UNIVERSITY OF ALABAMA
Department of Physics and Astronomy

PH 125 / LeClair Spring 2009

Problem Set 3

Instructions:

1. Answer all questions below. Follow the problem-solving template provided.
2. Some problems have different due dates!
3. You may collaborate, but everyone must turn in their own work

The following problems are due 27 January 2009 at the beginning of class.

1. A person standing at the top of a hemispherical rock of radius R kicks a ball (initially at rest on the top of the rock) to give it horizontal velocity $\vec{\mathbf{v}}_i$.

(a) What must be its minimum initial speed if the ball is never to hit the rock after it is kicked?

(b) With this initial speed, how far from the base of the rock does the ball hit the ground?

2. The air resistance experienced by an object in free fall can be modeled as an additional force opposite the direction of motion proportional to velocity squared:

$$\vec{\mathbf{F}}_{\text{drag}} = -\frac{1}{2} D\rho A|\vec{\mathbf{v}}|\vec{\mathbf{v}}$$

where D is an empirical constant, ρ the density of air, A the cross sectional area of the falling body, and v its velocity. For an object in free-fall, this drag force counteracts the gravitational force $F_g = mg$. Find an expression for the terminal velocity of a falling body, assuming the object is traveling straight downward.

3. A ball is dropped from a window 10 m above the ground at $t = 0$. When it bounces, its rebound speed is 71% of its impact speed. At $t = 2$ s, a second ball is released from the same place. Take $g = 10\,\text{m/s}^2$.

(a) Give an expression for the position of the first ball $y_1(t)$, that is valid after it has bounced once.

(b) When will the two balls collide? After how many total bounces?

The following problems are due 29 January 2009 at the beginning of class.

4. Exam review: A block of mass m is released from rest at h above the surface of a table, at the top of an incline of inclination θ, as shown below. The *frictionless* incline is fixed on a table of height H.

(a) Determine the acceleration of the block as it slides down the incline.

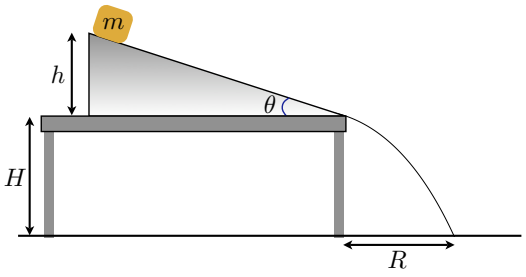

Figure 1: *A block is let go from the top of a ramp sitting on a table.*

(b) What is the velocity of the block as it leaves the incline?

(c) How far from the table will the block hit the floor?

5. Problem 6.55 from your textbook.

6. Problem 6.59 from your textbook.

The following three problems are due 30 January 2009 by the end of the day.

7. Problem 6.34 from your textbook.

8. Problem 6.60 from your textbook.

9. A mass m is released from rest at height h on the top of a ramp of inclination θ. The coefficient of kinetic friction between the ramp and mass is μ_k. The block slides down the ramp, up a second identical ramp, back down again, and so forth.

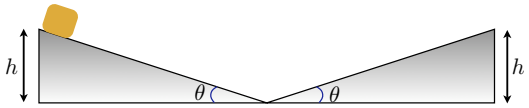

Figure 2: *A block is let go from the top of a ramp sitting on a table.*

(a) After one round trip (from the top of the first ramp and back again), how far away from the mass from its starting point?

(b) How about after n round trips?

(c) Does the mass ever stop?