Physics of Everyday Life

Why do you take really short steps when you walk on ice? Why are hybrid cars more efficient for in-town driving? Why does a standard electric outlet have three holes, but many devices only use two of them? Why is the sky blue, and why are sunsets red? Why are new light bulbs so much more efficient than the old incandescent bulbs? These are examples of the questions that we'll work out in this class. Each class, we'll start with some hands-on experimentation to help us understand basic principles of motion, of electricity, of light, of sound of magnetism and other topics. And then we'll discuss how what we've learned applies to everyday life. Come prepared to be active, to be social, and to be amazed! You don't need any background in science—just a bit of curiosity and a willingness to engage and explore!

As you come in:

- Get a name tent
- Introduce yourself to your neighbors
- Start chatting
- Introduce yourself to me, if you'd like!

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Week 1: Everything Is Electric
We'll make tinsel bundles fly through the air, and we'll discuss why it's safe, ⅔ of the time, to stick a fork in an electric outlet. (Please don't try this!)
Week 2: Is It Magic, or Is It Magnets?
We'll learn how to magnetize nails, and we'll discover why the dark side of a refrigerator magnet will stick to the fridge but the printed side won't. (Try it and see!)
Week 3: On Your Wavelength: Electromagnetic Waves
We'll see how to tell where a radio station is by changing reception, and we'll talk about why it's safe to stick light bulbs in the microwave. (Please don't try this!)
Week 4: Physics of Sound & Music
Bring your musical instruments to class for an open-ended exploration of how the science of sound explains how music is made.
Week 5: Energy, Thermodynamics & The Arrow of Time
We'll start by playing with toys to learn a bit about energy and heat—and then we'll discuss how the second law of thermodynamics explains why hybrid cars are more efficient and why time goes the direction it does.
Week 6: Push and Pull: Force & Motion
We'll start with a (rigged) tug-of-war contest, and discuss why you need to slow down on corners and walk with short steps on ice.
Week 7: Go With the Flow: Physics of Fluids
How do hot air balloons stay up? And why does your blood pressure go down when you exercise? We'll talk.
Week 8: A Warm Planet in a Cold Universe: How the Earth Stays Warm, and Why It's Getting Warmer
A very timely and relevant topic. We'll learn what makes a gas a greenhouse gas, and explore why—in the case of these very useful gases—you can have too much of a good thing.

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Physics Principles

Charges & Forces

Conductors & Insulators

Voltage

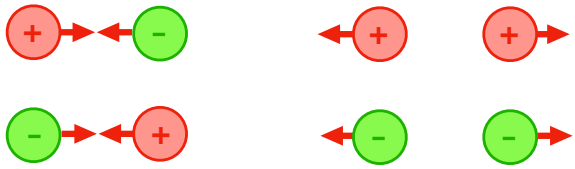
Current

Resistance

Electric Fields

Matter is made of charged particles.
They come in two types:
Positive and negative

Opposite charges attract
Like charges repel



When two different materials touch and then are taken apart, charges can be transferred.

When you pull a piece of tape off a roll, it picks up a positive charge.

Charges can move freely in and on conductors.
Charges stay put in and on insulators.

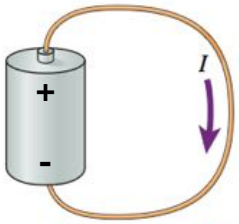
What are examples of conductors and insulators?

Current is the flow of charge.
We always imagine that the charges in motion are positive charges.

The positive terminal of a battery has an excess of positive charges; the negative terminal has an excess of negative charges.

The positive terminal is at a higher voltage than the negative terminal. Positive charges want to flow downhill from the high voltage to the lower voltage.

If you connect a conductor between the positive terminal and the negative terminal, current will flow from the positive to the negative terminal.



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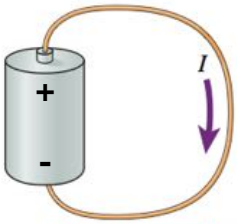
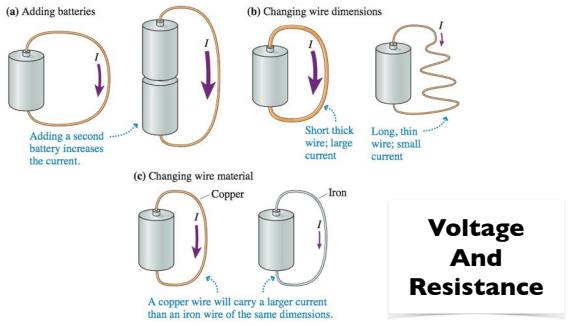
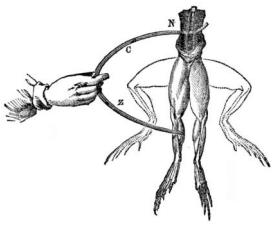


What determines the current?



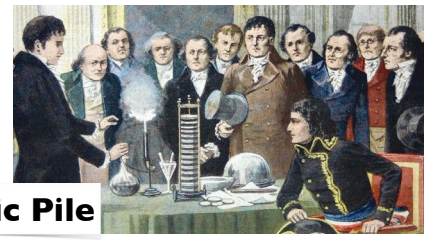
Voltage And Resistance

When different materials come in contact, one often "likes" positive charges more than the other. This makes a charge separation, and this produces a voltage.

