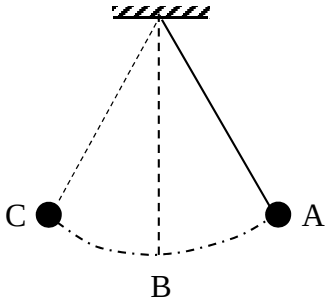
**PHYS 1200 Physics of Everyday Experience**

**Review questions and exercises for Lecture 20 (V&W-1)**

1. What physical process was involved with the collapse of the Tacoma Narrows bridge?
2. What is a harmonic oscillator?
3. What is meant by a "restoring" force?
4. What are the definitions of the period and frequency of a harmonic oscillator, and how are they related?
5. What does the pendulum not stop when it reaches its lowest point?
6. The pendulum shown in the figure is released from rest at point A.

   What type(s) of energy does it have at:

   (a) point A (b) point B (c) point C

   (d) between A and B

   (e) between B and C
7. If the period of a pendulum is 4 s, what is its frequency?
8. If the frequency of a harmonic oscillator is 10 Hz, what is its period?
9. When a mass of 2 kg is hung from a spring, it stretches by 10 cm. What is the spring constant, k for this spring?
10. The period of a pendulum that has a length L = 1 m is 5 s. What would the period of this pendulum be if L = 4 m?
11. How would the period of a mass-spring system change if the spring were replaced by another one having a spring constant that is 9 times smaller than the original spring?
12. A pendulum has a period of 12 s. How many complete cycles would this pendulum execute in one minute?

Answers and Solutions:

1. Resonance
2. A harmonic oscillator is a system whose motion is repeated at regular time intervals.
3. A restoring force is a force that always acts in a direction to bring a system back to its equilibrium position.
4. The period of an oscillator is the time it takes to complete one full cycle. The frequency of an oscillator is the number of full cycles it completes every second. T and f are reciprocals,

   T = 1/f, f = 1/T.
5. At the bottom of its swing, the pendulum is moving, so its inertia prevents it from stopping.
6. (a) PE (B) KE (C) PE (d) KE + PE (e) KE + PE
7. f = 1/T = ¼ s = 0.25 Hz
8. T = 1/f = 1/10 Hz = 0.1 s
9. The mass is in equilibrium under the action of its weight mg which is downward, and the upward spring force ky, where y is the amount by which the spring was stretched.

   → mg = k y → k = mg/y = (2 kg x 10 m/s$^2$) / 0.1 m = 200 N m. (y must be in m)
10. The period of a pendulum is proportional to the square root of the length, $T \propto \sqrt{\frac{L}{g}}$.

    If the length increases by a factor of 4, the period increases by a factor of 2. The new period will be 10 s.
11. The period of the mass-spring system is inversely proportional to the square root of the spring constant, $T \propto \sqrt{\frac{m}{k}}$. If k decreases by a factor of 9. Then T will increase by a factor of 3.
12. In 60 s, a pendulum with a period of 12 s would execute 5 complete cycles.