Practice Midterm Exam #1

Total points = 25. Show all of your work!

1. [6 points] If $\mathbf{A} = 5\mathbf{i}$ and $\mathbf{B} = 3\mathbf{i} + 4\mathbf{j}$ find

(a) [2] $\mathbf{A}.\mathbf{B}$

(b) [2] $\mathbf{A}_x\mathbf{B}$

(c) [2] The angle θ_{AB} between **A** and **B**.

2. [7 points] Suppose that the frictional force on an object of mass m traveling through a fluid is proportional to the cube of the velocity: $F = -mkv^3$ where k is a constant (and m is included to make the math a bit easier).

(a) [4] Find the velocity as a function of time, assuming that the initial velocity is v_0 at time $t = 0$. Neglect gravity.

(b) [3] After what time has the velocity slowed to half the initial velocity?

Note: There is another question on the next page!

3. [12 points] An object of mass $m_0 = 30$ kg. is launched at time $t = 0$ with a horizontal velocity of 40.0 m/s. (There is initially no vertical component to the velocity.)

(a) [2] What is the kinetic energy of the object, K_i (in Joules)?

(b) [4] If the initial height of the object is $h = 1000$ m, what is the expected range, R (in meters), before it hits the ground? (Use the x origin as the point of launch, and use $g = 9.81$ m.s^{-2}.)

Unfortunately, immediately after the launch, the object explodes into two fragments (each of mass equal to one-half of the original object ($m_1 = m_2 = m_0/2 = 15$ kg) i.e. we are neglecting the mass of the explosive material). The explosion contributes an additional energy of $E_{ex} = 10.0$ kJ (10000 Joules). The two fragments are ejected at right angles to the original line of flight of the initial object i.e. vertically in the CM frame, fragment m_1 straight up and fragment m_2 straight down.

(c) [6] Immediately after the explosion, what is the velocity (magnitude and angle relative to the horizontal) of fragment m_1 relative to an observer on the ground?