CH. 17 WELCOME TO THE WONDERFUL WORLD OF ELECTROMAGNETISM!

7th Physical Science

17.1 ELECTROSTATICS

Atom (Pg. 10)
- + charge on ________________
- - charge on ________________
- 0 charge on ________________
17.1 Electrostatics

- Pg. 9 #1
  - a) + charge on an object by [gaining][losing] electrons
  - b) - charge on an object by [gaining][losing] electrons

#2 Like charges ______________. Opposites ____________

- What is the unit for electric charge?
  
  **Coulomb**

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**Coulomb’s Law**

For

**Electric Force**

(pg. 1)
17.1 Electrostatics

- Electric (Coulomb) force

Coulomb’s Law for Electric Force

\[ F = k_e \frac{q_1 q_2}{r^2} \]

- Coulomb’s constant
  \[ k_e = 8.987551 \times 10^9 \text{ Nm}^2/\text{C}^2 \]
17.1 Electrostatics (Pg. 1)

- Electric force (unit ____ ) = ?
- Electric field (unit _____ ) = ?
- Static electricity = ?

17.1 Electrostatics

- Electric force (unit N) = push/pull between charges
- Electric field (unit N/C) = space around a charged object
- Static electricity = charges that are not moving
How to charge up?

- Friction: The friction of rubbing a balloon on your hair causes electrons to move from your hair to the balloon. Your hair and the balloon become oppositely charged and attract each other.
- Conduction: When a negatively charged plastic ruler touches an uncharged metal rod, the electrons in the ruler travel to the rod. The rod becomes negatively charged by conduction.
- Induction: A negatively charged balloon makes a small section of a metal beam have a positive charge through induction. Electrons in the metal are repelled by and move away from the balloon.
METHODS OF CHARGING UP

- Describe the methods you observe in this clip:
- [http://www.youtube.com/watch?v=EURZLiQfM7k&NR=1&feature=fvwpl](http://www.youtube.com/watch?v=EURZLiQfM7k&NR=1&feature=fvwpl) (Mr. Bean static electricity)

17.1 ELECTROSTATICS

- Pg. 10

Q) Label the following pictures as examples of **conduction**, **induction**, **friction**, or **electric discharge**.

1. ![Picture 1]
2. ![Picture 2]
3. ![Picture 3]
4. ![Picture 4]
5. ![Picture 5]
17.1 ElectroStatics

Charge is *conserved*

- How to **detect** charge: *electroscope*

- Can the electroscope detect if the charge is positive or negative? [yes][no]
17.1 ElectroStatic

- Charges can move
- charged metal rod. Touch another metal rod. What happens?
- + charged metal rod. Touch another metal rod. What happens?
- Some materials are better at letting charges move than others.
  - This is good at letting charges move: [conductor][insulator]
  - This is bad at letting charges move: [conductor][insulator]
17.1 Electrostatics

- Which parts are conductors? Insulators?

Earth is a big **sink** for electric charge.
17.1 Electrostatics

- How does static electricity build up?
  - Punny: [http://www.youtube.com/watch?v=HDfBAT1IEo](http://www.youtube.com/watch?v=HDfBAT1IEo)

- Why do static shocks happen on hot dry days?
17.1 Electrostatics

- How to avoid static cling of socks in the dryer?

17.1 Electrostatics

- What kind of shoes should people at grain silos wear? [conductive][insulating]
17.1 Electrostatics

- How does lightning happen?

- How do lightning rods work?
HW

- Read 17.1
- Page 3 (17.1 questions)
- Page 10 (induction, conduction, friction, or electric discharge)
  - Crossword (Pg. 6) — preview all the vocabulary words
- Mini-lab on Wednesday — making static electricity

CROSSWORD (PG. 6) — PREVIEW ALL THE VOCABULARY WORDS

- Word bank
  - insulator  power  load
  - conductor  voltage  battery
  - insulator  resistance  switch
  - static  current  photocell
  - induction  potential  series
  - conduction  force  circuit
  - discharge  charge  cell
  - field  thermocouple
Q) How does the balloon induce charge on the wall?
**Activity (Pg. 7~8) – Magic Wand Lab**

