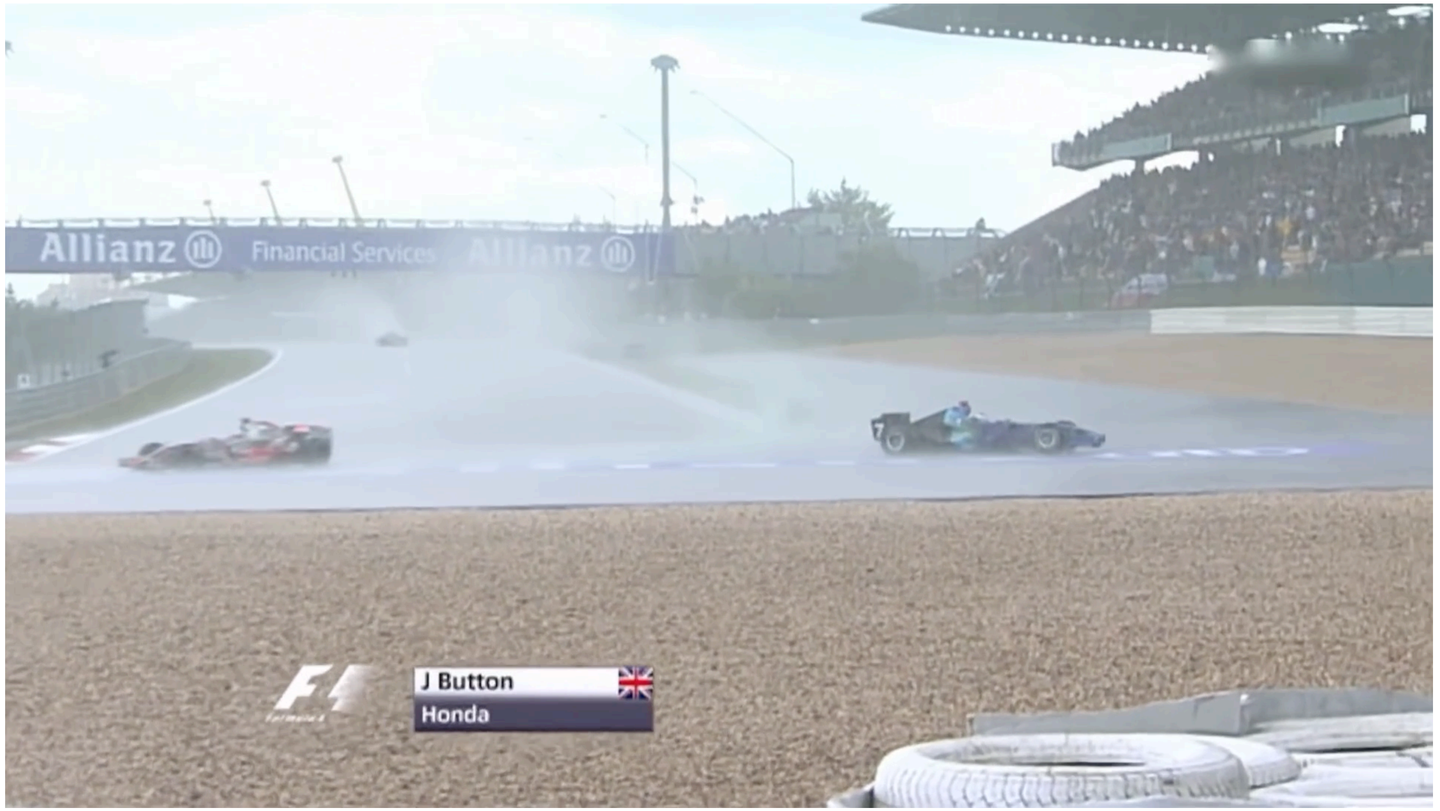
General Physics: Mechanics



PHYS-101(en)

