Asia - AFP

Typhoon Ma-on leaves Japan, leaves six dead, three missing

Sun Oct 10, 3:07 AM ET

MY Y! Asia - AFP

TOKYO (AFP) - The most powerful typhoon to hit eastern Japan in a decade fizzled out after causing a trail of destruction which left six people dead and three others missing, police and weather officials said.


AFP/File Photo

Typhoon Ma-on slammed into the Tokyo metropolitan area on Saturday, causing floods and mudslides while paralyzing transport systems in the Japanese capital and surrounding areas.

World - AP Asia

Strong Earthquake Rattles Eastern Japan

Wed Oct 6, 2:10 PM ET

MY Y! [World - AP Asia]

By KENJI HALL, Associated Press Writer

TOKYO - An earthquake struck eastern Japan late Wednesday, shaking buildings in Tokyo and other nearby areas, but there were no immediate reports of damage or injuries.

The 5.8-magnitude quake hit at 11:40 p.m. and was centered some 40 miles beneath the earth's surface in Ibaraki state, northeast of the capital, the Meteorological Agency said.

A magnitude-5 earthquake can cause damage to homes if it occurs in a residential area. But the depth of the temblor dampened much of its potentially destructive power.

The temblor, which lasted more than 30 seconds, was most strongly felt in Tsukuba city, in Ibaraki state, and Miyashiro town, in

Class 24 - Rotation
Chapter 10 - Wednesday October 20th

- Definitions
  - Angular displacement, velocity and acceleration
- Vector representation for angular quantities
- Rotation with constant angular acceleration
- Relating linear and angular variables
- Kinetic energy of rotation and rotational inertia

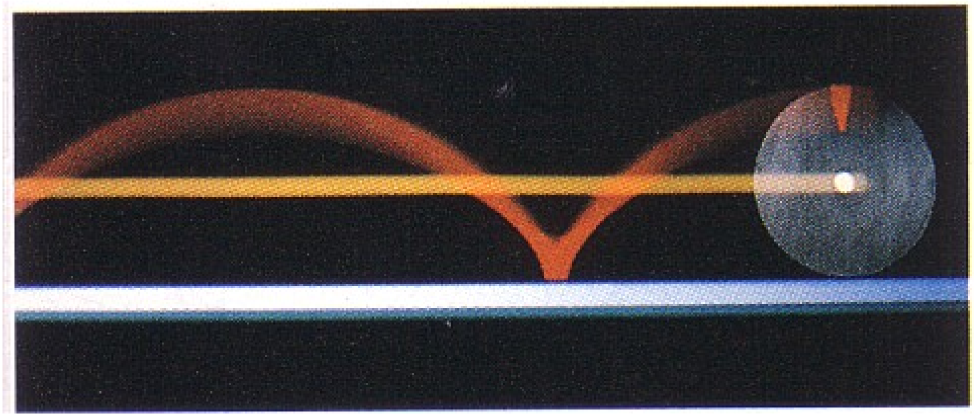
Reading: pages 241 thru 255 (chapter 10) in HRW
Read and understand the sample problems
Assigned problems for Wednesday from chapter 10 (due Sunday October 31st at 11pm):
2, 10, 28, 30, 36, 44, 48, 54, 58, 64, 78, 124

Translation and rotation

Translation

Rotation

Translation + rotation (Ch. 11)



