CHAPTER 13 Review

REFLECTING ON CHAPTER 13

- Simple harmonic motion is the motion of an object that is influenced only by a linear restoring force.
- A mass on a spring is a model for any object that is vibrating or oscillating in simple harmonic motion.
- The mathematical description of the shadow of a marker undergoing uniform circular motion is identical to the mathematical description of simple harmonic motion.
- The equation for the period of a mass on a spring is $T = 2\pi\sqrt{\frac{m}{k}}$.
- The motion of a simple pendulum is not precisely simple harmonic motion. However, if the angle between the position of the pendulum and the vertical never exceeds 15˚, the motion approximates simple harmonic motion to within less than 1% error.
- The equation for the period of a pendulum is $T = 2\pi\sqrt{\frac{\ell}{g}}$.
- The graphs of position, velocity, and acceleration of an object undergoing simple harmonic motion are sinusoidal curves.
- The equation describing position as a function of time for simple harmonic motion can be written, $x = A\sin\frac{360^\circ}{T}t$.
- The equation describing velocity as a function of time for simple harmonic motion can be written, $v = A\sqrt{\frac{k}{m}}\sin\frac{360^\circ}{T}t$.
- The equation describing acceleration as a function of time for simple harmonic motion can be written, $a = -A\left(\frac{k}{m}\right)\sin\frac{360^\circ}{T}t$.

Knowledge and Understanding

1. Explain what determines whether a form of periodic motion is simple harmonic motion.
2. Why is Hooke's law associated with simple harmonic motion?
3. Why is there a large emphasis on the motion of a mass oscillating on the end of a spring?
4. In the determination of the period of a mass and spring system, you developed an equation for the velocity of the mass relative to its position. Explain how this information was used?
5. Describe the relationship between simple harmonic motion and uniform circular motion.
6. Given that the frequency of a vibrating object in the inverse of the period, $f = \frac{1}{T}$, write the equation for the frequency of a mass and spring system.
7. Explain why pendulums are associated with clocks.
8. What is the source of the restoring force for the mass and spring system?
9. What is the source of the restoring force for the pendulum?
10. Explain how uniform circular motion was involved in the development of an equation relating position and time for a mass and spring system.
11. How did you establish a relationship between velocity and position in order to develop an equation for velocity versus time for a mass and spring system?
12. How did you find a relationship between acceleration and position in order to develop an equation for acceleration versus time for a mass and spring system?

Inquiry

13. Design an experiment that would allow you to determine the percent error for the period that would result from making the angle of the motion of a pendulum greater than 15˚.
14. Your lab partner tells you that a certain spring does not obey Hooke's law if it is stretched

more than 12 cm. Design an experiment using only one mass, that would allow you to test your partners statement.

Communication

15. Explain why a pendulum does not precisely follow simple harmonic motion.

16. Imagine that you are pushing a child on a swing and the child wants to go higher. Explain how you would achieve that change in motion. Imagine that the child wanted to go back and forth more frequently. Could you provide the motion that the child requested? Explain why or why not.

17. Explain, qualitatively, why a larger mass would have a longer period than a smaller mass on the same spring.

18. Imagine that a pendulum clock was running slowly. If you were adjusting the effective length of the pendulum to make the clock more accurate, would you make the pendulum longer or shorter? Explain your reasoning.

19. You crash landed your space ship on an unknown planet. You have a stopwatch, a ball of string and a candy bar. Explain how you would use those items to determine the acceleration due to gravity on the planet.

Making Connections

20. Suppose that you read about infrared spectroscopy being used to determine the presence of a certain compound in a solution containing many compounds. Do research to find out how this is possible and how the concept of vibrations or simple harmonic motion might be related to infrared spectroscopy.

21. Do research to find out how a seismograph works.

Problems for Understanding

22. You have three objects with masses of 145 g, 212 g, and 430 g. You also have two springs with force constants of 95.0 N/m and 256 N/m. Find all of the possible periods of oscillation that you could produce with these springs and masses.

23. A mass of 0.055 kg attached to a spring oscillates with a period of 0.10 s. If you attach a 1.25 kg mass to the same spring, what will be the period of oscillation?

24. You measure the period of an 864 g mass on a spring to be 0.64 s. You then stretch the spring a distance of 14 cm and release it.
(a) What will be the total energy of the spring and mass system?
(b) What will be the maximum velocity of the mass?

25. A mass of 0.36 kg is oscillating on the end of a spring. Its maximum velocity is 21.2 m/s.
(a) What is the total energy of the spring and mass system?
(b) If the maximum amplitude of the motion is 45 cm, what is the force constant of the spring?
(c) What will be the period of the motion?

26. A 55 kg bungee jumper attached to a bungee cord jumps off a bridge. After reaching his lowest point, he bounces through exactly 6.0 full cycles in 42 s. What is the force constant of the bungee cord?

27. You have determined that a 0.81 kg mass oscillates with a period of 0.12 s. If you exactly tripled the mass, what would the new period be?

28. What would the length of a pendulum have to be in order to have a period of 0.25 s?

29. You have a 345 g mass oscillating on a spring with a force constant of 35 N/m. What would be the length of a pendulum that had the same period as the spring and mass system?

30. A 785 g mass is oscillating on the end of a spring having a spring constant of 63 N/m. If the amplitude of the motion is 18 cm, what would be the velocity of the mass at the instant that it was 6.0 cm from its equilibrium position?