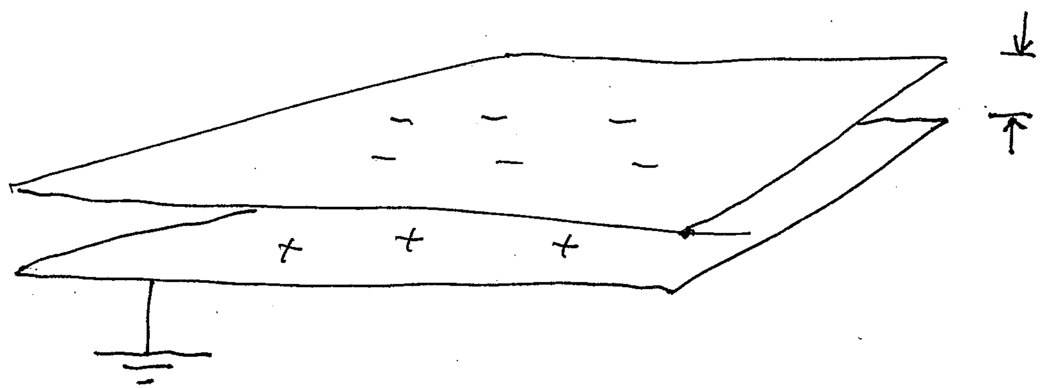
Lecture # 8

Electric Potentials (cont.)

What is the Potential of the upper plate relative to Ground ($\bar{E}$ is electric field in between plates)?



(a) $\bar{E}d$

(b) $-\bar{E}d$

(c) 0

(1)

Work needed in moving charge q in $\vec{E}$-field of q' depends only on radial distance

