

Ch9 Physics Laws

<p>9.1</p> <div style="background-color: #ffffcc; border-radius: 10px; padding: 10px; margin-bottom: 10px;"> Convert from cartesian to polar coordinates $r = \sqrt{x^2 + y^2} \quad \theta = \tan^{-1} \frac{y}{x}$ </div> <div style="background-color: #ffffcc; border-radius: 10px; padding: 10px;"> Convert from polar to cartesian coordinates $x = r \cos \theta \quad y = r \sin \theta$ </div>			
<p>9.2</p> <table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; vertical-align: top; padding-right: 10px;"> Convert from degrees to radians $\theta_r = \frac{\pi}{180} \times \theta^\circ$ </td><td style="width: 50%; vertical-align: top;"> Convert from radians to degrees $\theta^\circ = \frac{180}{\pi} \times \theta_r$ </td></tr> </table>	Convert from degrees to radians $\theta_r = \frac{\pi}{180} \times \theta^\circ$	Convert from radians to degrees $\theta^\circ = \frac{180}{\pi} \times \theta_r$	
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<p>9.3</p> <p>*Angular displacement $\Delta\theta = \frac{\theta_f - \theta_i}{r}$ rad</p> <p>*Angular velocity</p> <ol style="list-style-type: none"> ① $\omega = \frac{\Delta\theta}{\Delta t}$ ② $\omega = \frac{v}{r}$ rad/s ③ $\omega = \frac{2\pi}{T}$ ④ $\omega = 2\pi f$ <p>If v is constant in magnitude like in uniform circular motion</p> <p>*Period</p> $T = \frac{1}{f} \quad s$ <p>Note: for an object makes n revolutions during time t s.</p> $T = \frac{t}{n} \Rightarrow n = \frac{t}{T}$ $f = \frac{n}{t} \Rightarrow n = tf$			

9.4

Acceleration

* centripetal acceleration

$$\textcircled{1} \quad a_c = \frac{v^2}{r}$$

$$\textcircled{2} \quad a_c = \omega^2 r$$

$$\textcircled{3} \quad a_c = \omega v \quad \text{m/s}^2$$

$$\textcircled{4} \quad a_c = \frac{F_c}{m}$$

* Angular acceleration

$$\textcircled{1} \quad \alpha = \frac{\Delta\omega}{\Delta t}$$

$$\textcircled{2} \quad \alpha = \frac{\Delta\theta}{\Delta t}$$

rad/s^2

Total acceleration in circular motion

$$\ast \quad a = \sqrt{r^2 \alpha^2 + r^2 \omega^4} \quad \text{m/s}^2$$

9.5

* Centripetal force

(1) $F_c = \text{net force acting on the object moving in circular motion}$

$$\textcircled{2} \quad F_c = m a_c$$

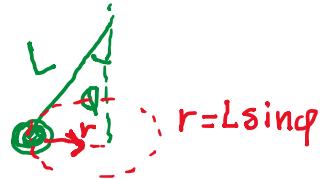
$$\textcircled{3} \quad F_c = \frac{mv^2}{r} \quad N$$

$$\textcircled{4} \quad F_c = m\omega v$$

$$\textcircled{5} \quad F_c = m\omega^2 r$$

* Centripetal Force Examples

Conical pendulum



$$* F_c = T \sin \varphi$$



$$* a_c = g \tan \varphi$$



$$* v = \sqrt{r g \tan \varphi} \\ = \sin \varphi \sqrt{\frac{Lg}{\cos \varphi}}$$



$$\omega = \sqrt{\frac{g \tan \varphi}{r}} \\ = \sqrt{\frac{g}{L \cos \varphi}}$$



$$T = 2\pi \sqrt{\frac{r}{g \tan \varphi}} \\ = 2\pi \sqrt{\frac{L \cos \varphi}{g}}$$



$$f = \frac{1}{2\pi} \sqrt{\frac{g \tan \varphi}{r}} = \frac{1}{2\pi} \sqrt{\frac{g}{L \cos \varphi}}$$

Roller coaster



at the top
to feel weightless

$$F_c = mg$$



$$a_c = g$$



$$v = \sqrt{rg}$$



$$\omega = \sqrt{\frac{g}{r}}$$



$$T = 2\pi \sqrt{\frac{r}{g}}$$



$$f = \frac{1}{2\pi} \sqrt{\frac{g}{r}}$$

car racing



$$F_c = \mu s N$$

$$= \mu s M g$$



$$a_c = \mu s g$$



$$v = \sqrt{r \mu s g}$$



$$\omega = \sqrt{\frac{\mu s g}{r}}$$



$$T = 2\pi \sqrt{\frac{r}{\mu s g}}$$



$$f = \frac{1}{2\pi} \sqrt{\frac{\mu s g}{r}}$$

9.6

constant angular acceleration
equations

$$\textcircled{1} \quad \omega_f = \omega_i + \alpha t$$

$$\textcircled{2} \quad \Delta\theta = \omega_i t + \frac{1}{2}\alpha t^2$$

$$\textcircled{3} \quad \omega_f^2 = \omega_i^2 + 2\alpha \Delta\theta$$

$$\textcircled{4} \quad \bar{\omega} = \left(\frac{\omega_i + \omega_f}{2} \right)$$

$$\textcircled{5} \quad \Delta\theta = \bar{\omega} t$$

Relation between
linear and
angular
quantities

$$\theta = \frac{s}{r}$$

$$\omega = \frac{v}{r}$$

$$\alpha = \frac{a}{r}$$