Lecture 4b: Circular motion

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October 1st, 2024

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Swiss Plasma Center

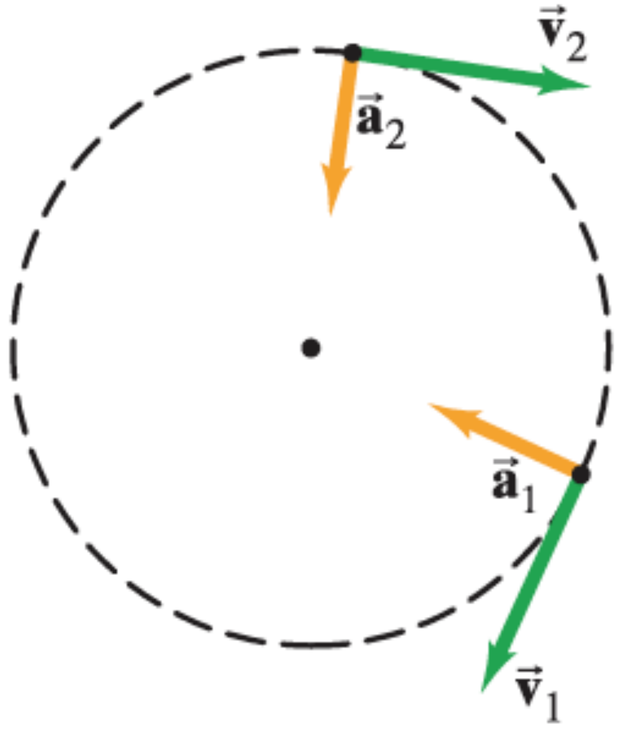
Reminder: Supplementary Q&A

- Sessions start today and run until the end of the semester.
- They will take place Tuesdays 17:30-19:00 and Thursdays 18:00-19:30 in room **CM 1 105.**
- Additional resource for those of you who want to further discuss current and previous problem sets.

Summary: **Uniform** circular motion

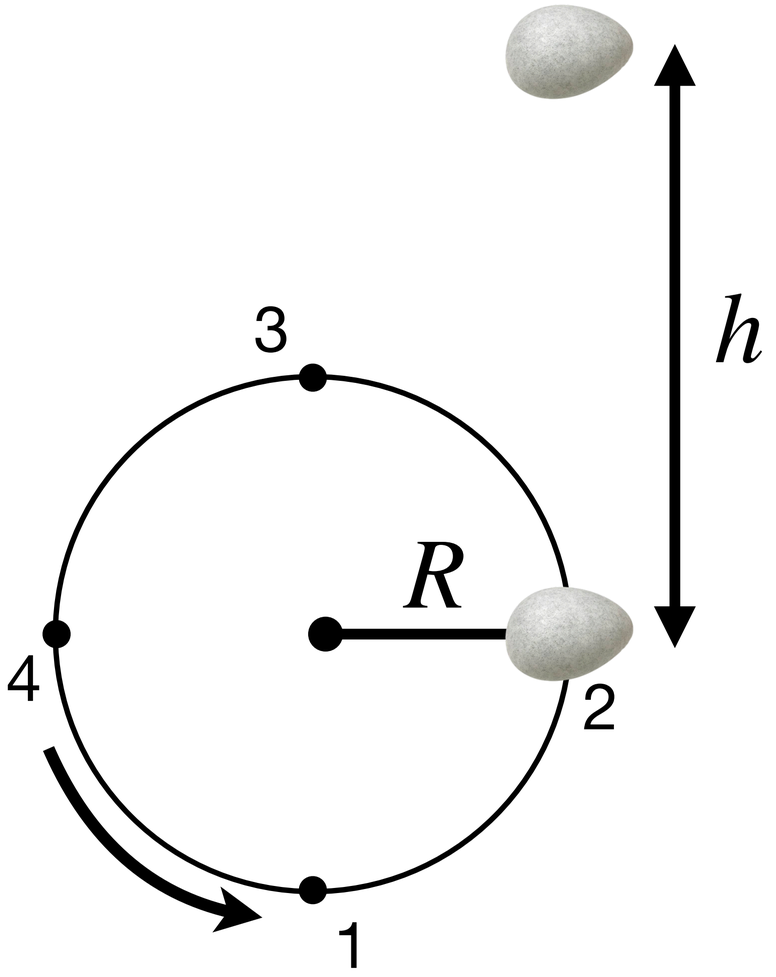
- Motion in a circle of constant radius ρ_0 at constant angular velocity $\vec{\omega}$ (in rad/s)
- Instantaneous velocity is always tangent to the circle and has magnitude $v = \rho_0 \omega$
- Acceleration always points to the axis of rotation and is called centripetal acceleration $\vec{a}_{cent} = \rho_0 \omega^2 (-\hat{\rho})$

- Cylindrical coordinates are extremely convenient to describe this motion!



