Physics 221

Quiz 4 — chapters 3 and 4, Form: A

Name: _____

Date: _____

Section 1. Force of a spring

1. A 0.25-kg object hangs in equilibrium from a vertically oriented spring. You measure that it stretches 0.2 m. Use the momentum principle to calculate the stiffness k of the spring.

2. Suppose you lift upward on the object and hold it steady so that the spring is only stretched 0.05 m from its unstretched length. Use the momentum principle to calculate the force of your hand on the object?

3. If you release the object from rest, it will oscillate. What will be the amplitude, period, angular frequency, and phase of the oscillation? Write the equation that describes the vertical position as a function of time $y(t)$ if y=0 is defined to be the equilibrium position.

Section 2. Energy principle

4. A tennis player wants to toss a 0.057-kg tennis ball into the air so that it rises to a maximum height of exactly 1.7 m. Define the ball to be a "particle" and apply the energy principle to the ball to find the initial speed of the ball, as the ball leaves her hand.

5. While the ball is in her hand, she exerts a constant upward force on the ball as it speeds up from rest to the speed it has when it leaves her hand. If her hand exerts a force on the ball through a displacement of $< 0, 0.5, 0 >$ m, what is the force of her hand on the ball?

6. What is the kinetic energy of a proton moving at a speed of $0.9c$? The mass of a proton is 1.7×10^{-27} kg.

Answer Key for Exam A

Section 1. Force of a spring

1. $\vec{F}_{net} = \Delta\vec{p}/\Delta t = 0$
   $\vec{F}_{grav} + \vec{F}_{spring} = 0$
   $< 0, ks, 0 >= - < 0, -mg, 0 >$
   $k = mg/s$

2. $\vec{F}_{net} = \Delta\vec{p}/\Delta t = 0$
   $\vec{F}_{grav} + \vec{F}_{spring} + \vec{F}_{spring} = 0$
   $\vec{F}_{hand} = - < 0, ks, 0 > - < 0, -mg, 0 >$
   $\vec{F}_{hand} =< 0, mg - ks, 0 >$

3. $A = 0.15m$
   $\omega = \sqrt{k/m} = 7rad/s$
   $T = 2\pi/\omega = 0.90s$
   $y_0 = Acos(\phi) = 0.15$ thus, $\phi = 0$
   $y(t) = 0.15cos(7t)$ m

Section 2. Energy principle

4. $W = \Delta E = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$ for low speeds and no change in rest energy
   $\vec{F}_{grav} \cdot \Delta\vec{r} = -mg\Delta y = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$
   $v_f = \sqrt{2g\Delta y}$

5.

6. $K = E - mc^2 = mc^2/\sqrt{(1 - v^2/c^2)}$