

Mechanism

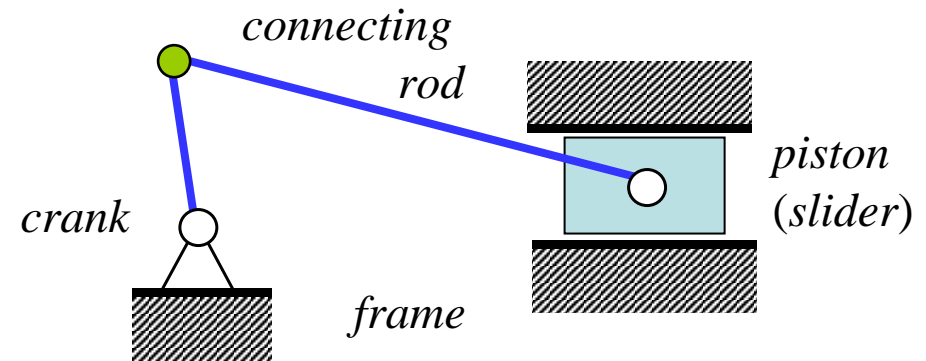
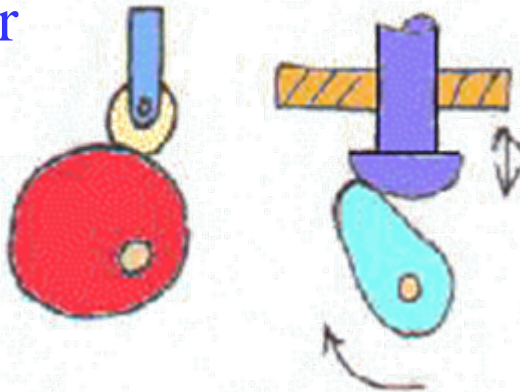
Any device that transforms motion

- Amplification
- Change type of motion
 - rotation \leftrightarrow translation
 - uniform \leftrightarrow reciprocating/oscillating



Sprocket and chain

Cam follower



Slider-crank linkage

Goal

- ❑ Understand kinematics of mechanisms
 - Focus on motion
- ❑ Apply particle kinematics
 - Focus on motions of particles attached to parts of mechanisms
 - Interested in constrained motion