Example: Whirling stone

A stone is attached to a wheel and held in place by a string. It is whirled in circular trajectory of radius R in a vertical plane. Suppose the string is cut when the stone is at position 2, and the stone then rises to a maximum height h above the point at position 2. What was the angular velocity of the stone when the string was cut? Give your answer in terms of R, h, and g.



Example: Whirling stone

Example: Formula 1 downforce

At top speed, an F1 car can generate as much as 5 g's of *downforce* (i.e. a downwards force 5 times its own weight). This comes from *airfoils* designed into the car, which are effectively upside down airplane wings. Imagine navigating a flat turn of radius R_0. How much faster can an F1 car *with* airfoils drive, compared to one *without*?

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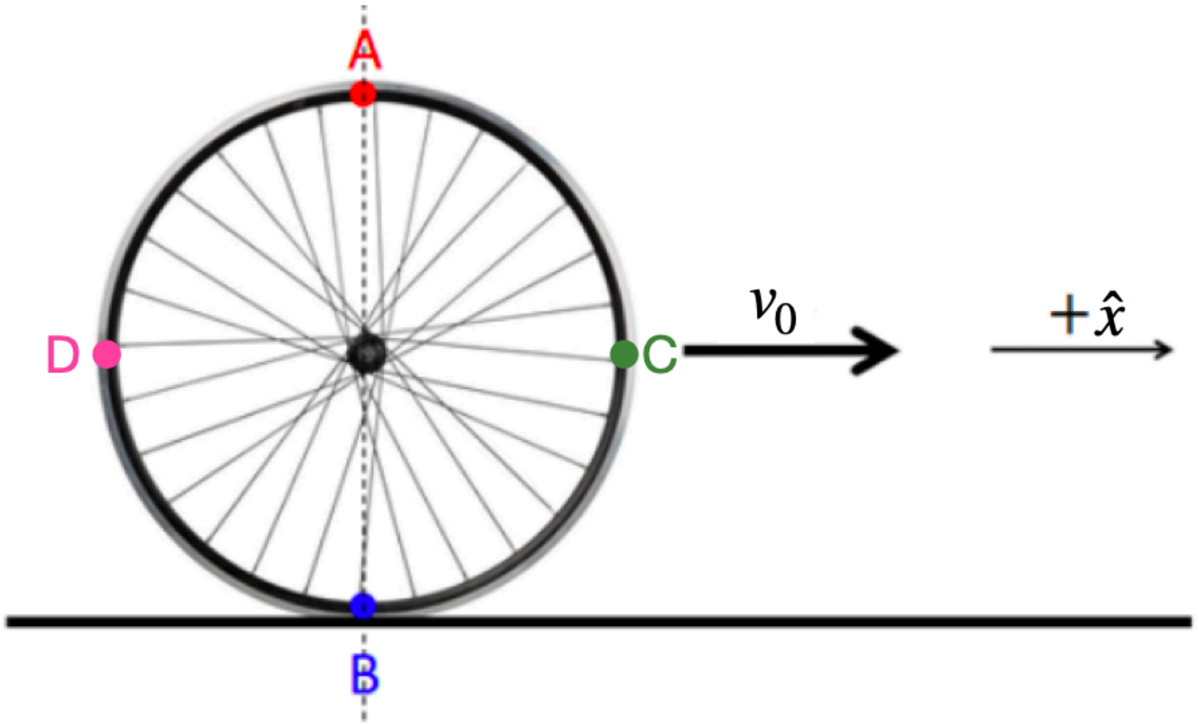
Example: Bicycle wheel

A bicycle wheel of radius R rolls without slipping along the ground. Its center moves with speed v_0. Neglect any resistance. What is the velocity of each of the four marked points on the tire shown in the figure below with respect to the center point? With respect to the ground?



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