#### CONDLICTION AND OHM'S LAW

#### Prof. Stephen Sekula 9/29/2010 Supplementary Material for PHY1308 (General Physics -Electricity and Magnetism)

#### ANNOLINCEMENTS

- Homework 6:
  - Due next Monday by 5pm
- In-class quiz
  - Friday, covering homework 5 (capacitors)
- Exam grading
  - Ongoing, expect results later today

#### EXTRA CREDIT #2

- . Attend the Physics Research Fair
  - . Friday, 2:30-5:00 p.m. in Fondren Science 127
  - . Undergraduate Research
- . Talk to the presenters
  - . format: poster presentations with speaker-driven narratives
  - No speaker for the poster you want to use? Contact the author and interview them outside of the fair. CITE THE INTERVIEW.
- Write a 1-2 page paper
  - . http://www.physics.smu.edu/sekula/phy1308/PHY1308\_PaperGuidelines.pdf

### GEORG SIMON OHM



1789-1854

German physicist who began his studies using the newly developed "electrochemical cell" (battery) invented by Italian Count Allesandro Volta.

Published in 1827 his discovery of a relationship between current and voltage.

## CONDUCTOR ECONOMICS

- Commodity Prices
  - Gold: ~\$1300/troy ounce
  - Copper: ~\$4/troy ounce







- How much potential (voltage) is needed to drive 15A of current through a 1.8mm diameter copper wire?
  - copper resistivity: 1.68  $\times$  10°  $\Omega m$
  - what do you think? Big voltage or little voltage?

- How much potential (voltage) is needed to drive 15A of current through a 1.8mm diameter copper wire?
  - copper resistivity: 1.68  $\times$  10  $^{\text{-8}}$   $\Omega\text{m}$

$$E = J \rho = \frac{I \rho}{A} = 99 \,\mathrm{mV/m}$$

 each meter of wire needs only 99mV of potential to drive 15A

- Flip the problem around: how much current can a 120V potential drive through 1.0 of such wire?
  - Answer: about 18,000A
  - Yikes!
  - Might it be bad to remove the appliance from the end of its electrical cable and then short the cable?

- How much power is being dissipated in the copper wire when it's shorted?
  - Answer:

 $P = IV = (1.8 \times 10^4 \text{ A})(120 \text{ V}) = 2.2 \times 10^6 \text{ J/s} = 2.2 \text{ Million Watts}$ 

- What does this equal? House fire!
- NEVER SHORT CIRCUIT YOUR HOUSE WIRING!!!

#### EXAMPLE: HUMAN

- You accidentally stick one finger from each hand in the slots of an electrical outlet (120V). How much current goes through your body under perfectly dry conditions?
  - Answer:

$$I = V/R = (120 \text{ V})/(10^5 \Omega) = 1.2 \text{ mA}$$

• Will you feel this? Is it enough to kill?

## USEFUL NUMBERS

- Current and human biology
  - 0.5-2.0 mA
    - threshold of sensation
  - 10-15 mA
    - involuntary muscle contractions; can't let go
  - 15-100 mA
    - Severe shock; muscle control lost; breathing difficult
  - 100-200mA
    - Fibrillation of heart; death within minutes
  - >200 mA
    - Cardiac arrest; breathing stops; severe burns

# DON'T TASE ME, BRO!

- What are the properties of a Taser (stun gun)?
  - Voltages in the range 50-1000 kV
  - Delivered to the body? More like 1500V
  - What current goes through your body?
  - ANSWER:
    - That's about 15mA in the range to paralyze



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