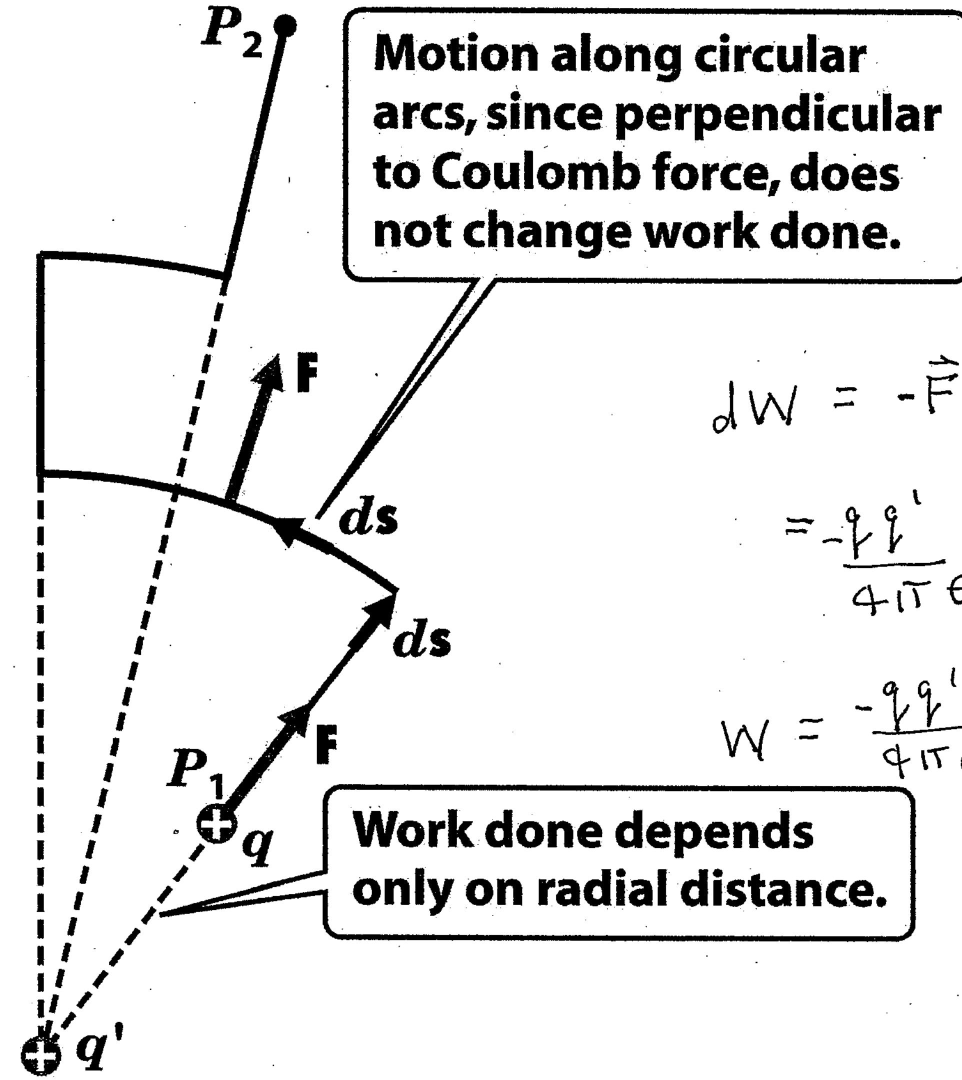


Figure 25-7 Physics for Engineers and Scientists 3/e

$$dW = -\vec{F}\cdot d\vec{r} = -F_r\, dr$$

$$= -\frac{qq'}{4\pi\epsilon_0}\frac{dr}{r^2}$$

$$W = \frac{-qq'}{4\pi\epsilon_0}\int_{\infty}^{r}\frac{dr'}{r'^2}$$

$$= \frac{qq'}{4\pi\epsilon_0}\frac{1}{r'}\Big|_{\infty}^{r}$$

$$= \frac{qq'}{4\pi\epsilon_0}\frac{1}{r} = U(r) \equiv PE$$

$$V(r) = \text{Electric Potential} = \frac{PE}{q} = \frac{q'}{4\pi\epsilon_0 r_2}$$

