1-1 Uniform Circular Motion

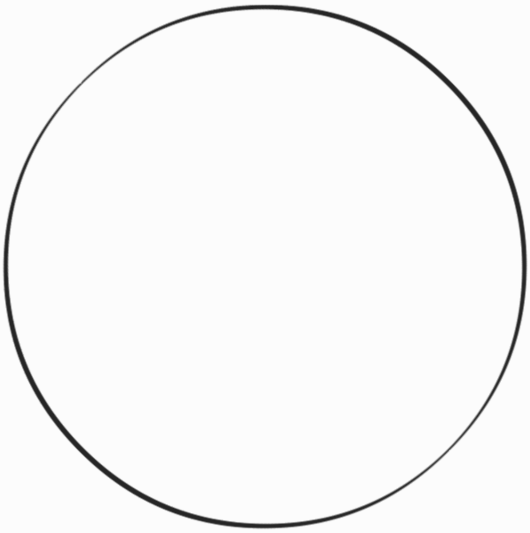


Diagram requires

At least 5 points
Representation
Position Vectors
Velocity Vector
Acceleration Vector

Times must be equally spaced

	Scalar/Vector?	Constant or Not?	Units	Symbolic Definition	Direction
Position					
Velocity					
Acceleration					
Mass					
Net Force					
Kinetic Energy					
Momentum					

1-1 Uniform Circular Motion

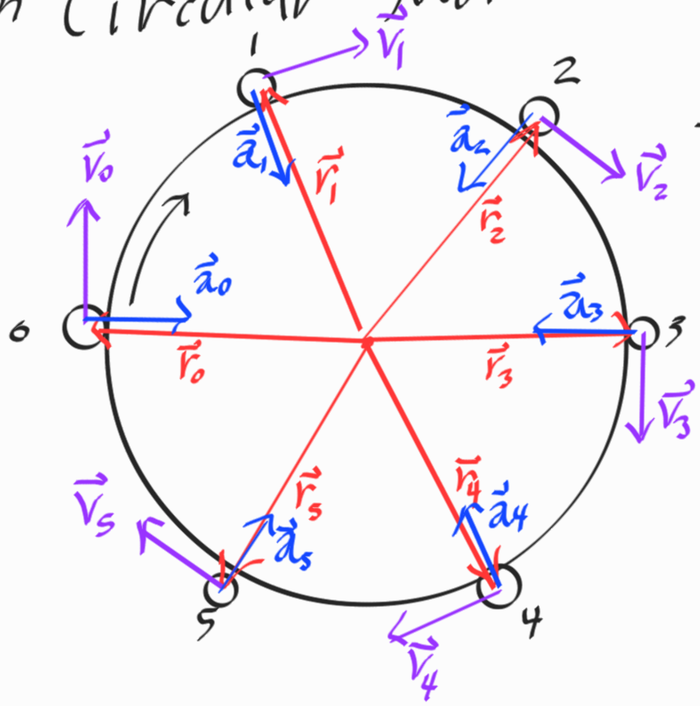


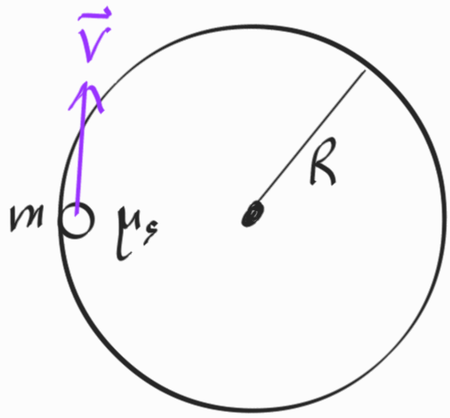
Diagram requires

At least 5 points
Representation
Position Vectors
Velocity Vector
Acceleration Vector

Times must be equally spaced

	Scalar/Vector?	Constant or Not?	Units	Symbolic Definition	Direction
Position	V	X	m	$\Delta\vec{r} = \vec{r}_f - \vec{r}_i$ (Displacement)	Out from center (if origin is center)
Velocity	V	X	m/s	$\vec{v} = \frac{d\vec{r}}{dt}$	Tangential
Acceleration	S	X	m/s^2	$\vec{a} = \frac{d\vec{v}}{dt}$	Centripetal
Mass	V	✓	kg	$\vec{F}_{net} = m\vec{a}$	—
Net Force	S	X	N $\frac{kg\,m}{s^2}$	$F_{net} = \sum_i \vec{F}_i$	Centripetal
Kinetic Energy	V	✓	J $\frac{kg\,m^2}{s^2}$	$K = \frac{1}{2}mv^2$	—
Momentum	V	X	$\frac{kg\,m}{s}$	$\vec{p} = m\vec{v}$	Tangential

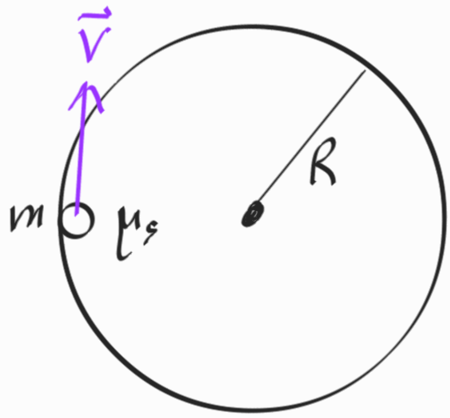
1-2 Coin on the Disc

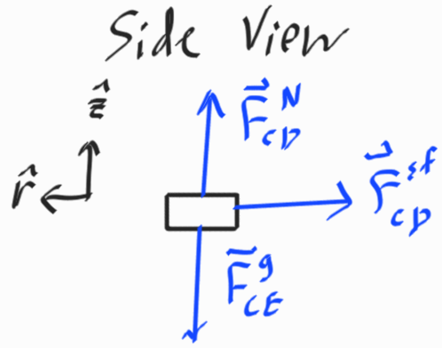


Special Cases

Covariation

1-2 Coin on the Disc





$$\vec{F}_{net} = \cancel{\vec{F}^N_{CD}} + \cancel{\vec{F}^g_{CE}} + \vec{F}^{sf}_{CD} = -F^{sf}_{CD}\hat{r}$$

$$F_{net} = F^{sf}_{CD} \quad \text{(magnitudes)}$$

$$F^{sf}_{CD} \leq \mu_s F^N_{CE}$$

$$\vec{F}_{net} = m\vec{a}$$

$$\Rightarrow F^{sf}_{CD} = ma$$

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

$$\Rightarrow \boxed{F^{sf}_{CD} = m\frac{v^2}{R}} \leq \mu_s F^N_{CE}$$

$$v = \omega r$$

$$\boxed{F^{sf}_{CD} = m\omega^2 R}$$

Special Cases

$R = 0\,m$, v const $\Rightarrow F^{sf}_{CD} = m\frac{v^2}{0m} \to \infty$ ill-defined, b/c v const as $R \downarrow$ requires $\omega \uparrow$

$R = 0\,m$, ω const $\Rightarrow F^{sf} = m\omega^2(0m) = 0\,N$ don't need any force to hold coin at center, spinning on it's own axis

$\mu_s = 0 \Rightarrow m\omega^2 R \geq \mu_s F^N_{CE}$, so coin can only stay on if stationary

Covariation

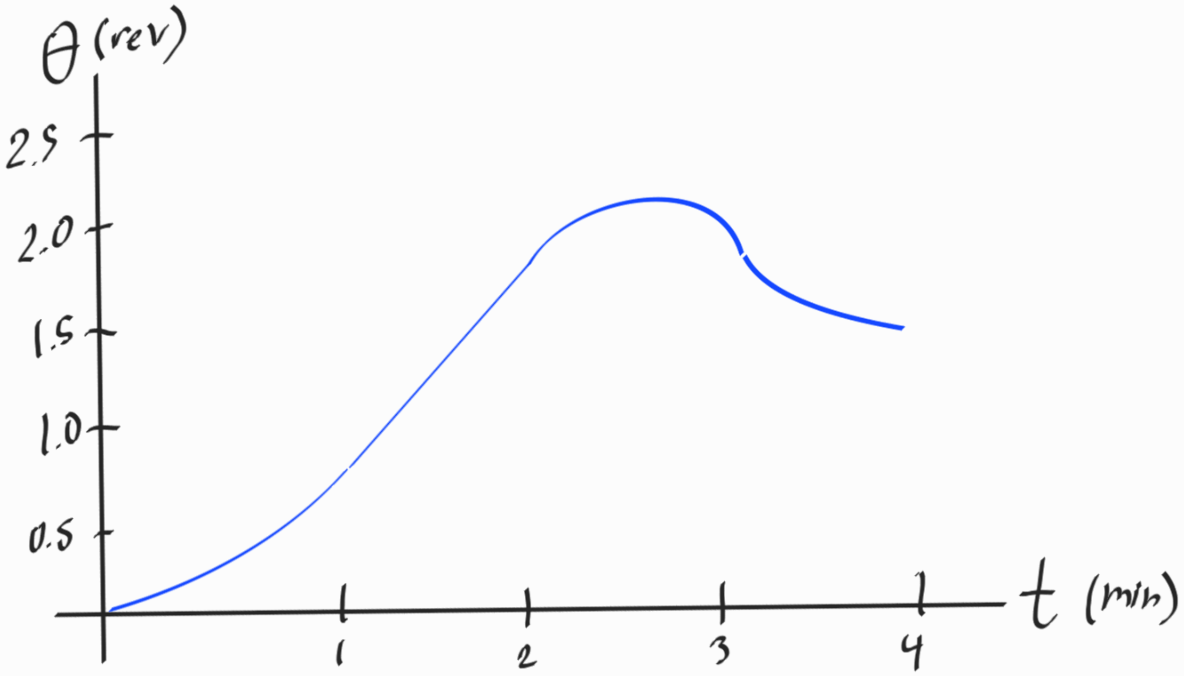
$m \uparrow \Rightarrow F^{sf} \uparrow$ b/c requires more force to overcome inertia

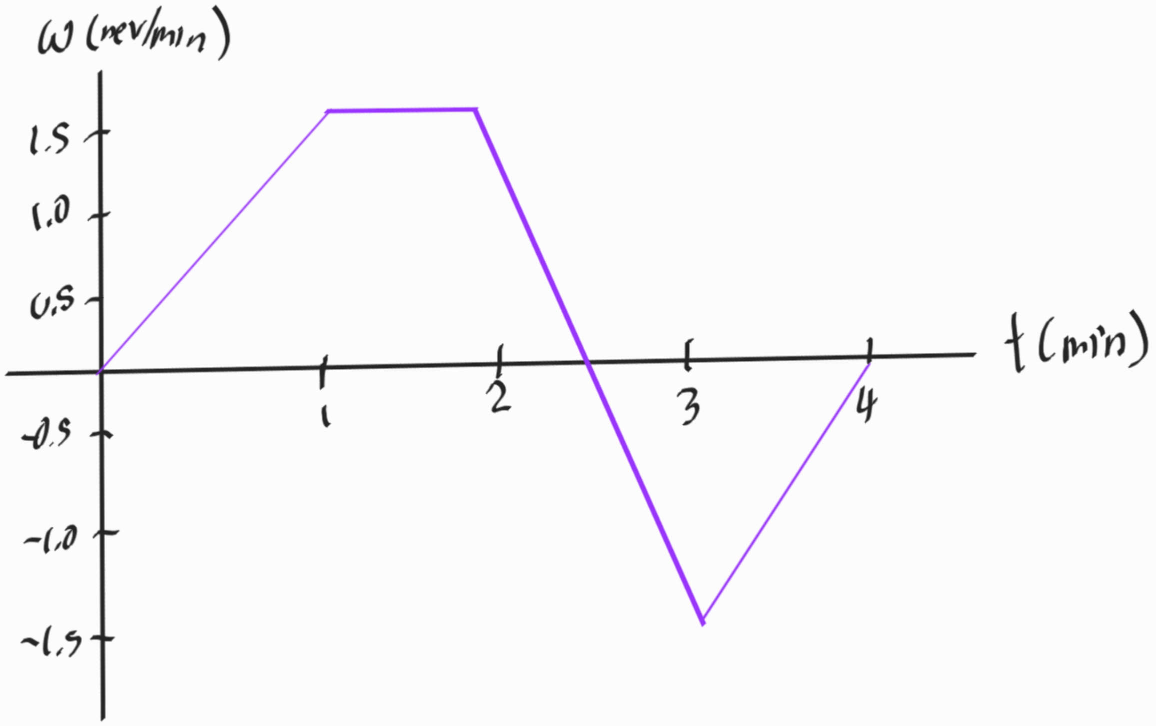
$v \uparrow \Rightarrow F^{sf} \uparrow$ b/c requires more force to make larger velocity change in less time

