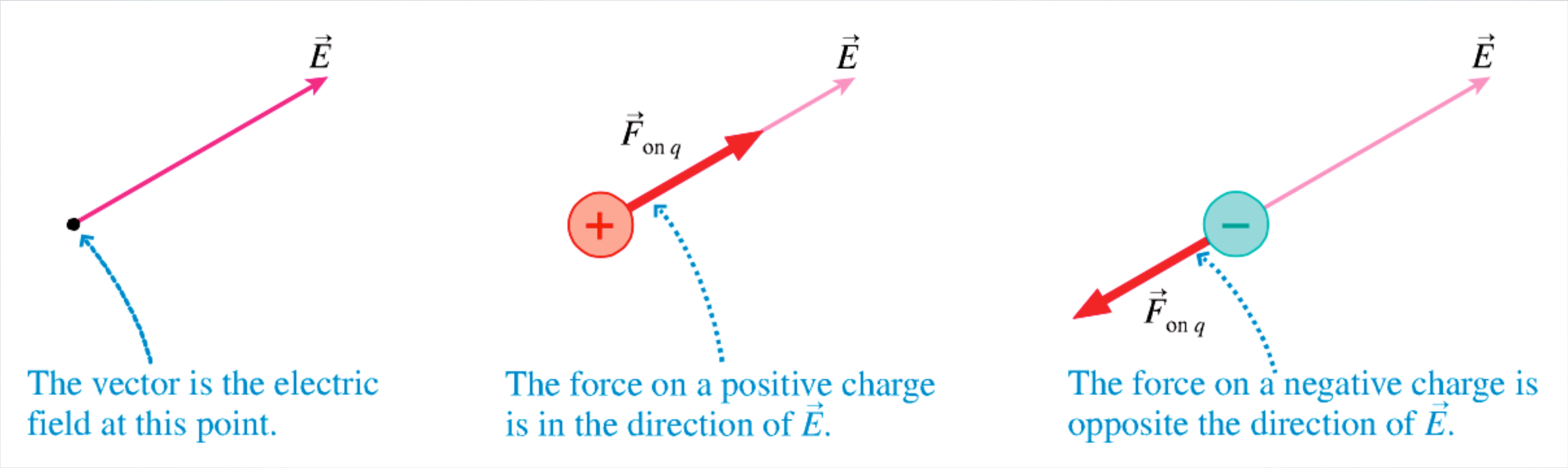
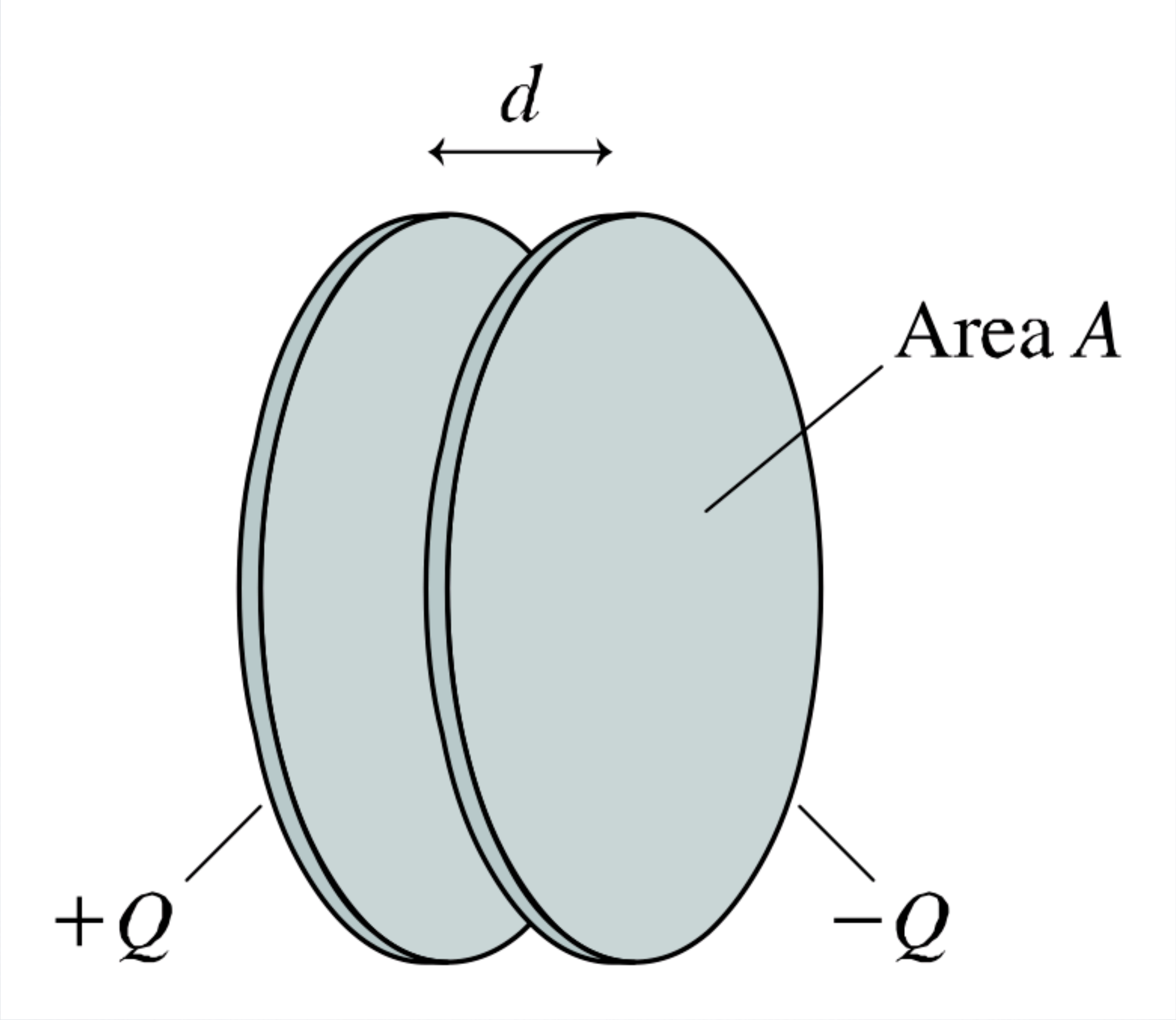
MOTION OF CHARGED PARTICLES IN A UNIFORM ELECTRIC FIELD

The electric field exerts a force on a charged particle.

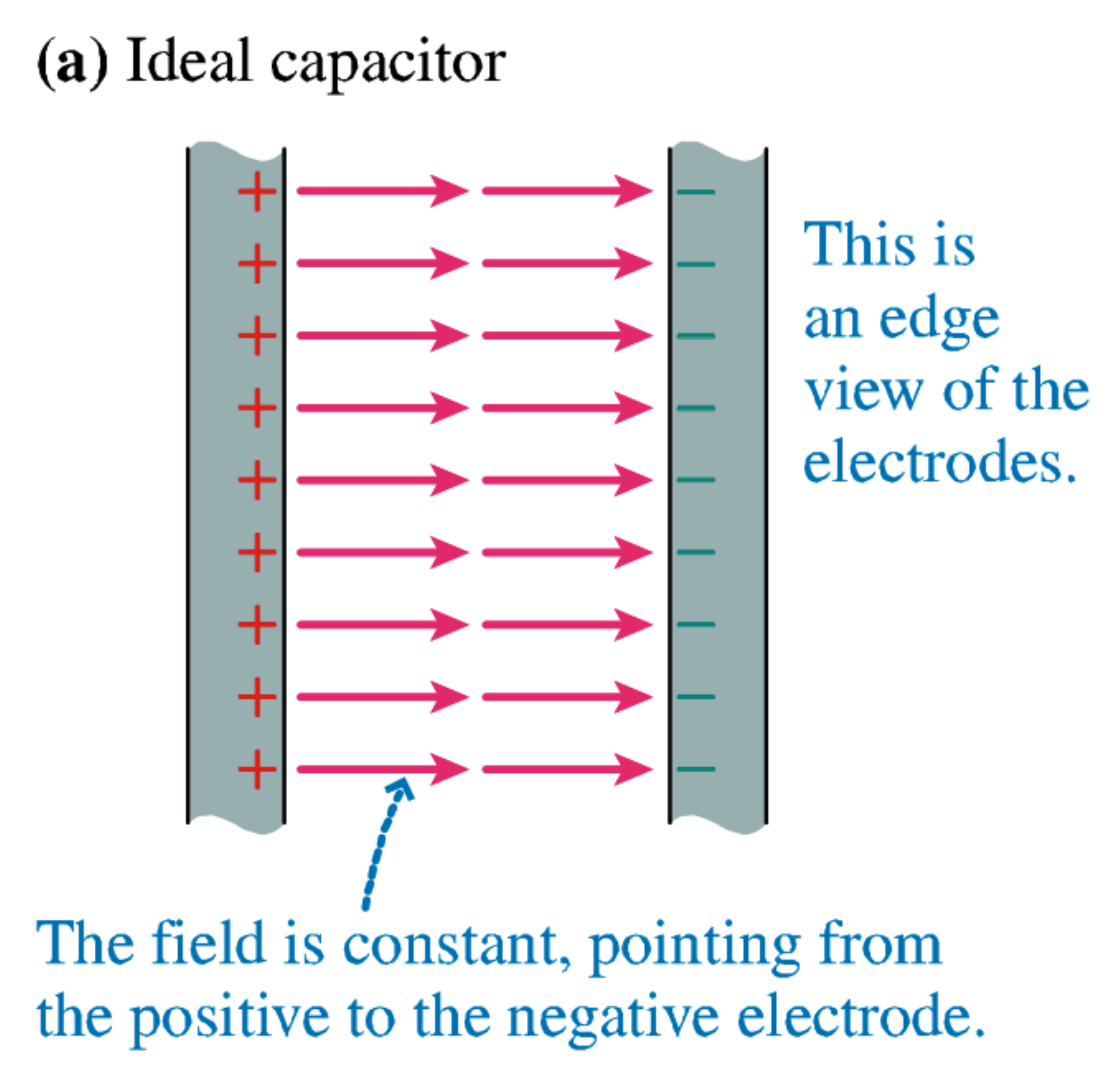


