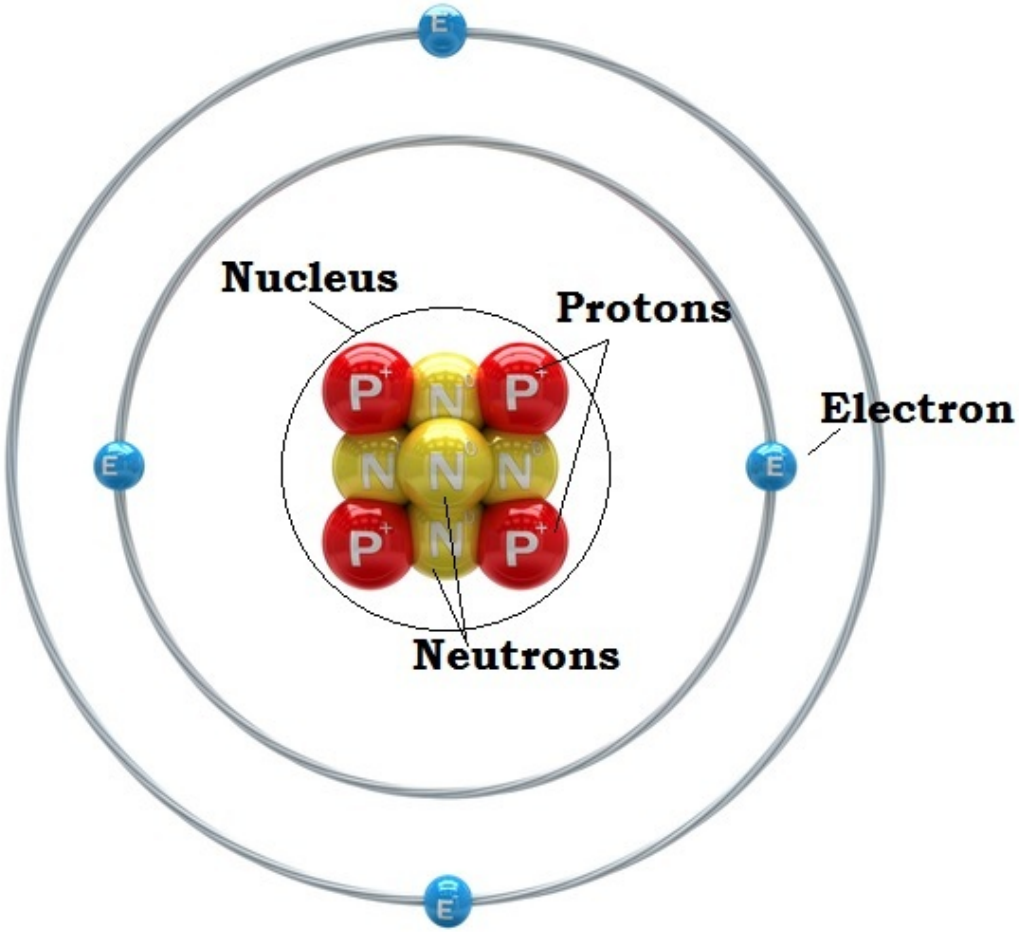
What you need to learn:

- The parts of an atom
- Definition of a circuit
- AC vs. DC
- How energy changes in a simple electric circuit
- The definitions of voltage, current, resistance, and power
- What parts of a circuit provide voltage and resistance
- What materials are insulators and what materials are conductors
- The difference in atomic structure between insulators and conductors

Part A: Basic Atoms



http://www.livescience.com/37206-atom-definition.html

Atoms Tiny pieces that make up the *matter* in the universe. Made of protons, neutrons, and electrons.

Protons Small, positively charged particle, stays in the nucleus.
Neutrons Small, neutral charged particles (no charge), stays in the nucleus.
Electrons Even smaller, negatively charged particle, remains outside the nucleus (1000 times smaller than protons and neutrons!)

A.1 What two particles are inside the nucleus?

A.2 Which particle has no charge?

A.3 Which particle is the smallest?

A.4
Write the charge of each particle: *positive*, *negative*, or *neutral*
Write the Location of each particle: *inside the nucleus* or *outside the nucleus*

Particle	**Charge**	**Where is it?**
Electron		
Proton		
Neutron		

Electric force

A force that affects all *charges*.
Two particles with the *same charge* repel.
Two particles with *different charges* attract.

A.5 On each row of the table, imagine two particles are next to each other.
Do they *attract, repel,* or *do nothing*? [consider only the electrical force!]

