Cycles
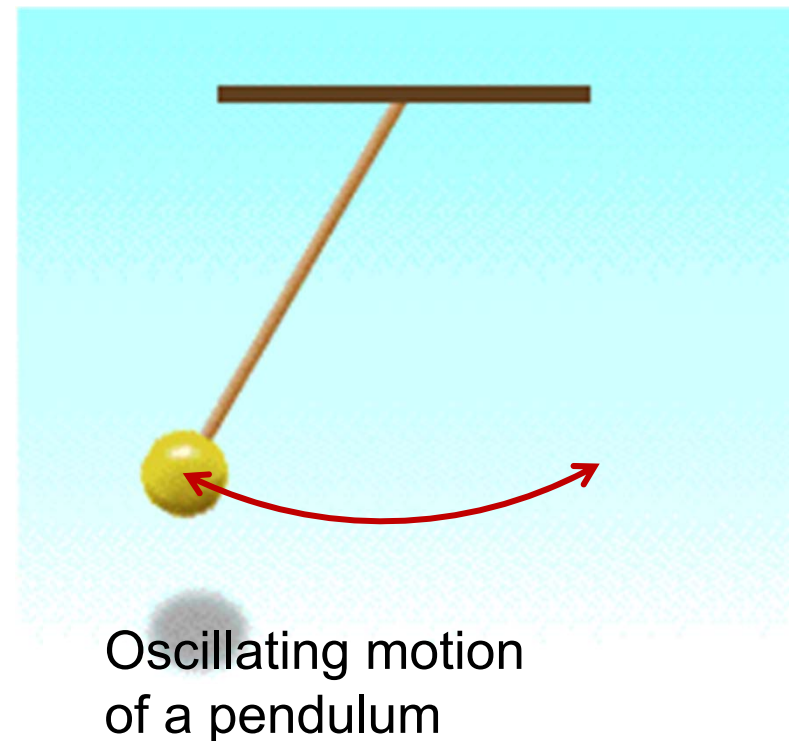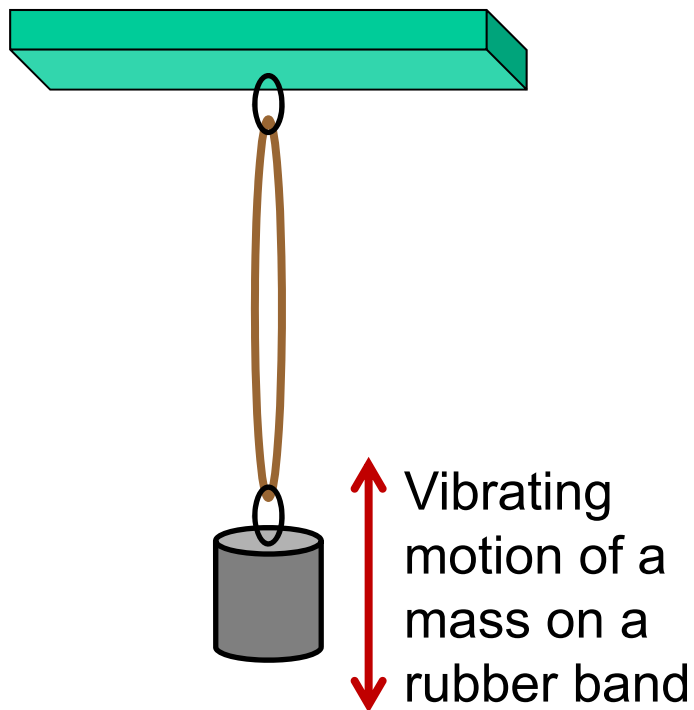
Cyclic Motion

Motion that has a repeating pattern is said to be cyclic motion (also called periodic motion).