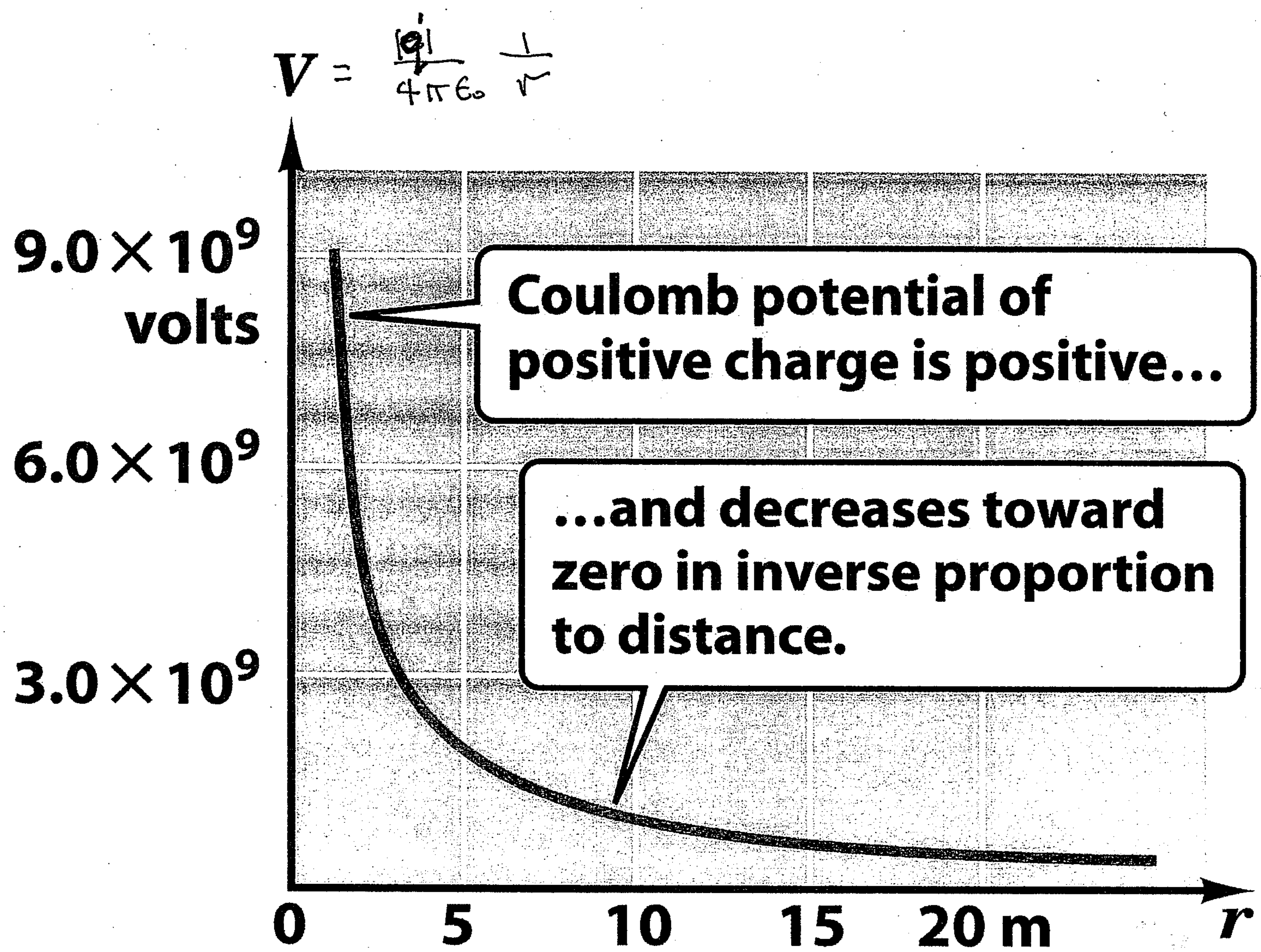


Figure 25-8a Physics for Engineers and Scientists 3/e

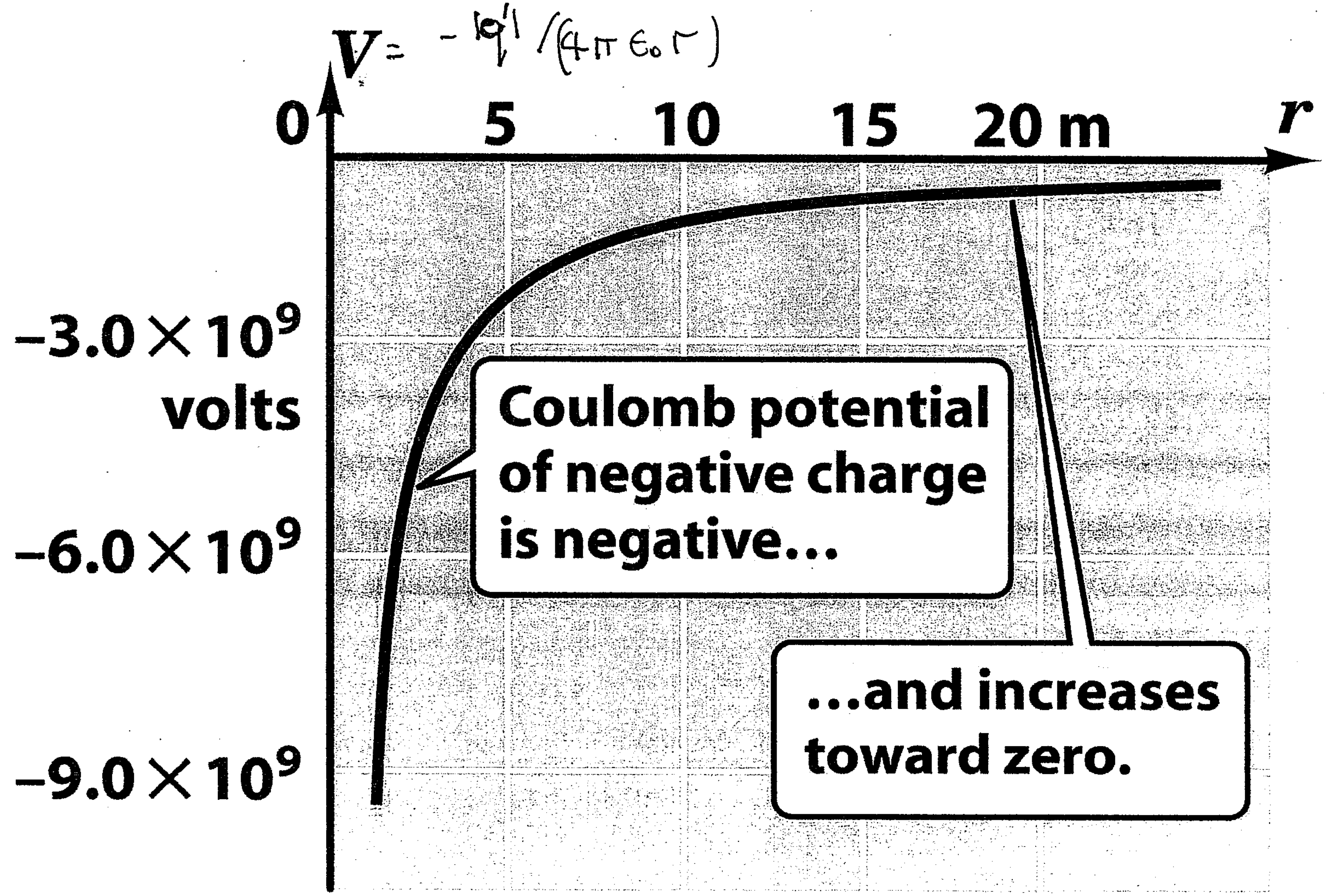


Figure 25-8b Physics for Engineers and Scientists 3/e

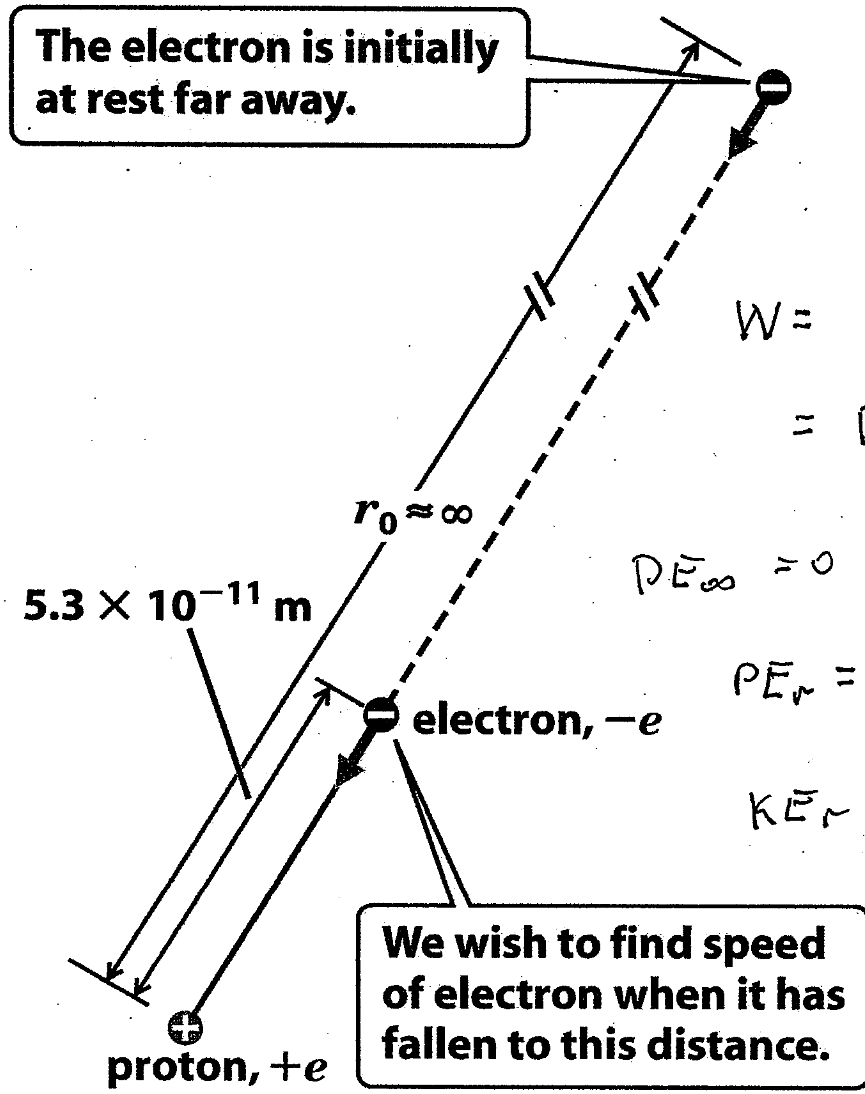


Figure 25-11 Physics for Engineers and Scientists 3/e

$$W = PE_\infty + KE_\infty$$

$$= PE_r + KE_r$$

$$PE_\infty = 0 \quad , \quad KE_\infty = 0$$

$$PE_r = (-e) \frac{e}{4\pi\epsilon_0} \frac{1}{r}$$

$$KE_r = \frac{1}{2} m_e v^2$$

$$\therefore \quad 0 = \frac{1}{2} m_e v^2 - \frac{e^2}{4\pi\epsilon_0} \frac{1}{r}$$

