Exam 1 Cheat Sheet

Chapter 21

$k = \frac{1}{4\pi\epsilon_0}$

$\vec{F} = q\vec{E}$ | $\vec{a}\cdot\vec{b} = ab\cos\theta_{ab}$ | $\vec{a} = a_x\hat{x} + a_y\hat{y} + a_z\hat{z}$

$\vec{p} = q\vec{\ell}$ | $\vec{a}\cdot\vec{b} = a_xb_x + a_yb_y + a_zb_z$ | $\vec{a}+\vec{b} = (a_x+b_x)\,\hat{x} + (a_y+b_y)\,\hat{y} + (a_z+b_z)\,\hat{z}$

$\vec{\tau} = \vec{p}\times\vec{E}$ | $\vec{a}\times\vec{b} = ab\sin\theta_{ab}\widehat{c_{RHR}}$

$U = -\vec{p}\cdot\vec{E}$ | $\vec{a}\times\vec{b} = (a_yb_z - a_zb_y)\,\hat{x} + (a_zb_x - a_xb_z)\,\hat{y} + (a_xb_y - a_yb_x)\,\hat{z}$

Cartesian:	Cylindrical:	Spherical:
(x,y,z)	(ρ,z,θ)	(r,θ,ϕ)
$a \equiv \lvert\vec{a}\rvert = \sqrt{\vec{a}\cdot\vec{a}} = \sqrt{a_x^2+a_y^2+a_z^2}$	$r' \equiv \lvert\vec{r'}\rvert = \sqrt{\vec{r'}\cdot\vec{r'}} = \sqrt{\rho^2+z^2}$	$r \equiv \lvert\vec{r}\rvert = \sqrt{\vec{r}\cdot\vec{r}}$
$\hat{a} \equiv \frac{\vec{a}}{\lvert\vec{a}\rvert} = \frac{a_x\hat{x}+a_y\hat{y}+a_z\hat{z}}{\sqrt{a_x^2+a_y^2+a_z^2}}$ (signs?)	$\hat{r'} \equiv \frac{\vec{r'}}{\lvert\vec{r'}\rvert} \simeq \frac{\rho\hat{\rho}+z\hat{z}}{\sqrt{\rho^2+z^2}}$ (signs?)	$\hat{r} \equiv \frac{\vec{r}}{\lvert\vec{r}\rvert} \simeq \hat{r}$ (signs?)
$dA = dxdy, dxdz, dydz$	$dA = \rho d\rho d\theta, \rho d\theta dz$	$dA = r^2\sin\theta d\theta d\phi$
$dV_{ol} = dxdydz$	$dV_{ol} = \rho d\rho d\theta dz$	$dV_{ol} = r^2 dr\sin\theta d\theta d\phi$
Charge Element:		Volume of a Shell $= \frac{4}{3}\pi\left(R_{Big}^3 - R_{Small}^3\right)$
$dq = \lambda d\ell,\ \sigma dA,\ \rho dV_{ol}$		
$\int \frac{xdx}{(a^2+x^2)^{1/2}} = \sqrt{a^2+x^2}$	$\int \frac{xdx}{(a^2+x^2)} = \frac{1}{2}\ln\left(a^2+x^2\right)$	$\int \frac{xdx}{(a^2+x^2)^{3/2}} = -\frac{1}{\sqrt{a^2+x^2}}$

Chapter 22

$\Phi_E = \oint_{Surface} \vec{E}\cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$ | $\oint dA = A$

$\int x^n dx = \frac{x^{n+1}}{n+1}\ (n \neq -1)$ | $\sin^2\theta + \cos^2\theta = 1$

$\int \sin\theta d\theta = -\cos\theta$ | $\sin\theta = \frac{o}{h}$

$\int \cos\theta d\theta = \sin\theta$

$\int \tan\theta d\theta = \frac{1}{\cos^2\theta}$

Chapter 23

$\Delta V = \frac{\Delta U}{q}$ | $e^{\ln(x)} = x$ | $\frac{d}{dx}e^{ax} = ae^{ax}$

