# C6: Introduction to Energy

## C6.1: Interactions and Energy

- Recall the story about Pedro and Christa and counting blocks. There is some quantity (energy) that remains constant no matter what. Energy is not "seeable" like momentum is; energy is some number that has to be calculated.
- There are, for now, two sorts of energy, *kinetic and potential.*
  1. *Kinetic:* This is a property of a single moving object.
  2. *Potential:* This arises from an interaction between two objects. It is not the property of a single object.
- The total energy of a system is the sum of all the potential and kinetic energies. This is what Eq. (C6.2) says.

## C6.2: Kinetic Energy

- The kinetic energy $K$ of an object of mass $m$ moving with speed $v$ has a kinetic energy given by

$$K \equiv \frac{1}{2}mv^2 \ . \tag{1}$$

  For now, we should view this as a definition.

- The units for energy are *Joules*:

$$1\mathrm{J} \equiv \frac{\mathrm{kg\ m}^2}{\mathrm{s}^2} \ . \tag{2}$$

- The last several paragraphs of this section argue that because the earth is so massive, interactions change its velocity by a minuscule amount, and hence we can ignore the earth's kinetic energy.

## C6.3: Measuring Potential Energy

- Potential energy is measure of the extent to which an interaction can give an object kinetic energy. By measuring the kinetic energy an object gets, we can measure the potential energy associated with the interaction.

- Carrying out this procedure, we are led to:

$$V(r_i) - V(r_f) = mg(z_i - z_f) \; . \tag{3}$$

  This equation is a bit of a mess notationally.

- A simpler way to write this is Eq. (C6.12): Gravitational Potential energy of an object of mass $m$ a height $z$ above a reference position ($z = 0$) is given by

$$V(z) \equiv mgz \; . \tag{4}$$

## C6.4: Negative Energy?

- Potential energy can be negative. All that matters physically are potential energy *differences.*

- When doing problems with gravitational potential energy, always state your reference level ($z = 0$).

- If you use a positive value for $g$, then up must be positive for $z$.

## C6.5: A Look Ahead

- Since all that matters is energy difference, Moore always writes conservation of energy in difference form:

$$0 \; = \; \Delta K_1 + \Delta K_2 - \Delta V \; . \tag{5}$$

## Examples

1. $$\frac{\text{(weight of box)} - 16\text{oz.}}{3\text{oz}} - \frac{\text{(height of water} - 6\text{in.)}}{.25\text{in.}} = \text{constant} \tag{6}$$

   In the morning the box weighs 25 ounces and the height of the water is 7 inches. Christa comes home in the evening and finds that the height of the water is now 6.25 inches. How much does the box now weigh?

2. You drop a 5 kg rock down a well that is 50 meters deep. What is the speed of the rock right before it reaches the bottom of the well? Do this problem two ways:

   (a) Use the ground as the reference point.

   (b) Use a point ten meters above ground as the reference point.

3. A 0.25 kg TAB mug is dropped the top of a 10 meter platform. What is its speed right before it hits the ground? What is the mug's speed if it is dropped from a 20 platform? What is the speed just before impact of a 0.5kg plate dropped from the 10 meter platform?

4. A TAB mug is thrown from a 10 meter rooftop. When the mug hits the ground its speed is 20 m/s. At what speed was it thrown?

5. From what height should you jump if you want to hit the ground at 10 m/s? From what height should you jump if you want to hit the ground at 20 m/s?