Storage of Charge

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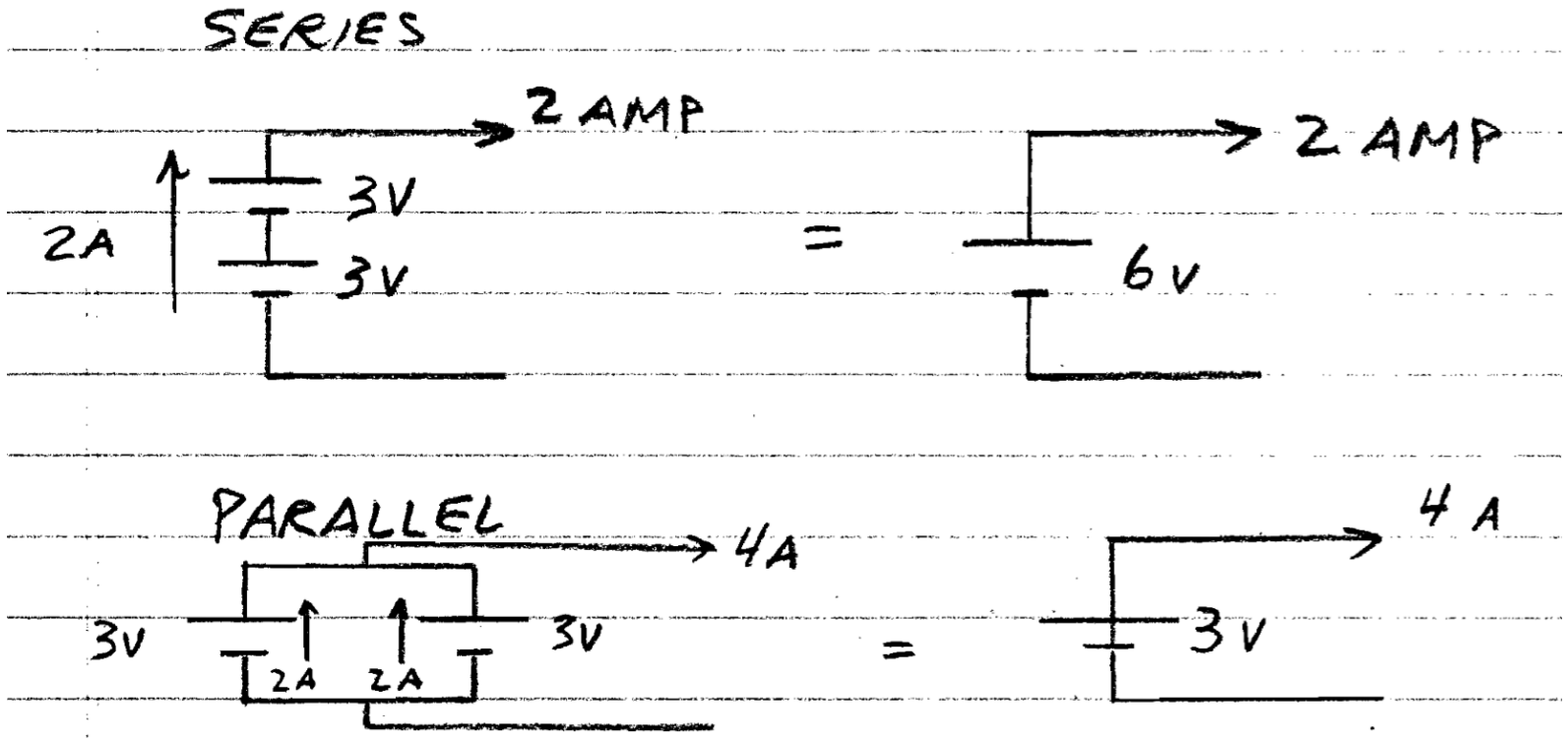
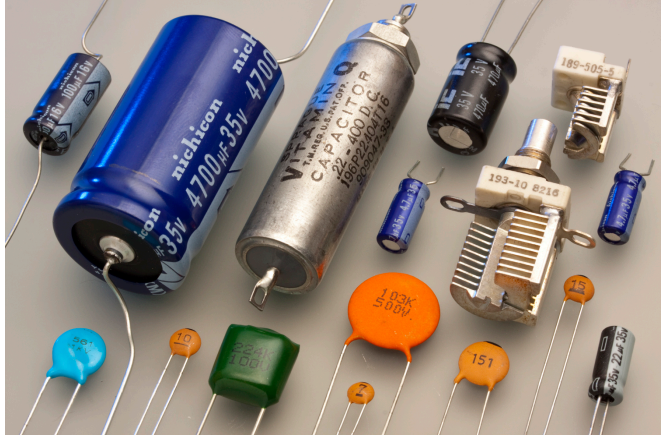
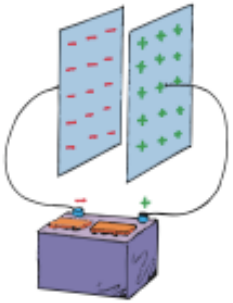
- **<u>Batteries</u>**
  - Series: Voltages are summed, current is constant
  - Parallel: Voltage is constant, currents summed



