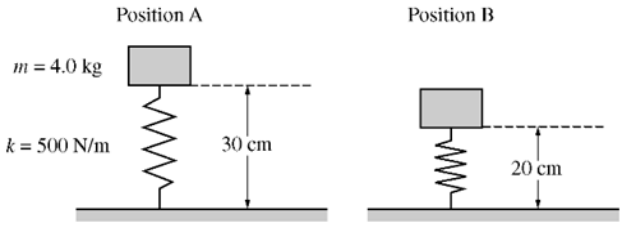
AP Physics 1 Name: _____

Unit 7 Quest: Oscillations

**Directions:** You must show your work for credit on mathematical problems and clearly explain your reasoning in complete sentences on written questions.

1. A pendulum has a period of 2 s on Earth. The same pendulum has a period of 4 s on planet Ocelot. Find the acceleration due to gravity on planet Ocelot.

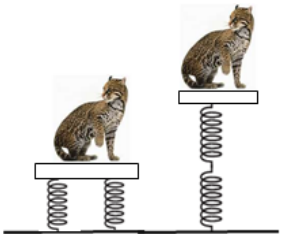
2. A person holds a 4.0 kg block at position A shown on the left, in contact with an uncompressed vertical spring with a spring constant of 500 N/m. The person gently lowers the block from rest at position A to rest at position B.




a) Calculate the change in energy between positions A and B.

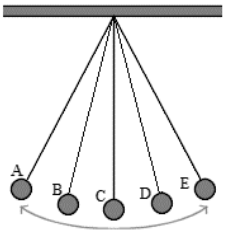
b) Does the person do positive or negative work on the block? How can you tell?

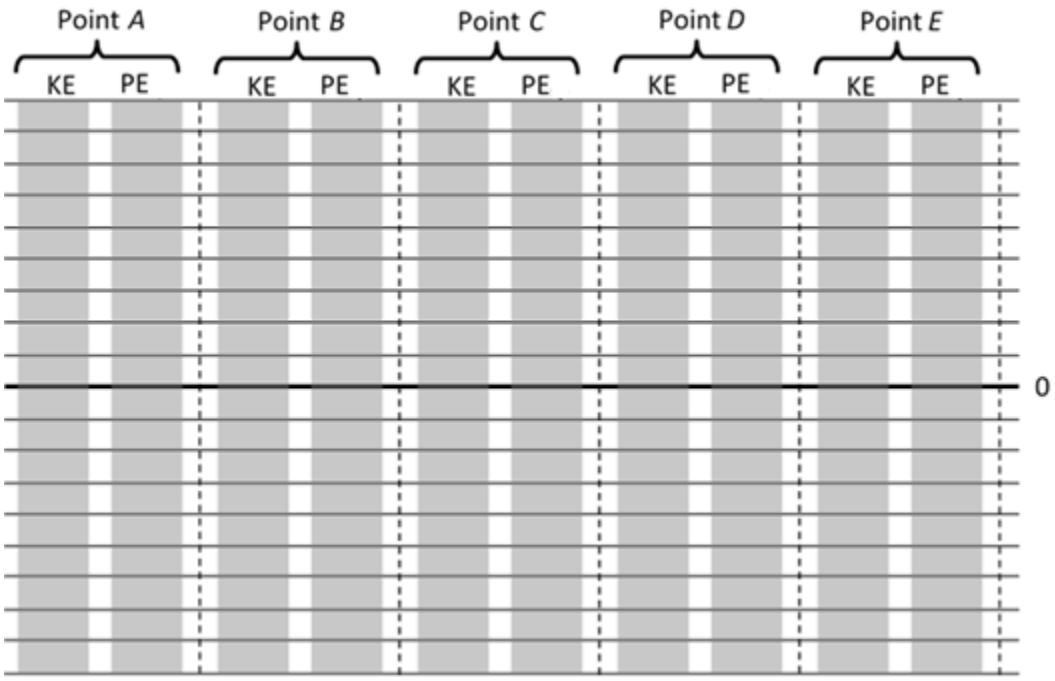
3. An ocelot aspires to oscillate. The 40 kg ocelot has 2 identical springs of spring constant 500 N/m and can connect them in series or parallel in order to oscillate.
a) How should the springs be connected, in series or parallel, in order to maximize the frequency of oscillation? Justify your answer.



b) Find the frequency of oscillation for the configuration you chose.

4. A pendulum swings in period motion as shown. Points A, B, C, D, and E are points on the motion, with A and E occurring when the pendulum switches directions and point C being an equilibrium point.
a) Sketch qualitative energy bar graphs of the potential and kinetic energy at each point.

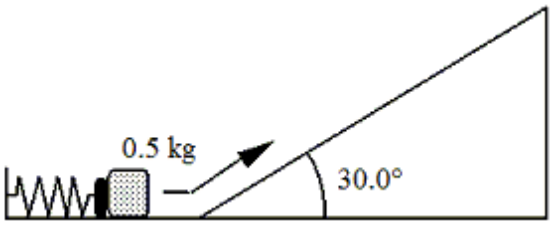



b) identify a part of the pendulum's motion when its acceleration and velocity are in the same direction.

5. A spring with constant $k$ = N/m is at the base of a frictionless, 30.0°-inclined plane. A 0.50-kg block is pressed against the spring, compressing it 0.20 m from its equilibrium position. The block is then released.

a) If the block is not attached to the spring, how far up the incline will it travel before it stops?



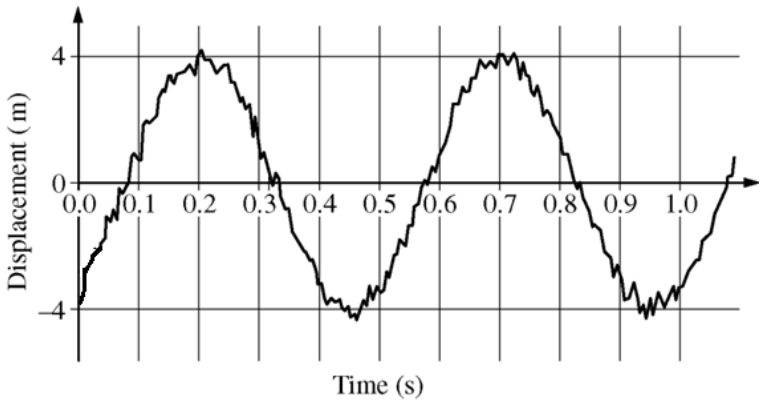

b) The block falls downhill after reaching max height and then the spring pushes it back uphill, and oscillates up and down hill due to the spring at the bottom. Is this simple harmonic motion? Justify your answer.

6. A hollow soccer ball off mass M and radius R rolls without slipping across a horizontal surface. It sticks to and compresses a spring that is initially unstretched. The spring has a constant K and the soccer ball is a hollow sphere with $I = \frac{2}{5}mr^2$.


a) Calculate the amplitude of the resulting oscillation.

b) Would a solid sphere with the same mass and radius going the same initial speed cause the amplitude to greater than, less than, or equal to the value form a). Justify your answer.

7. A spring is displaced from equilibrium and allowed to oscillate in order to make an AP Physics 1 test question. The data for the spring's oscillation is in the graph on the right.




a) Write the approximate equation for the spring's position, x(t), as a function of time.

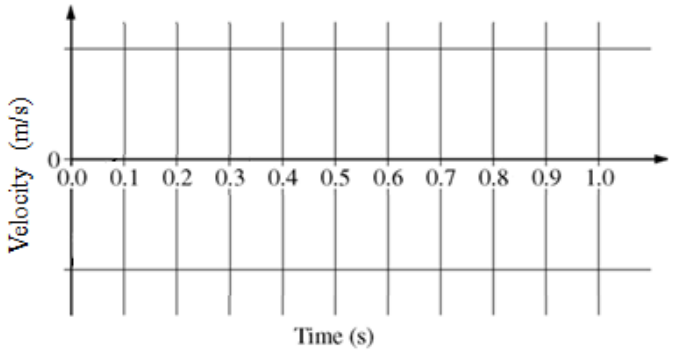
b) The mass at the end of the spring is 4.0 kg. Estimate the following values:

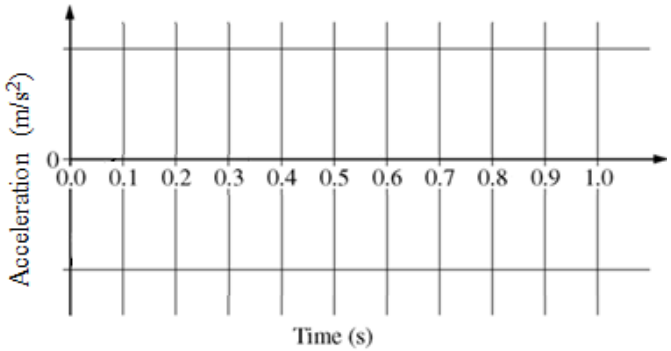
i. The spring constant.

ii. The maximum velocity of the spring.

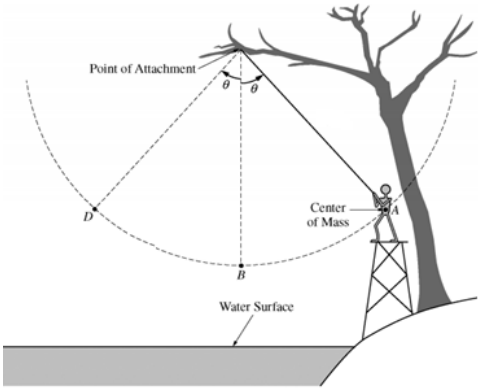
iii. The maximum acceleration of the spring.

c) One the graphs below, graph the velocity and acceleration vs. time for the spring's motion. Label any maxes or mins.



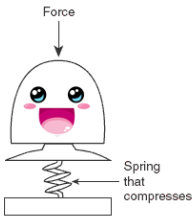
8. Starting from rest at point A, a 50 kg person swings along a circular arc ($\theta = 30°$) from a rope attached to a tree branch over a lake, as shown in the figure above. Point D is at the same height as point A.
a) The person swings from the rope. It takes 1.0 s for the person to reach point D (starting from point A). What is the length of the rope?




b) Using the length of the rope you found in part b), calculate tension in the rope at point B.

c) Suppose the person were to let go at point B. If point B is 1 m above the water, calculate how far they would travel before hitting the water.

Bonus: Planet QQ has twice the radius of Earth and four times the mass of Earth. On planet QQ, a spring toy has a mass of 20 grams and a spring constant of 150 N/m. A force is applied that compresses the spring 50 cm. Find the height maximum obtained by the toy. Neglect any air friction.

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