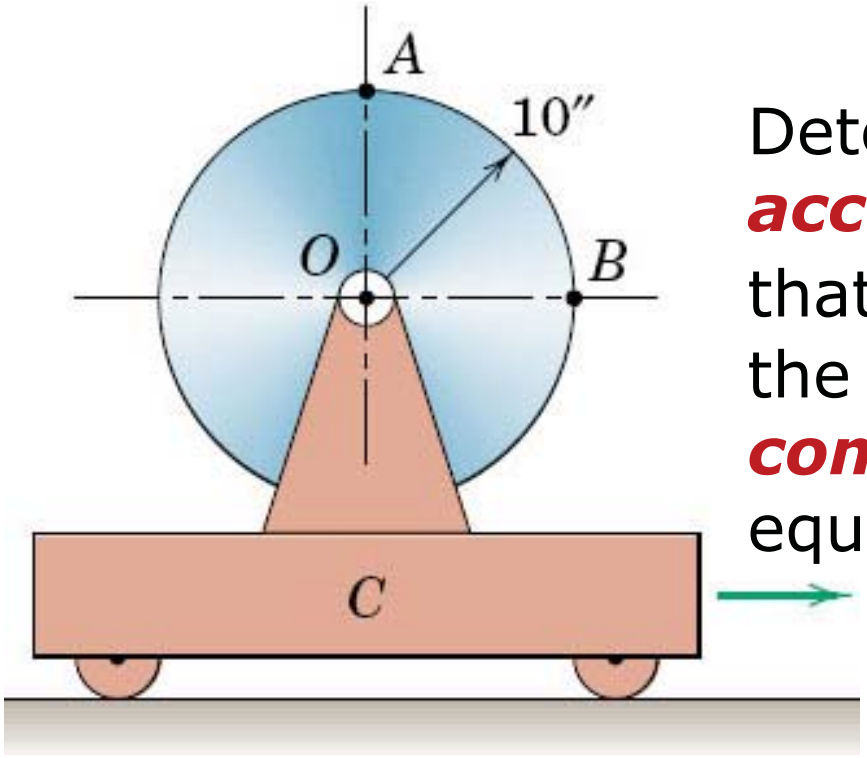
Relative Acceleration

Lecture 13

ME 231: Dynamics

Question of the Day



The ***acceleration*** of the cart is 4 ft/s^2 to the right.

Determine the ***angular acceleration*** of the wheel so that ***point A*** on the top of the rim has a ***horizontal component*** of ***acceleration*** equal to ***zero***.

Outline for Today

- Question of the day
- Relative acceleration due to rotation
- Interpretation of $\mathbf{a}_A = \mathbf{a}_B + \mathbf{a}_{A/B}$
- Solution of relative-acceleration eq.
- Answer your questions!

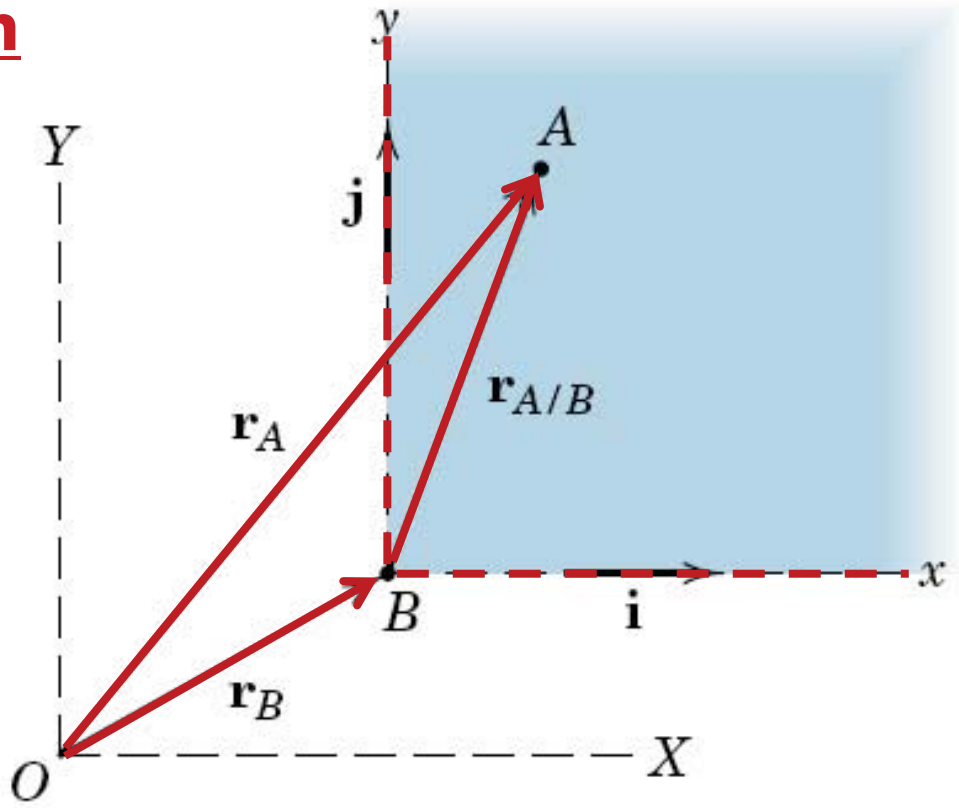
- What about next week?

