Lecture 12

Chapter 26

Capacitance - Examples

Capacitance – Question #4

- A) In (a) are C_1 and C_3 in series?

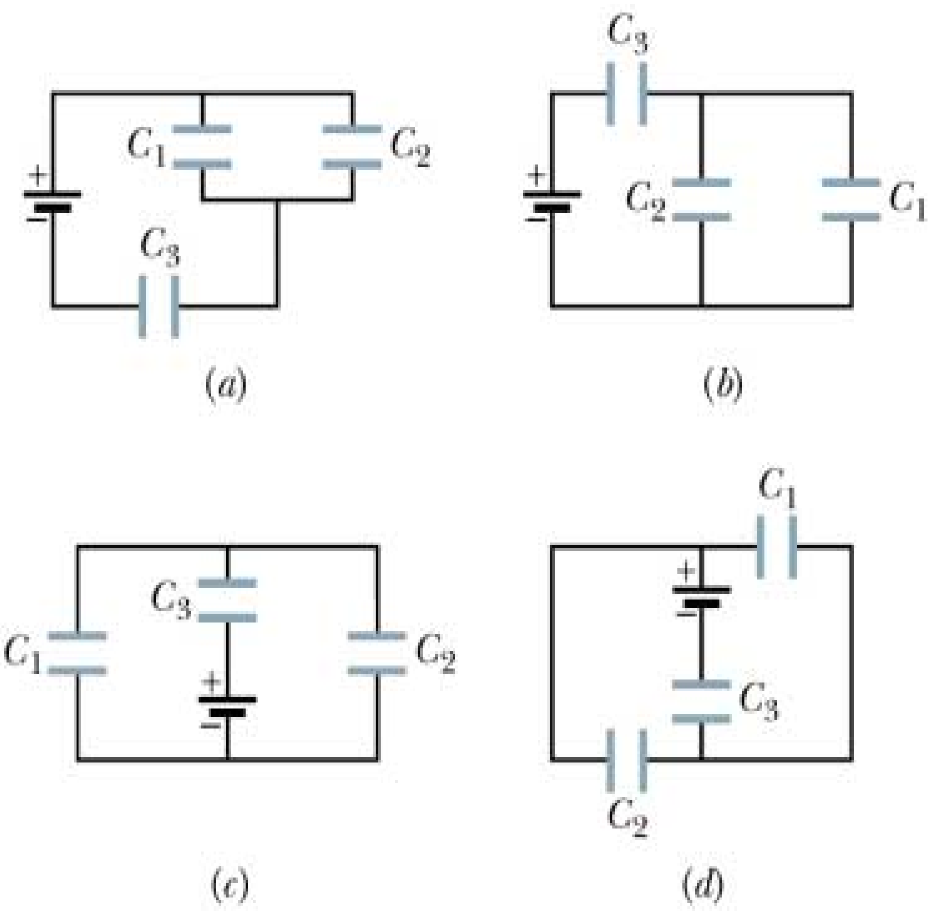
  YES

- B) In (a) are C_1 and C_2 in parallel?

  YES

- Rank the C_{eq} of the 4 circuits.

  All the same



Capacitance – Question #9

- After switches close for which circuit will the charge on the left-hand capacitor
- A) increase?

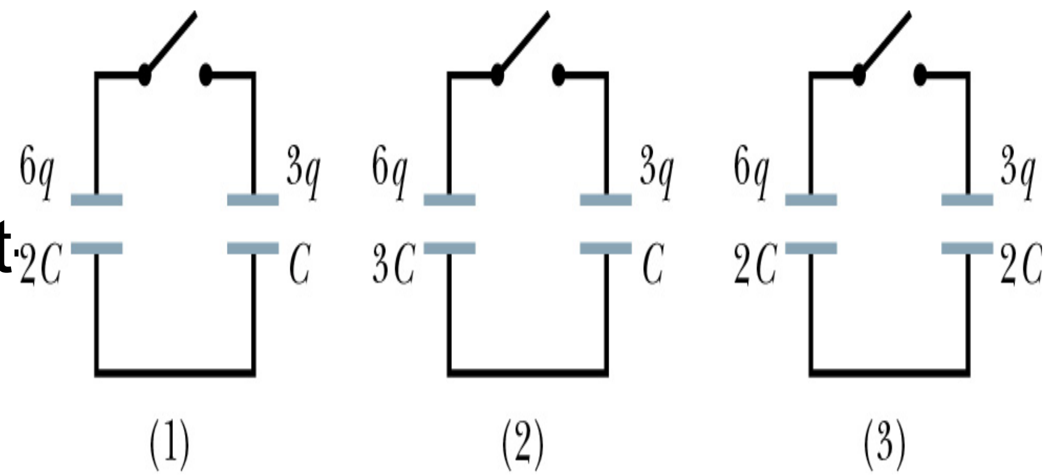
  2

- B) decrease?

