Chapter 6 Homework

Anay Aggarwal

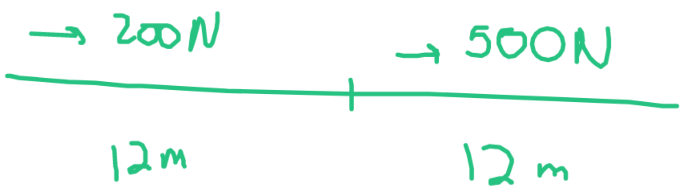
October 8, 2021

Example 0.1 (Context Rich Problem)
Moving stuff across a pond.

Solution. To solve this problem, we need to know about work and energy. Specifically,

$$W_{net} = \Delta E$$
$$K = \frac{1}{2}mv^2$$
$$W = F \cdot x$$

The diagram is as follows:



The system is the rock and the pond. Notice that at the beginning, there is zero kinetic energy since the object is at rest, and zero potential energy. At the end, there is only kinetic energy (potential energy is in the wrong direction), so the total energy is $\frac{1}{2}mv_{final}^2$. Hence $\Delta E = \frac{1}{2}mv_f^2$. Noting that

$$W_{net} = \Delta E$$

we can compute ΔE, and, in turn, v_f, if we can compute W_{net}. Notice that

$$W_{net} = \sum W = \sum F \cdot x$$

Which is known. Hence

$$\frac{1}{2}mv_f^2 = \sum F \cdot x$$
$$v_f = \sqrt{\frac{2\sum F \cdot x}{m}}$$

Before plugging in $F_1 = 200N, x_1 = 12m, F_2 = 500N, x_2 = 12m, m = 150kg$, we can do some sense-making. Notice that the units of v_f are

$$\sqrt{\frac{kg\frac{m^2}{s^2}}{kg}} = \frac{m}{s}$$

Which makes sense. Additionally, when m gets large, v_f gets small, which also makes sense. Plugging in, we get

$$v_f = \sqrt{\frac{2 \cdot (200 \cdot 12 + 500 \cdot 12)}{150kg}} = \sqrt{\frac{16800}{150}} \approx 10.58m/s$$

Which also makes sense. □

Example 0.2 (Explanation Task)

Ranking Work

Solution. Suppose pushing a block of mass m with a force F_0 on the time interval $[t_1, t_2]$ pushes it a distance d_0. Then the total work on each block in experiment 1 is $F_0 \cdot d_0$. So the total work is $2F_0 \cdot d_0$. This is the same in experiment two (since work is force *dotted* with distance) In experiment 3, the distance will be a bit less than d_0 so the work will be a bit less than $2F_0 \cdot d_0$, but still positive. In experiment 4, the distance for the right block will be larger than d_0, so the total work will be larger than $2F_0 \cdot d_0$. In experiment 5, the blocks won't move so zero net work will be done. Hence:

$$\exp 5 < \exp 3 < \exp 1 = \exp 2 < \exp 4$$

□