$$v = \left(\frac{e^2}{2\pi\epsilon_0 m_e r} \right)^{1/2}$$

Electric Field Inside Metallic Cavity

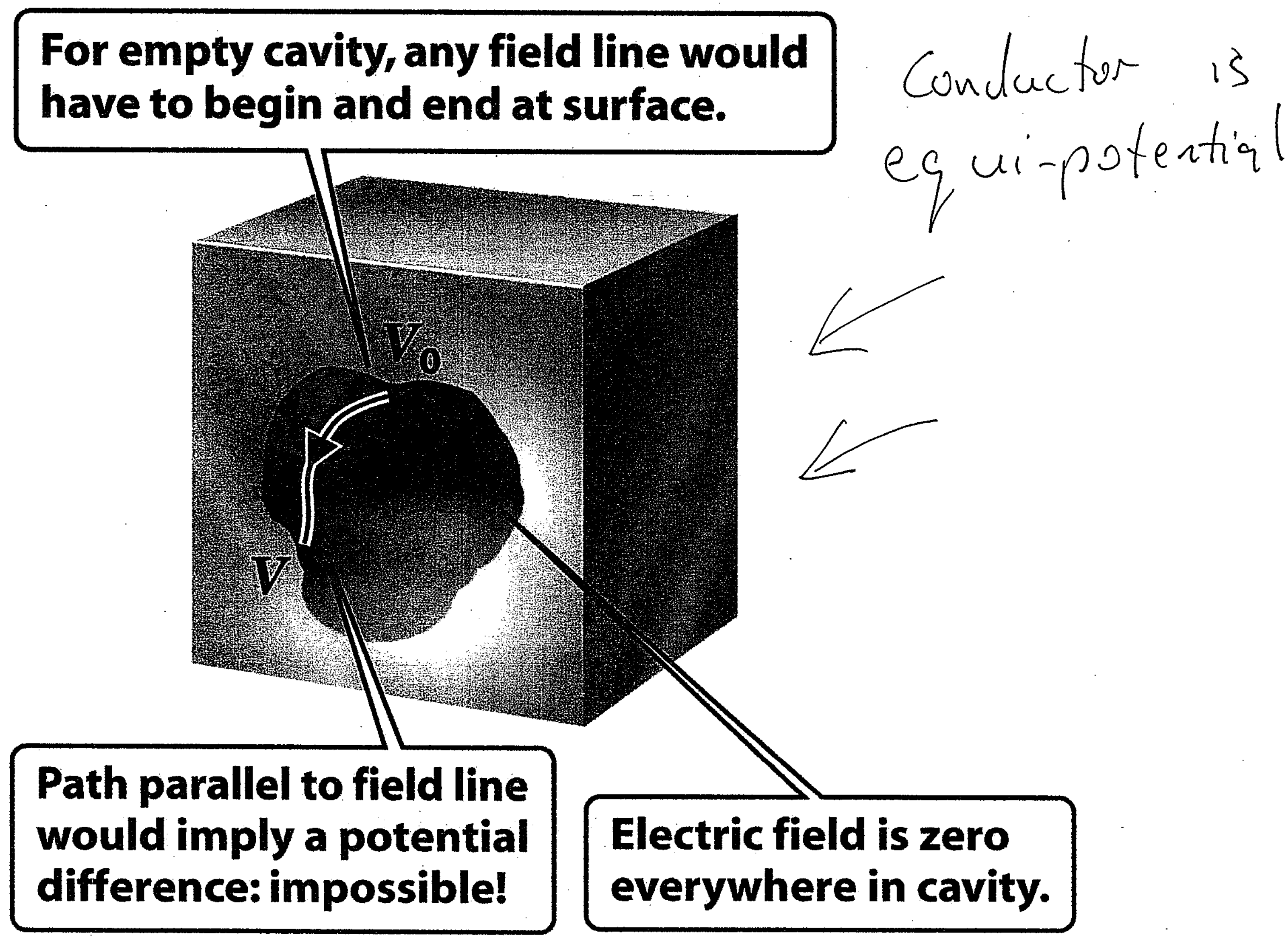
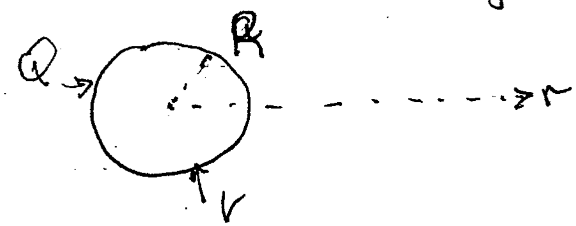