$V_{ba} = V_b - V_a = -\int_{(V=0)}^{b}\vec{E}\cdot d\vec{\ell}$ | $\int \frac{dx}{x} = \ln(x)$ | $\int e^{ax}dx = \frac{1}{a}e^{ax}$

Potential far from dipole $\vec{p}$: $V(x,y,z) = k\frac{p\cos\theta}{r^2}$

$\vec{E}$ from V: $E_x = -\frac{\partial V}{\partial x}$ $E_y = -\frac{\partial V}{\partial y}$ $E_z = -\frac{\partial V}{\partial z}$

Power Rule: $\frac{d}{dx}x^n = nx^{n-1}$

Product Rule: $\frac{d}{dx}f(x)\,g(x) = \frac{df(x)}{dx}g(x) + f(x)\,\frac{dg(x)}{x}$

Chain Rule: $\frac{d}{dx}f(g(x)) = \left(\frac{df(g)}{dg}\right)\left(\frac{dg(x)}{dx}\right)$

Chain Rule example: $\frac{d}{dx}\sin^n(x) = \left(n\sin^{n-1}(x)\right)(\cos(x))$

Chapter 24

$C = \frac{V}{Q}$ | $\vec{E}_{Parallel\,Plates} = \frac{Q}{\epsilon_0}\frac{\hat{x}}{A}$ | $W = U_{final} - U_{initial}$

Parallel Plate: $C = \epsilon_0\frac{A}{\ell}$ | Capacitors in Parallel: $C_{equiv} = \sum_i^n C_i$

Concentric Cylinders: $C = 2\pi\epsilon_0\frac{L}{\ln(R_2/R_1)}$ | Capacitors in Series: $\frac{1}{C_{equiv}} = \sum_i^n \frac{1}{C_i}$

Concentric Spheres: $C = 4\pi\epsilon_0\frac{R_2R_1}{R_2-R_1}$ | $U = \frac{QV}{2} = \frac{CV^2}{2} = \frac{1}{2}\frac{Q^2}{C}$ | $u = \frac{\epsilon_0}{2}E^2$

Isolated Sphere $C = 4\pi\epsilon_0 R$ | $C = KC_0$ | $\epsilon_i = K_i\epsilon_0$

Chapter 25

$I = \frac{dQ}{dt}$	$P = IV = \frac{V^2}{R} = I^2R$	$\vec{j} = \frac{\vec{I}}{A}$	$Amp = \frac{C}{s}$
$V = IR$	$\overline{P} = \frac{I_0V_0}{2} = \frac{V_0^2}{2R} = \frac{I_0^2R}{2} = I_{rms}V_{rms}$	$\vec{j} = \sum_i n_i q_i \vec{v}_{di} \Longrightarrow -ne\vec{v}_d$	$Farad = \frac{C}{V}$
$R = \rho\frac{L}{A}$	$V_{rms} = \frac{V_0}{\sqrt{2}}$	$\vec{j} = \sigma\vec{E}$	
$\sigma = \frac{1}{\rho}$	$I_{rms} = \frac{I_0}{\sqrt{2}}$	$\vec{E} = \rho\vec{j}$	
Kirchoff:	0: Combine	2: Unknown	4: Loop
	1: Label	3: Junction	5: Math

Chapter 26

Terminal Voltage:	$V_{ab} = \mathscr{E} - Ir$	Capacitor in RC:	$Q = Q_0 + C\mathscr{E}\left(1 - e^{-t/RC}\right)$
Series Resistors:	$R_{equiv} = \sum_i R_i$	Current in RC:	$I = -\frac{Q_0}{RC} + \frac{\mathscr{E}}{R}e^{-t/RC}$
Parallel Resistors:	$\frac{1}{R_{equiv}} = \sum_i \frac{1}{R_i}$	Time Constant of RC:	$\tau = RC$