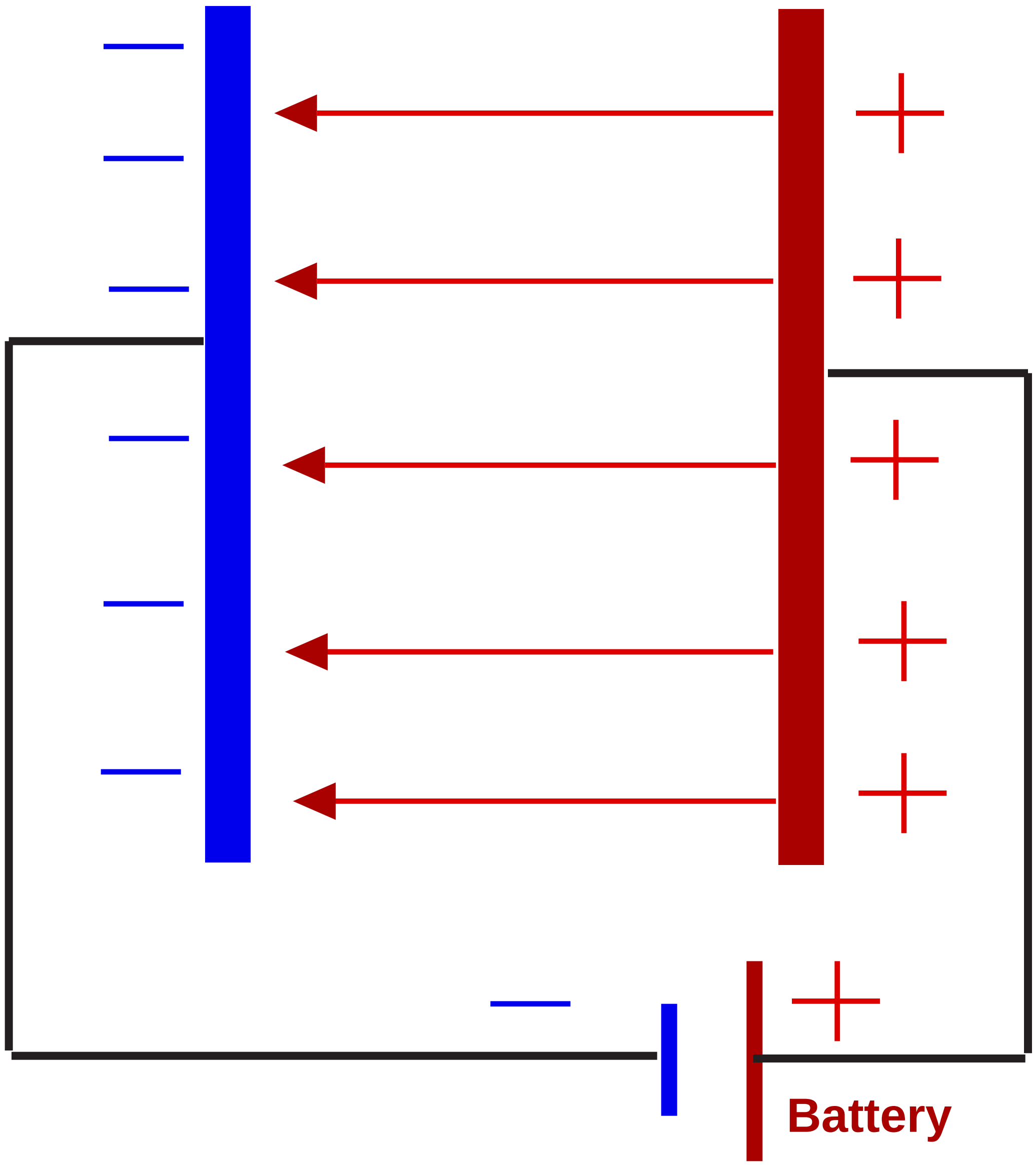
Topic 3

Uniform E fields



A uniform electric field exists between two paralle plates. This is due to the fact that as the field diminishes from one plate it grows equally from the other.

Note that the electric field lines are perpendicular to the plates and paralle to each other as well as being equally spaced, sugesting a uniform field.

