1. A ball of mass *m* has diameter *D.* For all parts of this problem, assume that the force of air resistance is proportional to the square of the speed of the ball, with drag coefficient *c*2 = 0.22*D*2.

A. Taking upward as the positive direction, write down the differential equations (in terms of *m, D,* and physical constants) that govern (i) the upward motion and (ii) the downward motion of the ball.

i) (upward motion)

ii) (downward motion)

B. If the ball were to eventually descend and reach terminal speed, express that speed in terms of *m* and *D.* Clearly show all work.

2. A small block of mass *m* slides up and down a very long, straight ramp of constant inclination angle *.* The block experiences *both* a frictional force by the incline (coefficient **k) *and* a retarding force by the surrounding air.



For this situation, treat the force of air resistance as proportional to the square of the speed of the block (*i.e.,* *c1* = 0 and *c2* > 0).

A. Write down the equation of motion (*i.e.,* the differential equation of motion, *not* the solution! ☺)   
that describes the uphill motion of the block. In your answer clearly state which direction (uphill or downhill) you choose for the positive (+*x*) direction.

B. Now write down the equation of motion that describes the downhill motion of the block. Use the same direction (uphill or downhill) for the positive (+*x*) direction that you chose in part A.

C. Determine the terminal speed of the block in terms of the given quantities. Show all work. (*Hint:* Does your expression reduce to the expected result when the inclination angle is equal to 90°?)

3. A small block of mass *m* slides down a very long, straight ramp of constant inclination angle *,* as shown. The block experiences *both* a frictional force by the incline (coefficient **k) *and* a retarding force by the surrounding air. As the block slides, it eventually attains a terminal speed.



Although the block is not spherical, treat the force of air resistance as proportional the square of the speed of the block (*i.e.,* *c1* = 0 and *c2* > 0).

A. Write down the equation of motion for the block. In your answer clearly state which direction you take to be positive.

B. Determine the terminal speed of the block in terms of the given quantities. Show all work.

C. Show that your expression for the terminal speed in part B reduces to the expected result when the angle of the incline is taken to be 90°. Show all work.