Recall: Relative Motion

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

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

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



- 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***

Relative Acceleration Due to Rotation

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

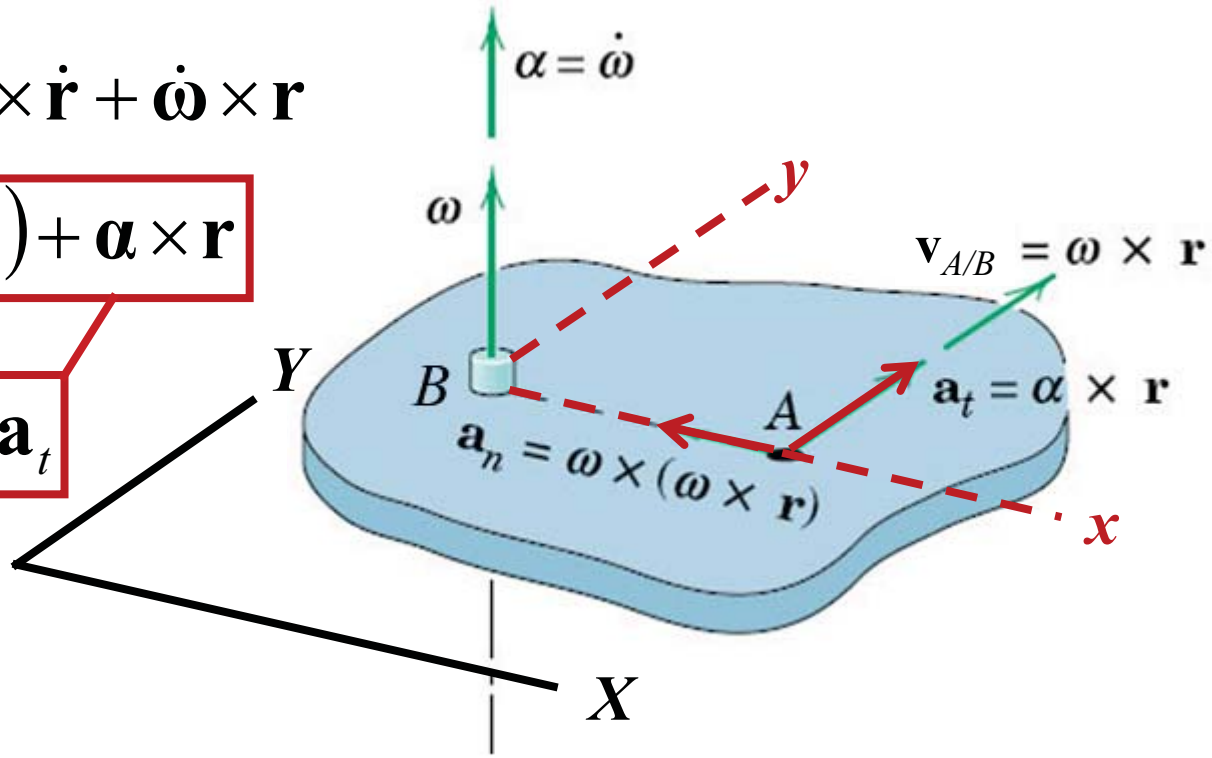
From ***translating*** (*non-rotating*) axes ***x*-*y*** attached to point ***B***, the ***acceleration*** is a simply due to ***circular motion*** about ***B***

$$\mathbf{v}_{A/B} = \dot{\mathbf{r}} = \boldsymbol{\omega} \times \mathbf{r}$$

$$\mathbf{a}_{A/B} = \dot{\mathbf{v}}_{A/B} = \boldsymbol{\omega} \times \dot{\mathbf{r}} + \dot{\boldsymbol{\omega}} \times \mathbf{r}$$

$$\mathbf{a}_{A/B} = \boldsymbol{\omega} \times (\boldsymbol{\omega} \times \mathbf{r}) + \boldsymbol{\alpha} \times \mathbf{r}$$