$R \uparrow$ v const $\Rightarrow F^{sf} \downarrow$ b/c doesn't have to turn as tightly

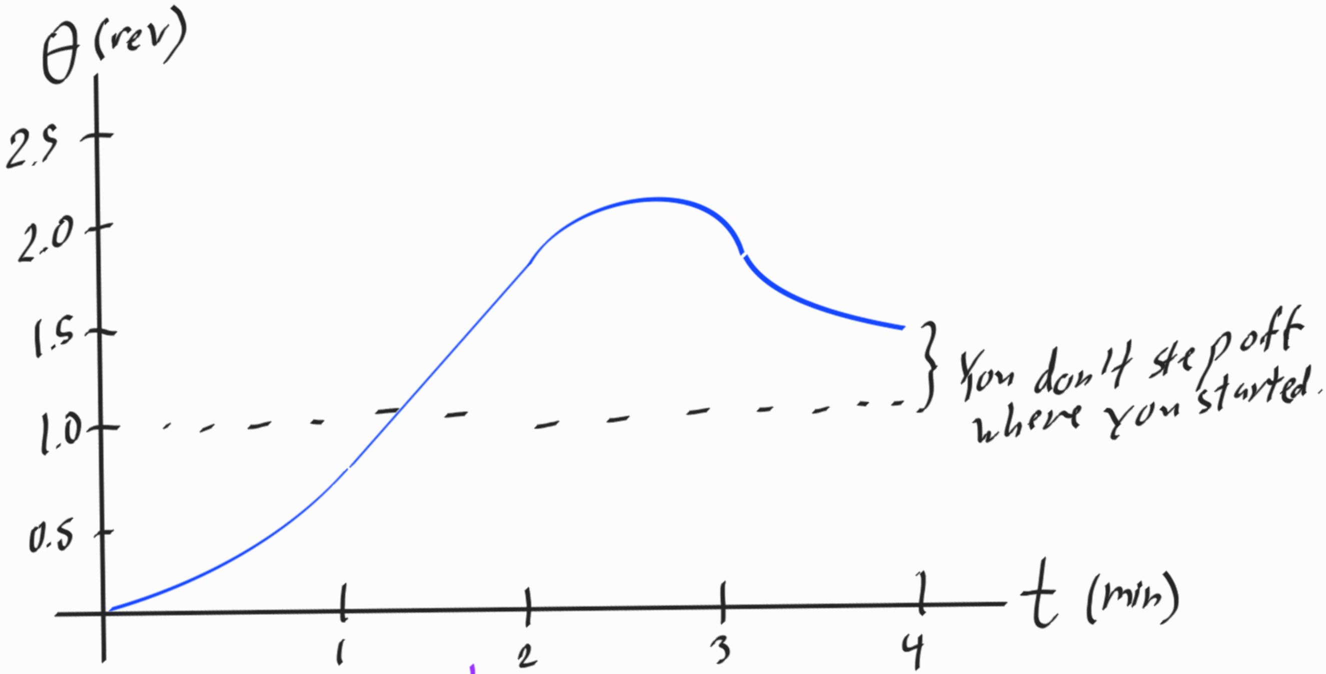
$R \uparrow$ ω const $\Rightarrow F^{sf} \uparrow$ b/c makes same direction change in same time at greater speed

