Physics 11 IB **Oscillating Mass**

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1 Planning A

1.1 Research Question

The aim of this experiment is to identify and investigate the various factors that affect the period of oscillation of a mass hanging on a spring.

1.2 Hypothesis

We have:

$$\omega = \sqrt{\frac{k}{m}}$$

But, $\omega = \frac{2\pi}{T}$, where T is the period of the oscillating mass. Solving for T, we get:

$$T = 2\pi\sqrt{\frac{m}{k}} \tag{1}$$

The above formula indicates that the only factors which could affect the period T of an oscillating mass are the mass m of the oscillating object, and the spring constant k.

If k is kept constant, and if m is increased, T increases too, and the oscillation is slowed down. Conversely, if m decreases, T is decreased too, and the oscillations occur more frequently (provided k is kept constant).

On the other hand, if the mass m is kept constant, and k is increased (by switching springs), then T decreases and the oscillations become faster. Conversely, if k is decreased, then T will increase and the oscillations will occur less frequently (provided the mass of the object remains constant).

1.3 Variables

Independent:	Mass m of the hanging object, the spring constant k.
Dependent:	The period T of the pendulum.
Controlled:	The mass m of the object (if k is the independent variable) and the spring constant k (if m is the independent variable).

2 Planning B

2.1 Materials

1. An elastic spring
2. A medium-sized mass ($10g$ approx.)
3. Photo-gate blocker timer
4. Photo-gates
5. Meter-stick
6. Balance

2.2 Procedure

Part 1

1. Determine the spring constant k of the spring by allowing it to hang freely and measuring its displacement x relative to its equilibrium position. The value mg/x will give you the spring constant in N/m.
2. Accurately measure the mass of the object and attach it to one end of the spring.
3. Prepare the timer and set it to pendulum/oscillation mode.
4. Do not switch springs between this part of the experiment, as k is being controlled.
5. From a height, gently let the spring fall through the photo gates. Determine the amount of time it takes to complete one full oscillation. This is the period T of the oscillation. Repeat this 3 or 4 times to obtain an average. Record both the mass m and the period T in a table.
6. Use different masses and repeat the above step, while making sure not to switch springs in between (in order to keep k constant). Record mass-period pair values for each different mass used.

Part 2

1. Keeping the mass constant this time, calculate the period of the oscillating mass T while switching springs for each trial. Remember to calculate the new spring constant k for each new spring.
2. Prepare a table containing the spring constant k and the corresponding period of oscillation T for each spring.

1. With the above data, graph a mass versus period and a spring-constant versus period graph. Analyze the resulting two graphs and their shapes. Explain the relationship between the mass m and the period T of the oscillating mass, and the relationship between the spring-constant k and the period T of the oscillating mass.
2. What happens if the mass m or the spring-constant k is doubled? Tripled? Halved? By what factor must one scale m or k, in order to quadruple the period T? How do these answers relate to equation (1) ? Explain.