Figure 25-19 Physics for Engineers and Scientists 3/e

potential from a conducting sphere



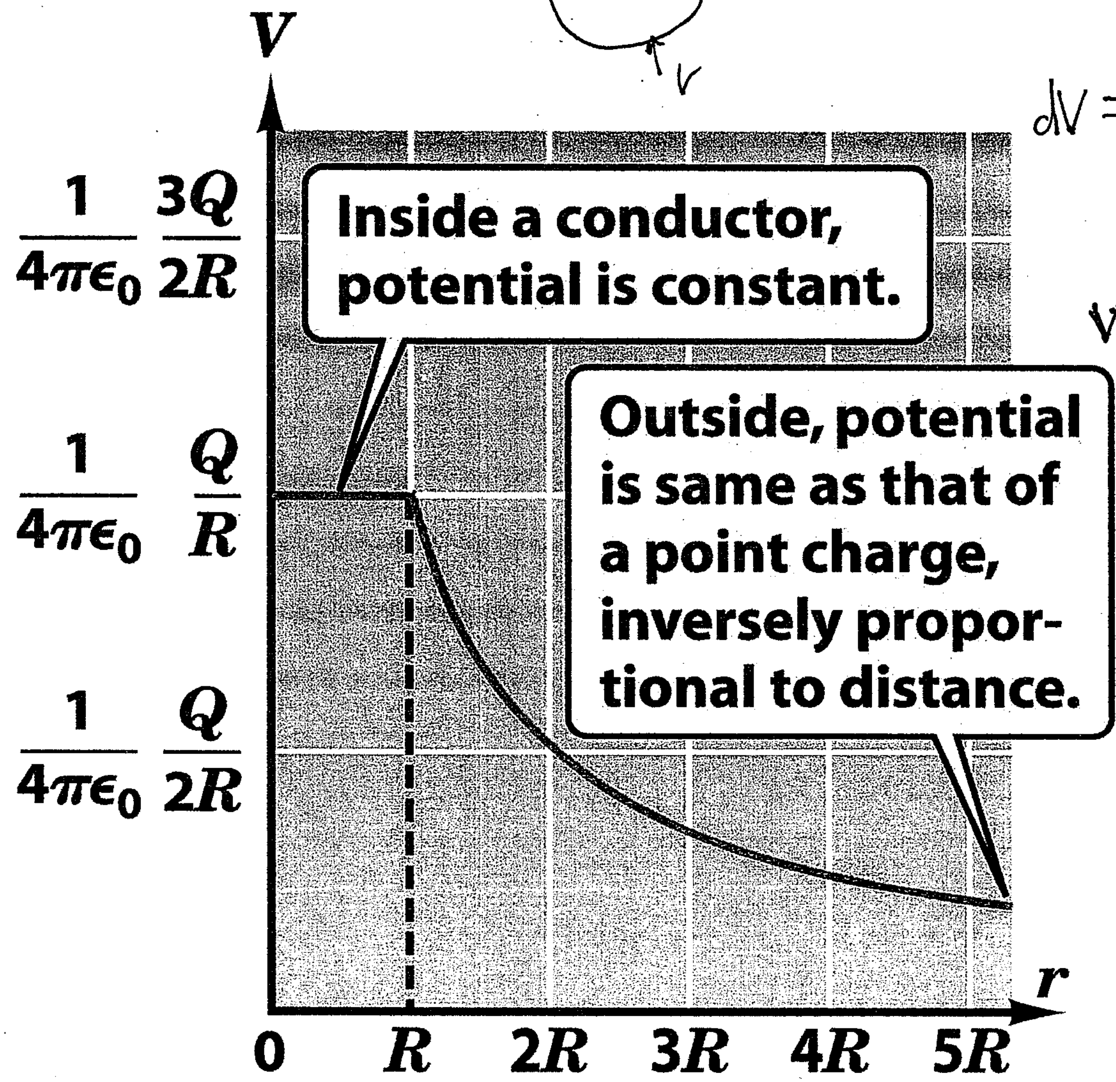


Figure 25-18 Physics for Engineers and Scientists 3/e

$dV = -E_r\,dr$

$= -\frac{Q}{4\pi\epsilon_0}\frac{dr}{r^2}$, $r > R$

$V = -\int_\infty^r E_r\,dr$

$= -\frac{Q}{4\pi\epsilon_0}\int_\infty^r \frac{dr}{r^2}$

$= +\frac{Q}{4\pi\epsilon_0}\frac{1}{r}$

$(r > R)$

$E_r = 0$, $r < R$

$r < a$

$V = V(a) - \int_a^r \underbrace{E_r}_{=0}\,dr$

$= V(a)$

$r > R$

$V = \frac{Q}{4\pi\epsilon_0}\frac{1}{r}$

$r \le R$

$V = \frac{Q}{4\pi\epsilon_0}\frac{1}{R}$

Find potential difference between P and P_0

Coaxial cables with conducting shells at a and b ($a < b$)

