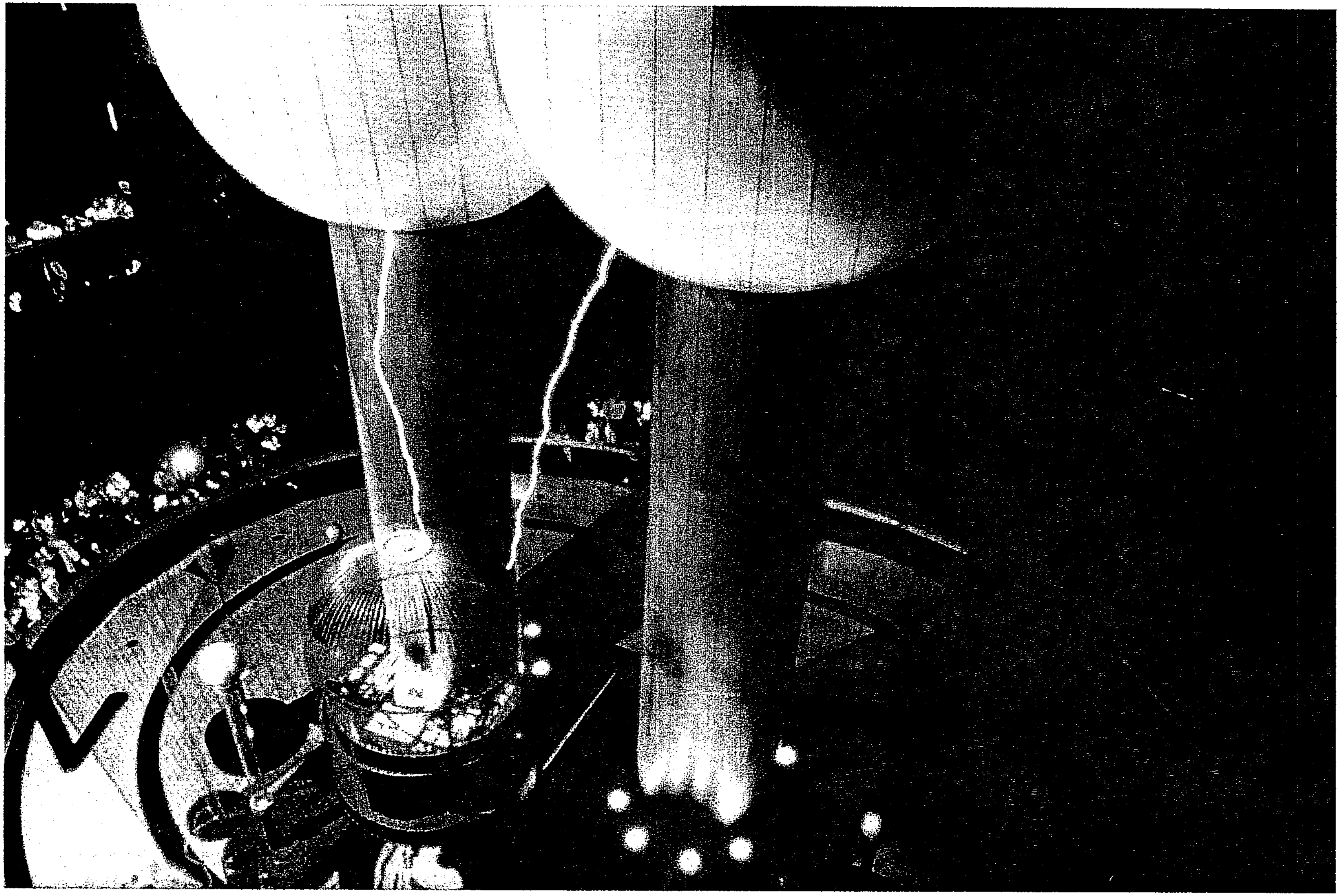
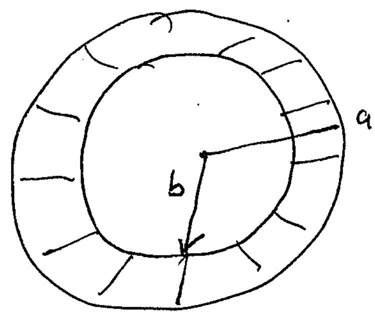
Lecture 5



Chapter 25 Opener Physics for Engineers and Scientists 3/e
Hank Morgan/Photo Researchers, Inc.

Surface Charges on a conductor

Sphere



Charge q_c on the conductor

How is this charge distributed?

