Topic 5: Circular Motion

Advanced Placement Physics 1

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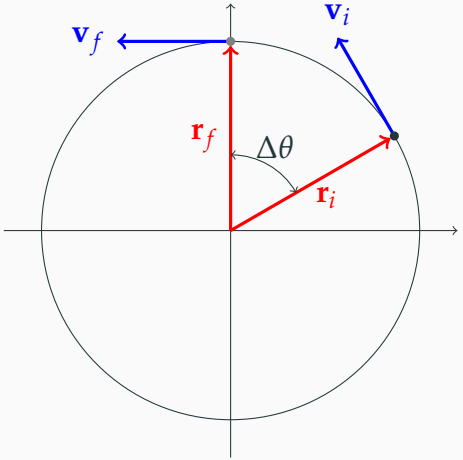
Olympiads School

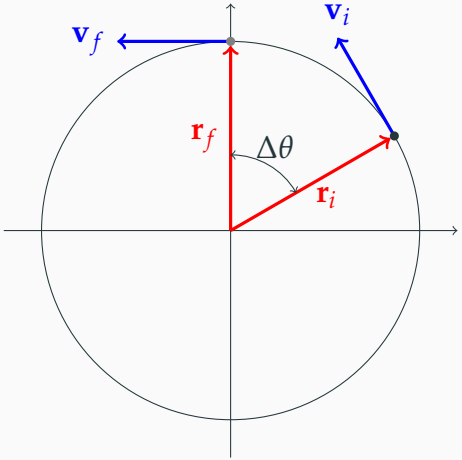
Centripetal Acceleration



Consider an object moving in circular motion in the counter clockwise direction with constant radius r and constant speed v.

- At initial time $t_i = 0$, the position and velocity of the object are given by $\mathbf{r}_i$ and $\mathbf{v}_i$
- At $t_f = t + \Delta t$, the object has moved by an angular displacement of $\Delta\theta$, and the final position and velocity are given by $\mathbf{r}_f$ and $\mathbf{v}_f$

Centripetal Acceleration



From the definition of acceleration,

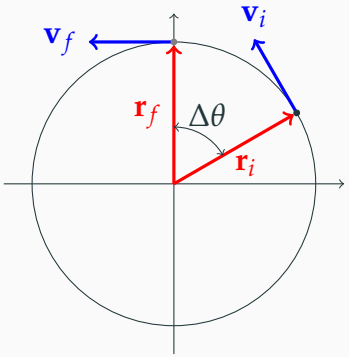
$$\mathbf{a} = \frac{\Delta \mathbf{v}}{\Delta t} = \frac{\mathbf{v}_f - \mathbf{v}_i}{\Delta t}$$

And the magnitude of the acceleration is

$$|\mathbf{a}| = \frac{|\Delta \mathbf{v}|}{\Delta t}$$

Both are important in deriving the expression for centripetal acceleration.

Displacement and Change in Velocity



Note that the triangles formed by the displacement vector and the change in velocity are similar isosceles triangles: