UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 125 / LeClair Spring 2009

Random sample problems

1. The position of a particle in meters can be described by $x = 10t - 2.5t^2$, where t is in seconds. What is the position of the particle when it changes direction?

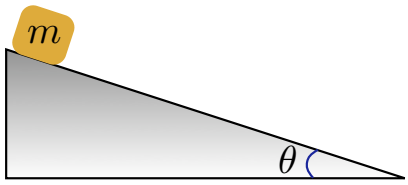
2. For the particle in the question above, what is its velocity when it returns to its original $t = 0$ position?

3. A projectile is launched with an initial velocity of $\vec{\mathbf{v}} = (17\,\hat{\boldsymbol{\imath}} + 3.0\,\hat{\boldsymbol{\jmath}})$ m/s. What is the angle of launch?

4. How far does the projectile above travel in the $\hat{\boldsymbol{\imath}}$ direction, assuming that it is launched over level ground and gravity acts in the $-\hat{\boldsymbol{\jmath}}$ direction?

5. A car is traveling at 20.0 m/s around a circular curve of radius 15.0 m. Calculate the centripetal acceleration of the car in m/s^2.

6. A block slides down a frictionless plane having an inclination of $\theta = 16.9°$ as shown in the figure below. The block starts from rest at the top, and the length of the incline is 2.10 m. Find the speed of the block at the bottom of the incline.

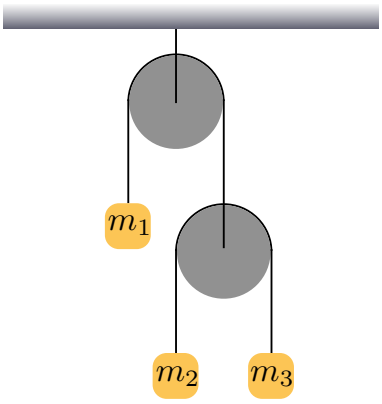


7. Consider the block on the incline above, but now in the presence of friction. What is the minimum coefficient of static friction μ_s such that the block *does not slide down the incline?*

8. A 5 kg object has an initial velocity of $7\,\hat{\boldsymbol{\imath}}$ m/s on a surface with no friction. A force acts on the object, and 6 seconds later its velocity is $2\,\hat{\boldsymbol{\imath}} + 12\hat{\boldsymbol{\jmath}}$ m/s. What was the magnitude of the force?

9. A box begins moving across a floor with an initial velocity of 7 m/s. It slides 10 m before coming to rest. What is the coefficient of kinetic friction μ_k?

10. Consider the double pulley system below with $m_1 = 5$ kg, and $m_2 = m_3 = 2.5$ kg. You may neglect the mass of the pulleys and strings as well as friction. What is the acceleration of m_1?



11. A plane travels horizontally at a constant speed of 40 m/s, 100 m above the ground. It drops a package out of its hold. How far does the dropped package travel horizontally before hitting the ground?

12. A particle's velocity is given by:

$$v(t) = \frac{mg}{b}\left(1 - e^{-\frac{b}{m}t}\right)$$

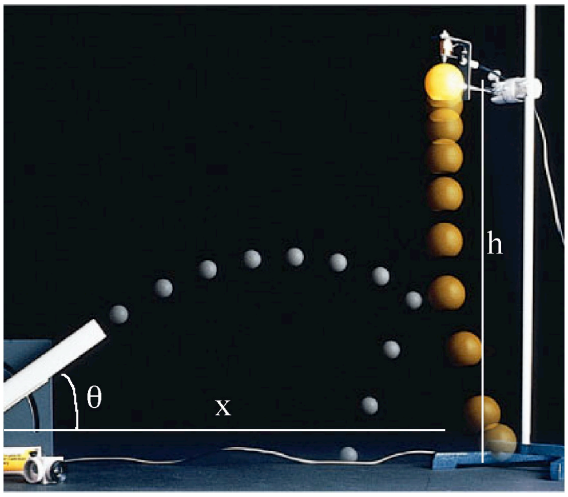
where b is a constant (units of kg/sec), and the particles mass is m. Find the acceleration at $t = 0$.

13. A projectile is launched at an initial angle of $75°$ over level ground, and lands at a distance d away. Neglecting air resistance, at what other launch angle ($< 90°$) would the projectile have landed at the same distance d?

14. A projectile is launched at an initial angle of θ over level ground, and at the same time, a second projectile is dropped from a height h a distance x away from the launch site. Neglecting air resistance, what is the required height h such that the two projectiles collide? Your answer should be in terms of x and θ.

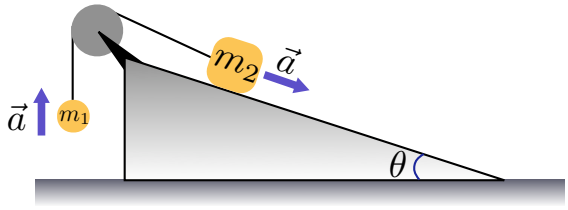
15. A hockey puck on a frozen pond is given an initial speed of 20.0 m/s. The puck always remains on the ice and slides 115m before coming to rest. Determine the coefficient of kinetic friction between the puck and the ice.

16. A ball starts from rest and accelerates to $0.500 m/s^2$ while moving down an inclined plane which is 9.00m long. What is the speed of the ball at the bottom of the plane?



17. A ski jumper leaves the ski track moving in the horizontal direction with a speed of 25.0 m/s. The landing incline below him falls off with a slope of 35°. Where does he land on the incline (x and y coordinates)?

