

Reference ♦ PHYSICS ♦ Information

| PHYSICS FORMULAS AND CONSTANTS | | |
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| <p>Speed Of Light</p> $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}} = 3.0 \times 10^8 \text{ m/s}$ <p>Permittivity Of Free Space</p> $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2 / (\text{N} \cdot \text{m}^2)$ <p>Permeability Of Free Space</p> $\mu_0 = 4\pi \times 10^{-7} \text{ (T} \cdot \text{m) / A}$ <p>Acceleration Due To Gravity At Earth's Surface</p> $g = 9.8 \text{ m/s}^2$ <p>Gravitational Constant</p> $G = 6.67 \times 10^{-11} \text{ (N} \cdot \text{m}^2) / \text{kg}^2$ | <p style="text-align: center;">h-bar</p> $\hbar = \frac{h}{2\pi}$ <p style="text-align: center;">Planck's Constant</p> $h = 4.14 \times 10^{-15} \text{ eV} \cdot \text{s}$ <p style="text-align: center;">Boltzmann's Constant</p> $k = 1.38 \times 10^{-23} \text{ J / (molecule} \cdot \text{K)}$ <p style="text-align: center;">Charge Of Electron</p> $e = 1.6 \times 10^{-19} \text{ C}$ <p style="text-align: center;">1 Atomic Mass Unit</p> $1 \text{ amu} = 1.66 \times 10^{-27} \text{ kg}$ <p style="text-align: center;">1 Electron Volt</p> $1 \text{ eV} = 1.6 \times 10^{-19} \text{ J}$ <p style="text-align: center;">Coulomb's Constant</p> $k = \frac{1}{4\pi\epsilon_0} = 8.99 \times 10^9 \text{ N} \cdot \text{m}^2 / \text{C}^2$ | <p>Mass Of Electron</p> $m_e = 9.11 \times 10^{-31} \text{ kg}$ <p>Mass Of Earth</p> $m_E = 5.98 \times 10^{24} \text{ kg}$ <p>Ideal Gas Constant</p> $R = 8.31 \text{ J / (mol} \cdot \text{K)}$ <p>Avogadro's Number</p> $N_A = 6.02 \times 10^{23} \text{ molecules/mol}$ <p>Radius Of Earth</p> $R_E = 6.38 \times 10^6 \text{ m}$ <p>Stefan-Boltzmann Constant</p> $\sigma = 5.67 \times 10^{-8} \text{ W / (m}^2 \cdot \text{K}^4)$ |
| <p style="text-align: center;">DYNAMICS AND KINEMATICS</p> $x = x_0 + v_0 t + \frac{1}{2} a t^2 \quad F_s = -kx$ $\vec{F}_{net} = m\vec{a} \quad T = 2\pi\sqrt{\frac{m}{k}}$ $\vec{F}_{net} = \frac{d\vec{p}}{dt} \quad T = 2\pi\sqrt{\frac{\ell}{g}}$ $f_k = \mu_k N \quad T = 2\pi\sqrt{\frac{I}{mgr}}$ $f_s \leq \mu_s N$ $a_c = \frac{v^2}{r} = \omega^2 r$ | <p style="text-align: center;">WORK, ENERGY, POWER, AND MOMENTUM</p> $W = \int \vec{F} \cdot d\vec{s} \quad P = \frac{dW}{dt}$ $U_s = \frac{1}{2} kx^2 \quad \vec{p} = m\vec{v}$ $U_g = mgh \quad F_x = -\frac{dU}{dx}$ $KE = \frac{1}{2} m v^2$ $\vec{r}_{cm} = \frac{\sum m_i \vec{r}_i}{\sum m_i}, \quad \vec{r}_{cm} = \int \vec{r} dm$ | <p style="text-align: center;">ROTATIONAL MOTION</p> $s = r\theta$ $\theta = \theta_0 + \omega_0 t + \frac{1}{2} \alpha t^2$ $\vec{\tau} = \vec{r} \times \vec{F}, \quad \vec{\tau} = \frac{d\vec{L}}{dt}$ $\vec{L} = \vec{r} \times \vec{p}, \quad \vec{L} = I\vec{\omega}$ $I_{ring} = MR^2$ $I_{disc} = \frac{1}{2} MR^2$ $I_{sphere} = \frac{2}{5} MR^2$ |
| <p style="text-align: center;">UNIVERSAL GRAVITATION</p> $F = \frac{Gm_1 m_2}{r^2}$ $T^2 = \frac{4\pi^2}{GM} r^3$ $U_g = -\frac{Gm_1 m_2}{r}$ | <p style="text-align: center;">THERMODYNAMICS</p> $\Delta L = \alpha L_0 \Delta T \quad W = \int p dV$ $Q = mc\Delta T \quad \Delta S = \int \frac{dQ}{T}$ $Q = Lm \quad pV = nRT = NkT \quad \epsilon \leq 1 - \frac{T_c}{T_H}$ $dE = dQ - dW \quad \frac{dQ}{dt} = kA \frac{T_H - T_C}{L}$ $e = \frac{W_{out}}{Q_{in}} \quad \frac{Q_C}{W} = \text{COP}$ | <p style="text-align: center;">WAVES</p> $v = f\lambda$ $y = A \sin(kx - \omega t)$ $k = \frac{2\pi}{\lambda}$ $v = \sqrt{\frac{T}{\mu}}$ $f' = f \frac{v \pm v_D}{v \mp v_S}$ $I = \frac{P}{A}$ $\beta = (10 \text{ dB}) \log_{10} \frac{I}{I_0}$ |
| <p style="text-align: center;">MAGNETISM</p> $\Phi_B = \int \vec{B} \cdot d\vec{A}$ $\vec{F} = q\vec{v} \times \vec{B}$ $\vec{F} = i\vec{l} \times \vec{B}$ $d\vec{B} = \frac{\mu_0}{4\pi} \frac{i d\vec{s} \times \hat{r}}{r^2}$ $\vec{\tau} = \vec{\mu} \times \vec{B}$ | <p style="text-align: center;">ELECTROSTATICS</p> $F = \frac{1}{4\pi\epsilon_0} \frac{q_1 q_2}{r^2} \quad \Delta V = -\int \vec{E} \cdot d\vec{s}$ $\vec{E} = \frac{\vec{F}}{q} \quad \Phi_E = \int \vec{E} \cdot d\vec{A}$ $E = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \quad C = \frac{Q}{V}$ $U = qV \quad C = \frac{\kappa\epsilon_0 A}{d}$ $V = \frac{1}{4\pi\epsilon_0} \frac{q}{r} \quad U = \frac{1}{2} CV^2$ | <p style="text-align: center;">CURRENTS</p> $i = \frac{dq}{dt}$ $J = n q v_d$ $E = \rho J$ $R = \frac{\rho \ell}{A}$ $V = IR$ $P = VI$ $i = I_0 e^{-\frac{t}{RC}}$ |
| <p style="text-align: center;">MECHANICS OF FLUIDS</p> $p = p_0 + \rho gh$ $\rho v A = \text{constant}$ $p + \frac{1}{2} \rho v^2 + \rho gh = \text{constant}$ | <p style="text-align: center;">MODERN PHYSICS</p> $\beta = \frac{v}{c} \quad E = hf$ $\gamma = \frac{1}{\sqrt{1 - \beta^2}} \quad eV_0 = hf - \Phi$ $\Delta t = \gamma \Delta t_0 \quad \frac{dQ}{dt} = \sigma A \epsilon T^4$ $L = \frac{L_0}{\gamma} \quad \lambda_{max} T = 2.898 \times 10^{-3} \text{ m} \cdot \text{K}$ $u'_x = \frac{u_x - v}{1 - \frac{u_x v}{c^2}} \quad E_n = (-13.6 \text{ eV}) \frac{Z^2}{n^2}$ $\lambda = \frac{h}{p} \quad \Delta x \Delta p \geq \frac{\hbar}{2} \quad N = N_0 e^{-\frac{t}{\tau}}$ | <p style="text-align: center;">PHYSICAL (WAVE) OPTICS</p> $d \sin \theta = m\lambda, m = 0, \pm 1, \pm 2, \dots$ $2d \sin \theta = m\lambda, m = 0, \pm 1, \pm 2, \dots$ $\sin \theta = 1.22 \frac{\lambda}{d}$ |
| <p style="text-align: center;">AMPERE'S LAW, FARADAY'S LAW, AND MAXWELL'S EQUATIONS</p> $\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0} \quad \epsilon_i = -L \frac{di}{dt}$ $\oint \vec{B} \cdot d\vec{A} = 0 \quad U = \frac{1}{2} Li^2$ $\oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt} \quad L = \mu_0 n^2 A \ell$ $\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{enc} \quad i = I \left(1 - e^{-\frac{tR}{L}} \right)$ $f_R = \frac{1}{2\pi\sqrt{LC}} \quad Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C} \right)^2}$ | | |
| <p style="text-align: center;">GEOMETRICAL (RAY) OPTICS</p> $n = \frac{c}{v}$ $n_1 \sin \theta_1 = n_2 \sin \theta_2 \quad I = I_0 \cos^2 \theta \quad m = -\frac{d_i}{d_o}$ $\theta_B = \tan \left(\frac{n_2}{n_1} \right) \quad \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f} \quad \frac{1}{f} = (n-1) \left(\frac{1}{R_1} - \frac{1}{R_2} \right)$ | | |

