AP Physics 1 Name: _____

Unit 7 Quest: Oscillations

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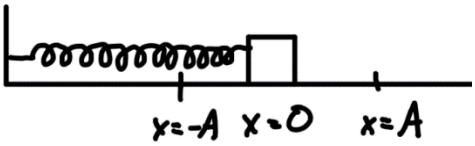
1. The second hand of a watch goes around a complete circle every minute. This is an example of periodic motion. Is this also an example of simple harmonic motion? Justify your answer.

2. A block on a horizontal frictionless plane is attached to a spring, as shown above. The block oscillates along the x-axis with simple harmonic motion of amplitude A. Consider the motion of the block as it travels from position x = +A to position x = -A (towards the left).

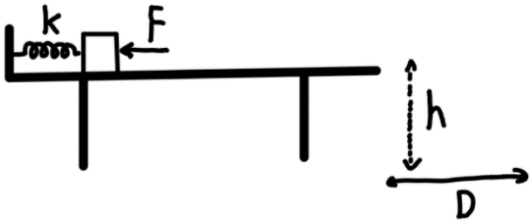


a) At which point(s) does the block experience the greatest velocity?

b) At which point(s) does the block experience the greatest magnitude in the rate of change of its momentum?

c) Describe how the acceleration (magnitude and direction) change as the block moves from +A to -A.

3. In the figure shown on the right, a force of magnitude F = 45 N compresses a spring with an elastic constant equal to k = 90 N/m. A block of mass m = 0.5 kg is in contact, but not attached to, the spring.



a) Calculate how far the spring is compressed.

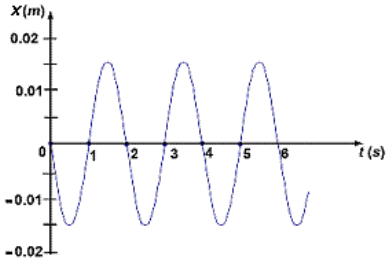
b) Does the force F exerted on the spring do positive, negative, or zero work? Justify your answer.

After the spring fully compresses, the force is released and the spring is allowed to decompress. The block is on a frictionless table and leaves the table at a height of h = 1.0 m above the ground.

c) Calculate the speed of the block when the spring has decompressed half the way.

d) Calculate the horizontal distance D that the block travels before hitting the ground.

4. 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 3.0 kg. Estimate the following values:

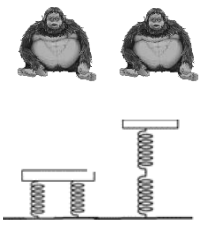
i. The spring constant.

ii. The maximum velocity of the spring.

iii. The maximum acceleration of the spring.

c) Graph the velocity and kinetic energy vs. time for the spring's motion. Label any maxes or mins.

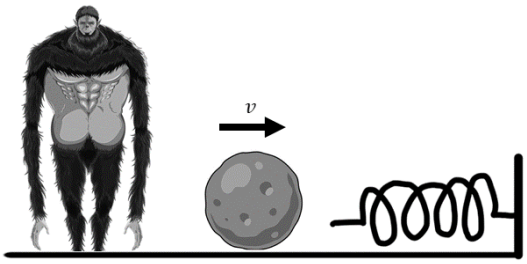
5. A monkey of mass m = 80 kg is dropped from a a height of h = 10 m above a spring. The monkey lands on two identical springs. The two springs (each of k = 100 N/m) can be arranged in series or parallel, as shown.



a) In which arrangement will the monkey oscillate with a greater period? Justify your answer.

b) Using your arrangement from a), calculate the frequency of oscillation.

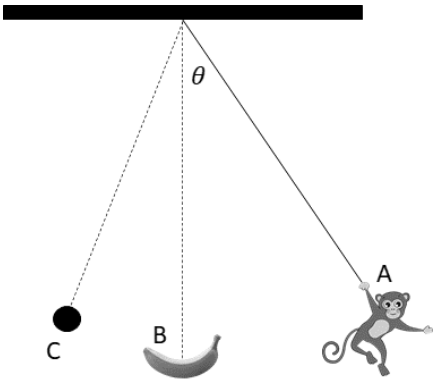
6. The Monkey Titan rolls a boulder of mass M=12.0 kg and radius R = 2.7 m without slipping across a horizontal surface. It sticks to and compresses a spring that is initially unstretched. The spring has a constant K = 80 N/m and the boulder ll is a roughly solid, with $I = \frac{3}{7}mr^2$. The bowling ball approaches the spring with a linear speed of v = 40 m/s.



a) Calculate the amplitude of the resulting oscillation.

b) Would a hollow boulder 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 monkey of mass M = 20 kg swings from a rope a shown. The monkey is released from point A, at which point, the rope makes an angle of $\theta = 22°$ with the vertical as shown. At point B, the monkey collides perfectly inelastically with a banana of mass m = 2.0 kg. The monkey/banana system then swings past point B and reaches a maximum displacement on the other side at point C. Before colliding with the banana at point B, the monkey has reached a velocity of 11 m/s.



a) Calculate the length of the string.

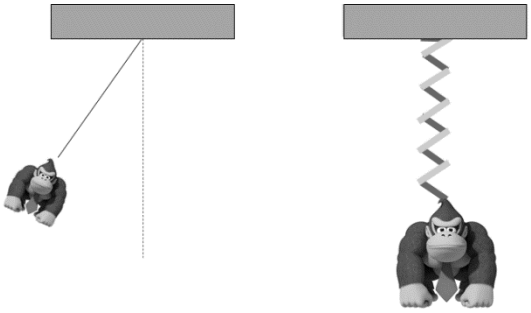
b) Calculate the tension in the rope right before the monkey collides with the banana.

c) Calculate the speed of the monkey after colliding with the banana.

d) Calculate the time it takes the monkey to swing from A to B.

e) Is the time it takes the monkey/banana system to swing from B to C greater than, less than, or equal to your answer from part d)? Justify your answer.

8. Donkey Kong oscillates on Earth in two cases. He oscillates at the end of a pendulum on Earth, with a period of T_P. He also oscillates at the end of a spring, with a period of T_s. Both systems, the pendulum and spring, are then brought to the planet Monke, which has half of Earth's gravity.



a) Determine an expression for the period of the pendulum system on Monke in terms of T_P.

b) Determine an expression for the period of the spring system on Monke in terms of T_s.