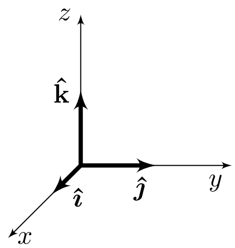
Formula Sheet - Physics 222

Vectors:



$$\mathbf{A} = A_x\,\hat{\boldsymbol{\imath}} + A_y\,\hat{\boldsymbol{\jmath}} + A_z\,\hat{\mathbf{k}} = (A_x, A_y, A_z)$$

$$|\mathbf{A}| = A = \sqrt{A_x^2 + A_y^2 + A_z^2}$$

Unit vector along A

$$\hat{\mathbf{A}} = \frac{\mathbf{A}}{|\mathbf{A}|}, \quad \left|\hat{\mathbf{A}}\right| = 1$$

Scalar (dot) product and Vector (cross) product:

$$\mathbf{A}\cdot\mathbf{B} = AB\cos\theta = A_xB_x + A_yB_y + A_zB_z$$

$$|\mathbf{A}\times\mathbf{B}| = AB\sin\theta$$

$$\mathbf{A}\times\mathbf{B} = (A_yB_z - A_zB_y)\,\hat{\boldsymbol{\imath}} + (A_zB_x - A_xB_z)\,\hat{\boldsymbol{\jmath}} + (A_xB_y - A_yB_x)\,\hat{\mathbf{k}}$$

Algebra, Calculus & Trigonometry:

$$ax^2 + bx + c = 0 \quad \Rightarrow \quad x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\frac{\mathrm{d}x^n}{\mathrm{d}x} = nx^{n-1} \quad \frac{\mathrm{d}\cos x}{\mathrm{d}x} = -\sin x \quad \frac{\mathrm{d}\sin x}{\mathrm{d}x} = \cos x$$

$$\frac{\mathrm{d}\tan x}{\mathrm{d}x} = \sec^2 x \quad \frac{\mathrm{d}\cot x}{\mathrm{d}x} = \csc^2 x \quad \frac{\mathrm{d}}{\mathrm{d}x}\left(\frac{f}{g}\right) = \frac{\frac{\mathrm{d}f}{\mathrm{d}x}g + f\frac{\mathrm{d}g}{\mathrm{d}x}}{g^2}$$

$$\cos(x \pm y) = \cos x\cos y \mp \sin x \sin y \qquad 2\sin^2 x + \cos(2x) = 1$$

$$\sin(x \pm y) = \sin x\cos y \pm \cos x\sin y \qquad 2\cos^2 x - \cos(2x) = 1$$

$$2\cos x\cos y = \cos(x-y) + \cos(x+y) \qquad \sin^2 x + \cos^2 x = 1$$

$$2\sin x\sin y = \cos(x-y) - \cos(x+y) \qquad \sec^2 x - \tan^2 x = 1$$

$$2\sin x\cos y = \sin(x-y) + \sin(x+y) \qquad \csc^2 x - \cot^2 x = 1$$

Conversion factors:

1 yard = 3 ft   1 ft = 12 in

1 in = 2.54 cm   1 mi = 1609 m

1 eV = 1.6×10^{-19} J   1 m^3 = 1000 L

1 Tesla = 10^4 Gauss = 1 Weber/m^2 1 Å = 10^{-10} m

1 lb = 4.448 N

femto- (f)	$= 10^{-15}$
pico- (p)	$= 10^{-12}$
nano- (n)	$= 10^{-9}$
micro- (μ)	$= 10^{-6}$
milli- (m)	$= 10^{-3}$
centi- (c)	$= 10^{-2}$
kilo- (k)	$= 10^{3}$
mega- (M)	$= 10^{6}$
giga- (G)	$= 10^{9}$
tera- (T)	$= 10^{12}$

Geometry

Circle: Perimeter $= 2\pi r$, Area $= \pi r^2$

Sphere: Surface Area $= 4\pi r^2$, Volume $= \frac{4}{3}\pi r^3$

Cylinder: Surface Area $= 2\pi r^2 + 2\pi r h$, Volume $= \pi r^2 h$

Physical Constants & Quantities:

$$\epsilon_0 = 8.85\times10^{-12}\ \mathrm{C^2/N\,m^2} \qquad k = 8.99\times10^{9}\ \mathrm{N\,m^2/C^2}$$

$$e = 1.60\times10^{-19}\ \mathrm{C} \qquad c = 3.00\times10^{8}\ \mathrm{m/s}$$

$$m_e = 9.11\times10^{-31}\ \mathrm{kg} \qquad m_p = 1.67\times10^{-27}\ \mathrm{kg}$$

$$\mu_0 = 4\pi\times10^{-7}\ \mathrm{T\,m/A} \qquad 1\ \mathrm{atm} = 1.01\times10^{5}\ \mathrm{Pa}$$

$$\rho_{\mathrm{water}} = 1.00\times10^{3}\ \mathrm{kg/m^3} \qquad \rho_{\mathrm{air}} = 1.20\ \mathrm{kg/m^3}$$

