***\*\*Please consider significant figures and draw visual graphics\*\****

**Conceptual Questions:**

* In the figure below, the shadow moves in simple harmonic motion. Where on the shadow’s path is (a) the velocity (v) equal to zero and (b) the acceleration (a) equal to zero?

*\*\*Please note that the velocity (v) and acceleration (a) have the same illustration, in this case I just draw the illustration for velocity (not the acceleration. I suggest that after solving for the velocity, replace the velocity with the acceleration \*\**

a

V

Film

X =0 m m

**VX**

**VT**

**VX**

+x

LIGHT

*Additional information for velocity and acceleration*

* *The velocity vx of the ball’s shadow is the x component of the tangential velocity VT of the ball on the reference circle.*

*--and--*

* *The acceleration ax of the ball’s shadow is the x component of the centripetal acceleration ac of the ball on the reference circle.*
* A block is attached to a horizontal spring and slides back and forth in simple harmonic motion on a frictionless horizontal surface. A second identical block is suddenly attached to the first block. The attachment is accomplished by joining the blocks at one extreme end of the oscillation cycle. The velocities of the blocks are exactly matched at the instant of the joining. Explain how (a) the amplitude, (b) the frequency, and (c) the maximum speed of the oscillation change.
* A particle is oscillating in simple harmonic motion. The time required for the particle to travel through one cycle is equal to the period of the motion, no matter what the amplitude is. But how can this be, since larger amplitude mean that the particle travels further? Explain.
* Is more elastic potential energy stored in a spring when the spring is compressed by one centimeter than when it is stretched by the same amount? Explain.

**Problems**

***The Ideal Spring and Simple Harmonic Motion***

* A hand exerciser utilizes a coiled spring. A force of 89.0 N is required to compress the spring by 0.0191 m. Determine the force needed to compress the spring by 0.0508 m.
* A 0.70-kg block is hung from the and stretches a spring that is attached to the ceiling. A second block is attached to the first one, and the amount of the spring stretches from its unstrained length triples. What is the mass of the second block?

***Simple Harmonic Motion and the Reference Circle***

* (Illustrates the concepts pertinent to this problem) 0.80 kg object is attached to one end of a spring, as in the figure below, and the system is set into simple harmonic motion. The displacement x of the object as a function of time is shown in the drawing. With the aid of these data, determine (a) the amplitude *A* of the motion, (b) the angular frequency , (c) the spring constant *K*, (d) the speed of the object at *t* = 1.0 s, and (e) the magnitude of the object’s acceleration at *t* = 1.0 s.

X (m) ((0cc(((m(m

0.080

2.0 4.0

0

Time (s)

1.0 3.0

-0.080

* A person bounces up and down on a trampoline, while always staying in contact with it. The motion is simple harmonic motion, and it takes 1.90 s to complete one cycle. The height of each bounce above the equilibrium position is 45.0 cm. Determine (a) the amplitude and (b) the angular frequency of the motion. (c) What is the maximum speed attained by the person?

***Energy and Simple Harmonic Motion***

* An archer pulls the bowstring back for a distance of 0.47 m before releasing the arrow. The bow and the string acts like a spring whose spring constant is 425 N/m. (a) What is the elastic potential energy of the drawn bow? (b) The arrow has a mass of 0.0300 kg. How fast is it traveling when it leaves the bow?
* A spring is hung from the ceiling. 0.045 kg block is then attached to the free end of the spring. When released from rest, after which it moves back upward. (a) What is the spring constant of the spring? (b) Find the angular frequency of the block’s vibrations.
* A rifle fires a 2.10 x 10**-2** kg pellet straight upward, because the pellet rests on a compressed spring that is released when trigger is pulled. The spring has a negligible mass and is compressed by 9.10 x 10**-2** m from its unstrained length. The pellet rises to a maximum height of 6.10 m above its position on the compressed spring. Ignoring air resistance, determine the spring constant.
* A vertical spring with a spring constant of 450 N/m is mounted on the floor. From directly above the spring, which is unstrained, a 0.30 kg block is dropped from rest. It collides with and sticks to the spring, which is compressed by 2.5 cm in bringing the block to a momentary halt. Assuming air resistance is negligible; from what height (in cm) above the compressed spring was the block dropped?
* A 3.2 kg block is hanging stationary from the end of a vertical spring that is attached to the ceiling. The elastic potential energy of the spring/mass system is 1.8 J. What is the elastic potential energy of the system when the 3.2 kg block is replaced by a 5.0 kg block?
* A 1.00 x 10**-2** kg block is resting on a horizontal frictionless surface and is attached to a horizontal spring whose spring constant is 124 N/m. The blocked is shoved parallel to the spring axis and is given an initial speed of 8.00 m/s. while the spring is initially unstrained. What is the amplitude of the resulting simple harmonic motion?