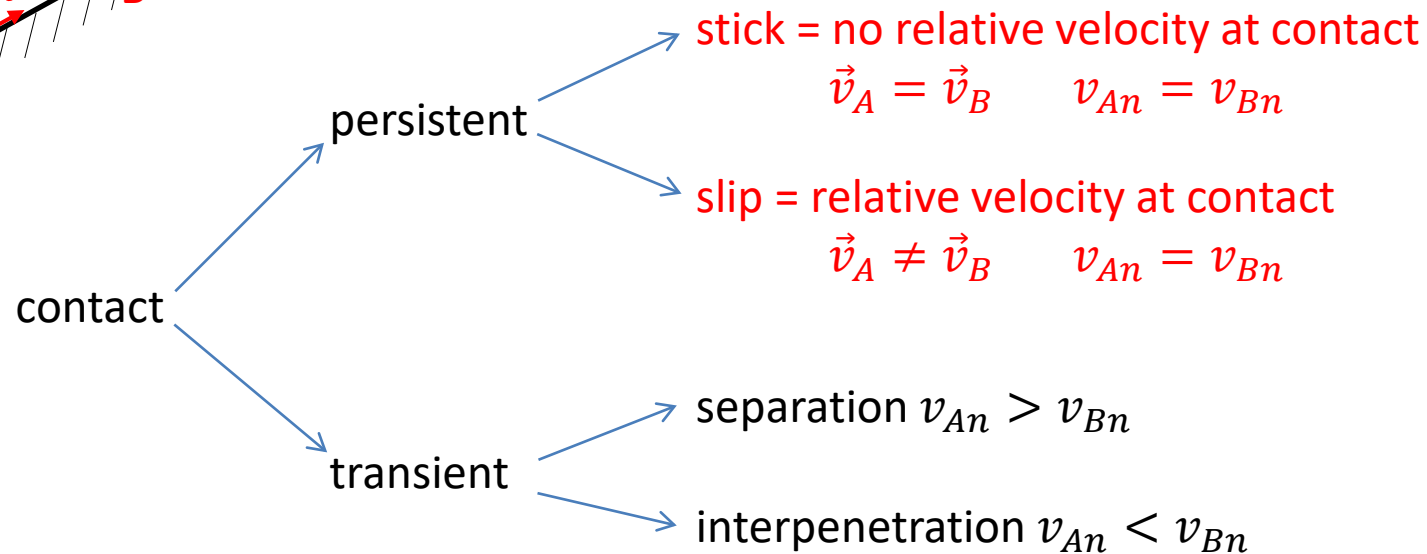
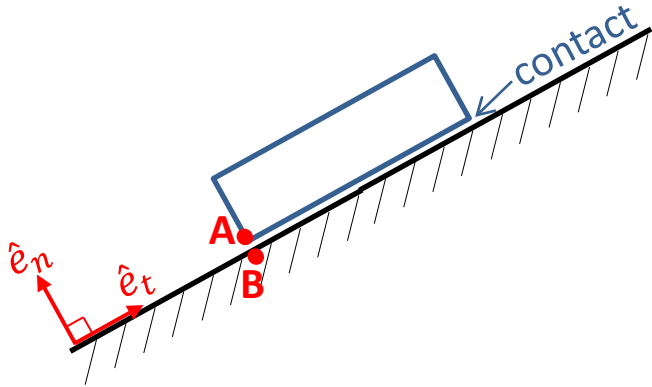