Circular motion

$$\omega = \frac{\mathrm{d}\theta}{\mathrm{d}t} \qquad s = R\theta \quad v = R\omega \quad a_{\tan} = R\alpha$$

$$\alpha = \frac{\mathrm{d}\omega}{\mathrm{d}t} \qquad a_{\mathrm{rad}} = \frac{v^2}{R} = \omega^2 R \qquad a_{\tan} = \frac{\mathrm{d}v}{\mathrm{d}t}$$

$$F_{\mathrm{net,rad}} = m\frac{v^2}{r} \qquad F_{\mathrm{net,tan}} = ma_{\tan}$$

Uniform Circular Motion: $T = \dfrac{1}{f} = \dfrac{2\pi}{\omega} = \dfrac{2\pi R}{v}$

Fluids

$$p = \frac{F}{A} \qquad p = p_0 + \rho g h \qquad \rho = \frac{m}{V}$$

$$F_{\mathrm{b}} = \rho_{\mathrm{f}} V_{\mathrm{displ}}\, g \qquad dV/dt = Av$$

$$\rho_1 A_1 v_1 = \rho_2 A_2 v_2 = \mathrm{const} \qquad p + \rho g y + \frac{1}{2}\rho v^2 = \mathrm{const}$$

Electrostatics

$$\mathbf{F}_{\mathrm{on\,2\,by\,1}} = \frac{k\ q_1 q_2}{r_{1\to2}^2}\,\hat{\boldsymbol{r}}_{1\to2} \qquad \mathbf{E} = \frac{\mathbf{F}}{q} \qquad \vec{\boldsymbol{p}} = q\mathbf{d}_{-\to+}$$

$$\mathbf{E}_{\mathrm{at}\,P\,\mathrm{by}\,q} = \frac{kq}{r_{q\to P}^2}\,\hat{\boldsymbol{r}}_{q\to P} \qquad U_{\mathrm{dip}} = -\vec{\boldsymbol{p}}\cdot\mathbf{E} \qquad \vec{\boldsymbol{\tau}}_{\mathrm{dip}} = \vec{\boldsymbol{p}}\times\mathbf{E}$$

$$\mathbf{E}_{\mathrm{sphere}} = \frac{kq}{r^2}\,\hat{\boldsymbol{r}} \qquad \mathbf{E}_{\mathrm{cylinder}} = \frac{2k\lambda}{r}\,\hat{\boldsymbol{r}} \qquad \mathbf{E}_{\mathrm{plane}} = \pm\frac{\sigma}{2\epsilon_0}\,\hat{\boldsymbol{\imath}}$$

$$E_{\mathrm{dip}}(r \gg d) = \frac{p}{2\pi\epsilon_0 r^3} \qquad \Phi_E = \int_{\mathcal{S}} \mathbf{E}\cdot\mathrm{d}\mathbf{A} \qquad \oint_{\mathcal{S}} \mathbf{E}\cdot\mathrm{d}\mathbf{A} = \frac{q_{\mathrm{encl}}}{\epsilon_0}$$

$$\rho = \frac{\mathrm{d}q}{\mathrm{d}V} \qquad \sigma = \frac{\mathrm{d}q}{\mathrm{d}A} \qquad \lambda = \frac{\mathrm{d}q}{\mathrm{d}l}$$

$$V_B - V_A = -\int_A^B \mathbf{E}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} \qquad \Delta V = \pm E_{\mathrm{const}}\,d \qquad V_{q\,\mathrm{at}\,P} = \frac{kq}{r_{q\to P}}$$

$$\mathbf{E} = -\vec{\boldsymbol{\nabla}}V \qquad U = qV \qquad W = -q\Delta V$$

Capacitors

$$C = \frac{Q}{V} \qquad C_{\mathrm{rectangular}} = \frac{\epsilon_0 A}{d} \qquad C_{\mathrm{sphere}} = 4\pi\epsilon_0\ a$$