Rotation
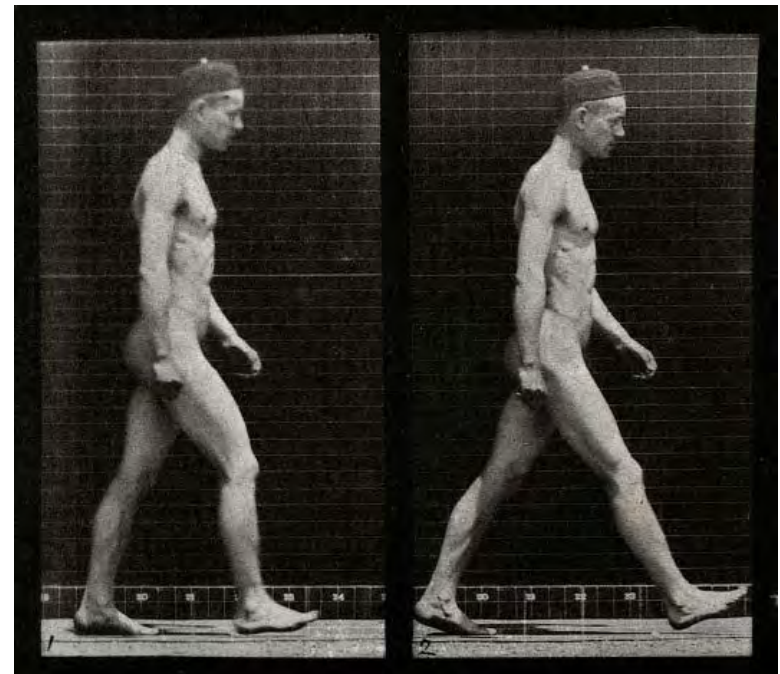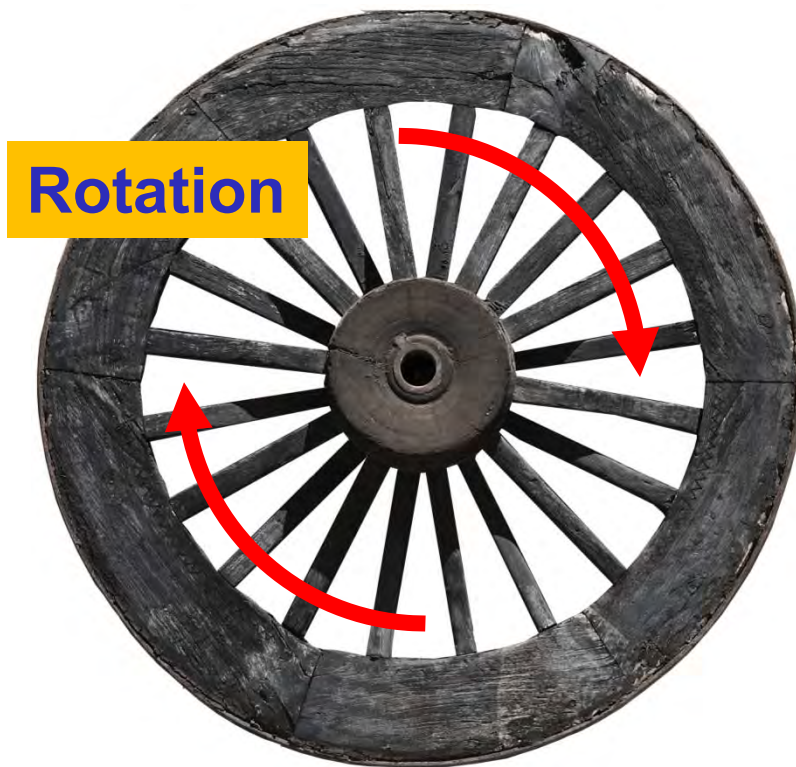
Walk Cycle

Vibrations & Oscillations

Other examples of cyclic motion are vibrations and oscillations.