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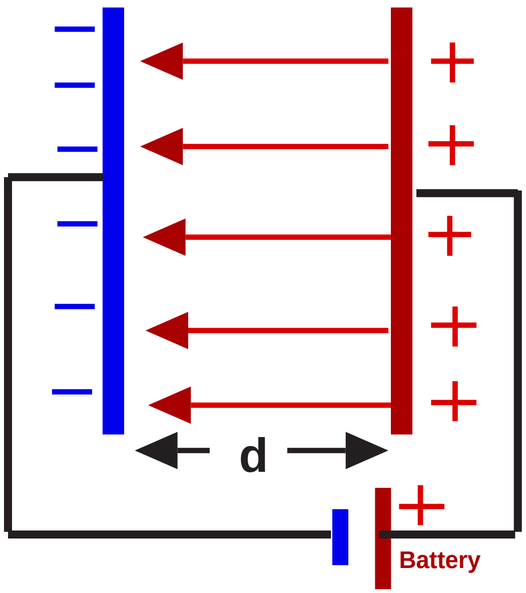
Uniform E fields

The stength of an electric field is determined by the voltage between the two plates and the distance that seperates the plates.



$$E = \frac{V}{d}$$

The electric field, measured in newtons per coulomb.
symbol "N/C"

Voltage or potential difference between the plates, measured in volts.
symbol "V" or "J/C"

The distance between the plates, measured in metres.
symbol "m"

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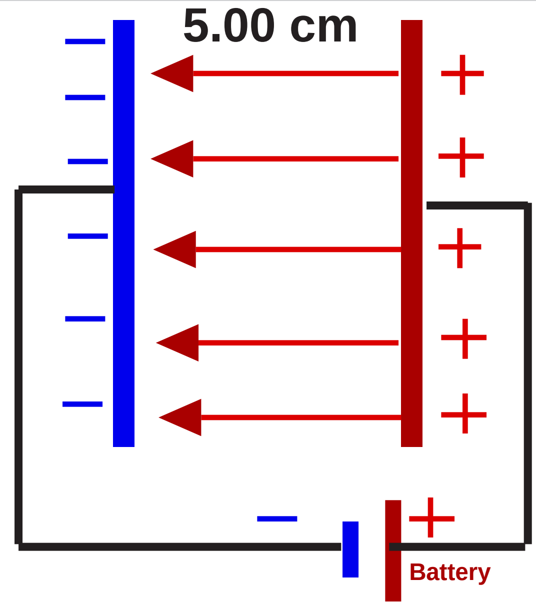

If two paralle plates have an electric field between them of 375 N/C and are seperated by 5.00 cm, what is the potential difference between the plates?

$$E = \frac{V}{d}$$

$$V = E \text{ x } d$$

$$V = 375 N/C \times 0.0500 m$$

$$V = 18.8 V$$

The voltage between the two plate is 18.8 V

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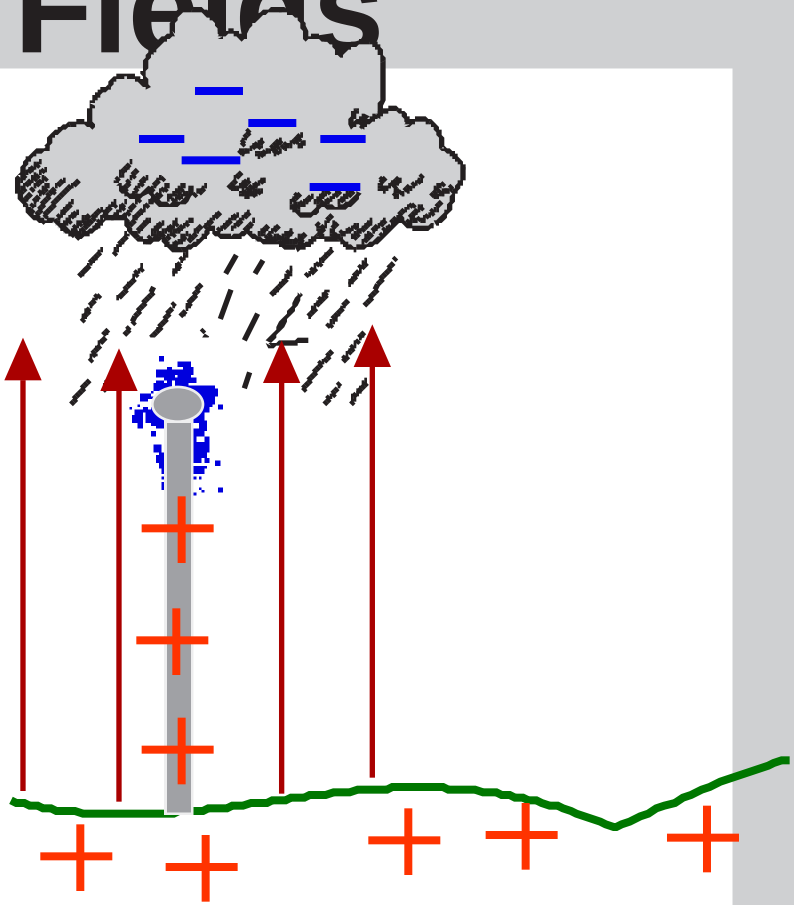
Uniform E Fields