$$C_{\mathrm{spherical}} = \frac{4\pi\epsilon_0\ ab}{b-a} \qquad C_{\mathrm{cylindrical}} = \frac{2\pi\epsilon_0 L}{\ln(a/b)}$$

$$C_{\mathrm{parallel}} = C_1 + C_2 + \ldots \qquad \frac{1}{C_{\mathrm{series}}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$$

$$\epsilon = \kappa\epsilon_0 \qquad C = \kappa C_0 \qquad E = \frac{E_0}{\kappa} \qquad u = \frac{1}{2}\epsilon E^2$$

$$U = \frac{1}{2}CV^2 = \frac{1}{2}QV = \frac{1}{2}\frac{Q^2}{C} \qquad \sigma_{ind} = \sigma_0\left(1 - \frac{1}{\kappa}\right)$$

Electric current and resistors

$$I = \frac{\mathrm{d}Q}{\mathrm{d}t} \qquad \vec{\boldsymbol{J}} = ne\vec{\boldsymbol{v}}_\mathrm{d} \qquad J = \frac{\mathrm{d}I}{\mathrm{d}A_\perp} \qquad \vec{\boldsymbol{v}}_\mathrm{d} = \frac{e\tau}{m_e}\mathbf{E}$$

$$\vec{\boldsymbol{E}} = \rho\vec{\boldsymbol{J}} \qquad V = RI \qquad \rho = \frac{m_e}{e^2 n\tau} \qquad R = \frac{\rho L}{A_\perp}$$

$$P = IV = I^2 R = \frac{V^2}{R} \qquad \frac{\Delta\rho}{\rho_0} = \alpha\Delta T \qquad \frac{\Delta R}{R_0} = \alpha\Delta T$$

$$R_\mathrm{series} = R_1 + R_2 + \dots \qquad \frac{1}{R_\mathrm{parallel}} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$I_\mathrm{series} = I_1 = I_2 = \dots \qquad I_\mathrm{parallel} = I_1 + I_2 + \dots$$

$$V_\mathrm{series} = V_1 + V_2 + \dots \qquad V_\mathrm{parallel} = V_1 = V_2 = \dots$$

Kirchhoff's Rules

$$\sum_\text{junction} I = 0 \qquad \sum_\text{loop} V = 0$$

R-C DC circuits

$$q(t) = Q_\infty\left(1 - e^{-t/\tau}\right) \qquad q(t) = Q_0 e^{-t/\tau}$$

$$v_C(t) = \mathcal{E}\left(1 - e^{-t/\tau}\right) \qquad v_C(t) = \mathcal{E}e^{-t/\tau}$$

$$i(t) = I_0 e^{-t/\tau} \qquad \tau = RC$$

Magnetostatic

$$\mathbf{F}_{on\,q\,by\,\mathbf{B}} = q\,\vec{\boldsymbol{v}} \times \mathbf{B} \qquad \mathbf{B}_{\text{at }P\text{ by }q} = \frac{\mu_0}{4\pi}\frac{q\vec{\boldsymbol{v}} \times \hat{\boldsymbol{r}}_{q\to P}}{r^2_{q\to P}}$$

$$\mathrm{d}\mathbf{F}_{on\,I\,by\,\mathbf{B}} = I\,\mathrm{d}\vec{\boldsymbol{\ell}} \times \mathbf{B} \qquad \mathrm{d}\mathbf{B}_{\text{at }P\text{ by }I} = \frac{\mu_0}{4\pi}\frac{I\,\mathrm{d}\vec{\boldsymbol{\ell}} \times \hat{\boldsymbol{r}}_{I\to P}}{r^2_{I\to P}}$$

$$\mathbf{B}_\text{long wire} = \frac{\mu_0 I}{2\pi r} \qquad \mathbf{B}_\mathrm{loop} = \frac{\mu_0 I a^2}{2\left(x^2 + a^2\right)^{3/2}} \qquad \frac{\mathbf{F}}{\ell} = \frac{\mu_0 I I'}{2\pi r}$$

$$\mathbf{B}_\mathrm{Solenoid} = \mu_0\frac{N}{\ell}I \qquad \mathbf{B}_\mathrm{Toroid} = \frac{\mu_0 N I}{2\pi r} \qquad R = \frac{mv}{|q|B}$$

$$\oint \mathbf{B}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} = \mu_0 I_\mathrm{encl} \qquad \Phi_B = \int_\mathcal{S}\mathbf{B}\cdot\mathrm{d}\mathbf{A} \qquad \oint_\mathcal{S}\mathbf{B}\cdot\mathrm{d}\mathbf{A} = 0$$

$$\vec{\boldsymbol{\mu}} = I\mathbf{A} \qquad \vec{\boldsymbol{\tau}}_{\vec{\boldsymbol{\mu}}} = \vec{\boldsymbol{\mu}} \times \mathbf{B} \qquad U_{\vec{\boldsymbol{\mu}}} = -\vec{\boldsymbol{\mu}}\cdot\mathbf{B}$$

