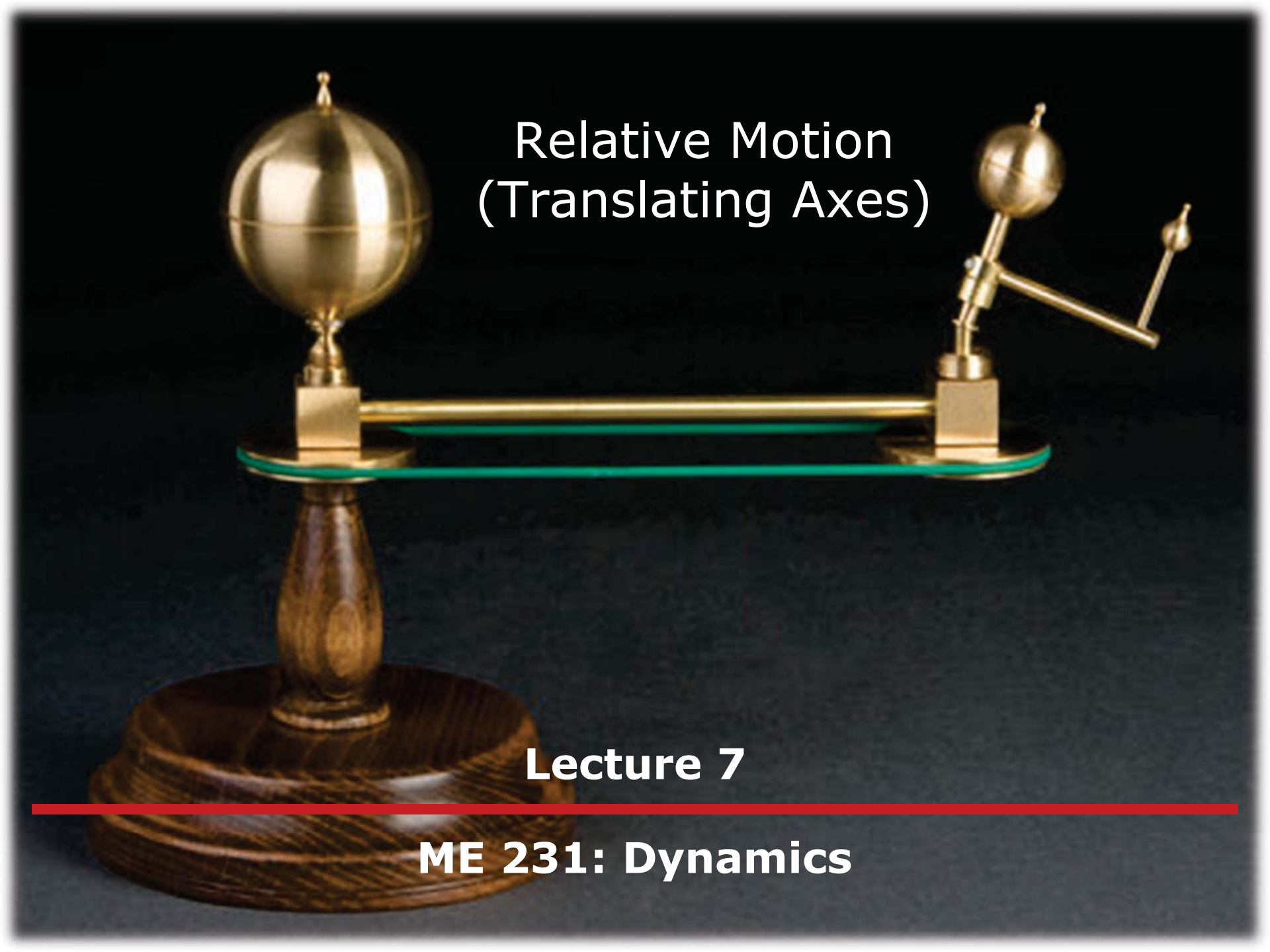
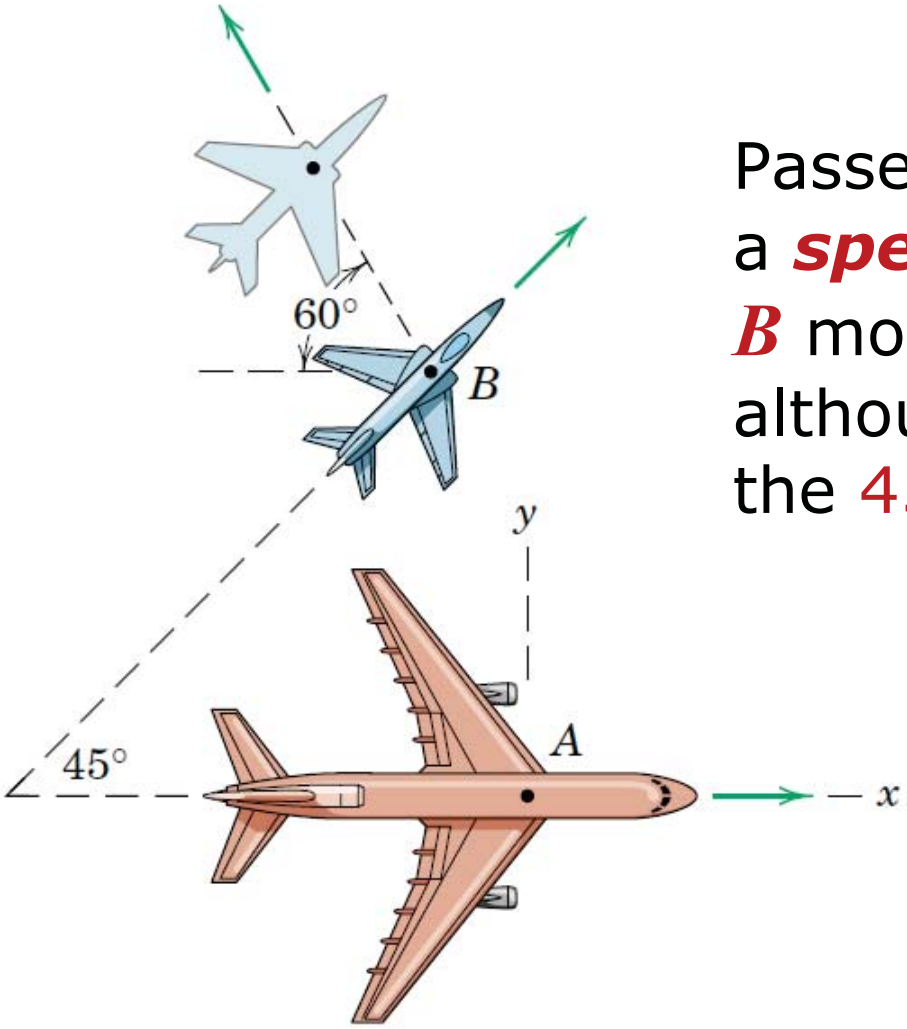


