Pythagorean Theorem
$$c^2 = a^2 + b^2$$

Absolute & Relative Error – Accuracy
$$\text{Absolute Error} = |\text{Observed} - \text{Accepted}|$$
$$\text{E}_\text{A} = |\text{O} - \text{A}|$$
$$\text{Relative Error} = \frac{\text{Absolute Error}}{\text{Accepted}} \bullet 100\%$$
$$\text{E}_\text{R} = \frac{\text{E}_\text{A}}{\text{A}} \bullet 100\% = \frac{|\text{O} - \text{A}|}{\text{A}} \bullet 100\%$$

Absolute & Relative Deviation – Precision
$$\text{Absolute Deviation} = |\text{Observed} - \text{Mean}|$$
$$\text{D}_\text{A} = |\text{O} - \text{M}|$$
$$\text{Relative Deviation} = \frac{\text{Absolute Deviation}}{\text{Mean}} \bullet 100\%$$
$$\text{D}_\text{R} = \frac{\text{D}_\text{A}}{\text{M}} \bullet 100\% = \frac{|\text{O} - \text{M}|}{\text{M}} \bullet 100\%$$

Trigonometric Functions
$$\sin\theta = \frac{opposite}{hypotenuse} \qquad \cos\theta = \frac{adjacent}{hypotenuse}$$
$$\tan\theta = \frac{opposite}{adjacent}$$

Resultant
$$Magnitude = R = \sqrt{R_x^2 + R_y^2} \qquad Direction = \theta = \tan^{-1}\frac{R_y}{R_x}$$

Speed, Velocity & Acceleration
$$\text{Speed}_{av} = \frac{\text{Distance}}{\text{ElapsedTime}} \qquad v_{av} = \frac{x_f - x_i}{t_f - t_i} = \frac{\Delta x}{\Delta t}$$
$$a_{av} = \frac{v_f - v_i}{t_f - t_i} = \frac{\Delta v}{\Delta t}$$

Linear Kinematics
$$v_f = v_i + a\Delta t \qquad \Delta x = \tfrac{1}{2}(v_i + v_f)\,\Delta t$$
$$v_f^2 = v_i^2 + 2a\Delta x \qquad \Delta x = v_i t + \tfrac{1}{2}a\Delta t^2$$

Relative Motion
$$v_{ab} = v_{ac} + v_{cb}$$

Falling Objects & Projectiles
$$v_x = \text{constant} \qquad g = -9.81\,{}^{m}\!/\!_{s^2}$$
$$v_{x,i} = v_i(\cos\theta) \qquad v_{y,i} = v_i(\sin\theta)$$
$$\Delta x = v_i(\cos\theta)\Delta t \qquad \Delta y = v_{y,i}t + \tfrac{1}{2}g\Delta t^2$$
$$v_{y,f} = v_{y,i} + g\Delta t$$
$$v_{y,f}^2 = v_{y,i}^2 + 2g\Delta y$$

Newton's Second Law
$$\sum F = ma \qquad @\ \text{Equilibrium } \Sigma F = 0$$
$$\sum F_x = ma_x = \ldots \qquad \sum F_y = ma_y = \ldots$$
$$F_f = \mu F_N$$

Force of Friction
$$F_f = \mu F_N$$
$$F_s = \mu_s F_N \qquad F_k = \mu_k F_N$$

Net Work Done by Constant Force
$$W_{net} = F_{net}\,d(\cos\theta)$$

Kinetic Energy
$$KE = \tfrac{1}{2}mv^2$$

Potential Energy
$$PE_{gravitational} = U = mgh \qquad PE_{elastic} = \tfrac{1}{2}kx^2$$

Conservation of Mechanical Energy
$$ME_i = ME_f$$
$$KE_i + PE_{g,i} + PE_{e,i} + U_i = KE_f + PE_{g,f} + PE_{e,f} + U_f$$
$$\tfrac{1}{2}mv_i^{\,2} + mgh_i + \tfrac{1}{2}kx_i^{\,2} = \tfrac{1}{2}mv_f^{\,2} + mgh_f + \tfrac{1}{2}kx_f^{\,2}$$

Work-Kinetic Energy Theorem
$$W_{net} = \Delta KE$$

Power
$$P = \frac{Work}{Time} = \frac{W}{t} = \frac{Fd}{t} = Fv$$

Momentum
$$p = mv$$

Impulse-Momentum Theorem
$$F\Delta t = \Delta p = mv_f - mv_i$$

Conservation of Momentum
$$mv_{1i} + mv_{2i} = mv_{1f} + mv_{2f}$$

Perfectly Inelastic Collisions
$$m_1v_{1,i} + m_2v_{2,i} = (m_1 + m_2)v_f$$
$$\tfrac{1}{2}m_1v_{1,i}^{\,2} + \tfrac{1}{2}m_2v_{2,i}^{\,2} \neq \tfrac{1}{2}(m_1 + m_2)v_f^{\,2}$$
or
$$(m_1 + m_2)v_i = mv_{1,f} + mv_{2,f}$$
$$\tfrac{1}{2}(m_1 + m_2)v_i^{\,2} \neq \tfrac{1}{2}m_1v_{1,f}^{\,2} + \tfrac{1}{2}m_2v_{2,f}^{\,2}$$