TAM 212 – Dynamics

Wayne Chang

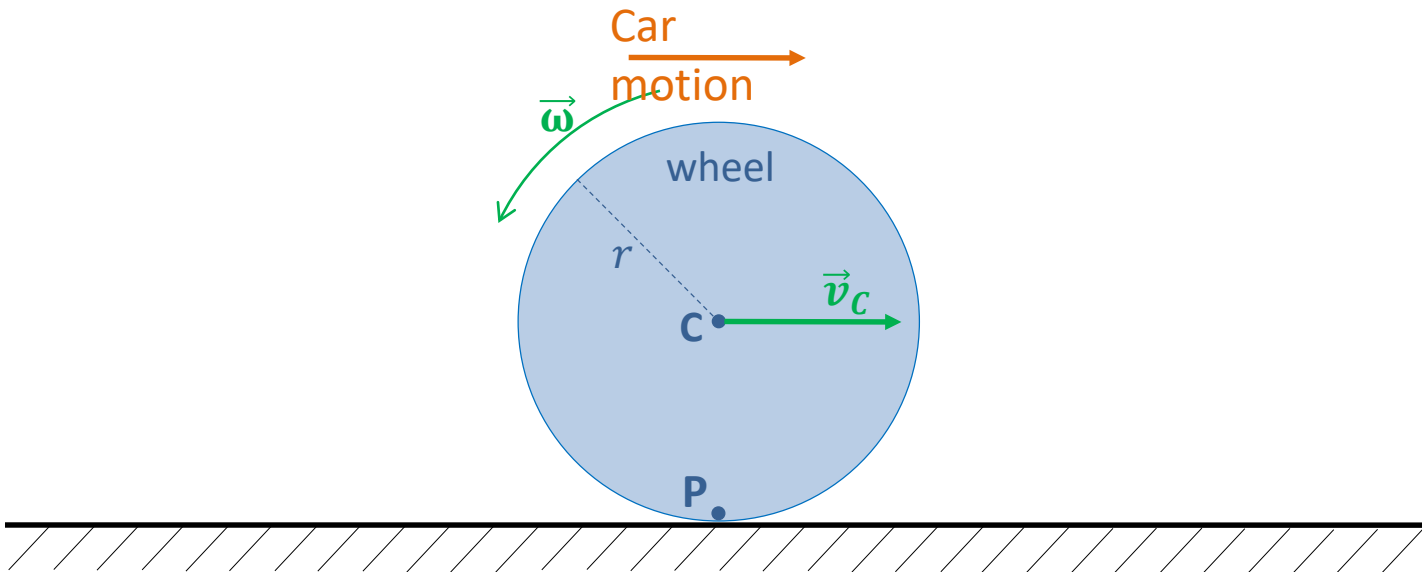
Summer 2019

Rigid bodies in contact

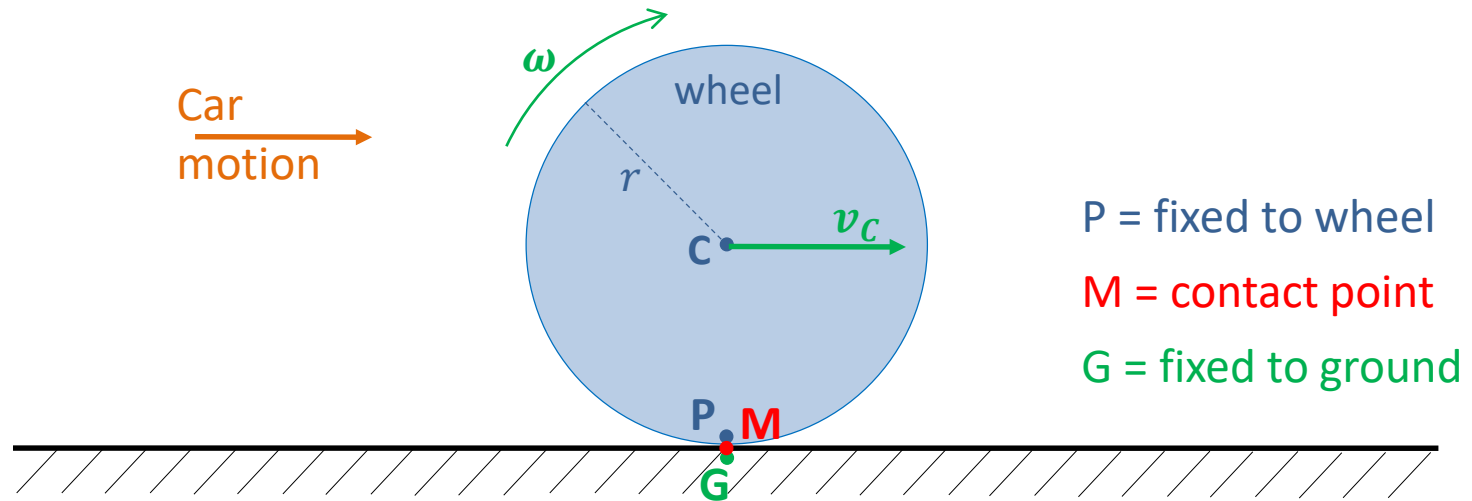


Rolling Motion

When a car is driving normally, the tire/road contact is:

