

Physics 321
Homework 3

Due at midnight on the day of Hour 5.

This homework will give you some experience working with both linear and quadratic drag as well as give you some experience in working with Maple in solving differential equations.

To do this assignment, you will need

1) The coefficients for linear and quadratic drag for smooth spheres are (p.44 of the text):

$$f_{linear} = bv = 1.6 \times 10^{-4} \text{ N s / m}^2 \times dv$$

$$f_{quad} = cv^2 = 0.25 \text{ N s}^2 / \text{m}^4 \times d^2v^2$$

2) In terms of components, we can write

$$\text{linear: } F_x = -bv_x$$

$$\text{quadratic: } F_x = -cvv_x = -c\sqrt{v_x^2 + v_y^2 + v_z^2} v_x$$

1. If someone were to drop two iron spheres, one of mass 1 kg and one of mass 10 kg from the leaning tower of Pisa, which would hit the ground first? Assume constant acceleration, but include linear and quadratic drag. The height of the tower is 58.36 m to the top, so assume that the distance each ball falls before striking the ground is 55.0 m. The density of iron is 7860 kg/m³. (Galileo stated that he didn't remember if he had tried the experiment or not, but others had tried it. Some stated that the time it took an object to fall was linearly proportional to its weight!)

2. You kick a smooth, spherical rock off a cliff. The diameter of the rock is 10.0 cm and the mass of the rock is 7.00 kg. The rock is traveling horizontally at a speed of 30 m/s as it reaches the edge of the cliff. After 3.24 seconds, you hear the rock strike something. How far did the rock fall? What is the horizontal component of its velocity as it strikes the ground below? Include both linear and quadratic drag in your calculation and assume the speed of sound is 330 m/s.