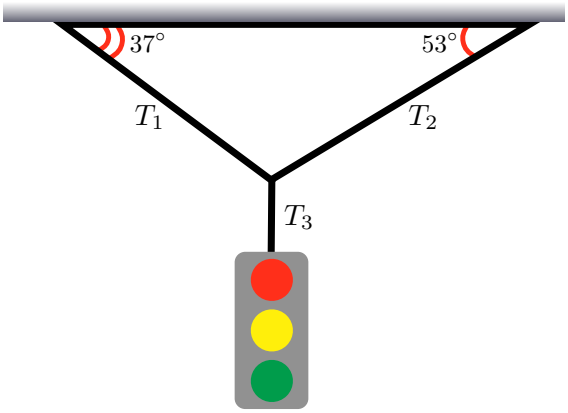
18. A ball of mass m_1 and a block of mass m_2 are connected b y a lightweight cord that passes over a frictionless pulley of negligible mass, as shown below. The block lies on a frictionless incline of angle θ. Find the magnitude of the acceleration of the two objects.

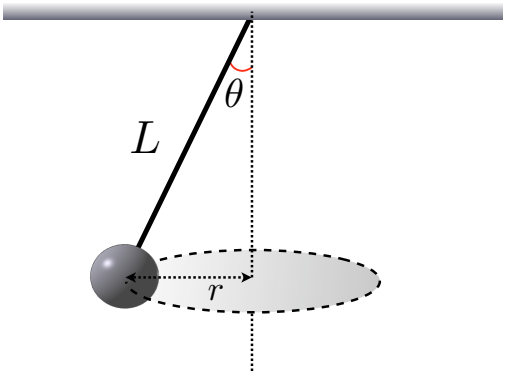


19. Consider the traffic light hanging from 3 cables below. If the traffic light weighs 200N, find the tension in cable 1, T_1.

20. A block is given an initial velocity of 5.00 m/s up a frictionless 20° incline. How far up the incline does the block slide before coming to rest?

21. Consider the conical pendulum below. Find an expression for the *linear* velocity v of the mass m as it orbits, in terms of L, g, and θ. (Hint: note that one can relate r, L, and θ in a simple geometric manner.)





22. A rubber ball was thrown at a brick wall with an initial speed of 10 m/s, and rebounded in the opposite direction with a speed of -8.5 m/s. The rebound was found to take 3.5×10^{-3} sec. What was the acceleration experienced by the ball during the rebound?

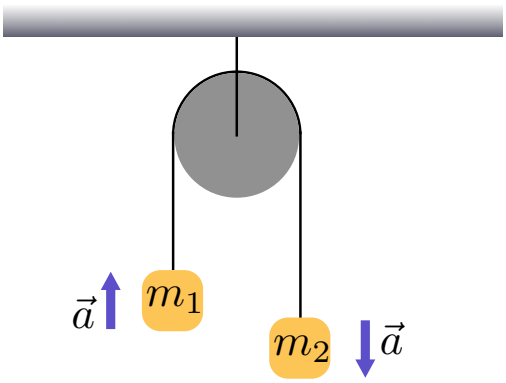
23. A projectile will be launched with an initial velocity of 750 m/s, and needs to hit a target 23 km away. What should the launch angle be? You can ignore air resistance.

24. Joe foolishly fires his .270 Winchester, which has a muzzle velocity of 957 m/s using a 130 grain load, into the air at a 17° angle. Ignoring air resistance, how far away from Joe will the bullet land?

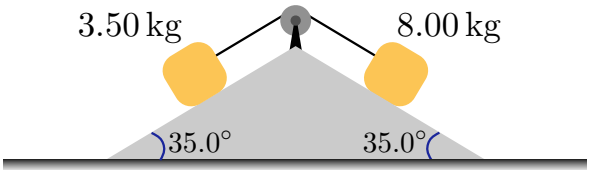
25. After being struck by a hockey stick, a hockey puck slides across the ice with an initial velocity of 7.0 m/s. If the coefficient of kinetic friction μ_k between the ice and the puck is 0.15, what is the velocity of the puck when it reaches the goal 10 m down the ice?

26. Consider the so-called "Atwood's machine" below. What is the acceleration of the two masses, if one ignores friction and the mass of the pulley and rope?

27. A block with mass 5 kg has an initial velocity of $\vec{\mathbf{v}}_\mathbf{i} = (7.0\,\hat{\boldsymbol{\imath}} + 3.1\,\hat{\boldsymbol{\jmath}})$ m/s on a surface with no friction. A force acts on the block, and 17 seconds later its velocity is $\vec{\mathbf{v}}_\mathbf{f} = (2.0\,\hat{\boldsymbol{\imath}} + 15\,\hat{\boldsymbol{\jmath}})$ m/s. What was the magnitude of the force that caused the change in velocity?



28. Two blocks of mass 3.50 kg and 8.00 kg are connected by a massless string that passes over a frictionless pulley, as shown in the figure below. The inclines are frictionless. Find the tension in the string. (*Hint: do you expect the blocks to be moving?*)



29. A 1500 kg car moving on a flat, horizontal road negotiates a curve. If the radius of the curve is 35.0 m and the coefficient of static friction between the tires and dry pavement is $\mu_s = 0.500$, find the maximum speed the car can have and still make the turn successfully. (*Hint: what is balancing the force of friction?*)