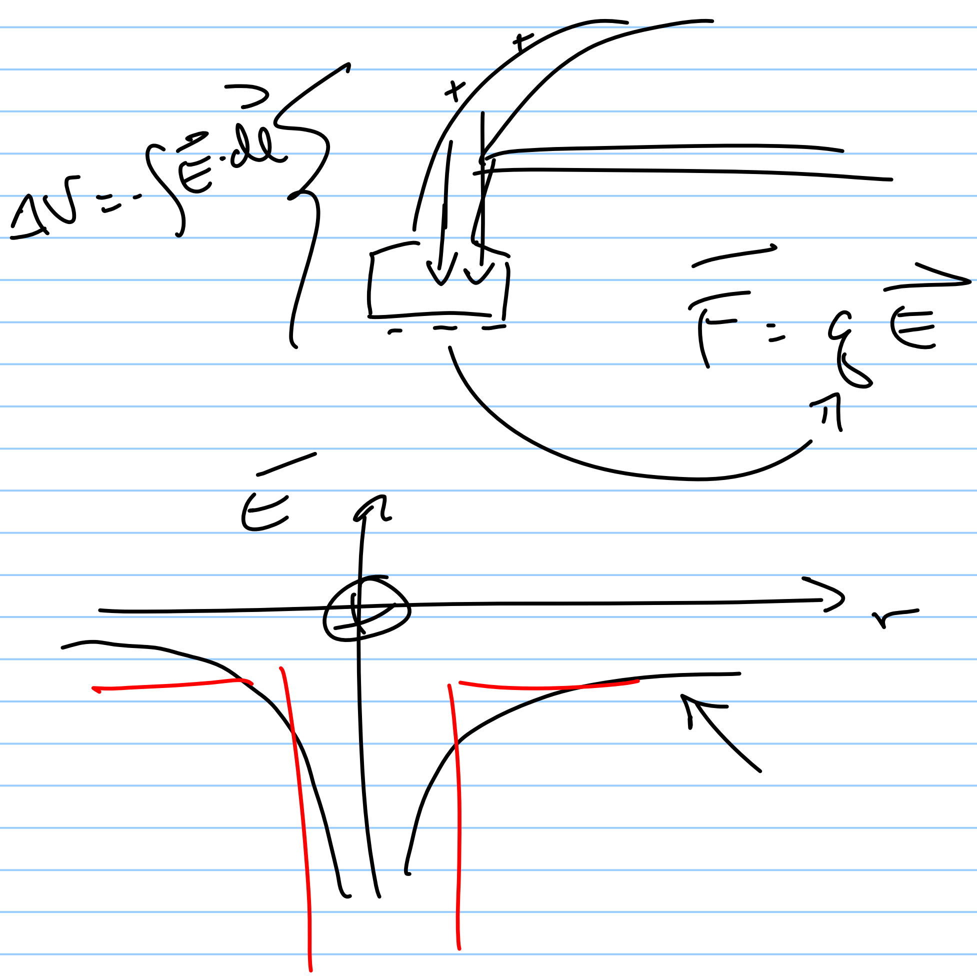
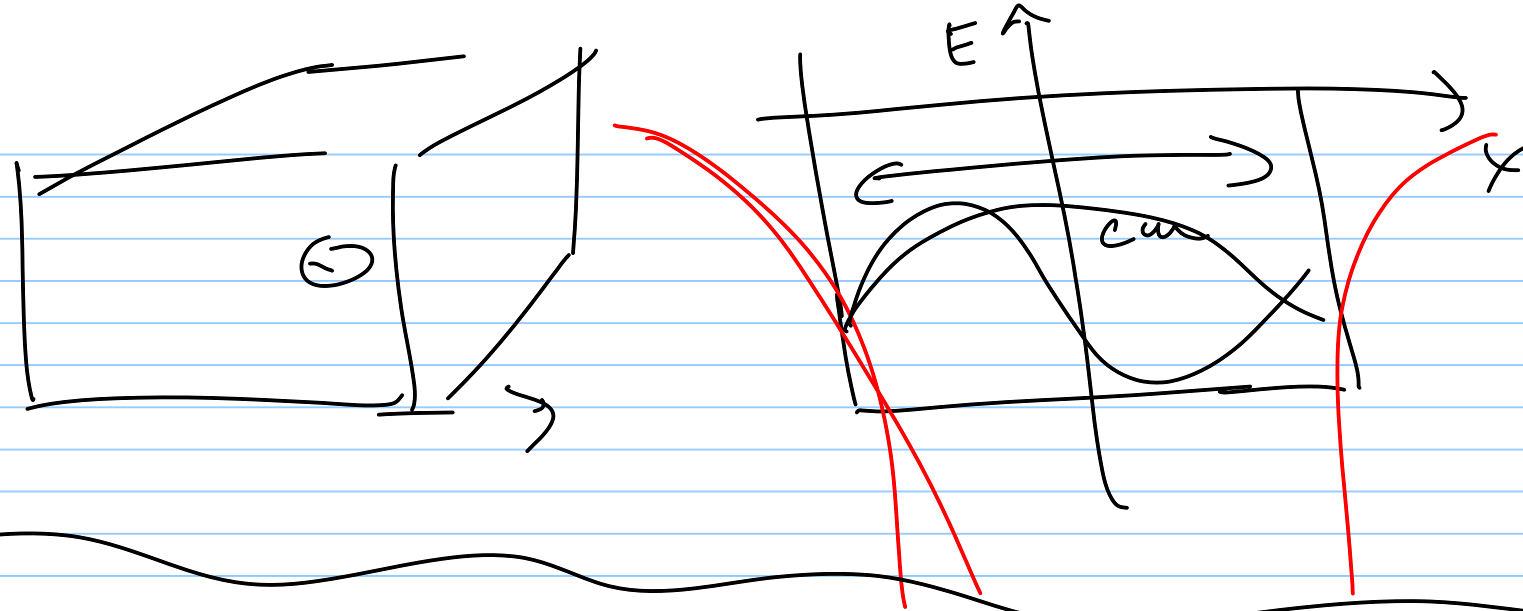
