This week’s workshop covers simple harmonic motion. The first question deals with energy in SHM.

1. A block of mass \( m \) is attached to a spring of spring constant \( k \) on a horizontal frictionless table. The spring is then stretched a distance of \( x_I \) and released so that the block undergoes simple harmonic motion.

   a. Write an expression for the total energy of the system.

   b. If \( m = 2.0 \) kg, \( k = 5.0 \) N/m \( x_I = 0.10 \) m, what is the total energy of the system?

   c. Where in the block’s motion is the kinetic energy greatest? What is the kinetic energy at that position?

   d. Find the speed of the block when it is a distance of \( x_2 = 0.05 \) m from its equilibrium position.

For the second and third questions you are given a spring, stand, masses, motion detector and ruler. You will use this equipment to determine the spring constant experimentally via 2 methods.

2. Use method 1 from your pre-lab to find the spring constant \( k \).
   
   (a). Write down your method step by step, your measured values.

   (b). What value for \( k \) do you deduce? (use a reasonable number of significant figures)
3. Method 2: A mass $M$ is hung from the same spring and given a small pull downwards and let go. The spring-mass system starts oscillating with a period of $T$.
   a. What is the relationship between the angular frequency $\omega$ and the time period $T$?

   b. What is the relationship between the angular frequency $\omega$ and the mass $M$ and the spring constant $k$?

   c. Use the above two equations to express the spring constant $k$ in terms of the mass $M$ and time period $T$.

Set up the spring so that it is hanging with the hook on. Hang a reasonable mass on the spring and give it a little pull downwards and let go, so it oscillates without swinging side to side. Use logger pro to record data.

**NOTE:** Do NOT remove the hanger from the spring. Assume the hanger+plate has mass=100 g. Do not add more than 200 g to the hanger.

d. From your data, find the time period $T_1$ of oscillation (make sure to take the average of multiple readings). Explain how you did this. Record total mass $M_1$ and $T_1$.

e. Using your recorded values, use method 2 from your prelab to find the spring constant $k$.

f. Repeat the above steps for a different total mass $M_2$. Find $T_2$ and find $k$ using these values.

4. Compare the 3 values of $k$ that you have. Explain why there might be discrepancies. What is the biggest source of error in method 1? What is the biggest source of error in method 2?