University of Alabama
Department of Physics and Astronomy

PH 105 LeClair Summer 2015

Quiz 2 Solution

$$a = \text{const} \qquad (|a| = 9.8\,\text{m/s near earth's surface})$$
$$v(t) = v_o + at$$
$$x(t) = x_o + v_o t + \frac{1}{2}at^2$$

1. A bullet is fired horizontally from a gun, and another bullet is simultaneously dropped from the same height. Which bullet hits the ground first (ignoring air resistance)?

- □ the fired bullet
- □ the dropped bullet
- ■ they hit the ground at the same time

Solution: In the absence of air resistance, along the vertical axis both objects are simply falling from rest. The fact that one also happens to be traveling horizontally has nothing to do with the vertical motion. This means both have the same vertical velocity, acceleration, and position at any given instant, and they should hit the ground at the same time.

2. You throw a ball upward. After half of the time to the highest point, the ball has covered:

- □ half the distance to the top
- ■ more than half the distance
- □ less than half the distance
- □ it depends on how fast you throw the ball

Solution: The ball slows down as it travels upward due to the downward acceleration of gravity. That means it is going faster during the first half of its flight to the top, meaning it will cover more distance in the same time.

3. A ball is dropped, and then another ball is dropped from the same spot one second later. As time goes on while the balls are falling, the distance between them (ignoring air resistance)

- ■ increases steadily
- □ increases and approaches a limiting value
- □ decreases

- □ remains the same

Solution: With zero initial velocity, position increases quadratically in time, $x = \frac{1}{2}gt^2$. That means the offset will increase steadily, made more clear by just writing out the two ball's positions

$$x_1(t) = \frac{1}{2}g\,(t+1)^2 = \frac{1}{2}g\left(t^2 + 2t + 1\right) \tag{1}$$

$$x_2(t) = \frac{1}{2}gt^2 \tag{2}$$

The difference between the two is $\frac{1}{2}g\,(2t+1)$, i.e., a steadily increasing function of time.

One key point here is the bit about "ignoring air resistance." Air resistance would cause both to approach a limiting terminal velocity, and the separation between them would also approach a limiting value. *However*, since you were told to ignore air resistance, you have to put aside part of your everyday intuition and see what the equations are telling you.

That being said: I'm likely to give you some partial credit for choosing the second answer, provided you bring me the quiz and request this (at least once the TAs hand back this quiz to you).