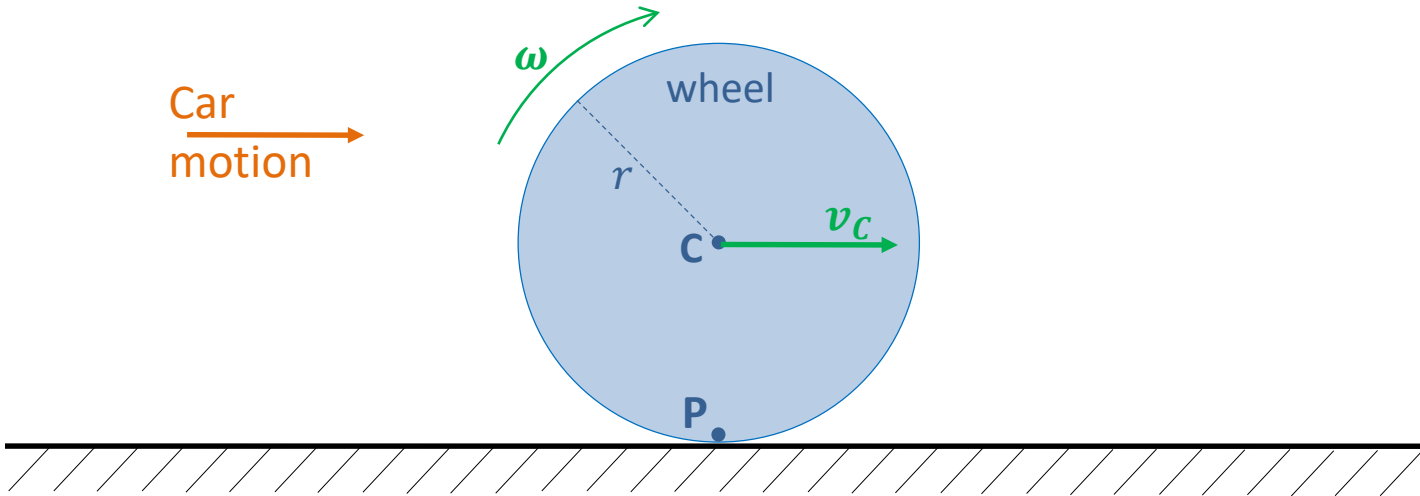


Rolling Motion

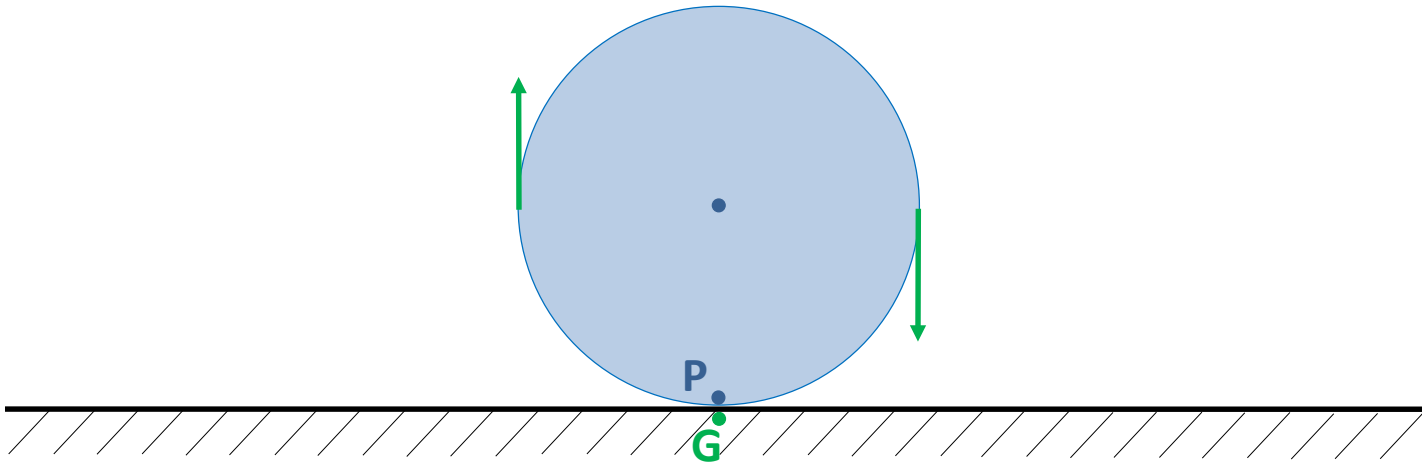


At the instant shown, $\vec{r}_P = \vec{r}_M = \vec{r}_G$

Rolling without Slip (= Sticking)



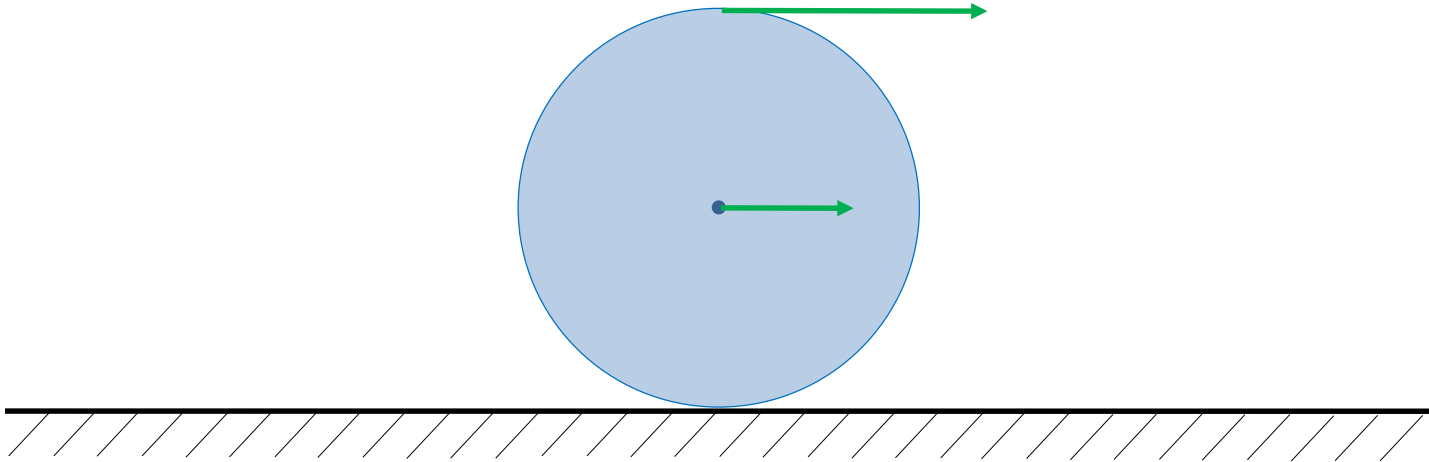
Example



What is happening at the contact?

- A. Slip ($\vec{v}_P \neq \vec{v}_G$)
- B. Roll without slip ($\vec{v}_P = \vec{v}_G$)
- C. Separate ($\vec{v}_{P,n} > \vec{v}_{G,n}$)
- D. Interpenetrate ($\vec{v}_{P,n} < \vec{v}_{G,n}$)
- E. Impossible or can't tell