(a) Uniformly throughout the conductor

(b) On both the outer and inner surfaces

(c) On only the inner surfaces

(d) On only the outer surfaces

CA

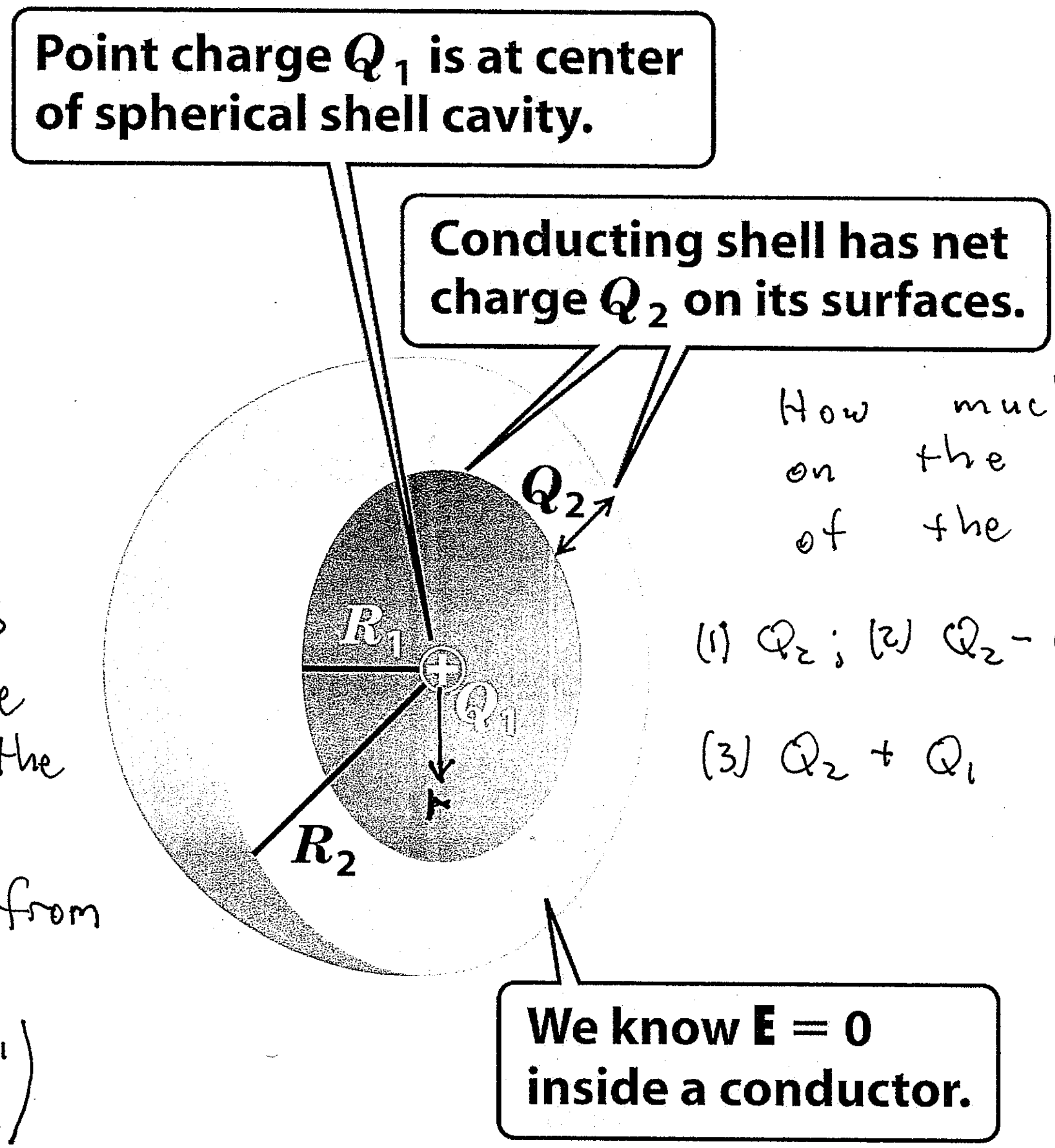


Figure 24-24 Physics for Engineers and Scientists 3/e

How much charge is on the outer surface of the conductor?

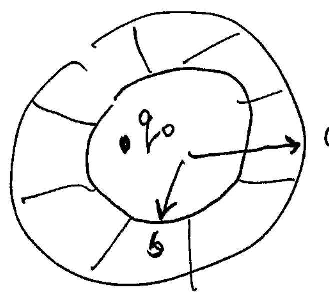
(1) Q_2; (2) $Q_2 - Q_1$;

(3) $Q_2 + Q_1$ (4) Indeterminate

What happens to the surface charge on the conductor if Q_1 moves from the center (with $r < R_1$ / with $r > R_1$)

How much charge on the inner shell of the conductor?

Which of the following is true if the charge q_0 is not at the center of the spherical conductor, which carries a total charge q_c.



charge q_c on conductor

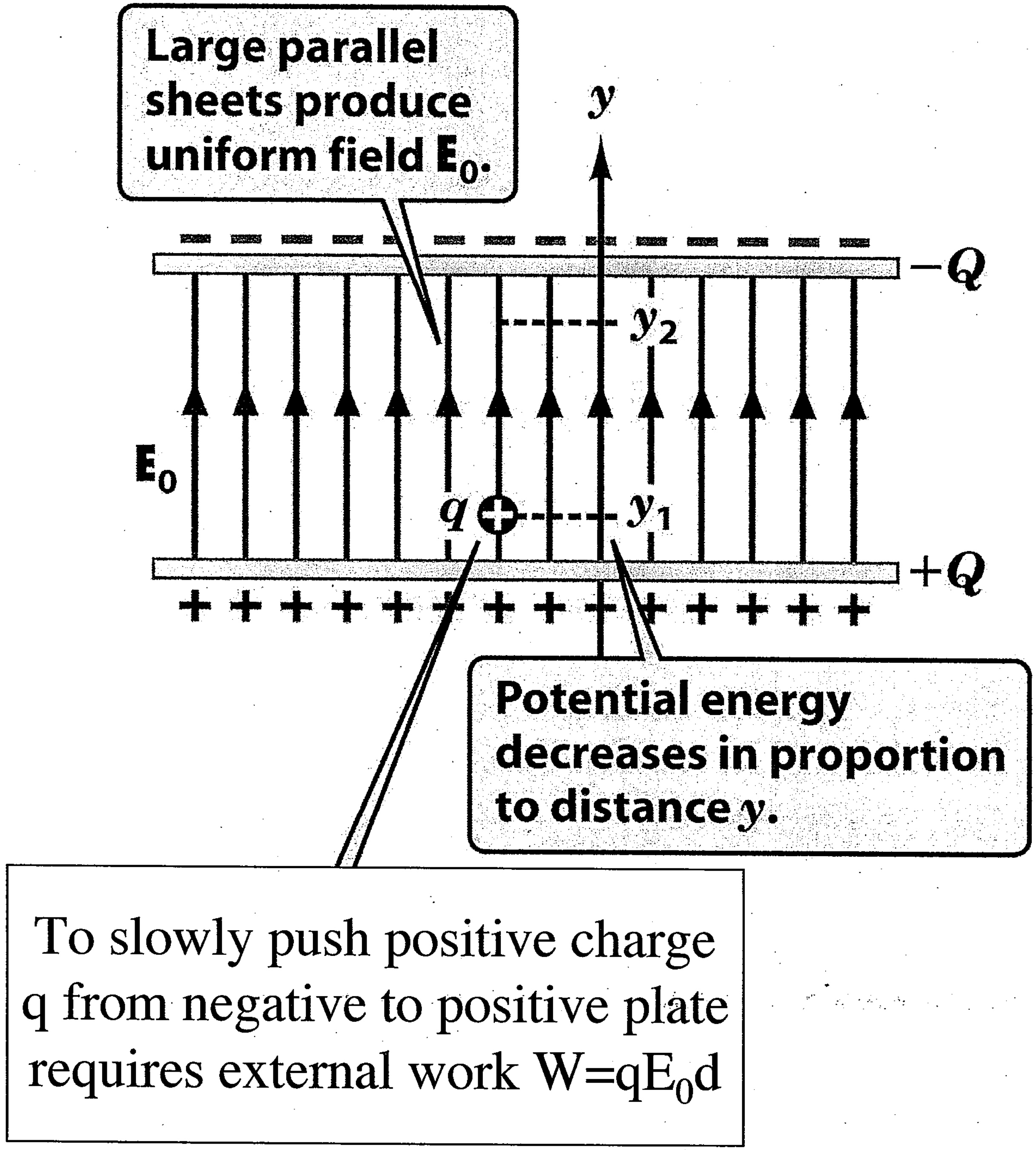
(a) The total charge on the inner surface of the conductor is $-q_0$

