Oberlin College Physics 103, Fall 2023

Model Solutions to Assignment 6

Problems from *College Physics* by P.P. Urone and R. Hinrichs.

Chapter 7, problem 6: Pulling a wagon

$$\begin{aligned} W &= (\text{component of force parallel to displacement}) \times (\text{displacement}) \\ &= (50\ \text{N} \cdot \cos(30^\circ)) \times (30.0\ \text{m}) \\ &= (50\ \text{N} \cdot \tfrac{\sqrt{3}}{2}) \times (30.0\ \text{m}) \\ &= 1.3\ \text{kJ} \quad \text{or} \quad 1.3 \times 10^3\ \text{J} \end{aligned}$$

⟦*Grading:* 2 points for knowing what work is (specific equation not required, but student must know what work is), 2 points for plugging in numbers, 2 points for number 1.3, 2 points for units, 2 points for two significant figures.⟧

Chapter 7, problem 7: Pushing a cart

(a) work done by friction $= (-35.0\ \text{N})(20.0\ \text{m}) = -700\ \text{J}$

(b) work done by gravity $= 0$ because force of gravity is perpendicular to displacement

(c) work done by shopper

$$\begin{aligned} W_{\text{total}} &= \text{KE}_f - \text{KE}_i \\ \text{work done by friction} + \text{work done by shopper} &= 0 \\ \text{work done by shopper} &= -\text{work done by friction} = +700\ \text{J} \end{aligned}$$

(d)

$$\text{work done by shopper} = \vec{F}_{\text{shopper}} \cdot \vec{d} = F_{\text{shopper}}(\cos(25.0^\circ))(20.0\ \text{m})$$

$$F_{\text{shopper}} = \frac{\text{work done by shopper}}{(\cos(25.0^\circ))(20.0\ \text{m})} = \frac{+700\ \text{J}}{(\cos(25.0^\circ))(20.0\ \text{m})} = 38.6\ \text{N}$$

(e) total work done on cart $= 0$

Notice that if we had executed this problem using force techniques, we would have needed to draw a detailed free body diagram. Using energy techniques we got the answer without that diagram.

⟦*Grading:* 2 points for each part.⟧

Chapter 7, problem 12: Stopping a car

Annika and I worked this problem together in class on Monday, 23 October. We found that the force needed to stop a car of mass m with initial velocity v_i over a distance d is

$$\frac{mv_i^2}{2d}.$$

All that remains is to plug in the numbers. Remember to convert 90.0 km/h to 25.0 m/s. The results are **(a)** 2.47 kN; **(b)** 148 kN. ⟦*Grading:* For each part, 3 points for number, 1 point for units, 1 point for three significant figures.⟧

Chapter 7, problem 13: Bumper

This is the same abstract problem is problem 12, so all we need to do is plug in different numbers. The answer is 2.82 kN. ⟦*Grading:* 6 points for number, 2 points for units, 2 points for three significant figures.⟧