Relative Motion (Translating Axes)

Lecture 7

ME 231: Dynamics

Question of the Day



Passengers in jet ***A*** flying east at a ***speed*** of 800 km/h observe jet ***B*** moving away at a 60º angle although its nose is pointed in the 45º direction.

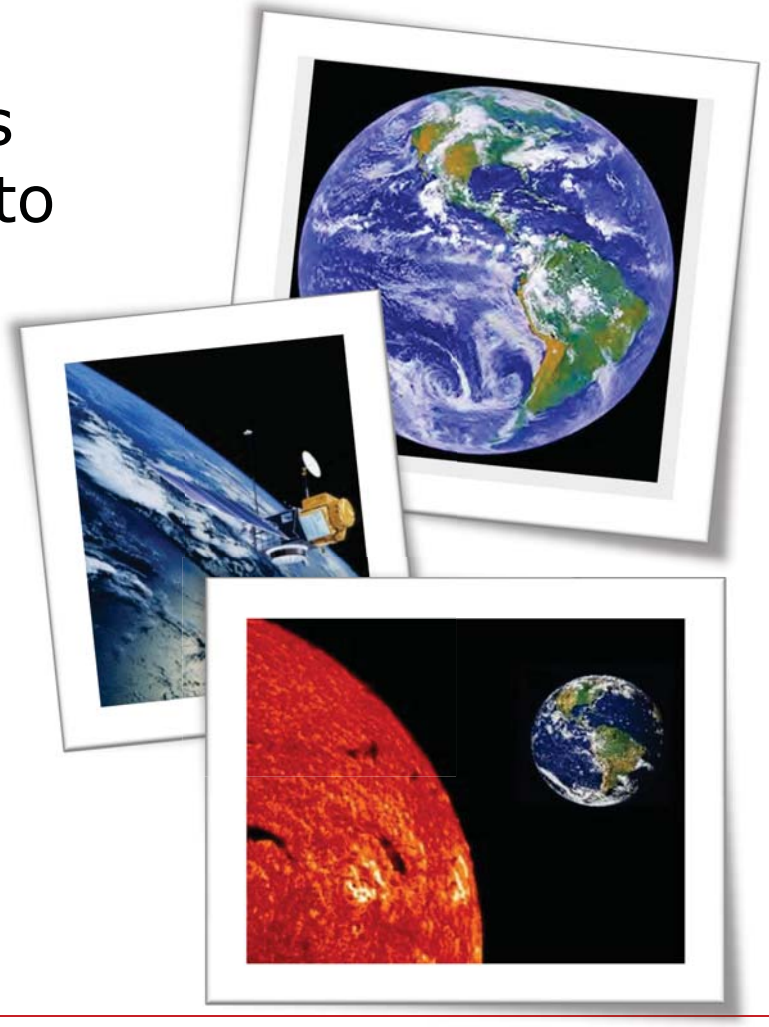
Determine the ***true velocity*** of ***B*** in an earth-fixed coordinate system.