  3

- C) same?

  1



- Charge flows until the capacitors have the same potential, *V*

$$q = CV$$

Lecture 12

Chapter 27

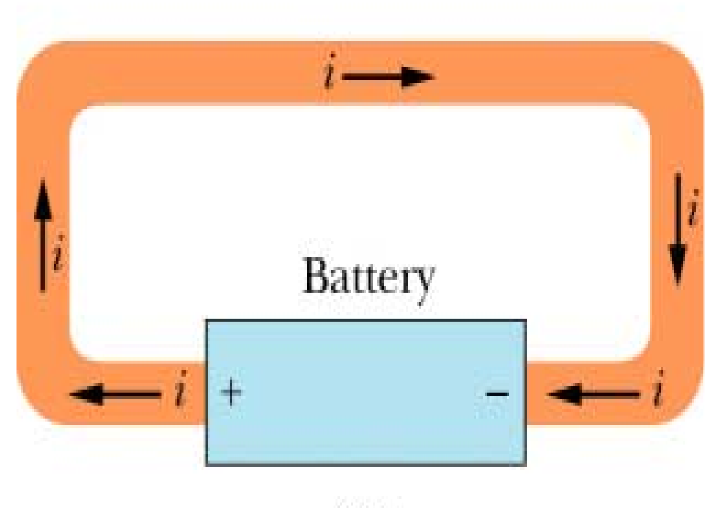
Current and Resistance

Current (1)

- What happens when charges move?
- Isolated conductor –
  - Random motion of conduction electrons in both directions so net transport of charges
  - Same potential everywhere, no *E* field inside or on surface so no electric *F* on electrons
- No current in isolated conductor

Current (2)

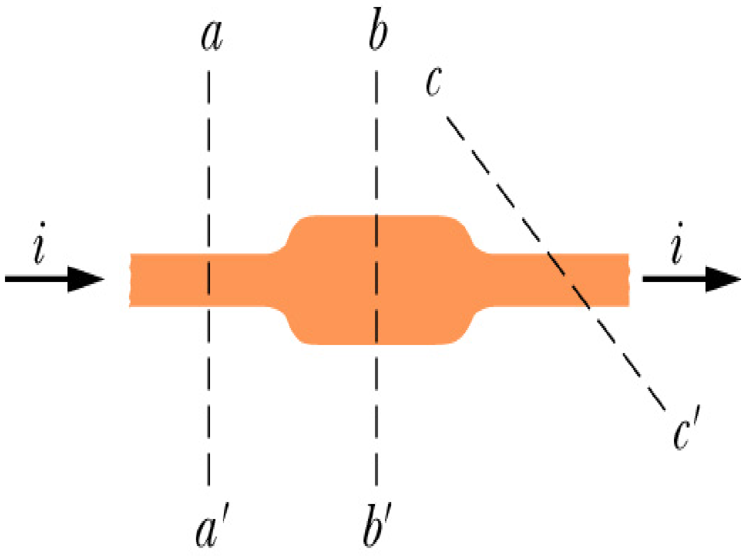
- What happens when charges move?
- Adding a battery –
  - Bias flow of conduction electrons in one direction have net transport of charge
  - Not a single potential, have *E* field inside which exerts *F* on electrons
- Current in a conductor when attached to a battery



Current (3)

