ELECTRIC CURRENT

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Supplementary Material for PHY1308 (General Physics - Electricity and Magnetism)

ANNOUNCEMENTS

- **Homework 5:**
  - Due next Tuesday by 9:30am
- **Exam 1, Quizzes 1-3, Homework 0-3**
  - Available for pickup RIGHT AFTER CLASS in FS60
  - Available during Mr. Ferrante's office hours tonight, 5-7pm
  - Pickup ONLY. Please discuss your grade or questions on the exam with me, not with Mr. Ferrante. Make an appointment to speak with me or just come to office hours on Monday.

REVIEW

Definition of a "current":

change in something / change in time

Definition of ELECTRIC CURRENT:

$$I_{average} = \frac{\Delta Q}{\Delta t}$$

Microscopic picture of electric current:

$$I_{average} = n\, q\, A\, v_{drift}$$

New Idea: current density (independent of area)

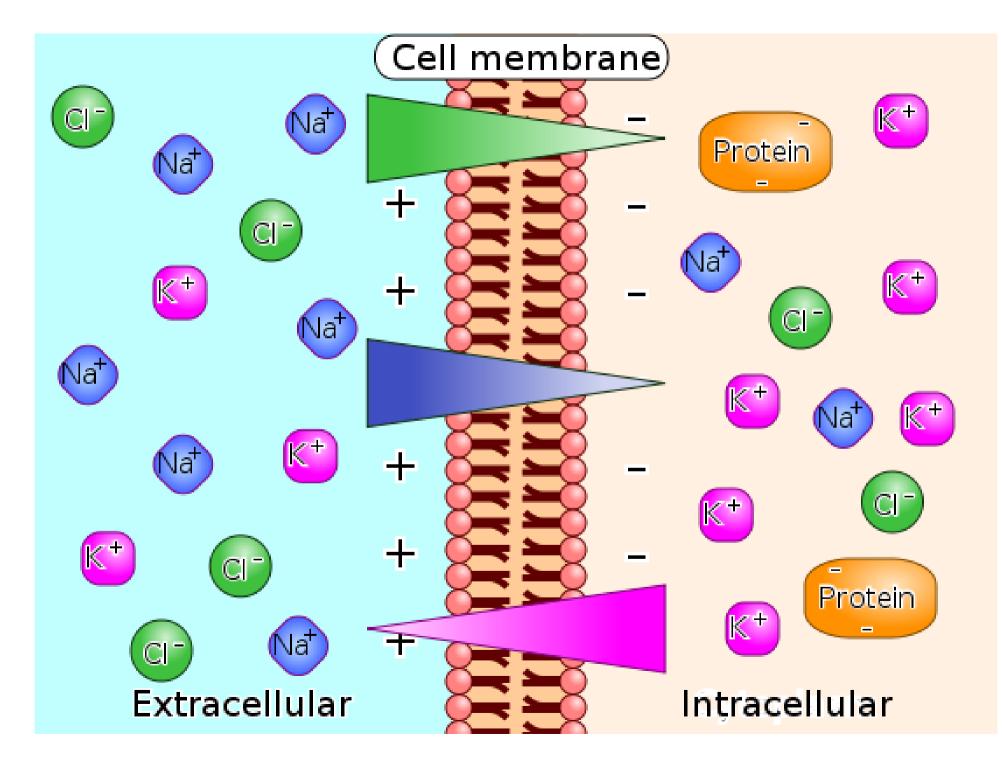$$J = \frac{I_{average}}{A} \rightarrow \vec{J} = n\, q\, \vec{v}_{drift}$$
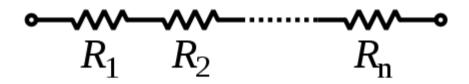
MECHANICAL MODEL

- Features:
  - nails/pins are the location of "atoms" in a conductor
  - steel balls are "electrons"
- Observations
  - average speed of electrons reduced by collisions with atoms
  - each collision produces a softer "plink" than would happen if the electrons dropped the full height of the model without colliding
- Conclusions
  - kinetic energy PER COLLISION leads to less energy transferred to atoms – less sound (less radiation) – when atoms are more closely spaced and provide more resistance to motion.

NUMBERS FROM MODEL

- Average speed
  - about 80-120 mm/s
- Estimate of instantaneous speed
  - 400-600 mm/s
  - depends on the distance between collisions
- Instantaneous and average speed can greatly differ!

Cell membrane

Extracellular

Intracellular

Cl^- Na^+ Na^+ Cl^- K^+ Na^+ Na^+ K^+ Na^+ K^+ Cl^-

Na^+ Cl^-

$-$ $-$ $-$ $-$ $-$

$+$ $+$ $+$ $+$ $+$

Protein $-$

K^+ Na^+ Cl^- K^+ K^+ Na^+ K^+ K^+ Cl^- K^+

Protein $-$

$$R_1 \quad\quad R_2 \quad\quad\quad\quad\quad R_n$$