Vibrating motion of a mass on a rubber band

Oscillating motion of a pendulum

Vocabulary for Cyclic Motion

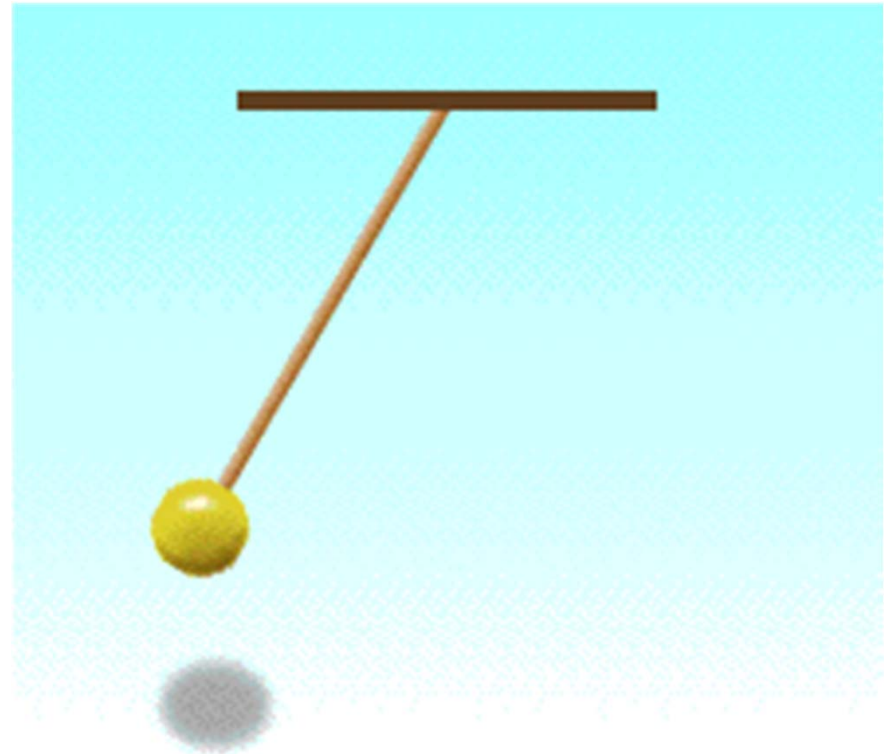All types of cyclic motion have the following elements:

- Period
- Frequency
- Amplitude
- Speed

In the rest of this tutorial we'll define these and describe how they're related.

Period

Time required for a full cycle (one round trip) is called the *period* of the cycle (an oscillation, vibration, rotation, etc.).
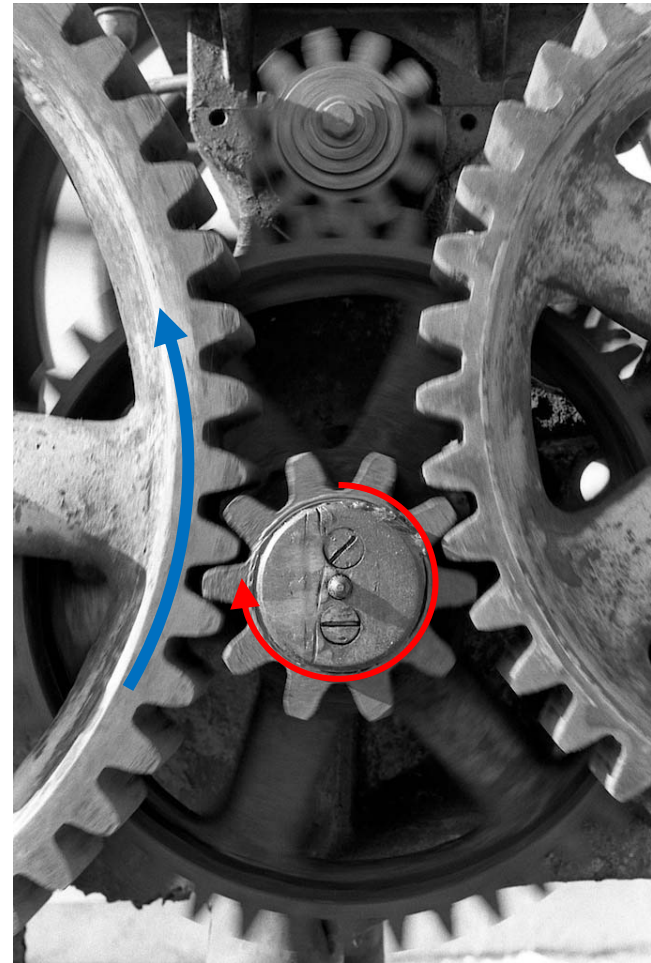
The period for a normal walk cycle is about one second per cycle (1 cycle = 2 steps)

Period of Rotation

The period of rotation is the amount of time that it takes to complete one full rotation (one cycle).

The period of rotation for the small gear wheel is shorter than the period for the large gear wheel.

Frequency

Frequency is the inverse of the period,

$$(Frequency) = \frac{1}{(Period)}$$

For example, for a period of 2 seconds per cycle, the frequency is ½ cycles per second or ½ Hertz.

