Conservation of Spring and Gravitational Potential Energy Lab

Purpose:

- Determine the value of the spring constant k for a spring
- Investigate the change in gravitational potential energy and the change in spring potential energy for a mass suspended from the spring
- Evaluate the extent to which the changes in energy are equal as the mass oscillates

Materials:

- A spring
- Set of calibrated hooked masses
- Table clamp and support rod
- Ring stand with clamp
- Meter stick

Procedure:

Spring Constant

1. Attach the table clamp to the end of the table and secure a rod so that it hangs out beyond the table horizontally. Hang a spring on the rod and secure it (perhaps with some tape).
2. Set a ring stand on the floor and attach a clamp so that it will hold up a meter stick below the spring. Adjust the height of the meter stick until the zero mark of the meter stick is aligned with the bottom of the hanging spring.
3. Place a hooked mass (see the chart below to see how much mass you add to your spring) on the end of the spring. Slowly lower the mass until it hangs at rest in equilibrium. Read the position of the bottom of the spring (not the bottom of the hanging mass). Record the value of the mass and the value of the displacement (to the nearest 0.100 mm) in a data table.
4. Repeat step 3, placing the next indicated mass on the spring and measuring the displacement of the spring. Record all values of mass and displacement in your data table.

Spring Color	**M_1**	**M_2**	**M_3**	**M_4**
Red	0.250 kg	0.500 kg	0.750 kg	1.000 kg
Blue	0.300 kg	0.600 kg	0.900 kg	1.200 kg
Yellow	0.350 kg	0.700 kg	1.050 kg	1.400 kg

Energy Conservation

1. Check that the lower end of the spring is still precisely at the zero mark. Adjust the meter stick if necessary. Hang a mass on the end of the spring (see the chart below to see how much mass you add to your spring) and support it with your hand with the lower end of the spring precisely at the 0.3000 m mark. Record this position as “Initial Position” in a second data table.

Spring Color	Red	Blue	Yellow
Mass Used	1.000 kg	1.250 kg	1.450 kg

2. Release the mass and mark the lowest point of the lower end of the spring. Release the mass several times until you have accurately located the lowest point of the motion. It may be easier to note the lowest position of the

mass itself, and then hold the mass at that position to determine the position of the lower end of the spring. Record this position as "Final Position" in your data table.

3. Repeat steps 1 and 2 for initial positions of 0.3200, 0.3400, and 0.3600 m. Measure the value of the final positions for each of these initial positions and record in your data table.
4. Check that the lower end of the spring is still precisely at the zero mark. Adjust the meter stick if necessary. Using the same mass as before, pull the mass down by hand until the lower end of the spring is precisely at the 0.5000 m mark. Record this position as "Initial Position" in a third data table.
5. Release the mass and determine how high it rises. The position of the lower end of the spring when the mass is at its highest point is the "Final Position". Again, release the mass several times to accurately determine the value of the final position. Record this position in the third data table.
6. Repeat steps 4 and 5 for initial positions of 0.4800, 0.4600, and 0.4400 m. Measure the value of the final positions for each of these initial positions and record in your data table.

Analysis:

Spring Constant

1. Calculate the force *mg* for each mass and record the values in a calculations table (same thing as a data table, but just displaying your calculations).
2. Plot your data points on a graph with the force *mg* on the vertical axis and the displacement on the horizontal axis. Draw a best-fit line and find the slope – *what does the value of the slope represent? Think. What is F/x equal to?*

Energy Conservation

1. For each of the four measurements of the falling mass in the second data table, calculate the change in the gravitational potential energy, ΔPE_g. Calculate the change in spring potential energy, ΔPE_s. Record these results in a second calculations table.
2. Calculate the percentage differences[i] between ΔPE_g and ΔPE_s for each case and record them in the calculation table.
3. For each of the four measurements of the rising mass in the third data table, calculate the change in the gravitational potential energy, ΔPE_g. Calculate the change in spring potential energy, ΔPE_s. Record these results in a third calculations table.
4. Calculate the percentage differences between ΔPE_g and ΔPE_s for each case and record them in the calculation table.

NOTE When you are writing the procedure section of your lab report, do not write "instructions" – just report your method. Remember, your report is not going to be used as instructions for next year's AP students so there's no need to write your methods as such. See it as reporting to fellow AP students what you did during the lab.

[i] Percentage Difference = $\frac{|E_2-E_1|}{(E_1+E_2)/2} \times 100$, where E_1 and E_2 are experimental values 1 and 2