Dipole Moment and Capacitor addition

3 – ELECTRIC CIRCUITS

Effect of Dielectrics

- Electric Dipole Moment – permanent separation of charge in polar or dipole molecules. (e.g. water)
- Other dielectrics are non-polar, they can achieve temporary polar characteristics by induction

TABLE 17–2
Dipole Moments of Selected Molecules

Molecule	Dipole Moment (C·m)
$H_2^{(+)}O^{(-)}$	6.1×10^{-30}
$H^{(+)}Cl^{(-)}$	3.4×10^{-30}
$N^{(-)}H_3^{(+)}$	5.0×10^{-30}
$>N^{(-)}—H^{(+)\ddagger}$	$\approx 3.0 \times 10^{-30}$
$>C^{(+)}=O^{(-)\ddagger}$	$\approx 8.0 \times 10^{-30}$

‡These groups often appear on larger molecules; hence the value for the dipole moment will vary somewhat, depending on the rest of the molecule.

Effects of Dielectrics

- Slab polarized by induction
- Surfaces become charged
  - result from dipole moments of dielectric molecules
  - *NOT* from transfer of electrons

Effects of Dielectrics

- Elec. field in slab by surface charge opposes the external field
- E = vector sum

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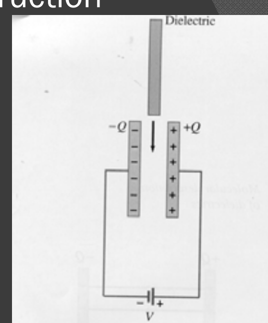
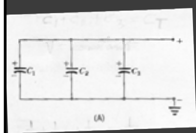
Capacitor Construction

- Large capacitances achieved by:
  - large plate areas
  - insulators with high K
  - small separation of plates.
- Dielectric strength limits the reduction in spacing between plates and defines quality of the material as an insulator
- Potential gradient will withstand being punctured by a spark discharge



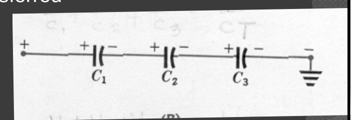
Capacitors in Circuits (parallel)



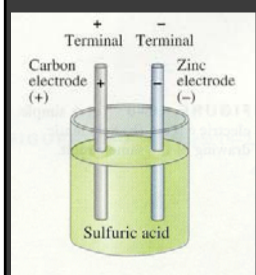
- C_1, C_2, C_3 in parallel
- 1 plate (of the capacitor) is attached to1 conductor while another plate connected to a second conductor
- Same Voltage across all
- $q_1=C_1V$ $q_2=C_2V$ $q_3=C_3V$
- $q_T= q_1+q_2+q_3$
- $q_T=C_1V+C_2V+C_3V$
- $q_T=C_TV$
- $C_TV=C_1V+C_2V+C_3V$
- $C_T=C_1+C_2+C_3$

Capacitors in Circuits (Series)

- C_1, C_2, C_3 in Series
- $q= q_1=q_2=q_3$
- Since charge is transferred
- $V_T=V_1+V_2+V_3$
- $V_T=q/C_T$
- $1/C_T=1/C_1+1/C_2+1/C_3$



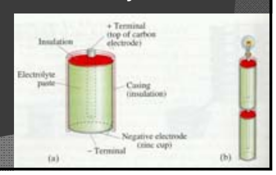
Electric Current



- Circa 1800
- Smackdown!!
  - Volta v Galvani
- We still refer to the type of battery he constructed as a Voltaic or Galvanic cell.
- It consists of 2 dissimilar metals as electrodes [carbon or platinum can serve as an "inert" electrode in place of one of the metals] immersed in an electrolyte [dilute solution of a strong acid or a nitrate solution of the metal serving as the electrode in that cell] and a connecting wire.
- The battery goes "dead" when chemical equilibrium is reached.

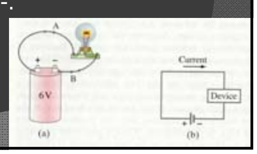
Series and Parallel

- If you connect the + terminal of one battery to the - terminal of the next they are connected in **series.**
- If you link + to + and - to-, then they are in **parallel**



Electric Current

- Electric Current–no longer static–electrons in motion!
- When we have a continuous conducting path between the terminals of a battery, we have an electric current.
- Note:
- the current flows from + to -.



Electric Current

- **Electric current–**the net amount of charge that passes through it per unit time at any point.
- $I = \Delta Q/\Delta t$
- It's unit is the ampere, amp
- A = 1 C/second
- In any single circuit, the current at any instant is the same at one point as at any other point since electric charge is conserved.