- Activity #1: Balloon
- Activity #2: Pith Balls
- Activity #3: Van de Graaf Generator Video
17.1 ElectroStatic

- Van-de-Graaff

- http://www.youtube.com/watch?v=WS9ISUXBsa8&feature=related
- http://www.youtube.com/watch?v=hh8PqQDOAb8

17.1 ElectroStatic

- Electric field
- Fill in Page 10
ELECTRIC FIELD: PG. 11

III. Electric Field = __________________________ = __________________________

SI Unit = __________________________

Draw the electric field lines.

Q) How does a CRT work?
17.1 **Electrostatics**

- How a cathode-ray tube (CRT) works

![Diagram of CRT](image)

<table>
<thead>
<tr>
<th>Name</th>
<th>Equation</th>
<th>SI Unit</th>
<th>Meaning</th>
<th>Picture</th>
</tr>
</thead>
<tbody>
<tr>
<td>electric force</td>
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<td>electric field</td>
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</tbody>
</table>
17.1 ELECTRICAL APPLICATIONS

- How a microwave works
- [http://www.colorado.edu/physics/PhysicsInitiative/image-bin/old_images/microwaveCartoon/page1.htm](http://www.colorado.edu/physics/PhysicsInitiative/image-bin/old_images/microwaveCartoon/page1.htm)
17.1 Electrical Applications

- How a microwave works

II. More on Electrostatics: Applications (Page 11)

- In an elevator: Conductor in electrostatic equilibrium

IV. Conductor with Static Electricity

Q) Wrap your cell phone in aluminum foil (without touching the antenna). Will you be able to receive calls? Why is it hard to get calls in a basement or elevator?
STATIC ELECTRICITY APPLICATIONS

Q) How do cosmetics stick?

II. MORE ON ELECTROSTATICS: APPLICATIONS

How does a Xerox machine work?

1. drum is positively charged
2. light cancels positive charge, leaving replica of image
3. negatively-charged toner attracted to drum
4. positively-charged paper attracts toner
5. toner fuses to paper
17.2 CIRCUIT VOCABULARY

- Electric Charge
- Electric Force
- Electric Field

- Voltage
- Current
- Resistance

17.2 FLOWING CHARGES

- Electrical energy = energy of electric charge
  - Potential energy
  - Kinetic energy
- Electric current
  - How fast charges flow
  - Amperes

*Figure 1* Electrons moving in a wire make up current and provide energy to the things that you use each day.
17.2 Flowing Charges

- When you flip the switch, the light turns on **instantly**.
  - Does the electron from the switch run all the way to the light bulb?

  - A single electron takes __________ to move 1 meter

An **electric field** is set up at the speed of light

A single electron takes **over an hour** to move 1 meter
17.2 **2 Types of Current**

- A battery sets up [AC][DC].
- The mains (outlet) sets up [AC][DC].
- The power company makes [AC][DC] at ______ V, ______ Hz.

17.2 **Voltage = Electrical Pressure**
17.2 Voltage = Electrical Pressure

- Charge can move → charge does work = force x distance
- Voltage = Work/charge = change in PE/charge
17.2 Voltage = Electrical Pressure

- Which one will set up a larger current? Why?
- Which one will make charges do more work?

17.2 Resistance = Electrical Opposing ‘Friction’

- HIGH voltage → [low][high] current
- HIGH resistance → [low][high] current

Resistance depends on the wire’s
- Material
- Length
- Cross-sectional Area (thickness)
- Temperature
A superconductor wire’s current can stay ________________
Superconductor at room temperature?
### 17.2 Resistance = Electrical Opposing ‘Friction’

- Resistance depends on the wire’s

<table>
<thead>
<tr>
<th>Material</th>
<th>HIGH R</th>
<th>LOW R</th>
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<tbody>
<tr>
<td>Length</td>
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<td></td>
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<tr>
<td>Thickness</td>
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<td>Temperature</td>
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#### 17.2 A Closer Look at: V, I, R (Pg. 1)

