Edexcel IAL Physics A-Level

Topic 4.2 - Electric and Magnetic Fields

Flashcards

Define ‘electric field’ and state the equation for electric field strength.

Define ‘electric field’.

A region where a charged particle experiences a force.

Electric Field Strength = Force / Charge

State the equation for the force between two charges.

State the equation for the force between two charges.

$F = kQq/r^2$ where $k=8.99 \times 10^9$.

R = distance between the two charges.

Q & q = charge of each of the point charges.

State the relationship between electric field strength and distance and the equation associating the two.

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Electric field strength is inversely proportional to the square of the distance between the charged objects.

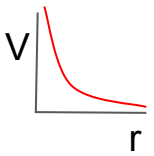
$$E = kQ/r^2$$

What is electric potential and how can we find it?

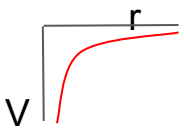
What is electric potential and how can we find it?

Electric potential is the potential energy that a unit positive charge (+1C) would have at a certain point. It is found by the equation V = kQ/r.

If the potential is positive, then the energy would become a repulsive force; if negative, it would be become an attractive force.



Repulsive;
Tends to zero as r increases to infinity



Attractive;
Tends to zero as r increases to infinity

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 shape of field do point charges have?

What shape of field do point charges have?

Radial fields.

What do equipotentials show?

What do equipotentials show?

Equipotentials show all points of equal potential in a field. When a point charge travels along an equipotential line, no work is done.

What are capacitors and how can the capacitance be calculated?

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Capacitors are electrical components which build up charge on parallel plates by preventing electrons crossing the ap between the plates. These capacitors then store potential energy which can be used after a battery has been turned off.

Capacitance = Charge / Potential Difference

How can we measure the energy stored by a capacitor?

How can we measure the energy stored by a capacitor?

$$W = \frac{1}{2}QV$$

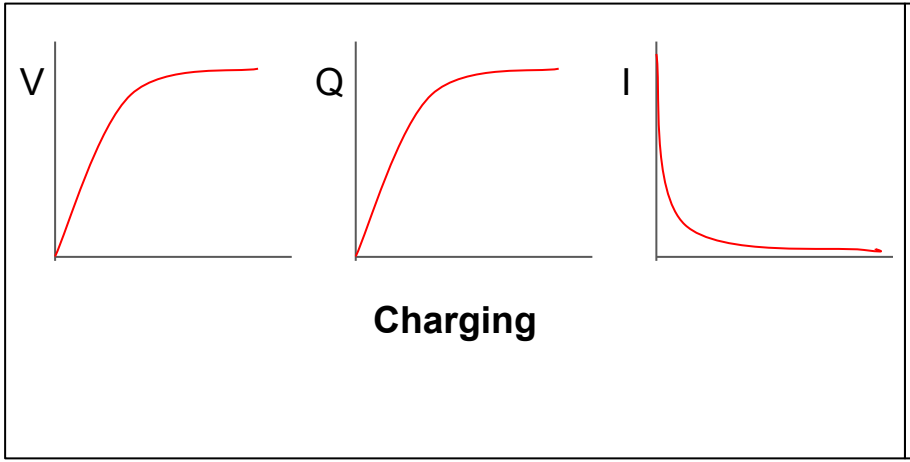
$$W = \frac{1}{2}CV^2$$

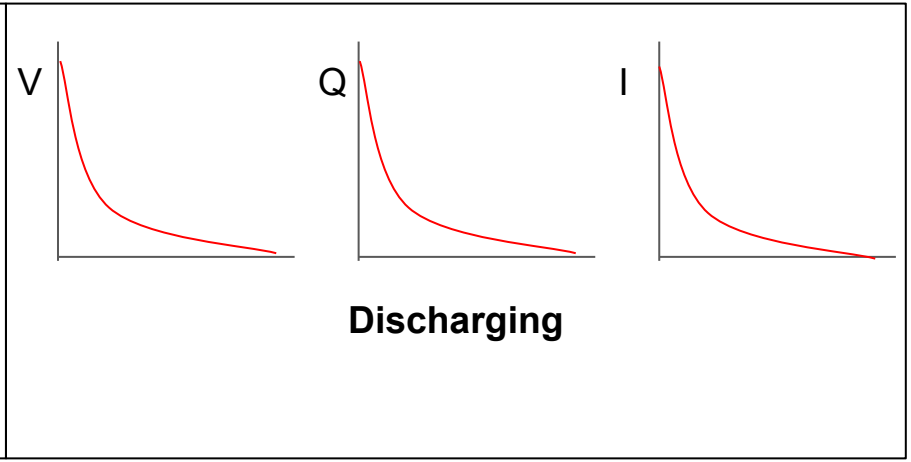
$$W = Q^2/2C$$

How can you discharge a capacitor? Sketch the current, charge and voltage charging and discharging over time.