Capacitors



- **<u>Capacitors</u>** store electrical energy
  - Made of two closely spaced metal parallel plates with material between them
- The capacitance (ability to store charge) depends upon:
  - Type of material between the plates
  - Area of the plates
  - Distance the plates are separated
- Capacitance is measured in units of Farads [F].



$$Q = CV$$

$Q = charge$ [C]
$C = capacitance$ [F]
$V = voltage$ [V]
$E = Energy$ [J]

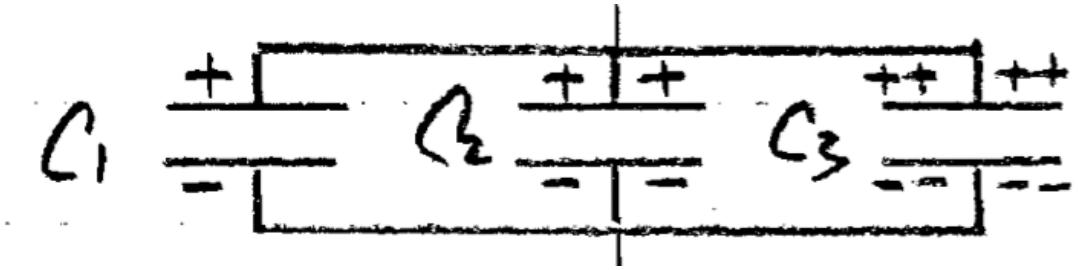
$$E = \frac{1}{2}QV$$

Ex: How much charge is stored in a 60 mF capacitor when it is hooked up to two 3 V batteries connected in series?

How much energy is stored in this capacitor?

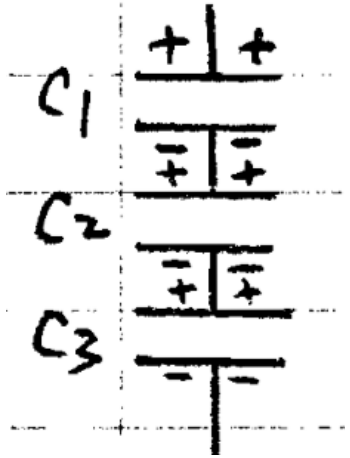
Equivalent Capacitance

- Parallel:



$$C_{total} = C_1 + C_2 + C_3$$

- Series:



$$\frac{1}{C_{total}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

What happens when you place a capacitor in series with a light bulb?

- When you place a capacitor in a circuit containing a light bulb and a battery, the capacitor will initially charge up.
- As this charging up is happening, there will be a nonzero current in the circuit, so the light bulb will light up.
- However, the capacitor will eventually be fully charged at which point the potential between its plates will match the voltage of the battery, and the current in the circuit will drop to zero.
- This is when the light bulb will dim and then fizzle out.

What happens when you remove the battery?

- When the battery is removed from the circuit, the capacitor will discharge.
- As this happens, there will once again be a nonzero current flowing through the circuit, and the bulb will light up.
- However, the current will steadily decrease as the capacitor discharges and will eventually drop to zero at which point the bulb will go off.