(b) The total charge on the outer conductor is $q_c + q_0$

(c) The surface charge density is not uniform on either surface of the conductor

(d) all of these

(e) none of these


Large parallel sheets produce uniform field $\mathbf{E}_0$.
y
$-Q$
y_2
$\mathbf{E}_0$
q
y_1
$+Q$
Potential energy decreases in proportion to distance y.
To slowly push positive charge q from negative to positive plate requires external work $W=qE_0d$

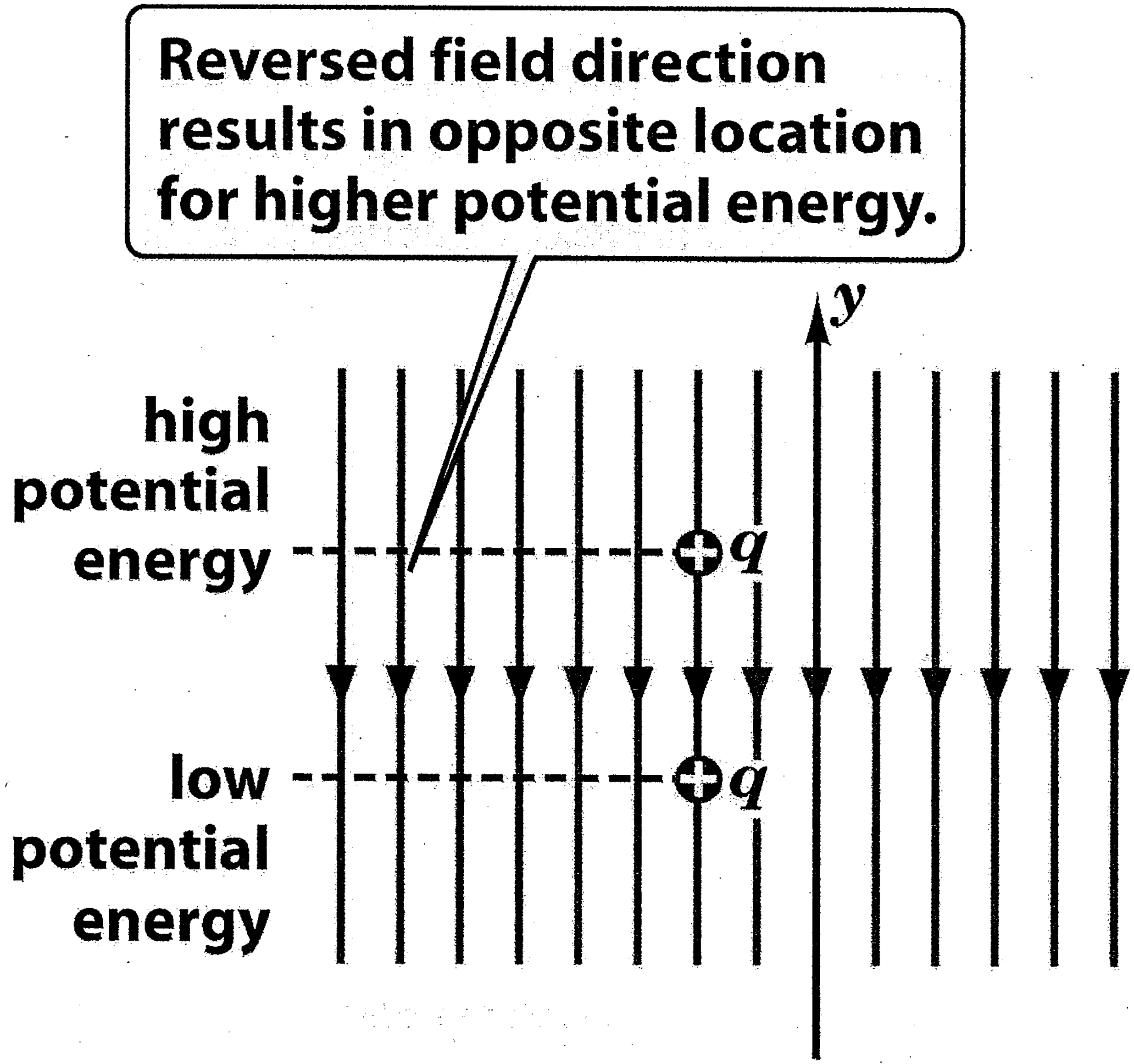


Figure 25-2b Physics for Engineers and Scientists 3/e

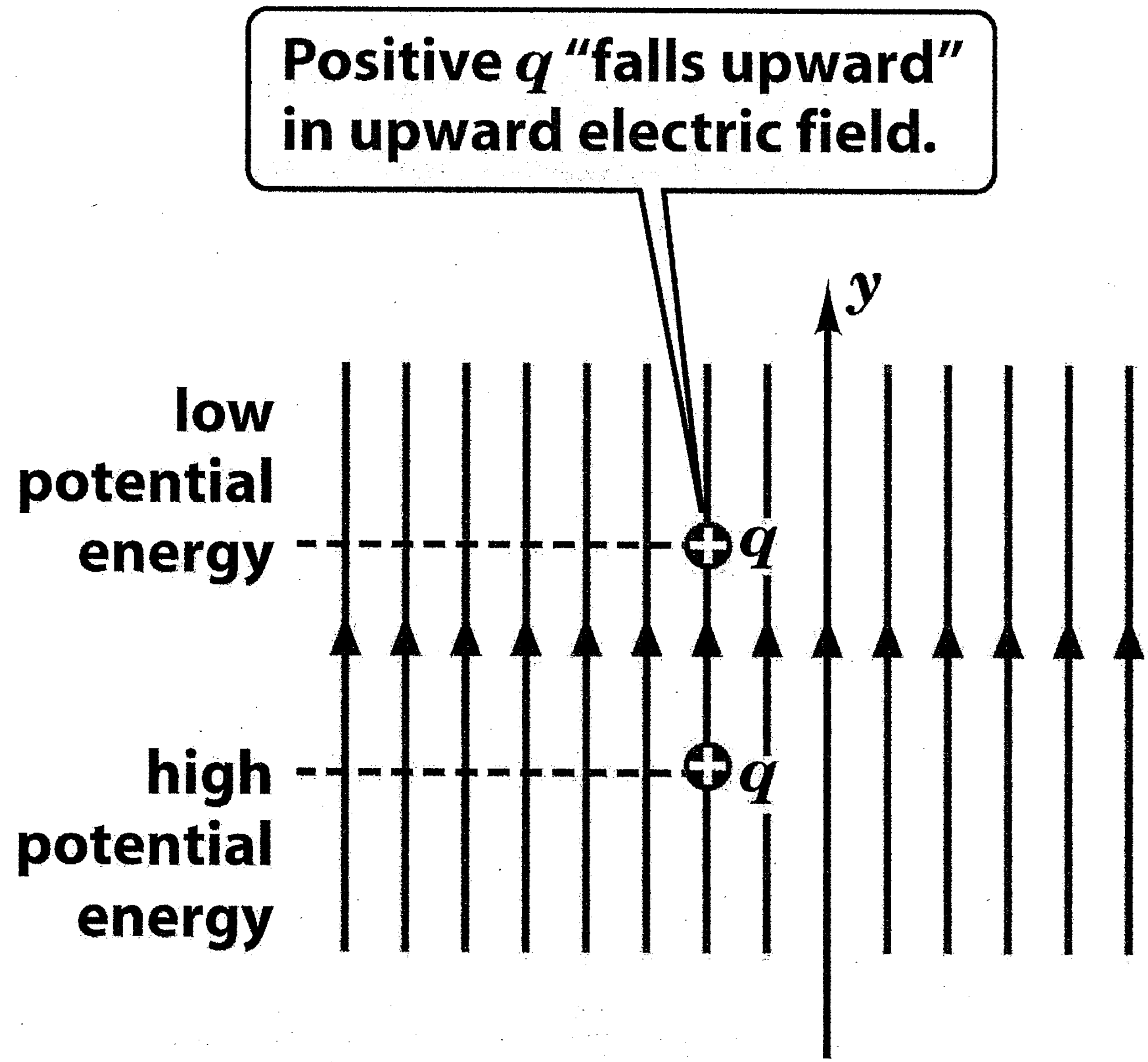


Figure 25-2a Physics for Engineers and Scientists 3/e

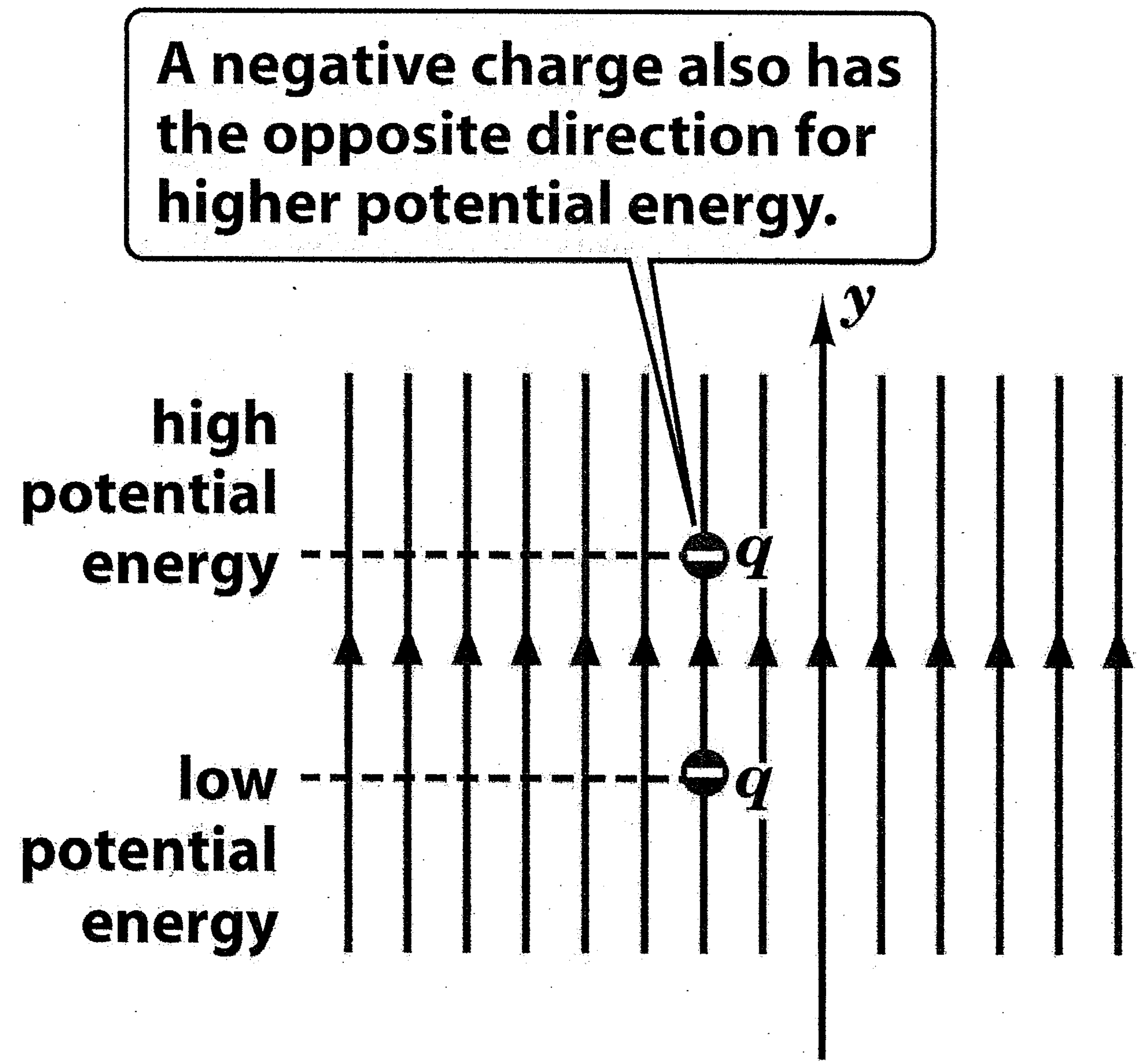