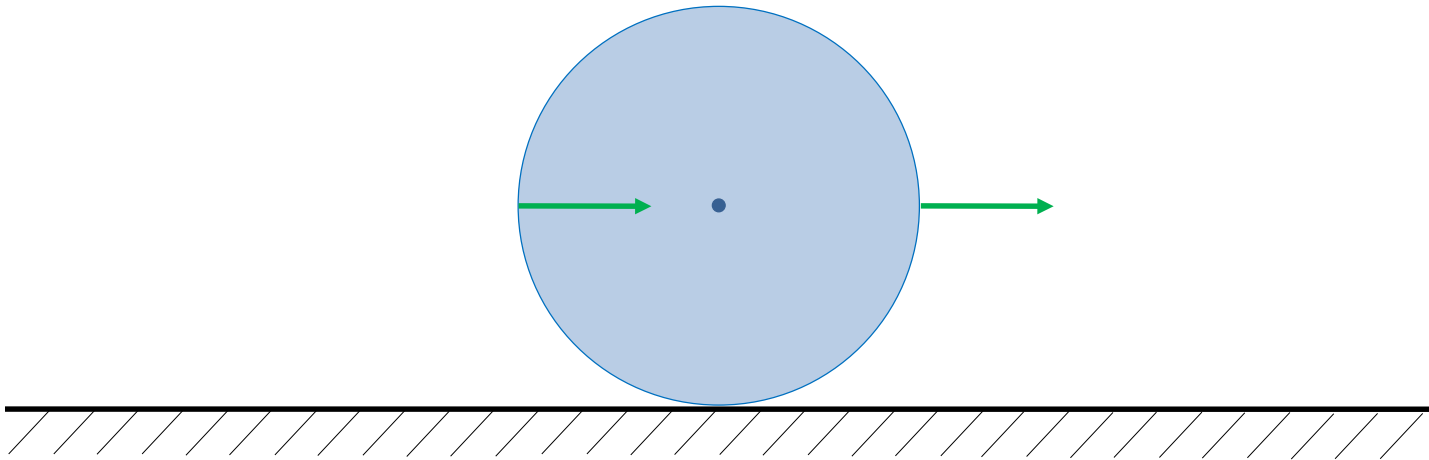
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

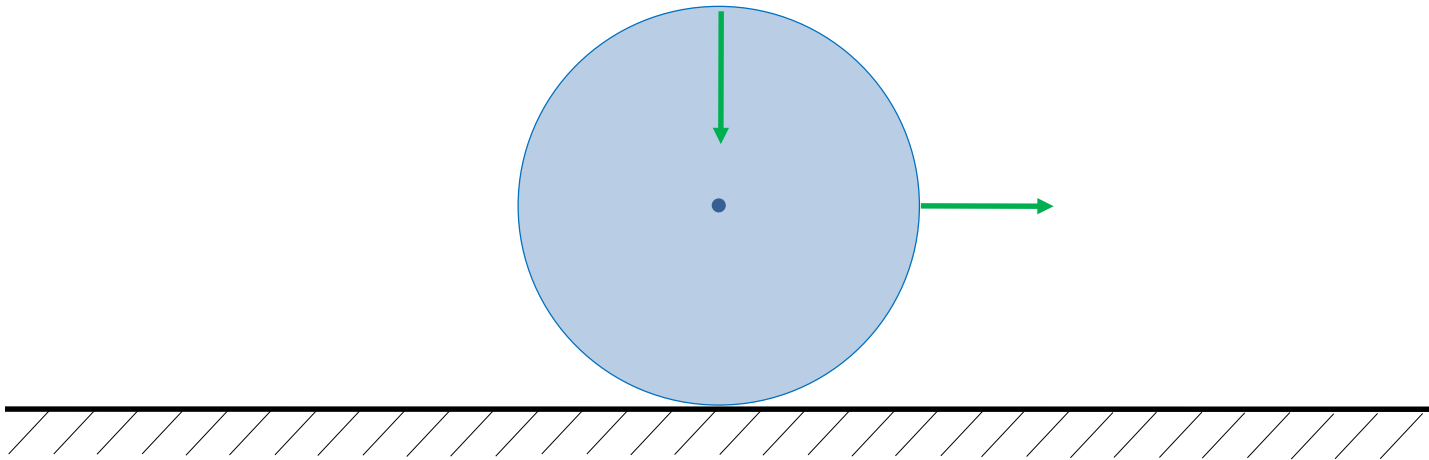
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

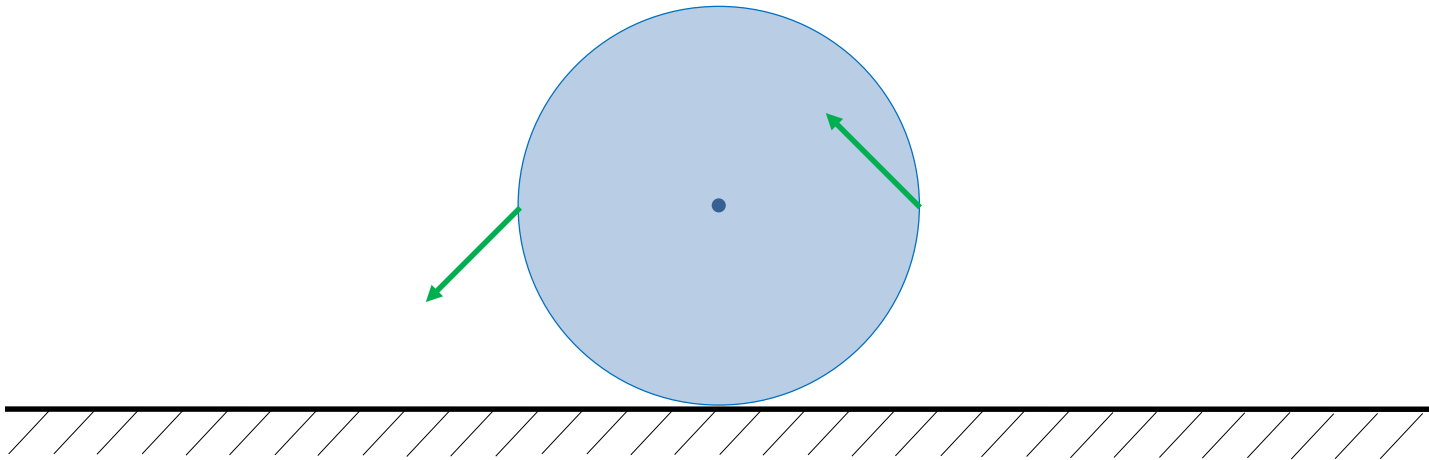
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

