Parallel Plate Capacitor

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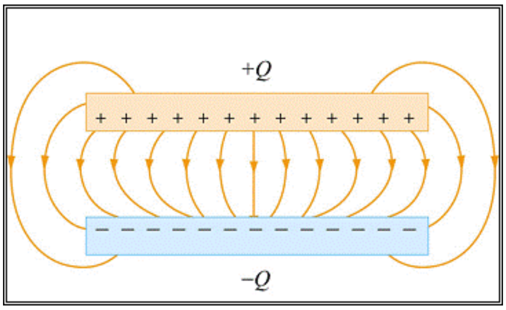
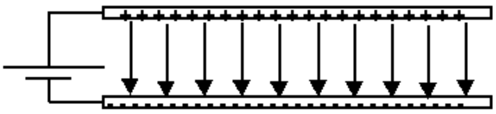
Introduction to Parallel Plate Capacitors

The electric field between the plates of a parallel-plate capacitor



A capacitor consists of two identical conducting plates which are placed in front of each other. One plate of the capacitor is connected to the positive terminal of a power supply and the other plate is connected to the negative terminal. The plate that is connected to positive terminal acquires a positive charge, while the other plate connected to the negative terminal acquires a negative charge. To maximize voltage, separation between the plates is very small, and is filled with air or any suitable dielectric material.



Remember that the direction of anelectric field is defined as the direction that a positive test charge would move. So in the case indicated above, the electric field would point from the positive plate to the negative plate. Since the field lines are parallel to each other, this type of electric field is uniform, and is calculated with the equation**E = V/d**.

Unit of a Capacitor

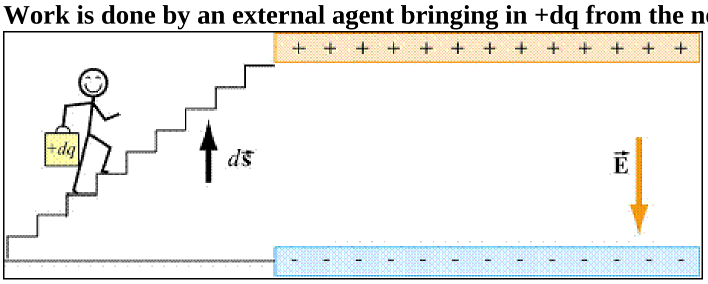
Note that the electric field strength, E, can be measured in either the units V/m, or equivalently, N/C.

[E] = V/d
(J/C)/m
(Nm)/C/ m
N/C

Since the field lines are parallel and the electric field is uniform between two parallel plates, a test charge would experience the same force of attraction or repulsion no matter where it was located. That force can be calculated with the equation**F = qE**.

Energy stored in a Capacitor

Work is done by an external agent bringing in +dq from the negative plate and depositing the charge on the positive plate.



Theenergy (measured injoules) stored in a capacitor is equal to the work done to charge it. Consider a capacitance C, holding a charge +q on one plate and ?q on the other. Moving a small element of charge dq from one plate to the other against the potential difference V = q/C requires the work dW:

$$\mathrm{d}W = \frac{q}{C}\,\mathrm{d}q$$

where W is the work measured in joules, q is the charge measured in coulombs and C is the capacitance, measured in farads. The energy stored in a capacitance is found by integrating this equation. Starting with an uncharged capacitance (q = 0) and work W moves charges from one plate to the other until the plates have charge +Q and ?Q:

$$W_{\text{charging}} = \int_0^Q \frac{q}{C}\,\mathrm{d}q = \frac{1}{2}\frac{Q^2}{C} = \frac{1}{2}CV^2 = W_{\text{stored}}.$$

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