Figure 25-2c Physics for Engineers and Scientists 3/e

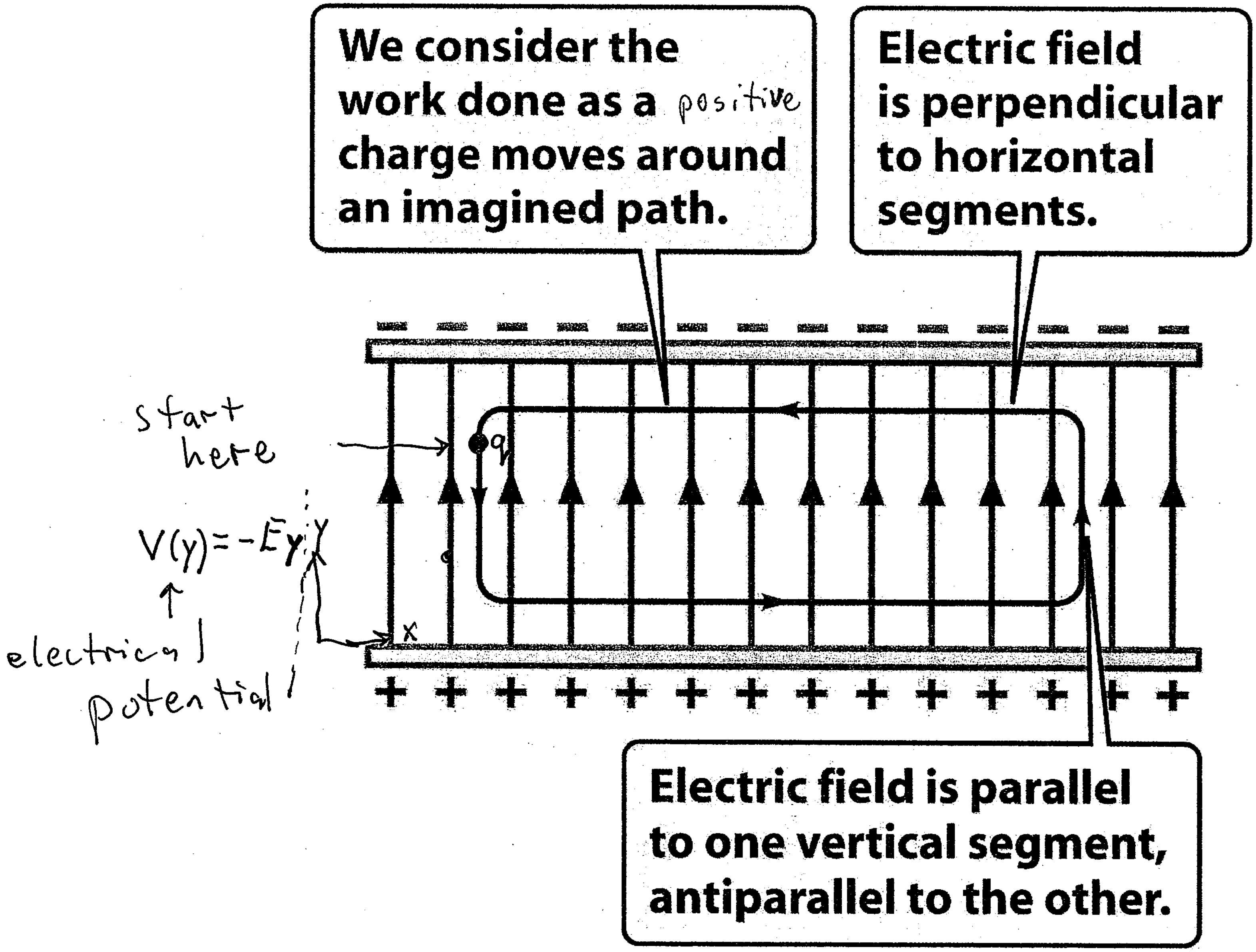


Figure 25-3a Physics for Engineers and Scientists 3/e

The work done on charge by ~~external~~ force to reach a point, is the potential energy of charge at that point.

The potential energy per unit charge is the electrical potential V, of that point

