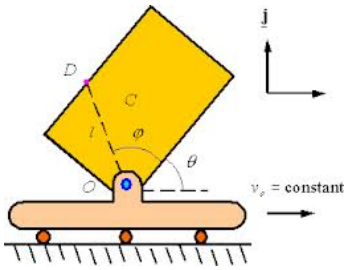
9.1 Rigid Bodies, Translations, Rotations



Rigid Bodies

We have considered objects as a center of mass (CM).

Rotational motion needs to have a broader perspective, since different parts of objects will have different tangential speeds.

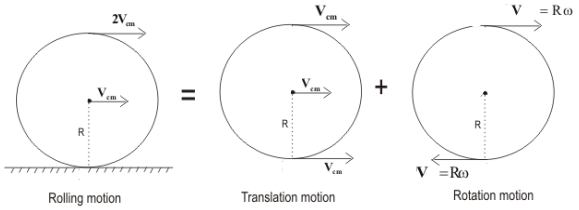
A Rigid Body is an object or system of particles in which distances between particles remain fixed.

Motion

Bodies in this Unit will be put through two types of motion:

Translational: linear motion studied earlier.

Rotational: movement about a fixed axis. All particles will have the same angular velocity.

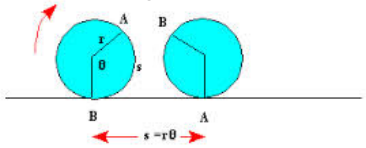


More Motion

When an object rolls (without slipping!), it contacts the ground along an instantaneous axis of rotation.

The point of the object at this axis has a velocity of zero, the center of the rolling object has a velocity of v, and the top of the object has a velocity of 2v.

The CM of the object will be above the instantaneous axis, and will move through the arc distance s.



Rolling Mathematics

The speed of the CM is a function of radius and angular speed:

$$v_{CM} = \frac{s}{t} = r\frac{\theta}{t} = r\omega$$

It is also expressed:

$$s = r\theta$$

And acceleration of a rolling body:

$$a_{CM} = \frac{v_{CM}}{t} = \frac{r\omega}{t} = r\alpha$$

Rolling Example

A rolling cylinder has a radius of 12 cm, and a CM speed of 0.10 m/s. If it continues traveling at this speed for 2.0 s, through what angle does the cylinder rotate?

Rolling Example Answer

First, find angular speed:

$$v_{CM} = r\omega$$

$$\omega = \frac{v_{CM}}{r} = \frac{0.10\,m/s}{0.12\,m} = 0.83\,rad/s$$

Then:

$$\theta = \omega t = 0.83\,rad/s \bullet 2.0\,s = 1.7\,rad$$

Homework 9.1

Read 8.1 & 8.2 in your book
Problems 9.1 in your Booklet
Due: Next Class