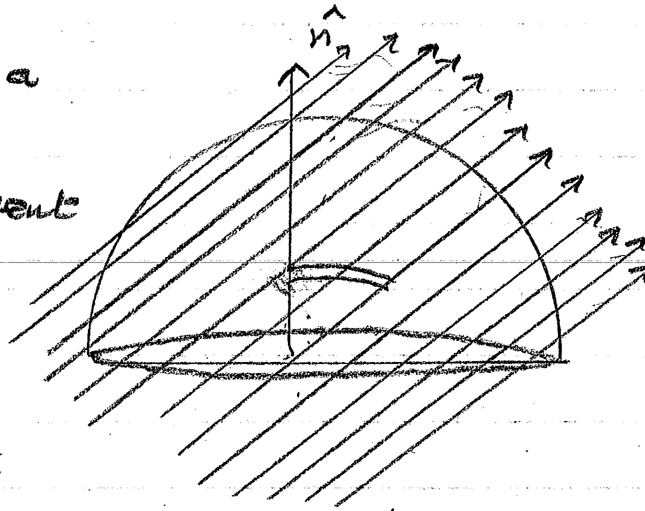
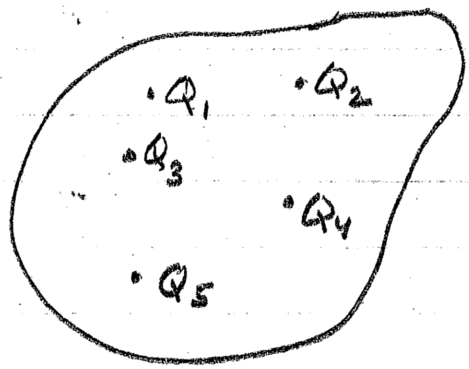
Test Questions (Exam II).

A. State Gauss's law in your own words.

B. The picture shows a hemisphere of radius 2m and the lines represent an $\vec{E}$ field of 500 N/C inclined at angle of 60° with respect to the y-axis. What is the flux of $\vec{E}$ through the "dome" (curved top)? Why? $(\hat{n} \parallel \hat{y})$



C. The picture shows a closed surface. The enclosed charges are $Q_1 = 1\mu C$; $Q_2 = 2\mu C$, $Q_3 = -3\mu C$, $Q_4 = 10\mu C$, $Q_5 = -10\mu C$. What is the total flux of $\vec{E}$ through the surface? Why? What is the value of the $\vec{E}$ field on the surface? Why?



D. Show that for a single charge Q located at $r=0$ the total flux of $\vec{E}$ through any closed surface surrounding it is $\frac{Q}{\varepsilon_0}$.

TEST QUESTIONS – EXAM II (Partial)

1. Sketch the $\underset{\to}{E}$ field due to a conducting sphere of radius R ~~and~~ which has a charge Q. (Assume Stationary Conditions).

2. In Prob 1 where is the charge Q located.

3. What is the direction of the $\underset{\to}{E}$-field at the surface of a conductor under stationary conditions.

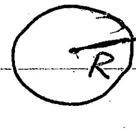
4. We are told that a thin sheet carrying a uniform charge density σ C/m^2 will produce an $\underset{\to}{E}$-field of $\pm \frac{\sigma}{2\epsilon_0}\hat{n}$ where $\hat{n}$ is perpendicular to the sheet. How would you use two sheets to produce the following field.

$$x < 0 \quad \vec{E} = 0$$

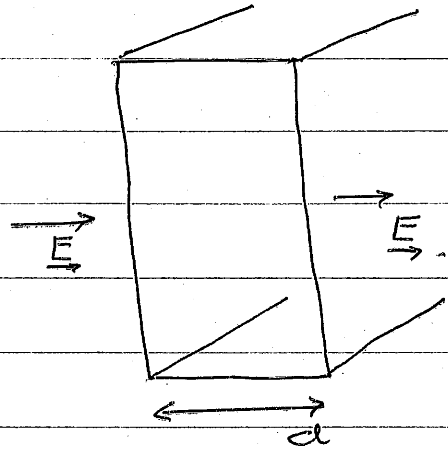
$$0 < x < d \quad \vec{E} = \frac{\sigma}{\epsilon_0}\hat{x}$$

$$x > d \quad \vec{E} = 0.$$

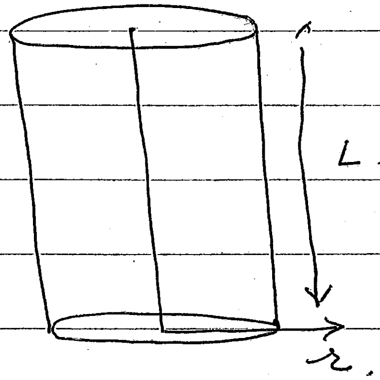
5. Shown is a hollow sphere of radius R which carries a charge Q uniformly distributed on its surface. Show that as r goes from $r<R$ to $r>R$ the $\vec{E}$ field jumps by $\frac{\sigma}{\varepsilon_0}$ where $\sigma = \frac{Q}{4\pi R^2}$.



