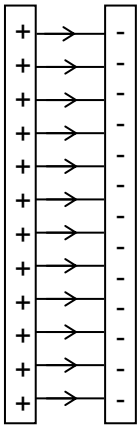
Field strength and voltage in the uniform electric field



Here you can see a plate capacitor, consisting of two parallel metal plates, with the one to the left carrying positive charge and the one to the right carrying negative charge. We assume the plates to be large and the distance between the plates to be small, and therefore the electric field between the plates to be uniform.

d: distance between the plates

E: electric field strength between the plates

q: test charge (positive, very small)

Task: Find an equation which describes how the voltage *U* between the plates depends on the electric field strength *E* and the distance *d* between the plates.

1. Write down an equation which allows you to calculate the force *F* acting on the test charge from *E* and *q*.

   $F =$

2. Write down the equation which allows you to calculate the work *W* which is defined as "the product of the force in the direction of motion and the distance over which an object is moved by the force"
   Here, the distance over which the object is moved is the distance between the plates - therefor replace *s* by *d*.

   $W =$ $\qquad\qquad =$

3. Use the second equation from 2. and replace the force *F* by the expression for *F* from 1.

   $W =$

4. Write down the equation for the definition of voltage *U* as the quotient of work *W* and charge *q*. Then replace the work *W* by the expression for W from 3. Then cancel.

   $U =$ $\qquad\qquad =$

The voltage between the plates of a plate capacitor is given by

Formulae: $E = \frac{F}{q}$ $\qquad W = F \cdot s$ $\qquad U = \frac{W}{q}$