How can you discharge a capacitor? Sketch the current, charge and voltage charging and discharging over time.

The capacitor will discharge when the power supply is removed and the switch is closed to form a closed circuit.





What affects the time taken to discharge on a capacitor?

What affects the time taken to discharge on a capacitor?

- Capacitance: affects how much charge can be transferred with a given potential difference.
- Resistance: affects the current in the circuit.

How can you work out the charge / current / PD for a discharging capacitor?

How can you work out the charge / current / PD for a discharging capacitor?

As the discharging is a negative exponential, the line can be worked out at $Q = Q_0e^{-T/RC}$ or by replacing the Q with I (current) or V (PD).

What is the time constant with capacitors?

What is the time constant with capacitors?

Time constant = m = RC = resistance x capacitance

The time constant is approximately 37% of the the original value. This means the capacitor will roughly be fully discharged at 5RC.

How can you find the time constant from a log-linear graph?

How can you find the time constant from a log-linear graph?

$$Q = Q_0 e^{-T/RC} \quad \textit{turns into} \quad \ln Q = -t/RC + \ln Q_0$$

This is the equivalent of y = mx + c so forms a straight line graph. This means the gradient is -1/RC and the y intercept is $\ln Q_0$. Therefore, RC = -1/gradient.

Define ‘magnetic field’.

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A magnetic field is a region where a force is exerted on magnetically susceptible materials.

What are some key points about a magnetic field surrounding a wire?

What are some key points about a magnetic field surrounding a wire?

- The field lines are concentric circles around the wire.
- The direction of the field is worked out with the right hand rule.
- In a coil, the fields act like a bar magnet.

What is the right hand rule and what is it used for?

What is the right hand rule and what is it used for?

The right hand rule is used to work out the direction of which the magnetic field flows around a current.

- Point the right hand up, the thumb is the direction of the conventional current and the curled fingers are the direction of the field.

What happens to a current carrying wire in a magnetic field?

What happens to a current carrying wire in a magnetic field?

The magnetic field in the wire will interact with the surrounding magnetic field, causing it to experience a force.

What are the labels for each finger of Fleming's Left Hand Rule?

What are the labels for each finger of Fleming's Left Hand Rule?

Thumb = **T**hrust/direction of motion

First finger = Direction of magnetic **f**ield

Se**C**ond finger = Direction of **C**urrent

Define magnetic flux density.

Define magnetic flux density.

Magnetic flux density is the force on one metre of wire carrying a current of 1A at right angles to the magnetic field.

What is the equation for the force acting on a wire passing through a magnetic field?

What is the equation for the force acting on a wire passing through a magnetic field?

$$F = BIL\sin\theta$$

F = force, B = magnetic flux density, I = current, L = length of wire, θ = angle between direction of field and direction of current.

What happens to a charged particle in a magnetic field and what is the equation used for this?

What happens to a charged particle in a magnetic field and what is the equation used for this?

Forces act on charged particles in a magnetic field.

$$F = Bqv\sin\theta$$

B = magnetic flux density, q = charge, v = velocity of particle, θ = angle between current and field lines

When is an emf induced in a conductor?

When is an emf induced in a conductor?

It is induced when it cuts magnetic flux. It can be induced in a solenoid by:

- Moving the coil closer and further away from the magnet.
- Moving a magnet towards and away from the coil.

How can you create a bigger emf?

How can you create a bigger emf?

- Create a bigger area for the magnetic field to pass through.
- Create more turns in the coil of wire ($\Phi = BAN$) N = number of coils.
- More coils = flux linkage.

Define magnetic flux and the equation to find it.

Define magnetic flux and the equation to find it.

The product of the average magnetic field times the perpendicular area that it penetrates.

$\Phi = BA$

B = magnetic flux density, A = area the flux passes through

What is Faraday's Law?

What is Faraday's Law?

The induced emf is directly proportional to the rate of change of flux linkage.

What is Lenz's law?

What is Lenz's law?

The induced emf is always in such a direction as to oppose the change that caused it.

How can you work out the rms value from the peak value? What does the rms value mean for an AC current?

How can you work out the rms value from the peak value? What does the rms value mean for an AC current?

$$V_{rms} = V_0/\sqrt{2}$$

The rms value is the effective value of a varying AC current. It is the equivalent to a constant DC supply.