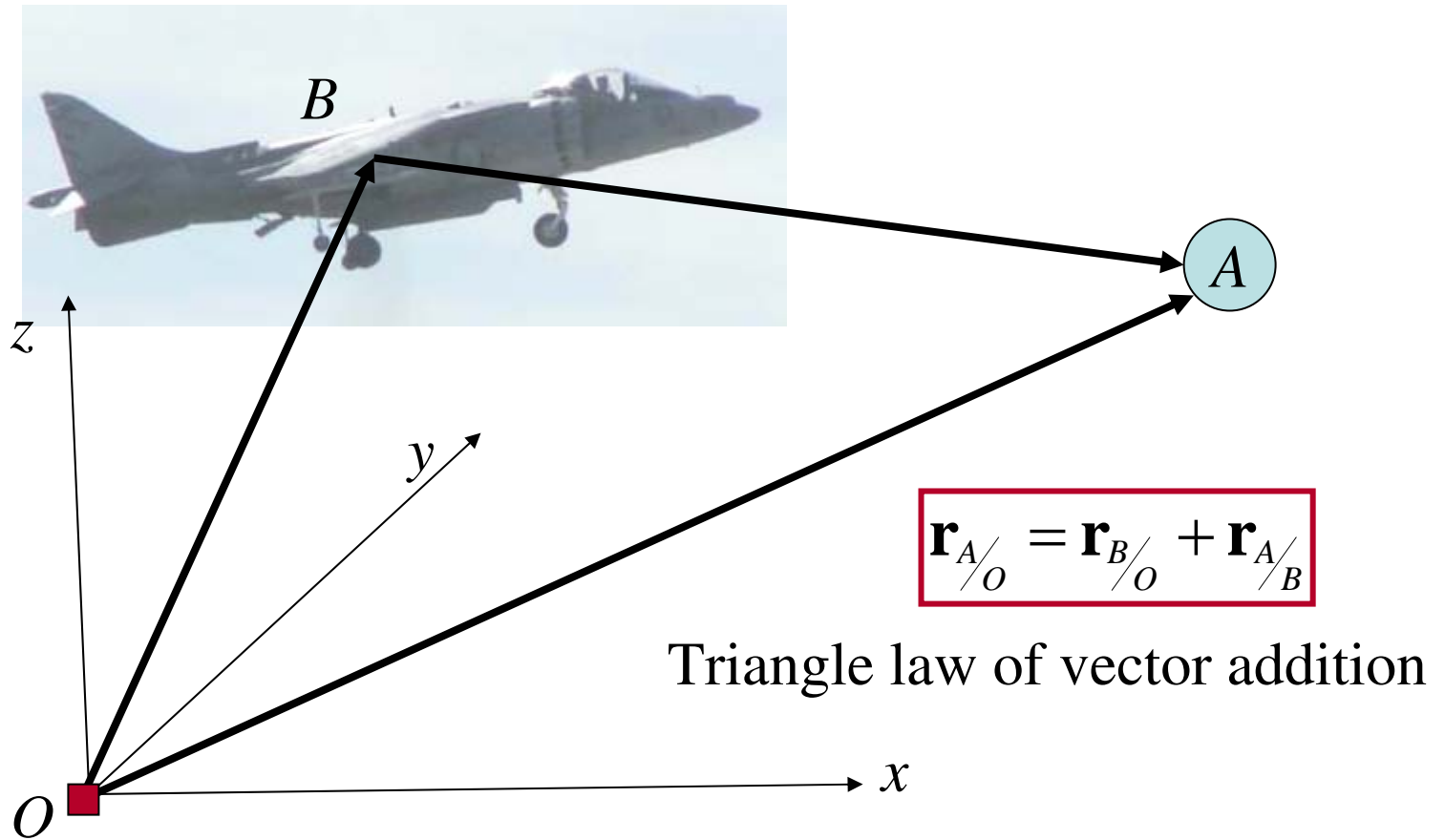
Note:

Technically machines are devices that transmit or modify energy/forces.

Mechanisms transmit/modify motion.

