Warm Up Exercises: Circular Motion

Prof. Jordan C. Hanson

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1 Memory Bank

- Let $\Delta\theta$ be the *angular displacement*, $\Delta\theta = \theta_f - \theta_i$. Let the time duration be $\Delta t = t_f - t_i$. Let the angular velocity be $\omega = \Delta\theta/\Delta t$. If $t_i = 0$ seconds and $\theta_i = 0$ degrees, then we can use *omega* to write $\theta = \omega t$ (just like $x = vt$. If an object is rotating with angular velocity ω on a circle of radius r, then the position versus time is:

$$\vec{r}(t) = r\cos(\omega t)\hat{i} + r\sin(\omega t)\hat{j} \tag{1}$$

- $v = r\omega$ ... Radial velocity.
- $a_{\mathrm{C}} = v^2/r$ ... Centripetal acceleration.
- $a_{\mathrm{C}} = r\omega^2$ ... Centripetal acceleration.
- $\vec{F}_{\mathrm{C}} = ma_{\mathrm{C}}$ ... Centripetal force.

2 Centripetal Force

1. Suppose a system is rotating about the origin with a radius $r = 1.0$ m, and angular speed $\omega = 50$ rotations per second. (a) What is the angular speed in radians per second? (b) Where is the system at $t = 0.75$ seconds? (c) What are the radial velocity and centripetal acceleration? (d) If a mass of 0.05 kg is attached to the end of the radius, what is $\vec{F}_{\mathrm{C}}$?

2. In the prior problem, what would $\vec{F}_{\mathrm{C}}$ be if the angular velocity was doubled?