The work-energy theorem, part 3

Units for energy

- The SI unit of energy is the Joule (J).

$$1 \text{ Joule } = 1 \text{ Newton } \cdot \text{meter}$$

- A common unit of energy in chemistry is the calorie (cal).

$$1 \text{ calorie } = 4.184 \text{ J}$$

- A common unit of energy in food science is the Calorie = 1 kcal

$$1 \text{ Calorie } = 4184 \text{ J}$$

The work-energy theorem

- This statement is similar to Newton's 2nd law of motion:

$$K_f - K_i = W_{tot}$$

$$K = \frac{1}{2}mv^2$$

$$W_{tot} = W_1 + W_2 + \ldots$$

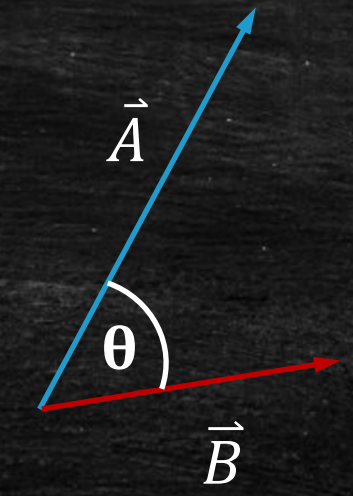
$$W_1 = \vec{F}_1 \cdot \Delta\vec{r}$$

A review of the dot product

- We can multiply two vectors with the dot product to get a scalar (a number).
- There are two ways that we can express the dot product:

$$\vec{A} \cdot \vec{B} = \left|\vec{A}\right|\left|\vec{B}\right| \cos(\theta)$$

