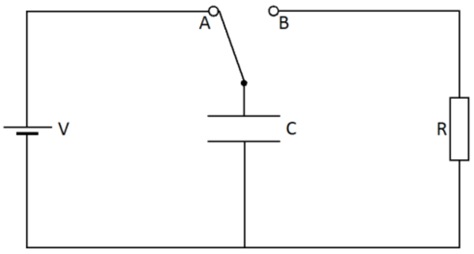
<u>Charging and Discharging a Capacitor</u>

To be able to sketch graphs of charge, p.d. and current over time for a charging capacitor
To be able to sketch graphs of charge, p.d. and current over time for a discharging capacitor
To be able to calculate the time constant and state its significance

In the diagram to the right a capacitor can be charged by the battery if the switch is moved to position A. It can then be discharged through a resistor by moving the switch to position B.



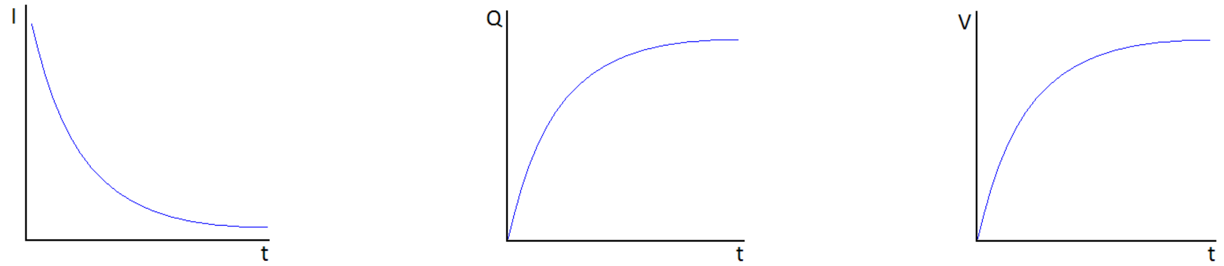
Charging a Capacitor

When the switch is moved to A the battery sends electrons to the lower plate and takes them from the upper plate. This leaves the lower plate negatively charged and the upper plate positively charged. An electric field is set up between the plates.

Current The current is the flow of electrons through the circuit (see Unit 1). There is a large current initially as electrons move to the lower plate. As time passes and more electrons are on the plate it becomes more difficult to add more due to the electrostatic repulsion of similar charges. When no more electrons move in the circuit the current drops to zero.

Charge The charge stored by the capacitor increases with every electron the moves to the negative plate. The amount of charge increases quickly at the beginning because a large current is flowing. As the current drops the rate at which the charge increases also drops. A maximum charge is reached.

P.D. Since potential difference is proportional to charge, as charge builds up so does p.d. The maximum value of p.d. is reached as is equal to the terminal p.d. of the battery.



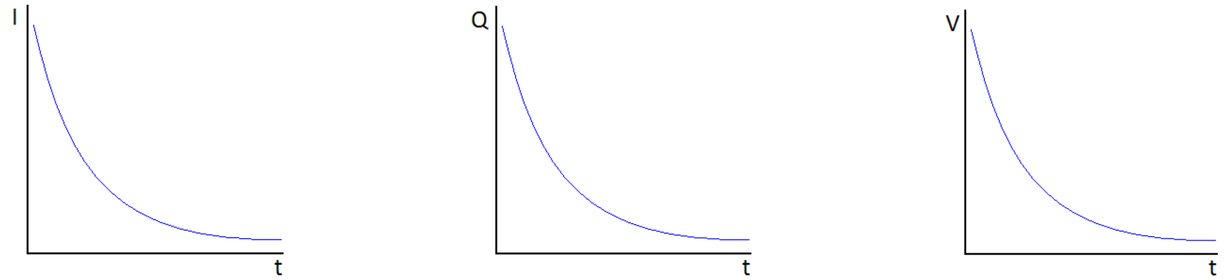
Discharging a Capacitor

When the switch in moved to B the electrons on the negative plate repel each other and move back into the circuit. Eventually both plates lose their charge and the electric field between them disappears.

Current There is initially a large current as the electrons leave the negative plate. As the number of electrons on the negative plate falls so does the size of the repulsive electrostatic force, this makes the current fall at a slower rate. When no more electrons move in the circuit the current drops to zero.

Charge The charge that was stored on the plates now falls with every electron that leaves the negative plate. The charge falls quickly initially and then slows, eventually reaching zero when all the charge has left the plates.

P.D. As the charge falls to zero so does the potential difference across the capacitor.



Time Constant, τ

The time it takes for the capacitor to discharge depends on the ‘time constant’.
The time constant is the time it takes for the charge or p.d. of a capacitor to fall **to 37%** of the initial value. OR
The time constant is the time it takes for the charge or p.d. of a capacitor to fall **by 63%** of the initial value.
It is given by the equation: $\boxed{\tau = RC}$

If the capacitor has a larger capacitance it means it can hold more charge, this means it will take longer to discharge. If the resistor has a larger resistance it means it is harder to move the electrons around the circuit, this also means it will take longer to discharge.