1 Hertz = 1 cycle per second

Frequency of Rotation

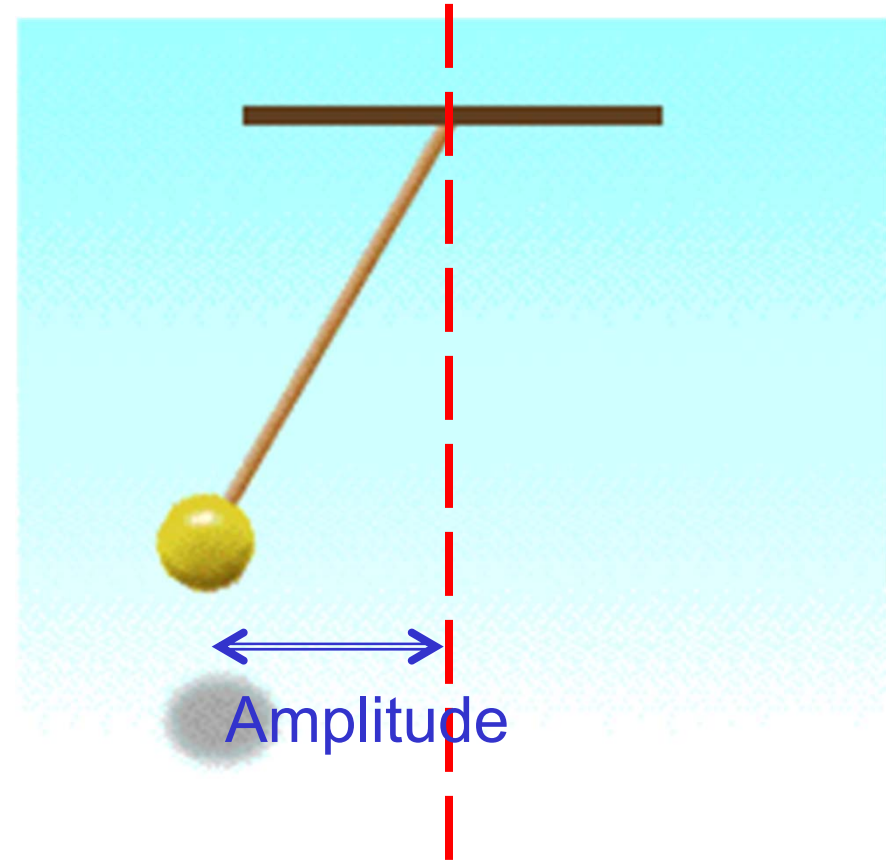Frequency of rotation is the number of revolutions (cycles) per second; it's also the inverse of the period of rotation.

If these tops are spinning 20 revolutions per second then the frequency of rotation is 20 Hertz.

The period of rotation would be 1/20th of a second.

Amplitude

The distance from the center position is the *amplitude* of the motion.

Amplitude

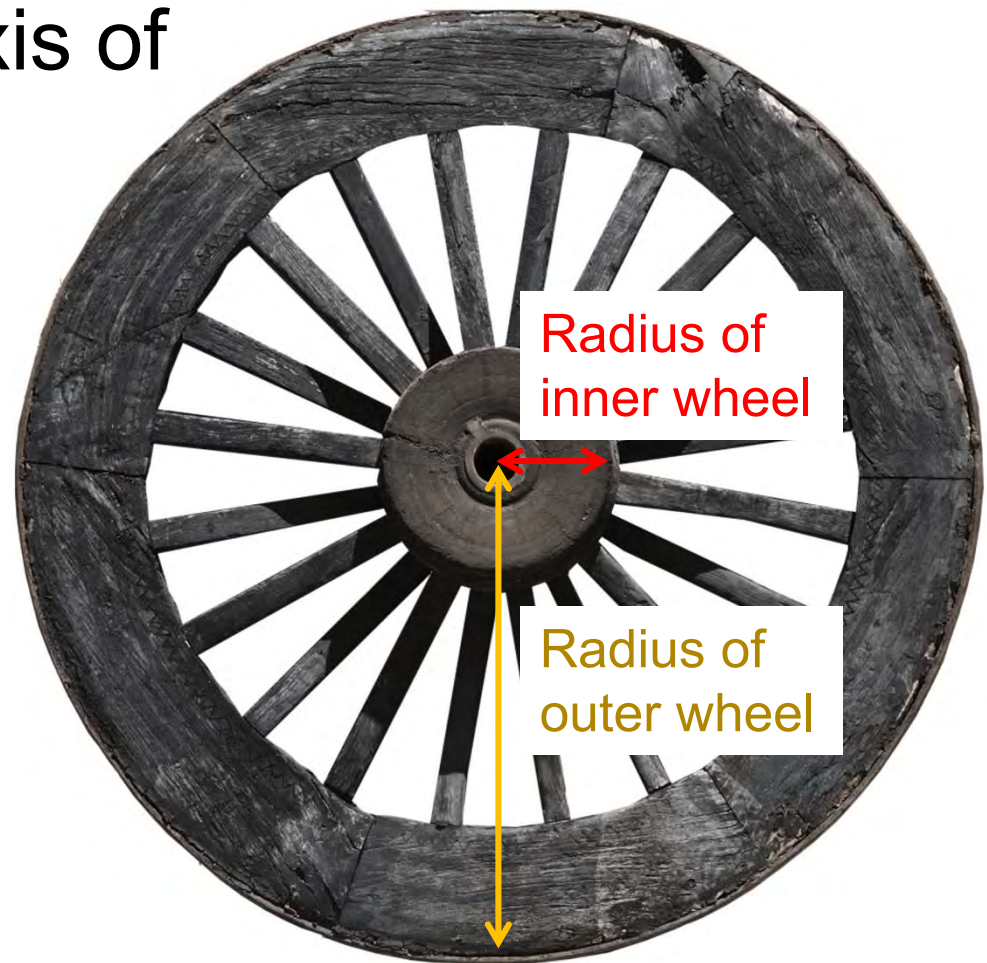In a walk cycle the amplitude is the stride length (distance for 2 steps).

Radius of Rotation

The radius of rotation is the distance from the axis of rotation to the point of interest.

Horse on the outer rim has a larger radius of rotation.

