PHY 110 Spring 2018 Quiz 2 Solution

1. Remember that froghopper from the homework? Let's take him to the moon, where the acceleration due to gravity is only 1.62 m/s^2. Suppose he uses his special jumping legs to accelerate upward at 4 km/s^2 for a distance of 2 mm. Ignore gravity for this acceleration phase. What is his upward velocity at the end of this acceleration phase? Assume positive is upward.

a) 1.00 m/s b) 2.00 m/s c) 3.00 m/s **d) 4.00 m/s**

This one is almost straight out of the homework problem. You're given info about starting and ending position as well as acceleration, then you're asked for final velocity – that sounds like the stopping equation:

$$v^2 - v_0^2 = 2a\left(x - x_0\right)$$
$$v^2 - 0 = 2\left(4000\right)\left(0.002 - 0\right)$$
$$v = 4\ \frac{m}{s}$$

2. Assume the answer to #1 is 5 m/s (it isn't, so just pretend). He is now 2 mm above the floor of his cage, headed upward, and his feet have left the floor. How fast is he going when he hits the top of his cage, 0.5 m above the floor? Ignore air resistance.

a) 1.90 m/s b) 2.66 m/s c) 3.52 m/s **d) 4.84 m/s**

Another stopping equation, with new values of initial position and velocity:

$$v^2 - v_0^2 = 2a\left(x - x_0\right)$$
$$v^2 - 5^2 = 2\left(-1.62\right)\left(0.5 - 0.002\right)$$
$$v = 4.84\ \frac{m}{s}$$

3. How long does this upward flight in #2 take? (Ignore the short time required for the acceleration phase, and assume the answer to #1 is still 5 m/s.)

a) 0.096 s **b) 0.101 s** c) 0.223 s d) 0.307 s

You could get the time of this part of the flight several ways: 1) use your knowledge of the final velocity from problem 2 and use the velocity equation; or 2) use the distance equation and solve a quadratic. The first way is easy, so I'll do it the second way.

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$
$$0.5 = 0.002 + 5t + \frac{1}{2}(-1.62)t^2$$
$$0.81t^2 - 5t + 0.498 = 0$$
$$t = 0.101s \;\; or \;\; 6.07s$$

The earlier time is the one you want. The later time assumes the froghopper flew freely in the air and came back down to a height of 0.5 m.

4. Pretend the answer to #2 is also 5 m/s. Suppose he bounces off the top of the cage and heads back downward with a speed of 1.50 m/s. If this bounce takes 0.04 s, what average acceleration did the bounce cause? Assume positive is upward.

a) -89 m/s^2 b) -125 m/s^2 **c) -163 m/s^2** d) -204 m/s^2

$$a_{avg} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{\Delta t} = \frac{-1.5 - 5}{0.04} = -162.5\frac{m}{s^2}$$

5. He now returns to the ground. How long does this downward flight take?

a) 0.175 s **b) 0.288 s** c) 0.312 s d) 0.455 s

$$x = x_0 + v_0 t + \frac{1}{2}at^2$$
$$0 = 0.5 + (-1.5)t + \frac{1}{2}(-1.62)t^2$$
$$0.81t^2 + 1.5t - 0.5 = 0$$
$$t = 0.288s \;\; or \;\; -2.14s$$

Some possibly useful equations for 1-dimensional motion with constant acceleration:

$$a_{avg} = \frac{\Delta v}{\Delta t} \quad v = v_0 + at \quad x = x_0 + v_0 t + \frac{1}{2}at^2 \quad v^2 - v_0^2 = 2a(x - x_0)$$
$$To\, solve\;\; Ax^2 + Bx + C = 0,\; x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$