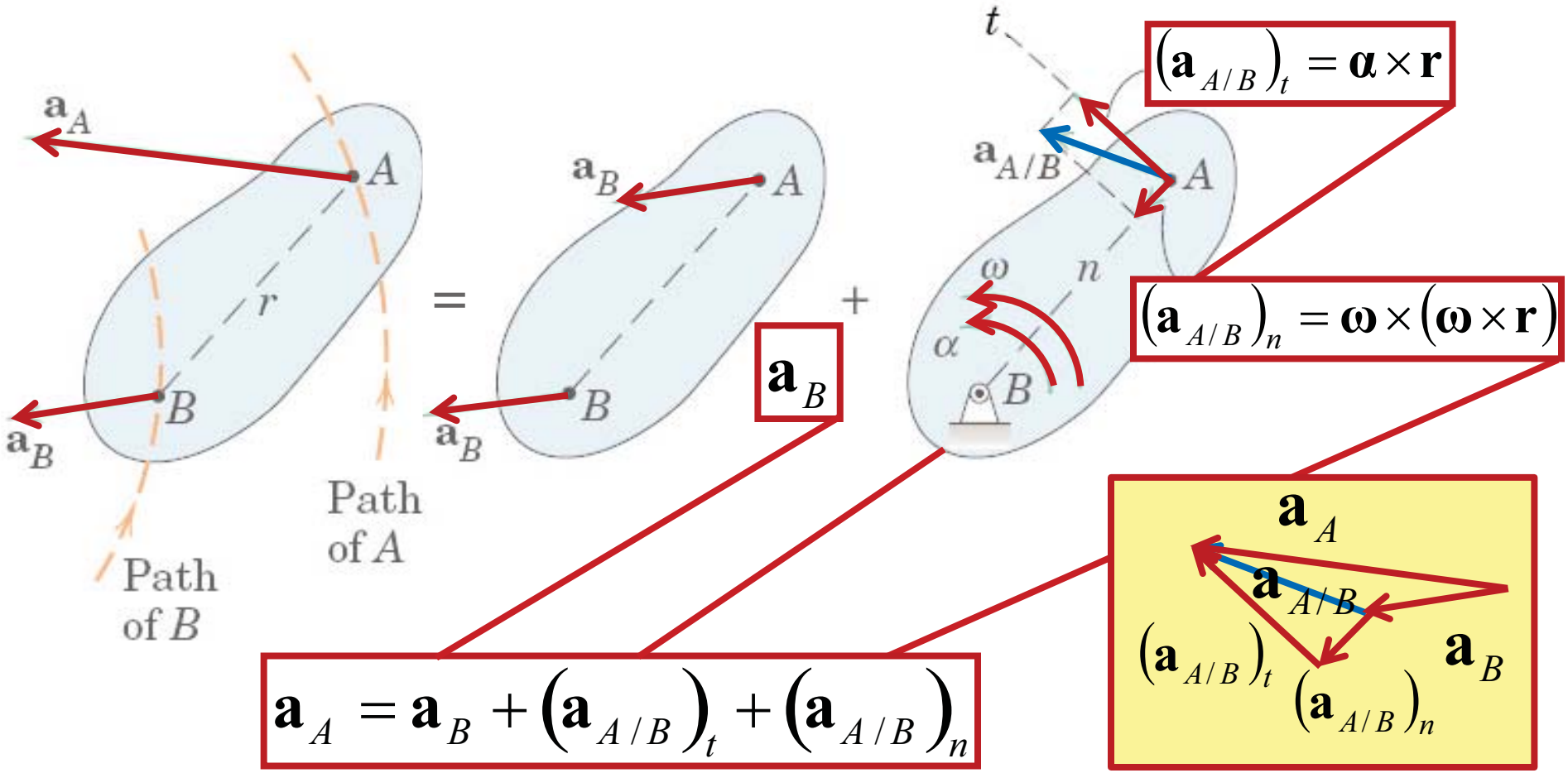
$\mathbf{a}_n$ $\mathbf{a}_t$



Interpretation of Relative-Acceleration Eq.