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<tr>
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<tr>
<td>current</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>resistance</td>
<td></td>
<td></td>
<td>Oh, my goodness!</td>
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</tbody>
</table>
17.2 A CLOSER LOOK AT: \( V, \ I, \ R \) (Pg. 12)

**V, Voltage**  What is the voltage across the metal plates?

Q) Voltage: Think ____________. Have ____________, will ____________.
Which causes damage: current or voltage?
To have current, we need 2 things
1) ________________ 2) ________________

---

17.2 A CLOSER LOOK AT: \( V, \ I, \ R \)

Q) Draw the Electric field lines and current, if any.

- 125 V ________
- 5 V ________
- 120V _______
- 0 V ________
- 120V _______
- -120V ________
17.2 A CLOSER LOOK AT: V, I, R

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<tbody>
<tr>
<td>Power</td>
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</table>

Watt’s happening?

17.3 ELECTRICAL CALCULATIONS

- Ohm’s Law
- Power
- Calculating household energy use
- Watt
- Kilowatt
- Kilowatt-hour
17.3 OHM’S LAW  \( \Omega \)

- More voltage \( \rightarrow \) [more][less] current
- More resistance \( \rightarrow \) [more][less] current

What is Ohm’s Law?

**Figure 1** The relationship between current and voltage is

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**Math Focus**  
What is the voltage if the current is 2 A and the resistance is 12 \( \Omega \)?

**Step 1:** Write the equation for voltage.

\[ V = I \times R \]

**Step 2:** Replace the current and resistance with the measurements given in the problem, and solve.

\[ V = 2 \, \text{A} \times 12 \, \Omega \]
\[ V = 24 \, \text{V} \]

**Now It’s Your Turn**

1. Find the voltage if the current is 0.2 A and the resistance is 2 \( \Omega \).
2. The resistance of an object is 4 \( \Omega \). If the current in the object is 9 A, what voltage must be used?
3. An object has a resistance of 20 \( \Omega \). Calculate the voltage needed to produce a current of 0.5 A.
17.3 Electric Power

- Which bulb is brightest?
17.3 **Electrical Energy**

\[
\text{Energy} = \quad \text{[Blank]} \quad \text{[Blank]}
\]

(a) You use 100W lightbulb for 24 hours. How much energy in kilowatt-hours did you consume?

17.3 **Electrical Energy**

(b) How do you read an electric meter? (Fig. 492, Figure 3)
17.3 ELECTRICAL ENERGY

**Power and Energy** A small television set draws a current of 0.42 A at 120 V. What is the power rating for the television? How much energy is used if the television is on for 3 h?

**Step 1:** Write the equation for power.

\[ P = V \times I \]

**Step 2:** Replace the voltage and current with the measurements given in the problem, and solve.

\[ P = 120 \, \text{V} \times 0.42 \, \text{A} \]

\[ P = 50.4 \, \text{W}, \text{ or } 0.0504 \, \text{kW} \]

**Step 3:** Write the equation for electrical energy.

\[ E = P \times t \]

---

(b) **Energy (kWh)** = 

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**Step 4:** Replace the power and time with the measurements given in the problem and solve.

\[ E = 0.0504 \, \text{kW} \times 3 \, \text{h} \]

\[ E = 0.1512 \, \text{kWh} \]

**Now It’s Your Turn**

1. A computer monitor draws 1.2 A at a voltage of 120 V. What is the power rating of the monitor?
2. A light bulb draws a 0.5 A current at a voltage of 120 V. What is the power rating of the light bulb?
3. How much electrical energy does a 100 W light bulb use if it is left on for 24 h?
17.4 ELECTRICAL CIRCUITS

Electric Circuit = ______________________

There must be

1) ______________________

2) ______________________

---

- 3 parts of a circuit

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Figure 1: Necessary Parts of a Circuit

The energy source can be a battery, a photocell, a thermocouple, or an electric generator at a power plant.

Wires connect the other parts of a circuit. Wires are made of conducting materials that have low resistance, such as copper.

