Physics II S 2023 Crib Sheet Exam 1 Hayden Fuller Notes:

Culombs Law, conductors, insulators, polarization, induced charges, adding vector fields and forces

$\vec{F}_{1on2} = \vec{F}_{12} = -\vec{F}_{21} = q_2\vec{E}_1 = k\frac{q_1 q_2}{r_{12}^2}\frac{\vec{r}_{12}}{r_{12}} = k\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12}$; $\vec{F}_{tot} = q_0\vec{E}_{tot}$; $\vec{E}_{tot}(X_0, y_0, z_0) = \int d\vec{E}(x', y', z') = \int k\frac{dq'(x',y',z')}{r_0'^2}\frac{\vec{r}_0'}{r_0'}$, $\vec{r}_0' = \vec{r}_0 - \vec{r}' = (x_0 - x')\hat{i} + \ldots$, $\vec{r}' = x'\hat{i} + \ldots$

distance away from line charge linearly, line starts at 0, at x=-D, $\vec{E} = -k\int_0^L \frac{\lambda dx'}{(D+x')^2}\hat{i}$, $V = k\lambda\ln(\frac{D+L}{D})$

with θ up from x axis, $r_x = x\cos\theta$, $r_y = y\sin\theta$, $r = \sqrt{r_x^2 + r_y^2}$, $k = 9*10^9 = \frac{1}{4\pi\epsilon_0}$, $\epsilon_0 = 8.85*10^{-12}$

Electric field for point charges, electric field for a continuous distribution of charge

$\vec{F}_E = q\vec{E}$; $\vec{E}_s = k\frac{q_s}{r^2}\frac{\vec{r}}{r} = k\frac{q_s}{r^2}\hat{r}$

Gauss's law and elecctric flux through a surface, Use of Gauss's law to find field

$\Phi_E = \oint \vec{E}\cdot d\vec{A} = \int E\cdot dA\cos\phi = \frac{Q_{encl}}{\epsilon_0}$, $\phi = \angle\vec{E} - d\vec{A}$, $d\vec{A} = dA\hat{n}$ net elec field $\vec{E} = 0$, $V = c$ within a cond.

gauss sphere: $\Phi_E = \oint \vec{E}(r)\cdot d\vec{A} = E(r)4\pi r^2$, $E(r) = k\frac{q}{r^2}$,

sphere radius R: outside or point charge: $V = k\frac{q}{r}$, $E = k\frac{q}{r^2}$ inside: cond: $V = k\frac{q}{R}$, $E = 0$, insulating: $E = k\frac{qr}{R^3}$

long thin wire: $E(r) = \lambda/(2\pi r\epsilon_0)$ thin flat sheet: $E = \sigma/(2\epsilon_0)$, stepped: go from in to out matching net $Q_i n$

infinite plane w/ cylinder in it, $E = \sigma/\epsilon_0$

Electric potential for point charge, distribution. Electric field vs potential, equipotential. Potential for group of points, conservation of energy.

Change Elec Pot Engry $\Delta U = -\int_{\vec{r}_A}^{\vec{r}_B} q\vec{E}\cdot d\vec{s} = -W_{AB}$; Change Elec Pot $\Delta V = \frac{\Delta U_E}{q} = -\int_{\vec{r}_A}^{\vec{r}_B}\vec{E}\cdot d\vec{s}$ so $\Delta U_E = q\Delta V$

Point charge, Σ for system $V(r) = \frac{kq}{r}$, $U_E = k\frac{q_1 q_2}{R_{12}} + \ldots$; Field from pot: $E_x = -\Delta V = -\frac{\delta V}{\delta x} - \ldots$.

work on closed path =0;

Caps, Dielectrics, steads state, equiv, energy storage, electric fielld energy density

$C = Q/V = \frac{\epsilon_0 A}{d} = kC_0$, ElcPotEnrInCap $U_E = .5QV = .5Q^2/C = .5CV^2$, EnrFieldDen $u_E = .5\epsilon_0 E^2$, $E = \frac{\sigma}{k\epsilon_0}$, $V_1 = V\frac{C_{equiv}}{C_1}$

Current and densityJ, Resistance and itivity, Power relations and dissipation, DC steady state, KCVL Ohms

$I = \frac{dQ}{dT}$, $I = \vec{J}d\vec{A}$, $\vec{J} = qn\vec{v}_d = I/A$. $E = \rho J$, $V = IR$, $R = \rho L/A$, $P = IV = I^2R = V^2/R$; $V_{bat} =$ EMF $-Ir$

Temp: conductor: $\rho(T) = \rho_0 + \rho_0\alpha(T - T_0)$ semi: $\rho(T) = \rho_0 e^{(\frac{E_a}{kT})}$, $E_a =$ actiEngr, $k = 1.38e-23 =$ bolt const.

Magnetic forces and fields

$\vec{F} = q\vec{v}\times\vec{B}$, finger velocity, curl field, thumb force, flip for negative. $\vec{F}_B = I\vec{L}\times\vec{B}$, $r = \frac{mv}{|q|B}$

misc

$W = q\Delta V$, Centripital force $F = mv^2/r$, $E = -\Delta V/d$, $V = kq/r$, $V = \Delta KE = -\Delta PE$, $KE = 0.5*mv^2$

$F = ma$, earth south is north, use conventional, $\vec{c} = \vec{a}\times\vec{b}$, $|\vec{c}| = |\vec{a}||\vec{b}|\sin\theta_{ab}$, cross is det, dot is sum

RMS = $\sqrt{\sum(x^2)}$, %error = (act-exp)/exp

Force	F	$kg*m/s^2$	Newton	N
Energy/Work	$U, KE\|W$	$N*m, W*s$	Joule	J
Charge	Q	$A*s$	Coulomb	C
Chg den linear	λ	C/m	–	C/m
Chg den surface	σ	C/m^2	–	C/m^2
Chg den volume	ρ	C/m^3	–	C/m^3
Elec Field	E	N/C	–	N/C
Elec Flux	Φ	$N*m^2/C$	–	Nm^2/C
Elec Potential	V	$J/C, W/A$	Volt	V
Current	I	C/s	Amp	A
Current density	J	I/m^2	–	I/m^2
Resistance	R	V/A	Ohm	Ω
Resistivity	ρ	$E/J, RA/L$	–	Ωm
Power	P	$VA, J/s$	Watt	W
Capacitance	C	Q/V	Farad	F
Magnetic field	B	$Ns/Cm, N/mA$	Tesla	T