# 1 Kinematics

$$\vec{v}(t) = \vec{v_0} + \vec{a}t \tag{1.0.1}$$
$$\vec{r}(t) = \vec{r_0} + \vec{v_0}t + \frac{1}{2}\vec{a}t^2 \tag{1.0.2}$$
$$\vec{v}^2(t) = \vec{v_0}^2 + 2\vec{a} \cdot (\vec{r_1} - \vec{r_0}) \tag{1.0.3}$$
$$\vec{r} = \frac{\vec{v_0} + \vec{v_1}}{2}t \tag{1.0.4}$$

# 2 Polar Coordinates

$$\hat{r} = cos(\theta)\hat{x} + sin(\theta)\hat{y} \tag{2.0.1}$$
$$\hat{\theta} = -sin(\theta)\hat{x} + cos(\theta)\hat{y} \tag{2.0.2}$$
$$\frac{d}{dt}\hat{r} = \dot{\theta}\hat{\theta} \tag{2.0.3}$$

$$\vec{r} = r(t) \cdot \hat{r}(t) \tag{2.0.4}$$
$$\vec{v} = \dot{r}\hat{r} + r\dot{\theta}\,\hat{\theta} \tag{2.0.5}$$
$$\vec{a} = (\ddot{r} - r\dot{\theta}^2)\hat{r} + (r\ddot{\theta} + 2\dot{r}\dot{\theta})\,\hat{\theta} \tag{2.0.6}$$

## 2.1 Uniform Circular Motion

$\theta$ is constant in time

$$\vec{v} = \omega r\,\hat{\theta} \tag{2.1.1}$$
$$\vec{a} = -\omega r^2 \hat{r} \tag{2.1.2}$$