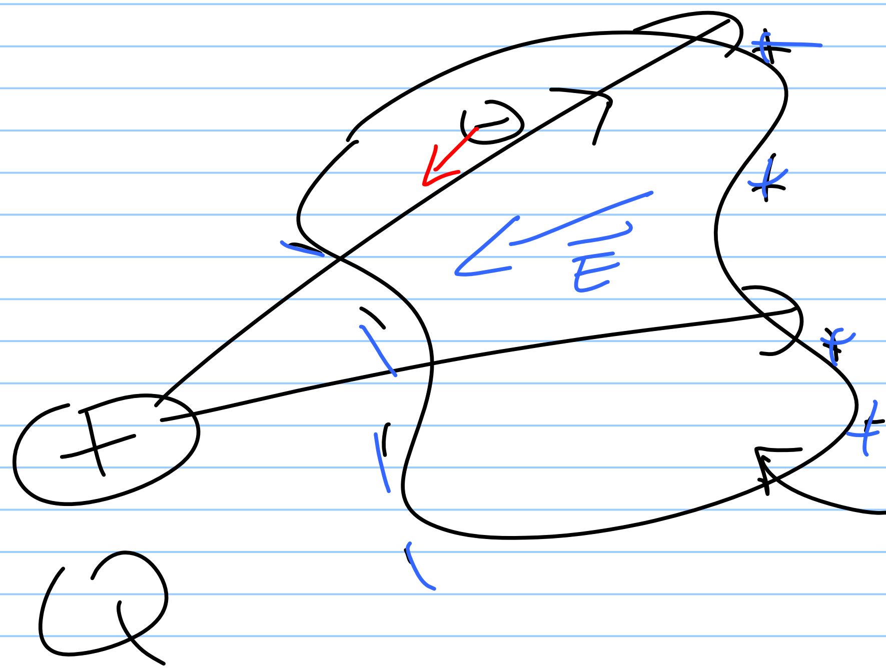
Conductors: electrons free to move in material

