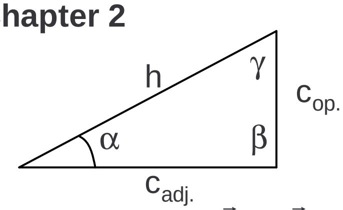
Chapter 1

$$\Delta x = x_f - x_i \qquad v_{av} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{t_f - t_i} \qquad (a = cnt.) \quad v_{av} = \frac{v_i + v_f}{2} \qquad a_{av} = \frac{\Delta v}{\Delta t}$$

$$x = x_0 + v_{0x}t + \tfrac{1}{2}a_x t^2 \qquad v_x = v_{ox} + a_x t \qquad Az^2 + Bz + C = 0 \quad \rightarrow \quad z = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

Chapter 2



$$h^2 = c_{adj.}^2 + c_{op.}^2 \qquad \alpha + \beta + \gamma = 180^o$$

$$\sin\alpha = \frac{c_{op.}}{h} \quad \cos\alpha = \frac{c_{adj.}}{h} \quad \tan\alpha = \frac{c_{op.}}{c_{adj.}} = \frac{\sin\alpha}{\cos\alpha}$$

$$\vec{v}_{og} = \vec{v}_{cg} + \vec{v}_{oc} \qquad \vec{v}_{13} = \vec{v}_{12} + \vec{v}_{23} \qquad \vec{v}_{ij} = -\vec{v}_{ji}$$

Chapter 3

$$x = x_0 + v_{ox}t + \tfrac{1}{2}a_x t^2 \qquad v_x = v_{ox} + a_x t$$
$$y = y_0 + v_{oy}t + \tfrac{1}{2}a_y t^2 \qquad v_y = v_{oy} + a_y t$$

General-launch angle: Range: $x_R = \frac{v_0^2 \sin(2\theta)}{g}$ *Time to Range:* $t_R = \frac{2v_0 \sin\theta}{g}$

Maximum height: $y_M = \frac{v_0^2 \sin^2\theta}{2g}$ *Time to Max. Height:* $t_M = \frac{v_o \sin\theta}{g}$

Zero-launch angle: Landing site: $x_L = v_o\sqrt{\frac{2h}{g}}$ *Time to Landing:* $t_L = \sqrt{\frac{2h}{g}}$

Chapters 4

$$\sum \vec{F} = m\vec{a} \quad \rightarrow \quad \sum F_x = ma_x \quad \sum F_y = ma_y \qquad F_{cp} = m\frac{v^2}{r}$$

$$W = mg \quad \rightarrow \quad W_a - W = (\pm)ma \qquad \vec{F}_k = \mu_k \vec{N} \qquad \vec{F}_{s,\max} = \mu_s \vec{N} \qquad \vec{N} = -\sum \vec{F}_\perp \qquad F = -kx$$

Chapters 7

$$W = \vec{F}\cdot\vec{d} = Fd\cos\theta \qquad W_T = \sum_i W_i = \sum_i \vec{F}_i \cdot \vec{d}_i = \sum_i F_i d\cos\theta_i$$

$$E = K + U \qquad K = \tfrac{1}{2}mv^2 \qquad U_{spring} = \tfrac{1}{2}kx^2 \qquad U_g = mgy \qquad P = \frac{W}{t}$$

Conservative forces

$$\Delta E = 0$$
$$E_f = K_f + U_f = E_i = K_i + U_i$$

Non-conservative forces

$$\Delta E = W_{NC} \qquad E_f \neq E_i$$

In general

$$W_T = \Delta K = K_f - K_i$$
$$W_C = -\Delta U = U_i - U_f$$
$$W_{NC} = \Delta E = E_f - E_i = K_f + U_f - (K_i + U_i)$$

Chapter 8 $\vec{p} = m\vec{v}$ $\Delta\vec{p} = \vec{p}_f - \vec{p}_i$ $\vec{I} = \vec{F}_{av}\Delta t = \Delta t \sum_i \vec{F}_i = \Delta\vec{p} = \vec{p}_f - \vec{p}_i = m\vec{v}_f - m\vec{v}_i$

System of several objects $\vec{p}_T = \sum_i \vec{p}_i = \sum_i m_i\vec{v}_i$

$\vec{F}_{net} = \sum \vec{F} = \sum \vec{F}_{ext} + \sum \vec{F}_{\text{int}}$ $\sum \vec{F}_{\text{int}} = 0$ so if $\sum \vec{F}_{ext} = 0$ $\longrightarrow$ $\vec{p}_{Tf} = \vec{p}_{Ti}$

Collisions $\vec{p}_{Tf} = \vec{p}_{Ti}$ Inelastic: $K_f < K_i$ Elastic: $K_f = K_i$

1-D collisions Comp. inelastic $v_f = \dfrac{m_1 v_{1i} + m_2 v_{2i}}{m_1 + m_2}$ Elastic with $v_{2i} = 0$ $v_{1i} = v_0$ $\Rightarrow$ $v_{1f} = \left(\dfrac{m_1 - m_2}{m_1 + m_2}\right) v_0$, $v_{2f} = \left(\dfrac{2m_1}{m_1 + m_2}\right) v_0$

2-D collisions $\sum_j p_{jxf} = \sum_j p_{jxi}$, $\sum_j p_{jyf} = \sum_j p_{jyi}$ 2-D elastic: $K_f = K_i$ with $v = \sqrt{v_x^2 + v_y^2}$

Chapter 9 1 revolution = 2π radians $\Delta\theta = \theta_f - \theta_i$ $\omega_{av} = \dfrac{\Delta\theta}{\Delta t}$ $T = \dfrac{2\pi}{\omega}$ $\alpha_{av} = \dfrac{\Delta\omega}{\Delta t}$

$\theta = \theta_0 + \omega_0 t + \tfrac{1}{2}\alpha t^2$ $\omega = \omega_0 + \alpha t$

$v_t = r\omega = r\dfrac{2\pi}{T}$ $a_t = r\alpha = r\dfrac{\Delta\omega}{\Delta t} = \dfrac{\Delta v_t}{\Delta t}$ $a_{cp} = \dfrac{v_t^2}{r} = r\omega^2 = r\left(\dfrac{2\pi}{T}\right)^2$ $a = \sqrt{a_t^2 + a_{cp}^2}$ $\phi = \tan^{-1}\left(\dfrac{a_{cp}}{a_t}\right)$

$E_f = E_i$ $E = K_T + U$ $K_T = K + K_R = \tfrac{1}{2}mv^2 + \tfrac{1}{2}I\omega^2$ $K_R = \tfrac{1}{2}I\omega^2$

Chapter 10 $\vec{\tau}_{net} = \sum_i \vec{\tau}_i = \sum_i \vec{r}_i \times \vec{F}_i = \sum_i r_i F_i \sin\theta_i$ $\vec{L} = I\vec{\omega}$ $\vec{L} = \vec{r} \times \vec{p} = rp\sin\theta$

Static equilibrium conditions:
$\sum \vec{F} = m\vec{a} = 0$ $\sum \vec{\tau} = \left(\sum I\right)\vec{\alpha} = 0$

$\vec{\tau} = I\vec{\alpha} = \dfrac{\Delta\vec{L}}{\Delta t}$ $\Delta\vec{L} = L_f - L_i = \vec{\tau}\Delta t$
