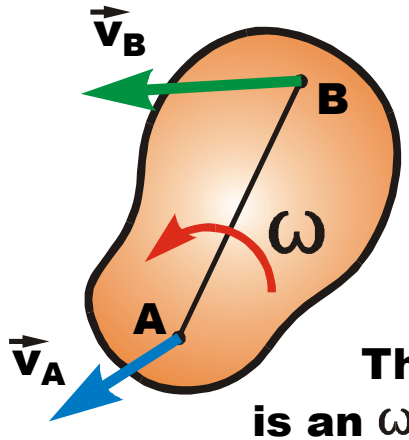
Ch. 16: Rigid Body Planar Motion (cont'd)

- Last Class: Intro to RB Motion, Fixed Axis Rotation
- Today: General Plane Motion (Using the Relative Velocity Eqn)

Today's topic is extremely important.

In the weeks to come, we will use the Relative Velocity Equation repeatedly to solve for velocities in many kinds of mechanisms. Work hard to learn this well. It will take some time to get comfortable with it, but hang in there. It's fun!



Body undergoing general plane motion.

$$\vec{v}_A + \vec{v}_{B/A} = \vec{v}_B$$

The relative term, $\vec{v}_{B/A}$, is an $\omega \cdot r_{B/A}$ term. In other words, it is a rotation term. More later on this.

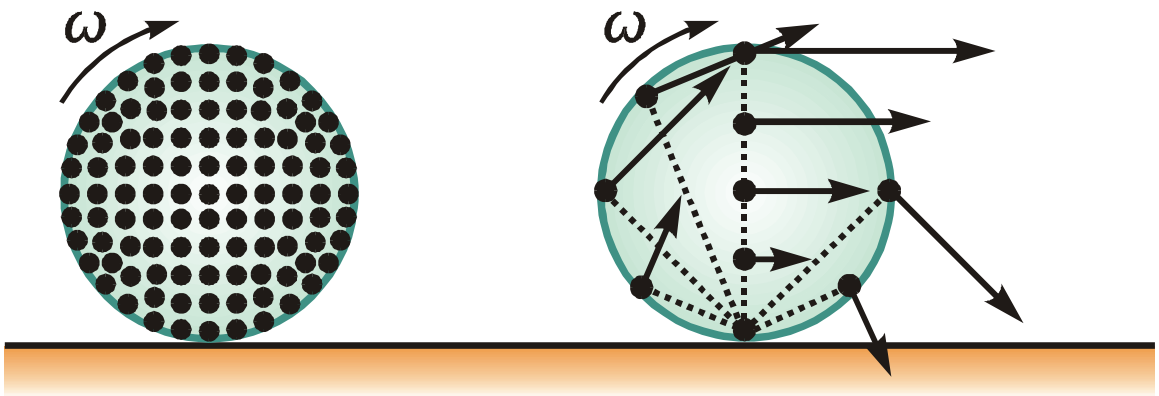
Important: We will use the Rel Vel Eqn to relate any two velocities on a Rigid Body to that body's angular velocity, ω.

A rigid body undergoing general plane motion has…

- An infinite number of points (duh! This is the def'n of a rigid body)
- Thus, an infinite number of velocities (one per point)
- One angular velocity, ω.

General Plane Motion: ∞ **number of points, velocities**

Example: Rolling Wheel **ONE** ω **(angular velocity)**



Every point on the body has a different velocity.

Understanding the terms in the Relative Velocity Equation

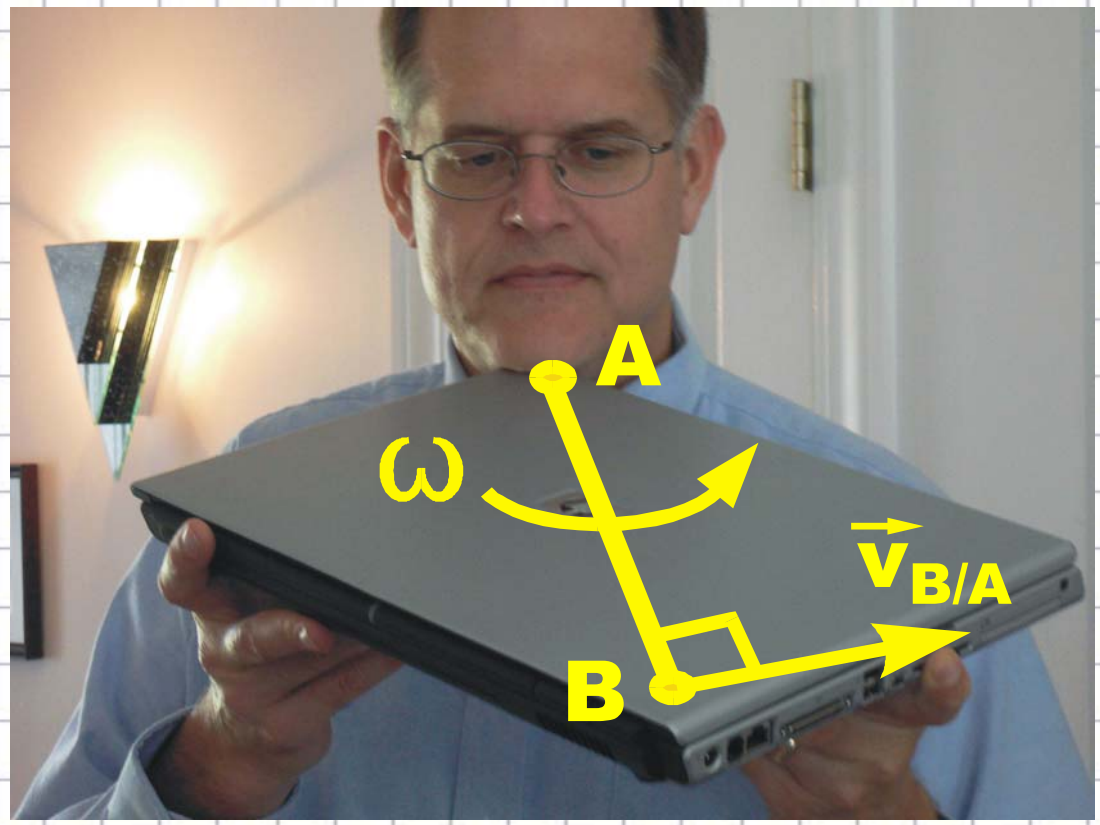
The Relative Velocity Equation:

$$\mathbf{v_B = v_A + v_{B/A}}$$

- v_B and v_A are self-explanatory: They are vectors, the velocities (both magnitude and direction) of points B and A.
- The relative term, $v_{B/A}$, is a rotation term.
- The motion of B relative to A is what an observer at A sees. If I place my chin at A on a body (a book or briefcase) and look at B, B cannot move toward me nor away from me. Why? Because the body is rigid. Line $r_{B/A}$ is a fixed length. For B to move toward or away from me the body would have to stretch.
- So, the only way that B can move relative to A is perpendicular to a line ($r_{B/A}$) drawn from A to B.
- But, this is a rotation! Point B moves in a circle relative to A.
- See the picture on the next page.

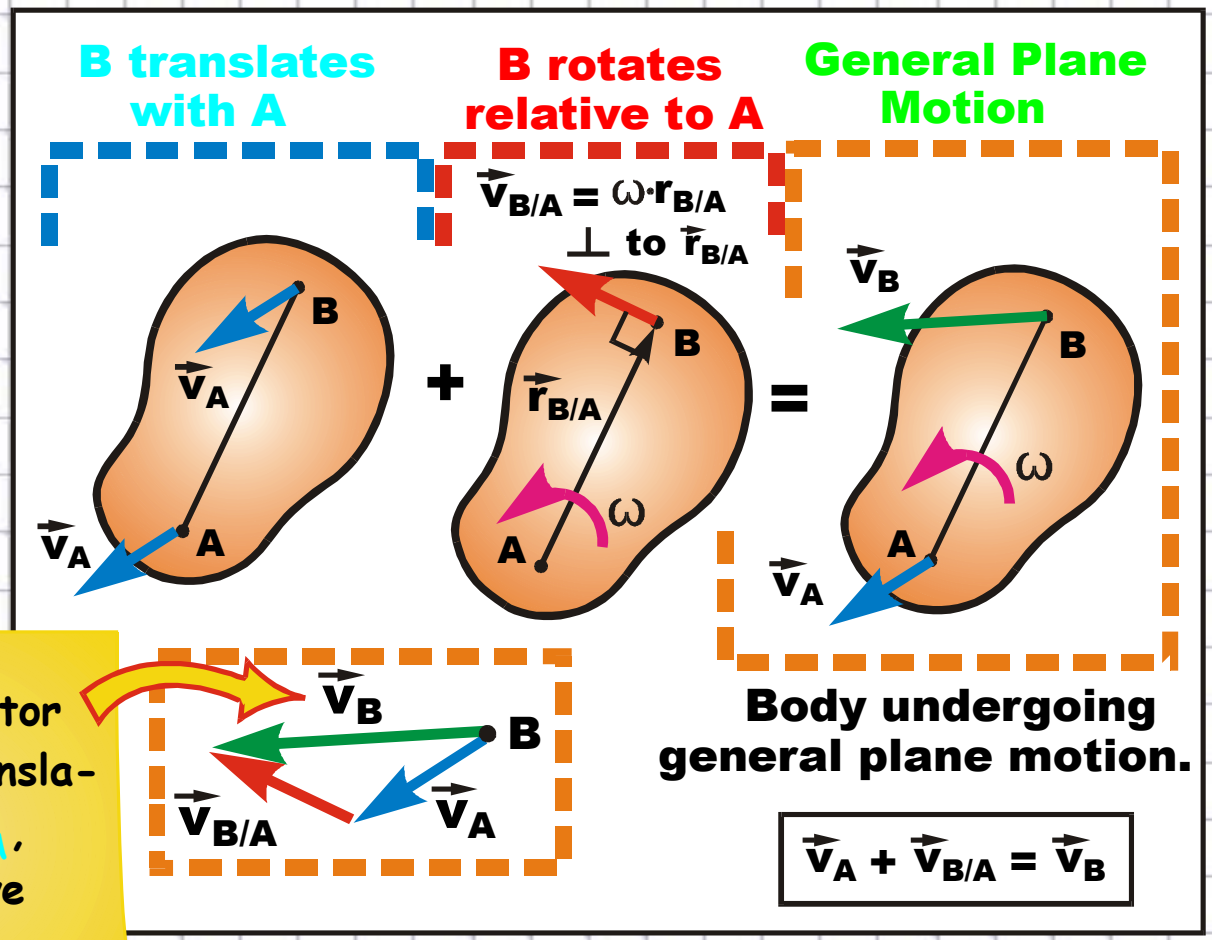
Understanding the relative term, $v_{B/A}$

The motion of B relative to A is what an observer at A sees. If I place my chin at A on a body (a book or laptop) and look at B, B cannot move toward me nor away from me. Why? Because the body is rigid. Line $r_{B/A}$ is a fixed length. For B to move toward or away from me the body would have to stretch.



General Plane Motion = Translation + Rotation

The v_B vector is the vector sum of v_A plus an ωr rotation term.



$\vec{v}_B$ is the vector sum of a translation term, $\vec{v}_A$, plus a relative rotation, $\vec{v}_{B/A}$.