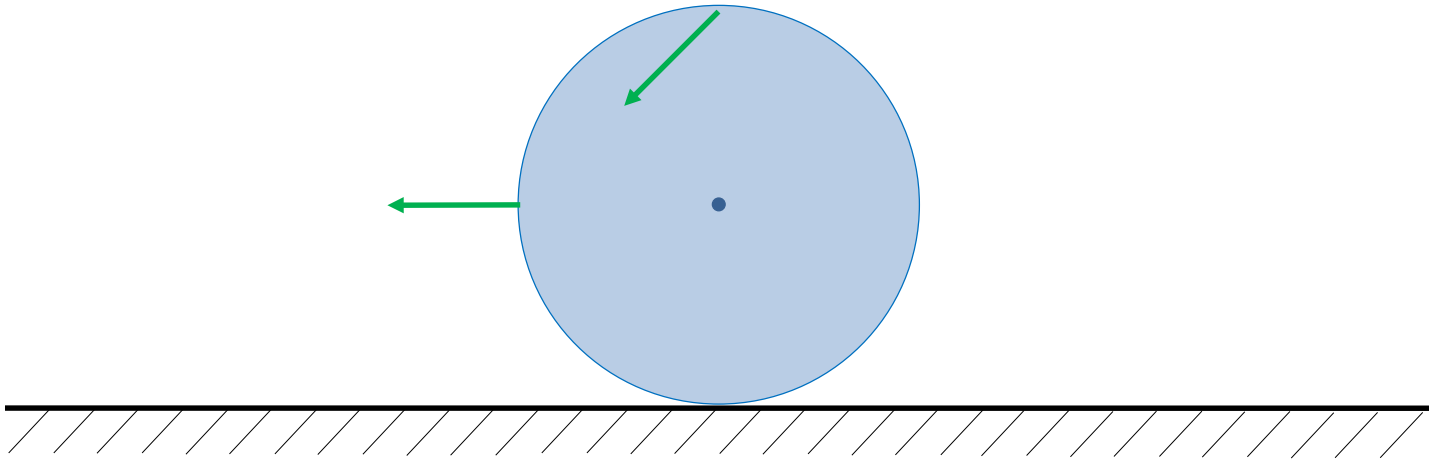
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

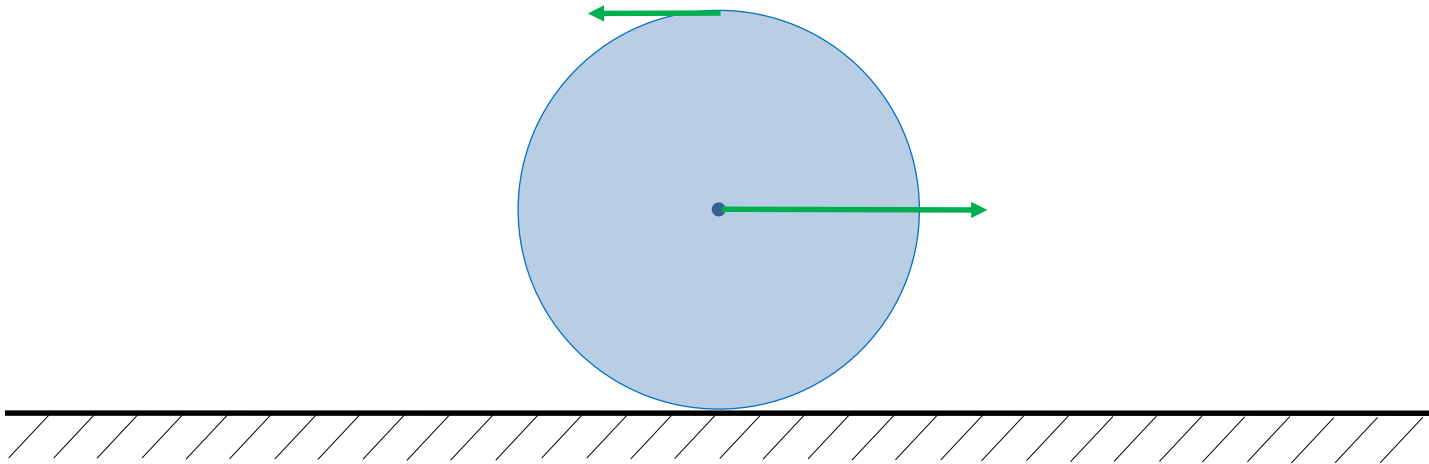
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

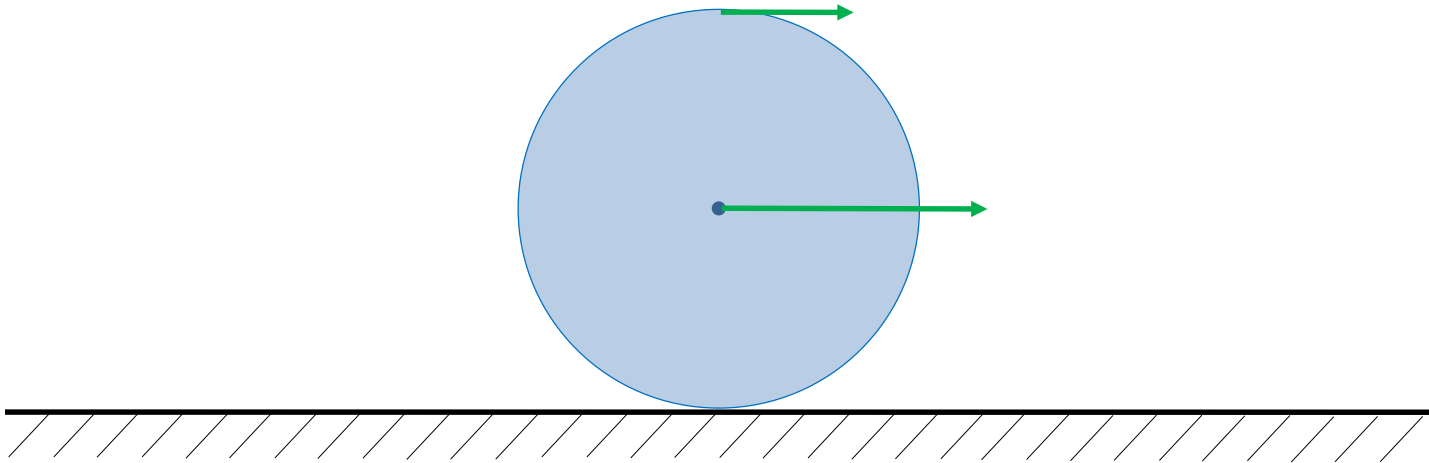
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

