15-Series Problem

15.1) A spring with a 130 N/m spring constant is set up to move freely over a horizontal, frictionless surface. A 0.60 kg mass is attached to the spring, which is then displaced a distance 0.130 m. Just as the block is released:

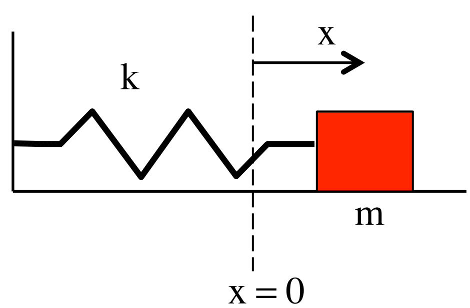
a.) What is the force on the block due to the spring?
b.) What is the block's acceleration?

15.3) When a 10.0 gram mass is attached to a vertical, ideal spring and the spring allowed to SLOWLY elongate, it displaces 3.90 centimeters before coming to rest. If the mass is then replaced by a second mass of 25.0 grams and made to oscillate (it will move in simple harmonic motion), what will be its period of oscillation?

15.5) A particle has a position function defined by $x = 4.00\cos(3\pi t + \pi)$ meters, where *t* is in seconds.

a.) What is the particle's frequency?
b.) What is the particle's period of oscillation?
c.) What is the particle's amplitude of motion?
d.) What is the motion's phase constant?
e.)Where is the particle at t = 0.250 seconds?

15.9) An ideal spring is hung from the ceiling with a 7.00 kg mass attached to it. If the system's oscillatory period is 2.60 seconds, what is the spring's spring constant?



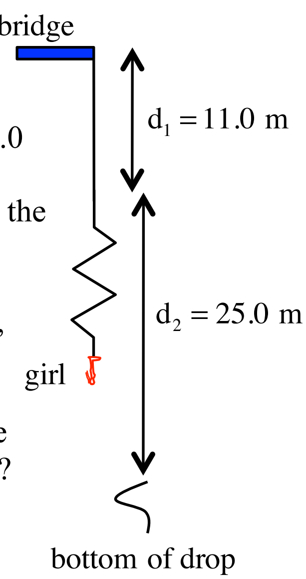
15.13) At t = 0, a mass attached to a spring moves in the x-direction and passes through the origin and into the positive region. Its frequency is 1.50 Hz and its amplitude 2.00 cm.

a.) Write out the function for the mass's position as a function of time.
b.) Determine the mass's maximum speed.
c.) At what point in time (greater than zero) does the mass first reach this maximum speed.
d.) Determine the mass's maximum acceleration.
e.) At what point in time (greater than zero) does the mass first reach this maximum acceleration.
f.) How far, total (i.e., the total distance), does the mass travel between t = 0 and t = 1.00 seconds?

15.17) Assume no mechanical energy is lost to heat or deformation or sound as a 1,000 kg car runs into a wall. How fast must the car be moving if its bumper, acting like an ideal spring of spring constant $5.00\text{x}10^6$ N/m, compresses 3.15 cm upon impact as the car comes to rest?

15.19) A spring with spring constant 35.0 N/m has a 50.0 gram mass attached to it. The system oscillates in the horizontal on a frictionless surface. Its amplitude is 4.00 cm.

a.) What is the total energy wrapped up in the system?
b.) How fast is the object moving when its displacement from equilibrium is 1.00 cm?
c.) What's the object's kinetic energy when at 3.00 cm?
d.) What's the object's potential energy when at 3.00 cm?



15.22) A 65.0 kg bungee jumper dives off a bridge, free falls for the 11.0 meters that is the length of the unstretched bungee cord, then executes simple harmonic motion, oscillating over the remaining 25.0 meters of the run (her lowest point is 36.0 meters below her take-off point). Ignoring the mass of the cord:

a.) What is the appropriate analytical model for analyzing her motion during the free fall part?
b.) Determine how long she is in free fall?
c.) During the simple harmonic part of the run, is the jumper, the spring (i.e., the cord) and the Earth an isolated or non-isolated system?
d.) Determine the spring constant for the cord/spring.
e.) At what point is the gravitational force on the jumper and the spring force due to the cord equal (i.e., where is the equilibrium point for the system)?
f.) Determine the oscillation's angular frequency.
g.) How long did it take for the cord to stretch 25 meters (i.e., half a cycle)?
h.) Determine the total time for the entire 36.0 meter drop.

15.31) A 1.00 m long simple pendulum of mass 0.250 kg is displaced by 15° and released. Assuming its motion is simple harmonic in nature:

a.) Determine the bob's maximum speed.
b.) Determine the bob's maximum angular acceleration.
c.) Determine the maximum restoring force on the bob.
d.) Solve *Parts a* through *c* without resorting to what you know about simple harmonic motion. That is, use energy considerations to determine the maximum speed, Newton's second rotational style to determine the angular acceleration, and tangential force on the bob to determine the maximum restoring force.

15.33) Consider a 5.00 m long simple pendulum.

a.) If the pendulum was hung in an elevator that was accelerating upward at $5.00\ \text{m/s}^2$, what would its small-oscillation period be?
b.) If the pendulum was hung in an elevator that was accelerating downward at $5.00\ \text{m/s}^2$, what would its small-oscillation period be?
c.) If the pendulum was hung in an enclosed truck that was accelerating horizontally at $5.00\ \text{m/s}^2$, what would its small-oscillation period be?