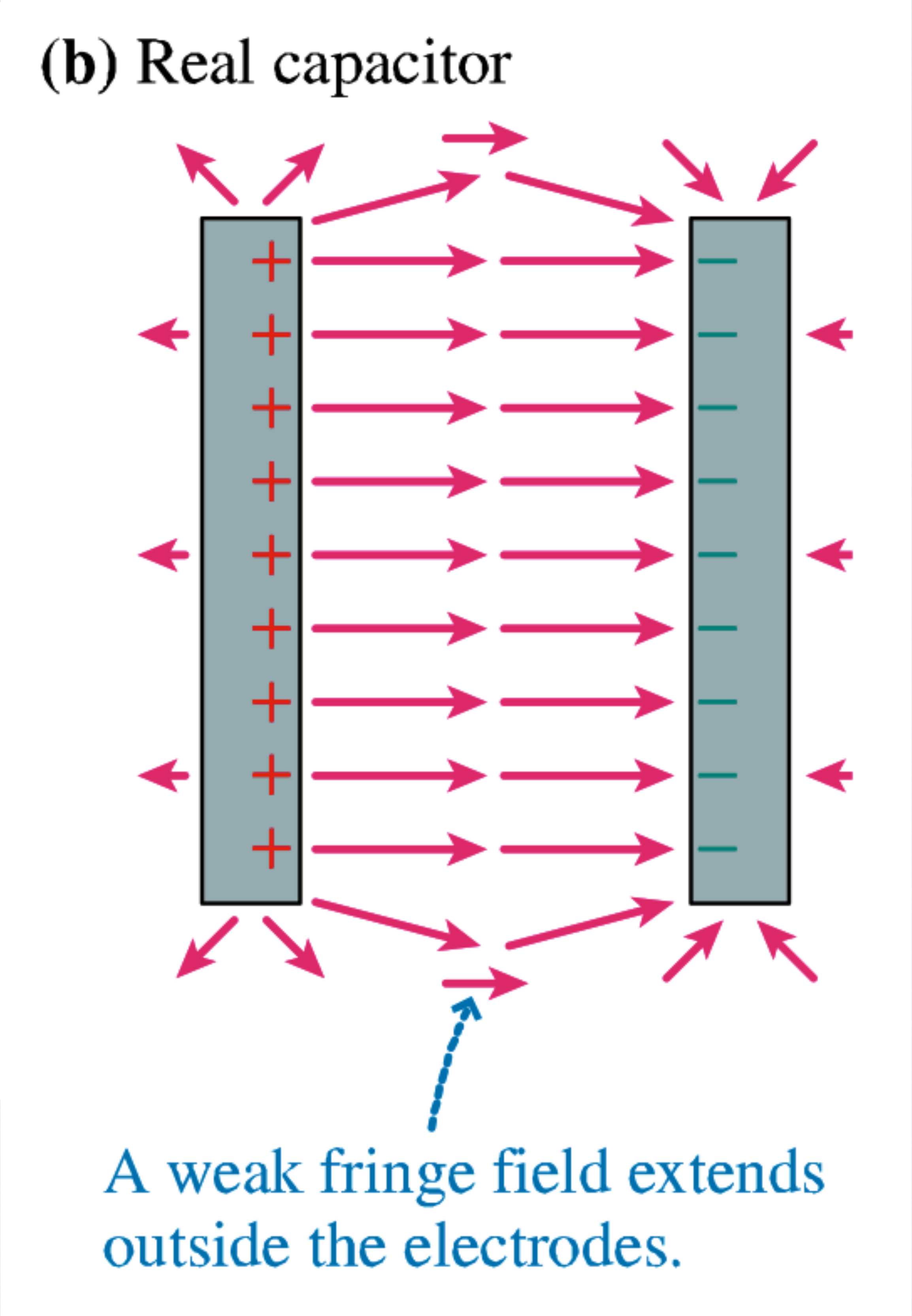
$$\mathbf{F}_{\text{on q}} = q\mathbf{E}$$

A parallel-plate capacitor.

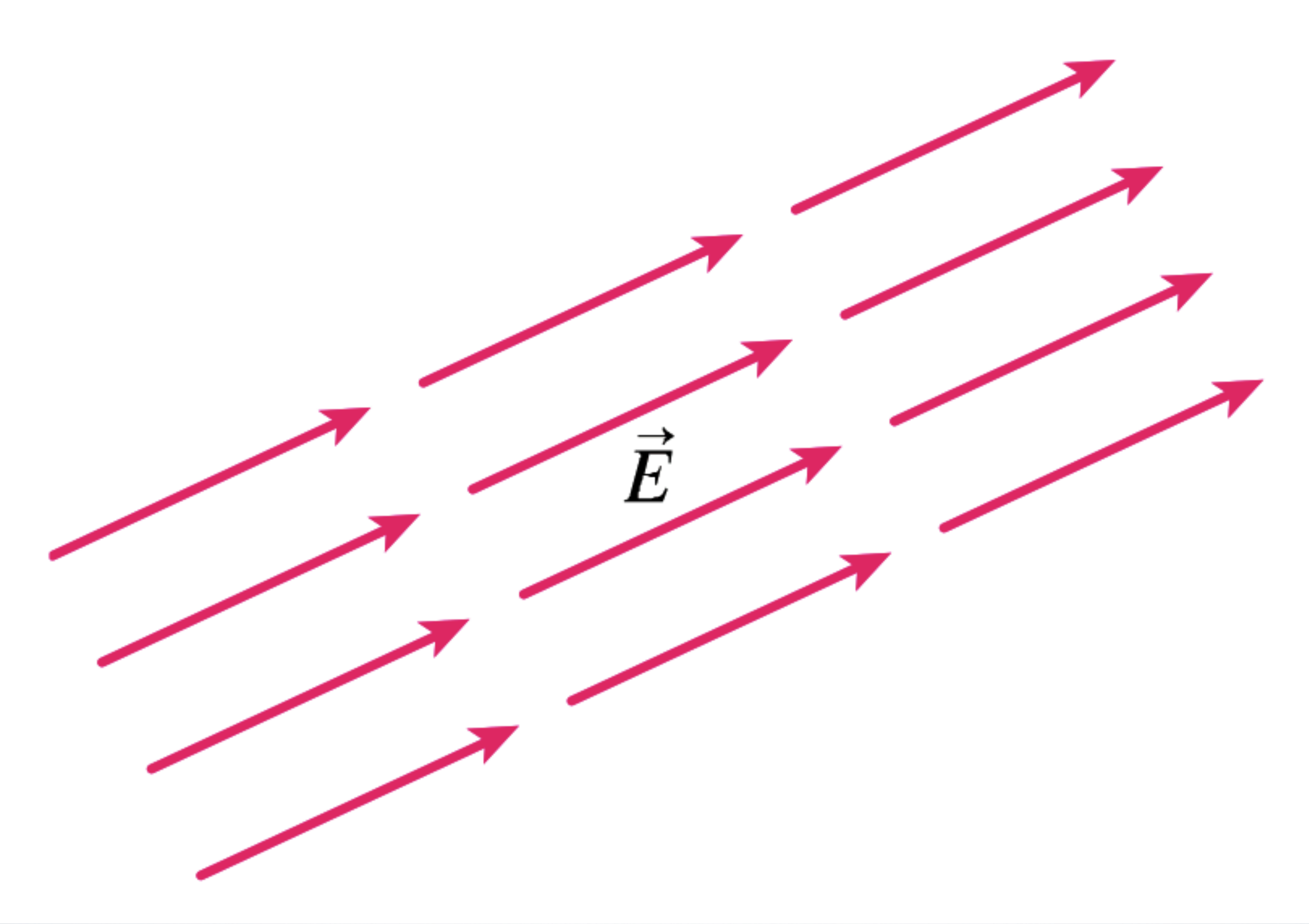


The electric field of a capacitor.



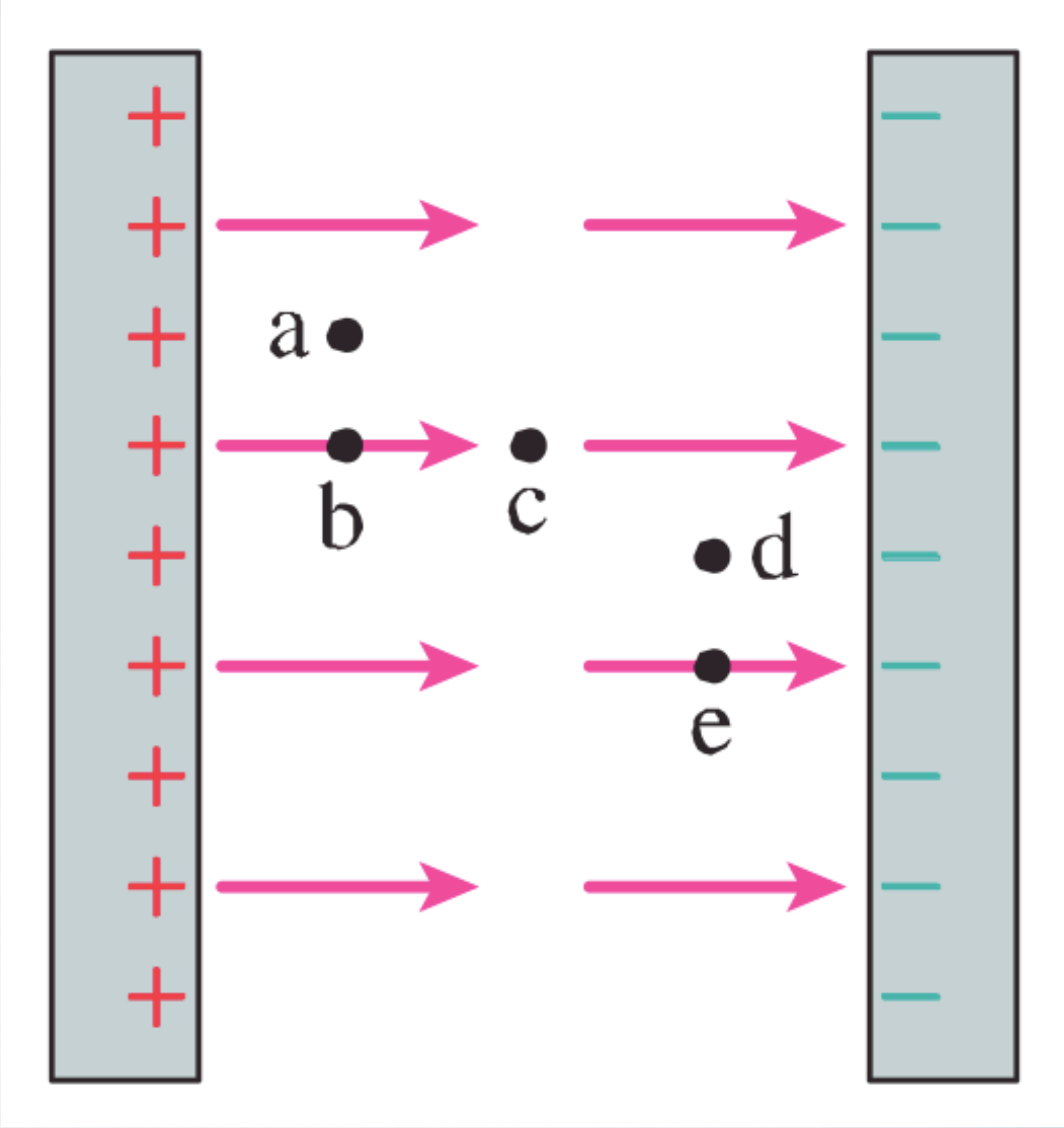


A uniform electric field.



Quick Quiz

Rank in order, from largest to smallest, the forces F_a to F_e a proton would experience if places at points a to e in this parallel-plate capacitor.