Outline for Today

- Question of the day
- Choice of inertial coordinate system
- Vector representation
- Additional considerations
- Answer your questions!

Choice of Inertial Coordinate System

Moving coordinate systems are measured with respect to an ***inertial*** coordinate system whose ***motion is negligible***.

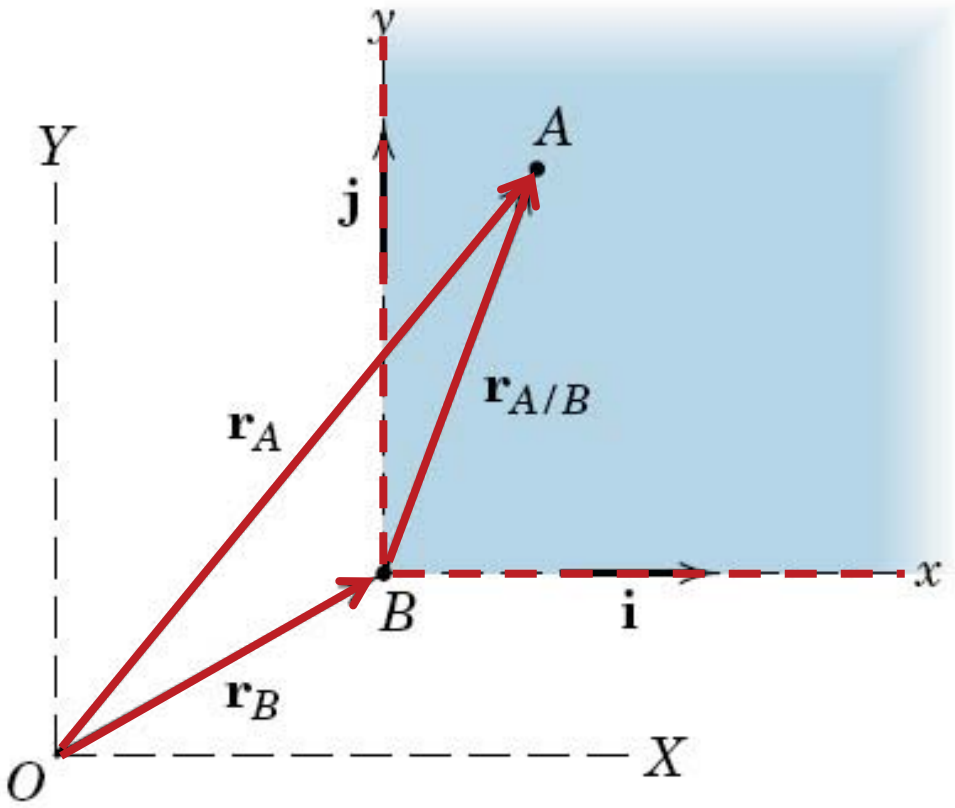


Vector Representation

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

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

$$\mathbf{a}_A = \dot{\mathbf{v}}_A = \ddot{\mathbf{r}}_A = \ddot{\mathbf{r}}_B + \ddot{\mathbf{r}}_{A/B}$$