Translational portion

Rotational portion



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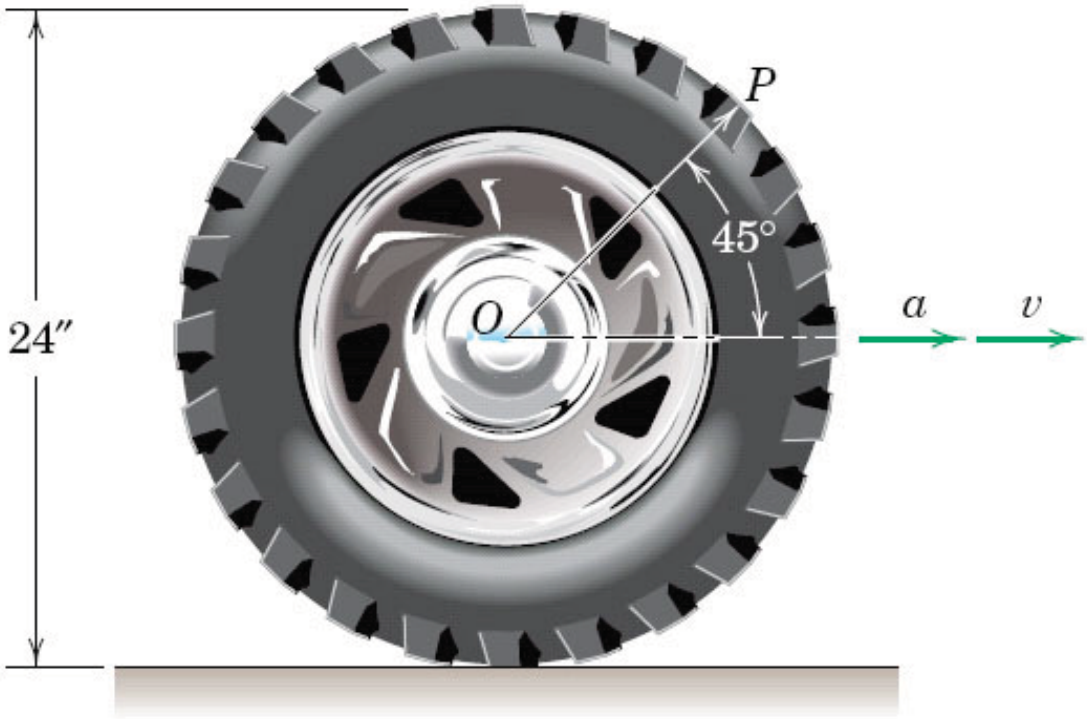
Solution of Relative-Acceleration Eq.: Exercise

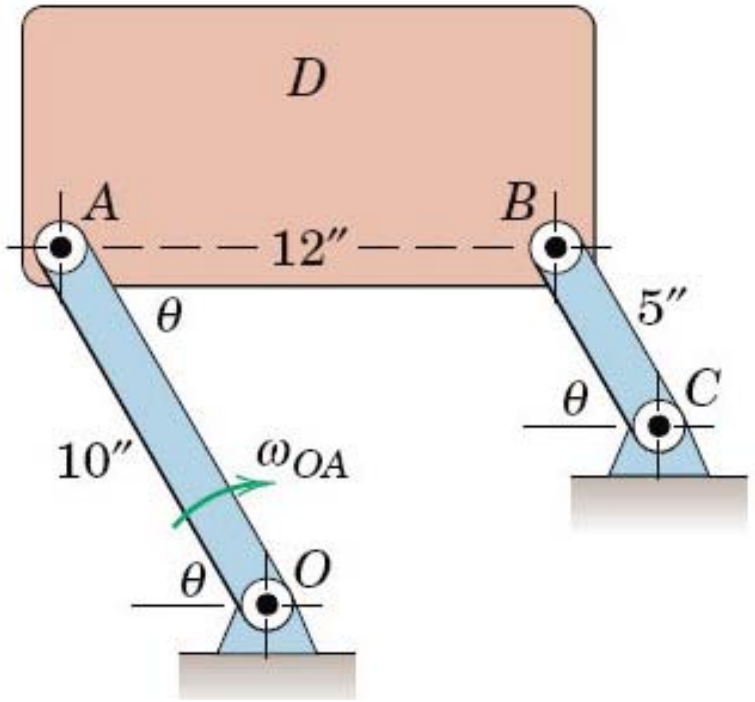
A truck has forward ***acceleration*** $\mathbf{a}$ = 12 ft/s^2 rolling without slipping its 24" tires.