Position Vectors

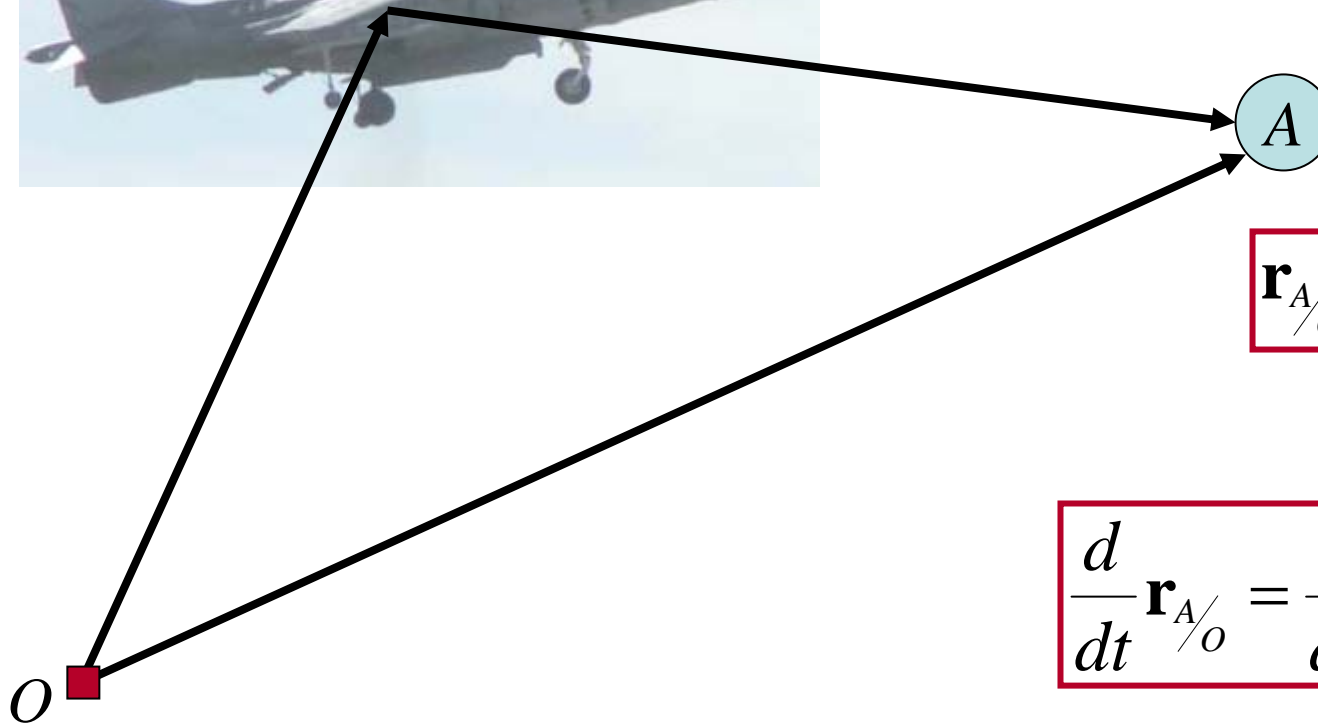
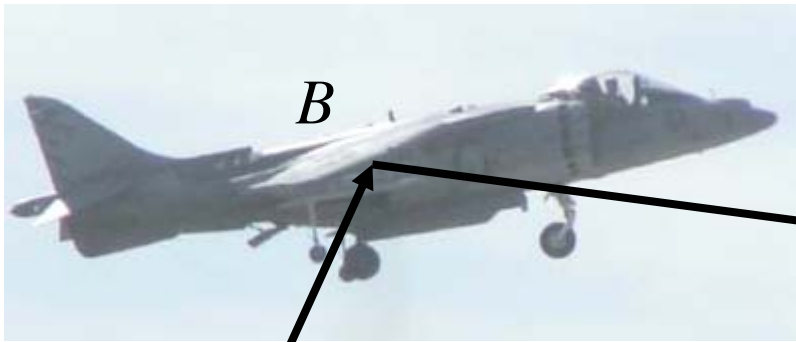
Position Vector (s)



Note: No need for a x - y - z coordinate system

Velocity and Acceleration Vectors

What do these vectors really mean?