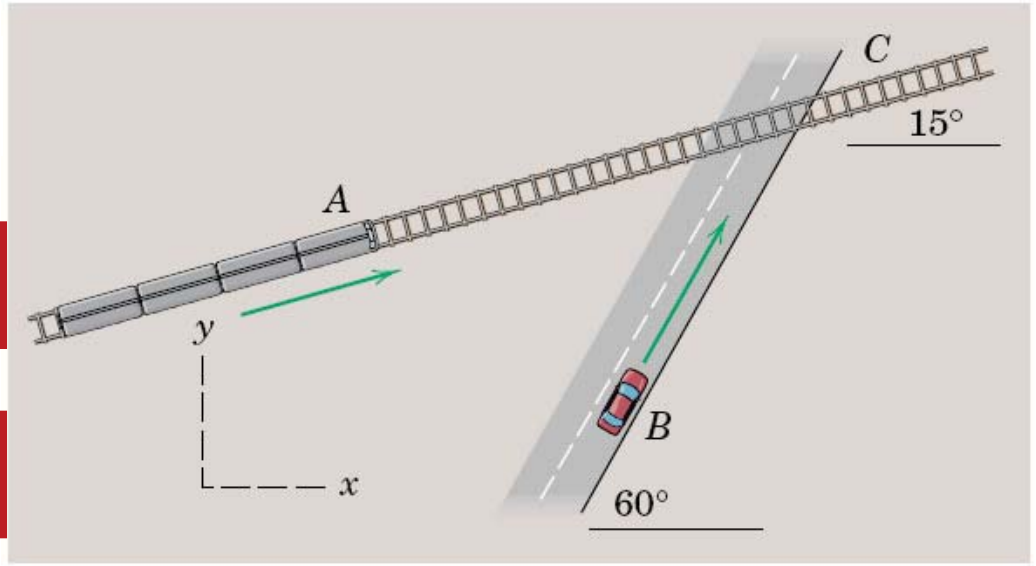
- Absolute position of ***B*** is defined in an inertial coordinate system ***X*-*Y***
- Attach a set of translating (*non-rotating*) axes ***x*-*y*** to particle ***B*** and define the position of ***A***
- Define position of "***A relative to B***" ("***A/B***") in ***x*-*y***

Vector Representation: Exercise

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

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

$$\mathbf{a}_A = \dot{\mathbf{v}}_A = \ddot{\mathbf{r}}_A = \ddot{\mathbf{r}}_B + \ddot{\mathbf{r}}_{A/B}$$



Train A travels with constant ***speed*** v_A= 120 km/h.

Anticipating the need to stop, car B decreases its ***speed*** of 90 km/h at the rate of 3 m/s^2.

Determine the ***velocity*** and ***acceleration*** of the train relative to the car.

Outline for Today

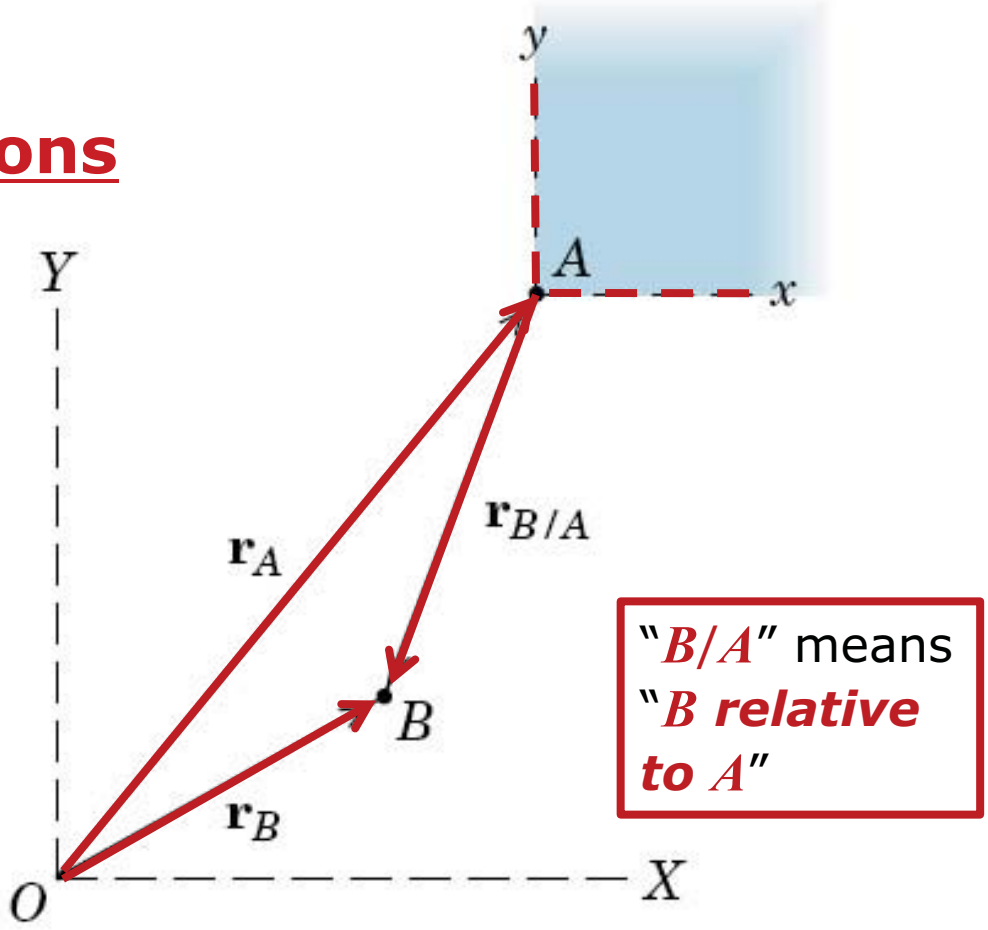
- Question of the day
- Choice of inertial coordinate system
- Vector representation
- Additional considerations
- Answer your questions!