An apparent discrepancy

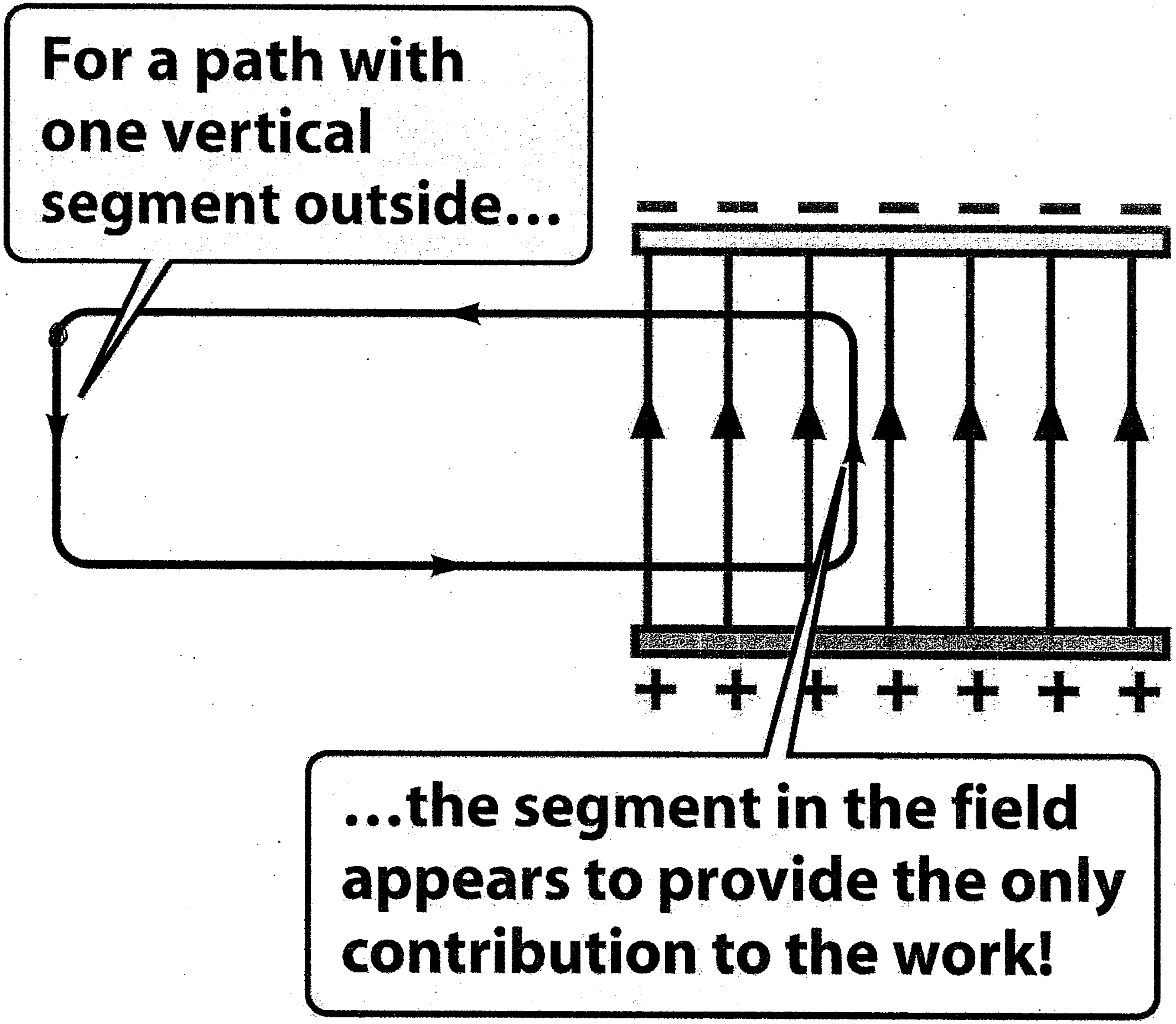


Figure 25-3b Physics for Engineers and Scientists 3/e

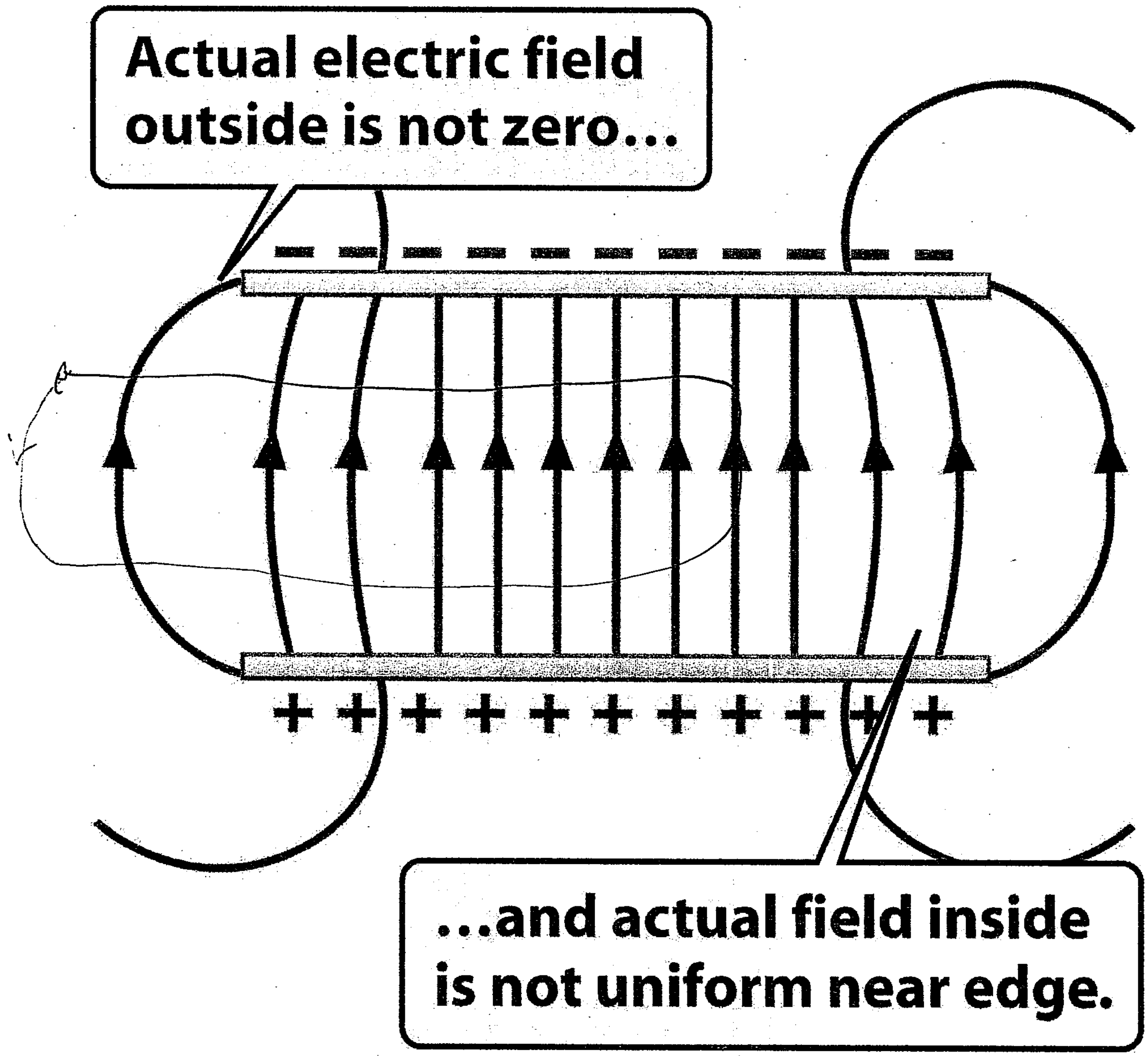
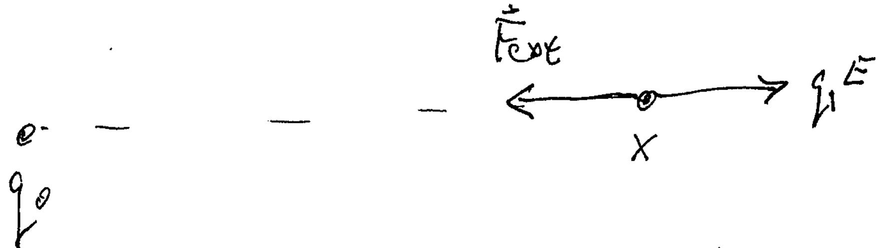


