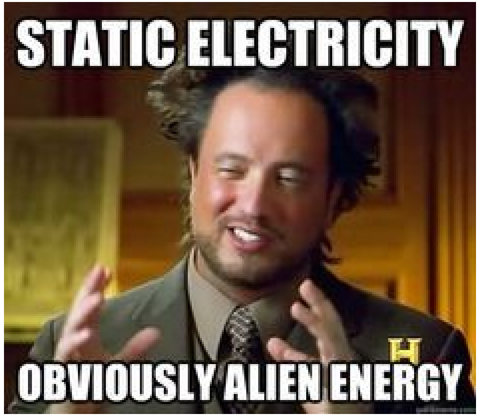
Elect-bro-statics

“The only way to win is to prepare for everything”

- Candice Dea

What is Electrostatics ???



Greek R0_ots:

Electro = when rubbed, produces static electricity

Static = stand still, stationary

Electro + Statics = stationary particles that contain charge

Key Concepts

1. Characteristics of charges
2. Electric Force
3. Electric Field
4. Electric Potential Energy
5. Voltage
6. Capacitors
7. Dielectrics

Charges

PROTONS CARRY A POSITIVE CHARGE

ELECTRONS CARRY A NEGATIVE CHARGE

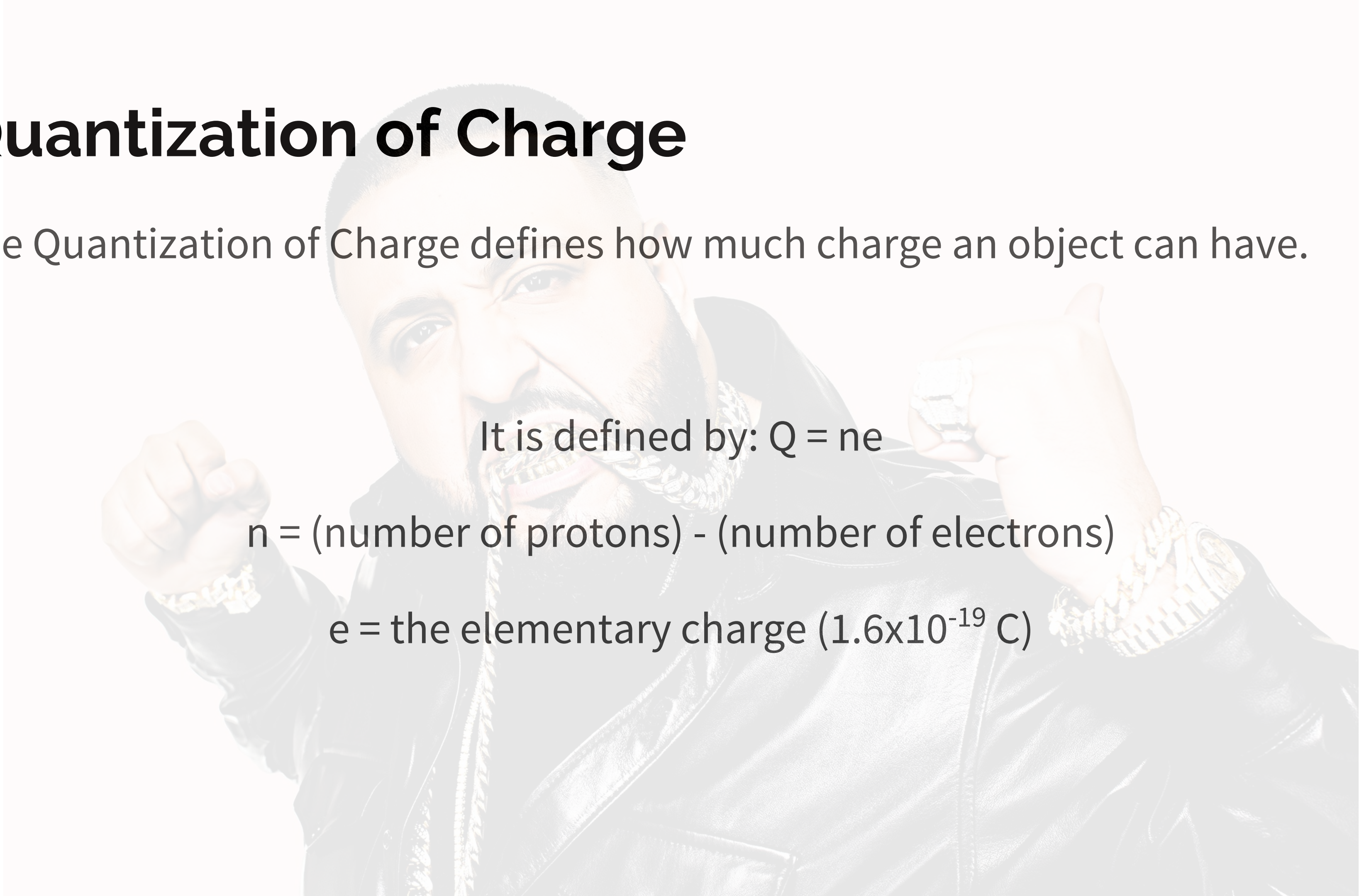
Charge is measured in Coulombs (C)

Protons = 1.6×10^{-19} C

Electrons = -1.6×10^{-19} C

Quantization of Charge

The Quantization of Charge defines how much charge an object can have.

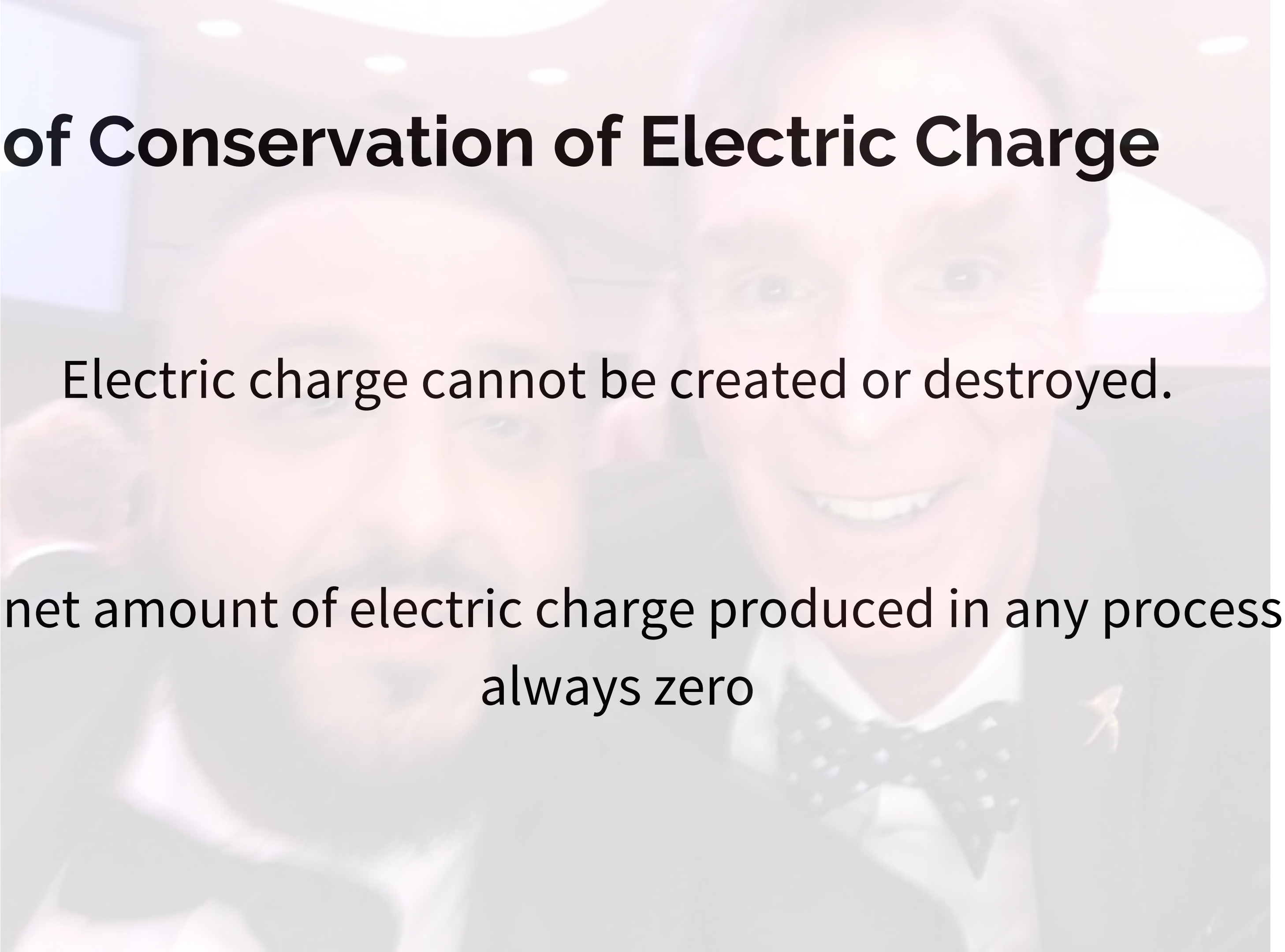


It is defined by: $Q = ne$

n = (number of protons) - (number of electrons)

e = the elementary charge (1.6×10^{-19} C)

Law of Conservation of Electric Charge



Electric charge cannot be created or destroyed.

The net amount of electric charge produced in any process is always zero

How do charges move around???

Conduction

Induction

Friction

Electric Force

Coulomb's Law

Electric Force = $F_e = (kq_1q_2)/(r^2)$

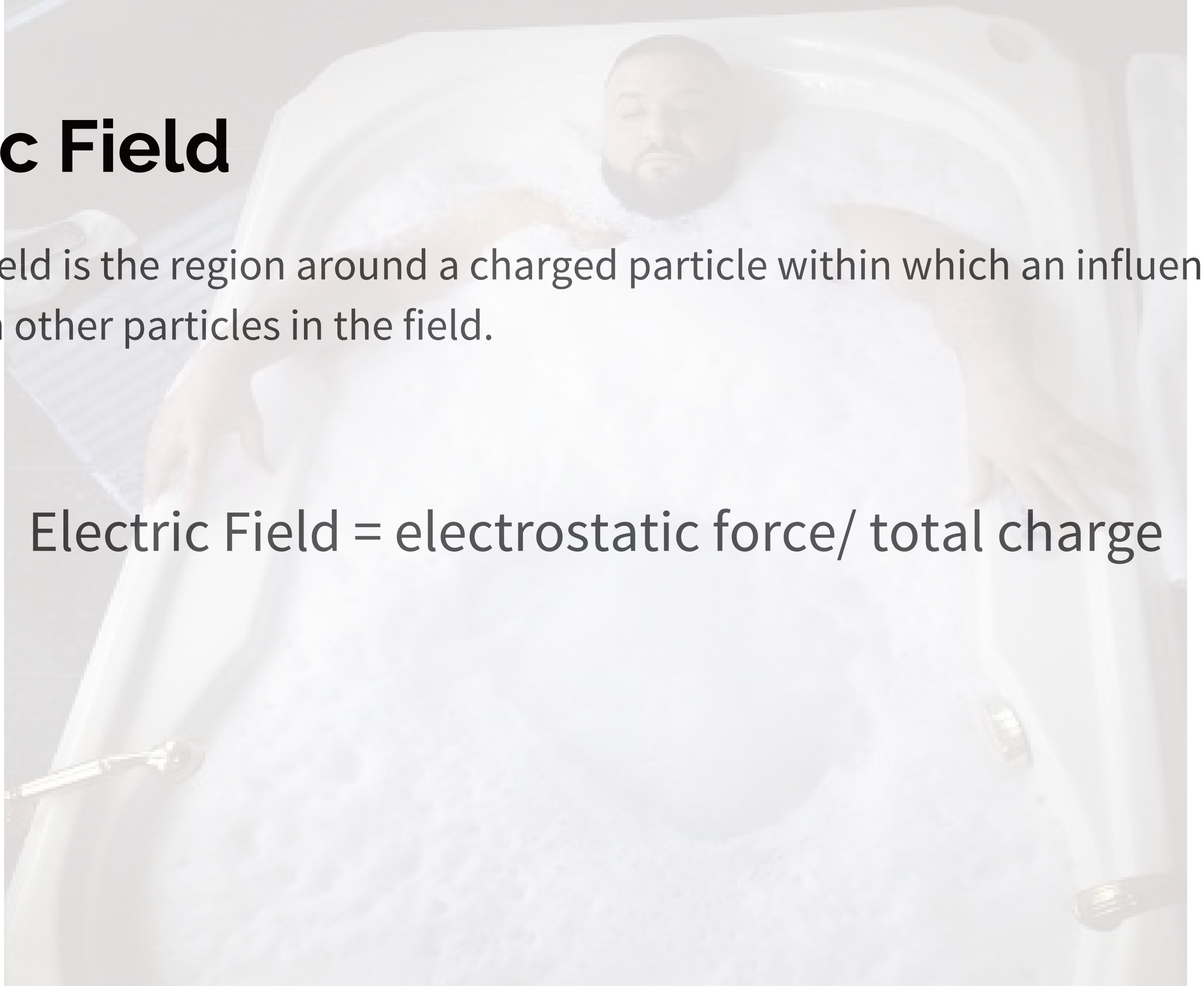
$k = 9x10^9\ Nm^2/C^2$

Example Problem

In a grain elevator on Farmer Judd's farm, pieces of grain become electrically charged while falling through the elevator. If one piece of grain is charged with 5.0×10^{-16} C while another holds 2.0×10^{-16} C of charge, what is the electrostatic force between them if they are separated by 0.050m?

Answer: 3.6×10^{-19} N

Electric Field



An electric field is the region around a charged particle within which an influence of force is exerted on other particles in the field.

Electric Field = electrostatic force/ total charge

Electric Field Lines

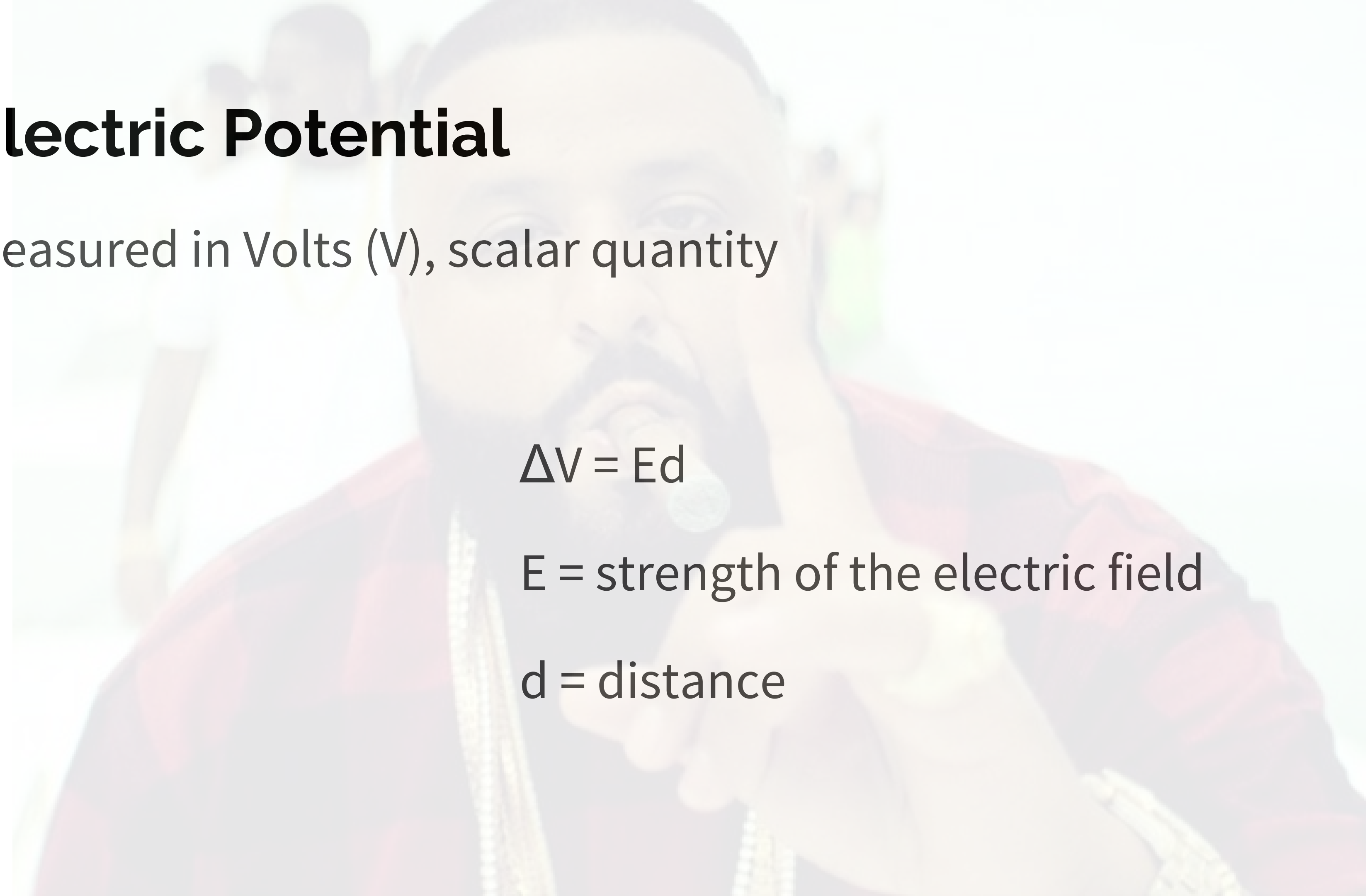
1. Flow from (+) to (-)
2. Field lines point radially and never cross
3. Lines are perpendicular to the surface of the conductor
4. Density of field lines is proportional to its strength

*Note: The electric field inside a good conductor is equal to 0

Electric Potential Energy

-Objects naturally flow from states of higher potential energy to lower states of potential energy.

-Potential Energy is represented by equation: $PE=(kQq)/r$



Electric Potential

Measured in Volts (V), scalar quantity

$\Delta V = Ed$

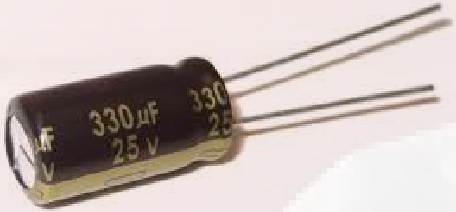
E = strength of the electric field

d = distance

Capacitance

A capacitor is a thing that stores electric charge.

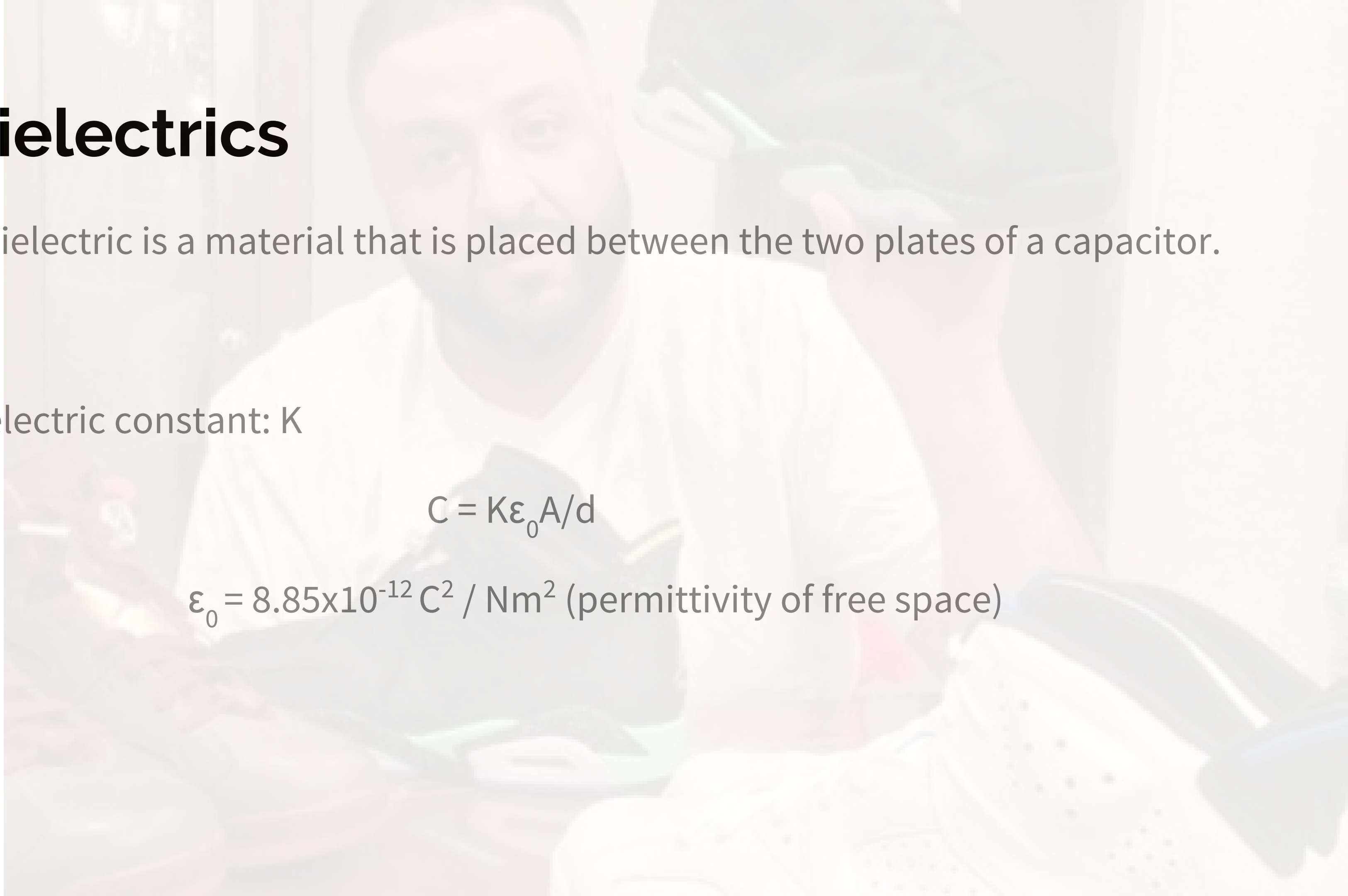
They look like this ---->



It consists of two oppositely charged plates that are very close to each other.

Capacitance of a capacitor is defined by: $Q = CV$(measured in farads) F

$U = 1/2QV = 1/2CV^2 = \frac{1}{2} Q^2/C$



Dielectrics

A dielectric is a material that is placed between the two plates of a capacitor.

Dielectric constant: K

$$C = K\varepsilon_0 A/d$$

$$\varepsilon_0 = 8.85\text{x}10^{-12}\ C^2 / Nm^2 \text{ (permittivity of free space)}$$

Common Misconceptions

The equation $F_e=(kQq)/r^2$ can only be used for point charges, not for the charge of the capacitor (instead use $Q=CV$).

It is natural for charges to seek stages of lower potential energy instead of higher potential energy.

Electric Field lines are drawn to indicate the direction of the force due to a positive test charge.

Practice Problem

In the human body, nerve cells work by pumping sodium ions out of the cell in order to maintain a potential difference across the cell wall. If a sodium ion carries a charge of 1.60×10^{-19} C as it is pumped with an electrical force of 2.0×10^{-12} N, what is the electric field between the inside and outside of the nerve cell?

Answer: 1.3×10^{7} N/C