Lecture 15: Energy

Warm-Up Activity

Which of these vectors, when dotted with the red vector below, results in a negative value?

(A) 

(B) 

(C) 

(D) 

L15-1: The Drop and Bounce

You drop a tennis ball of the top of a tall building. It falls to the ground, bounces, and rises back into the air.

- Identify the different types of energy in this situation and to which object or system these energies belong.
- Describe how energy is transformed within systems and transferred between systems during the drop and bounce.
- Which of the energies, transformations, or transfers do you think you might be able to calculate?

Changing a System's Energy

- The total energy of a system can only change through an *interaction* with something external to the system.
- If that interaction is a force, then the energy transferred to the system is known as *work*.

$$W = \int_{r_i}^{r_f} \vec{F} \cdot d\vec{r}$$

L15-2: The Drop – Part 1

- Consider the system of the tennis ball.
- Starting at the moment you drop the ball and ending right before the ball hits the ground:
  - How much work does the force of gravity do on the tennis ball if you drop it from rest?
  - If you instead throw the ball with an initial vertical speed of v_0, do you think the work done by the gravitational force is *greater than*, *less than*, or *equal to* the original work?

The Work-Energy Theorem

$$W_{\text{net,ext}} = \Delta E_{\text{total}}$$

- The net external work done on a system is equal to the change in total energy of that system.
- What you decide to put in your system is ***absolutely critical!***

L15-2: The Drop – Part 2

- Consider the system of the tennis ball.
- Starting at the moment you drop the ball and ending right before the ball hits the ground:
  - How much work does the force of gravity do on the tennis ball if you drop it from rest?
  - If you instead throw the ball with an initial vertical speed of v_0, do you think the work done by the gravitational force is *greater than*, *less than*, or *equal to* the original work?
  - **What is the speed of the tennis ball right before it hits the ground?**

A Deeper Model for Interactions

- Quantities
  - Energy E
  - Kinetic Energy $K = \frac{1}{2}mv^2$
- Laws
  - Work-energy theorem $W_{\text{net,ext}} = \Delta E_{\text{total}}$

Main Ideas

- Energy is a powerful, ubiquitous concept that can help us solve a wide array of physics problems.
- Energy is a *scalar*—it is not a vector.
- There are different forms of energy, and energy can be transferred between objects and between forms.