Electric Fields

12PHYS - Electricity

Finn LeSueur

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Starter

1. If a balloon has charge of $-3C$: did the balloon lose or gain electrons, and how many?
2. If Charlotte has charge of $0.2C$ did she lose or gain electrons and how many?

Starter: Answer

1. If a balloon has charge of $-3C$: did the balloon lose or gain electrons, and how many?

Negative C means electrons are gained (negative charge)

$num_e = 3 \times (6.25 \times 10^{18})$

$num_e = 1.875 \times 10^{19}$ electrons gained

2. If Charlotte has charge of $0.2C$ did she lose or gain electrons and how many?

Positive C means electrons are lost (positive charge)

$num_e = 0.2 \times (6.25 \times 10^{18})$

$num_e = 1.25 \times 10^{18}$ electrons lost

Electric Fields

A field is an area of influence.

An electric field is an area of influence in which a charged object will feel a force due to the object being electrically charged.

A field can exist in a vacuum or inside an substance.

E.g. An electric field exists in the space around a Van der Graaf generator.

Electric Fields Continued

Fields are **invisible** but we can use a series of lines to visually *represent* them. It is worth noting that a field is continuous and that lines only represent certain areas.

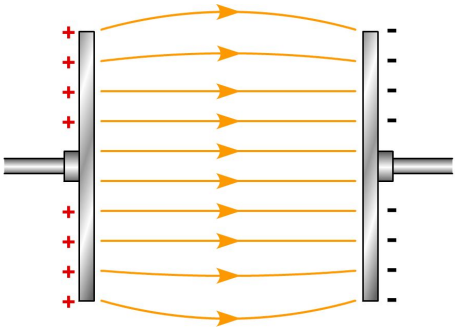

Figure 1: Electric Field

In a **uniform** field, force is felt in the direction of the field. In a curved field, force is felt at tangent to the field lines.

- Field lines never cross one-another
- The closer the field lines are together, the stronger the field
- Field lines originate and end at right angles to charged areas.

Electric Fields & Forces

Electric fields exert a force on charged objects & particles.

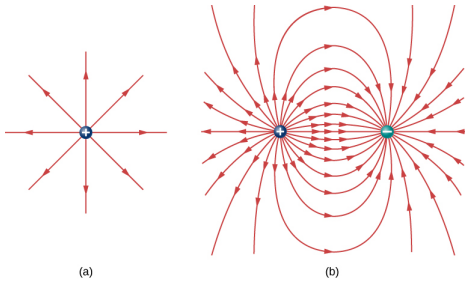

Figure 2: Electric Field

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

Question 1

A small charge of $2 \times 10^{-4}C$ experiences a force of $1.5 \times 10^{-4}N$. Calculate the electric field strength.

Question 1: Answer

A small charge of $2 \times 10^{-4}C$ experiences a force of $1.5 \times 10^{-4}N$. Calculate the electric field strength.

$$\vec{E} = \frac{\vec{F}}{q}$$
$$\vec{E} = \frac{1.5 \times 10^{-4}}{2 \times 10^{-4}}$$
$$\vec{E} = 0.75NC^{-1}$$

Electric Potential Energy

Electric potential energy is akin to gravitational potential energy. Moving a charged particle against the direction of the field is similar to lifting an object up in a gravitational potential field.

Gravity Field:

$$W = F \times d$$
$$W = mg \times h$$
$$W = mgh \qquad \text{gravitational potential energy}$$

Electric Field:

$$W = F \times d$$
$$W = Eq \times d \qquad W = Eqd \qquad \text{electric potential energy}$$
$$E_p = Eqd$$

Starter

An object with charge $25 \times 10^{-6} C$ is placed in an electric field with strength $3000 NC^{-1}$.

1. Define *electric field*
2. Calculate the force experienced by the object inside the electric field
3. In the object moves **against** the force by 2m, does it gain or lose electric potential energy? And how much?

Electric Fields & Parallel Plates

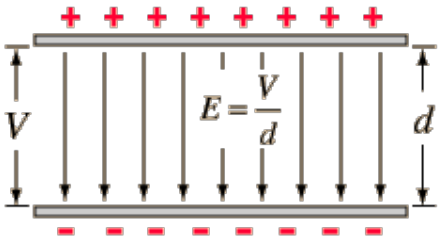

Figure 3: Parallel Plates

- Field goes from **positive** to **negative**
- Exits the positive plate at a right angle
- Enters the negative plate at a right angle

What is voltage?

Voltage of a Field

The electric potential energy stored **per unit charge**. The amount of energy in one coulomb of charge.

$$V = \frac{E_p}{q}$$

Voltage between Plates

We can also calculate the electric field strength between two plates.

$$E = \frac{V}{d}$$

$E =$ electric field strength

$V =$ voltage applied on the two plates

$d =$ distance between the two plates

Question

An object with charge $-4\mu C$ is placed between two charged plates $2cm$ apart with a potential difference of $500V$.

1. Calculate the **electric field strength** between the two charged plates
2. Calculate the size of the force experienced by the charged object

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Question: Answer

An object with charge $-4\mu C$ is placed between two charged plates $2cm$ apart with a potential difference of $500V$.

1. Calculate the **electric field strength** between the two charged plates

$$\vec{E} = \frac{\vec{V}}{d}$$
$$\vec{E} = \frac{500}{0.02}$$
$$\vec{E} = 25000NC^{-1}$$

2. Calculate the size of the force experienced by the charged object

$$\vec{F} = \vec{E}q$$
$$\vec{F} = 25000 \times -4 \times 10^{-6}$$
$$\vec{F} = -0.1N$$