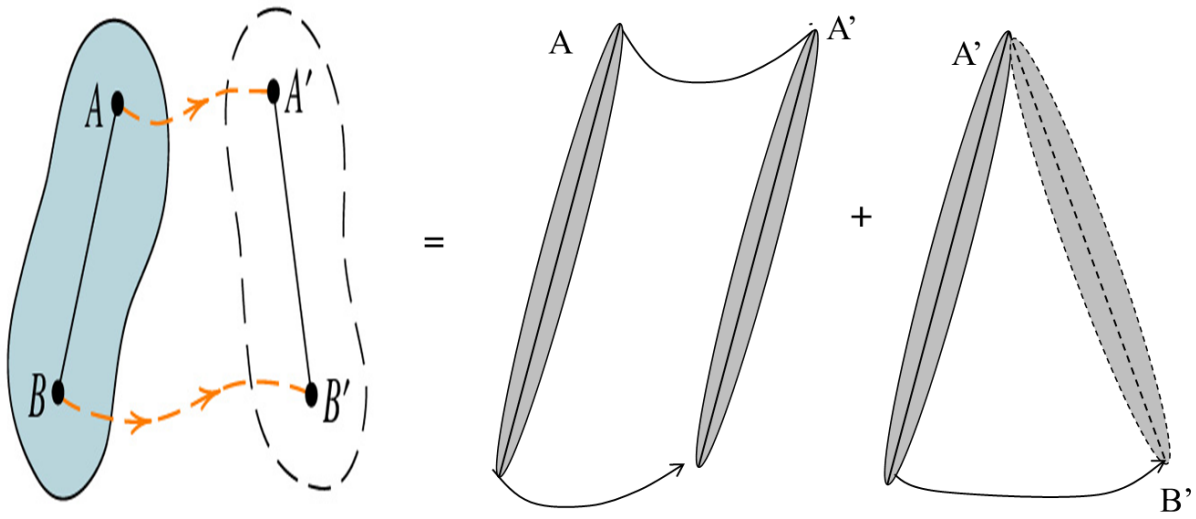
MMAN2300
Engineering Mechanics 2

Part A: Week 1

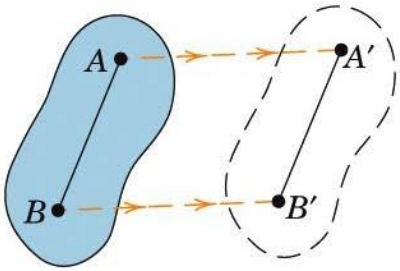
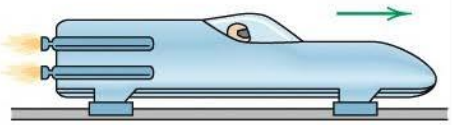
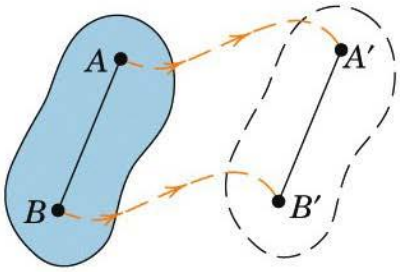
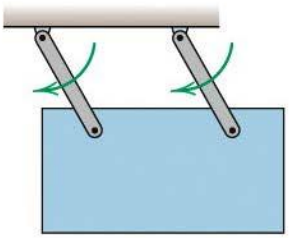
Velocity analysis of rigid bodies

(Chapter 5/1-5/4 Meriam and Kraige)

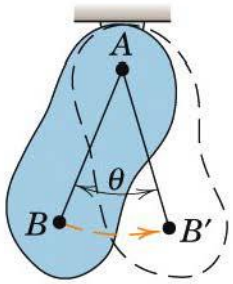
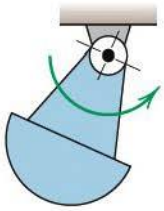
1. General plane motion of a rigid body can be described as a combination of translation and rotation



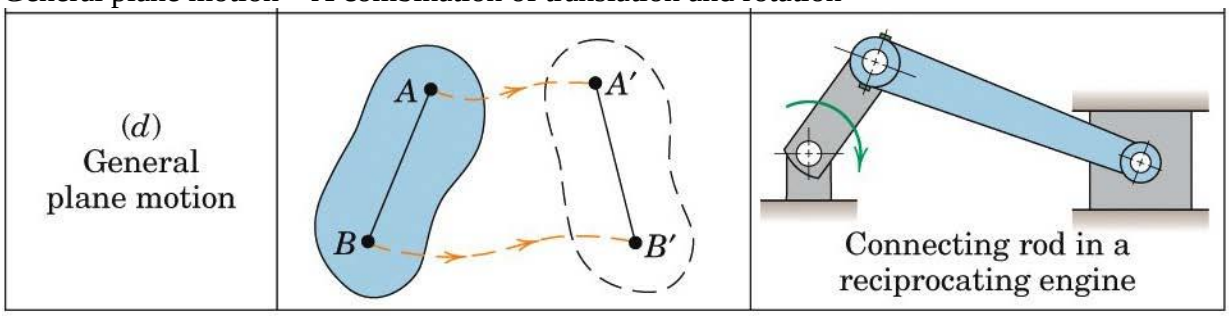
Translation - Defined as any motion in which every line in the body remains parallel to its original position at all times