Magnetic Material

$$\mathbf{M} = \frac{\vec{\boldsymbol{\mu}}_\mathrm{total}}{V} \qquad \mathbf{B} = \mathbf{B}_\mathrm{ext} + \mu_0\mathbf{M} \qquad \mu = \kappa_\mathrm{M}\mu_0$$

$$\chi = \kappa_\mathrm{M} - 1 \qquad \chi_\mathrm{dia} < 0\ ,\ \chi_\mathrm{para} > 0 \qquad \mathbf{M} = \frac{\chi}{\mu_0}\mathbf{B}_\mathrm{ext}$$

Induction

$$\oint \mathbf{E}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} = -\frac{\mathrm{d}\Phi_B}{\mathrm{d}t} \qquad \mathcal{E} = vB\ell \qquad \mathcal{E} = \oint(\vec{\boldsymbol{v}} \times \mathbf{B})\cdot\mathrm{d}\vec{\boldsymbol{\ell}}$$

$$\oint \mathbf{B}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} = \mu_0\left(i_\mathrm{C} + i_\mathrm{D}\right)_\mathrm{encl} \qquad i_\mathrm{D} = \epsilon_0\frac{\mathrm{d}\Phi_E}{\mathrm{d}t} \qquad \mathcal{E} = -N\frac{\mathrm{d}\Phi_B}{\mathrm{d}t}$$

Maxwell's equations

$$\oint_S \mathbf{E}\cdot\mathrm{d}\mathbf{A} = \frac{Q_\mathrm{encl}}{\epsilon_0} \qquad \text{(Gauss' law for }\mathbf{E}\text{ field)}$$

$$\oint_S \mathbf{B}\cdot\mathrm{d}\mathbf{A} = 0 \qquad \text{(Gauss' law for }\mathbf{B}\text{ field)}$$

$$\oint \mathbf{E}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} = -\frac{\mathrm{d}\Phi_B}{\mathrm{d}t} \qquad \text{(Faraday's law)}$$

$$\oint \mathbf{B}\cdot\mathrm{d}\vec{\boldsymbol{\ell}} = \mu_0\left(i_\mathrm{C} + \epsilon_0\frac{\mathrm{d}\Phi_E}{\mathrm{d}t}\right)_\mathrm{encl} \qquad \text{(Ampere's law)}$$

Inductance

$$\mathcal{E}_\text{in 2 by 1} = -M\frac{\mathrm{d}i_1}{\mathrm{d}t} \qquad \mathcal{E} = -L\frac{\mathrm{d}i}{\mathrm{d}t} \qquad L = \frac{N\Phi_B}{i}$$

$$\mathcal{E}_\text{in 1 by 2} = -M\frac{\mathrm{d}i_2}{\mathrm{d}t} \qquad M = \frac{N_1\Phi_{B1}}{i_2} = \frac{N_2\Phi_{B2}}{i_1}$$

R-L circuits

$$i(t) = I_\infty\left(1 - e^{-t/\tau}\right) \qquad v_L(t) = \mathcal{E}e^{-t/\tau} \qquad U = \frac{1}{2}LI^2$$

$$i(t) = I_0 e^{-t/\tau} \qquad \tau = \frac{L}{R} \qquad L = \mu_0 n^2 \ell A \qquad u = \frac{B^2}{2\mu_0}$$

$$L_\mathrm{series} = L_1 + L_2 + \dots \qquad \frac{1}{L_\mathrm{parallel}} = \frac{1}{L_1} + \frac{1}{L_2} + \dots$$

R-L-C circuit

$$q(t) = Q_0 e^{-\frac{R}{2L}t}\cos\left(\omega' t + \phi\right) \qquad \omega' = \sqrt{\frac{1}{LC} - \frac{R^2}{4L^2}}$$