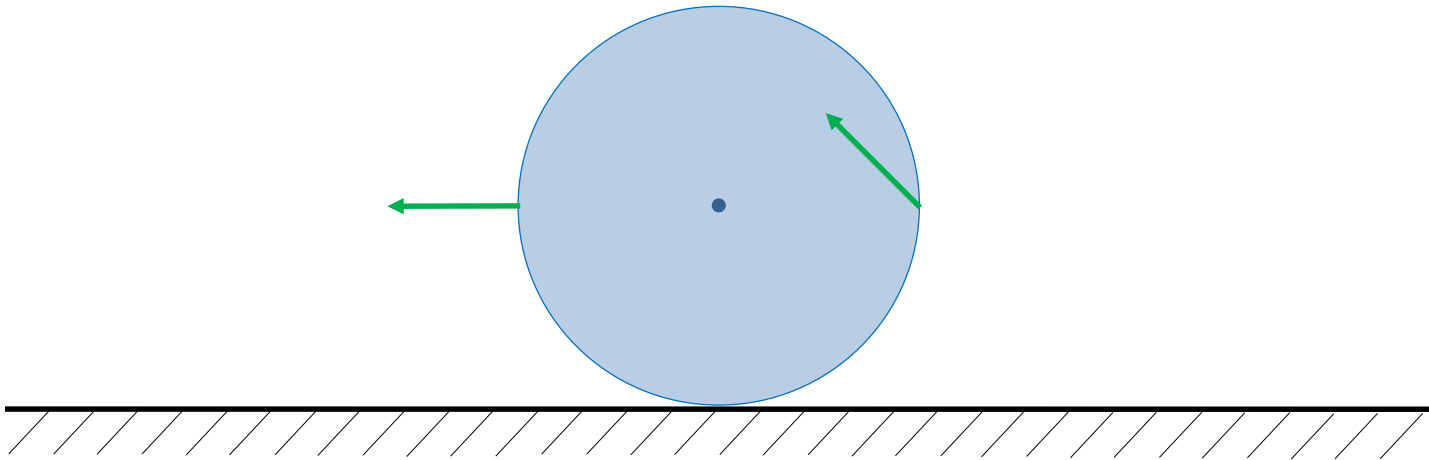
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

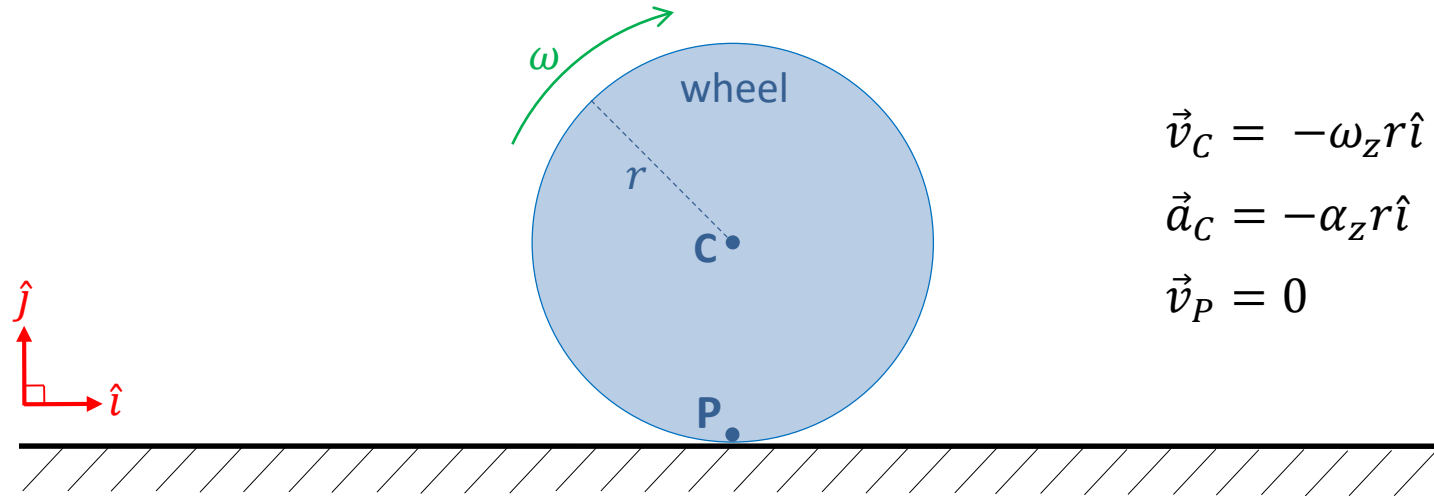
Example



What is happening at the contact?