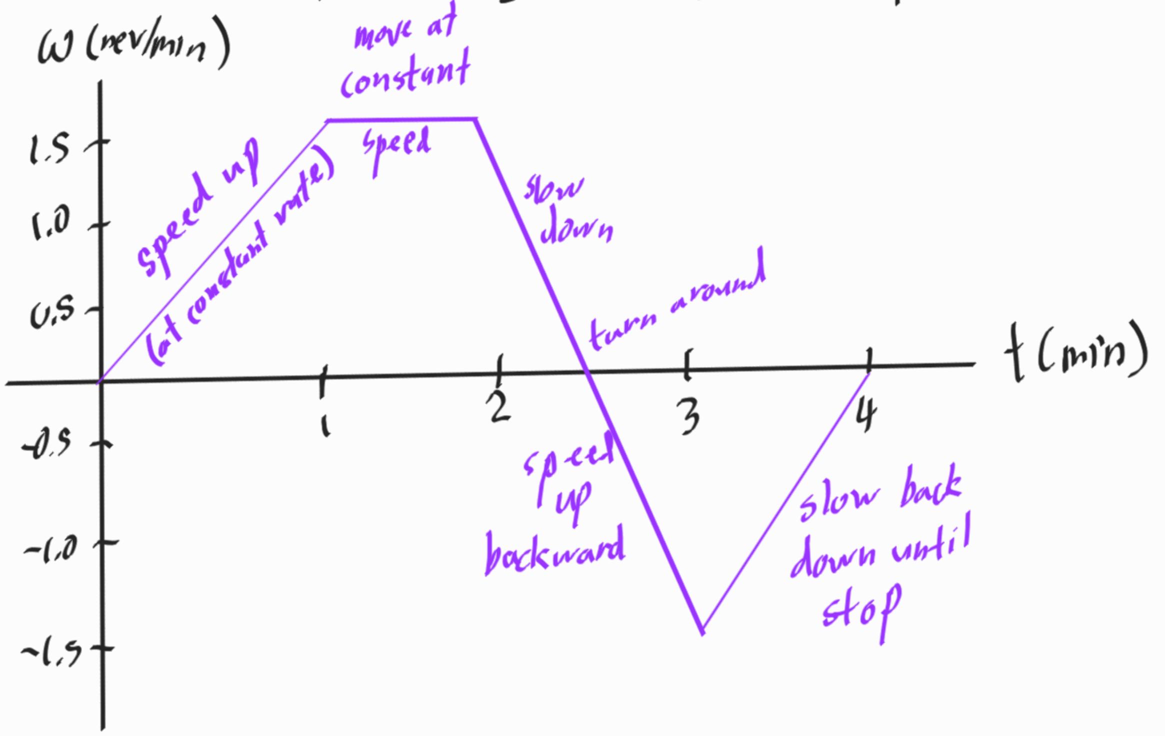
1-3 Merry-Go-Round



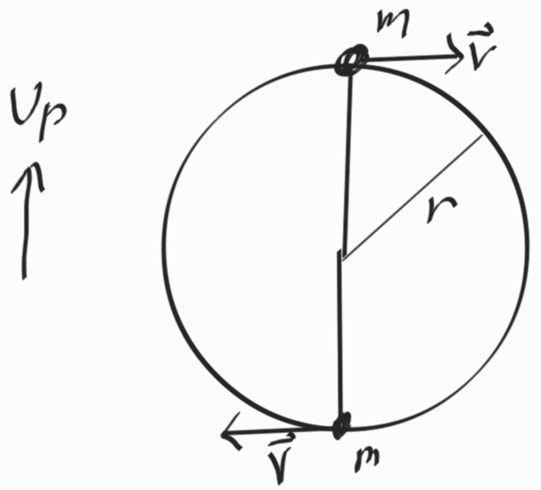


1-3 Merry-Go-Round





1-4 Swing in a Circle

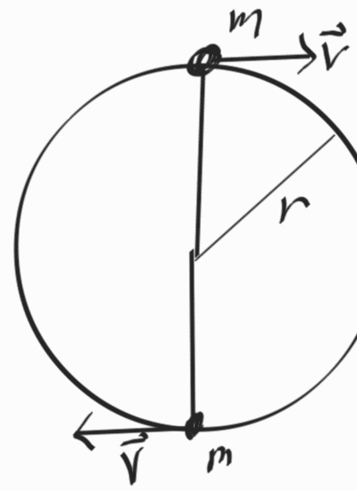


Top □

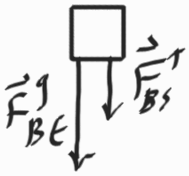
Bottom □

1-4 Swing in a Circle

Up

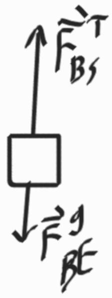


Top



depends on m, v, r

Bottom



$F^T > F^g$ to have $\vec{a}$ up

$$F^{net} = ma$$

$$F^T_{BS} + F^g_{BE} = m\frac{v^2}{r}$$

$$F^T_{BS} = m\left(\frac{v^2}{r} - g\right) \begin{cases} >0 & \text{if } \frac{v^2}{r} > g \\ =0 & \text{if } \frac{v^2}{r} = g \\ \cancel{<0 \text{ if } \frac{v^2}{r} < g} \end{cases}$$

Tension can't push!

$$F^T_{BS} - F^g_{BE} = m\frac{v^2}{r}$$

$$F^T_{BS} = m\left(\frac{v^2}{r} + g\right)$$