http://www.flickr.com/photos/quinet/

Radius of inner wheel

Radius of outer wheel

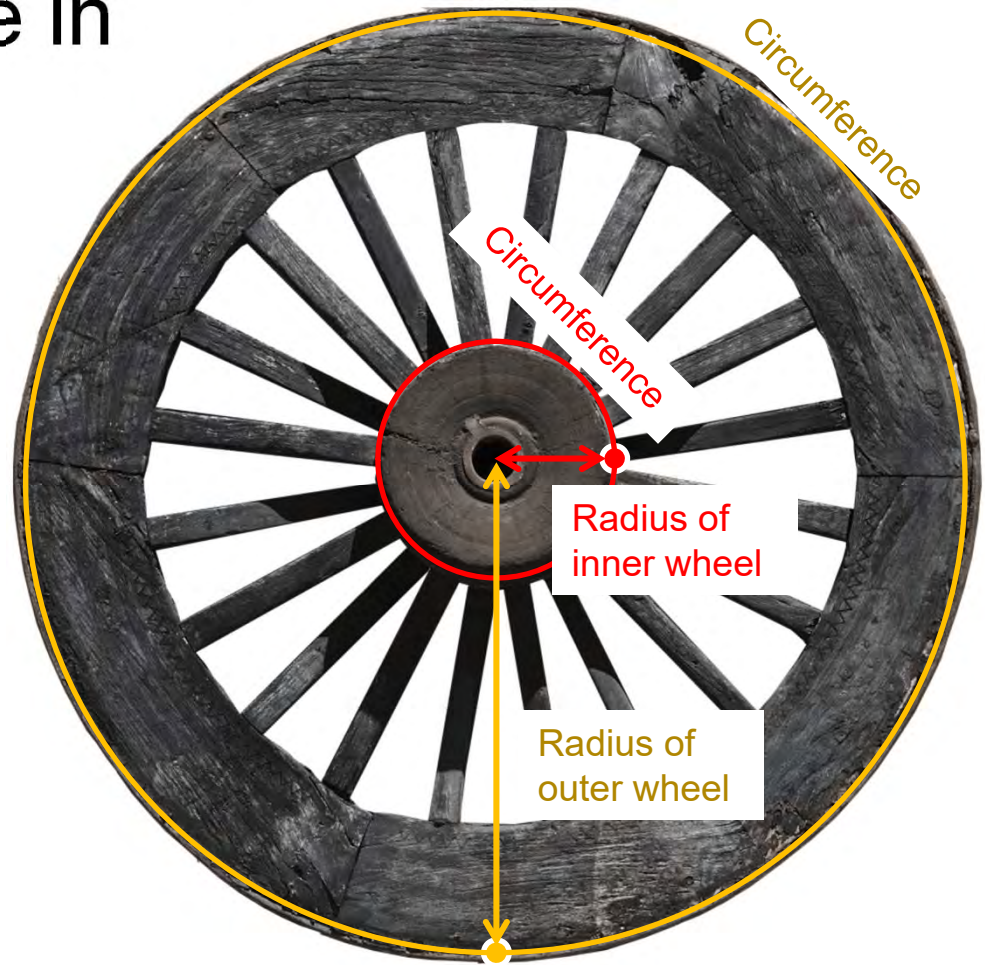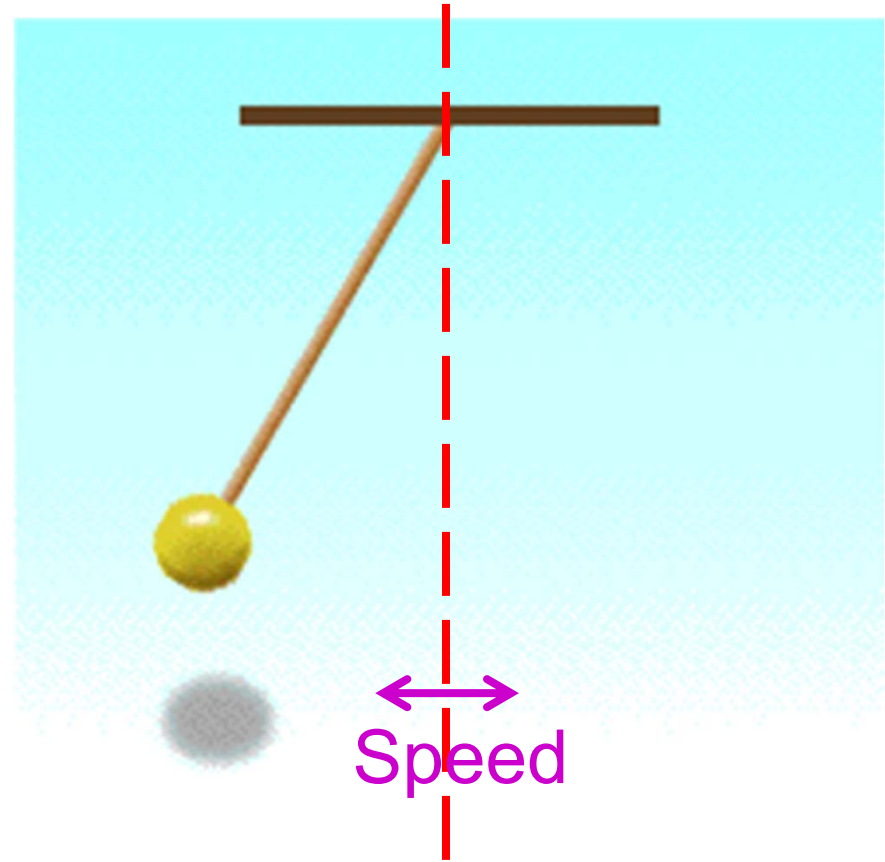# Amplitude and Circumference

Amplitude of a cycle in rotation is the circumference, which depends on the radius of the circle.

(Circumference) = 2π x (Radius)

Speed

Speed of cyclic motion increases with frequency and with amplitude.

(Speed) = (Amplitude) x (Frequency)

or

(Speed) = (Amplitude) / (Period)

Walking Slower or Faster

Going from a slow walk to a fast walk you increase both your stride length (amplitude) and your stride rate (frequency).

Walk	Stride length	Stride rate	Speed
Slow walk	3 feet	$^2/_3$ stride per second	2 feet per sec. (1 $^1/_3$ m.p.h.)
Fast walk	4 feet	1 stride per second	4 feet per sec. (2 $^2/_3$ m.p.h.)

