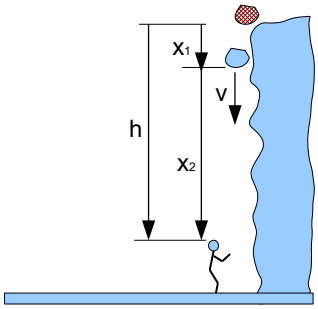
Chapter 3 Problem 76 †



Given
$h = 105.0\ m$
$t_2 = 1.50\ s$
$v_{sound} = 343\ m/s$
$a = g = 9.80\ m/s^2$

Solution
a) How far above the hiker is the rock when he can hear it?

For this problem we will assume the downward direction is positive. That means acceleration due to gravity will also be positive.

Calculate the time it take the sound of the rock breaking loose to be heard by the climber. Sound moves at a constant speed. Using the given distance, the time is

$$h = v_{sound} t_1$$

$$t_1 = \frac{h}{v_{sound}} = \frac{105.0\ m}{343\ m/s} = 0.306\ s$$

During this time, the rock was able to fall a distance of

$$x_1 = v_0 t + \tfrac{1}{2} a t^2 = 0(0.306\ s) + \tfrac{1}{2}(9.80\ m/s^2)(0.306\ s)^2 = 0.459\ m$$

When the hiker hears the rock break loose, it is $105.0\ m - 0.459\ m = 104.54\ m$ above him. At this point, he is still not able to see it.

b) How much time does the hiker have to avoid the falling rock?

The hiker sees the rock $1.50\ s$ after he hears the sound. Therefore, the time it is seen is

$$t_3 = t_1 + t_2 = 0.306\ s + 1.50\ s = 1.81\ s$$

The time it takes the rock to reach the hiker can be determined with the third kinematic equation.

$$h = v_0 t + \tfrac{1}{2} a t^2$$

Since the intial velocity is zero, simple algebra allows us to solve for time.

$$h = \tfrac{1}{2} a t^2$$

†Problem from University Physics by Ling, Sanny and Moebs (OpenStax)

$$t = \sqrt{\frac{2h}{a}} = \sqrt{\frac{2(105.0\ m)}{9.80\ m/s^2}} = 4.63\ s$$

The difference between the time the rock is seen and when it reaches the location of the hiker is

$$\Delta t = t - t_3 = 4.63\ s - 1.81\ s = 2.82\ s$$