University Physics 1A

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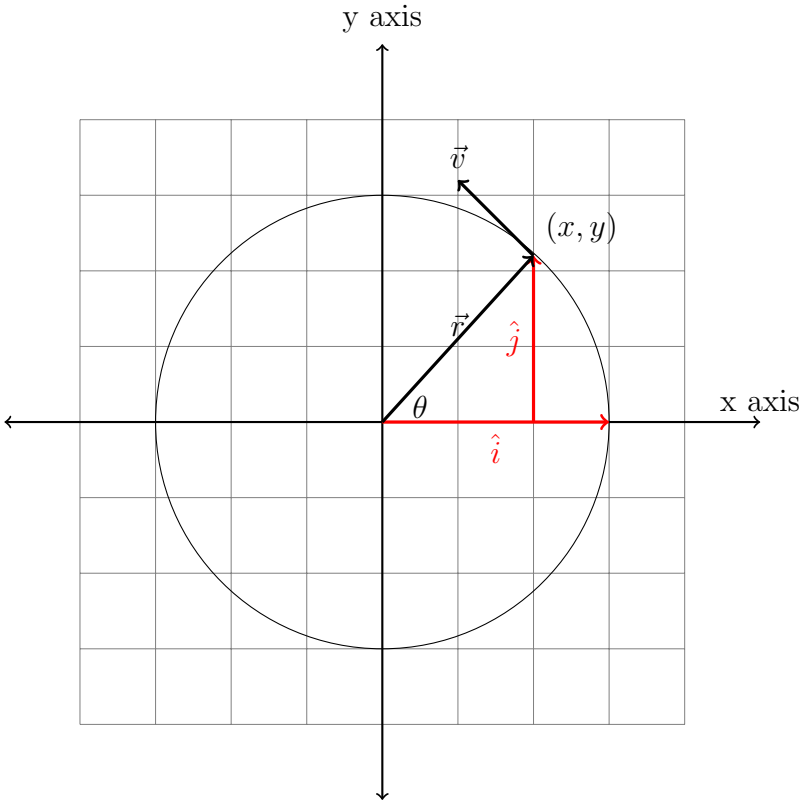
Circular Motion



The position of an object in circular motion:

$$\vec{r} = x\hat{i} + y\hat{j}$$

Constant Speed

$$\begin{aligned}\text{speed } v &= \frac{\text{distance traveled}}{\text{time}} \\ &= \frac{\text{arc length}}{\text{time}} \\ &= \frac{r\theta}{t}\end{aligned}$$

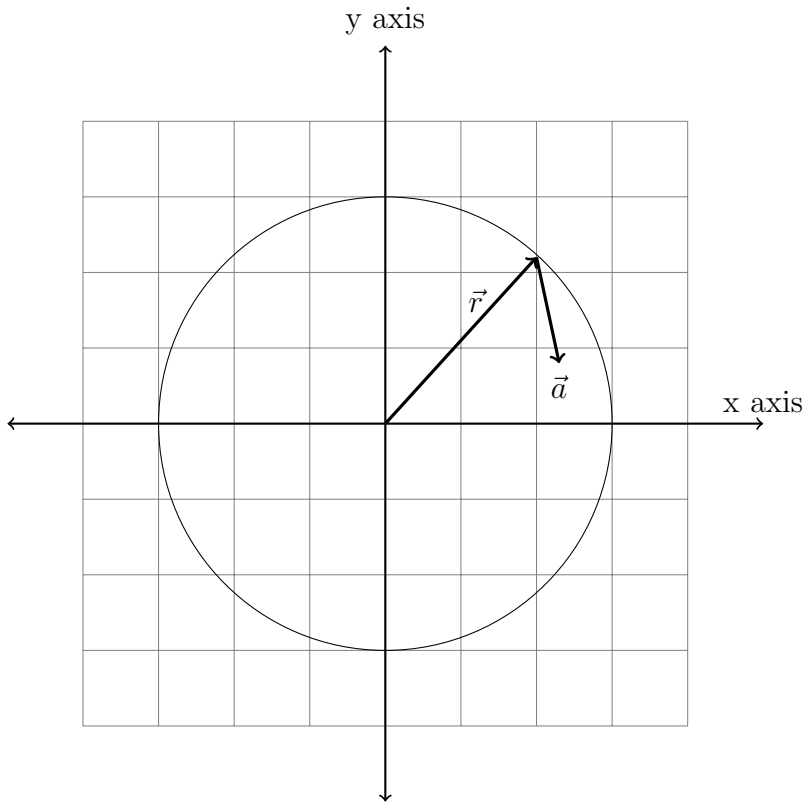
where t is the time it takes to travel θ.

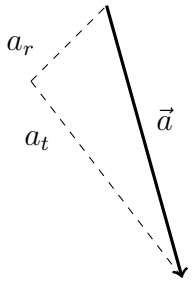
$$\begin{aligned}\theta &= \frac{vt}{r} \\ \vec{r} &= x\hat{i} + y\hat{j} \\ &= r\cos\theta\hat{i} + r\sin\theta\hat{j} \\ \vec{r} &= r\cos(\frac{vt}{r})\hat{i} + r\sin(\frac{vt}{r})\hat{j} \\ \vec{v} &= \frac{\mathrm{d}\vec{r}}{\mathrm{d}t} \\ &= -r\frac{v}{r}\sin(\frac{vt}{r}) + r\frac{v}{r}\cos(\frac{vt}{r})\hat{j} \\ &= -v\sin(\frac{vt}{r})\hat{i} + v\cos(\frac{vt}{r})\hat{j} \\ \vec{a} &= \frac{\mathrm{d}\vec{v}}{\mathrm{d}t} \\ &= -v\frac{v}{r}\cos(\frac{vt}{r})\hat{i} - v\frac{v}{r}\sin(\frac{vt}{r})\hat{j} \\ &= -\frac{v^2}{r}(\cos(\frac{vt}{r})\hat{i} + \sin(\frac{vt}{r})\hat{j}) \\ \|\vec{a}\| &= \frac{v^2}{r}\end{aligned}$$

Note that the direction of $\vec{a}$ is the opposite of $\vec{r}$ and points towards the center of the circle.

Changing Speed

If v is not constant:





$$a_r = \frac{v^2}{r}$$

$$a_t = \frac{\mathrm{d}v}{\mathrm{d}t} = \text{rate of change of speed}$$

Reminders and Homework

Complete the homework on TheExpertTA and WebAssign.
Remember to bring the Activities Manual

You can find all my notes at `http://omgimanerd.tech/notes`. If you have any questions, comments, or concerns, please contact me at alvin@omgimanerd.tech