$$\mathbf{r}_{A/O} = \mathbf{r}_{B/O} + \mathbf{r}_{A/B}$$

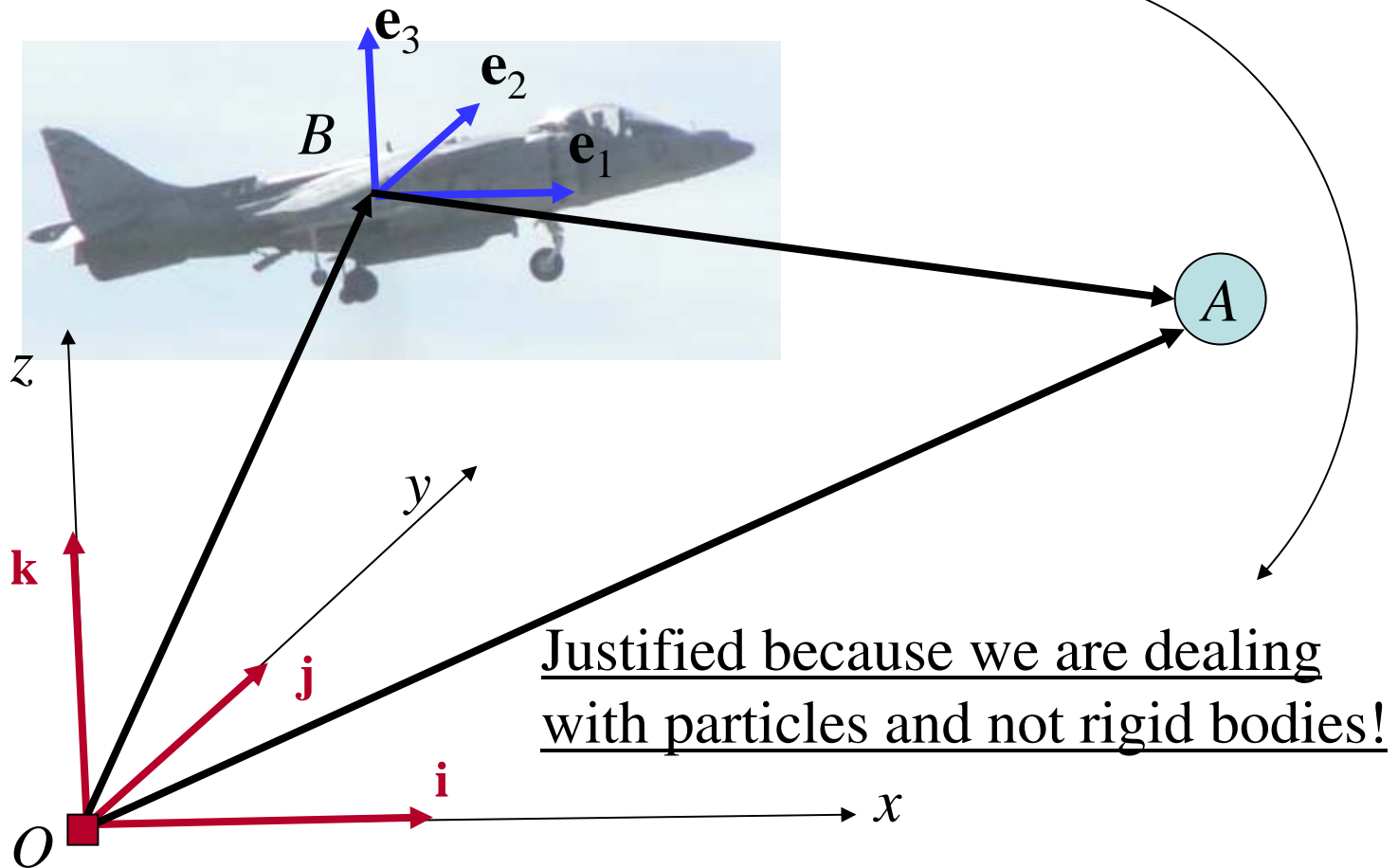
$$\frac{d}{dt} \mathbf{r}_{A/O} = \frac{d}{dt} \mathbf{r}_{B/O} + \frac{d}{dt} \mathbf{r}_{A/B}$$

$$\frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{A/O} \right) = \frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{B/O} \right) + \frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{A/B} \right)$$

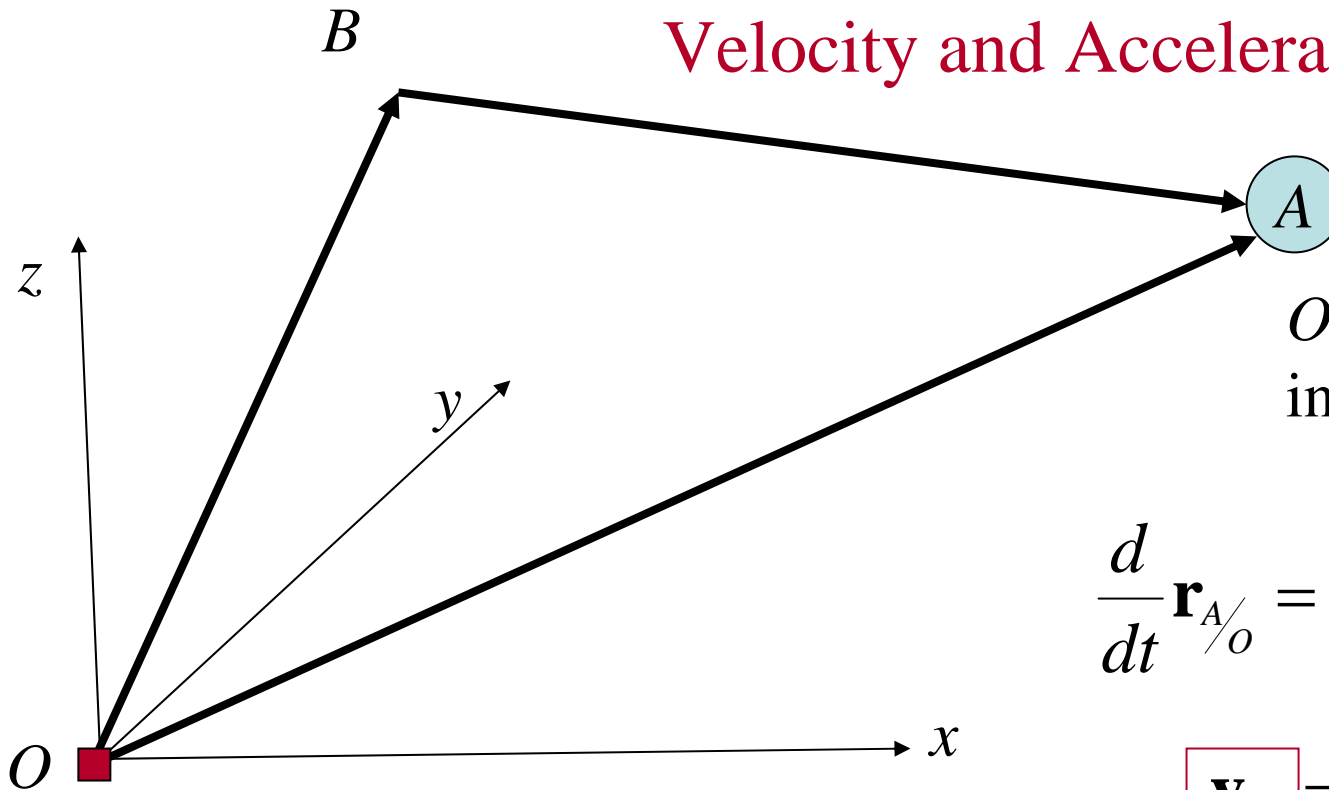
Differentiation of Vectors

Assume

- All coordinate systems are parallel (for now)
- O is fixed to an inertial frame



Velocity and Acceleration Vectors



O is fixed to an inertial frame

$$\frac{d}{dt} \mathbf{r}_{A/O} = \frac{d}{dt} \mathbf{r}_{B/O} + \frac{d}{dt} \mathbf{r}_{A/B}$$

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

$$\frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{A/O} \right) = \frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{B/O} \right) + \frac{d}{dt} \left(\frac{d}{dt} \mathbf{r}_{A/B} \right)$$

$$\mathbf{a}_A = \mathbf{a}_B + \mathbf{a}_{A/B}$$

Why have we dropped the subscript

$_{/O}$ from $\mathbf{v}_{A/O}$? And from $\mathbf{v}_{B/O}$?

Constraints

Constraints on the position (configuration) of a particle (or system of particles).

- Particle in 3-D, but constrained to lie on a plane:

$$A x + B y + C z + D = 0$$

- A particle suspended from a string in three dimensional space.

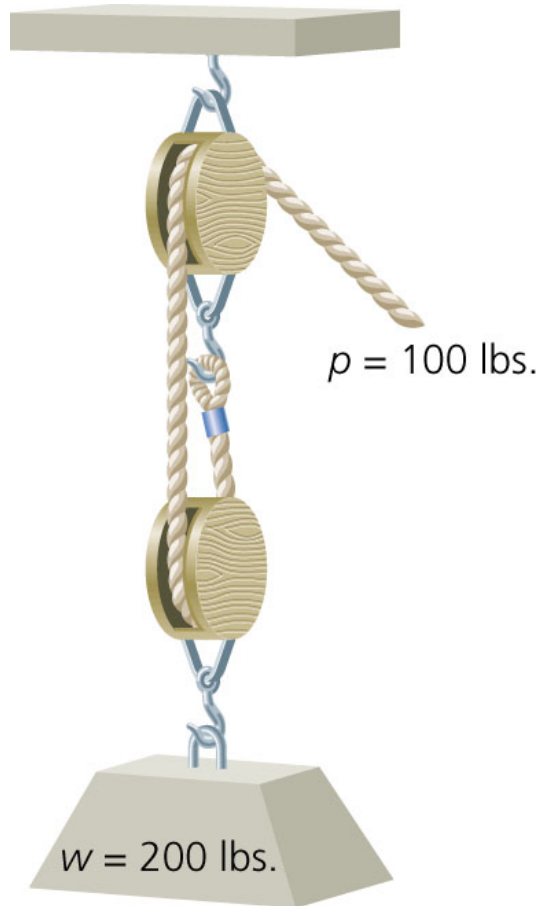
$$(x - a)^2 + (y - b)^2 + (z - c)^2 - r^2 = 0$$

