CHAPTER 7 KINETIC ENERGY AND WORK

Module 7-4 Work Done by a Spring Force
Module 7-5 Work Done by a General Variable Force
Problems 28, 31, 38, 54 (Note: Skip 46, I’ll treat power later.)

Today’s key formulas:
\[ W = \int_{r_i}^{r_f} \vec{F} \cdot d\vec{r}, \quad W = \int_{x_i}^{x_f} F_x(x) \, dx, \quad F_{spring,x} = -kx \]

Problem 1

A rubber-tubing balloon launcher is modeled as a Hooke’s law type spring when it is stretched. Suppose the launch speed of a 0.34 kg balloon is 23 m/s and the launcher was stretch a distance of 1.2 m. Assume that the balloon leaves the launcher at \( x = 0 \).

What is the spring constant \( k \) that best characterizes this launcher?

Note about stretch and compression in springs: In one important way, the slingshot is not spring like: you can only stretch it (no symmetric compression). A spring can be both stretched and compressed. Hooke’s law is a model for which compression and stretch are symmetric. What I mean by this is that if we stretch or compress the spring by a the same amount away from its relaxed state, the magnitude of the spring force is the same with the direction directed back towards the \( x = 0 \) location.

Problem 2

Suppose for the scenario above, the launcher is stretched an additional 0.20 m. How much additional kinetic energy will this extra stretch impart to the balloon after release?

Problem 3

Suppose that the net force acting on a 0.84 kg particle is characterized by the function \( F_x = 20e^{-x} \) where \( F_x \) is in Newtons and \( x \) is in meters. The particle has an initial velocity \( v_{i,x} = +2.4 \) m/s at its initial position \( x_i = +1.3 \) m.

What is the particle’s velocity when it reaches very large values of \( x \)?

Attention! The work kinetic energy theorem will tell us about the kinetic energy and then from that, speed. You will need to consider the direction of the force and the initial velocity to come to a conclusion about \( v_{f,x} \) as opposed to simply just \( v_f \).