Additional Considerations

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

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

$$\mathbf{a}_B = \dot{\mathbf{v}}_B = \ddot{\mathbf{r}}_B = \ddot{\mathbf{r}}_A + \ddot{\mathbf{r}}_{B/A}$$



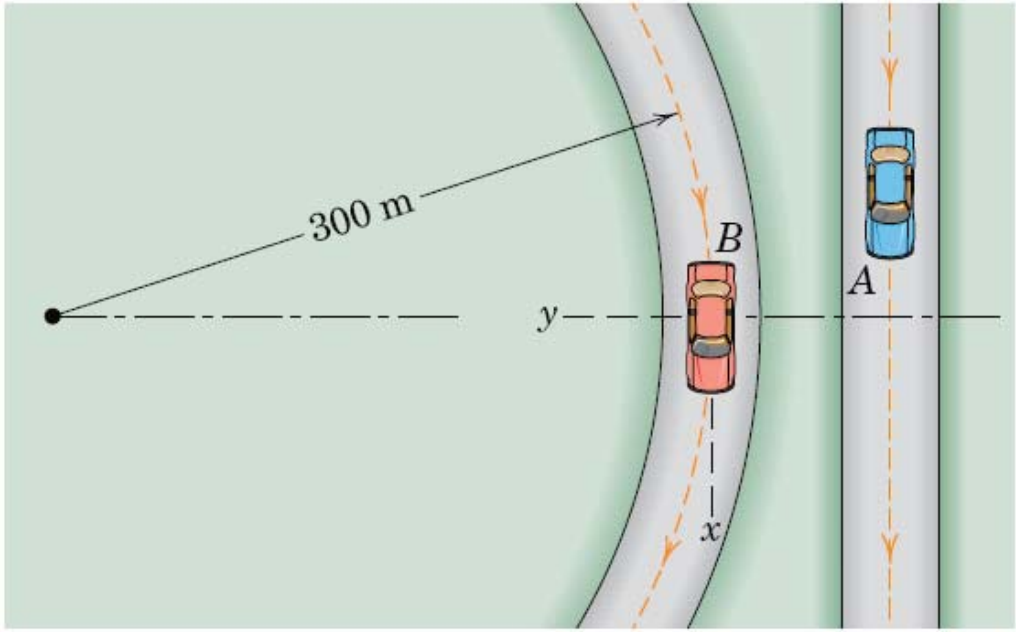
- Selection of the moving point (e.g., ***A*** or ***B***) is arbitrary
- Absolute position of ***A*** is defined in an inertial coordinate system ***X***-***Y***
- Attach a set of translating (*non-rotating*) axes ***x***-***y*** to particle ***A*** and define the position of ***B***

Another Exercise

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

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

$$\mathbf{a}_B = \dot{\mathbf{v}}_B = \ddot{\mathbf{r}}_B = \ddot{\mathbf{r}}_A + \ddot{\mathbf{r}}_{B/A}$$



Car A has a ***speed*** v_A= 100 km/h, which is increasing at the rate of 8 km/h each second. Car B has a ***speed*** v_B= 100 km/h, around the turn and is slowing down at the rate of 8 km/h each second.

Determine the ***acceleration*** that car B appears to have to an observer in car A.

Outline for Today

- Question of the day
- Choice of inertial coordinate system
- Vector representation
- Additional considerations
- Answer your questions!

For Next Time…

- Begin Homework #3 due next week (9/12)
- Read Chapter 2, Section 2.7 again