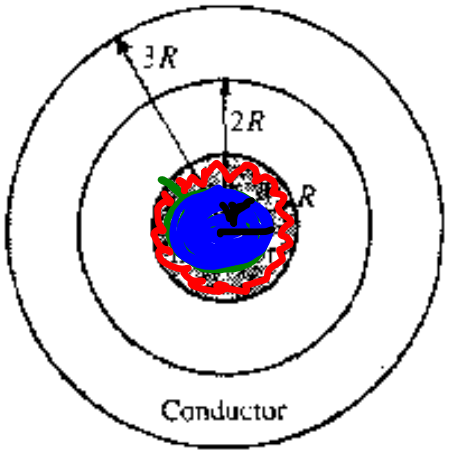
1990E1



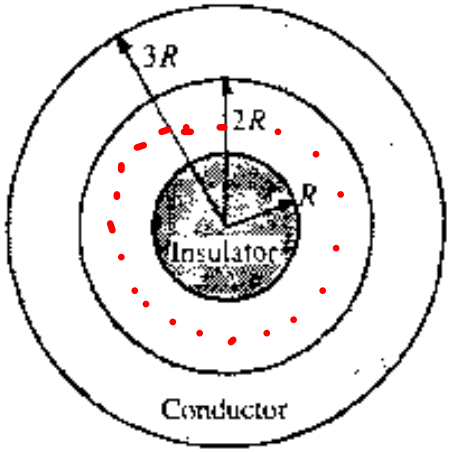
$$\oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$E \oint d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$E\, 4\pi r^2 = \frac{q_{enc}}{\varepsilon_0}$$

$$q_{enc} = \frac{Q\,\frac{4}{3}\pi r^3}{\frac{4}{3}\pi R^3}$$

$$E = \frac{Q\,r^3/R^3}{4\pi\varepsilon_0 r^2} = \frac{Q}{4\pi\varepsilon_0}\frac{r}{R^3}$$

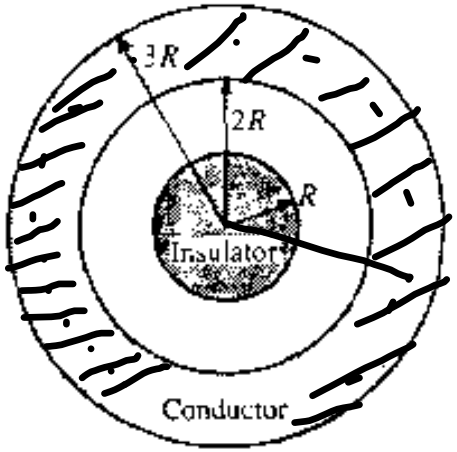


$$\oint E \cdot dA = \frac{q_{enc}}{\varepsilon_0}$$

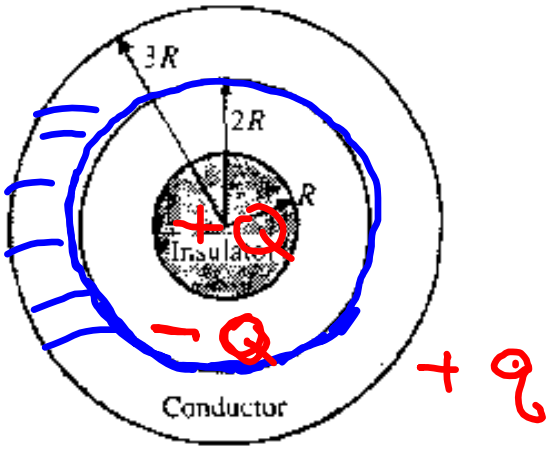
$$E\, 4\pi r^2 = \frac{Q}{\varepsilon_0}$$

$R < r < 2R$

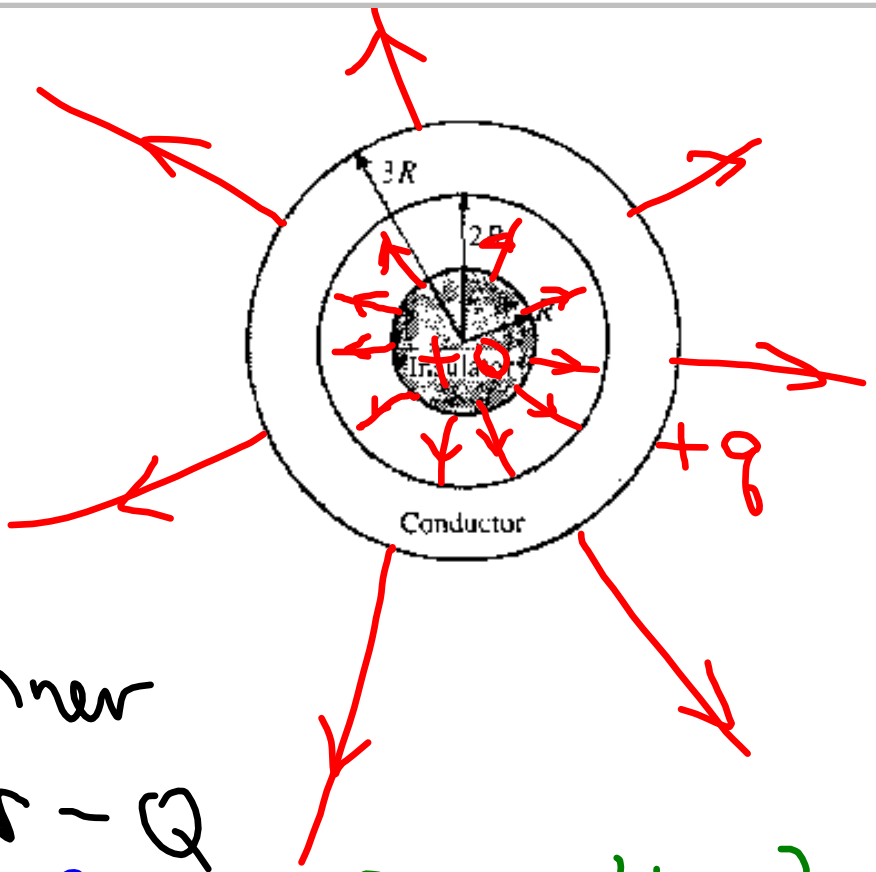
$$E = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$$



c) $E = 0$



+q



+q

d) charge on inner surface is $-Q$

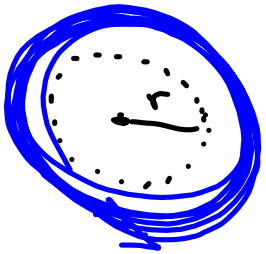
$$\sigma = \frac{\text{charge}}{\text{Area}} = \frac{-Q}{4\pi(2R)^2}$$

$$\sigma = \frac{-Q}{16\pi R^2}$$

$\text{area} = 4\pi r^2$

1996 E3

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$



$$\oint E \cdot dl = -\frac{d\Phi_B}{dt}$$

$$E \oint dl = -\frac{d(B \cdot A)}{dt}$$

$$\Rightarrow E\, l$$

$$\Rightarrow E\, 2\pi r = -A \frac{dB}{dt}$$

$$E = -\frac{\pi r^2}{2\pi r} \frac{dB}{dt} = -\frac{r}{2} \frac{dB}{dt}$$