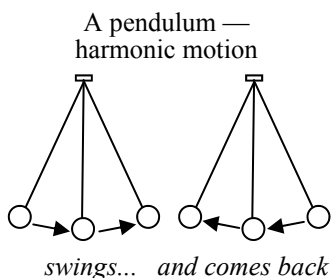


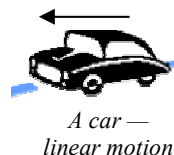
Harmonic Motion

Harmonic Motion is any motion that is repetitive (doing the same thing over and over) and caused by a **restoring force**. Pendulums, bouncing springs, wheels (circular motion), waves, music: these are all harmonic motion.



Restoring force: a force that tries to return an object to equilibrium (center resting position). If a pendulum is disturbed (moved), gravity (restoring force) pulls it back to center. Because it has too much momentum, it goes past center and keeps going back and forth.

Linear motion goes from here to there: one direction.



Linear motion—
up uses a different
force than down

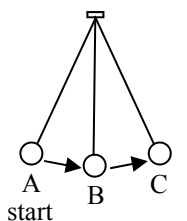
A bird flying *looks* like harmonic motion because the wings are going up and down. Actually, it is linear motion because up and down require two different sets of muscles.

Parts of Harmonic Motion

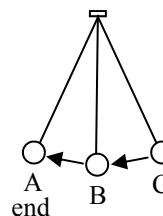
Cycle: the repeated portion of the motion; includes all of the steps of the motion.

Period: length of time for one cycle; how long it takes for one repetition.

Frequency: number of cycles per second in hertz (Hz). A hertz is a cycle per second.



From A to C
is only half a
cycle.



When the pendulum
gets back to A it has
completed one cycle
and starts over.

If it takes 2 seconds for the pendulum to go from A to C and back to A, the pendulum's period is 2 seconds.

Period (in secs) $\rightarrow T = \frac{1}{f}$ OR $f = \frac{1}{T}$ $\leftarrow$ Period (in secs)
f $\nwarrow \nearrow$ Frequency (in hertz)

Ex: A pendulum has a frequency of 4 Hz. Find its period.

$$f = 4 \text{ Hz}$$

$$T = ?$$

$$T = 1/f$$

$$T = 1/4 \text{ Hz}$$

$$T = 0.25 \text{ sec}$$

Ex: A wheel has a period of 2 seconds. Find its frequency.

$$T = 2 \text{ sec}$$

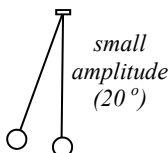
$$f = ?$$

$$f = 1/T$$

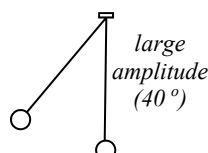
$$f = 1/2 \text{ sec}$$

$$f = 0.5 \text{ Hz}$$

Amplitude: the maximum distance or angle the motion moves from its center position. Can be measured in distance (meters, centimeters) or degrees.



small
amplitude
(20°)



large
amplitude
(40°)

$$\text{Amplitude} = \frac{1}{2}(\text{high} - \text{low})$$

Graphing Harmonic Motion

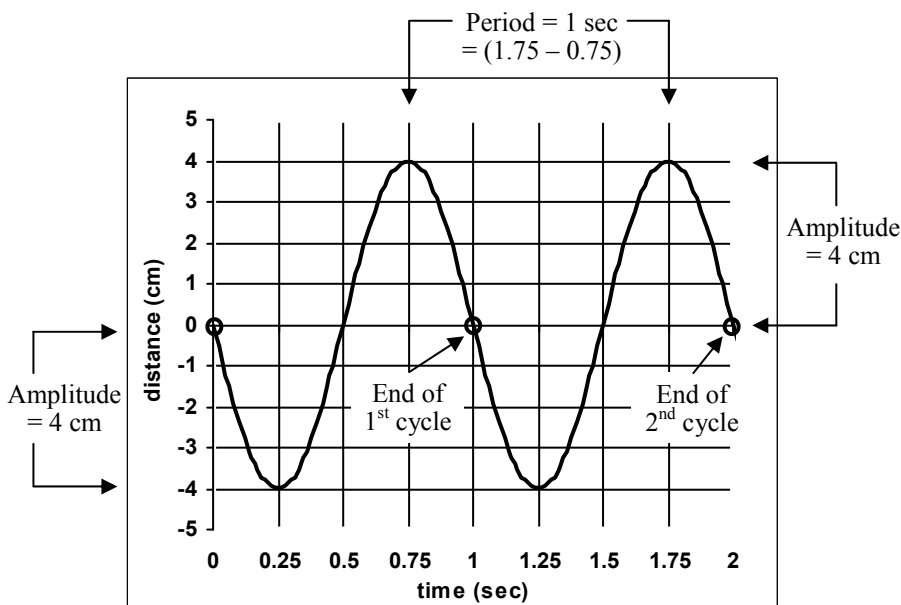
On a graph you can see all parts of harmonic motion.

Cycle—one repetition of the motion (top to top, bottom to bottom, etc.).

Period—time for one cycle; time from top to top, etc.

Frequency—how many cycles in one second.

