5.2 Angular & Tangential Speed

Angular Speed (symbol: ω)

How much a body rotates per second is analogous to linear speed:

$$\omega = \frac{\Delta\theta}{\Delta t}$$

ω = angular speed (rad/s)
Δθ = change in angle (rad)
Δt = change in time (s)

Omega! Not double you.

Angular Velocity

An object in linear motion moves in a positive or negative direction, making it a vector quantity.

For rotating bodies with some angular speed, we can assign positive or negative direction also, resulting in angular velocity.

We use a trick called the right hand rule (RHR).

How to use RHR:

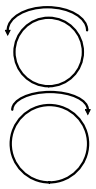
Imagine a rotating wheel.

Curl the fingers of your right hand in the direction of the rotating wheel, thumb sticking out.

If your thumb points toward you, the wheel has positive angular velocity (counterclockwise).

If your thumb points away it is negative (clockwise).

Logic: angles get more positive as you go counterclockwise, and more negative clockwise.



Revolutions Per Minute

It is important to note that angular speed is often measured in terms of revolutions (or rotations (or cycles)) per minute: rpm.

1. How many radians are there in one rotation?

$2\pi\ rad$

2. What is the angular speed of a 1 rpm system?

$$\omega = \frac{\theta}{t} = \frac{2\pi\ rad}{60\ s} = 0.105\frac{rad}{s}$$

This can be used as a conversion factor:

1 rpm = .105 rad/s

Tangential Speed (v_t)

For a point on the edge of a rotating wheel, the rate at which it traces an arc (remember: symbol = s) is its tangential speed (v_t):

$$v_t = r \bullet \omega$$

v_t = tangential speed m/s
r = radius (m)
ω = angular speed (rad/s)

Merry Go Round Physics Democracies!

3. A merry-go-round rotates every 45 s. Two children are on it: one 3.0 m and one 6.0 m from the center. Which child has greater angular speed? Explain your vote.

3 m child	6 m child	same

Angular Speed Physics Democracy

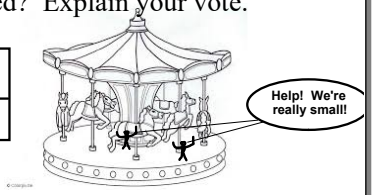
Both riders have the **same** angular speed: they'll sweep out the same angle in the same amount of time:

$$\omega = \frac{\theta}{t} = \frac{2\pi\ rad}{45\,s} = 0.14\,rad/s$$

Another Physics Democracy!

4. For the same merry-go-round, which child has a greater tangential speed? Explain your vote.

3 m child	6 m child	same



Tangential Speed Physics Democracy

The 6 m child: $v_t = r \bullet \omega$

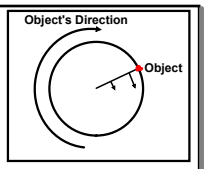
$$= 6.0\,m \bullet 0.14\frac{rad}{s} = 0.84\,m/s$$

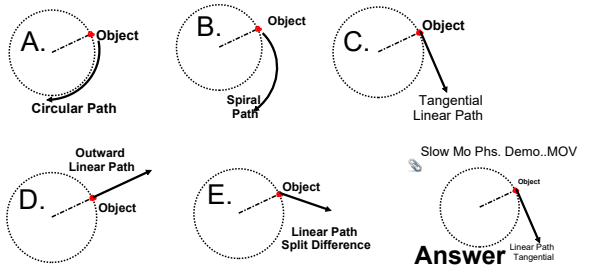
3.0 m child: $v_t = r \bullet \omega$

$$= 3.0\,m \bullet 0.14\frac{rad}{s} = 0.42\,m/s$$

5. Physics Democracy!

If an object in circular motion (like a ball on a string) is released, which way does it go?





Period and Frequency

Period (symbol = T) - time it takes an object to make a full rotation. Units: seconds.

Frequency (symbol = f) - number of rotations per second. Units: cycles/second, s^{-1}, or Hertz (Hz).

Relation: $\boxed{T = \frac{1}{f}}$ and: $\boxed{f = \frac{1}{T}}$

Since an angular distance of 2π rad is traveled in one period: $\boxed{\omega = 2\pi f = \frac{2\pi}{T}}$

6. CD Examples

What are the frequency (cycles/s) and period (s) of a CD player rotating at 200 rpm?

CD Example Answers

You are given a frequency of RPM: cycles per minute.
If you divide that by 60, you'll have a value of revolutions (cycles) per second, or Hz:

$$\omega = 200\,RPM \bullet \frac{1\,\text{min}\,ute}{60\,\text{sec}\,onds} = 3.33\,RPS\,(Hz)$$

Then: $T = \frac{1}{f} = \frac{1}{3.33\,Hz} = 0.300\,s$

This means that it takes 0.300 seconds for the CD to rotate once.

Tomorrow's Plan:

5.3 & 5.4 Notes

Train for manipulatives (toys)

Homework 5.2

Preview 5.3

Problems 5.2 in your Booklet
Due: Next Class

Attachments

Slow Mo Phs. Demo..MOV