When electrons start to be pushed together in a cloud they cause a charge seperation to occur in the ground below the cloud. This forms a strong electric field between the cloud and ground. Any negative charges in that field will be push downward. This movement of charges often causes them to collide with other atoms. This collision excites the atoms which then give off a blue glow. This is what sailors saw at the tops of thier masts during storms as particles in the air where racing toward the oppositly charged mast.



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Work in Uniform E fields

A charged particle in a uniform electric field is given kinetic energy by the field. The amount of energy depends only on the voltage of the field and the charge on the object.

$$W = Vq$$

The energy given to the charged particle, measured in joules.
symbol "J"

Voltage between plates, measured in volts.
symbol "V"

Charge on the particle in the field, measured in coulombs.
symbol "C"

Note: The reason speed of the particle at the opposite plate is not affected by the distance between plates is that the distance only changes the objects acceleration rate. When the plates are close together the electric field is strong and accelerates the object at a high rate but for a short distance. When the plates are further apart the particle accelerates slower, but for a longer time and reaches the same velocity (same energy) as when the plates were closer together.

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Work in Uniform E fields

An electron is placed in a uniform electric field with a 100 V potential difference. What is the energy of the electron when it reaches the positive plate?

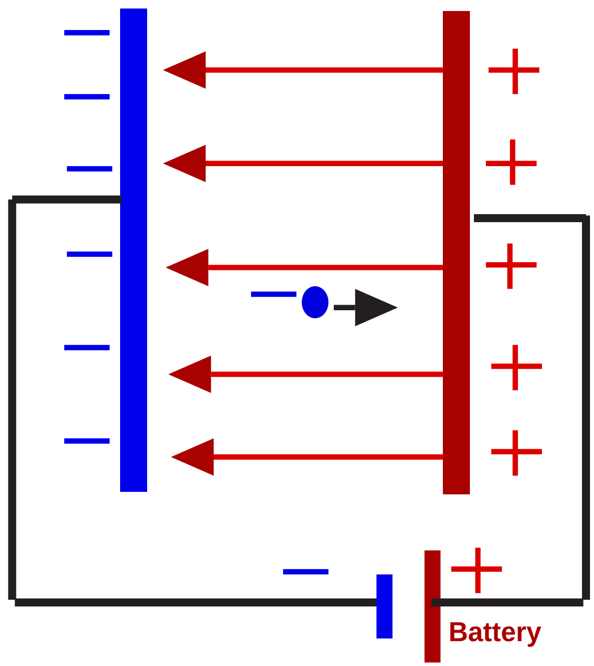
$$W = Vq = KE = \frac{1}{2}mv^2$$

$$Vq = \frac{1}{2}mv^2$$

$$v = \sqrt{\left(\frac{2Vq}{m}\right)}$$

$$v = \sqrt{\left(\frac{2 \times 100V \times 1.6 \times 10^{-19}C}{9.11 \times 10^{-31}kg}\right)}$$

$$v = 5.93 \times 10^{6} m/s$$



Note: to acheive this velocity the electron must start at the negative plate.

The velocity of the electron at the positive plate is

$$5.93 \times 10^{6} m/s$$

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Work in Uniform E fields

We can prove that the distance between plates does not matter. Lets combine the following formulas to find final velocity.

$F = Eq$ $\quad v_f^2 = v_1^2 + 2ad$ $\quad E = \frac{V}{d}$ $\quad F = ma$

#1 Since "E" is equal "v/d" we can substitute it in the other formula.

$$F = \frac{V}{d} q$$

#2 Since "F" is equal to "ma" we can substitute.

$$ma = \frac{V}{d} q$$

#3 Now we can substitute "a" for what it equals

$$a = \frac{v_f^2 - v_1^2}{2d}$$

$$m \frac{v_f^2 - v_1^2}{2d} = \frac{V}{d} q$$

#4 Now we can solve for velocity final. Note that velocity is zero and the "d" is on the bottom of both equations and cancells out.

$$v = \sqrt{\frac{2Vq}{m}}$$

Same as the previous method

$$Vq = \frac{1}{2} mv^2$$

$$v = \sqrt{\left(\frac{2Vq}{m}\right)}$$

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