$\Delta V = -\int \vec{E} \cdot d\vec{l}$

$\vec{F} = q\vec{E}$







Is there an $\vec{E}$ inside conductor at instant Q appears?

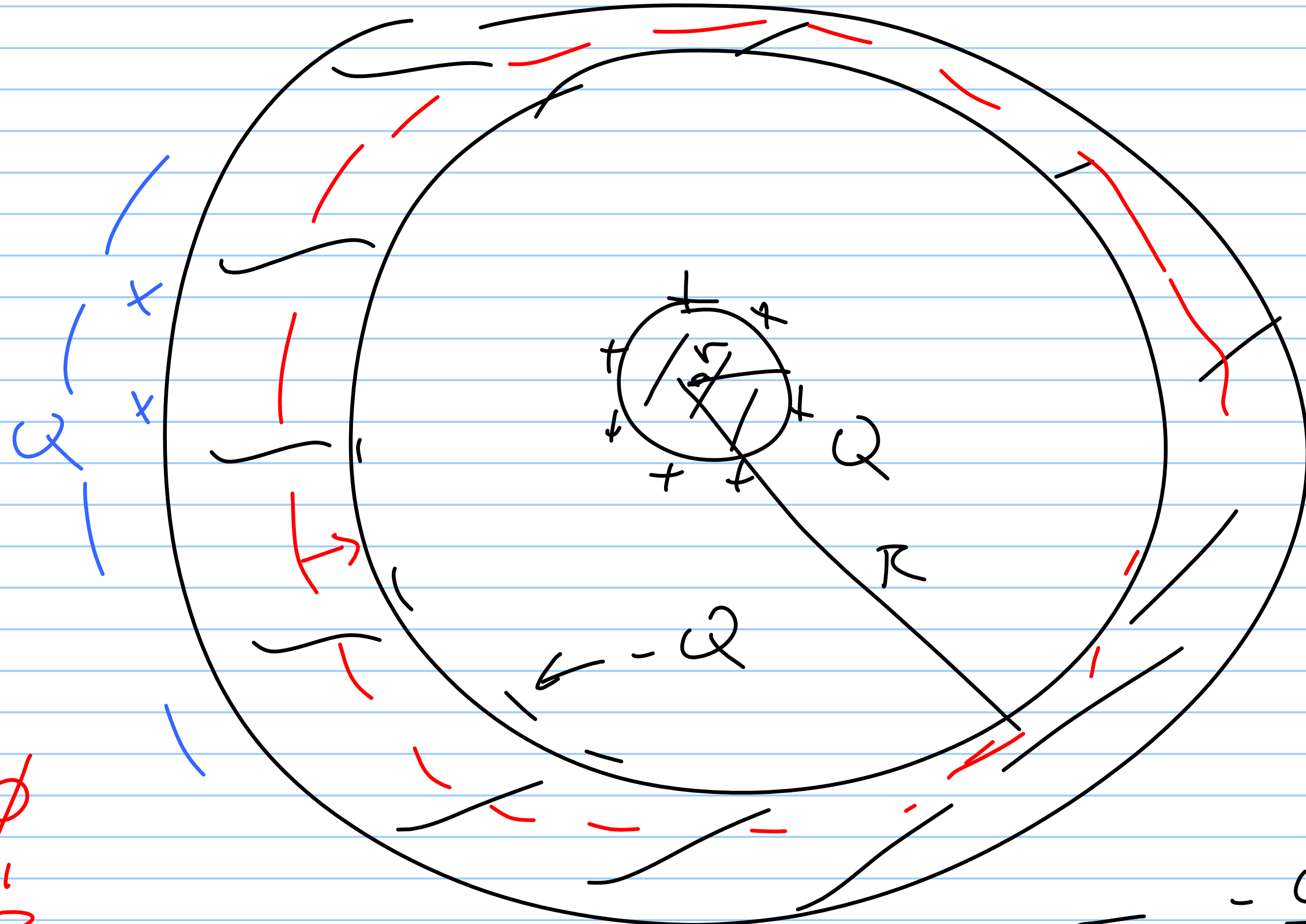
Yes

copper

$\vec{F} = q\vec{E}$

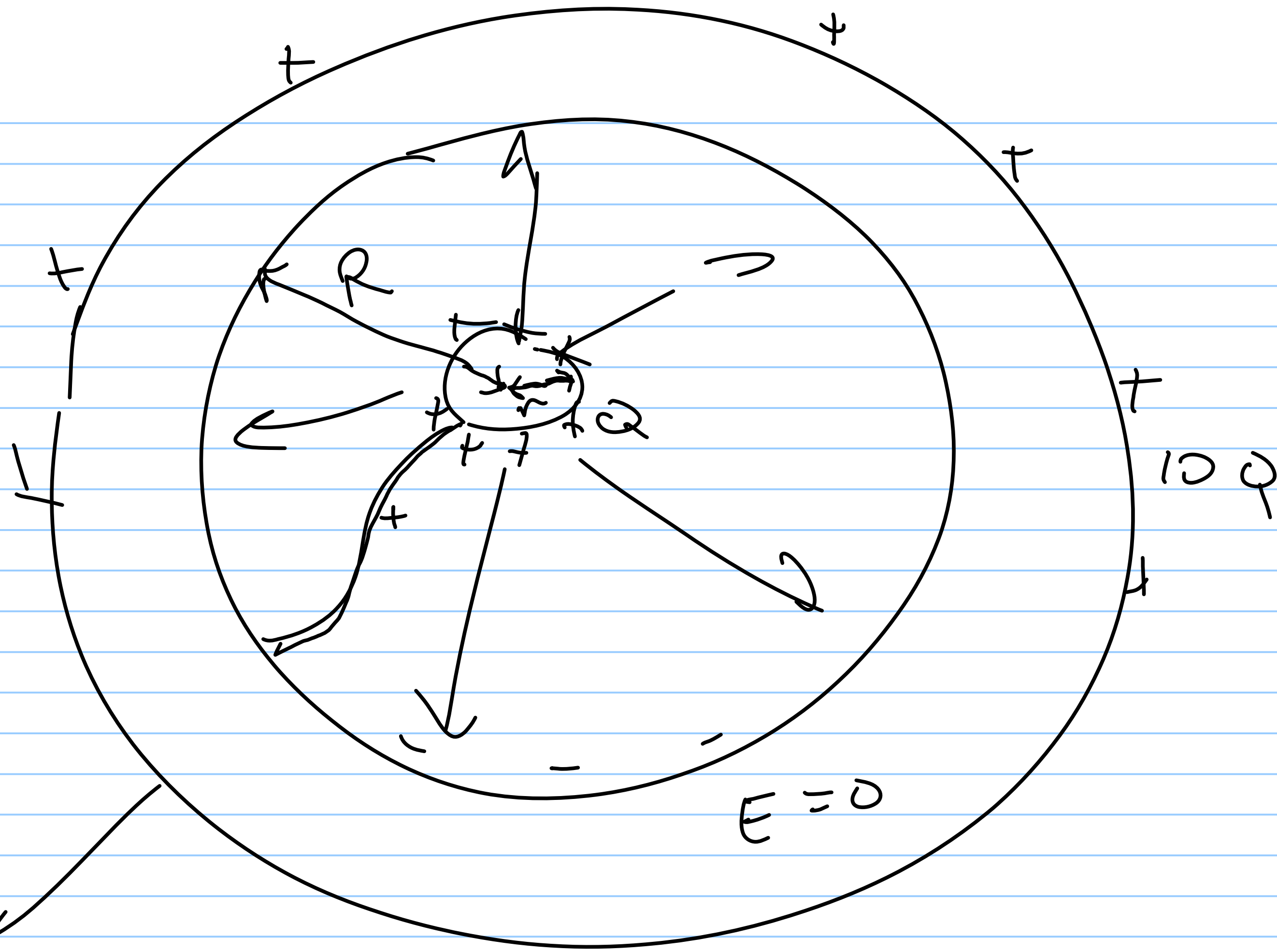
free charges

No then $\vec{F} = 0$



$$\Phi = \oint \vec{E} \cdot d\vec{a} = \frac{Q_{encl}}{\epsilon_0}$$

$$\sigma = -\frac{Q}{4\pi R^2}$$



methods

(I) Newtons $F = ma = q\vec{E}$ charges move to outer shell

(II) cons energy

$W_{\text{non-conservative}} = \Delta(KE + PE)$

$$\overset{\shortparallel}{0} = (KE + PE)_f - (KE + PE)_i$$

$KE_i = 0 \quad PE = qV_r$

$KE_f \qquad PE_f = qV_R$

$\Delta V = -\int \vec{E} \cdot d\vec{l} = V_{final} - V_{initial}$ let V_{final} be at R

& $V_{initial}$ be at r

$$V_R - V_r = -\int_r^R \frac{kQ}{r'^2}\, dr' = \left.\frac{kQ}{r'}\right|_r^R = kQ\left(\frac{1}{R} - \frac{1}{r}\right)$$

$$\Delta PE = q_0 \Delta V = kq_0Q\left(\frac{1}{R} - \frac{1}{r}\right) = \underset{\overset{\shortparallel}{PE_f}}{PE_R} - \underset{\overset{\shortparallel}{PE_i}}{PE_r} < 0$$

$$PE_f < PE_i$$

Work energy $\Rightarrow$ $KE_i + PE_i = KE_f + PE_f$

$KE_f = PE_i - PE_f > 0$ so charge moves away from smaller sphere!