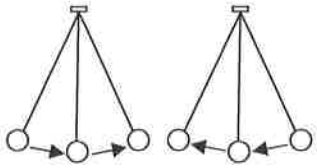
Name: _____

Period: _____

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.

A pendulum — harmonic motion



swings... and comes back

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.

A car — linear motion

Linear motion— up uses a different force than down

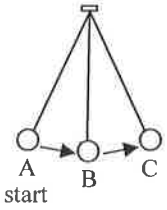
A bird flying *looks* like harmonic motion because the wings are going up and down. Actually, it is linear motion because up and down require two different sets of muscles.

Parts of Harmonic Motion

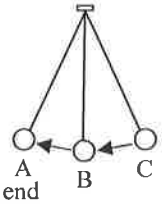
Cycle: the repeated portion of the motion; includes all of the steps of the motion.

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.

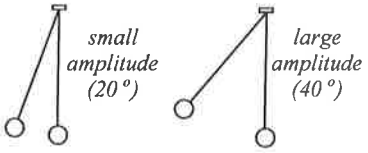
Period (in *secs*) $\rightarrow T = \frac{1}{f}$ OR $f = \frac{1}{T}$ ← Period (in *secs*)

Frequency (in *hertz*)

Ex: A pendulum has a frequency of 4 Hz. Find its period.	
f = 4 Hz T = ?	T = 1/f T = 1/4 Hz T = 0.25 sec

Ex: A wheel has a period of 2 seconds. Find its frequency.	
T = 2 sec f = ?	f = 1/T f = 1/2 sec f = 0.5 Hz

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



Amplitude = ½(high – low)

Graphing Harmonic Motion

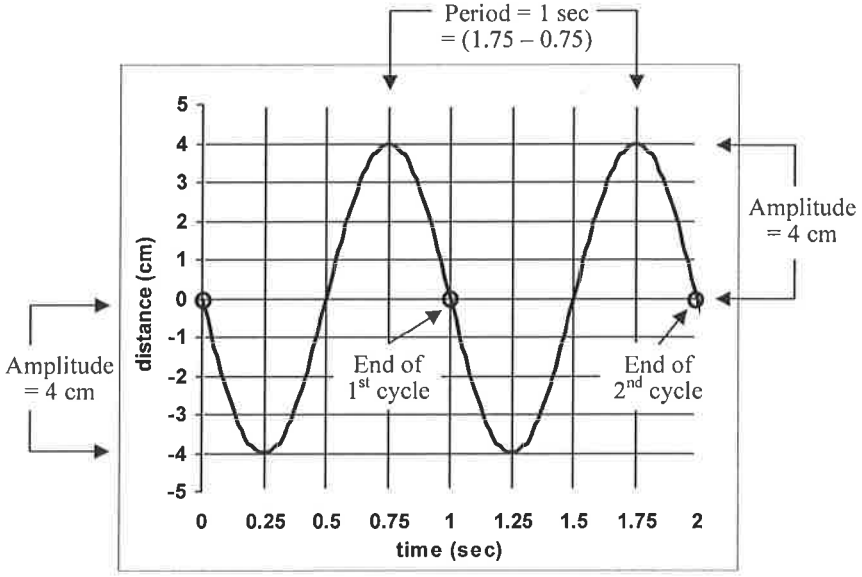
On a graph you can see all parts of harmonic motion.

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: Amplitude = ½(high – low)



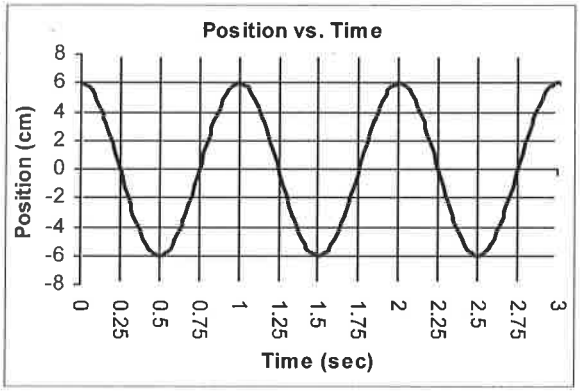
Name: _____

Period: _____

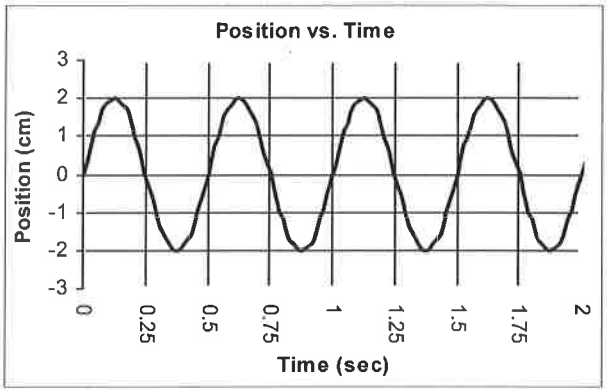
Harmonic (H) or Linear (L) motion?		
Person running: ____	A swing: _____	Music: _____
The moon: _____	A car moving: ____	Bird flying: _____
Clock pendulum: ____	Jumping Jacks: ____	Bouncing spring: ____
Ocean waves: _____	Moving bicycle: ____	A radio wave: _____

