PhyzGuide: Rotational Kinematics

I. DEFINITIONS

ENGLISH	EQUATIONS
Δ (Delta) means "change in," so Δ*n* means "change in *n*." Given two values of the quantity *n*, Δ*n* is calculated by subtracting the **first** value from the **second**.	$\Delta n = n_2 - n_1$ $\Delta n = n - n_0$
Angular speed is defined as the rate at which an object's orientation changes with respect to time. Therefore the angular speed of an object is the change in its orientation divided by the amount of time that passed during the object's change in orientation.	$\omega \equiv \Delta\theta/\Delta t$
Angular acceleration is defined as the rate at which an object's angular speed changes with time. Therefore the angular acceleration of an object is the change in its angular speed divided by the amount of time that passed during the object's change in angular speed.	$\alpha \equiv \Delta\omega/\Delta t$

II. ALGEBRAIC MANIPULATIONS

A. UM: Uniform Motion (no acceleration)

$\omega = \theta/t$ — For a motion that involves *no* acceleration, this equation is sufficient.

CAUTION > **DO NOT USE THIS EQUATION FOR ANY MOTION INVOLVING ACCELERATION.** If you do, you will promptly dry up and blow away, or perhaps turn into a pumpkin.

B. UAM: Uniform Accelerated Motion

These equations are valid when there **IS** acceleration, and even when there **ISN'T**.

EQUATION	"WHO CARES" QUANTITY					
$\omega = \omega_0 + \alpha t$	θ					THE "WHO CARES" QUANTITY tells you which equation to use. For example, suppose you know α, θ, and ω_0 but not ω or t. If you are looking for t, then you don't care about ω, so use the equation whose "WHO CARES" quantity is ω. If, however, you need to find ω, use the equation whose "WHO CARES" quantity is t.
$\theta = \omega_0 t + {}^1\!/_2\alpha t^2$		ω				
$\theta = {}^1\!/_2(\omega_0 + \omega)t$			α			
$\omega^2 = \omega_0^2 + 2\alpha\theta$				t		
$\theta = \omega t - {}^1\!/_2\alpha t^2$					ω_0	

The Small Print

The equations above are written as they are usually used. But they leave room for some confusion. The t's above represent Δt's—the time interval, and not a specific point in time. And the θ's above represent Δθ's. When one is involved in heavy kinematics work, most Δ's become "understood" and unwritten. An alternate way of writing some of the above equations is

$\omega = \omega_0 + \alpha\Delta t$ $\quad \Delta\theta = {}^1\!/_2(\omega_0 + \omega)\Delta t$ $\quad \Delta\theta = \omega_0\Delta t + {}^1\!/_2\,\alpha(\Delta t)^2$ $\quad \omega^2 = \omega_0^2 + 2\alpha(\Delta\theta)$