

# Worksheet 1.9

## A Potpourri of Questions

1. A weather balloon with a skydiving hitchhiker is traveling with a velocity of 8 m/s directly upward. When the balloon is 2000 m above the ground, the skydiver jumps out.
- a. What is the velocity of the skydiver just before he lands on the ground below?

$$\begin{aligned} v_i &= +8 \text{ m/s} && \text{time of flight} && v_f = -10(20.8) + 8 \\ y_i &= 2000 \text{ m} && 0 = -\frac{10}{2}t^2 + 8t + 2000 && v_f = -200 \text{ m/s} \\ &&& t &= 20.8 \text{ s} && \end{aligned}$$

- b. How long is he in the air after he jumps?

$$20.8 \text{ s}$$

- c. What is the greatest height reached by the skydiver above the ground?

$$\begin{aligned} v_f &= 0 = -10\left(\frac{t}{10}\right) + 8 \\ t &= \frac{8}{10} \text{ s} \end{aligned}$$

$$y_f = -\frac{10}{2}\left(\frac{8}{10}\right)^2 + 8\left(\frac{8}{10}\right) + 2000 \text{ m} = 2062.4 \text{ m}$$

- d. What is the distance between the weather balloon and the skydiver 4 seconds after he jumps?

$$\begin{aligned} \text{Diver: } y_f &= -\frac{10}{2}(4^2) + 8(4) + 2000 = 1952 \text{ m} \\ \text{Balloon: } y_f &= 0(4^2) + 8(4) + 2000 = 2032 \text{ m} \end{aligned} \quad \Delta y = 80 \text{ m}$$

2. You are sitting on your bike at rest. Your friend comes running at you from behind at a speed of 3 m/s. At the exact moment they pass you, you start up on your bike with an acceleration of 2 m/s<sup>2</sup>.

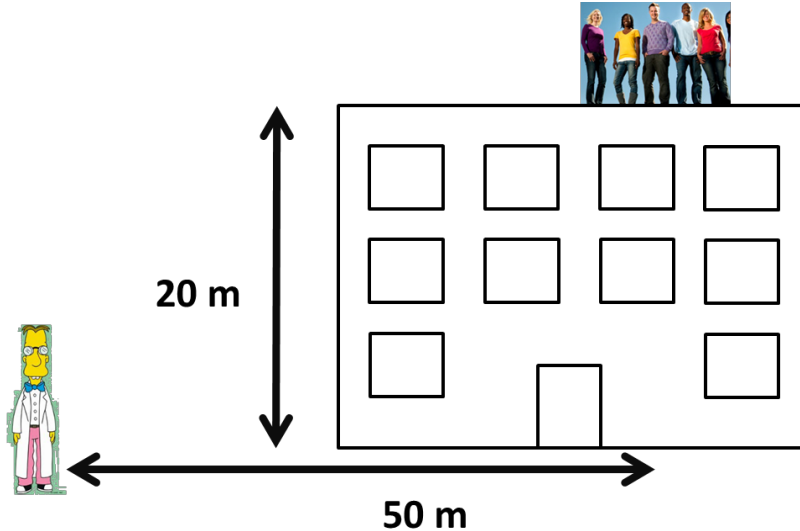
$$\begin{aligned} v_{f, \text{bike}} &= v_{f, \text{friend}} \\ 2t + 0 &= 0t + 3 \end{aligned}$$

$$t = \frac{3}{2} \text{ s}$$

- b. At what time t do you pass your friend?

$$\begin{aligned} y_{f, \text{bike}} &= y_{f, \text{friend}} \\ 2t^2 + 0t + 0 &= 0t^2 + 3t + 0 \\ 2t^2 &= 3t \\ 2t &= 3 \\ t &= \frac{3}{2} \text{ s} \end{aligned}$$

3.



A group of college students are on the roof of their dorm at a height of 20 m with a bucket of water balloons. The first student sees his physics professor walking by. The professor is 50 m away and moving with a constant velocity of 3 m/s toward the students.

a. If the students drop a water balloon, how long will it take to hit the ground?

$$\begin{aligned}
 y_i &= 20 \text{ m} & t_f &=? & 0 &= -\frac{10}{2}t^2 + 0t + 20 \\
 a &= -10 \text{ m/s}^2 & & & & \\
 v_i &= 0 \text{ m/s} & & & 9t &= 20 \\
 y_f &= 0 \text{ m} & & & t &= 2 \text{ s}
 \end{aligned}$$

b. How much time will pass until the professor is directly under the students?

$$\begin{aligned}
 50 &= 0t^2 + 3t + 0 \\
 50 &= 3t \\
 t &= 16.7 \text{ s}
 \end{aligned}$$

c. How long must the students wait to drop the balloon in order to hit their professor as he walks underneath them?

$$14.7 \text{ s}$$

d. How fast is the balloon traveling when it hits the professor?

$$\begin{aligned}
 v_f &= -10(2) + 0 \\
 &= -20 \text{ m/s}
 \end{aligned}$$

After getting hit by the water balloon, the professor accelerates from his initial velocity at a rate of 2 m/s<sup>2</sup> toward a campus police car that is 50 m away.

e. How long do the students have until he alerts the police?

$$\begin{aligned}
 v_i &= 3 \text{ m/s} & 50 &= \frac{2t^2}{2} + 3t + 0 \\
 a &= 2 \text{ m/s}^2 & & \\
 y_i &= 0 & & \\
 y_f &= 50 \text{ m} & t &= 5.7 \text{ s}
 \end{aligned}$$