# Topic 4 – Practical 4

## *Relationship between a mass suspended by a spring and the period of oscillation of the spring–mass system*

### Safety

Wear safety glasses/ goggles.

### Apparatus and materials

* stand and two clamps
* steel spring (of known spring constant)
* ruler
* plumb line
* mass hanger (100 g) and slot masses (100 g)
* fiducial mark (long pin)
* adhesive putty
* stopwatch

### Introduction

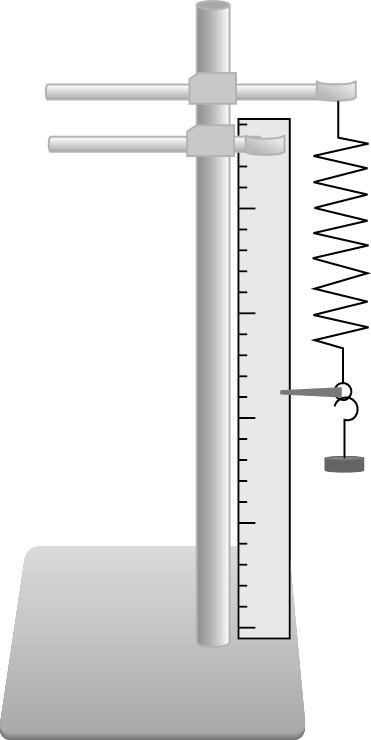
In this practical, you will use measurements of the period of oscillation of a spring to determine its spring constant.

The period *T* of the oscillations of a small point mass *m* suspended from an ideal spring of spring constant *k* is given by:

The equation above can be written as:

so that the gradient of a *T*2 vs *m* graph is equal to

### Procedure

1. Attach one end of the spring to the clamp and stand securely.
2. Use a small piece of adhesive putty to attach the fiducial mark at the end of the spring.
3. Place the ruler next to the spring. Use the plumb line to check that both spring and ruler are vertical. Place a mass hanger at the other end of the spring and mark on the ruler the equilibrium position.
4. Displace the mass from its equilibrium position by a certain distance. This distance will be the amplitude of the oscillations and should remain constant throughout the experiment.
5. Release the mass and measure the time for the system to complete 20 full oscillations. (Note: the time it takes the end of the spring to go from the equilibrium position to the next equilibrium position is half a period. One full period is the time it takes to return to the equilibrium position **from the same side**.)
6. Repeat four more times for this mass.
7. Record your measurements in an appropriate table.

*Raw data table*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| mass  *m* / kg ± …. | Time for 20 full oscillations / s ± . . . | | | | |
| #1 | #2 | #3 | #4 | #5 |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

1. Repeat the process (steps **3**–**7**), each time adding a slot mass of 100 g.
2. For each mass calculate:
3. the average time for 20 oscillations and the uncertainty of repeated measurements
4. the period of one oscillation and the relevant uncertainty
5. the square of the period and the relevant uncertainty.

Record these calculations in a separate table.

*Processed data table*

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Mass,  *m* / kg ± …. | Average time for 20 oscillations   / s | Uncertainty from repeated measurements of *t* / s | Period, *T* /s | Uncertainty of *T* / s2 | *T*2 / s2 | Uncertainty of *T*2 / s2 |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |

1. Plot a graph of the square of the period *T*2 against mass *m*. Use the values of uncertainty of *T*2 to draw error bars.
2. Draw a best-fit line for your points and calculate its gradient.
3. From the value of the gradient, calculate the experimental value of *k* .
4. Determine the gradient uncertainty and use it to calculate the uncertainty of the experimental

value of *k*. Compare the known value of *k* with the experimentally determined one.

### Questions

1. Is there another way of plotting your data in a linear graph? How would you re-arrange the equation to allow you to do this?
2. In this case, how would you determine the value of *k* from the gradient of your graph?