Flipping Physics Lecture Notes:

Centripetal Acceleration Introduction

When an object is rotating at a constant angular velocity, the whole object has a constant angular velocity. Therefore, every mint on the turntable has the same, constant angular velocity.

Looking at a single mint on the turntable:

- $\omega = \text{constant}$
- Because the angular velocity is constant, there is no angular acceleration.
    - $\alpha = \frac{\Delta\omega}{\Delta t} = \frac{0}{\Delta t} = 0$
- Because the angular acceleration is zero, the tangential acceleration of the mint is zero.
    - $a_t = r\alpha = r(0) = 0$
- The angular velocity of the mint is constant, however, the tangential velocity of the mint is *not* constant. Remember tangential velocity is a vector.
    - The *magnitude* of the tangential velocity of the mint *is* constant.
    - The *direction* of the tangential velocity of the mint is *not* constant.
- Because the tangential velocity of the mint is changing, the mint must have a linear acceleration.
    - $\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$ (If velocity is changing, there must be a linear acceleration.)
    - As shown above, this line acceleration is not a tangential acceleration.
    - It also is not an angular acceleration.
        - Angular acceleration is angular, not linear.
        - Also, it's zero anyway.
- The acceleration which causes the tangential velocity to change direction is called Centripetal Acceleration.

Centripetal Acceleration:

- The acceleration that causes circular motion.
- "Centripetal" means "Center Seeking".
    - Centripetal acceleration is always in toward the center of the circle.
    - Coined by Sir Isaac Newton. Combination of the Latin words "centrum" which means center and "petere" which means "to seek".
- Is a *linear* acceleration.
- $a_c = \frac{v_t^2}{r} = \frac{(r\omega)^2}{r} = \frac{r^2\omega^2}{r} = r\omega^2 \Rightarrow a_c = \frac{v_t^2}{r} = r\omega^2$
- Base S.I. units for centripetal acceleration are $\frac{m}{s^2}$
    - $a_c = r\omega^2 \Rightarrow (m)\left(\frac{rad}{s}\right)^2 = \frac{m \cdot rad^2}{s^2} = \frac{m}{s^2}$