Figure 25-4 Physics for Engineers and Scientists 3/e

These stray fields allows the work to be done on a charge in a closed path to be zero (if there is no friction)

Derive external work done by on charge q_1, to bring from infinity to a distance x from charge q_0



$$\vec{F}_{ext} = -q_1\vec{E} = -q_1 \frac{k q_0}{x^2}\hat{x}$$

$$W = \int_\infty^x \vec{F}_{ext}(x')\cdot d\vec{x}' = -q_0 q_1 k \int_\infty^x \frac{dx'}{x'^2} = \frac{q_0 q_1 k}{x}$$

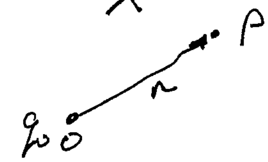
$$= -q_1 \int_\infty^x \vec{E}(x')dx'$$

The work done by the ~~pot~~ conservative external force, is the change of potential energy of particle 2

$$U(x) - U(\infty) = U(x) = q_0 q_1 k/x$$

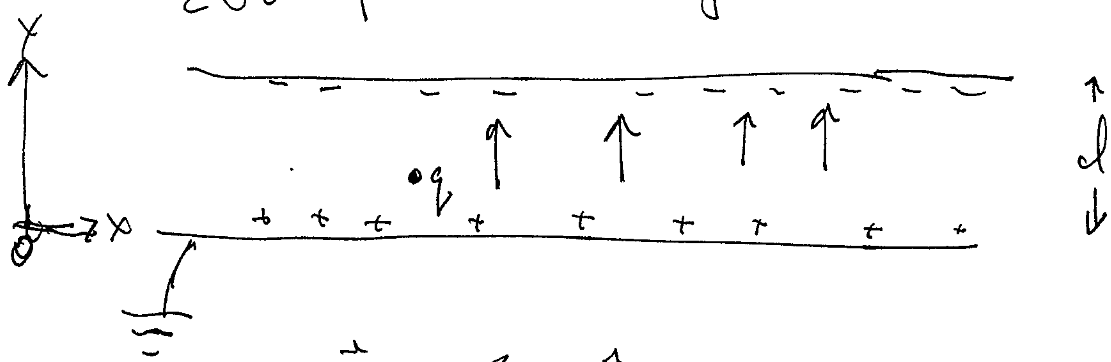
$$\text{Electric Potential} = \frac{\text{Potential Energy}}{q_1} = \frac{k q_0}{x}$$

More general $U(\vec{r}) = \frac{k q_0}{r}$



Potential across a capacitor plate

~~W~~ often one plate is consider zero potential (grounded



$$\vec{E} = \frac{\sigma}{\epsilon_0}\hat{y}$$

$$W = -q\int_0^y E\,dy$$

$$= -q\frac{\sigma}{\epsilon_0}\int_0^y dy = -\frac{q\sigma}{\epsilon_0}y = U(y)$$

Potential energy of charge (with respect to grounded positive plate)

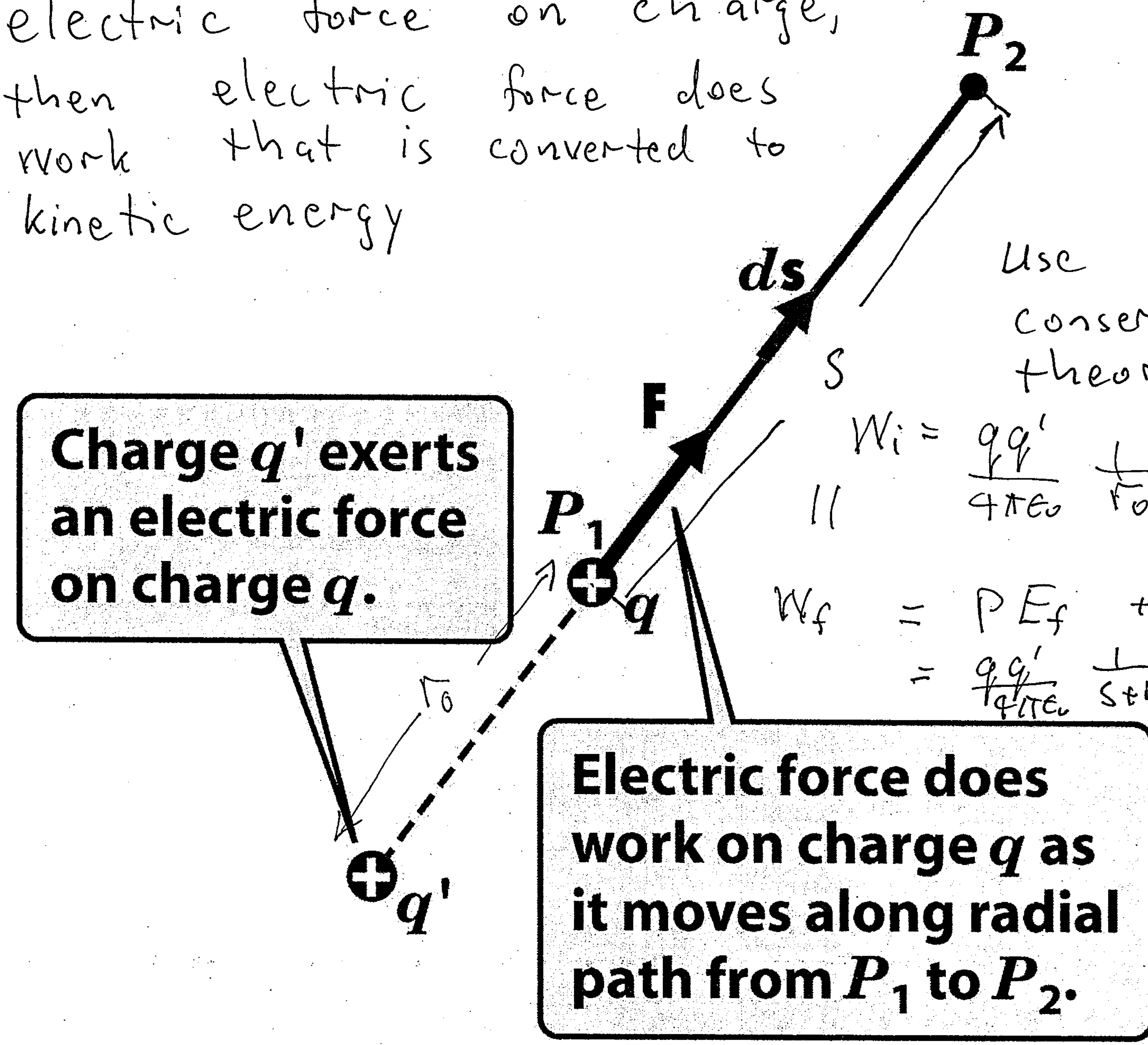
$$U(y) = -\frac{q\sigma}{\epsilon_0}y \equiv q\,V(y)$$