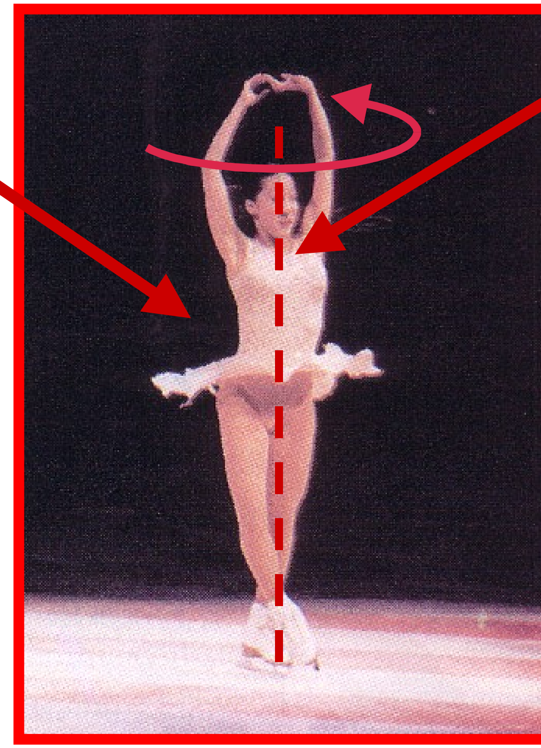
Translation and rotation

Translation

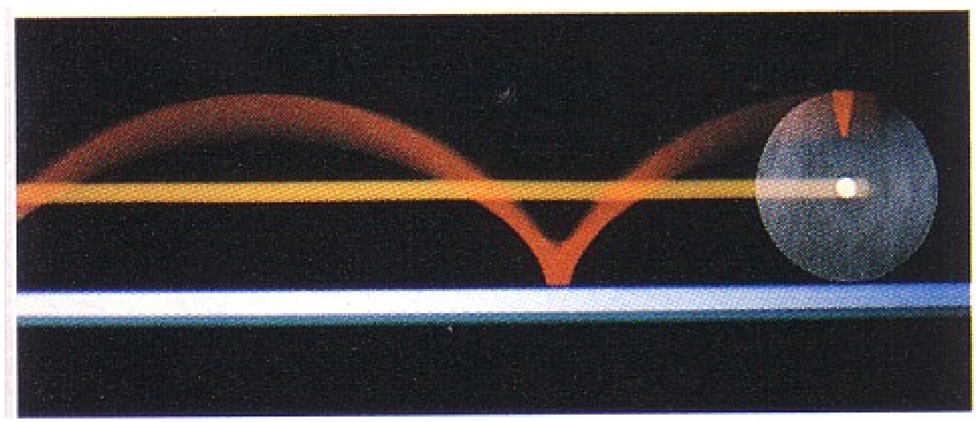
Rotation

Rigid body

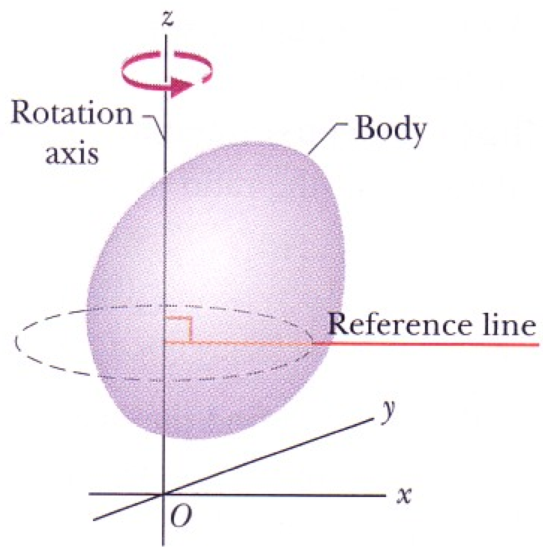
Fixed axis

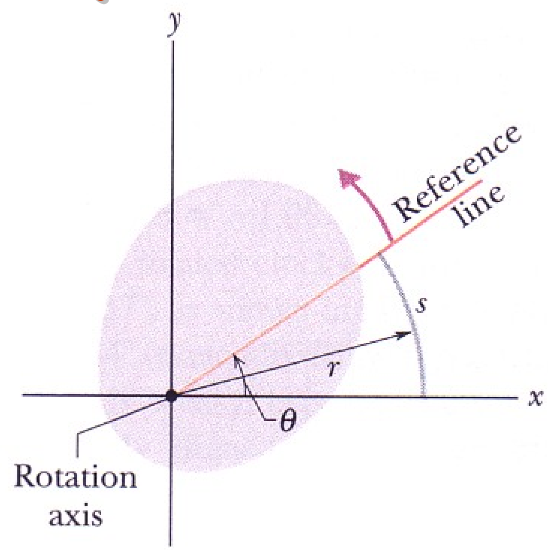


Translation + rotation (Ch. 12)



The rotational variables (scalar notation)





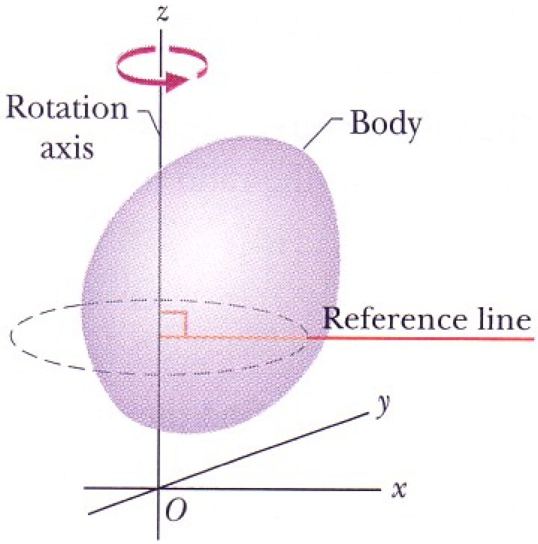
Angular position: $$\theta = \frac{s}{r} \qquad (\text{in radians})$$

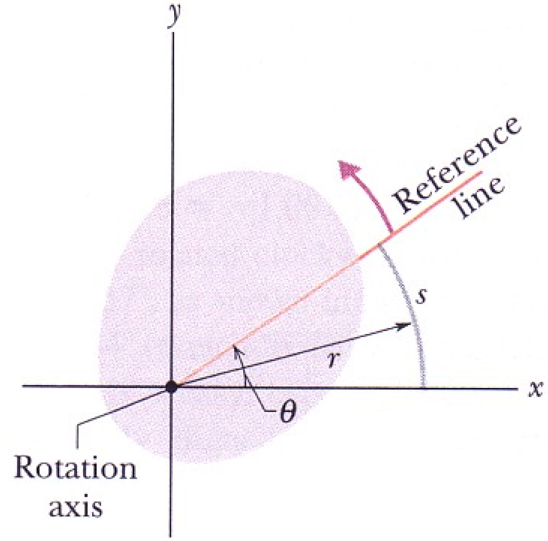
- s is the length of the arc from a reference ($\theta = 0$ rad) line, to the angle θ, at constant radius r.
- The angle θ is measured in radians (rad), which is a ratio of arc length to radius; it is, therefore, a dimensionless quantity.

$$1 \text{ revolution} = 360^o = \frac{2\pi r}{r} = 2\pi \text{ rad}$$

$$1\text{rad} = \frac{360^o}{2\pi} = 57.3^o = 0.159 \text{ revolutions}$$

The rotational variables (scalar notation)

