-vector notation? (The fact that the ball rolls is irrelevant to the problem.)



4. A cannon of mass *M* that is initially at rest on a horizontal frozen pond fires a projectile of mass *m* with muzzle velocity *v*. The cannon barrel makes an angle ϕ with

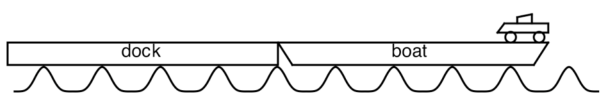
respect to the surface of the pond. (a) Find the recoil speed of the cannon. (b) What is the maximum height above the end of the cannon's barrel reached by the projectile? (c) Find the initial angle of the projectile's trajectory with respect to the ground.

5. Two blocks, *L* and *R* are held in place with a compressed spring between them. The left-hand block *L* has m_L = 1.00 kg and the right-hand block *R* has m_R = 0.500 kg. When the blocks are released, the spring sends them sliding across a frictionless floor. (The spring has negligible mass and falls to the floor after the blocks leave it.) (a) If the spring gives block *L* a release speed of 1.20 m/s relative to the floor, how far does block *R* travel in the next 0.800 s? (b) If instead, the spring gives block *L* a release speed of 1.20 m/s relative to the velocity that the spring gives block *R*, how far does block *R* travel in the next 0.800 s?

6. Ricardo, of mass 80 kg, and Carmelita, who is lighter, are enjoying Lake Merced at dusk in a 30 kg canoe. When the canoe is at rest in the placid water, they exchange seats, which are 3.0 m apart and symmetrically located with respect to the canoe's center. If the canoe moves 40 cm horizontally relative to a pier post, what is Carmelita's mass?

7. A 7 5 kg man is riding on a 39 kg cart traveling at a velocity of 2.3 m/s. He jumps off with zero horizontal velocity relative to the ground. What is the resulting change in the cart's velocity, including sign?

8. Particle A and particle B are held together with a compressed spring between them. When they are released, the spring pushes them apart, and they then fly off in opposite directions, free of the spring. The mass of A is twice the mass of B, and the energy stored in the spring was 60J. Assume that the spring has negligible mass and that all its stored energy is transferred to the particles. Once that transfer is complete, what are the kinetic energies of (a) particle A and (b) particle B?



9. The script for an action movie calls for a small race car (of mass 1500 kg and length 3.0 m) to accelerate along a flattop boat (of mass 4000 kg and length 14 m), from one end of the boat to the other, where the car will then jump the gap between the boat and a somewhat lower dock. You are the technical advisor for the movie. The boat will initially touch the dock, as in the figure; the boat can slide through the water without significant resistance; both the car and the boat can be approximated as uniform in their mass distribution. Determine what the width of the gap will be just as the car is about to make the jump.

10. A 500.0 kg module is attached to a 400.0 kg shuttle craft, which moves at 1000 m/s relative to the stationary main spaceship. Then a small explosion sends the module backward with speed 100.0 m/s relative to the new speed of the shuttle craft. As measured by someone on the main spaceship, by what fraction did the kinetic energy of the module and shuttle craft increase because of the explosion?