1. Period	A. The number of cycles per second.
2. Amplitude	B. A unit of one cycle per second.
3. Frequency	C. The size or strength of a cycle.
4. Cycle	D. Time it takes to complete one cycle.
5. Hertz	E. A part of motion that repeats over and over with a set series of events.

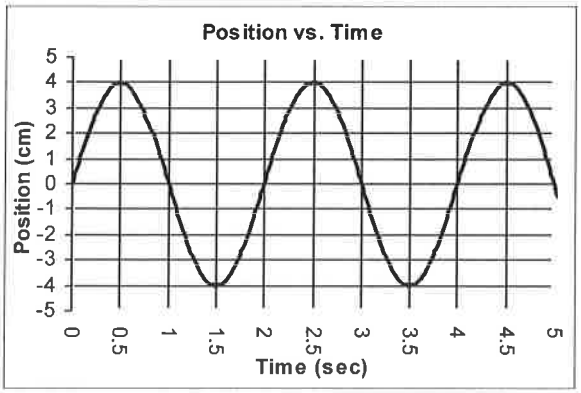
Convert from period (T) to frequency (f):		Convert from frequency (f) to period (T):	
1 sec = _____	4 sec = _____	1 Hz = _____	10 Hz = _____
0.1 sec = _____	2 sec = _____	2 Hz = _____	5 Hz = _____
0.5 sec = _____	0.25 sec = _____	0.5 Hz = _____	0.1 Hz = _____



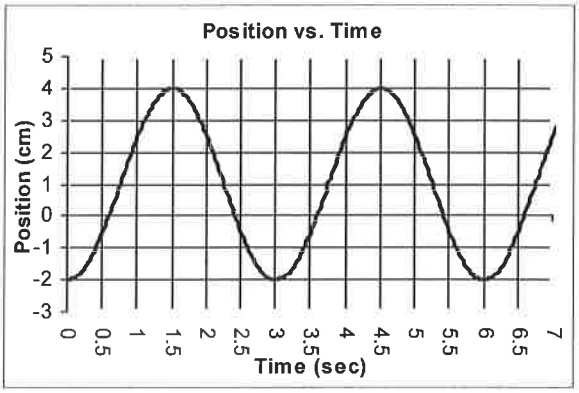
Mark 1 cycle of the harmonic motion.
Starting at 0 secs, when does the 1st cycle end:
Number of complete cycles:
Period: Frequency:
Amplitude:



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:

Name: _____

Period: _____

Harmonic (H) or Linear (L) motion?

Person running: L	A swing: H	Music: H
The moon: H	A car moving: L	Bird flying: L
Clock pendulum: H	Jumping Jacks: H	Bouncing spring: H
Ocean waves: H	Moving bicycle: L	A radio wave: H

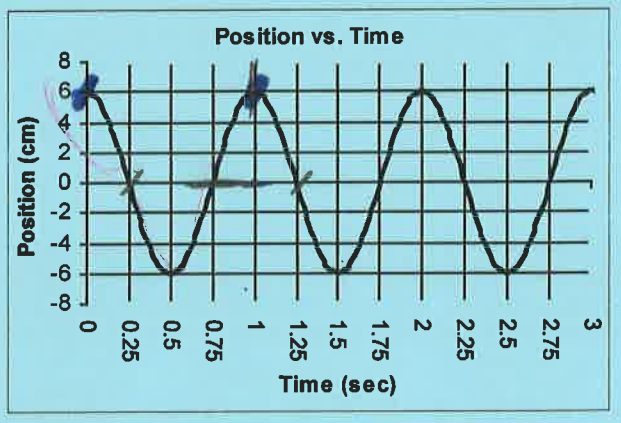
1. Period D	A. The number of cycles per second.
2. Amplitude C	B. A unit of one cycle per second.
3. Frequency A	C. The size or strength of a cycle.
4. Cycle E	D. Time it takes to complete one cycle.
5. Hertz B	E. A part of motion that repeats over and over with a set series of events.