Elastic Collisions
$$m_1v_{1,i} + m_2v_{2i} = m_1v_{1,f} + m_2v_{2,f}$$
$$\tfrac{1}{2}m_1v_{1,i}^{\,2} + \tfrac{1}{2}m_2v_{2,i}^{\,2} = \tfrac{1}{2}m_1v_{1,f}^{\,2} + \tfrac{1}{2}m_2v_{2,f}^{\,2}$$

Arc Length
$$\Delta s = r\Delta\theta$$

Angular Velocity
$$\omega_{av} = \frac{\theta_f - \theta_i}{t_f - t_i} = \frac{\Delta\theta}{\Delta t}$$

Angular Acceleration
$$\alpha_{av} = \frac{\omega_f - \omega_i}{t_f - t_i} = \frac{\Delta\omega}{\Delta t}$$

Tangential Speed
$$v_T = r\omega$$

Tangential Acceleration
$$a_T = r\alpha$$

Centripetal Acceleration
$$a_C = \frac{v_T^{\,2}}{r} = r\omega^2$$

Centripetal Force
$$F_C = \frac{mv_T^{\,2}}{r} = mr\omega^2$$

Newton's Universal Law of Gravitation
$$F = G\frac{m_1m_2}{r^2} \qquad G = 6.6732 \bullet 10^{-11}\ {}^{N\bullet m^2}\!/\!_{kg^2}$$

Orbital Period
$$T = 2\pi\sqrt{\frac{r^3}{Gm}}$$

Orbital Speed
$$v_T = \sqrt{G\frac{m}{r}}$$

Rotational Kinematics
$$\omega_f = \omega_i + \alpha\Delta t \qquad \Delta\theta = \tfrac{1}{2}(\omega_i + \omega_f)\Delta t$$
$$\omega_f^2 = \omega_i^2 + 2\alpha\Delta\theta \qquad \Delta\theta = \omega_i t + \tfrac{1}{2}\alpha\Delta t^2$$

Torque
$$\sum\tau = Fl \qquad @\ \text{Equilibrium } \Sigma\tau = 0$$
$$\sum\tau = Fl\cos\theta$$

Heat & Calorimetry
$$Q = mc\Delta T$$
$$Q_{gained} = -Q_{loss}$$
$$m_wc_w\Delta T_w = -m_xc_x\Delta T_x$$

Heat during a Phase Change
$$Q = mL_F \qquad Q = mL_v$$

Temperature Conversions
$$K = {}^0C + 273.15 \qquad {}^0F = \tfrac{9}{5}({}^0C) + 32$$
$${}^0C = K - 273.15 \qquad {}^0C = \tfrac{5}{9}({}^0F - 32)$$

Work done by a Gas
$$W = PAd = P\Delta V$$

First Law of Thermodynamics
$$\Delta U = Q - W$$

Cyclic Process
$$\Delta U_{net} = 0 \qquad Q_{net} = W_{net}$$

Efficiency of a Heat Engine
$$eff = \frac{W_{net}}{Q_h} = \frac{Q_h - Q_c}{Q_h} = 1 - \frac{Q_c}{Q_h}$$

Elasticity
$$Stress = \frac{F}{A} \qquad Strain = \frac{\Delta L}{L_0}$$
$$Young's\ \ Modulus = \frac{FL_0}{A\Delta L}$$

Expansion
$$\Delta L = L_0\alpha\Delta T \qquad \Delta A = 2A_0\alpha\Delta T$$
$$\Delta V = V_0\beta\Delta T$$

Mass Density

$$\rho = \frac{m}{V}$$

$$\rho_{water} = 1.0 \bullet 10^3 \ {}^{kg}/_{m^3} \qquad \rho_{seawater} = 1.025 \bullet 10^3 \ {}^{kg}/_{m^3}$$

Buoyant Force on Floating Objects

$$F_B = F_g(Displaced \quad Fluid) = m_f g$$

$$F_B = F_g(Object) = m_o g$$

Pressure

$$P = \frac{F}{A} = \frac{Force}{Area}$$

$$P_0 = 1.01 \bullet 10^5 Pa$$

$$1 \quad atm = \ 101.3 kPa, \ 1.013 \bullet 10^5 Pa, \ 760 mmHg, \ 760 torr$$

Fluid Pressure as a Function of Depth

$$P = P_o + \rho g h$$

Bernoulli's Equation

$$P + \tfrac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

Gas Laws

$$Combined \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$Ideal \quad PV = nRT$$