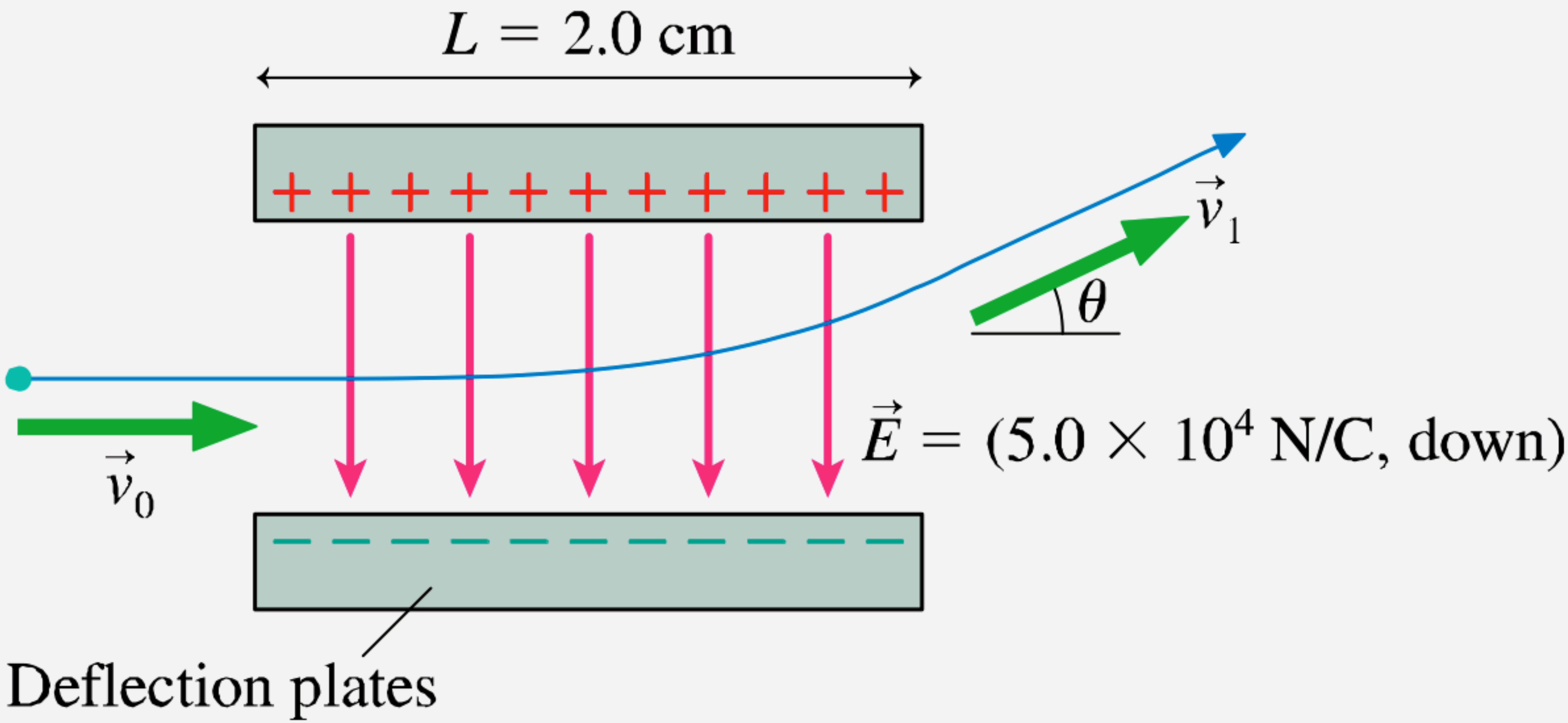


If $\mathbf{F}_{\text{on } q}$ is the only force acting on *q*, it causes the charged particle to accelerate with

$$\vec{a} = \frac{\vec{F}_{\text{on } q}}{m} = \frac{q}{m}\vec{E}$$

Exercise

An electron gun creates a beam of electrons moving horizontally with a speed of 3.3×10^7 m/s. The electrons enter a 2.0-cm-long gap between two parallel electrodes where the electric field is $\vec{E} = (5.0 \times 10^4 \text{ N/C, down})$. In which direction, and by what angle, is the electron beam deflected by these electrodes?



Homework

Serway P23.41, p. 737

An electron and a proton are each placed at rest in an electric field of 520 N/C. Calculate the speed of each particle 48.0 ns after being released.

Serway P23.43, p. 737

A proton accelerates from rest in a uniform electric field of 640 N/C. At some later time, its speed has reached 1.20×10^6 m/s (nonrelativistic, since *v* is much less than the speed of light). (a) Find the acceleration of the proton. (b) How long does it take the proton to reach this speed? (c) How far has it moved in this time? (d) What is its kinetic energy at this time?

Serway P23.47, p. 737

A proton moves at 4.50×10^5 m/s in the horizontal direction. It enters a uniform vertical electric field with a magnitude of 9.60×10^3 N/C. Ignoring any gravitational effects, find (a) the time it takes the proton to travel 5.00 cm horizontally, (b) its vertical displacement after it has traveled 5.00 cm horizontally, and (c) the horizontal and vertical components of its velocity after it has traveled 5.00 cm horizontally.