- A particle on spinning platter (carousel)

$$x = a \cos(\omega t + \phi);$$

$$y = a \sin(\omega t + \phi)$$

Pulleys, cables, blocks and tackles



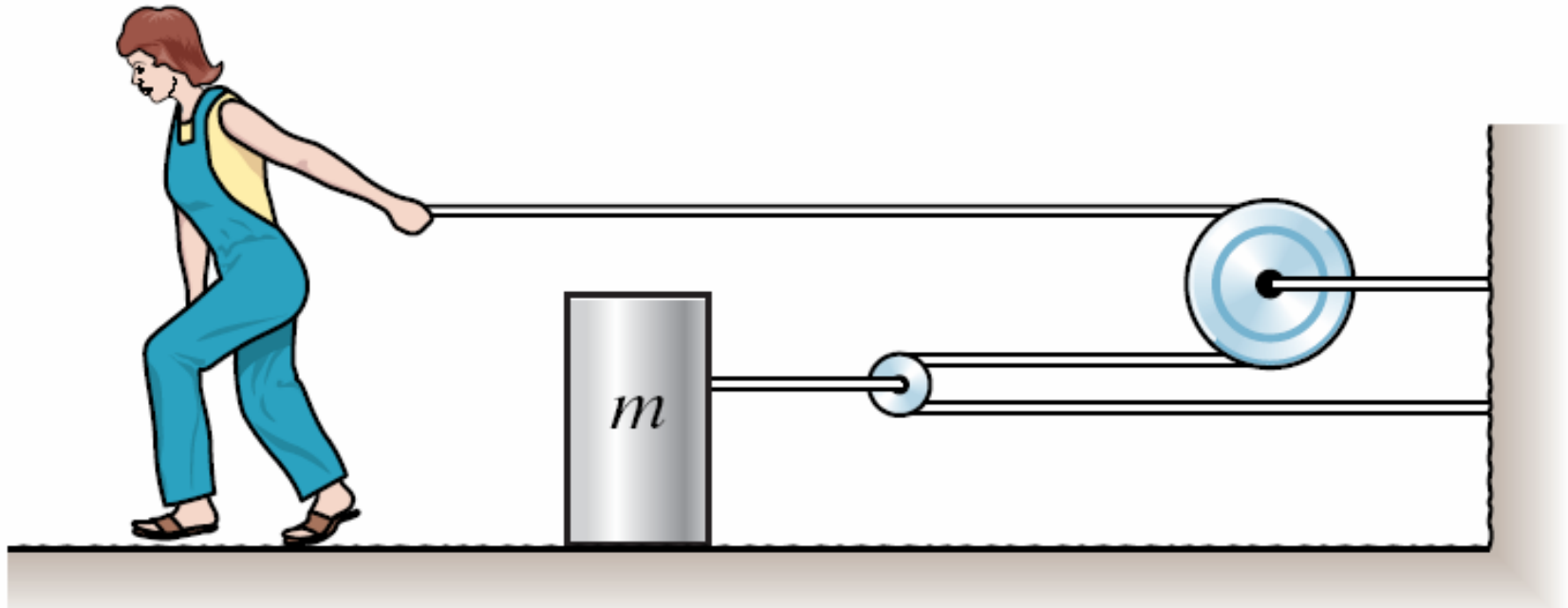
Block and Tackle assembly

- An assembly of blocks, pulleys, and cables that allow a single cable to hoist a large weight (or apply a large force)

