University of Alabama
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PH 105 LeClair Summer 2015

Quiz 1 Solution

1. If an object has negative velocity and negative acceleration, is it:

- ■ speeding up
- □ slowing down
- □ remaining stationary

Solution: The sign of v just tells you which direction the object is traveling - positive means moving along $+x$, negative means moving along $-x$. The same is true for acceleration. All that really matters then is whether the two have the *same* sign or *opposite* signs. Speed is the *magnitude* of the velocity, the sign indicates direction. If velocity is negative, the object is moving along $-x$, and a negative acceleration means the velocity is increasing in the same direction. That means the object is speeding up and moving along the $-x$ direction.

If the acceleration were positive and the velocity negative, then the object would be moving along $-x$ and slowing down, since the acceleration is working in the opposite direction compared to the velocity. If the acceleration persisted, the object would stop for an instant and change direction to move along the $+x$ direction once the velocity became positive.

2. A wombat moves along an x axis. What is the sign of its acceleration in the following situations? (a) moving in positive direction, increasing speed, (b) moving in positive direction, decreasing speed, (c) moving in negative direction, increasing speed, (d) moving in negative direction, decreasing speed

- □ a,b,c,d $= +, +, -, -$
- ■ a,b,c,d $= +, -, -, +$
- □ a,b,c,d $= +, -, +, -$
- □ a,b,c,d $= -, -, +, +$

Solution: What matters here is which direction the velocity is changing compared to the direction the wombat is moving. Acceleration acting in the same direction as the motion will always increase the speed, and acceleration acting against the direction of motion will decrease the speed. The question then is just to figure out if the change in velocity, i.e., the acceleration, is with or against the direction of motion.

Moving along the positive direction, a positive acceleration means increasing speed. A negative acceleration would be acting against the direction of motion, and would decrease the speed. Moving along the negative direction, increasing speed means that the acceleration is acting in the same direction as the motion, the negative direction. Moving along the negative direction and decreasing speed means the acceleration opposes the direction of motion, which would make it in the positive. Thus, the answer must be $+, -, -, +$.

3. Dropping a stone into a deep hole, you find it takes 1 s to reach the bottom. Later, you find a second, deeper hole and a stone takes 3 s to reach the bottom. How much deeper is the second hole?

- □ $\sqrt{3}$ times deeper
- □ 3 times deeper
- ■ 9 times deeper
- □ cannot be determined without the mass of the stone

Solution: We know that starting at rest means $v_o = 0$. Let the starting position of the stone in each case be our origin, so $x_o = 0$. That means the position of the stone at any given time in either case is just $x(t) = \frac{1}{2}gt^2$ (positive or negative, depending on which way you define to be $+x$). With $g \approx 10\,\text{m/s}^2$, after 1,s the object falls 5 m, and after 3 s the object falls 45 m. Thus, the second hole is 9 times deeper.

Easier would be to just notice that $x(t) \propto t^2$. Since position is quadratic in time, falling 3 times longer means it covers $3^2 = 9$ times more distance.