# CAIE Physics A-level
## 18 - Electric Fields
## Flashcards

# Define an electric field.

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A region of space in which charged particles are subject to an electrostatic force.

What equation can be used to calculate the magnitude of the force that a charged particle is subject to in an electric field?

What equation can be used to calculate the magnitude of the force that a charged particle is subject to in an electric field?

$$F = qE$$

Where q is the charge of the particle (C) and E is the field strength ($NC^{-1}$).

# What units does an electric field have?

# What units does an electric field have?

An electric field is quantitatively expressed as the force per unit positive charge i.e. $NC^{-1}$.

Note that the magnitude of the electric field is a vector quantity, since it has direction.

# What type of field do point charges have?

# What type of field do point charges have?

Radial fields.

# How are uniformly charged spheres modelled?

# How are uniformly charged spheres modelled?

As a point charges, located at the centre of the sphere.

# What do field lines show?

# What do field lines show?

The path a positive test charge would take when placed in an electric field.

# Which direction do the field lines point?

# Which direction do the field lines point?

Positive to negative – the lines always point away from a positive charge and towards a negative charge.

What effect does distance have on the strength of the electrostatic force?

# What effect does distance have on the strength of the electrostatic force?

The greater the distance, the weaker the force.

How is the strength of an electric field represented in a diagram?

How is the strength of an electric field represented in a diagram?

By how close together the field lines are – the closer the lines, the stronger the field.

# What is the formula for electric field strength for a uniform field?

What is the formula for electric field strength for a uniform field?

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

Where ⊿$d$ is the distance between parallel charged plates.

What effect does a uniform electric field have on the motion of charged particles?

# What effect does a uniform electric field have on the motion of charged particles?

It causes positively charged particles to accelerate towards the negative pole and negatively charged particles to accelerate towards the positive pole of the electric field.

# What is Coulomb's Law?

## What is Coulomb's Law?

The force between any two point charges is proportional to the product of their charges and inversely proportional to the square of the distance between them.

# What is the formula for the force between two point charges? (Coulomb's Law)

# What is the formula for the force between two point charges? (Coulomb's Law)

$$F = \frac{Q_1 Q_2}{4\pi \varepsilon_0 r^2}$$

charges of the particles (c)

distance between the charges (m)

permittivity of free space (constant) :

$8.85 \times 10^{-12} \, C^2 N^{-1} m^{-2}$

# Define permittivity.

Define permittivity.

The ability of a material to transmit an electric field. (A measure of how easily the atoms become polarised.)

What is the formula for the electric field strength of a point charge?

# What is the formula for the electric field strength of a point charge?

charge of the particle (c)

$$E = \frac{Q}{4\pi \varepsilon_0 r^2}$$

distance from the point charge

permittivity of free space (constant):

$8.85 \times 10^{-12} \, C^2 N^{-1} m^{-2}$

This can be derived using E = F ÷ Q and the formula for force (Coulomb's Law).

What is the formula for the work done when moving a charge in an electric field?

# What is the formula for the work done when moving a charge in an electric field?

## Work done = Force x Distance moved

Define potential at a point in an electric field.

Define potential at a point in an electric field.

The work done per unit charge in moving a positive test charge from infinity to that point in the electric field.

What is the formula for the potential at a point in an electric field?

What is the formula for the potential at a point in an electric field?

$$V = W / Q$$

V = Potential (V)

W = Work done in moving the particle (J)

Q = Charge of the particle (C)

What is the formula for the potential between two parallel plates?

# What is the formula for the potential between two parallel plates?

$$V = E \times d$$

V = Potential (V)

E = Electric Field strength ($NC^{-1}$)

d = distance between the plates (m)

What can the motion of charged particles in an electric field be modelled as?

What can the motion of charged particles in an electric field be modelled as?

Projectile motion: the two components of velocity are independent of each other.

The velocity perpendicular to the field is not affected, whereas the velocity parallel to the field is.

How do you calculate the parallel component of velocity for a charged particle in a uniform electric field?

# How do you calculate the parallel component of velocity for a charged particle in a uniform electric field?

1. Calculate the time the particle is in the field (using time = distance ÷ speed, where distance = length of charged plates and speed = velocity perpendicular to the field).
2. Use $a = F÷m$ and $F=Eq$ to calculate the acceleration of the particle while it is in the field ($a = Eq ÷ m$).
3. Substitute these values into $V = u + at$ , where u is the initial parallel velocity and V is the final parallel velocity.

# What is the formula for the potential near a point charge?
# (Coulomb's Law)

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charge of point charge (c)
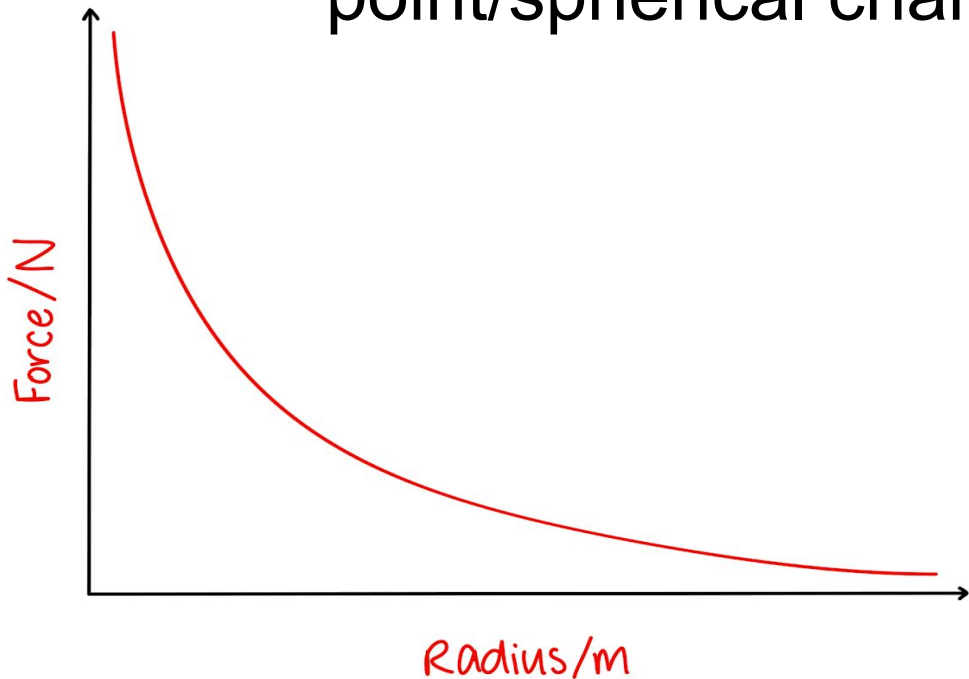
$$V = \frac{Q}{4\pi\varepsilon_0 r}$$

distance from point charge (m)

permittivity of free space ($8.85\times10^{-12}\,C^2N^{-1}m^{-2}$)

What does the force-distance graph for a point/spherical charge look like?

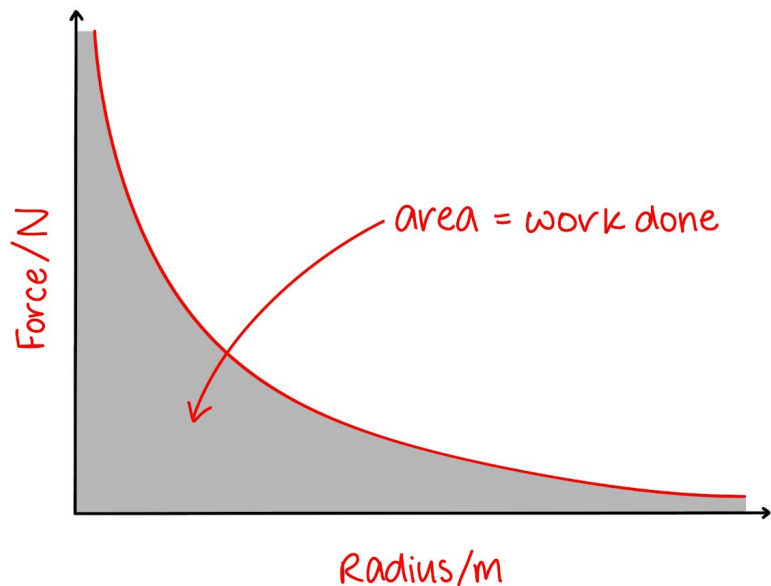What does the force-distance graph for a point/spherical charge look like?

Force is inversely proportional to the square of the distance.

Force/N

Radius/m

What does the area under a force-distance graph for a point/spherical charge represent?

What does the area under a force-distance graph for a point/spherical charge represent?

The work done in moving the charge.

area = work done

Force /N

Radius/m

What is the formula for electric potential energy near a point charge?
(Coulomb's Law)

What is the formula for electric potential energy near a point charge? (Coulomb's Law)

charges (C)

$$E = \frac{Q_1 Q_2}{4\pi \varepsilon_0 r}$$

← not squared

electric potential energy (J)

permittivity of free space

$8.85 \times 10^{-12} \, C^2 N^{-1} m^{-2}$

distance from point charge (m)