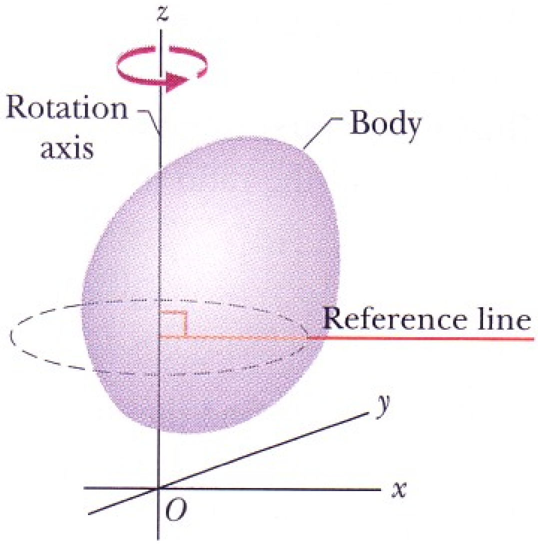


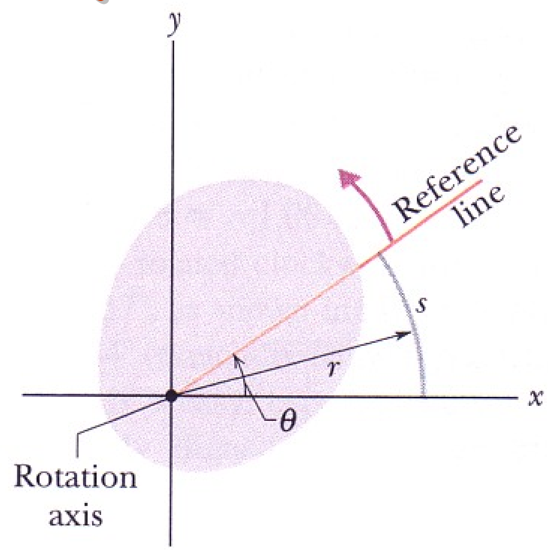


Angular displacement: $$\Delta\theta = \theta_2 - \theta_1$$

An Angular displacement in the counterclockwise direction about an axis (usually the *z*-axis) is positive, and one in the clockwise direction is negative.

The rotational variables (scalar notation)





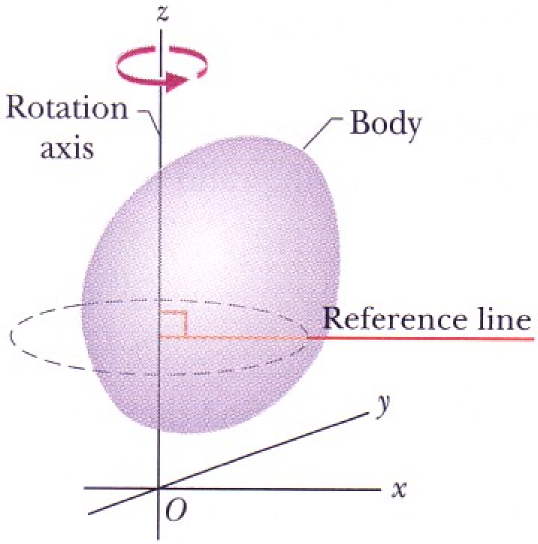
Average angular velocity:

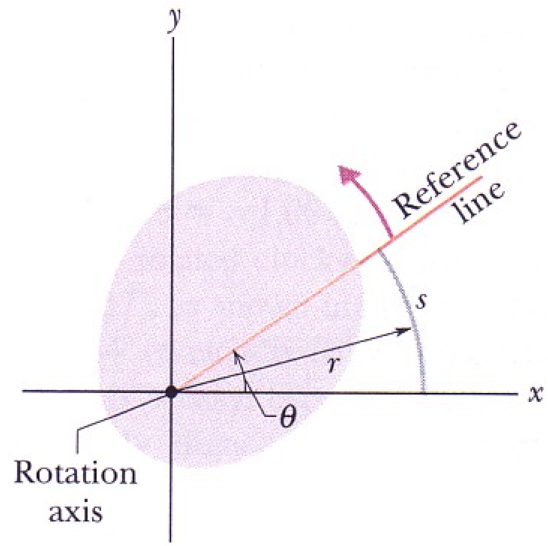
$$\omega_{avg} = \frac{\theta_2 - \theta_1}{t_2 - t_1} = \frac{\Delta\theta}{\Delta t}$$

Instantaneous angular velocity:

$$\omega_{avg} = \lim_{\Delta t \to 0} \frac{\Delta\theta}{\Delta t} = \frac{d\theta}{dt}$$

The rotational variables (scalar notation)