<http://www.jimloy.com/cindy/block.htm>

American Heritage

Example

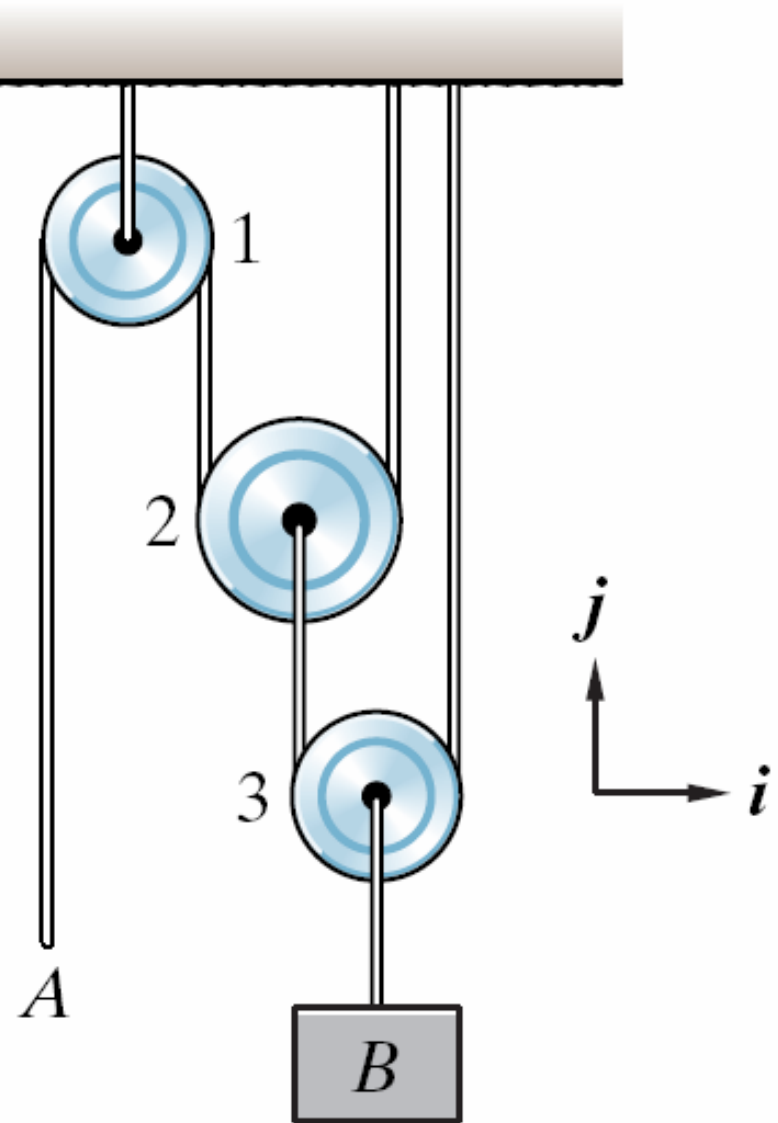


If she moves to the left at 2 m/sec,
how fast does the mass m move?
I.e., what is the velocity of the
mass?

Exercise 2.5.10 (p. 85)