Particle 1	**Particle 2**	**Attract, repel, or no force?**
electron	electron	
electron	proton	
electron	neutron	
neutron	neutron	
neutron	proton	
proton	proton	

A.6 Which particle *never* experiences an electric force?

Part B: What is a circuit

Electric Circuit Electric circuits move because electrons move *around* a wire, from one end to the other
Electric Current When electrons are moving consistently around a wire, we call that electric current.

Direct Current (DC) Circuit In a direct current circuit, the electric current moves in only one direction. Direct current comes from a *battery*.
Alternating Current (AC) Circuit The electric current constantly reverses direction (usually 60 times a second!) Alternating current comes from an electrical generator or from a wall outlet.
AC-DC Adapter When you plug an AC-DC adapter into the wall, giving it AC current, it gives you DC current. The most common example of an AC-DC adapter is a *charger* for your cell phone.

For each option, say if it is *direct current* or *alternating current*:

B.1 Current from a D battery:

B.2 Current from an electric outlet:

B.3 The current that comes out of a cell phone charger:

B.4 The current from a lemon battery:

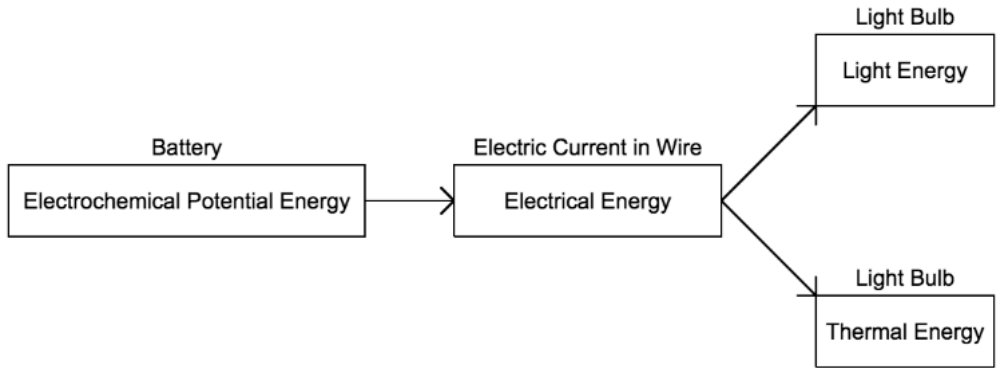
B.5 Current that reverses direction:

B.6 Current in only one direction:

Part C: Energy in an Electrical Circuit

Chemical Potential Energy Any energy that can be released by a chemical reaction.
Electrochemical Potential Energy A type of chemical potential energy in which energy is released by a chemical reaction *and* electrons are exchanged during the reaction. Electrochemical potential energy is stored in a *battery*!
Electrical Energy A type of *kinetic energy*. Any time that electrons move, they have electrical energy.
Light Energy (also called Electromagnetic Energy) Energy contained in a ray of light.
Thermal Energy Caused by moving molecules, the faster molecules move, the more thermal energy they release.

Energy Transfer in an Electrical Circuit The battery contains *electrochemical potential energy*. When it is connected to a wire, it turns into *electrical energy*. When electric current passes through the light bulb, it is converted into *light energy* and *thermal energy*.



You should memorize this diagram!

Questions

C.1 What type of energy do you put into a circuit?

C.2 What two types of energy are released from an incandescent light bulb?

C.3 What type of energy is able to move through an electrical wire?

C.4 What type of energy is contained within a battery?

Part D: Voltage, Current, and Resistance

Voltage How hard electrons are pushed around the circuit How much energy the battery provides each electron.	Unit: Volts (V)
In a direct-current circuit, the part of the circuit that provides the voltage is the *battery*. To get more current, add more batteries in series. Try this with a light bulb, and you will see it gets brighter.	

Resistance What's blocking electrons from moving around the circuit A light bulb is a circuit that provides resistance Reduces the current in a circuit from becoming to dangerous.	Unit: Ohms (Ω)
In the simplest circuit we built, the resistance is provided by the light bulb. If there is too much resistance, no current flows (you can test this by putting 5 light bulbs in series).	

Current How fast charge is moving around the circuit. Too much current is *dangerous* and leads to overheating.	Unit: Amperes, also called Amps (A)

Ohm's Law: Voltage = Current * Resistance
As resistance increases, current *decreases*. As voltage increases, current *increases*. To increase the current, add more voltage and reduce the resistance.

True or False?

D.1 The unit for voltage is volts.

D.2 The unit for resistance is Amps.

D.3 Voltage is equal to current times resistance.

D.4 The unit for resistance is Ohms.

D.5 Voltage comes from the light bulb.

D.6 Voltage comes from the battery.