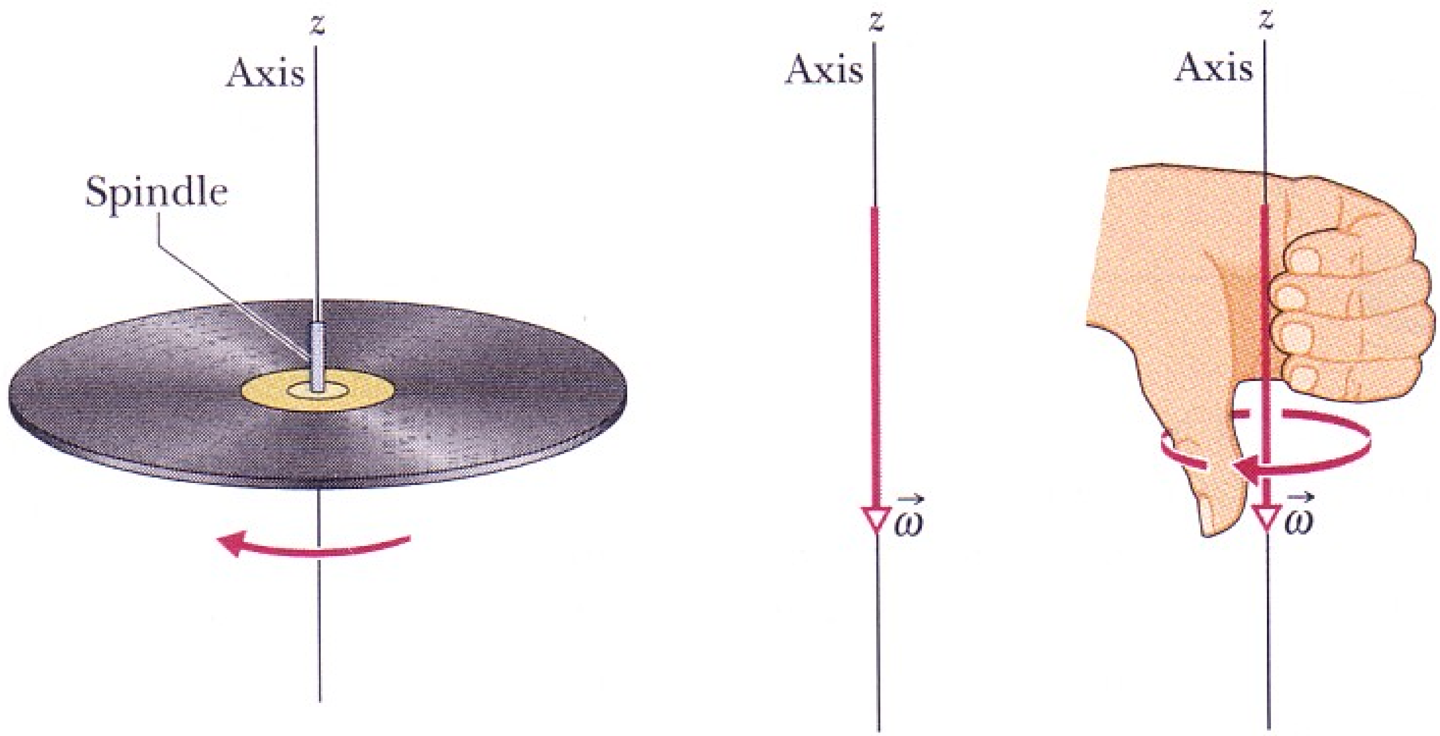




Average angular acceleration: $$\alpha_{avg} = \frac{\omega_2 - \omega_1}{t_2 - t_1} = \frac{\Delta\omega}{\Delta t}$$

Instantaneous angular acceleration: $$\alpha_{avg} = \lim_{\Delta t \to 0} \frac{\Delta\omega}{\Delta t} = \frac{d\omega}{dt}$$

Vector representation of angular quantities



- Angular velocity and acceleration are vector quantities.
- Angular displacement is not (see section 10-3 in HRW).
- Right hand rule determines the direction of the vector, and the magnitude is given by ω for velocity, and by α for acceleration.
- Although displacement does not obey the rules for vectors, one must still specify an axis when giving an angular displacement.

