landscape]geometry

Electromagnetism

$c=\lambda f$, Capacitance $C=\frac{Q}{V}$

$E=hc/\lambda$, Parll plates $C=\frac{A\epsilon_0}{d}$

$\nabla\cdot\vec{E}=\frac{\rho}{\varepsilon_0}$, Conc-Sph $C=\frac{4\pi\epsilon_0 ab}{b-a}$, $b>a$

$\nabla\cdot\vec{B}=0$, Induc $L=\frac{N\Phi_B}{I}=\frac{u_0N^2A}{l}\to\epsilon=-L\frac{dI}{dt}$, $U_C=\frac{Q^2}{2C}=\frac{CV^2}{2}$, $E_L=\frac{LI^2}{2}$

$\nabla\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}$,

$\nabla\times\vec{B}=\mu_0\vec{+}\mu_0\varepsilon_0\frac{\partial\mathbf{E}}{\partial t}$,

$\vec{F}=q(\vec{E}+\vec{v}\times\vec{B})$, Lorentz

$E=\frac{force}{unitcharge}$, Energy

$\oint\vec{E}\cdot d\vec{S}=\frac{Q\text{enc}}{\epsilon_0}$, Gauss law

$\oint\vec{E}\cdot\vec{dl}=-\frac{d\Phi_B}{dt}$, $\oint\vec{B}\cdot d\vec{S}=0$,

$\oint\vec{B}\cdot\vec{dl}=\mu_0\epsilon_0\frac{d\Phi_B}{dt}+\mu_0 i_{enc}$

$\vec{F}=\frac{1}{4\pi\epsilon_0}\frac{q_1q_2}{r^2}\hat{\underline{r}}$, $\quad V=\frac{q}{4\pi\epsilon_0 r}$.

$V(r)=-\int_\infty^r\vec{E}\cdot\vec{dr}$ electro stat pot

$\underline{B}(\underline{r})=\frac{\mu_0}{4\pi}\int\frac{dI(\underline{r}')\times(\underline{r}-\underline{r}')}{|\underline{r}-\underline{r}'|^3}$,curnt element$\vec{dI}$

Series $R_T=R_1+R_2$, // $\frac{1}{R_T}=\frac{1}{R_1}+\frac{1}{R_2}$

Series $L_T=L_1+L_2$, // $\frac{1}{L_T}=\frac{1}{L_1}+\frac{1}{L_2}$

Series $\frac{1}{C_T}=\frac{1}{C_1}+\frac{1}{C_2}$, // $C_T=C_1+C_2$,

Quantum

$\hat{H}\Psi=E\Psi$, $\quad\hat{H}=\hat{T}+\hat{V}$,

$\hat{P}=-i\hbar\frac{\partial}{\partial x}$, $\quad[\hat{x},\hat{p}]=i\hbar$,

$\hat{T}=\frac{\hat{P}\cdot\hat{P}}{2m}=\frac{-\hbar}{2m}\frac{\partial^2}{\partial x^2}$, Kinetic

$\frac{-\hbar^2}{2m}\frac{\partial^2\Psi(x)}{\partial x^2}=(E-V(x))\Psi(x)$, T ind.

$i\hbar\frac{\partial\Psi(\mathbf{r},t)}{\partial t}=\hat{H}\Psi(\mathbf{r},t)$, T dep.

$i\hbar\frac{\partial\Psi}{\partial t}=-\left[\frac{\hbar^2}{2m}\nabla^2+V\right]\Psi$,

$\Delta x\cdot\Delta p\geq\frac{\hbar}{2}$, $\quad\Delta E\cdot\Delta t\geq\hbar$

$\lambda=h/p=h/mv$, De Broglie

$E=hf=\frac{hc}{\lambda}$,

$\langle A\rangle=\int\Psi^*\hat{A}\Psi dV$,

$E_n=\frac{n^2\pi^2\hbar^2}{2mL^2}$, potential well

$\psi_n(x)=\sqrt{\frac{2}{L}}\sin\left(\frac{n\pi x}{L}\right)$, eig.state

Pert theory $E^{(1)}=\langle\psi^{(0)}|V|\psi^{(0)}\rangle$,

$E^{(2)}=\sum_{n\neq 0}\frac{|\langle\psi^{(0)}|V|\psi^{(n)}\rangle|^2}{E^{(0)}-E^{(n)}}$,

Van-Waals $u(R)=-\frac{A}{R^6}+\frac{B}{R^{12}}$,

$u(R)=-4\epsilon\left[(\frac{\sigma}{R})^{12}-(\frac{\sigma}{R})^6\right]$,

Harmonic oscil $E_n=\hbar\omega\,(n+1/2)$,

Thermodyn

$Q=mL$, latent heat fusion

$Q=mc\Delta T$, specific HC

$P=\sigma AT^4$, Black body radiation

$-dw$ if work done ON system

$dU=dQ-dW$, internal E 1st law

$dU=-dW$, For Adiabatic

Constant Vol and pressure:

$C_V=\left(\frac{dQ}{dT}\right)_V=\left(\frac{dU}{dT}\right)_V$,

$C_P=\left(\frac{dQ}{dT}\right)_P=\left(\frac{dH}{dT}\right)_P$,

H, C = Hot and Cold Baths

$W=Q_H-Q_C$,

Carnot $\eta=\frac{W}{Q_H}=1-\frac{Q_C}{Q_H}=1-\frac{T_C}{T_H}$,

Heat pump $COP=\frac{QH}{W}=\frac{T_H}{T_H-T_C}$

$dS=\frac{dQ}{T}$, Entropy change

Reversible when: $S=$ const. and,

$dU=dQ-PdV=TdS-PdV$,

Max work $dS=dV=0$,

$H=U+PV$, Enthalpy

$dH=TdS+VdP$,

Max Work $dS=dP=0$,

$F=U-TdS$, Free energy

$dF=-SdT-PdV$,

Max Work $dT=dV=0$,

$G=U+PV-TS$, Gibbs

$dG=-SdT+VdP$

Max Work $dT=dP=0$,

Special Rel

$E^2=(pc)^2+(m_0c^2)^2=\gamma m_0c^2$,

$x'=\gamma x-\gamma\beta ct)$,

$y'=y$, $z'=z$, $ct'=\gamma ct-\gamma\beta x$, time dil

$\gamma=\frac{1}{\sqrt{1-\frac{v^2}{c^2}}}\approx 1+\frac{\beta^2}{2}+\frac{3\beta^4}{8}+...\ \beta=\frac{v}{c}$,

$L'=\frac{L}{\gamma}$, length contrap

$p'=m_0v\gamma$,

$w=\frac{u+v}{1+\frac{uv}{c^2}}$, vel addit

$f_o=f_e\sqrt{\frac{1-\beta}{1+\beta}}$, doppler

Optics

$n_1\sin(\theta_1)=n_2\sin(\theta_2)$,

$2d_{hkl}\sin\theta=\lambda$, Braags law, a=slit width:

$\theta=\lambda/a$, ang width central max

min resolvable angle $\theta=\frac{1.22\lambda}{D}$, D=lens diam, $\frac{1}{f}=(n-1)\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$, f foc-length

$\frac{1}{u}+\frac{1}{v}=\frac{1}{f}$. u dist lens-obj,v dist len-imag

Imag-mag $M=\frac{h_1}{h_0}=-\frac{v}{u}$

380nm to 700nm visible light

Classical Mech

$\vec{F}=m\vec{a}$,

$F=\frac{mv^2}{r}$, Centripetal Force

$\vec{\tau}=\vec{r}\times\vec{F}$, torque

$\tau=I$(ang. accel), torque

$\frac{d}{dt}\left(\frac{\partial L}{\partial\dot{q}_i}\right)-\frac{\partial L}{\partial q_i}=0$, Euler-Lagrange,

$F=-G\frac{m_1m_2}{r^2}$, $U=\frac{-GMm}{r}\to$ energy

$\nabla\cdot\underline{g}=-4\pi G\rho$, Const areal vel $\frac{dA}{dt}=\frac{r^2}{2}\frac{d\theta}{dt}$

Periods: $\frac{a^3}{T^2}=\frac{GM}{4\pi^2}$, a=dist in au

$E=\frac{1}{2}m(\dot{r})^2-\frac{GMm}{r}+\frac{L^2}{2mr^2}$,

mom. of inertia: $I=n\omega r^2$, $\omega=v/r$, n=0.5 for ring. Rotational $KE=\frac{1}{2}I\omega^2$,

Waves

1D wave eqn $\frac{\partial^2 f}{\partial x^2}=\frac{1}{v^2}\frac{\partial^2 f}{\partial t^2}$,

3D $\nabla^2 f=\frac{1}{v^2}\frac{\partial^2 f}{\partial t^2}$

$f_a=\frac{f_1+f_2}{2}$, beat freq

$f_b=|f_2-f_1|$, intensity oscil of beat freq

Doppler effect: s=source, 0=observer

$F_0=\frac{v+v_0}{v+v_s}$, v =speed of sound

Helpful stuff

$f(x-a)=\sum_{n=0}^{\infty}\frac{f^{(n)}(a)}{n!}(x-a)^n$,

$f(x)=f(0)+xf'(0)+\frac{x^2}{2!}f''(0)+\frac{x^3}{3!}f'''(0)$,

$e^x\approx\sum_{n=0}^{\infty}\frac{x^n}{n!}$

$sin(x)\approx x-\frac{x^3}{3!}+\frac{x^5}{5!}-\frac{x^7}{7!}$

$\int_a^{-a}(\text{odd})(\text{even})=0$,

$(a+x)^n=\sum_{k=0}^{n}\frac{n!}{(n-k)!k!}a^{n-k}x^k$, $(0!=1)$,

Stirling approx: $\ln N!\approx N\ln N-N$,

$(\delta f)^2=\left(\frac{\partial f}{\partial x}\right)(\delta x)^2+\left(\frac{\partial f}{\partial y}\right)(\delta y)^2+$..etc.

Identities

$\sin(\alpha\pm\beta)=\sin(\alpha)\cos(\beta)\pm\cos(\alpha)\sin(\beta)$,

$\cos(\alpha\pm\beta)=\cos(\alpha)\cos(\beta)\mp\sin(\alpha)\sin(\beta)$,

$\tan(\alpha\pm\beta)=\frac{\tan(\alpha)\pm\tan(\beta)}{1\mp\tan(\alpha)\tan(\beta)}$,

$\sin(2\theta)=2\sin(\theta)\cos(\theta)$,

$\cos(2\theta)=\cos^2(\theta)-\sin^2(\theta)$,

$\tan(2\theta)=\frac{2\tan(\theta)}{1-\tan^2(\theta)}$,