6. A conductor of thickness d is placed as shown in a uniform $\vec{E}$-field [i.e. $\vec{E} \perp$ surface]. Under stationary conditions what are the charge densities that appear on its surface? Why?



7. A hollow cylinder of radius R carries a charge Q on its surface. Show that as r goes from $r<R$ to $r>R$ the $\vec{E}$-field jumps by $\frac{\sigma}{\varepsilon_0}$ where $\sigma = \frac{Q}{2\pi R L}$. [Assume that L is very large].



8. Why is there a minus sign on the right of these equations:

$$\Delta P = -\sum \vec{F}_E \cdot \Delta \vec{s}$$

$$\Delta V = -\sum \vec{E} \cdot \Delta \vec{s}$$

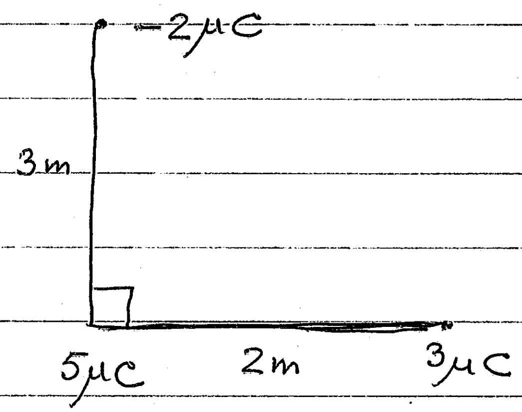
9. Show that the Coulomb Force

$$\vec{F}_E = \frac{q_1 q_2}{4\pi\varepsilon_0 r^2}\hat{r}$$

is a conservative force.

10. Which potential is larger: 0.1m away from a charge of 10μC or 0.3m away from a charge of 30μC? why?

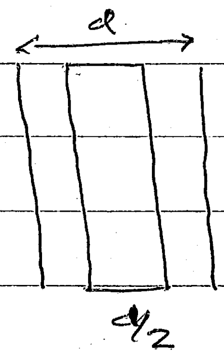
11. Calculate the potential energy of the charge configuration shown here.



12. Sketch the potential due to a charge $-|q|$ placed at $r=0$. Sketch the concomitant potential energy for a) $+q'$, b) $-|q'|$.

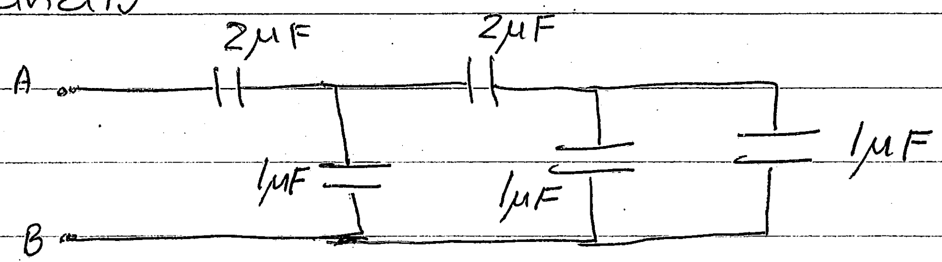
13. Begin with a parallel plate capacitor filled with air. Plate area A, separation d. Put charges $\pm Q$ on the plates. What is the potential difference between the plates?

14. Place a conductor of area A and thickness $\frac{d}{2}$ between the plates of Prob 13. What is the potential difference between the plates? Why?



15. Place a dielectric of thickness d, area A and dielectric const. $k = 2$. ~~What~~ between ~~the p~~ the plates of Prob 13. What is the potential difference? Why?

16. What is the capacitance between points A and B



17. Attach a 12V battery across AB. Calculate

the charge on Each Capacitor.

18. In order to place a charge Q on a capacitor C_0 the battery has to perform $U_E = \frac{Q^2}{2C_0}$ Joules of work. Where does this energy go?

19. Show that an $\vec{E}$-field stores $\eta_E = \frac{1}{2}\epsilon_0 E^2$ Joules/m^3 of energy.

20. Show that in a dielectric, the energy density in the $\vec{E}$-field is

$$\eta_E(\kappa) = \frac{1}{2}\kappa\epsilon_0 E_k^2.$$

where $E_k = \frac{\sigma}{k\epsilon_0}$.

21. Given two identical capacitors C. Charge one to Q and store energy $\frac{Q^2}{2C}$. Next connect the two as shown. What is the total energy now? What do we learn from this expriment?