$$V(y) = -\frac{\sigma}{\epsilon_0}y$$

Potential of negative plate is

$$\boxed{V(d) = -\frac{\sigma}{\epsilon_0}d}$$

If there is only electric force on charge, then electric force does work that is converted to kinetic energy



Use energy conservation theorem

$W_i = \frac{qq'}{4\pi\epsilon_0}\frac{1}{r_0}$

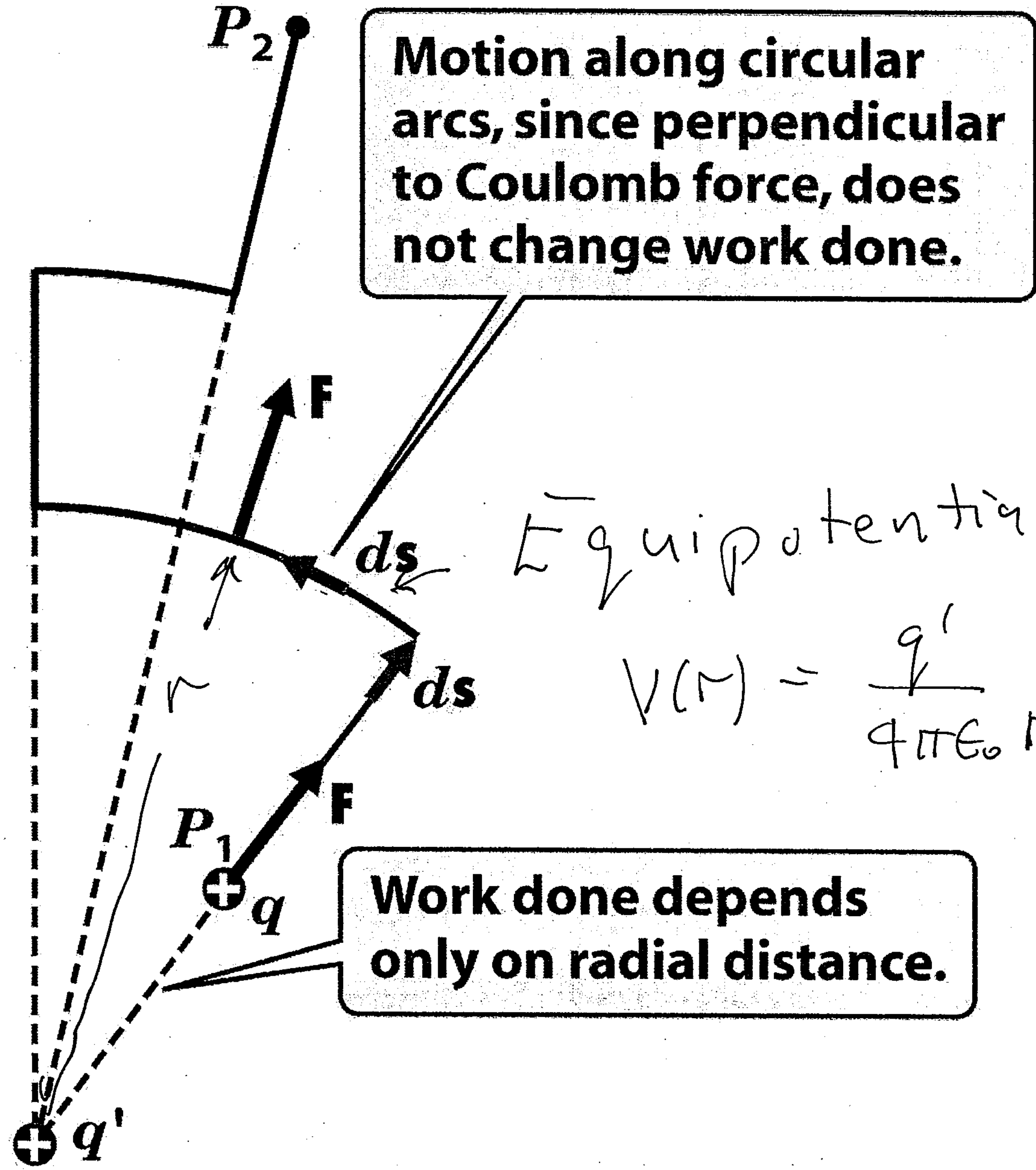
$\|$

$W_f = PE_f + KE_f$

$= \frac{qq'}{4\pi\epsilon_0}\frac{1}{s+r_0} + \frac{1}{2}mv^2$

Figure 25-6 Physics for Engineers and Scientists 3/e

$\frac{1}{2}mv^2 = \frac{qq'}{4\pi\epsilon_0}\left[\frac{1}{r_0} - \frac{1}{s+r_0}\right]$



Equipotential

$V(r) = \frac{q'}{4\pi\epsilon_0 r}$

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