Name____________________

Period of a Pendulum

1. Measure the total time for a $m = 0.05$ kg, $L = 75$ cm, $A \approx 30°$ (the angle between 4:00 and 6:00), pendulum to make 20 oscillations. (First set the pendulum *already* swinging; then start timing and start counting with "0" instead of "1" the moment the pendulum has swung all the way back.) Then divide by 20 to determine the period T (in seconds) of this pendulum.

2. Experimentally determine the dependence of the period T on the parameters below. (i) Record each new period, and (ii) state whether the period T depends ($\uparrow$, $\downarrow$, or constant) on the following parameters:

(a) Mass $m\uparrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(b) Mass $m\downarrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(c) String length $L\uparrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(d) String length $L\downarrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(e) Oscillation amplitude $A\uparrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(f) Oscillation amplitude $A\downarrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)
(g) Gravitational constant $g\downarrow$(?) (T$\uparrow$, $\downarrow$, or constant?)
(h) Constant phase $\phi\downarrow\uparrow$. T____s (T$\uparrow$, $\downarrow$, or constant?)

The exact expression for a pendulum period is T = _____.

!

- Look for *significant* dependencies, and not negligible variations.
- Change one parameter at a time!

Mass-Spring Period

1. Measure the total time for a $m = 0.5$ kg, $k \approx 9.5$ N/m, $A = 5$ cm (as measured down from its equilibrium position) to make 20 oscillations. (First set the mass *already* oscillating; then start timing and start counting with "0" instead of "1" the moment the mass is at its lowest point.) Then divide by 20 to determine the period T (in seconds) of this mass-spring system.

2. Experimentally determine the dependence of the period T on the parameters below. (i) Record each new period, and (ii) state whether the period T depends (↑, ↓, or constant) on the following parameters:

(a) Mass m↑. T____s (T↑, ↓, or constant?)
(b) Mass m↓. T____s (T↑, ↓, or constant?)
(c) Spring strength k↑ T____s
(use two springs in parallel) (T↑, ↓, or constant?)
(d) String strength k↓ T____s
(use two springs in series) (T↑, ↓, or constant?)
(e) Oscillation amplitude A↑. T____s (T↑, ↓, or constant?)
(f) Oscillation amplitude A↓. T____s (T↑, ↓, or constant?)
(g) Constant phase ϕ↓↑. T____s (T↑, ↓, or constant?)

The exact expression for a mass-spring period is T = _____.

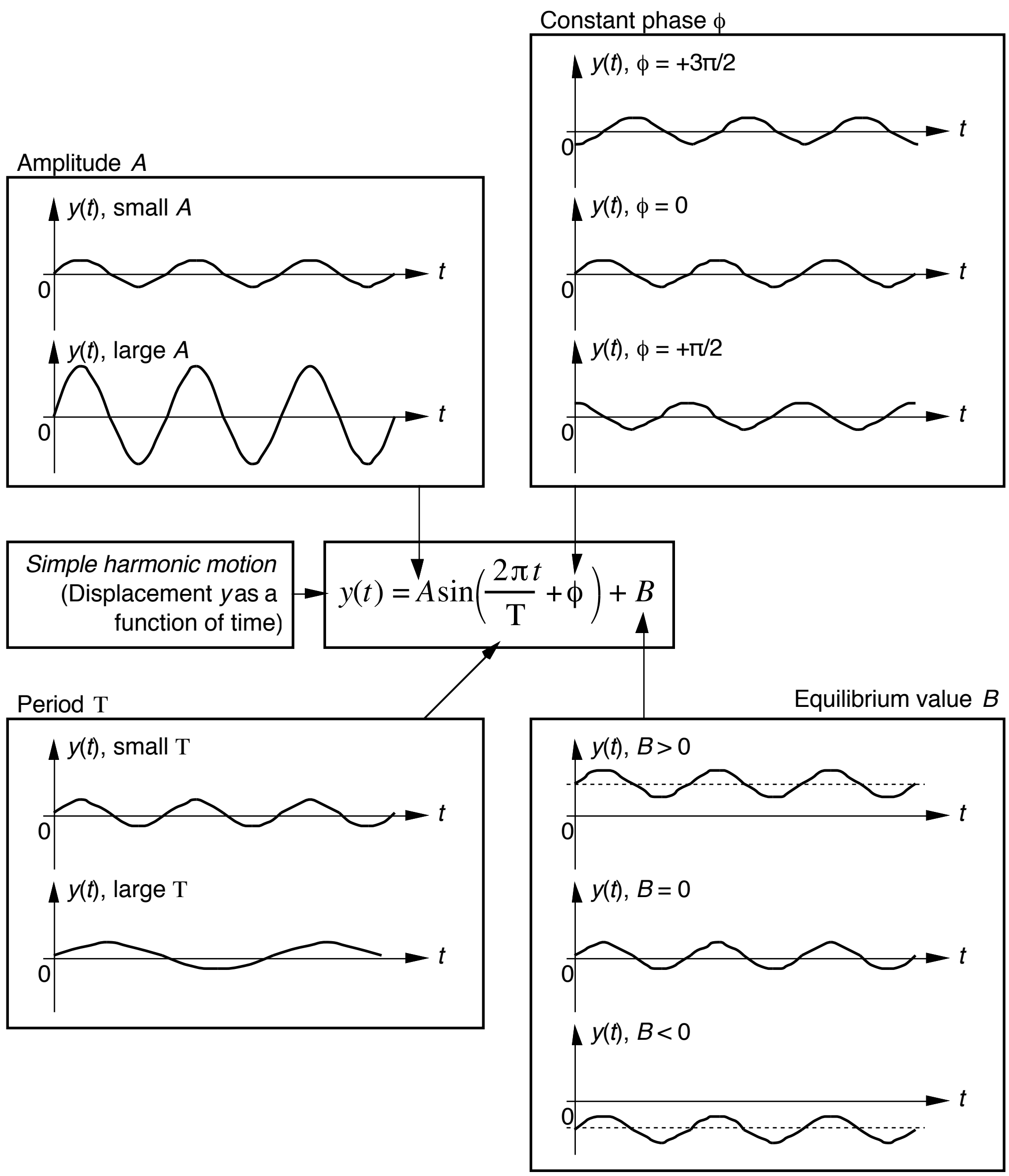
!

