Questions from Taylor, Chapter 2. Please show all your work on your own paper and write legibly for full credit! If you get stuck or have any questions, please don't hesitate to ask!

- **2.4** – Deriving the quadratic drag term
- **2.3** – Relation to Reynold's numbers (I do suggest doing this after 2.4. You'll also need the relation given in problem 2.2)
- **In-between drag:** We've mainly been compartmentalizing drag into either linear or quadratic forms, but of course it can scale as other powers of velocity. Take the case of a mass m which has velocity v_0 at time $t = 0$ and at position $x = 0$. It moves in purely the horizontal direction through a region or medium where the drag force is given by:

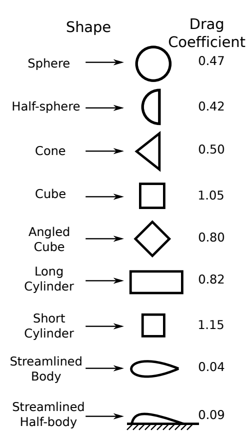
$$F(v) = -\alpha v^{3/2}$$

  where α is just a constant that would account for the mass's size, shape, etc, and v is of course the velocity. So with a velocity dependence of 1.5, this drag force is something between linear and quadratic drag. Write out your equation of motion and then solve the differential equation to find both the mass's velocity and position as a function of time and other given parameters. At what time (if any) will the mass come to rest?
- **2.44** – Varying density (will need computer)
- **Alternative Shapes:** The constant that appeared in problem 2.4 can be generalized in terms of the drag coefficient, and thus you will frequently see written that:

$$f_{quad} = \frac{1}{2}\rho v^2 C_D A$$

  where ρ is the density of the surrounding material, v the velocity, A the cross-sectional area, and C_D the drag coefficient. Use this to answer the below questions:

  1. Comparing the above equation to Eq (2.6) in your text, determine what the c value for a object with a drag coefficient of 1.05 would be. You can assume the same density of air as used in Problem 2.4 (ρ=1.29 kg/m^3) and a cross-sectional area of 0.01 m^2, (small cannonball sized).
  2. The below table lists the drag coefficients for a variety of common shapes. Use this to numerically solve and plot the trajectories of a 5 kg sphere, cube, and streamlined body all launched at an angle of 40° with the horizontal at a speed of 60 m/s. You can assume they all have the same cross-sectional area as above (0.01 m^2). For comparisons sake, plot the trajectory of a particle with zero air drag on the same plot as well.



Measured Drag Coefficients