We'll do a bit of Ch 6 review, then start on ch 7

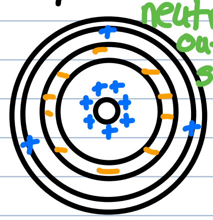
A hint for HW #6 Problem #42

$\rho(r) = \rho_0 \frac{r}{R}$ Need to carefully compute $Q_{enclosed}$

$$Q_{enc} = \int_0^r dV \, \rho(r)$$

Consider a charge dq distributed over a thin shell of thickness dr $\quad dV = 4\pi r^2 dr$

example for group work at the whiteboards:



An inner metal ball w/ charge +7Q

An intermediate non-conducting shell -10Q
→ assume charge uniformly distributed

An outer metallic shell w/ charge +3Q

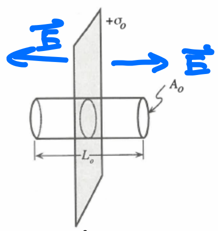
Pretest: Gauss' law Name ________ Pretests 133

1. Shown at right is a small portion near the center of a *very large* nonconducting sheet. The sheet has a uniform positive charge per unit area $+\sigma_o$.

If the entire sheet has a width *W* and a height *H*, how much charge is distributed over the entire sheet?

$Q_{total} = +\sigma_o A = \sigma_o W H$

2. An imaginary cylindrical surface encloses a small portion of the sheet near the center. The cylinder has a length L_o, and the area of each end cap is A_o.

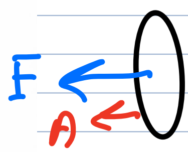


a. What is the net charge enclosed by the cylinder? Explain.

$Q = \sigma_o \pi R^2 = \sigma_o A_o$

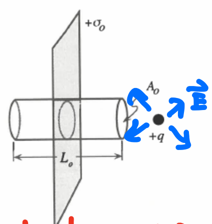
b. Is the electric flux through the curved side wall of the cylinder *positive, negative,* or *zero*? Explain.

cos 90° everywhere on tube



left hand cap

3. A positive point charge is now placed to the right of the imaginary cylinder, as shown.



a. Does the electric flux through the left-hand end cap of the cylinder *increase, decrease,* or *remain the same?* Explain.

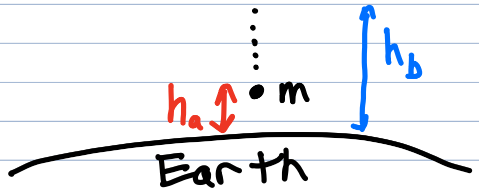
E field due to +q points in same direction as surface normal

b. Does the net electric flux through the entire imaginary cylinder *increase, decrease,* or *remain the same?* Explain.

The charge is outside the tube, so Q_{enc} is unchanged ⇒ Φ_e unchanged

ch 7 Electric Potential

We'll focus on work and energy

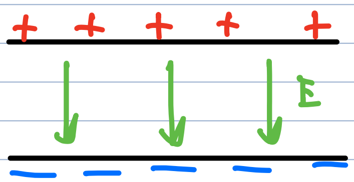


Potential energy $U_a = mgh_a$
$U_b = mgh_b$

$$W_{a\to b} = U_a - U_b = mgh_a - mgh_b = mg(h_a - h_b)$$
$$= -mg\Delta h \qquad \Delta h \equiv h_b - h_a$$

recall $W_{a\to b} = \int_a^b \vec{F}\cdot d\vec{l} = \int_a^b mg\,dl\cos 180° = -mg\int_a^b dl = -mg\Delta h$

Straight analogy to E field and potential



raising charge $+q$ from h_a above bottom plate to h_b would require

$$W_{a\to b} = \int_a^b qE\,dl\cos 180° = -qE\Delta h$$

we explored potential using the PheT sim "charges and fields"

Potential difference for moving two charges from separation r_a to r_b $\quad q_1 \bullet\longleftarrow r \longrightarrow\bullet q_2$

First, compute work done by E field

$$W_{a\to b} = \int_a^b \vec{F}\cdot d\vec{l} = \int_a^b \frac{kq_1q_2}{r^2}\,dr\cos 0° = kq_1q_2\int_a^b \frac{dr}{r^2}$$

$$= \frac{kq_1q_2}{r_a} - \frac{kq_1q_2}{r_b} \Rightarrow \text{potential E } kq_1q_2/r \quad \text{"U"}$$

Voltage ΔV is difference in potential $V_a - V_b$

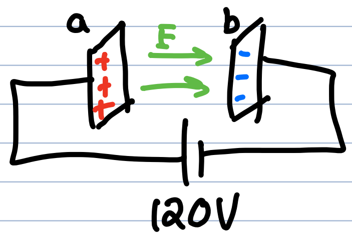
$\Delta V = \Delta U / q_0 = V_a - V_b = W_{a \to b} / q_0$

A 120V battery is connected between two parallel plates of separation dx=10.0cm

A) What is E?

B) if you place a proton at rest near plate a, what is the change in PE after hitting negative plate?

C) what is the impact speed?



a) $V_a - V_b = \Delta V = \frac{W}{q_0} = \frac{1}{q_0} \int_a^b q\vec{E} \cdot \vec{dl}$

$= E \int_a^b dl \cos 0^\circ = E \, \Delta x \Rightarrow E = \frac{V_a - V_b}{\Delta x}$

$= 120V / 0.1m = 1200 \frac{V}{m}$