Chapter 6 Equations

Work & Kinetic & Potential Energies:
\[ W = F \cdot d \cdot \cos \theta, \quad KE = \frac{1}{2} mv^2, \quad PE_{\text{gravity}} = mg \cdot y, \quad PE_{\text{spring}} = \frac{1}{2} k x^2. \]

Conservation or Transformation of Energy:
“work-KE theorem” \( \Delta KE = W_{\text{net}}, \) or use conservation law \( \Delta KE + \Delta PE = W_{NC}. \)

Power:
\[ P_{\text{ave}} = \frac{W}{t}, \quad \text{or use} \quad P_{\text{ave}} = \frac{\text{energy}}{\text{time}}. \]

Chapter 5 Equations

Centripetal Acceleration:
\[ a_R = \frac{v^2}{r}, \] towards the center of the circle.

Circular motion:
speed \( v = \frac{2\pi r}{T} = 2\pi f, \) frequency \( f = \frac{1}{T}, \) where \( T \) is the period of one revolution.

Gravitation:
\[ F = G \frac{m_1 m_2}{r^2}; \quad g = \frac{GM}{r^2}, \] where \( G = 6.67 \times 10^{-11} \text{ Nm}^2/\text{kg}^2; \)

Orbits:
\[ \frac{v^2}{r} = g = \frac{GM}{r^2}; \quad v = \sqrt{\frac{GM}{r}}. \]

Chapter 4 Equations

Newton’s Second Law:
\[ \vec{F}_{\text{net}} = m \vec{a}, \] which means \( \Sigma F_x = ma_x \) and \( \Sigma F_y = ma_y. \)

Static friction (magnitude):
\[ f_s \leq \mu_s N \text{ or } F_{tr} \leq \mu_s F_N. \]

Kinetic or sliding friction (magnitude):
\[ f_k = \mu_k N \text{ or } F_{tr} = \mu_k F_N. \]

Gravitational force near Earth:
\[ F_G = mg, \] downward.

Acceleration Equations
\[ \vec{a} = \frac{\Delta \vec{v}}{\Delta t}, \quad \Delta x = x - x_0, \quad \text{slope of } x(t) = v(t). \]
\[ \vec{a} = \frac{\Delta v}{\Delta t}, \quad \Delta v = v - v_0, \quad \text{slope of } v(t) = a(t). \]

For constant acceleration in one-dimension:
\[ \vec{a} = \frac{1}{2}(v_0 + v), \quad v = v_0 + at, \quad x = x_0 + v_0 t + \frac{1}{2} at^2, \quad v^2 = v_0^2 + 2a(x - x_0). \]
Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=$V$, direction=$\theta$ or by components $(V_x, V_y)$.

$$V_x = V \cos \theta, \quad V_y = V \sin \theta,$$

$$V = \sqrt{V_x^2 + V_y^2}, \quad \tan \theta = \frac{V_y}{V_x}.$$  \hspace{1cm} \theta is the angle from $\vec{V}$ to $+x$-axis.

Addition: $\mathbf{A} + \mathbf{B}$, head to tail.  Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Trig summary

\begin{align*}
\sin \theta &= \frac{\text{opp}}{\text{hyp}}, \quad \cos \theta = \frac{\text{adj}}{\text{hyp}}, \quad \tan \theta = \frac{\text{opp}}{\text{adj}}, \quad (\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2. \\
\sin \theta &= \sin(180^\circ - \theta), \quad \cos \theta = \cos(-\theta), \quad \tan \theta = \tan(180^\circ + \theta), \quad \sin^2 \theta + \cos^2 \theta = 1.
\end{align*}