# PROCEDURE

Construct a pendulum by attaching one end of the string to the binder clip and the other end to a fixed support, as shown in Pics 1 and 2. The pendulum in Pic 2 is supported by inserting the free end of the string between two pages of a book placed on a high table. Possible places to support the pendulum are a closet shelf, a basement beam, a ceiling hook or a shower curtain rod. *Note that these are suggestions only about support. You must decide on your own how to proceed and we assume no responsibility for possible damage from whatever method you use*.

## Part I: Period versus oscillation amplitude

In this part of the experiment, you will keep the mass and length of the pendulum fixed and only change the oscillation angle (or amplitude). The purpose is to investigate the relation between oscillation period and oscillation amplitude.

To start the experiment, place a number of coins in the binder clip making sure they fit tightly and do not fall off during oscillation. Measure the length of the pendulum from the point of support to the center of the coins. Record this measurement, in addition to the type and number of coins used. Make few trial oscillations, in different directions, and decide about the best direction to swing the pendulum.

Wit the pendulum in equilibrium, hold the protractor near the top of the string with the rounded edge facing down, as shown in Pic 3. The string should coincide with the 90° line in the middle of the protractor. With your other hand, gently displace the clip from the equilibrium position until it makes an angle of 5° with the vertical. Put the protractor away, so that it does not interfere with the moving string, and release the pendulum. Allow for few oscillations before you start timing. Make sure that the timing starts when the pendulum is either at the far right or far left position. Stop the timing when the pendulum completes 10 oscillations (see Vid 1). Remember that, a complete oscillation consists of a single round trip back to the starting position. Repeat the same procedure for oscillation angles 10°, 15°, 20°, 25°, and 30° and enter your measurements into the table below.

**Table 1**

| Oscillation angle $\theta$ | Time for 10 oscillations $t$ (s) | Period $T \pm$ (s) |
|---|---|---|
| 5° | | |
| 10° | | |
| 15° | | |
| 20° | | |
| 25° | | |
| 30° | | |
| Pendulum length $L = ( \pm )$ m | | |
| Pendulum mass $m = ( \pm )$ kg | | |

## Part II: Period versus pendulum mass

In this part of the experiment, you will keep the oscillation angle and pendulum length fixed and only change the mass of the suspended object. The purpose is to investigate the relation between oscillation period and mass of the pendulum.

Start the experiment with a single coin in the binder clip. Displace it by approximately 15° from the equilibrium position and let go. As you did in Part I, measure the time it takes the pendulum to complete 10 oscillations. Repeat, with 2, 3, 4, 5 and 6 coins placed in the binder clip. Enter the total mass and the measured times into the appropriate columns in the table below.

**Table 2**

| Pendulum mass $m$ (kg) | Time for 10 oscillations $t$ (s) | Period $T \pm$ (s) |
|---|---|---|
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| Pendulum length $L = ($ $\pm$ $)$ m | | |
| Oscillation angle $\theta =$ | | |

## Part III: Period versus pendulum length

In this part of the experiment, you will keep the oscillation angle and pendulum mass fixed and only change the pendulum length. The purpose here is to investigate the relation between oscillation period and length of the pendulum.

Before you start, place 5 coins in the binder clip and extend the pendulum to its maximum length. Measure the length, as accurately as possible and estimate the uncertainty of your measurement. For instance, $\Delta L = \pm 0.5$ cm is a reasonable estimate of the error in length measurement. To start the experiment, displace the pendulum by approximately 15° from the equilibrium position and let go. As you did in Parts I and II, measure the time it takes the pendulum to complete 10 oscillations.

To prepare for the next set of measurements, shorten the string by about 10 cm and record the new pendulum length. Measure the oscillation time as above, using the same mass and amplitude. Repeat at least ten times spaning the possible range of string lengths, from about 10 cm to about 100 cm. Enter the pendulum length and the measured times into the appropriate columns in the table below.

Take a picture of your experimental setup to be included in the lab report.

**Table 3**

| Pendulum lenght $L \pm$ (m) | Time for 10 oscillations $t$ (s) | Period $T \pm$ (s) |
|---|---|---|
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| | | |
| Pendulum mass $m = (\quad \pm \quad)$ kg | | |
| Oscillation angle $\theta =$ | | |