- Look for *significant* dependencies, and not negligible variations.
- Change one parameter at a time!

Simple Harmonic Motion (SHM) parameters

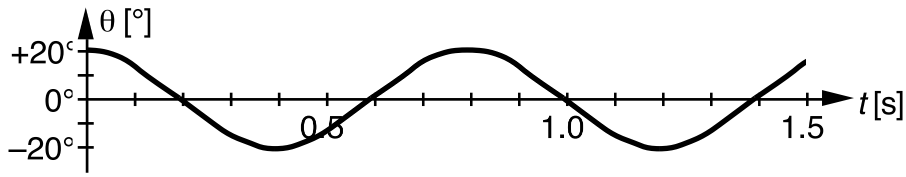
The most general form of the equation that describes *any* object undergoing SHM (simple harmonic motion) is given by:

$$y(t) = A\sin\left(\frac{2\pi t}{T} + \phi\right) + B.$$



Applying SHM Parameters

Consider the specific case of this graph of angular position versus time for an $m = 0.2$ kg pendulum:



1. What are the values *and* units of these SHM parameters?

	Value?	Units?
(a) A		
(b) T		
(c) ϕ		
(d) B		

For the following situations (2)-(5), redraw the angular position $\theta(t) \leftrightarrow y(t)$ versus time graph from (1) if the physical parameters below are changed. Scale (rescale) your axes as necessary.

2. The mass m is doubled.

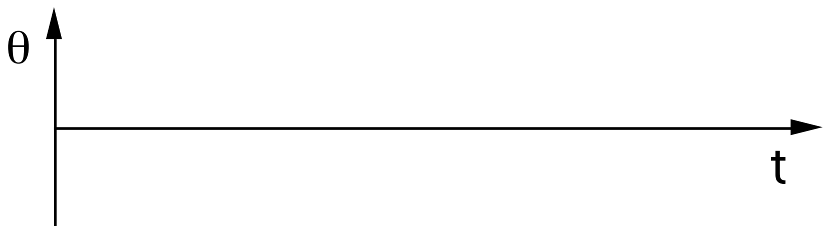
3. The string L is doubled.

4. The amplitude A is doubled.

5. The parameter ϕ is doubled.

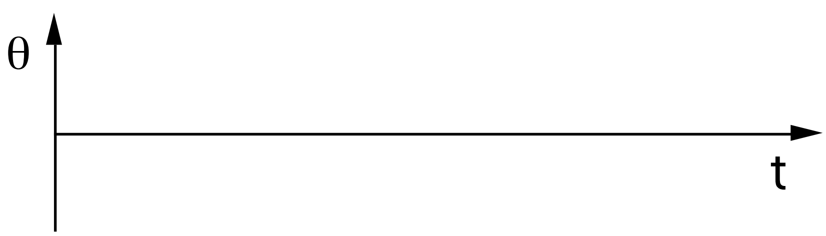
6. For each of the above situations (2)-(5), demonstrate for yourselves what the actual pendulum motion looks like, by using the appropriate m, L, A, and ϕ in your demonstration.

mass is doubled



string L is doubled

amplitude is doubled



ϕ is doubled