AC R-L-C circuit

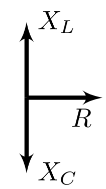
$$i = I\cos(\omega t - \phi) \qquad I_\mathrm{rms} = \frac{I}{\sqrt{2}} \qquad V_\mathrm{rms} = \frac{V}{\sqrt{2}}$$

$$v = V\cos\omega t \qquad I_\mathrm{rav} = \frac{2}{\pi}I \qquad V_\mathrm{rms} = I_\mathrm{rms}Z$$

$$V_R = IR \qquad V_L = IX_L \qquad X_L = \omega L$$

$$V = IZ \qquad V_C = IX_C \qquad X_C = \frac{1}{\omega C}$$

$$Z = \sqrt{R^2 + \left(X_L - X_C\right)^2} \qquad \tan\phi = \frac{X_L - X_C}{R}$$



$$P_\mathrm{av} = I_\mathrm{rms}V_\mathrm{rms}\cos\phi = \frac{1}{2}IV\cos\phi \qquad p = iv$$

$$\textbf{Transformers}: \quad \frac{V_2}{V_1} = \frac{N_2}{N_1} \qquad V_1 I_1 = V_2 I_2$$

Complex impedance

$$\mathbf{Z}_\mathrm{series} = \mathbf{Z_1} + \mathbf{Z_2} + \cdots \qquad \frac{1}{\mathbf{Z}_\mathrm{parallel}} = \frac{1}{\mathbf{Z_1}} + \frac{1}{\mathbf{Z_2}} + \cdots$$

$$\mathbf{Z} = R + jX \qquad X = X_L - X_C \qquad \cos\phi = R/Z$$

$$\mathbf{Z} = Ze^{j\phi} \qquad Z = \sqrt{R^2 + X^2} \qquad \tan\phi = X/R$$

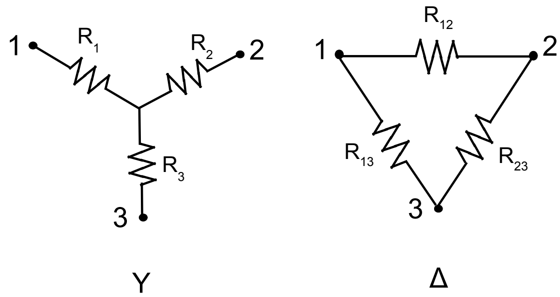
$$\mathbf{V} = V_0 e^{j\omega t} \qquad \mathbf{I} = \mathbf{V}/\mathbf{Z} = I_0 e^{j(\omega t - \phi)} \qquad v_X = \mathrm{Re}(\mathbf{I_X Z_X})$$

$$z = a + jb \qquad z^* = a - jb \qquad \frac{1}{z} = \frac{z^*}{Z^2} \qquad Z^2 = a^2 + b^2$$

$$z_1 z_2 = a_1 a_2 - b_1 b_2 + j(a_1 b_2 + a_2 b_1) = Z_1 Z_2 e^{j(\phi_1 - \phi_2)}$$

$$\frac{z_1}{z_2} = \frac{z_1 z_2^*}{Z_2^2} = \frac{a_1 b_1 + b_1 b_2 + j(a_2 b_1 - a_1 b_2)}{a_2^2 + b_2^2} = Z_1 Z_2 e^{j(\phi_1 - \phi_2)}$$

Y-Δ transform



$$R_1 = \frac{R_{12}R_{13}}{R_{12}+R_{13}+R_{23}} \qquad R_{12} = \frac{R_1R_2+R_1R_3+R_2R_3}{R_3}$$

$$R_2 = \frac{R_{12}R_{23}}{R_{12}+R_{13}+R_{23}} \qquad R_{13} = \frac{R_1R_2+R_1R_3+R_2R_3}{R_2}$$

$$R_3 = \frac{R_{13}R_{23}}{R_{12}+R_{13}+R_{23}} \qquad R_{23} = \frac{R_1R_2+R_1R_3+R_2R_3}{R_1}$$

EM waves and optics

$$\mathbf{E}(x,t) = \hat{\boldsymbol{\jmath}}\, E_{\max}\cos(kx-\omega t) \qquad E = cB \qquad c = \frac{1}{\sqrt{\epsilon_0\mu_0}}$$

$$\mathbf{B}(x,t) = \hat{\mathbf{k}}\, B_{\max}\cos(kx-\omega t) \qquad \mathbf{S} = \frac{1}{\mu_0}\mathbf{E}\times\mathbf{B}$$

$$u = \frac{1}{2}\epsilon_0E^2 + \frac{1}{2\mu_0}B^2 = \epsilon_0E^2 = \frac{B^2}{\mu_0} \qquad \frac{1}{A}\frac{\mathrm{d}p}{\mathrm{d}t} = \frac{S}{c} = \frac{EB}{\mu_0 c}$$

