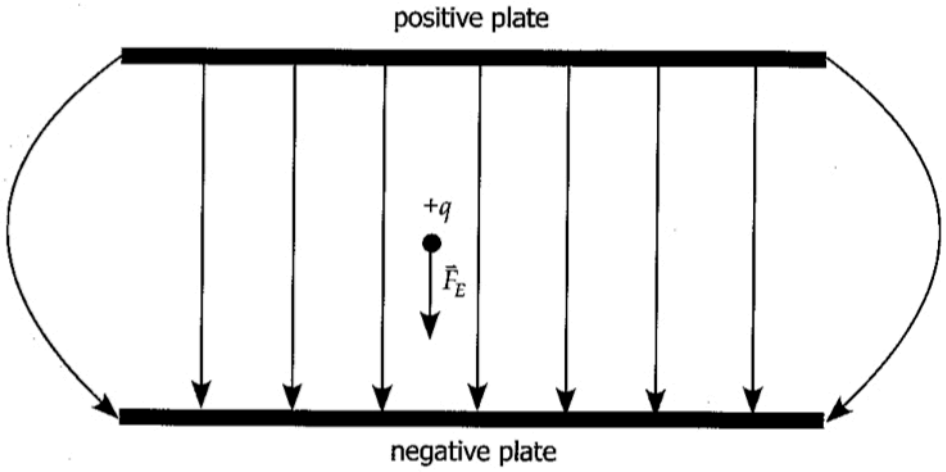
The Parallel Plate Apparatus

Recall

The electric field between two charged parallel plates points away from the positive plate towards the negative plate. There is a slight bulge at the edges of the plates.



In the region between the plates, the electric field lines are parallel and evenly spaced, indicating that the field has a uniform magnitude and direction throughout.

A positive charge placed between the plates will experience a force in the same direction as the field lines. A negative charge will experience a force in a direction opposite to the field lines.

The amount of electric force on the charged particle can be determined by

$$F_E = q \cdot E$$

If the electric field is horizontal, then we can disregard gravity. In such cases,

$$\sum F = F_E$$

If, however, the electric field is vertical, then we cannot ignore gravity. In this case,

$$\sum \vec{F} = \vec{F_E} + \vec{F_g}$$

Example 1

A particle of mass $m = 4.00 \times 10^{-4}\ kg$ and charge $q = +2.00\ C$ is placed between charged parallel plates. If the electric field strength between the plates is $10.0\ N/C\ [right]$ calculate the acceleration of the particle.

Example 2

An electron ($m = 9.11 \times 10^{-31}\ kg$, $q = 1.6 \times 10^{-19}\ C$) moving at $400 m/s\ [E]$ enters a uniform electric field. It leaves the electric field $5.0\ s$ later, traveling at $950\ m/s\ [E]$. Determine the magnitude and direction of the electric field.

Electric Fields Worksheet #3

1. An electron (charge -1.6×10^{-19} C and mass 9.1×10^{-31} kg) is injected into a region of uniform electric field of magnitude 1.0×10^{5} N/C [right]. What is the acceleration of the electron? (1.8×10^{16} m/s^2 [left])

2. What is the magnitude of the acceleration of an electron in a 3500 N/C electric field? (6.15×10^{14} m/s^2)

3. What is the magnitude of the electric field at a point in space where a proton (charge $+1.6\times10^{-19}$ C and mass 1.67×10^{-27} kg) experiences an acceleration of 9.8×10^{4} m/s^2? (1.02×10^{-3} N/C)

4. A proton accelerates from rest to 3.00×10^{6} m/s in 1.00×10^{-6} s in a uniform electric field. What is the magnitude of the electric field? (3.13×10^{4} N/C)

5. A small object has a mass of 2.0×10^{-3} kg and a charge of $-25\ \mu$C. It is placed at a certain spot where there is an electric field. When released, the object experiences an acceleration of 3.5×10^{3} m/s^2 to the right. Determine the magnitude and direction of the electric field. (2.8×10^{5} N/C [left])

6. A particle of mass 3.8×10^{-5} kg and charge $+12\ \mu$C is released from rest in a region where there is a constant electric field of 480 N/C. How long does it take the particle to travel 0.020 m? (1.62×10^{-2} s)

7. An electron with initial velocity 2.4×10^{6} m/s is traveling parallel to (in the same direction as) an electric field of magnitude 8.4×10^{3} N/C. How far will it travel before it stops? (1.95×10^{-3} m)