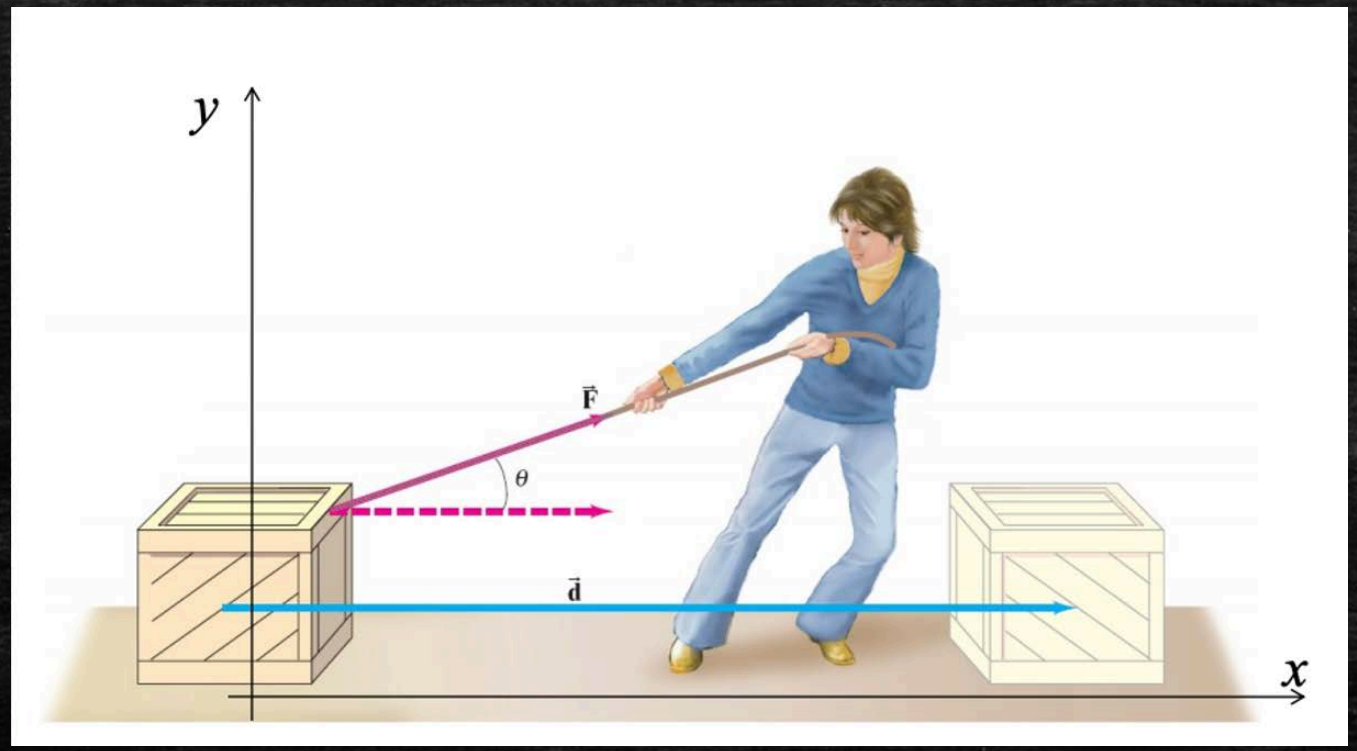
$$= A_x B_x + A_y B_y$$



- Which one of these equations is most useful depends on what information you are given.

A woman pulls a crate at an angle θ above the horizontal

- What is the work done as she pulls the crate a distance d across the floor with force F at angle **θ**?



Work from non-constant forces

- The spring force is variable and depends on how much it is stretched or compressed.

$$\vec{F}_{spring} = -kx\ (\hat{x})$$

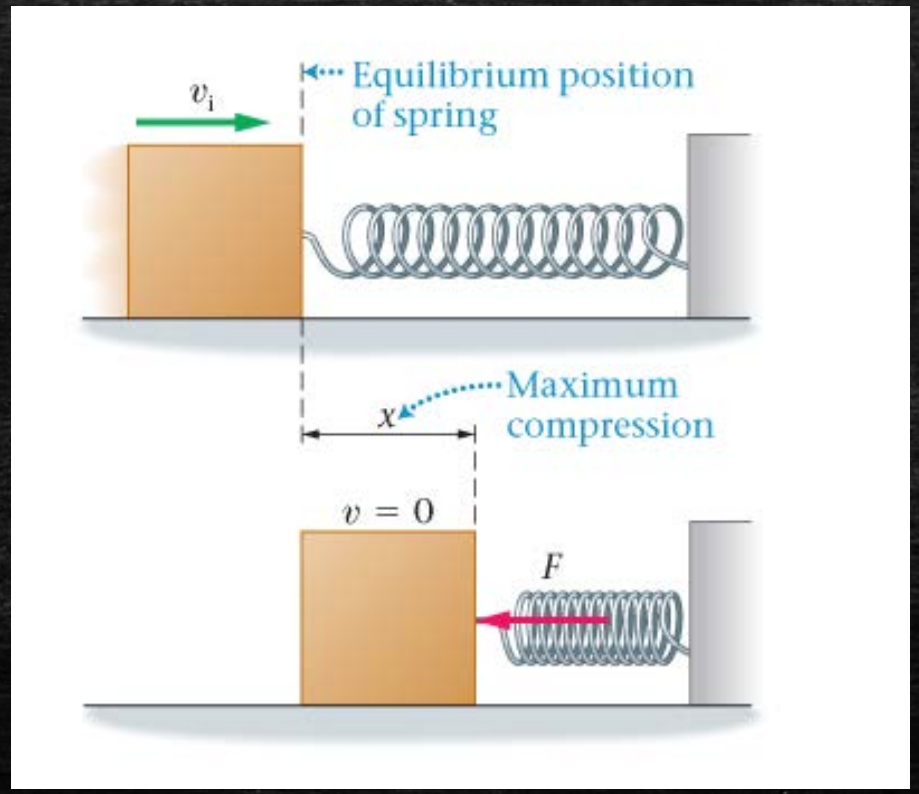
- The work done by a spring force depends on whether the spring is giving or absorbing kinetic energy from an object:

$$W_{spring} = \pm\frac{1}{2}kx^2$$

We use the + sign when a spring starts compressed and causes an object to speed up, and we use the – sign when it starts uncompressed and then compresses to slow an object down.

Work from non-constant forces

- What is the work done by the spring as it stops a mass (m) moving with initial speed v_i?



Power

- Power measures the rate at which work is being done.

$$P = \frac{W}{t} = Fv$$

- The SI unit of power is the Watt (abbreviated as W, which is not the same thing as work).

$$1 \text{ Watt} = 1 \frac{\text{Joule}}{\text{second}}$$

$$1 \text{ horsepower (hp)} = 745.7 \text{ W}$$