Physics Lab
Oscillations

This lab will be assessed on all the assessment criteria

Introduction:
A system will undergo periodic motion provided a restoring force acts in a direction opposite to displacement towards a stable equilibrium point. When the restoring force is directly proportional to the displacement then the system undergoes simple harmonic motion (SHM). The resulting equation of motion is sinusoidal and the period of motion is independent of the amplitude. In this lab you will investigate an oscillating spring system consisting of a number of different springs connected together. The period will depend on the mass and the number of springs in your system. Your task is to investigate these relationships.

Procedure:
Select three identical springs and a variety of different slotted masses.

First select one of your springs and use it to to verify the following relationship between period *T* and mass *m.*

$$T = 2\pi\sqrt{\frac{m}{k}},$$

Attach a mass to one end of the spring and suspend the other end from the ceiling. Set the system in motion and record the period. Repeat with a sufficient number of masses so that you can use graphical analysis to verify the relationship. From the slope of a suitable plot determine the value of the spring constant *k* in Newtons per meter. If your springs are identical you may assume the other springs have the same spring constant as your first one. If you are not confident about this repeat the above experiment with each of the other springs separately and determine the spring constant for each spring.

Now you are ready to find a relationship between period and the number of springs in your system.

Attach two springs together in series with the mass at one end and set this system into oscillatory motion. Measure the period and use the equation above to find the effective spring constant for the combined system.

How does the effective spring constant of the combined system relate to the spring constants of the individual springs? Postulate what the effective spring constant for the three springs will be.

Check your hypothesis by oscillating a system of three springs and measuring the period.

Modify your hypothesis if necessary and generalize it to the case of *n* identical springs connected in series. That is, state a relationship for the effective spring constant of *n* identical springs connected in series in terms of the spring constant of an individual spring. Prove your hypothesis by starting with the definition of the spring constant in Hooke's Law. (Hint: Consider how the extension for *n* springs in series will relate to the extension for a single spring with the same applied tension.)

Now write down a relationship between the period and the number of springs attached in series.

How would the relationship change if the springs were not identical? How would the relationship change if the springs were connected in parallel?

Extension:

Repeat your experiment with springs attached in parallel.