Frequency vs. Speed

Don't confuse the frequency of a cycle with the speed of the motion. The two are related but they're not the same thing.

These dogs can all walk at the same speed but since the small dogs have short legs, their stride rate (frequency) is higher, that is, they take more steps per second.
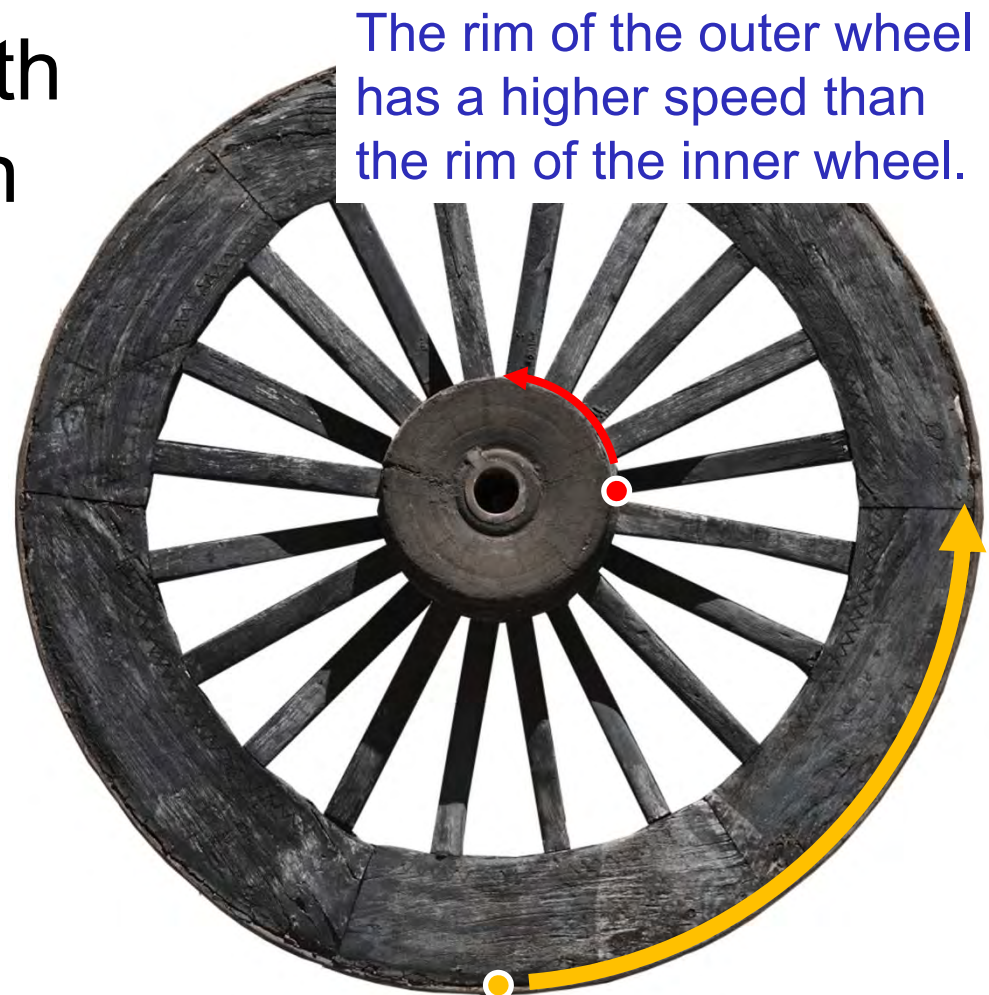

http://www.flickr.com/photos/valeehill/

Speed of Rotational Motion

The speed of rotational motion increases with frequency of rotation and with the radius.

The rim of the outer wheel has a higher speed than the rim of the inner wheel.

Horses on the outer rim travel at a higher speed.

Summary

- Motion that has a repeating pattern is called cyclic motion (or periodic motion).
- The time it takes to complete one full cycle, such as one rotation, is called the period.
- Frequency is the number of cycles per second.
- The amplitude indicates the size of the motion, for example, the stride length in a walk cycle.
- For rotation, the amplitude is the circumference, which depends on the radius of rotation.
- The speed of the motion increases with both amplitude and frequency.