University of Alabama
Department of Physics and Astronomy

PH 105 LeClair Summer 2012

Quiz 1: Solution

1. A particle moves along the x axis according to the equation $x(t) = 5.00 + 2.75t - 4.90t^2$, where x is in meters and t is in seconds. What is the position of the particle at $t = 2.5\,\text{s}$?

- □ 5.50 m
- ■ -18.75 m
- □ -0.375 m
- □ -23.75 m

$$x\,(2.5\,\text{s}) = 5.00 + 2.75\,(2.5) - 4.90\,(2.5)^2 = -18.75$$

2. What is the velocity at $t = 2.50\,\text{s}$? for the particle in question 1?

- □ -23.8 $\frac{\text{m}}{\text{s}}$
- ■ -21.8 $\frac{\text{m}}{\text{s}}$
- □ -37.5 $\frac{\text{m}}{\text{s}}$
- □ 23.8 $\frac{\text{m}}{\text{s}}$

$$v\,(t) = \frac{d}{dt}\,[x\,(t)] = 2.75 - 9.8t \qquad \Rightarrow \qquad v\,(2.5) = 2.75 - 9.8\,(2.5) = -21.8$$

3. A thrown object travels along the $+x$ axis according to $x(t) = 20.0t - 4.90t^2$, where x is in meters and t is in seconds. Determine the time when it reaches its maximum x value.

- ■ 2.04 s
- □ 4.08 s
- □ 2.00 s
- □ 3.06 s

Maximum x occurs when the velocity is zero:

$$v\,(t) = \frac{d}{dt}\,[x\,(t)] = 0 = 20 - 9.8t \qquad \Rightarrow \qquad t = 2.04\,\text{s}$$

4. A basketball player leaps for a rebound (from rest) and spends 0.50 s in the air. What is the player's vertical leap (maximum height)? (Hints: falling object, how long is spent going *up*?)

- □ 0.24 m
- □ 0.62 m
- □ 1.23 m
- ■ 0.31 m

First, note that if the total jump takes 0.5 s, half of that time is spent going up, and half is spent going down. We can then just consider the part of the jump where the player is *falling* for half the time (0.25 s), and treat the player as an object in free fall with zero initial velocity. Start with our general equation of motion in 1-D:

$$x_f = x_i + v_i t + \frac{1}{2} a_x t^2$$

Considering the player falling from maximum vertical leap, we want to find the initial height x_i, *i.e.,* the vertical leap. In the equation above, we set $x_f = 0$ (at the ground), $t = 0.25\,\text{s}$, $v_i = 0$, and $a_x = -g$:

$$0 = x_i - \frac{1}{2} g t^2 = x_i - \frac{1}{2}\,(9.8)\,(0.25)^2 \qquad \Rightarrow \qquad x_i = \frac{1}{2}\,(9.8)\,(0.25)^2 = 0.31$$

Common mistake: not remembering that the player spends only half the total time going up or down. This gives you 1.23 m, which naturally appears as a possible answer ...