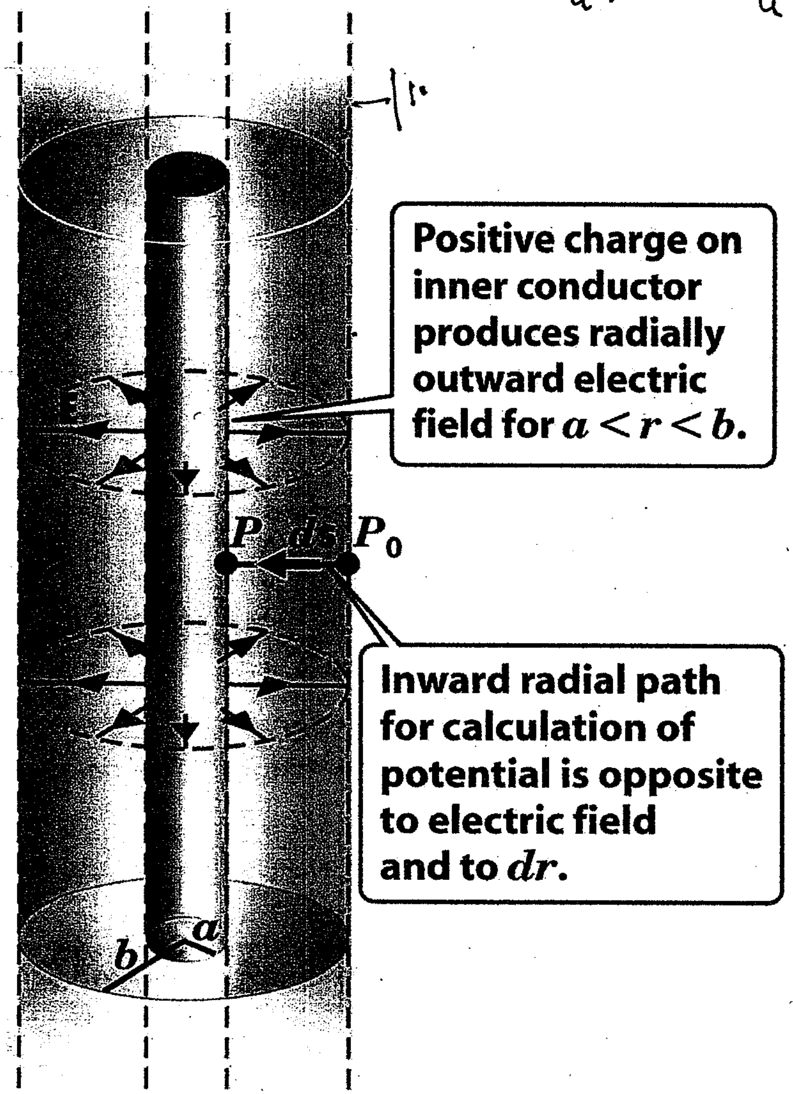


Figure 25-14 Physics for Engineers and Scientists 3/e

$$E_r = \frac{\lambda}{2\pi\epsilon_0 r}$$

$$\int_a^b dr\,E_r = \frac{\lambda}{2\pi\epsilon_0}\int_a^b \frac{dr}{r}$$

$$= \frac{\lambda}{2\pi\epsilon_0}\ln\left(\frac{b}{a}\right)$$

$$V = \frac{\lambda}{2\pi\epsilon_0}\ln\left(\frac{b}{a}\right)$$

Find Potential and electric field (new way)