- Amount of current, *i* equals amount of *q* that passes in *t* through an area ⊥ to the flow
- If *i* doesn't vary with time (called steady state) *q* is conserved, *i* is the same for all planes which pass through conductor
  - Orientation doesn't matter

$$i = \frac{dq}{dt}$$

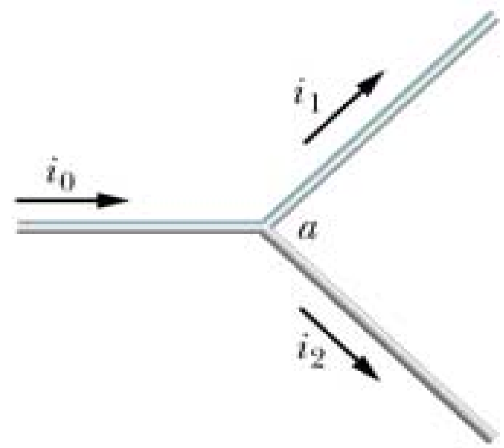


Current (4)

- SI unit for current is ampere

$$1A = 1C/s$$

- Current is a scalar



- Use arrows to indicate charge flow along conductor

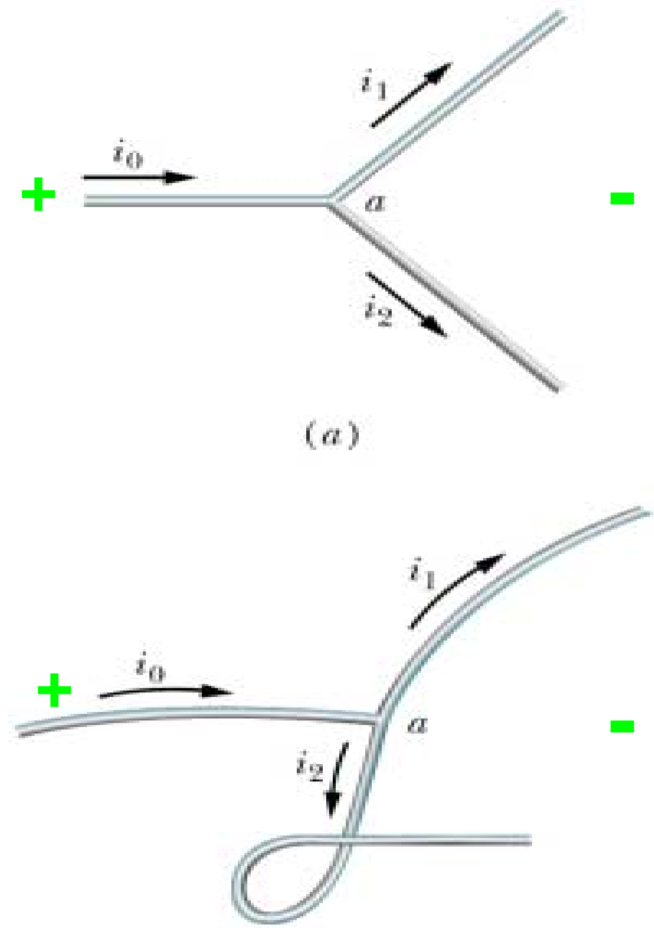
- q is conserved so

$$i_0 = i_1 + i_2$$

Current (5)

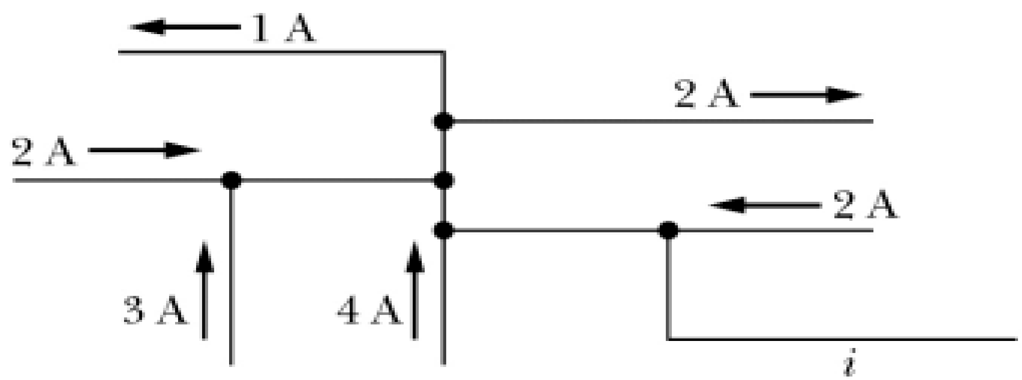
- Convention: a current arrow is drawn in direction of + charge flow
  - Defined direction of current is opposite to direction of physical current (electrons are the moving charges)
- Current arrows are not vectors
- Bending or reorienting wires does not change

$$i_0 = i_1 + i_2$$



Current (6)

