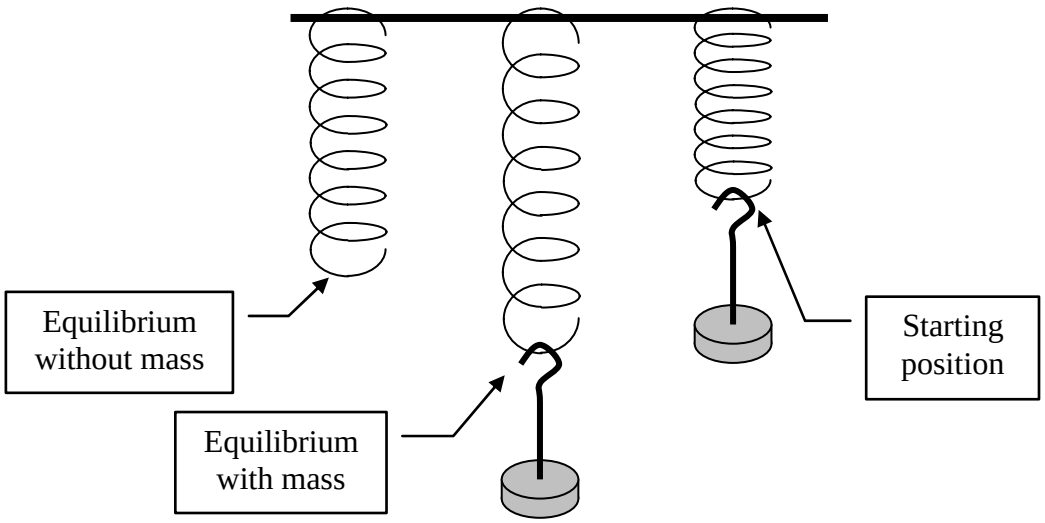
Conservation of Energy:
Springs, Gravity, and Motion



An ideal spring is suspended from a horizontal support and the equilibrium position is measured. When a 100.0 gram mass is suspended from the spring, the spring lengthens by 2.50 cm before coming to rest at a new equilibrium position. The mass is then raised 5.00 cm and released from rest. Assume the mass is firmly attached to the spring so that it is possible to compress the spring beyond the equilibrium position without the spring losing contact with the mass. Also assume the spring is a massless Hooke's law spring.

1. What is the spring constant *k* for this spring? (Work in SI units and assume for the sake of sanity that the acceleration of objects in free fall is 10.0 m/s^2.)

2. When the mass and spring are in their starting position…
    a. What is the kinetic energy of the mass? Do you need to define any constants or adopt any conventions to assign a value to the kinetic energy? If so state your definition.

    b. What is the gravitational potential energy of the mass? Do you need to define a constant or adopt a convention to determine this energy? If so, state your definition.

    c. What is the elastic potential energy in the spring? Do you need to define a constant or adopt a convention to determine this energy? If so, state your definition.

3. Assume there is no friction, or at least that friction is small enough to be ignored. After releasing the mass, what will happen?
    a. Exactly where will the mass be when it is at its maximum speed?

    b. Exactly where will the mass be when it is at its lowest point?

4. Fill in the table below (2 sig figs are fine). *You probably won't be able to fill in the columns in the order that they are listed!* The table lists positions of the mass with up as the positive direction and the origin at the "new equilibrium position" when 100 grams is suspended from the spring. *This is not the equilibrium of the spring!* Your answers from question #2 should help you to fill in the first row.

"x" (m)	v (m/s)	Δx (m) from eq.	U_{grav} (J)	$U_{elastic}$ (J)	K (J)	E (J)
0.050						
0.040						
0.030						
0.020						
0.010						
0.000						
-0.010						
-0.020						
-0.030						
-0.040						
-0.050						

5. When x = 0.040 m, what is x/x_{max}? What is v/v_{max}? What is $\left(\frac{x}{x_{max}}\right)^2+\left(\frac{v}{v_{max}}\right)^2$?

6. When x = 0.030 m, what is x/x_{max}? What is v/v_{max}? What is $\left(\frac{x}{x_{max}}\right)^2+\left(\frac{v}{v_{max}}\right)^2$?

7. Choose another point in the table. What is $\left(\frac{x}{x_{max}}\right)^2+\left(\frac{v}{v_{max}}\right)^2$?