Convert from period (T) to frequency (f): $f = \frac{1}{T}$

1 sec = $\frac{1}{1\text{ sec}}$ = 1 Hz	4 sec = $\frac{1}{4\text{ sec}}$ = .25 Hz
0.1 sec = $\frac{1}{.1\text{ sec}}$ = 10 Hz	2 sec = $\frac{1}{2\text{ sec}}$ = .5 Hz
0.5 sec = $\frac{1}{.5\text{ sec}}$ = 2 Hz	0.25 sec = $\frac{1}{.25\text{ s}}$ = 4 Hz

Convert from frequency (f) to period (T): $T = \frac{1}{f}$

1 Hz = $\frac{1}{1\text{ Hz}}$ = 1 sec	10 Hz = $\frac{1}{10\text{ Hz}}$ .1 sec
2 Hz = $\frac{1}{2\text{ Hz}}$ = .5 sec	5 Hz = $\frac{1}{5\text{ Hz}}$ .2 sec
0.5 Hz = $\frac{1}{.5\text{ Hz}}$ = 2 sec	0.1 Hz = $\frac{1}{.1\text{ Hz}}$ 10 sec



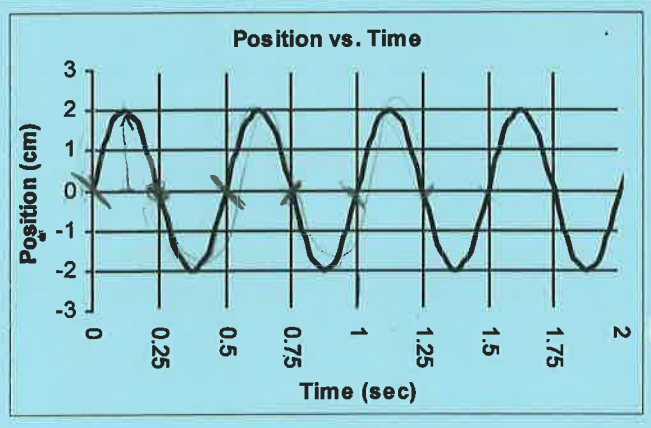
Mark 1 cycle of the harmonic motion.

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

Number of complete cycles: 3

Period: 1 sec Frequency: 1 Hz

Amplitude: 6 cm $f = \frac{1}{1\text{ sec}}$



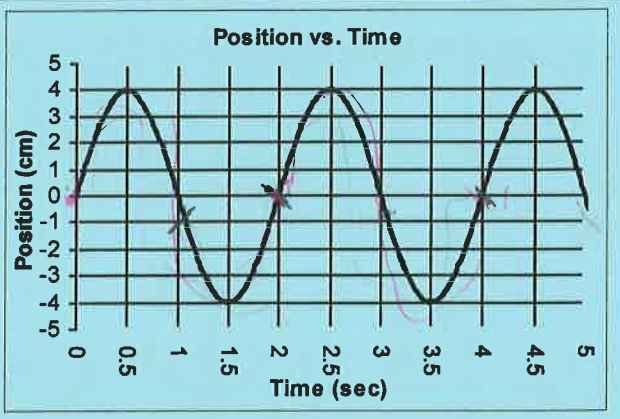
Mark 1 cycle of the harmonic motion.

Starting at 0.25 secs, when does the 2nd cycle end: 1.25 s

Number of complete cycles: 4

Period: .5 sec Frequency: 2 Hz

Amplitude: 2 cm $\frac{1}{2}(2-(-2))$



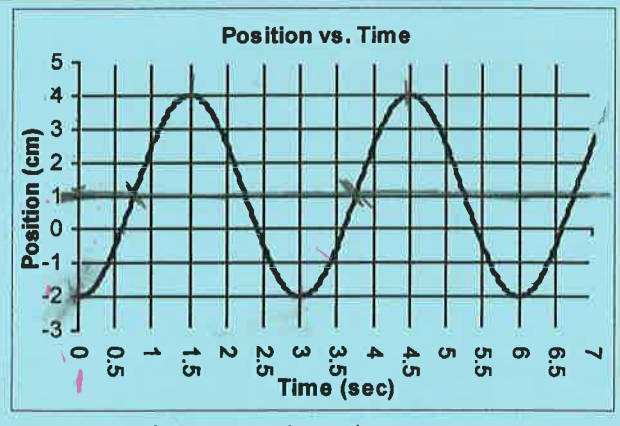
Mark 1 cycle of the harmonic motion.

Starting at 1 secs, when does the 1st cycle end: 3 sec

* Number of complete cycles: 2 (+ ½)

Period: 2 sec Frequency: .5 Hz

Amplitude: 4 cm



Mark 1 cycle of the harmonic motion.

Starting at 0 secs, when does the 1st cycle end: 3.0 sec

Number of complete cycles: 2 (+ ½)

Period: 3 sec Frequency: .33 Hz

Amplitude: 3 cm $\frac{1}{2}(4-(-2))$