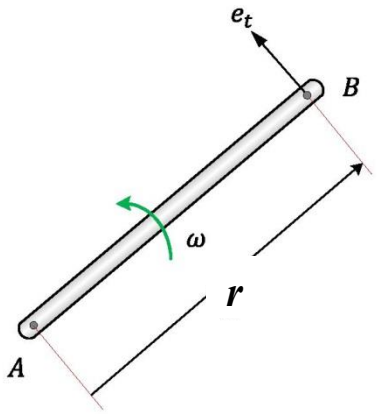
(*a*) Rectilinear translation		 Rocket test sled
(*b*) Curvilinear translation		 Parallel-link swinging plate

Rotation - All particles in a rigid body move in circular paths about the axis of rotation, and all lines in the body which are perpendicular to the axis of rotation rotate through the same angle in the same time

(*c*) Fixed-axis rotation		 Compound pendulum

General plane motion – A combination of translation and rotation





Points *A* and *B* are fixed on a rigid body.

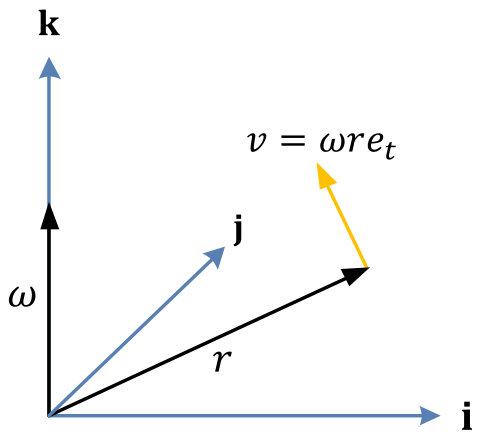
The velocity of point *B* is:

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

(or $\vec{v}_B = \vec{v}_A + \vec{v}_{B/A}$, $\underline{v}_B = \underline{v}_A + \underline{v}_{B/A}$)

$\boldsymbol{v}_{B/A} = \omega r \boldsymbol{e}_t = = \boldsymbol{\omega} \times \boldsymbol{r}$

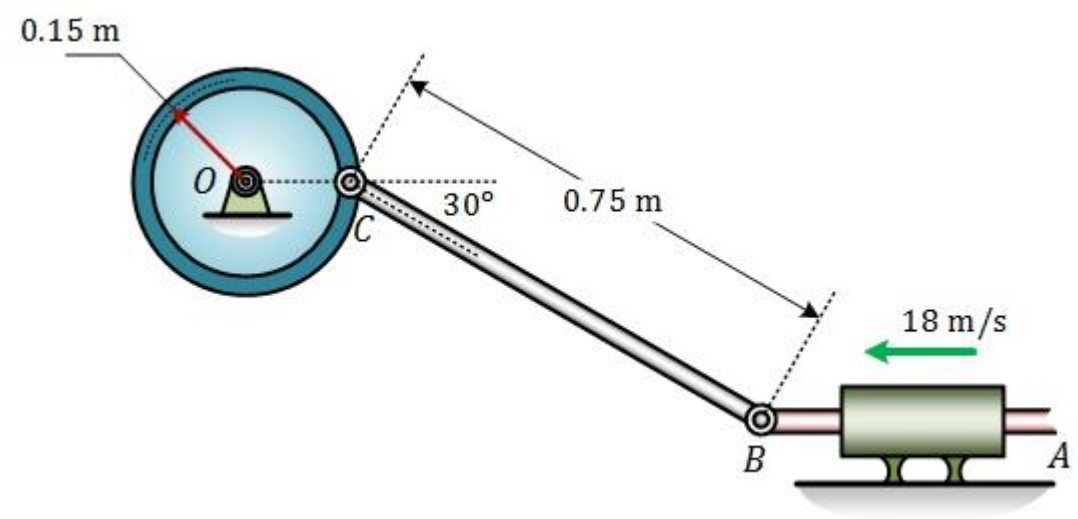
Right hand rule



Alternatively, the definition $\boldsymbol{v} = \boldsymbol{\omega} \times \boldsymbol{r}$ gives the direction of $\boldsymbol{v}$. It is at right angles to both $\boldsymbol{\omega}$ and $\boldsymbol{r}$ is in the right-handed sense. If you put your right thumb in the direction of $\boldsymbol{\omega}$ and your forefinger in the direction of $\boldsymbol{r}$, your right middle finger points in the direction of $\boldsymbol{v}$.

Example 1

If rod *AB* slides along the horizontal slot with a velocity of 18 m/s, determine the angular velocities of link *BC* and the disk at the instant shown.



Example 2

For the instance represented, crank *OB* has a clockwise angular velocity $\omega = 0.8$ rad/s and is passing the horizontal position.
Determine:
(a) the corresponding velocity of the guide roller *A* in the 20° slot,
(b) the velocity of point *C* midway between *A* and *B*.