A Thing on a Spring:
Transition Problem #1 of 2

PHYSICS 204:

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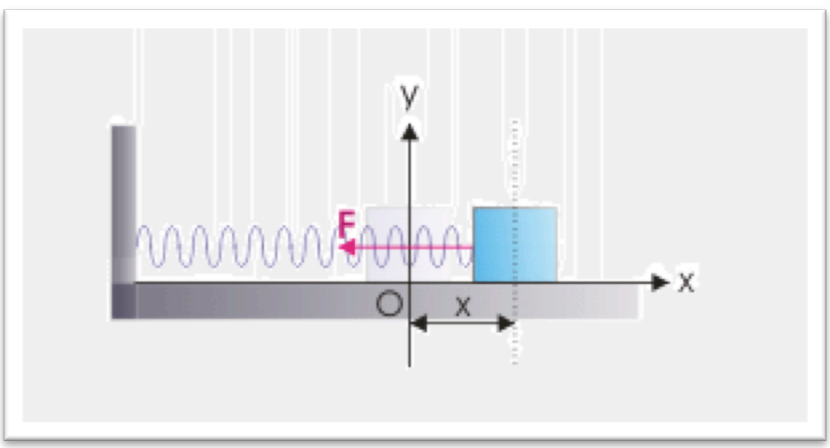
A mass is fixed to one end of a horizontal spring. The other end of the spring is fixed to a wall. The spring is "ideal": Its mass is insignificant when compared to that of the mass, it is coiled tightly and it is far longer than any distance the mass will ever move. The spring, that is, obeys Hooke's Law.



The mass is 300 grams (.3 kg). The spring has a stiffness given by the constant K = 200 Newtons/meter. The mass is initially displaced 15 cm (.15 m) from equilibrium. It is held at rest and then RELEASED. The mass therefore starts traveling in—toward the equilibrium position. The equilibrium position is designated x = 0 m.

1. In meters/sec, at what ***instantaneous speed*** does the mass travel through the equilibrium position?

2. In meters, at what ***position*** does the mass achieve an instantaneous speed of 3 meters/sec?

3. In meters, ***how far*** will the mass compress the spring once the mass has instantaneously stopped and is about to reverse direction?

4. Assuming that the amount of friction is too small to make a measurable difference, ***how many*** indistinguishable cycles can this mass complete until it is incapable of moving?

5. As the mass travels from 15 cm toward the equilibrium, what happens to the ***magnitude of*** . . .

   a. The VELOCITY (increase, decrease or remain constant)?

   b. The ACCELERATION (increase, decrease or remain constant)?

   c. The DERIVATIVE of ACCELERATION (i.e. "JERK") (increase, decrease or remain constant)?

6. *** CHALLENGING BUT CENTRAL ***

In meters, *WHERE* will the mass be at precisely t = 1 sec (1 second after it is released from rest)
?

Hint A: Can you use $x = \frac{1}{2} at^2 + v_o t$? Why or why not?

Hint B: Strongly consider the option *why not*.

Hint C: In asking yourself *why not* (if, by chance, you are),
translate the English into English. It's a surprisingly fruitful technique—
particularly if the 'into English' is more specific than the given English:
By asking *why not*, in this case, you are asking yourself:
What particular difficulty impedes our use of
a standard constant-acceleration ***position/time function*** *such as the above?*

Hint D: In strongly considering Hint C, note the term ***constant acceleration***.

HINT E: Ever cure the boredom-blues by re-writing
Hooke's Law as a ***second-order differential equation***?
No way! Me too!