D.7 Resistance comes from the light bulb.

D.8 Too much current is dangerous.

D.9 Too much resistance is dangerous.

D.10 Too much resistance makes a circuit not work.

D.11 Draw a circuit with very high voltage:

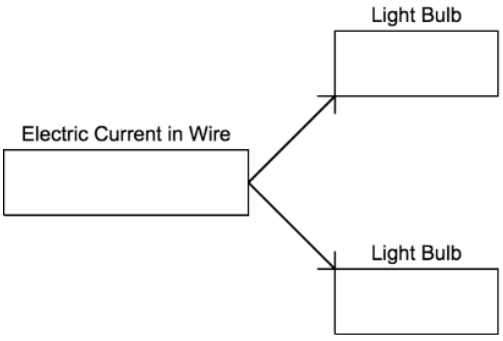
D.12 Draw a circuit with very high resistance:

D.13 As voltage increases, what happens to current?

D.14 As resistance increases, what happens to current?

D.15 If current is too high, what happens?

D.16
Draw an energy transfer diagram for a light bulb changes energy:
(use the boxes to show how energy changes)



Short Circuits

When a circuit has *almost no resistance* and *very high current*, it is a short circuit.

A short circuit is *dangerous* because the high current causes the circuit to produce thermal energy and overheat.

Often, short circuits are *accidentally built* by creating extra paths around the resistors and not properly adding resistors to a circuit.

If you open up nearly any electrical device, you will find many resistors included to *control the current* in the circuit.

Part E: How a Wire Works

Conductor	**Examples:**
A *conductor* is any material that allows electrical current to flow. Conductors are usually made of *metal*.	Copper wire Steel Iron
Insulator	**Examples:**
An *insulator* is any device that does not allow electrical current to flow. Conductors are usually not made of metal.	Rubber Piece of paper Cloth Glass

For each item **E.1 – E.8**, say if it is a conductor or an insulator:

E.1 a rubber glove

E.2 a paper clip

E.3 a stainless steel fork

E.4 a sweater

E.5 a copper penny

E.6 a glass window

E.7 something that allows electricity to flow

E.8 something that stops electricity from flowing

E.9 Explain the difference between an insulator and a conductor.

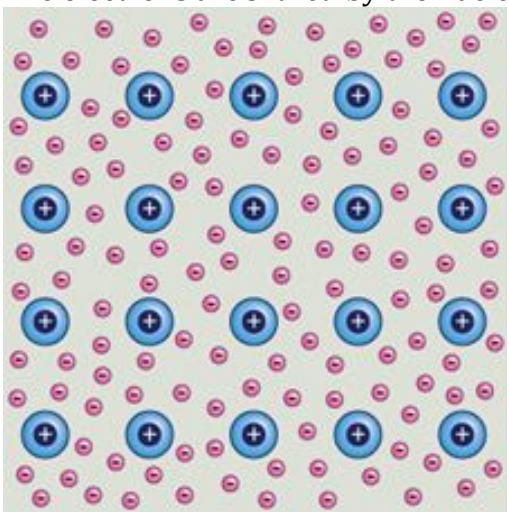
Metal Atoms

Not all atoms look exactly like the picture on the first page of this packet. Metal atoms are arranged differently.

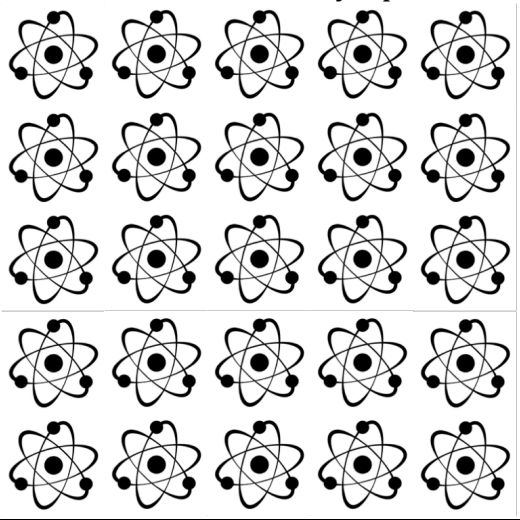
Inside a metal atom, the nuclei *share* the electrons outside the atom. Electrons don't belong to an individual nucleus.

Inside of an insulator, each atom has its own electrons.

Conductor Atoms
The electrons are *shared* by the nuclei.



Insulator Atoms
Each electron is *owned* by a particular nuclei.



True or false:

E.10 In a conductor, electrons are shared by all atoms.

E.11 In an insulator, each nucleus holds on to individual electrons.