Determine the ***velocity*** of the truck when point ***P*** in the ***position*** shown will have ***zero horizontal component*** of ***acceleration***.

Solution of Relative-Acceleration Eq.: Exercise

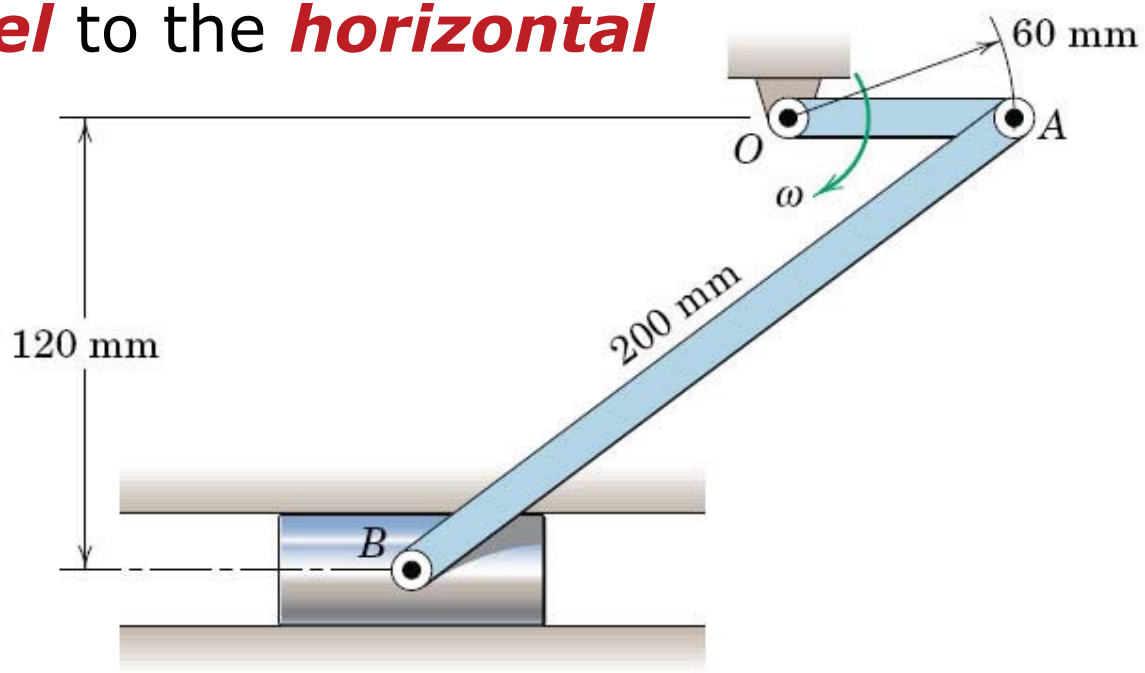
Calculate the ***angular acceleration*** of the plate, where ***OA*** has a constant ***angular velocity*** ω_{OA} = 4 rad/s and θ = 60° for both links.



Solution of Relative-Acceleration Eq.: Exercise

Link OA has constant ***angular velocity*** $\omega = 4$ rad/s.

Determine the ***angular acceleration*** α_{AB} of link AB when OA is ***parallel*** to the ***horizontal axis*** through B.



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LECTURE SCHEDULE
ME 231 ~ Dynamics

Month		Monday		Wednesday		Friday
August	13		15		17	
	20		22	Overview & Intro. 1.1 – 1.3	24	Rectilin. Motion 2.1 – 2.2
	27	Curvilin. Motion 2.3 – 2.4	29	Normal, Tangential 2.5	31	Polar 2.6
September						
	3	**Labor Day (no class)**	5	Space Motion 2.8	7	Relative Motion 2.7
	10	Constrained Motion 2.7	12	Rotation 6.1	14	Absolute Motion 6.1
	17	Relative Velocity 6.2	19	Instant Center 6.2	21	Relative Accel. 6.3
	24	Relative Accel. 6.3	26	Rotating Axes 6.4	28	Rotating Axes 6.4
	1	Kinematics Review (Ch. 1, 2, & 6)	3	**Exam 1 (Ch. 1, 2, & 6)**	5	Newton's 2nd Law 3.1

For Next Time…

- Continue Homework #5 due next Wednesday (9/26)
- Read Chapter 6, Sections 6.3 and 6.4