Amplitude—how far the graph goes away from the center (or use the equation: $\text{Amplitude} = \frac{1}{2}(\text{high} - \text{low})$)

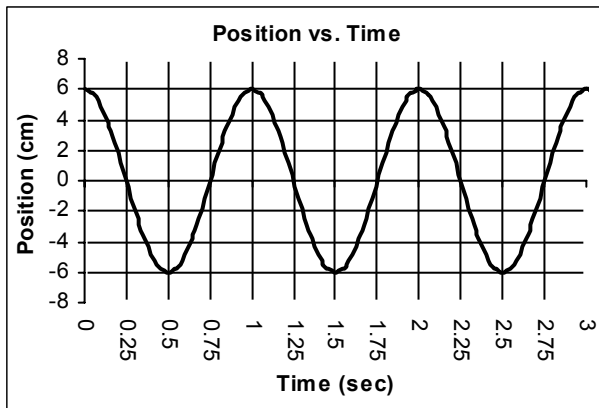


Name: _____

Period: _____

Harmonic (H) or Linear (L) motion?			1. Period	A. The number of cycles per second.
Person running: _____	A swing: _____	Music: _____	2. Amplitude	B. A unit of one cycle per second.
The moon: _____	A car moving: _____	Bird flying: _____	3. Frequency	C. The size or strength of a cycle.
Clock pendulum: _____	Jumping Jacks: _____	Bouncing spring: _____	4. Cycle	D. Time it takes to complete one cycle.
Ocean waves: _____	Moving bicycle: _____	A radio wave: _____	5. Hertz	E. A part of motion that repeats over and over with a set series of events.

Convert from period (T) to frequency (f):		Convert from frequency (f) to period (T):	
1 sec = _____	4 sec = _____	1 Hz = _____	10 Hz = _____
0.1 sec = _____	2 sec = _____	2 Hz = _____	5 Hz = _____
0.5 sec = _____	0.25 sec = _____	0.5 Hz = _____	0.1 Hz = _____



Mark 1 cycle of the harmonic motion.

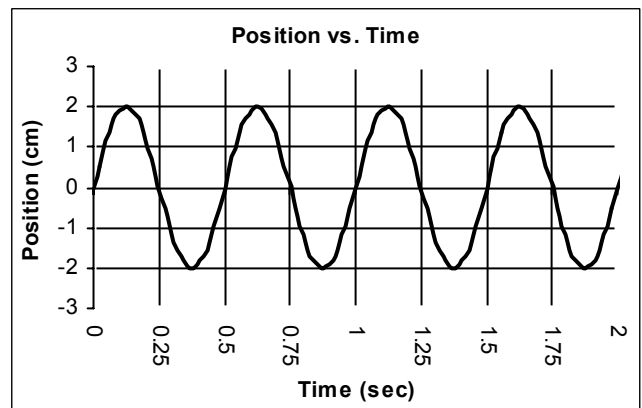
Starting at 0 secs, when does the 1st cycle end:

Number of complete cycles:

Period:

Frequency:

Amplitude:



Mark 1 cycle of the harmonic motion.

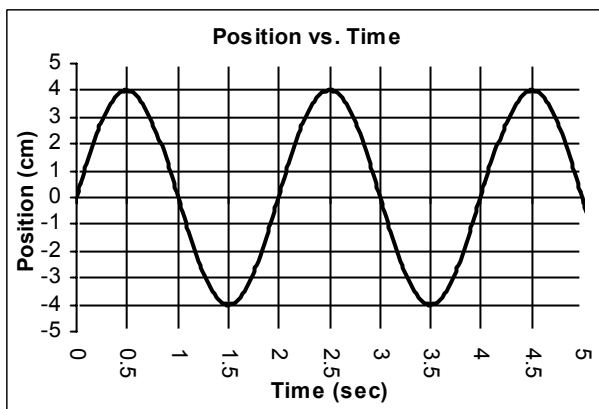
Starting at 0.25 secs, when does the 2nd cycle end:

Number of complete cycles:

Period:

Frequency:

Amplitude:



Mark 1 cycle of the harmonic motion.

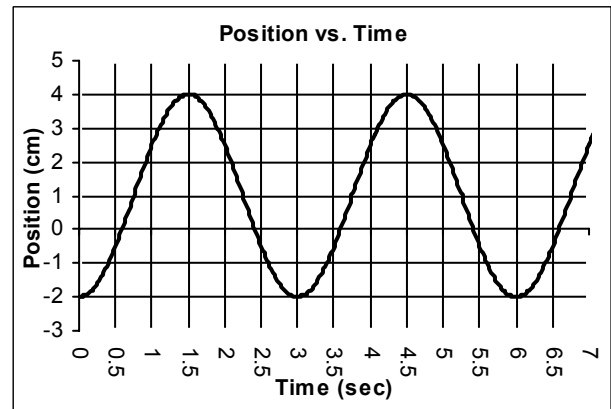
Starting at 1 secs, when does the 1st cycle end:

Number of complete cycles:

Period:

Frequency:

Amplitude:



Mark 1 cycle of the harmonic motion.

Starting at 0 secs, when does the 1st cycle end:

Number of complete cycles:

Period:

Frequency:

Amplitude: