OCR (A) A-Level Physics

6.2 Electric Fields

Flashcards

Define Electric Field

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

What shape of field do point charges have?

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Radial fields.

How can you model uniformly charged spheres?

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As a point charge at the centre of the sphere.

What do field lines show?

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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.

Define Electric Field Strength

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Force per unit charge on a positive test charge placed in the field.

What is the formula for Electric Field Strength?

What is the formula for Electric Field Strength?

$$E = F \div Q$$

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

F = Force (N)

Q = Charge (C)

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)

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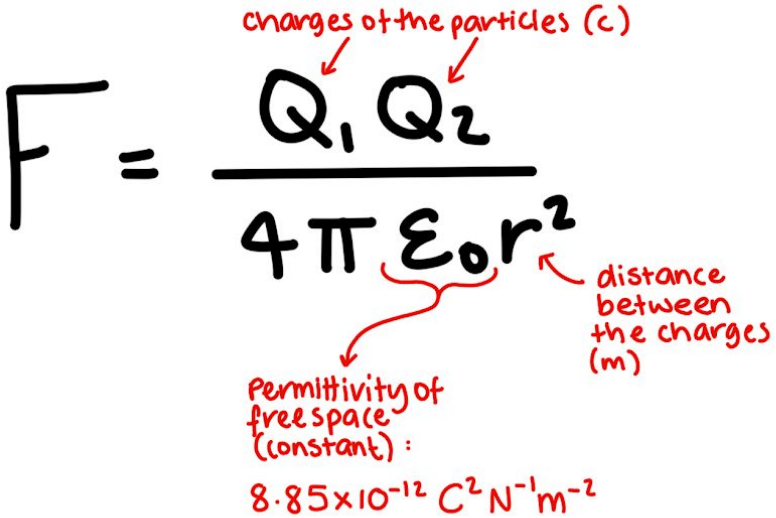

Define permittivity

Define permittivity

The ability of a material to transmit an Electric Field (how easily the atoms become polarised).

What is the formula for the Electric Field Strength of a point charge?

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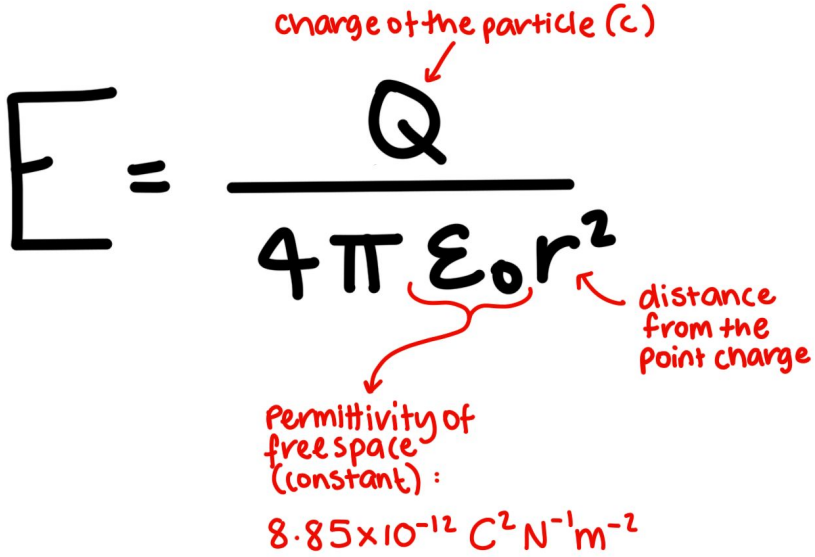
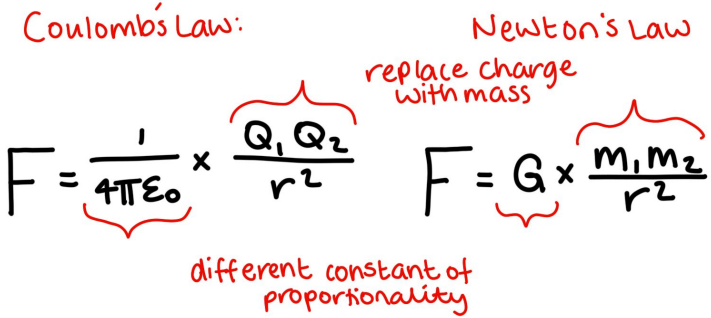


This can be derived using E = F ÷ Q and the formula for force (Coulomb's Law).

Name some similarities between Gravitational and Electric Fields

Name some similarities between Gravitational and Electric Fields

- Both follow the inverse square law for the force.
- Point masses and point charges both produce a radial field.
- Newton's law and Coulomb's law formulae for force are very similar:
- Field strength is defined by force per unit charge/mass.



Name some differences between Gravitational and Electric Fields

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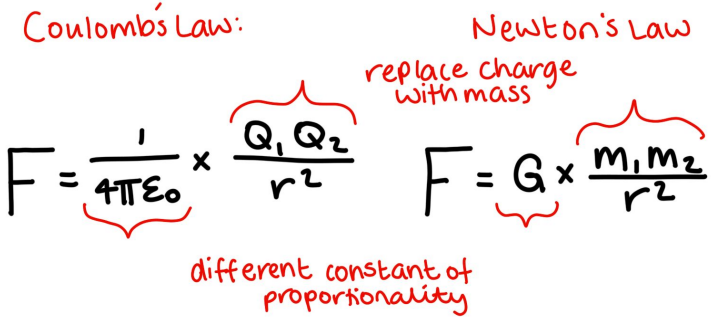
- Gravitational fields are always attractive, Electric Fields can be attractive or repulsive (depending on the charge).
- The constants of proportionality in Newton's Law and Coulomb's Law are different:



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

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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?

$$V = W \div Q$$

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 is the formula for the capacitance of a parallel plate capacitor?

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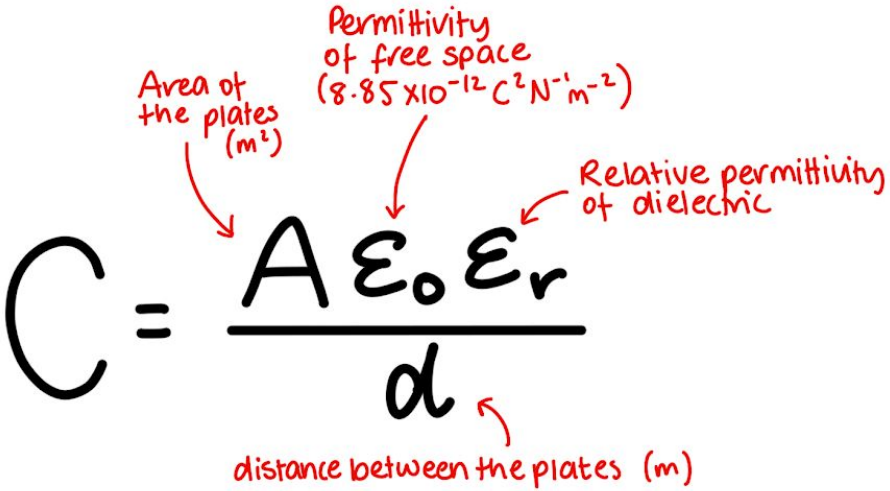

What can the motion of charged particles in an Electric Field be modelled as?

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.

Velocity perpendicular to the field is not affected, 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. First, 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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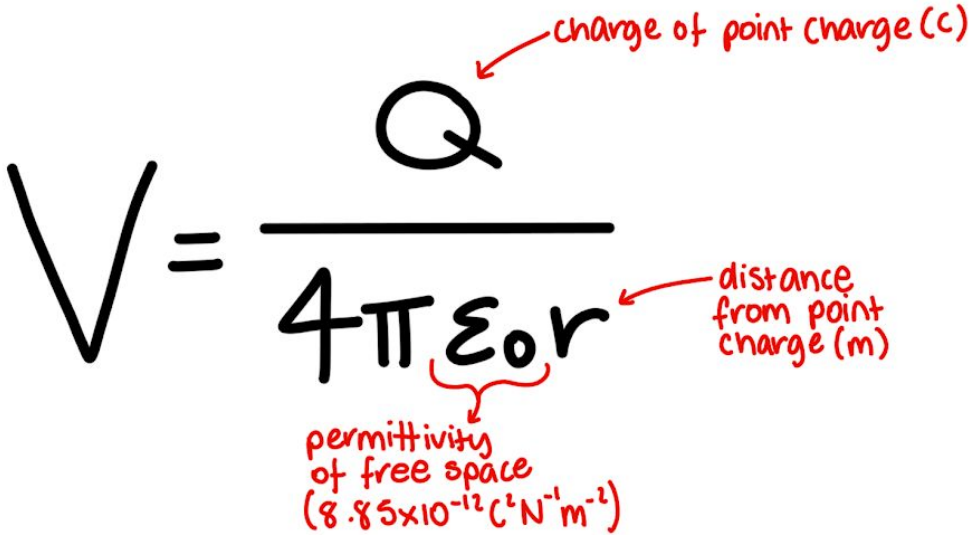

What does the force-distance graph for a point/spherical charge look like?

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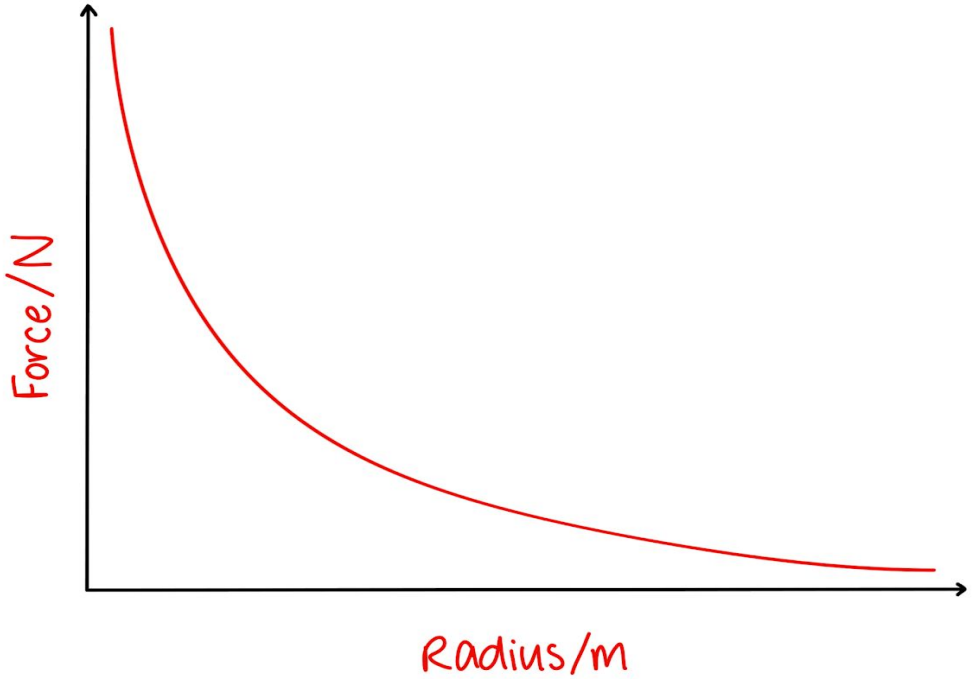

Force is inversely proportional to the square of the distance.

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

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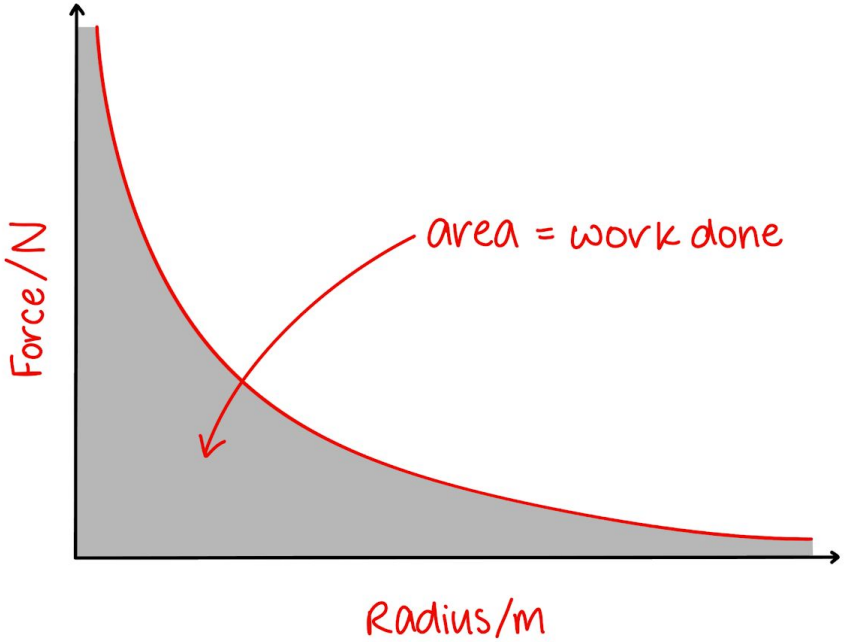

The work done in moving the charge.

What is the formula for electric potential energy near a point charge?

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$$E = V \times q$$

E = electric potential energy (J)

V = potential (V)

q = charge of the point charge (C)

What is the formula for the capacitance of an isolated sphere?

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Isolated spheres can store charge, so technically they can be classed as capacitors.

Using C = Q ÷ V and the formula for V (in terms of Coulomb's law), you can derive the formula for capacitance:

$$V = \frac{Q}{4\pi\varepsilon_0 r} \quad \& \quad C = \frac{Q}{V}$$

$$C = Q \div \frac{Q}{4\pi\varepsilon_0 r} \rightarrow C = 4\pi\varepsilon_0 r$$

permittivity of free space $8.85 \times 10^{-12}\ C^2 N^{-1} m^{-2}$

radius of sphere

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