$$I = S_{\text{av}} = \frac{E_{\max}B_{\max}}{2\mu_0} = \frac{E_{\max}^2}{2c\mu_0} = \frac{1}{2}\sqrt{\frac{\epsilon_0}{\mu_0}}E_{\max}^2 = \frac{1}{2}\epsilon_0 cE_{\max}^2$$

$$c = \lambda f = \frac{\omega}{k} \qquad k = \frac{2\pi}{\lambda} \qquad \omega = 2\pi f$$

$$n = c/v \qquad \theta_i = \theta_r \qquad n_1\sin\theta_1 = n_2\sin\theta_2$$

$$I = I_{max}\cos^2\phi \qquad \sin\theta_c = n_2/n_1 \qquad \tan\theta_p = n_2/n_1$$

Interference and diffraction

$$d\sin\theta = m\lambda \qquad d\sin\theta = \left(m+\frac{1}{2}\right)\lambda \qquad y = mR\frac{\lambda}{d}$$

$$I = I_{\max}\cos^2\frac{\phi}{2} \qquad \phi = 2\pi\frac{r_2-r_1}{\lambda} = 2\pi\frac{d\sin\theta}{\lambda}$$

$$2t = m\lambda_n \qquad 2t = \left(m+\frac{1}{2}\right)\lambda_n \qquad \lambda_n = \lambda/n$$

$$a\sin\theta = m\lambda \qquad \beta = 2\pi\frac{a\sin\theta}{\lambda} \qquad I = I_{\max}\frac{\sin^2\left(\frac{\beta}{2}\right)}{\left(\frac{\beta}{2}\right)^2}$$

$$R = \frac{\lambda}{\Delta\lambda} \qquad \sin\theta_1 = 1.22\frac{\lambda}{D} \qquad 2d\sin\theta = m\lambda$$

Data Analysis - Lab Formulas

Basic statistical estimators

Mean value : $\bar{x} = \langle x\rangle = \dfrac{1}{n}\displaystyle\sum_{i=1}^{n} x_i$ Standard deviation : $s = \sqrt{\dfrac{\sum_{i=1}^{n}(x_i-\bar{x})^2}{n-1}}$ Standard error : $SE = \dfrac{s}{\sqrt{n}}$

Propagation of uncertainty

Assume that x and y are independent variables and that their mean values and corresponding standard errors are:

$$x = x_0 \pm \varepsilon_x \qquad \text{and} \qquad y = y_0 \pm \varepsilon_y$$

Function f	Standard error	Limit of error
$x \pm y$	$\sqrt{\varepsilon_x^2+\varepsilon_y^2}$	$\varepsilon_x+\varepsilon_y$
xy	$\lvert x_0y_0\rvert\sqrt{\left(\frac{\varepsilon_x}{x_0}\right)^2+\left(\frac{\varepsilon_y}{y_0}\right)^2} = \sqrt{(x_0\varepsilon_y)^2+(y_0\varepsilon_x)^2}$	$\lvert x_0y_0\rvert\left(\frac{\varepsilon_x}{\lvert x_0\rvert}+\frac{\varepsilon_y}{\lvert y_0\rvert}\right) = \lvert x_0\rvert\varepsilon_y+\lvert y_0\rvert\varepsilon_x$
$\frac{x}{y}$	$\left\lvert\frac{x_0}{y_0}\right\rvert\sqrt{\left(\frac{\varepsilon_x}{x_0}\right)^2+\left(\frac{\varepsilon_y}{y_0}\right)^2}$	$\left\lvert\frac{x_0}{y_0}\right\rvert\left(\frac{\varepsilon_x}{\lvert x_0\rvert}+\frac{\varepsilon_y}{\lvert y_0\rvert}\right)$
x^n	$\lvert nx_0^{n-1}\rvert\varepsilon_x$	$\lvert nx_0^{n-1}\rvert\varepsilon_x$
$\sin(x)$	$\lvert\cos(x_0)\rvert\varepsilon_x$ (ε_x must be in radians)	$\lvert\cos(x_0)\rvert\varepsilon_x$ (ε_x must be in radians)
$\cos(x)$	$\lvert\sin(x_0)\rvert\varepsilon_x$ (ε_x must be in radians)	$\lvert\sin(x_0)\rvert\varepsilon_x$ (ε_x must be in radians)