

# Ch 21

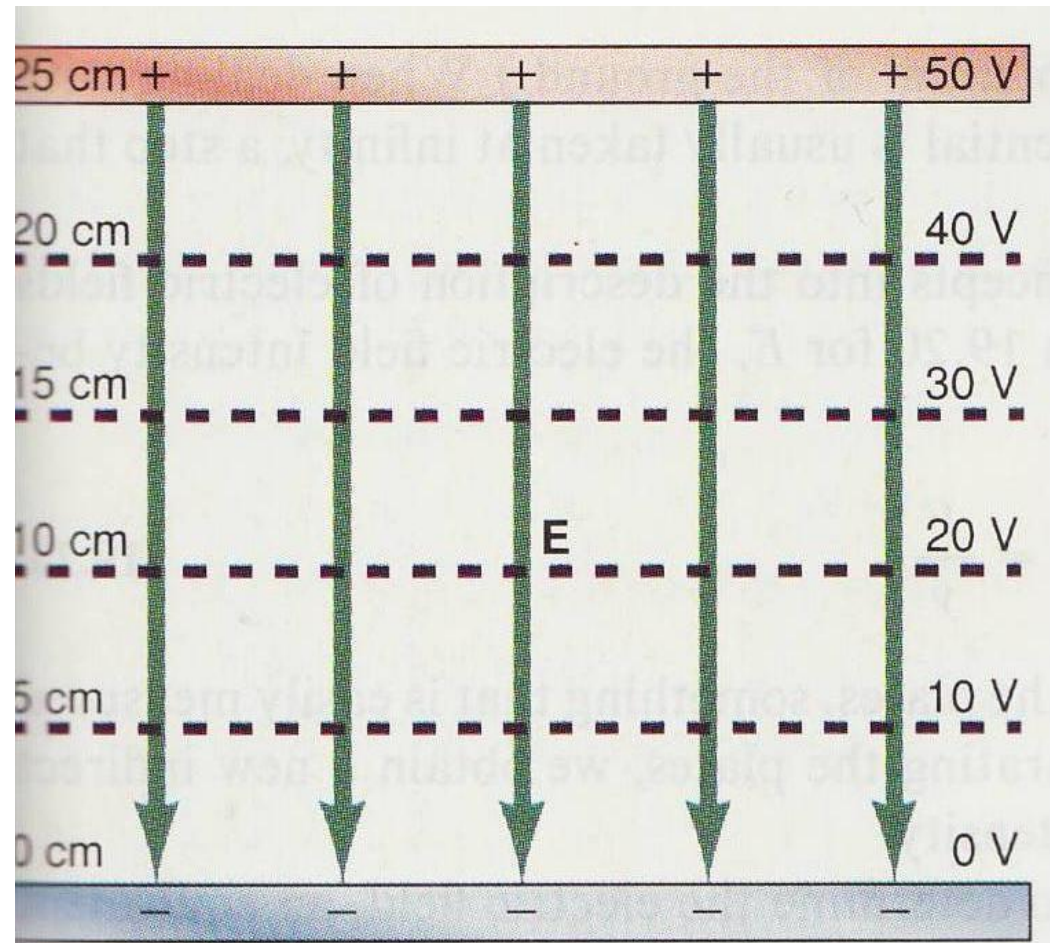
## Capacitance

Two conductors with opposite charges constitute a capacitor and can store energy in the form of an electric field.

From ch 19 on E field . . .

$$V = Ed$$

$$V = Ey$$



Here is a parallel plate capacitor with both electric field lines shown, note the note the arrows on the field lines pointing from + to -. Also, note the equipotential lines (40 V, 30 V, and so on), recall the electric field is a vector quantity and the potential is a scalar. We compared potential to the contours on a topographic map).

Now we juggle  
cats for a bit ...

$$V = Ed$$

This is “Gauss’s law”  
by gauss  
for E field

$$E = \frac{q}{\varepsilon_0 A}$$

Easy stuff

$$V = \left( \frac{q}{\varepsilon_0 A} \right) d$$

Here we notice the stuff  
in the () is constant,  
Permittivity we can’t change  
and Area and distance are  
constant unless we change the  
structure of the device. We’ll  
just rename this constant C  
for Capacitance

$$q = \left( \frac{\varepsilon_0 A}{d} \right) V$$

$$q = CV \quad \text{or} \quad \frac{q}{V} = C$$

Let's play with units:

$$1V = \frac{1 \text{ Joule}}{1 \text{ coulomb}}$$

$$1 \text{ Amp} = \frac{1 \text{ coulomb}}{1 \text{ second}}$$

$$V = IR$$

$$R = \frac{V}{I}$$

$$\text{ohms} = \frac{\frac{J}{c}}{\frac{1c}{1\text{sec}}} = \frac{1J \text{ sec}}{1c^2}$$

A quick glance back at Ch 20, circuits

- Kirchoff's laws.

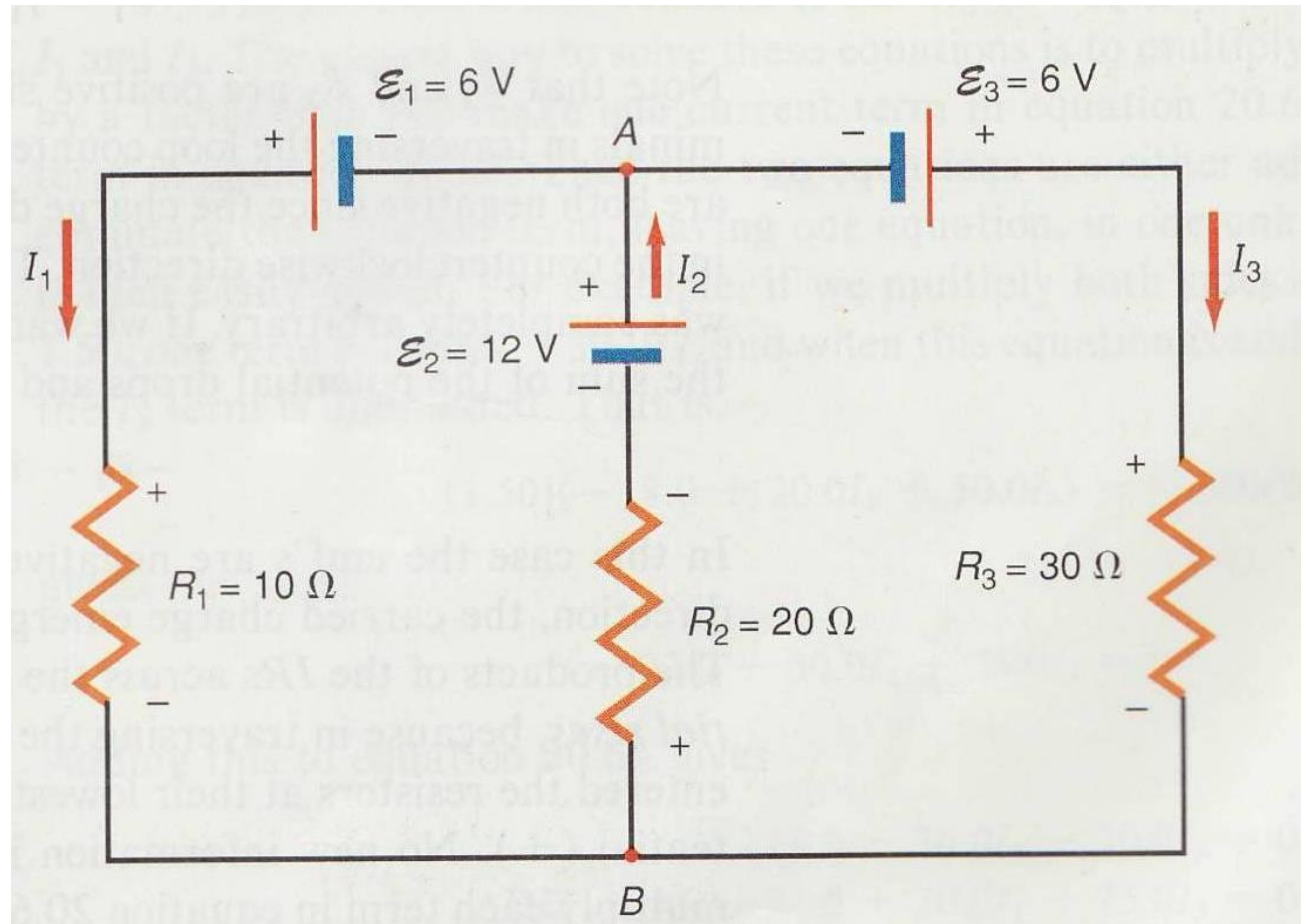
1. For any junction in a circuit:

$$\sum I_{\text{Entering the loop}} = \sum I_{\text{Leaving the loop}}$$

2. For any loop in a circuit:

$$\Delta V_{\text{Closed loop}} = 0$$

Kirchoff's laws come into play more formally as a circuit becomes more complex. For example, having several batteries.



What can we notice about this circuit?

1. It has three batteries. But ohm's law and power formula must still work.
2. The arrows show conventional current (hole flow), how do we know this?
3. The + and - signs on the resistors are to show voltage drops as a positive charge (test charge, remember???) is carried around the circuit.