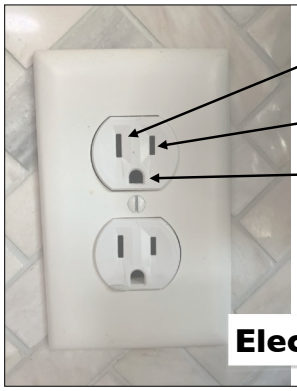


Galvanic Action

If you stack the metals with conducting materials between, this makes a battery. A bigger stack means a bigger voltage!



The Voltaic Pile



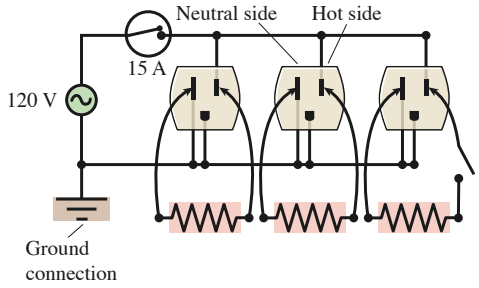
0 V / neutral

120 V / hot

0 V / ground

Electricity in your house

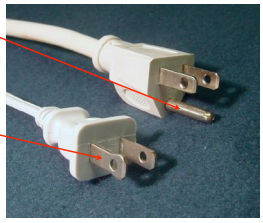
Household Electricity is Grounded Parallel Circuits.



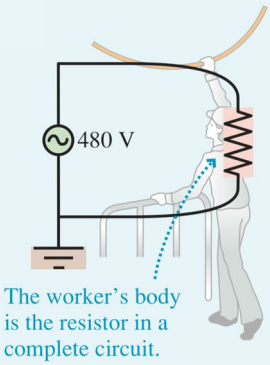
Plugs and outlets have safety features built in

The ground wire. Electrically, the same as the neutral wire. Provide an extra ground connection.

The neutral wire. This side of the plug is larger, so you can't plug it into the hot side of an electric outlet.



Because the 0 V terminals, the neutral and the ground, are at the same potential as the earth, you can get a shock from a live wire.



The worker's body is the resistor in a complete circuit.

A "ground fault" in a GFCI outlet will cause the outlet to disconnect.

The GFCI.

If the current in the hot wire isn't the same as the current in the neutral wire, the circuit breaker shuts off power.

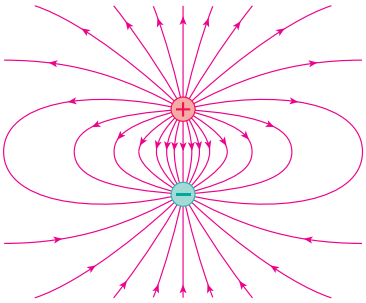
Electric Fields

In the force model, A exerts a force directly on B.

In the field model, A alters the space around it. (The wavy lines are poetic license. We'll soon learn a better representation.)

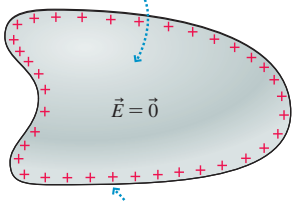
Particle B then responds to the altered space. The altered space is the agent that exerts the force on B.

Field Between Two Charges



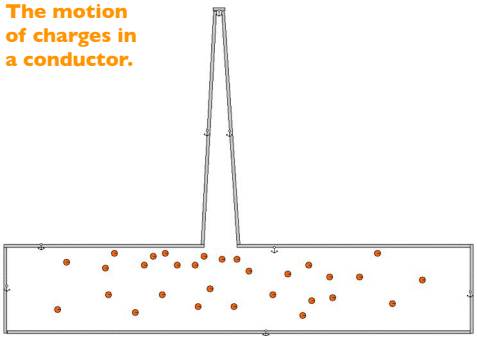
Electric fields and conductors

The electric field inside the conductor is zero.

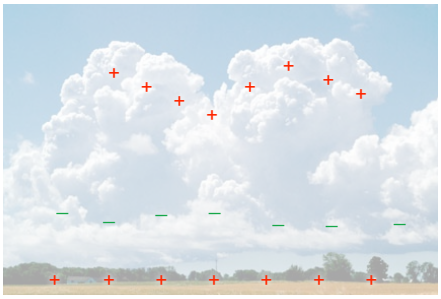


All excess charge is on the surface.

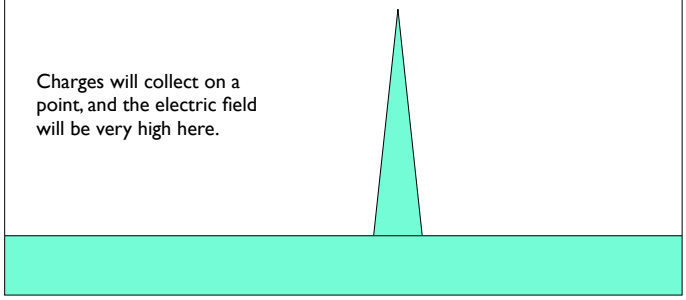
The motion of charges in a conductor.



The charge separation in the clouds induces charges in the ground.



Charges will collect on a point, and the electric field will be very high here.



Keeping Safe, Part I

The Lightning Rod

Putting a pointy bit at the top of the building...

Are they asking for trouble?

Keeping Safe, Part II

The Faraday Cage

Stay inside a conducting shell. It's all good.

The average plane is struck by lightning once per year.