Prefixes

a=10^{-18}, f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}

Physical Constants

$g = 9.80$ m/s^2 (gravitational acceleration)
$M_E = 5.98 \times 10^{24}$ kg (mass of Earth)
$m_e = 9.11 \times 10^{-31}$ kg (electron mass)
$c = 299792458$ m/s (speed of light)
$G = 6.67 \times 10^{-11}$ N·m^2/kg^2 (Gravitational constant)
$R_E = 6380$ km (mean radius of Earth)
$m_p = 1.67 \times 10^{-27}$ kg (proton mass)

Units and Conversions

1 inch = 1 in = 2.54 cm (exactly)
1 mile = 5280 ft
1 m/s = 3.6 km/hour
1 acre = 43560 ft^2 = (1 mile)^2/640
1 foot = 1 ft = 12 in = 30.48 cm (exactly)
1 mile = 1609.344 m = 1.609344 km
1 ft/s = 0.6818 mile/hour
1 hectare = 10^4 m^2

Trig summary

$\sin\theta = \frac{\text{(opp)}}{\text{(hyp)}}$, $\cos\theta = \frac{\text{(adj)}}{\text{(hyp)}}$, $\tan\theta = \frac{\text{(opp)}}{\text{(adj)}}$, $\text{(opp)}^2 + \text{(adj)}^2 = \text{(hyp)}^2$.
$\sin\theta = \sin(180° - \theta)$, $\cos\theta = \cos(-\theta)$, $\tan\theta = \tan(180° + \theta)$, $\sin^2\theta + \cos^2\theta = 1$.

Acceleration Equations

$\bar{v} = \frac{\Delta x}{\Delta t}$, $\Delta x = x - x_0$, slope of $x(t)$ curve = $v(t)$.
$\bar{a} = \frac{\Delta v}{\Delta t}$, $\Delta v = v - v_0$, slope of $v(t)$ curve = $a(t)$.

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

Vectors

Written $\vec{V}$ or **V**, described by magnitude=V, direction=θ or by components (V_x, V_y).
$V_x = V\cos\theta$, $V_y = V\sin\theta$,
$V = \sqrt{V_x^2 + V_y^2}$, $\tan\theta = \frac{V_y}{V_x}$. θ 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.

Newton's Second Law:
$\vec{F}_{\text{net}} = m\vec{a}$, means $\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$. $\vec{F}_{\text{net}} = \sum \vec{F}_i$, sum over all forces on a mass.

Acceleration Equations

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

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

Gravitation:
$F = G\frac{m_1 m_2}{r^2}$; $g = \frac{GM}{r^2}$, where $G = 6.67 \times 10^{-11}$ Nm^2/kg^2;

Energy, Force, Power

Work & Kinetic & Potential Energies:
$W = Fd\cos\theta$, $\text{KE} = \frac{1}{2}mv^2$, $\text{PE}_{\text{gravity}} = mgy$, $\text{PE}_{\text{spring}} = \frac{1}{2}kx^2$. θ = angle btwn $\vec{F}$ and $\vec{d}$.

Conservation or Transformation of Energy:

Work-KE theorem:
$\Delta\text{KE} = W_{\text{net}}$ = work of all forces.

General energy-conservation law:
$\Delta\text{KE} + \Delta\text{PE} = W_{\text{NC}}$ = work of non-conservative forces.

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

Linear Momentum

Momentum & Impulse:

momentum $\vec{p} = m\vec{v}$, impulse $\Delta\vec{p} = \vec{F}_{\text{ave}}\ \Delta t$.

Conservation of Momentum:

(2-body collision): $m_A\vec{v}_A + m_B\vec{v}_B = m_A\vec{v'}_A + m_B\vec{v'}_B$.

Center of Mass:

$x_{\text{cm}} = \frac{m_1x_1+m_2x_2+\ldots}{m_1+m_2+\ldots}$, $v_{\text{cm}} = \frac{m_1v_1+m_2v_2+\ldots}{m_1+m_2+\ldots}$.

Rotational Motion

Rotational coordinates:

1 rev = 2π radians = $360°$, $\omega = 2\pi f$, $f = \frac{1}{T}$, $\bar{\omega} = \frac{\Delta\theta}{\Delta t}$, $\bar{\alpha} = \frac{\Delta\omega}{\Delta t}$, $\Delta\theta = \bar{\omega}\Delta t$.

Linear coordinates vs. rotation coordinates and radius:

$l = \theta r$, $v = \omega r$, $a_{\tan} = \alpha r$, $a_R = \omega^2 r$, (must use radians in these).

Constant angular acceleration:

$\omega = \omega_0 + \alpha t$, $\theta = \theta_0 + \omega_0 t + \frac{1}{2}\alpha t^2$, $\bar{\omega} + \frac{1}{2}(\omega_0 + \omega)$, $\omega^2 = \omega_0^2 + 2\alpha\Delta\theta$.

Torque & Dynamics:

$\tau = rF\sin\theta$, $I = \Sigma mr^2$, $\tau_{\text{net}} = I\alpha$, $L = I\omega$, $\Delta L = \tau_{\text{net}}\Delta t$, $\text{KE}_{\text{rotation}} = \frac{1}{2}I\omega^2$.

Static Equilibrium:

$\Sigma F_x = \Sigma F_y = \Sigma F_z = 0$, $\Sigma\tau = 0$, $\tau = rFsin\theta$.

Chapter 10 Equations: Fluids

Density:

$\rho = m/V$, SG=$\rho/\rho_{\text{H}_2\text{O}}$, $\rho_{\text{H}_2\text{O}} = 1000$ kg/m^3 = 1.00 g/cm^3 (at 4°C).

Static Fluids:

$P = F/A$, $P_2 = P_1 + \rho gh$, $\Delta P = \rho gh$, $P = P_{\text{atm.}} + P_G$, $B = \rho gV$ or $F_B = \rho gV$.

Pressure Units:

1 Pa = 1 N/m^2, 1 bar = 10^5 Pa = 100 kPa, 1 mm-Hg = 133.3 Pa.

1.00 atm = 101.3 kPa = 1.013 bar = 760 torr = 760 mm-Hg =14.7 lb/in^2.

Moving Fluids:

$A_1v_1 = A_2v_2$ = a constant, $P + \frac{1}{2}\rho v^2 + \rho gy$ = a constant.

Chapter 11 Equations: Oscillations and Waves

Oscillators, frequency, period, etc.:

$F = -kx = ma$, $f = 1/T$, $\omega = 2\pi f = 2\pi/T$, $\omega = \sqrt{k/m}$, $\omega = \sqrt{g/L}$.

Oscillator energy, speed, etc.:

$E = \frac{1}{2}mv^2 + \frac{1}{2}kx^2 = \frac{1}{2}kA^2 = \frac{1}{2}mv_{\max}^2$, $v_{\max} = \omega A$.

Waves:

$\lambda = vT$, $v = f\lambda$, $v = \sqrt{\frac{F_T}{m/L}}$, $I = P/A$, $I = P/4\pi r^2$.

Standing waves:

node to node distance = $\lambda/2$.

Chapter 12 Equations: Sound

Sound: In air, $v \approx (331 + 0.60\ T)$ m/s, T in °C, $v = 343$ m/s at 20°C, $d = vt$.

Sound Intensity, Level: $I = P/A$, $I = P/4\pi r^2$, $\beta = (10\text{ dB})\log\frac{I}{I_0}$, $I = I_0\ 10^{\beta/(10\text{ dB})}$, $I_0 = 10^{-12}$ W/m^2.