Physics 11 in a nutshell

Thermal Physics

0F	**equipartition theorem**:	$\langle K \rangle = 3\frac{1}{2}kT$	mean kinetic energy, temperature
1D	specific heat:	$\frac{dU}{dT} = mc$	rate of change of internal energy with temperature
1D	latent heat:	$Q = m\ell$	heat for phase change per mass
1F	heat conduction:	$\frac{dQ}{dt} = kA\frac{dT}{dx}$	rate of heat flow
1F	radiation:	$\frac{dQ}{dt} = \sigma\epsilon AT^4$	rate of heat flow
1F	:	$W = P\Delta V$	work of expanding gas
1F	First Law of Thermodynamics:	$\Delta U = Q - W$	

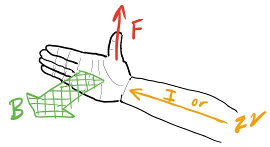
Electricity

0F	**Coulomb's law**:	$F = \frac{1}{4\pi\epsilon_0}\frac{\lvert q_1\rvert\,\lvert q_2\rvert}{r^2}$	force between point charges
0D	**electric field**:	$\vec{E} = \frac{\vec{F}_q}{q}$	force per charge
0D	**electric potential**:	$\Delta V = \frac{\Delta U_q}{q}$	potential energy per charge
0T	**potential and field**:	$\Delta V = -\vec{E}\cdot\vec{\Delta}\ell$	relationship between field and potential
1T	point charge:	$E = \frac{1}{4\pi\epsilon_0}\frac{q}{r^2}$	electric field created by a point charge
1T	point charge:	$V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$	electric potential created by a point charge
1F	capacitance:	$Q = CV_C$	charge is proportional to potential difference
2F	Energy stored in a capacitor:	$U = \frac{1}{2}QV_C = \frac{1}{2}CV_C^2$	
0D	**electric current**:	$I = \frac{dq}{dt}$	rate of charge flow
1F	Ohm's law:	$V_R = IR$	
0T	**Electrical power**:	$P = IV$	rate of energy dissipation
2T	Root-mean-square voltage:	$V_{\text{RMS}} = \frac{V_0}{\sqrt{2}}$	effective voltage of sinusoidal voltage
0T	**Kirchhoff's junction rule**:	$\sum_{n\text{ in}} I_n = \sum_{n\text{ out}} I_n$	
0T	**Kirchhoff's loop rule**:	$\sum V = 0$	
2T	Effective resistance:	$R_S = R_1 + R_2$ and $\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2}$	
2T	Effective capacitance:	$C_P = C_1 + C_2$ and $\frac{1}{C_R} = \frac{1}{C_1} + \frac{1}{C_2}$	
2T	RC circuits:	$V_C(t) - V_\infty = (V_0 - V_\infty)e^{-t/RC}$	

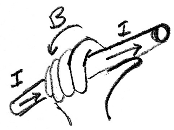
0F **Magnetic Force**: $\vec{F}_B = q\vec{v} \times \vec{B}$ force on charge, velocity, field

0F **Magnetic Force**: $\vec{F}_B = I\vec{L} \times \vec{B}$ force on current, length, field

0F **Right Arm Rule**: direction of magnetic force relative to velocity and field



0F **Right Hand Rule**: direction of field caused by current



0F **Field due to a current**: $B = \alpha I$ magnetic field is proportional to current

0F **Faradays Law**: $\mathcal{E} = -\frac{d}{dt}\vec{B} \cdot \vec{A}$ field caused by changing magnetic flux

0F **Lenzs law**: induced current opposes change direction of field

Ray Optics

0D	**Index of refraction**:	$n = \frac{c}{v} \quad \longrightarrow \quad \lambda = \frac{\lambda_0}{n}$	
0T	**Snells law**:	$n_1 \sin\theta_1 = n_2 \sin\theta_2$	
0T	**Thin lens equation**:	$\frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{f}$	

Electromagnetic Waves & Wave Optics

1T	Energy density:	$\langle u \rangle = \frac{1}{2}\epsilon_0 E_0^2$	energy density of EM field
0T	**Energy flux density**:	$\langle I \rangle = c\langle u \rangle$	intensity of EM field
0T	**Wave speed**:	$c = \frac{1}{\sqrt{\epsilon_0 \mu_0}} = \frac{\lambda_0}{T} = \lambda_0 f$	
0T	**Sinusoidal Wave**:	$E = E_0 \cos(\frac{2\pi}{\lambda}x - \frac{2\pi}{T}t) = E_0 \cos(kx - \omega t) \quad \text{with} \quad k = \frac{2\pi}{\lambda} \quad \text{and} \quad \omega = \frac{2\pi}{T}$	
1T	Single slit:	$a \sin\theta_n = n\frac{\lambda}{2} \begin{cases} I_{\min} & \text{if } n \text{ even and } n \neq 0, \\ I_{\max} & \text{if } n \text{ odd and } n \neq 1. \end{cases}$	min and max of intensity
1T	Double slit:	$d \sin\theta_n = n\frac{\lambda}{2} \begin{cases} I_{\max} & \text{if } n \text{ even}, \\ I_{\min} & \text{if } n \text{ odd}. \end{cases}$	min and max of intensity
1T	Diffraction grating:	$d \sin\theta_n = n\frac{\lambda}{2} \quad I_{\max} \text{ if } n \text{ even}.$	maximum of intensity
0T	**Sum of two waves**:	$\Delta\phi = n\pi \begin{cases} I_{\max} & \text{if } n \text{ even}, \\ I_{\min} & \text{if } n \text{ odd}. \end{cases}$	min and max of intensity
0D	**Phase due to path**:	$\Delta\phi_{\text{path}} = \frac{2\pi}{\lambda}(r_b - r_a)$	
1T	Phase due to reflection:	$\Delta\phi_{\text{reflection}} = \begin{cases} 0 & \text{if } n_1 > n_2, \\ \pi & \text{if } n_1 < n_2. \end{cases}$	