Hooke's Law

$$F_{elastic} = -kx$$

Period of a Simple Pendulum - SHM

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

Period of a Mass-Spring System- SHM

$$T = 2\pi\sqrt{\frac{m}{k}}$$

Wave Equation

$$v = f\lambda \qquad c = f\lambda$$

$$c = 3.00 \bullet 10^8 \ {}^{m}/_{s}$$

Intensity of a Spherical Wave

$$Intensity = I = \frac{P}{4\pi r^2}$$

Loudness

$$\beta = (10dB)\log\left(\frac{I}{I_0}\right)$$

$$I_o = 1 \bullet 10^{-12} \ {}^{W}/_{m^2}$$

Doppler Effect

$$f_o = f_s \frac{\left(1 \pm \frac{v_o}{v}\right)}{\left(1 \pm \frac{v_s}{v}\right)}$$

Velocity of Wave through a Wire

$$v = \sqrt{\frac{F}{m/L}}$$

Harmonic Series – Vibrating String

$$f_n = n\frac{v}{2L} \quad n = 1,2,3,\ldots$$

Harmonic Series – Open Pipe

$$f_n = n\frac{v}{2L} \quad n = 1,2,3,\ldots$$

Harmonic Series – Closed Pipe

$$f_n = n\frac{v}{4L} \quad n = 1,3,5,\ldots$$

Mirror & Lens Equation

$$\frac{1}{p} + \frac{1}{q} = \frac{2}{r} = \frac{1}{f}$$

Magnification Equation

$$M = \frac{h'}{h} = -\frac{q}{p}$$

Index of Refraction

$$n = \frac{c}{v}$$

Snell's Law

$$n_i(\sin\theta_i) = n_r(\sin\theta_r)$$

Critical Angle

$$\sin\theta_c = \frac{n_r}{n_i}\left(\sin 90^0\right) = \frac{n_r}{n_i}$$

$$for \quad n_i > n_r$$

Destructive Interference

$$d(\sin\theta) = \left(m + \tfrac{1}{2}\right)\lambda \quad m = 0, \pm1, \pm2, \ldots$$

Constructive Interference

$$d(\sin\theta) = m\lambda \quad m = 0, \pm1, \pm2, \ldots$$

Coulomb's Law - Electric Field Strength

$$F_{electric} = k_c \frac{q_1 q_2}{r^2}$$

Electric Field Strength – Point Charge

$$E = k_c \frac{q}{r^2}$$

Electric Potential Energy – Uniform Field

$$PE_{electric} = -qEd$$

Potential Difference

$$\Delta V = \frac{\Delta PE_{electric}}{q} = -E\Delta d$$

Potential Difference - Infinity & Point

$$\Delta V = k_c \frac{q}{r}$$

Capacitance

$$C = \frac{Q}{\Delta V} \qquad C_{vacuum} = \varepsilon_0 \frac{A}{d}$$

Electrical PE - Stored

$$PE_{electric} = \tfrac{1}{2}Q\Delta V = \tfrac{1}{2}C(\Delta V)^2 = \frac{Q^2}{2C}$$

Electrical Current

$$I = \frac{\Delta Q}{\Delta t} \qquad I = \frac{\Delta V}{R_{eq}}$$

Voltage & Resistance

$$\Delta V = IR \qquad R = \frac{\Delta V}{I}$$

Electrical Power

$$P = I\Delta V = I^2 R = \frac{(\Delta V)^2}{R}$$

Series Circuit

$$I_{Total} = I_1 = I_2 = I_3 = \ldots$$

$$emf = \Delta V = V_1 + V_2 + V_3 + \ldots$$

$$R_{eq} = R_1 + R_2 + R_3 + \ldots$$

$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \ldots$$

Parallel Circuit

$$I_{Total} = I_1 + I_2 + I_3 + \ldots$$

$$emf = \Delta V = \Delta V_1 = \Delta V_2 = \Delta V_3 = \ldots$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$C_{eq} = C_1 + C_2 + C_3 + \ldots$$

Magnitude of a Magnetic Field

$$B = \frac{F_{magnetic}}{qv}$$

Force on a Current-Carrying Conductor ⊥ to a Magnetic Field

$$F_{magnetic} = BI\ell$$

Energy of Light Quantum

$$E = hf$$

$$\text{Planck's} \quad \text{Constant} = 6.63 \bullet 10^{-34} \ J \bullet s$$

Max Kinetic Energy of a Photoelectron

$$KE_{max} = hf - hf_t$$

Wavelength of Matter Waves

$$\lambda = \frac{h}{p} = \frac{h}{mv}$$

Binding Energy & Mass Defect

$$atomic \quad mass \quad of \quad H = 1.007825u$$

$$m_n = 1.008665u$$

$$c^2 = 931.49 \ {}^{MeV}/_{u}$$

$$\Delta m = Z(atomic \quad mass \quad of \quad H) + Nm_n - atomic \quad mass$$

$$E_{binding} = \Delta mc^2$$

Activity (Decay Rate) & Half-Life

$$Activity = -\frac{\Delta N}{\Delta t} = \lambda N \qquad T_{1/2} = \frac{0.693}{\lambda}$$