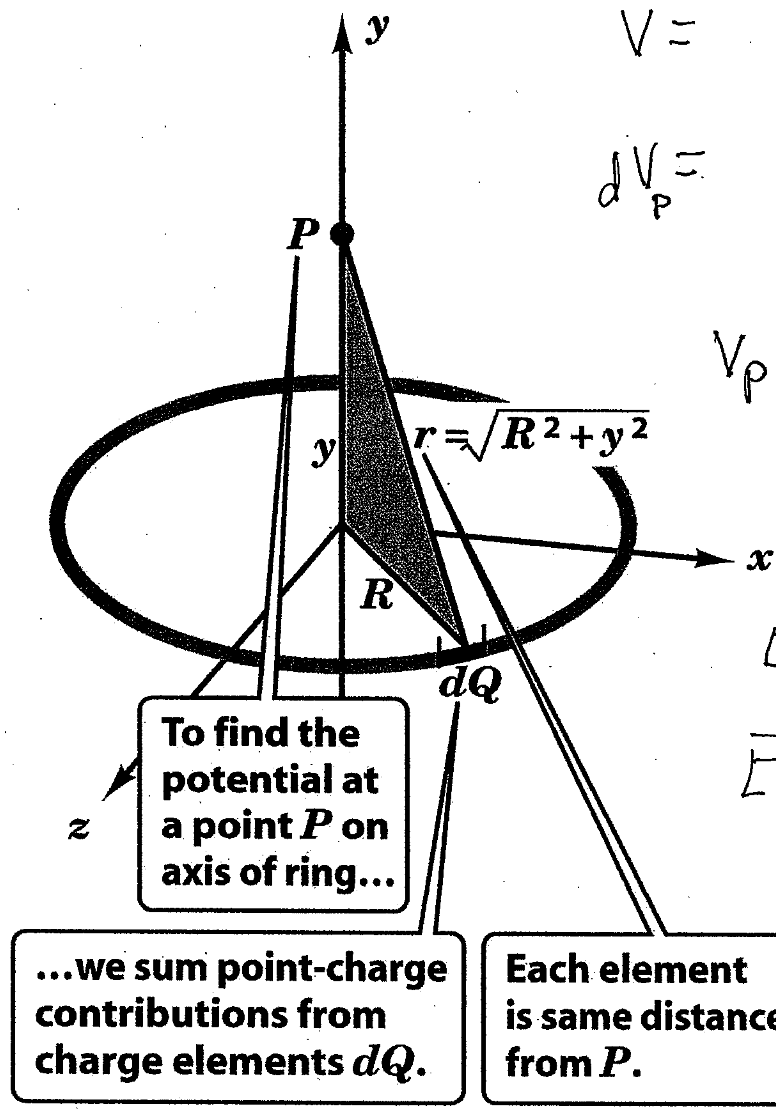


Figure 25-22 Physics for Engineers and Scientists 3/e

$$V = \int \frac{dq}{4\pi\epsilon_0} \frac{1}{|r|}$$

$$dV_p = \frac{dQ}{4\pi\epsilon_0} \frac{1}{|R^2+y^2|^{1/2}}$$

$$V_p = \frac{Q}{4\pi\epsilon_0} \frac{1}{[R^2+y^2]^{1/2}}$$

$$E_y = -\frac{dV}{dy}$$

$$E_y = \frac{Q}{4\pi\epsilon_0} \frac{y}{[R^2+y^2]^{3/2}}$$

How will the potential vary on each conductor?

a. Since there are many Conductors, the potential will vary on each conductor

b. Each conductor will have its unique constant potential ✓

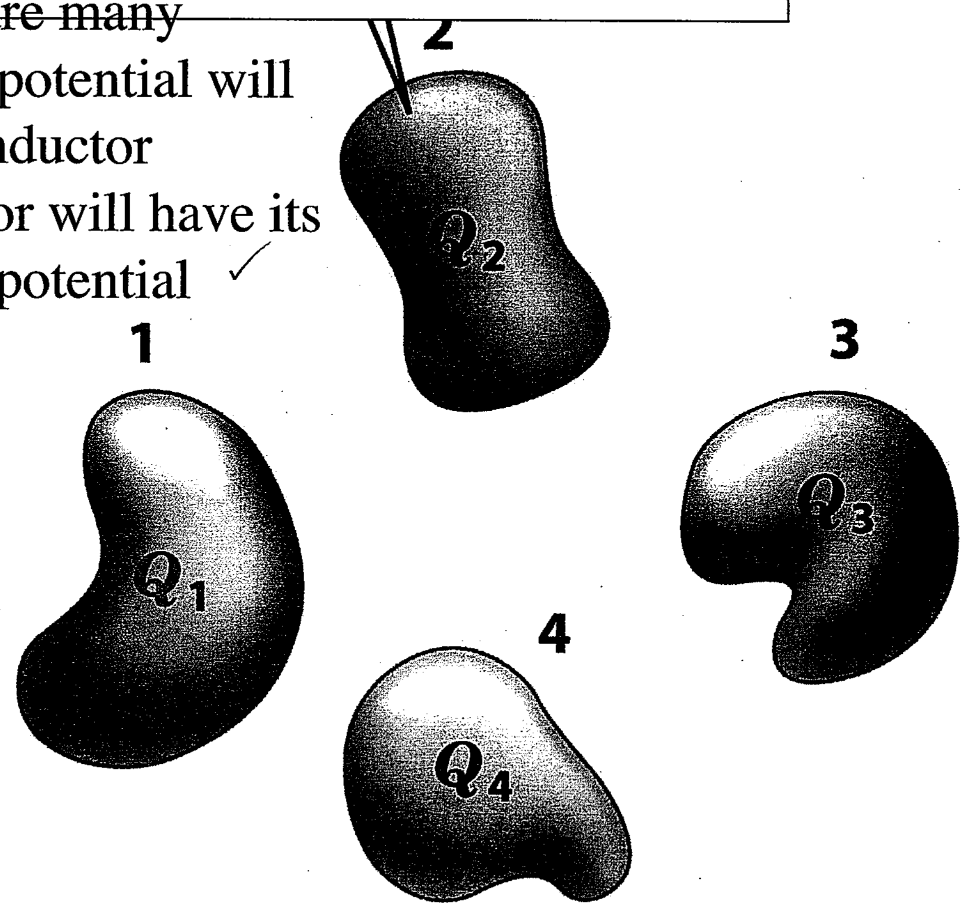


Figure 25-29 Physics for Engineers and Scientists 3/e