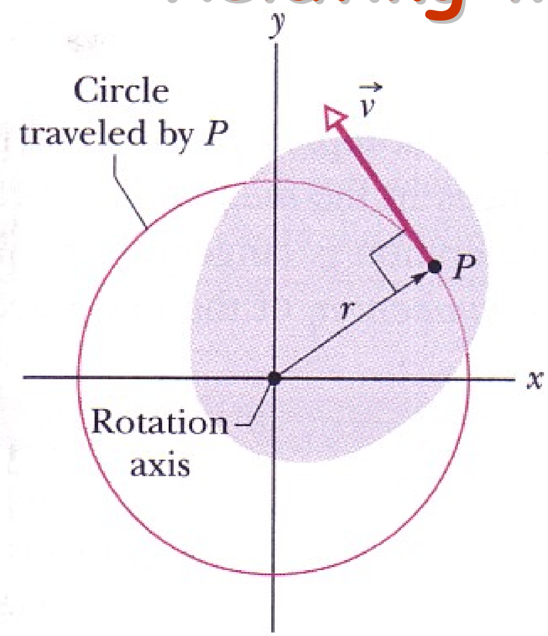
Rotation at constant angular acceleration

TABLE 11-1 Equations of Motion for Constant Linear Acceleration and for Constant Angular Acceleration

Equation Number	Linear Equation	Missing Variable		Angular Equation	Equation Number
(2-11)	$v = v_0 + at$	$x - x_0$	$\theta - \theta_0$	$\omega = \omega_0 + \alpha t$	(11-12)
(2-15)	$x - x_0 = v_0 t + \frac{1}{2}at^2$	v	ω	$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$	(11-13)
(2-16)	$v^2 = v_0^2 + 2a(x - x_0)$	t	t	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$	(11-14)
(2-17)	$x - x_0 = \frac{1}{2}(v_0 + v)t$	a	α	$\theta - \theta_0 = \frac{1}{2}(\omega_0 + \omega)t$	(11-15)
(2-18)	$x - x_0 = vt - \frac{1}{2}at^2$	v_0	ω_0	$\theta - \theta_0 = \omega t - \frac{1}{2}\alpha t^2$	(11-16)

Missing variable	Angular Equation	Equation Number
$\theta - \theta_0$	$\omega = \omega_0 + \alpha t$	(11-12)
ω	$\theta - \theta_0 = \omega_0 t + \frac{1}{2}\alpha t^2$	(11-13)
t	$\omega^2 = \omega_0^2 + 2\alpha(\theta - \theta_0)$	(11-14)
α	$\theta - \theta_0 = \frac{1}{2}(\omega_0 + \omega)t$	(11-15)
ω_0	$\theta - \theta_0 = \omega t - \frac{1}{2}\alpha t^2$	(11-16)

Relating linear and angular variables



(a)

The position: $s = \theta r \qquad (\theta \text{ in radians})$

The speed (differentiate the above):

$$\frac{ds}{dt} = \frac{d\theta}{dt} r$$

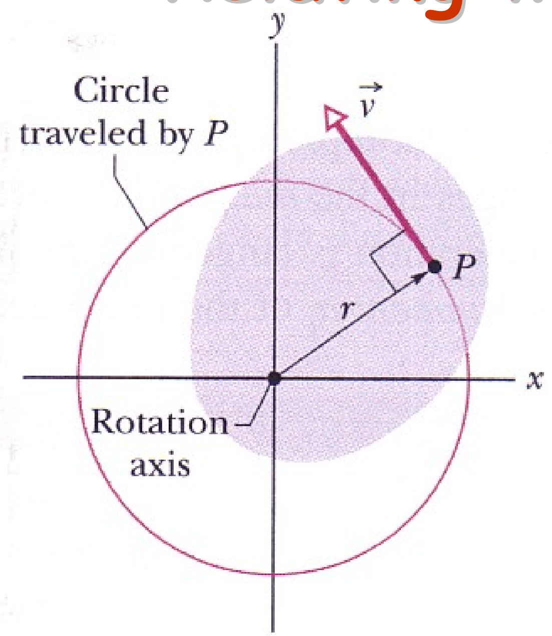
But, ds/dt is the instantaneous speed v.

$$v = \frac{d\theta}{dt} r = \omega r$$

All points on a rigid body have the same ω, so points with greater radius r have greater speed v; the directions are not the same for different points on a rigid body - in fact

$$\boxed{\vec{v} = \vec{\omega} \times \vec{r}}$$

Relating linear and angular variables



(a)

