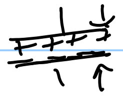
-Equation sheet must be turned in Thursday 5 PM. Add one sheet of paper but you can write on both sides. Only formulas allowed. No examples, problems, etc.
-Ask any question you have about the exam on the forum or see me.

On exam 2, I expect you to be able to

(1) use Gauss's law given a symmetric charge distribution (both free and bound) and calculate E, P, and bound charge densities.
(2) apply the differential form of Gauss's law for E and D.
(3) write an integral expression for V given P
(4) write integral expressions for the Divergence and Stokes theorems.
(5) calculate Eperp and Eparallel across a boundary using the divergence and Stokes theorems.
(6) calculate the field of a dipole and the dipole moment of an atom in an electric field given its polarizability, alpha and then be able to determine P.
(7) Understand how to derive a solution to Laplace's equation using separation of variables and apply it to a simple case in Cylindrical coordinates.
(8) determine capacitance.

① Forces by $\vec{F} = q\vec{E}$ given ρ find E

② Work energy



$\boxed{Q = CV}$ Fix Q & vary C & V changes
all three can vary

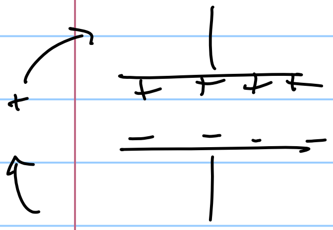
$PV = nRT$ Fix Temp & vary Vol & pressure

$W_{net} = \Delta KE$

$W_{nc} + W_{cons}$

ΔPE

$dW_{me} = dq\,V = dq\,\frac{q}{C_0}$ $W_{nc} = \Delta(KE + PE)$

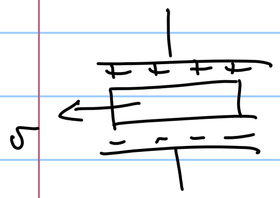


move charge at const velocity $\Delta KE = 0$

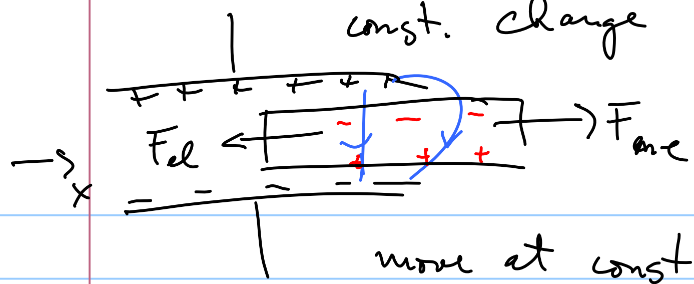
$$W_{me} = \int_0^{Q_f} \frac{q}{C_0}\,dq = \frac{Q_f^2}{2C_0}$$ C is const

$W_{nc} = W_{me} = \Delta PE = q\,\Delta V$

$$W_{me} = \frac{Q_f^2}{2C_0} = \frac{C_0 V^2}{2}$$ Joule energy stored in cap



$C = KC_0$
Energy stored
const Voltage $\frac{1}{2}KC_0V^2$
const charge $\frac{1}{2}\frac{Q_0^2}{KC_0}$



$W_{nc} = \Delta(\cancel{KE}^{0} + PE)$

$\parallel$

W_{me}

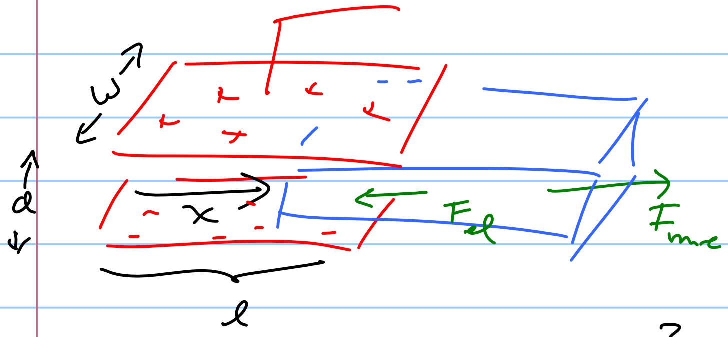
$$\boxed{Q = CV}$$

$dW_{me} = F_{me}\,dx = -\underline{F_{elect.}}\,dx$ $F_{elect} = -\frac{dW_{me}}{dx}$

$W_{me} = \frac{Q^2}{2C(x)}$ $C = \frac{\epsilon_0 w}{d}(l\epsilon_r - \chi_e x)$

$\downarrow$

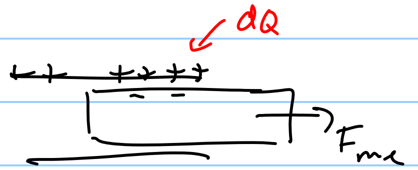
$\frac{\epsilon}{\epsilon_0}$



Find F on dielectric

$F_{el} = -\frac{dW}{dx} = -\frac{d}{dx}\frac{1}{2}\frac{Q^2}{C(x)} = \frac{1}{2}\frac{Q^2}{C(x)^2}\frac{dC}{dx}$ $\frac{dC}{dx} = -\frac{\epsilon_0 w \chi_e}{d}$

If a battery is hooked up $W = \frac{1}{2}C(x)V^2$



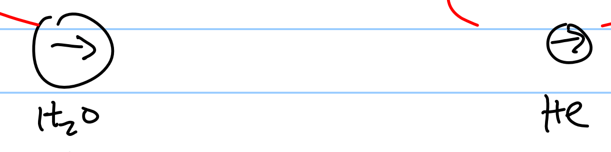
$W_{nc} = \Delta PE$ VdQ

$\swarrow \quad \searrow$ $\Rightarrow dW = F_{me}\,dx + dW_{battery}$

$W_{batt} + W_{me}$ $\frac{1}{2}CV^2$ $Q = CV$

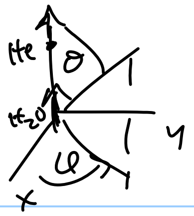
$-\underline{F_{el}} = \frac{dW}{dx} = F_{me} + V\underline{\frac{dQ}{dx}}$ $F_{me} = -\frac{dW}{dx} + V\frac{dQ}{dx}$

α polarizability



↑ generates E which polarizes He $P_{He} = \alpha E_{dipole\,H_2O}$

$\vec{E} = \frac{P_{He}}{4\pi\epsilon_0 r^3}(2\cos\theta\,\hat{r} + \sin\theta\,\hat{\theta})$ $\theta = 0$ $P_{He} = \alpha\frac{P_{He}}{4\pi\epsilon_0 r^3}2$



P_{He} generates an E_{dipole}