- A. Slip**
- B. Roll without slip**
- C. Separate**
- D. Interpenetrate**
- E. Impossible or can't tell**

Recap – Roll without Slip



$$\vec{v}_C = -\omega_z r \hat{i}$$

$$\vec{a}_C = -\alpha_z r \hat{i}$$

$$\vec{v}_P = 0$$

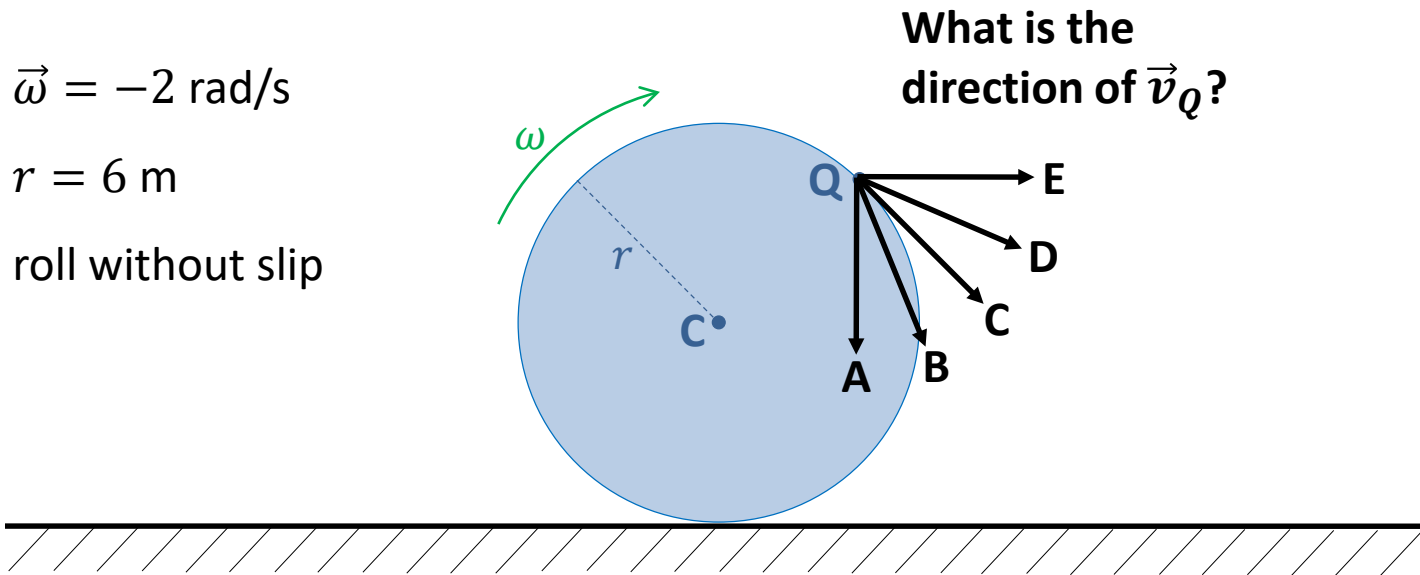
What is $\vec{a}_P$?