Examples of loads are light bulbs, appliances, televisions, and motors.
17.4 Electrical Circuits

- Electrical Calculations:
  - Ohm’s Law: _____________
  - Power calculation: ___________
What is a SWITCH?
17.4 ELECTRICAL CIRCUITS

- 2 Types of Circuits

[Diagram of electrical circuits]
17.4 ELECTRICAL CIRCUITS

- 2 Types of Circuits – Your Turn

(a) 2 Types of Circuits – Series / Parallel Circuit?
- \( I = \) ____

(b) Series / Parallel?
- \( I_1 = \) ____
- \( I_2 = \) ____
- \( I_3 = \) ____
- \( I = \) ____

17.4 ELECTRICAL CIRCUITS

- 2 Types of Circuits – HW: Finish this

(c) \( I_1 = \) ____
- \( I_2 = \) ____
- \( I = \) ____

(d) \( I_1 = \) ____
- \( I_2 = \) ____
- \( I = \) ____
17.4 Electrical Circuits

- 2 Types of Circuits in the
17.4 ELECTRICAL CIRCUITS: Pg. 14

- 2 Types of Circuits

(a) Christmas Tree Lights

Circuit Type: __________

Advantage | Disadvantage

(b) __________

Circuit Type: __________

Advantage | Disadvantage
17.4 **Electrical Circuits**

- 2 Types of Circuits
17.4 Electrical Circuits: Pg. 15

Household Circuits

@ How does electric power get sent to your house?

@ Is each outlet in your home connected in series or in parallel? Why?

17.4 Safety

@ What is a circuit breaker? What's circuit overload?
17.4 SAFETY

- why does a ground wire make things safer?

- What's a GFCI?
17.4 SAFETY

- Safety

<table>
<thead>
<tr>
<th>Current</th>
<th>Effect</th>
</tr>
</thead>
</table>

- = dangerous!

\[ I = \frac{120V}{0V} \]

\[ R = \text{[Diagram of a rectangle]} \]
III. CIRCUITS

- Voltage
I. ELECTROSTATICS

- Worksheet on Static Electricity

http://www.youtube.com/watch?v=JzSF8iZTPBw&feature=related
I. ELECTROSTATICS

- Worksheet on Static Electricity: Van de Graaf Generator
  
  [Video 1](http://www.youtube.com/watch?v=WS9ISUXBa8&feature=related)
  
  [Video 2](http://www.youtube.com/watch?v=hh8PqQDOAb8)

7TH SCIENCE MONDAY

- Preview crossword 17.1 due
- Balloon, magic wand, electrostat mini-lab
- More on electric field, voltage
- Crt
- Bird + bonus worksheet
- Van-de-graaff descriptions, video
- Elevator and aluminum foil

- Safety [http://www.tva.gov/power/homesafety.htm](http://www.tva.gov/power/homesafety.htm)
7TH SCIENCE - WEDNESDAY

- Basic circuits
- New packet 17b
- Collect device information over the break
- V=IR module over break
- 17a due after break
- Ch. 19 – each student writes 1 page on different device in own words. Present on a Wednesday.

- Ohm's law lab (1 class) +
- Household circuit activity (take-home)

- http://www.youtube.com/watch?v=EURZLiQfM7k&NR=1&feature=fvwps (Mr. Bean static electricity)
- http://www.engineeringinteract.org/resources/siliconspies.html (electricity interactive games)
- http://www.engineeringinteract.org/ (Cambridge)
- http://www.engineeringinteract.org/resources/siliconspies.html
Congratulations! You've solved the puzzle!

MISSION COMPLETE: Dr. Voit's evil plans have been found. Silicon City is saved!

Buzz has prepared a report on your work. Click the button below to find out how you did and to display your certificate.

Max Wells was a double-agent! Your final score: 20

Final Report

Agent Name: YOUR NAME
Final Score: 20 out of 40
Agent Knowledge Rating: 50%
Agent Investigation Rating: 100%

Buzz has promoted you to chief spy!

Thank you for playing!