Recitation Problems for Week 5, Tuesday

4.C1. An object of mass $m = 750\,g$ starts out at the origin of our coordinate system. A force $\vec{F} = (300\,\hat{x} + 400\hat{y})\,N$ acts on the mass as it moves to the point $\vec{r} = (60\hat{x} + 80\hat{y})\,cm$. How much work is done on the object?

4.C3. A cart is being pulled along a flat street by a force that depends on how far it has traveled. For a cart of mass m that starts at the position $x = 0$, the force is given by the expression

$$\vec{F}(x) \;=\; \begin{array}{ll} F_0(1 - x/d)\hat{x} & x < d \\ 0 & x > d \end{array}$$

How much work is done in pulling the object from $x = 0$ to $x = d$?

4.C8. An object with a mass of 120 kg is in outer space. The object has an initial speed of $v_i = 12\ m/s$ and it moves from the location $\vec{r}_1 = (7\hat{x} - 20\hat{y} - 8\hat{z})\,m$ to the location $\vec{r}_2 = (10\hat{x} - 29\hat{y} - 13\hat{z})\,m$ under the influence of a constant force,

$$\vec{F} \;=\; (250\hat{x} + 490\hat{y} - 160\hat{z})\ N\,.$$

What is the speed of the object when it is at $\vec{r}_2$?

4.S40. A $120\,g$ mass is hanging from a spring near the surface of the Earth. Your lab partner throws the mass downward with an initial speed of $3.4\,m/s$ at a point when the spring is not stretched. (a) As the mass moves, gravity does work on it. How much work does gravity do as it moves through a distance of $7\,cm$? (b) In terms of the unknown spring constant k, how much work does the spring do on the object as it moves through the distance $D = 7\,cm$? (c) If the final speed of the object is measured to be $2.85\,m/s$, what is the spring constant, k?

4.S44. An electron is traveling at a speed $v = 0.95\,c$, 95% the speed of light. An electric force of $F_e = 1.6 \times 10^{-13}\,N$ is applied in the direction of motion of the electron. (a) If the electron travels a distance of $2\,m$ through this force, what is the energy of the electron? (b) What is the final final speed of the electron?

4.S62. The relativistic energy-momentum relation is given as

$$E^2 \;=\; (pc)^2 + (mc^2)^2\,.$$

Verify this formula is true for our relativistic forms of energy and momentum.

$$\vec{p} \;=\; \frac{m\vec{v}}{\sqrt{1 - v^2/c^2}}$$

$$E \;=\; \frac{mc^2}{\sqrt{1 - v^2/c^2}}$$