| 10 ⁿ | Prefix | Symbol | Decimal |
|-------------------|--------|--------|-----------------------------------|
| 10 ²⁴ | yotta- | Y | 1 000 000 000 000 000 000 000 000 |
| 10 ²¹ | zetta- | Z | 1 000 000 000 000 000 000 000 |
| 10 ¹⁸ | exa- | E | 1 000 000 000 000 000 000 |
| 10 ¹⁵ | peta- | P | 1 000 000 000 000 000 |
| 10 ¹² | tera- | T | 1 000 000 000 000 |
| 10 ⁹ | giga- | G | 1 000 000 000 |
| 10 ⁶ | mega- | M | 1 000 000 |
| 10 ³ | kilo- | k | 1 000 |
| 10 ² | hecto- | h | 100 |
| 10 ¹ | deca- | da | 10 |
| 10 ⁰ | (none) | (none) | 1 |
| 10 ⁻¹ | deci- | d | 0.1 |
| 10 ⁻² | centi- | c | 0.01 |
| 10 ⁻³ | milli- | m | 0.001 |
| 10 ⁻⁶ | micro- | μ | 0.000 001 |
| 10 ⁻⁹ | nano- | n | 0.000 000 001 |
| 10 ⁻¹² | pico- | p | 0.000 000 000 001 |
| 10 ⁻¹⁵ | femto- | f | 0.000 000 000 000 001 |
| 10 ⁻¹⁸ | atto- | a | 0.000 000 000 000 000 001 |
| 10 ⁻²¹ | zepto- | z | 0.000 000 000 000 000 000 001 |
| 10 ⁻²⁴ | yocto- | y | 0.000 000 000 000 000 000 000 001 |

Force Diagrams

