Wake up and spring your name on this paper: Key

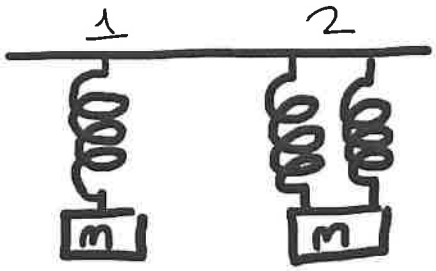
AP Physics C: 5.4 Spring Energy

1. You learned 3 types of energy in this chapter. Write them all down with their formulas.

2. Work can be calculated two different ways. Write down each formula.

3. What does the negative derivative of potential energy calculate?

4. Below are two blocks that each have a mass m=2kg. Except one block is hanging from one spring with a spring constant of k=0.4, while the other block is hanging from 2 springs both, with a spring constant k=0.4. Answer the following questions.



   a. Which block would require more energy to pull down a distance 0.7-meters?

      _____Left ____Right ____Same

   b. Calculate how much energy it would require to pull down each mass a distance 0.7-meters.

$U_1 = \frac{1}{2}(.4)(.7)^2 = .098J$ $U_2 = \frac{1}{2}(.4)(.7)^2 + \frac{1}{2}(.4)(.7)^2 = .196J$

   c. Calculate the max velocity of each mass.

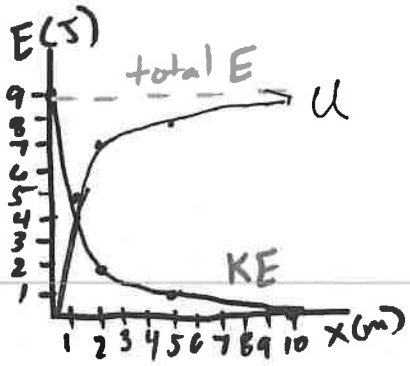
$U = K$

$\frac{1}{2}(.4)(.7)^2 = \frac{1}{2}(2)(v^2) \Rightarrow v = .313 m/s$ | $U = K$ $.196 = \frac{1}{2}(2)(v^2) \Rightarrow v = .442 m/s$

5. The force by a spring is given by the function $F = 3x^2 - 5$, calculate the potential energy of the spring in the first 1.2 meters.

$$U = \int_0^{1.2} 3x^2 - 5\,dx = -4.27J$$

6. To the right is a graph of the KE of a ball as it rolls up a hill. If the ball has a mass of 2.5-kg, answer the following questions,



   a. Calculate the max speed of the ball.

$\frac{1}{2}(2.5)v^2 = 9$

$v = 2.68 m/s$

   b. Sketch a graph of what the potential energy would be.

   c. Calculate the height of the hill.

$U = mgh$

$9 = (2.5)(9.8)h$

$h = .367m$

Wake up and spring your name on this paper:_____

7. A spring with a spring constant of k has a mass of M attached to the end of it. The spring is compressed and released at a maximum displacement of D.
   a. Calculate the maximum velocity of the mass as it passed through the equilibrium in the variables given. $U = K$

$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \rightarrow kx^2 = mv^2$

$v = \sqrt{\frac{kx^2}{m}}$

   b. If half the energy was lost through one cycle how do you believe the velocity of the mass would change.

_____more than double _____double _____same _____half _____less than half

   c. The mass is attached to the spring so it comes back through the equilibrium after being extended. If the spring loses half its energy through the cycle, what will be the velocity of the mass as it goes through the equilibrium the second time?

$\frac{1}{2}\left(\frac{1}{2}kx^2\right) = \frac{1}{2}mv^2$

$\frac{1}{4}kx^2 = \frac{1}{2}mv^2 \rightarrow \frac{1}{2}kx^2 = mv$

$\sqrt{\frac{kx^2}{2m}} = v$

changed by $\sqrt{\frac{1}{2}}$

8. The potential energy of a spring is $U(x) = 0.5x^3$, calculate the force at x=4 meters.

$F = -\frac{dU}{dx}$ $F = -1.5x^2$ $F(4) = -1.5(4)^2 = -24\,N$

9. The potential energy of a spring is given by the function $U(x) = 5x^4 - x + 4$, at x=0 the kinetic energy is 6 J. Answer the following questions,
   a. Calculate the total energy of the system.

$U_0 = 5(0)^4 - (0) + 4 = 4\,J$

$K_0 = 6\,J$

$U_0 + K_0 = 10\,J$

   b. Calculate the Kinetic Energy of the mass at x=1.

$U(1) = 5(1)^4 - (1) + 4 = 8\,J$

Total − Potential @ x=1 = 10 − 8 = 2 J

   c. If there is a 2.1-kg mass attached to the end of the spring, calculate the speed of the block at x=1.

$2 = \frac{1}{2}mv^2$

   d. Is the force acting on the object positive or negative at x=1?

_____positive __X__negative _____zero

$F = -\frac{dU}{dx}$

$F = -(20x^3 - 1)$

$F(1) = -(20(1)^3 - 1)$

$= -19$

Explain your reasoning.

Force is the negative derivative of potential.