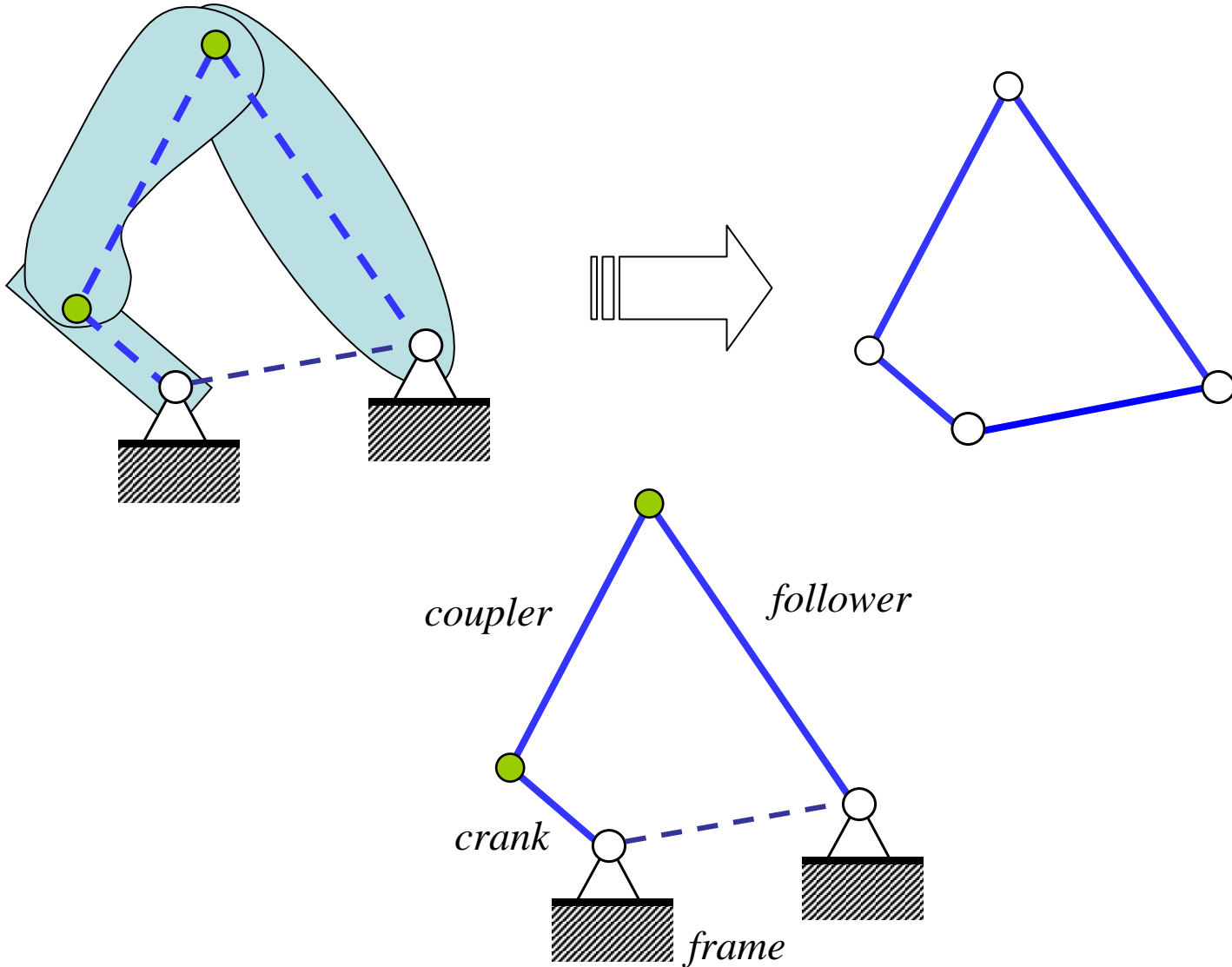
Example

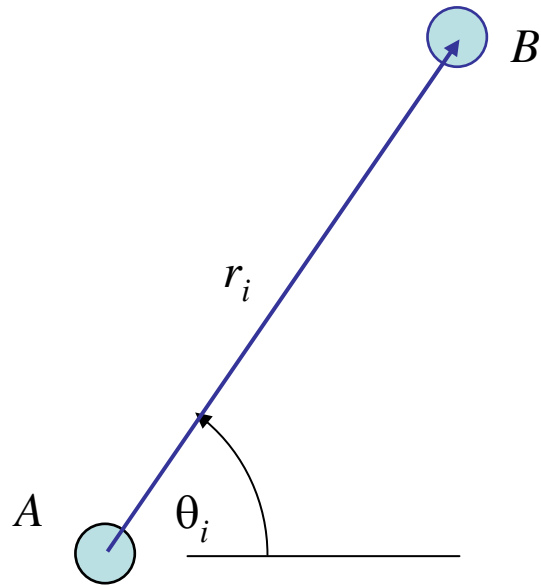
A is pulled down at 3 m/s . What is the motion of B ?



Exercise 2.5.11 (p. 85)

Four Bar Linkages





$$\mathbf{r}_{B/A} = r_i \cos \theta_i \mathbf{i} + r_i \sin \theta_i \mathbf{j}$$

