

## Chapter 2 Voltage and Current

## Atomic Theory

- Atom
  - Contains a nucleus of protons and neutrons
  - Nucleus is surrounded by a group of orbiting electrons
- Electrons are negative, protons are positive

## Atomic Theory

- Electrically neutral atom
  - Equal number of electrons and protons
- Ion
  - An atom with an excess or deficit of electrons

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## Atomic Theory

- Bohr model
  - Electrons orbit the nucleus in discrete orbits called shells
  - Designated by letters K, L, M, N, etc.
- Only certain numbers of electrons can exist within any given shell

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## Atomic Theory

- Quantum mechanical model
  - Electrons occupy positions within the atom that are determined statistically

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## Atomic Theory

- Valence shell
  - Outermost shell of an atom
  - Electrons in this shell are called valence electrons

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## Atomic Theory

- No element can have more than eight valence electrons
- Number of valence electrons affects its electrical properties

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## Conductors

- Materials with a large numbers of free electrons
  - Metals are good conductors because they have few loosely bound valence electrons

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## Conductors

- Excellent conductors
  - Silver
  - Gold
  - Copper
  - Aluminum

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## Insulators

- Materials that do not conduct because their valence shells are full or almost full
  - Glass, porcelain, plastic, and rubber are good insulators
  - High voltage will cause an insulator to break down and conduct

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## Semiconductors

- Half-filled valence shells (4 electrons)
  - Neither good conductors nor good insulators
- Silicon and germanium
  - Primary materials in semiconductor devices
  - Used to make transistors, diodes, and integrated circuits

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## Electrical Charge

- Objects become charged when they have an excess or deficiency of electrons
- An example is static electricity

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## Electrical Charge

- Unit of charge is the coulomb (C)
- One coulomb
  - $6.24 \times 10^{18}$  electrons (or protons)
- The charge on one electron (or proton)
  - $1/6.24 \times 10^{18}$  or  $1.6 \times 10^{-19}$  C

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## Voltage

- When two objects have a difference in charges
  - They have a potential difference or voltage between them
- Unit of voltage is the volt
- Thunderclouds
  - Millions of volts between them

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## Voltage

- Difference in potential energy
- Voltage between two points
  - One volt if it requires one joule of energy to move one coulomb of charge from one point to another

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## Voltage

- $V = \text{Work/Charge}$

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}}$$

- Voltage is always measured between two points

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## Current

- Movement of charge is electric current
- More electrons per second passing through a circuit, the greater the current
- Current is rate of flow of charge

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## Current

- Unit of current is ampere (A)
- One ampere
  - Current in a circuit when one coulomb of charge passes a given point in one second
- Current = Charge/time
- $I = Q/t$

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## Current

- Electron current flow
  - Electrons flow from the negative terminal of a battery to the positive terminal
- Conventional current flow
  - We may also assume currents flow from positive to negative

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## Current

- Conventional current flow is used in this course
- Alternating current changes direction cyclically
- Alternating voltage changes sign cyclically

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## Batteries

- Alkaline
- Carbon-Zinc
- Lithium
- Nickel-Cadmium
- Lead-Acid

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## Battery Capacity

- Specified in amp-hours
- Life
  - Capacity/current drain
- Affected by
  - Discharge rates, operating schedules, temperatures, and other factors

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## Other Voltage Sources

- Electronic Power Supplies
- Solar Cells
- DC Generators

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## How to Measure Voltage

- Place voltmeter leads across components
- Red lead is positive
- Black lead is negative
- If leads are reversed, you will read the opposite polarity

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## How to Measure Current

- Measurable current must pass through meter
- Open circuit and insert meter
- Connect with correct polarity

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## Switches

- Single-pole, single-throw
- Single-pole, double-throw
- Double-pole, single-throw
- Push-button - normally open or normally closed

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## Fuses and Circuit Breakers

- Protect equipment or wiring against excessive current
- Fuses use a metallic element that melts
- Slow-blow and fast-blow fuses

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## Fuses and Circuit Breakers

- If current exceeds rated value of a circuit breaker
  - Magnetic field produced by the excessive current operates trips open a switch

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