The position: $s = \theta r \quad (\theta \text{ in radians})$

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$$\frac{ds}{dt} = \frac{d\theta}{dt} r$$

But, ds/dt is the instantaneous speed v.

$$v = \frac{d\theta}{dt} r = \omega r$$

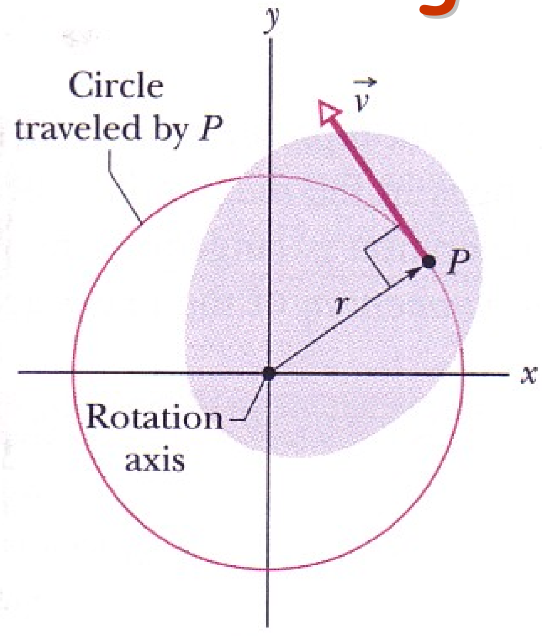
The time period for rotation is:

$$T = \frac{\text{circumference}}{\text{velocity}} = \frac{2\pi r}{v} = \frac{2\pi}{\omega}$$

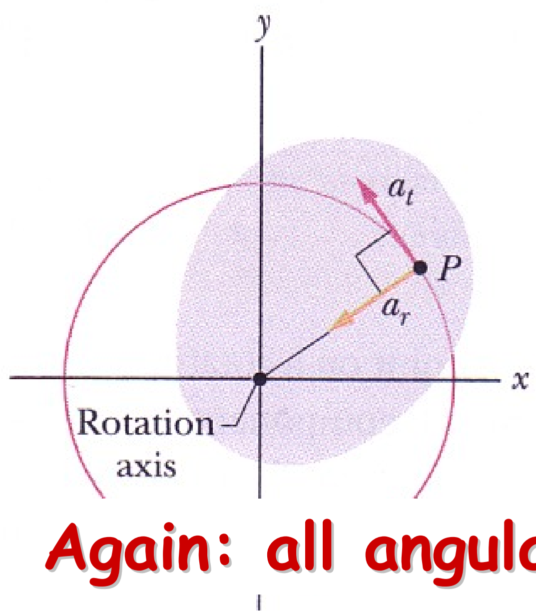
Note: T is independent of r.

Important: all angular measurements must be in radians!

Relating linear and angular variables



(a)



Acceleration:

$$\frac{dv}{dt} = \frac{d\omega}{dt} r$$

So, $$a_t = \alpha r$$

a_t is the linear tangential acceleration

Centripetal acceleration:

$$a_r = \frac{v^2}{r} = \omega^2 r$$

Again: all angular measurements must be in radians!

Kinetic energy of rotation

$$K = \tfrac{1}{2}m_1v_1^2 + \tfrac{1}{2}m_2v_2^2 + \tfrac{1}{2}m_3v_3^2 + \cdots\cdots$$

$$= \sum \tfrac{1}{2}m_iv_i^2$$

where m_i is the mass of the ith particle and v_i is its speed.

Re-writing this:

$$K = \sum \tfrac{1}{2}m_i(\omega r_i)^2 = \tfrac{1}{2}\left(\sum m_i r_i^2\right)\omega^2$$

The quantity in parentheses tells us how mass is distributed about the axis of rotation. We call this quantity the rotational inertia (or moment of inertia) I of the body with respect to the axis of rotation.

$$I = \sum m_i r_i^2 \qquad\qquad K = \tfrac{1}{2}I\omega^2$$