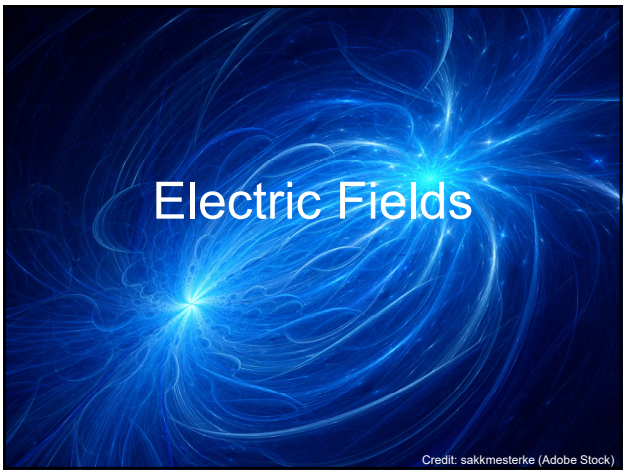
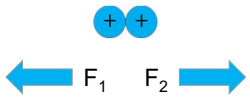



- A force exists between two charged objects.
  - Like charges repel




  - Unlike charges attract


- A **field** is a way of conceptualizing and mapping the force that surrounds any object and acts on another object at a distance without apparent physical connection.
  - The gravitational field surrounding Earth and all other masses represents the gravitational force that would be experienced if another mass were placed at a given point within the field.

- Michael Faraday (English) proposed the concept of an **electric field**.
- If you know the electric field, then you can easily calculate the force (magnitude and direction) applied to any electric charge that you place in the field.

Henry Williams Picker (after)
Wellcome Collection
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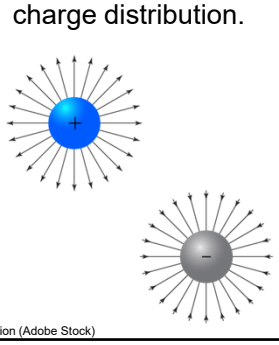
- An electric field is generated by electric charge and tells us the force per unit charge at all locations in space around a charge distribution.



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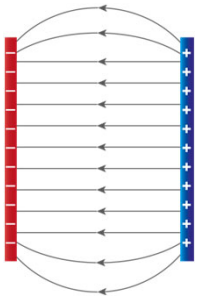

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- The electric field extends into space around the charge distribution.
- The electric field exerts a force on a test charge in a given direction.
  - A test charge is a positive electric charge whose charge is so small that it does not significantly disturb the charges that create the electric field.
- The force exerted is proportional to the charge of the test charge.

- Mathematically, saying that electric field is the force per unit charge is written as

$$E = \frac{F}{q}$$

Units: N/C
(Newtons/Coulomb)

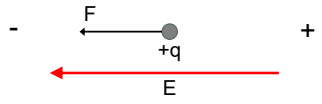
- The electric field is a vector field that points in the same direction as the force on a positive test charge.

## Example

- A $+3.2 \times 10^{-8}$ C charge is placed in an electric field. The charge experiences a 0.5 N force to the left. What is the magnitude and direction of the electric field?

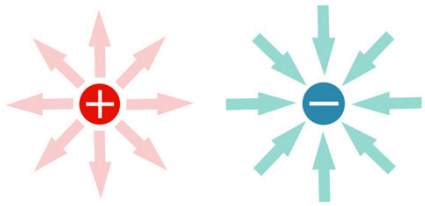
$$E = \frac{F}{q}$$

$$E = \frac{0.5}{3.2 \times 10^{-8}} = 1.6 \times 10^{7}\ \text{N/C}$$



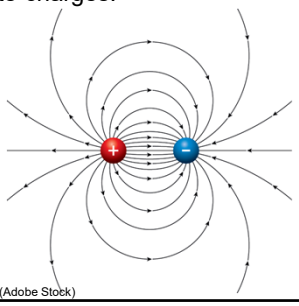

$E = 1.6 \times 10^{7}$ N/C left

- A **positive** charge creates an electric field that is directed radially **out of** the charge.
- A **negative** charge creates an electric field that is directed radially **into** the charge.



Credit: Oksana Zjigulenkova (Adobe Stock)

- For more complex structures the lines representing the direction of the electric field may be curved.
  - The electric field surrounding two equal and opposite charges.



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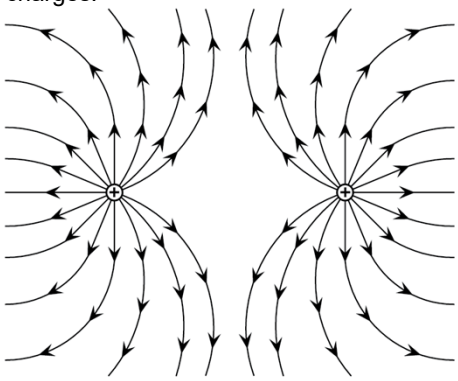
  - The electric field surrounding two positive charges.



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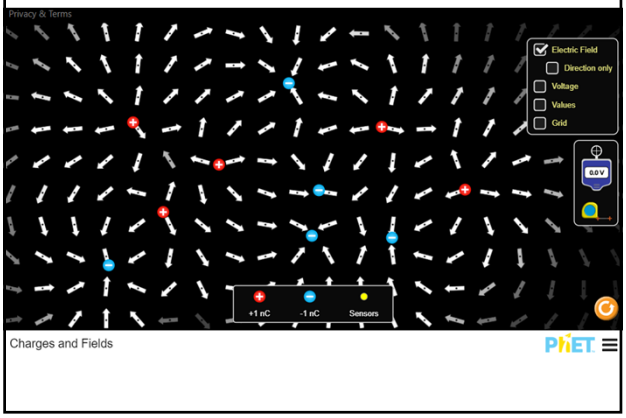
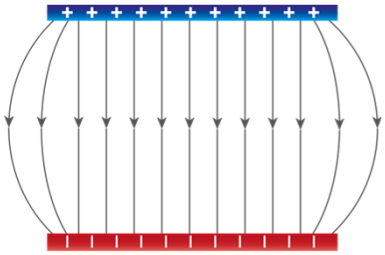



- A uniform electric field has constant magnitude and direction.
  - This type of field is produced by parallel plates of opposite charge.

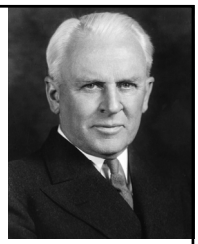


  - The field will not be uniform at the edges.

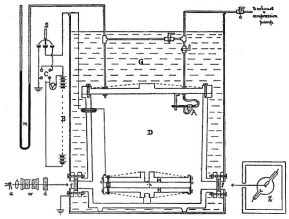
koray (Adobe Stock)

- Robert Millikan (American) 1909, determined the charge on the electron.
  - Referred to as the elementary charge.

$$e = 1.6 \times 10^{-19}\text{C}$$



Unknown (public domain)



Mikkikan (public domain)

Unknown (public domain)

## Example

What is the charge on a particle that contains 200 excess electrons?

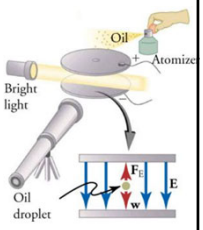
1 electron has a charge of $1.6 \times 10^{-19}$ C, so a particle with 200 excess electrons would have a charge of $200(1.6 \times 10^{-19}) = 3.2 \times 10^{-17}$ C.

## Example

A 0.2 g negatively charged oil drop is suspended between two charged plates as shown. The electric field between the plates is 0.5 N/C.

a) What is the charge on the oil drop?

b) How many excess electrons are on the oil drop?






a) $F_E$ / $F_g$

$$\Sigma F = ma$$
$$F_E - F_g = ma = 0$$
$$F_E = F_g$$
$$qE = mg$$
$$q = \frac{mg}{E}$$
$$q = \frac{(0.2 \times 10^{-3})(9.8)}{(0.5)} = 3.9 \times 10^{-3}\ \text{C}$$

b) $1\ e^- = 1.6 \times 10^{-19}\ C$

$x\ e^- = 3.9 \times 10^{-3}\ C$

$x = 2.4 \times 10^{16}$