- Checkpoint #1 – What is the magnitude and direction of the current, *i* , in the lower right-hand wire?
- q is conserved



$$i_{in} = i_{out}$$

$$i_{in} = 11A$$ $$i_{out} = 3A + i$$

$$i = 8A$$ To the right

Current (7)

- Total current through a surface can be defined as
- Current density, *J* – flow of charge through a cross section
- If *i* uniform and parallel to *dA*
- SI unit for *J* is A/m^2

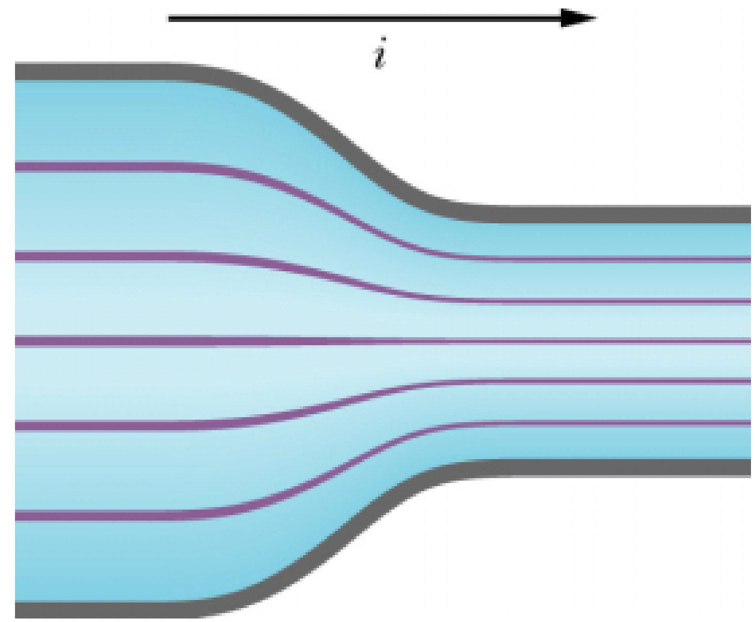
$$i = \int \vec{J} \bullet d\vec{A}$$

$$i = \int J dA = JA$$

$$J = \frac{i}{A}$$

Current (8)

- Represent J by streamlines



- q is conserved so amount of i cannot change
- J becomes greater in narrower conductor
- Streamlines closer together mean greater J

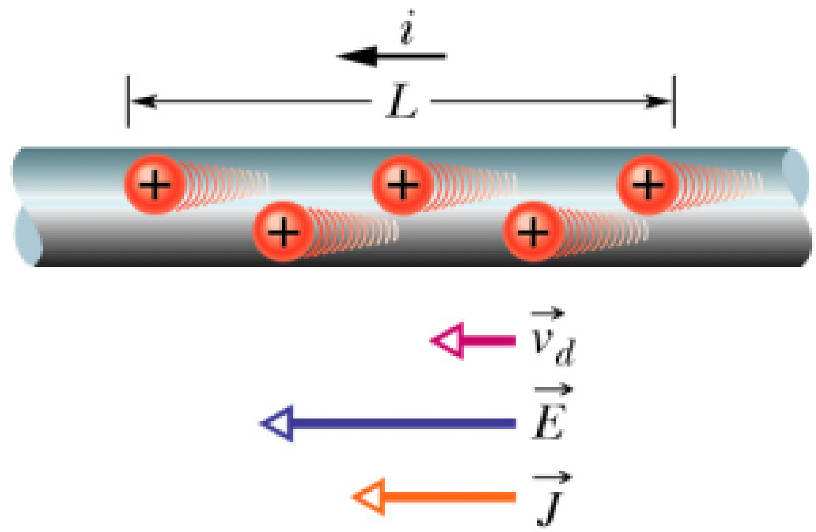
$$J = \frac{i}{A}$$

Current (9)

- No current in conductor electrons move randomly with speeds ≈ 10^6 m/s

- If current present electrons also move with a drift speed v_d

- Drift speeds are tiny $v_d \approx 10^{-5}$ or 10^{-4} m/s



- Why do the lights come on quickly?
- E field moves at speed of light