Example

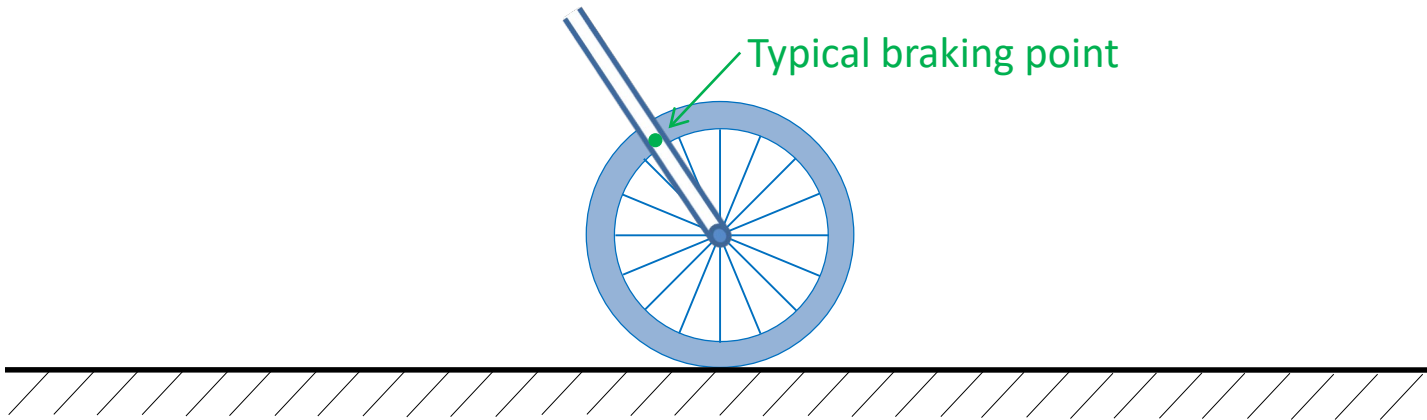
$$\vec{\omega} = -2 \text{ rad/s}$$

$$r = 6 \text{ m}$$

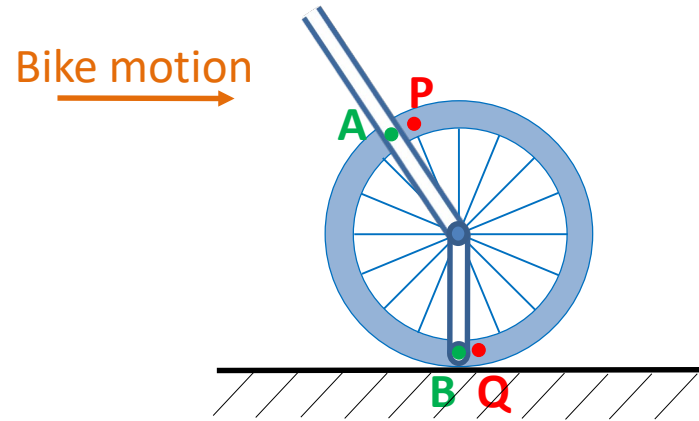
roll without slip



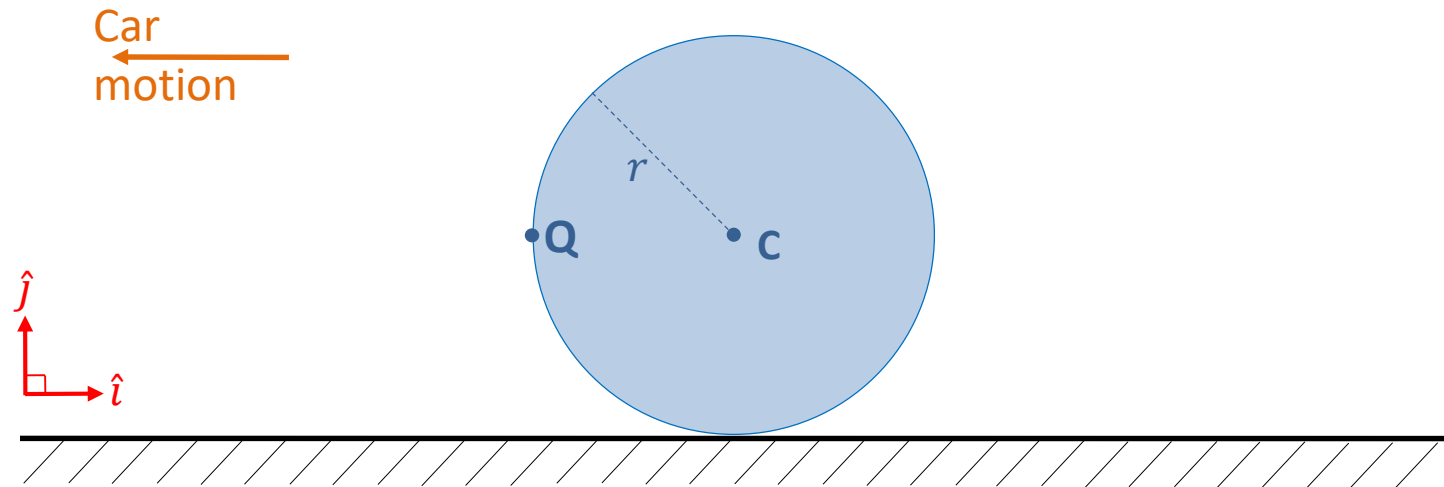
Example: Bicycle Front Wheel



Example: Bicycle Front Wheel (Alternative Braking)

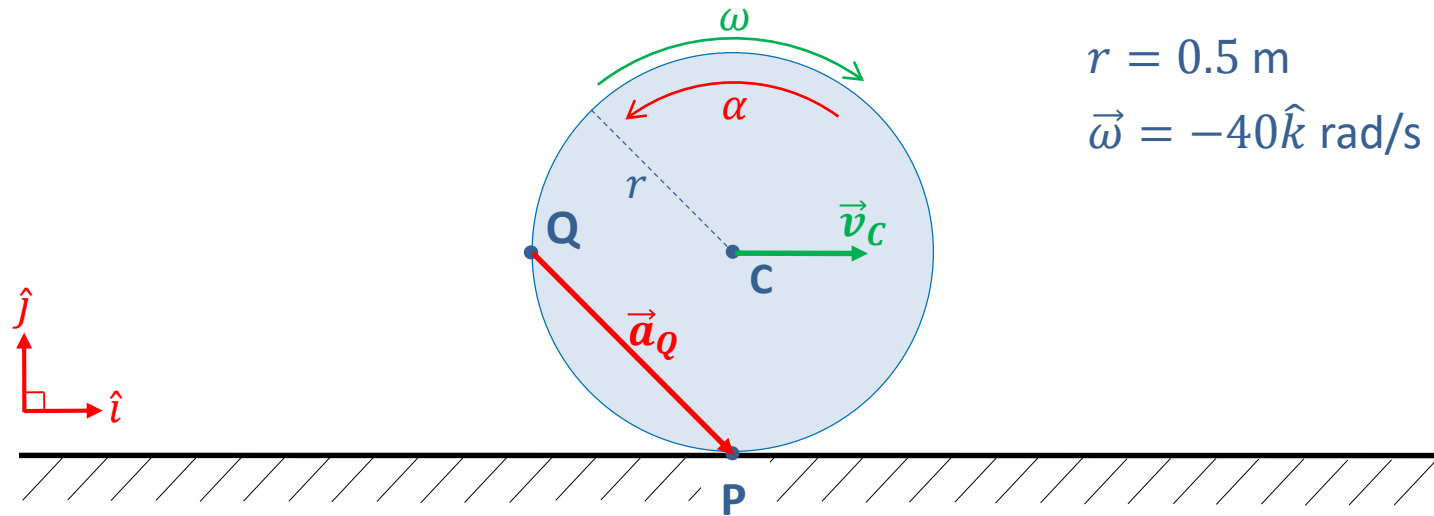


Example



Car driving to the left at 4 m/s, slowing down at 2 m/s^2 . Wheel $r = 0.5 \text{ m}$.

Example – Roll without Slip



Car is driving to the right.