E.12 It is easy for electrons to move from one nucleus to another in a conductor.

E.13 In a conductor, each nucleus holds on to its individual electrons.

Answers:

A.1 Protons and neutrons
A.2 Neutron
A.3 Electron

A.4

Particle	**Charge**	**Where is it?**
Electron	Negative	Outside the nucleus
Proton	Positive	Inside the nucleus
Neutron	Neutral	Inside the nucleus

A.5

Particle 1	**Particle 2**	**Attract, repel, or no force?**
electron	electron	Repel
electron	proton	Attract
electron	neutron	Do nothing
neutron	neutron	Do nothing
neutron	proton	Do nothing
proton	proton	Repel

A.6 The neutron

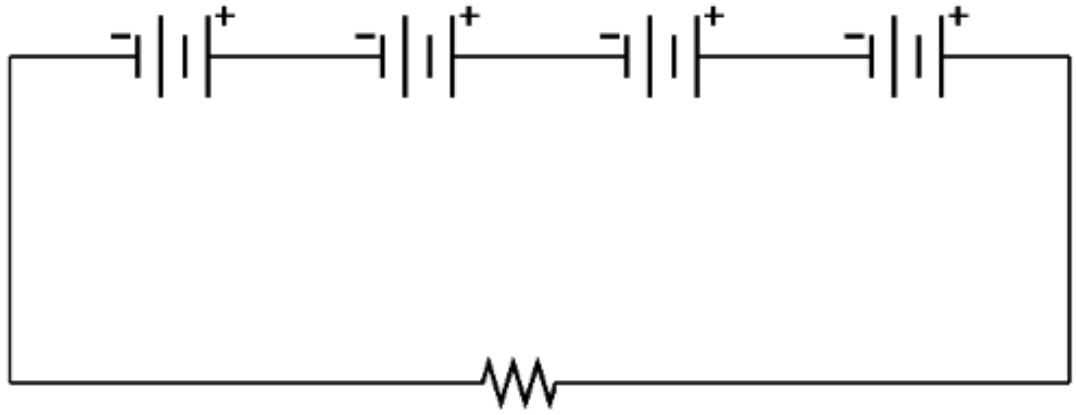
NOTE: In this section, we are only considering the *electrical forces* on the objects. If you include other forces, such as magnetic forces, strong nuclear forces, and weak nuclear forces, then neutrons may experience forces.

B.1 Direct current
B.2 Alternating current
B.3 Direct current [the charge converts AC to DC]
B.4 Direct current
B.5 Alternating current
B.6 Direct current

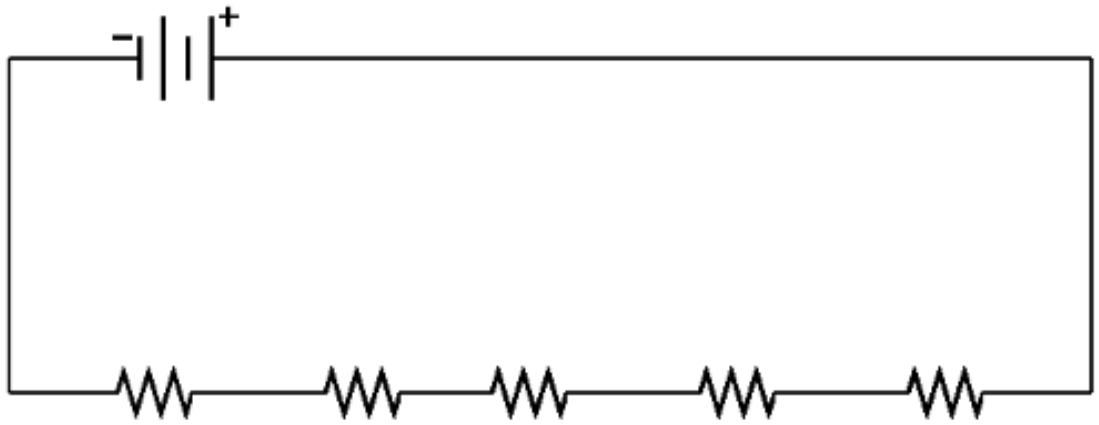
C.1 Electrochemical potential energy
C.2 Heat energy and light (electromagnetic) energy
C.3 Electrical Energy
C.4 Electrochemical potential energy

D.1 True
D.2 False
D.3 True
D.4 True
D.5 False
D.6 True
D.7 False
D.8 True
D.9 False, it isn't dangerous but it will make your circuit not work.
D.10 True

D.11 For a very high voltage, draw a circuit with many batteries in series.



D.12 For a very high resistance, draw a circuit with many resistors in series.

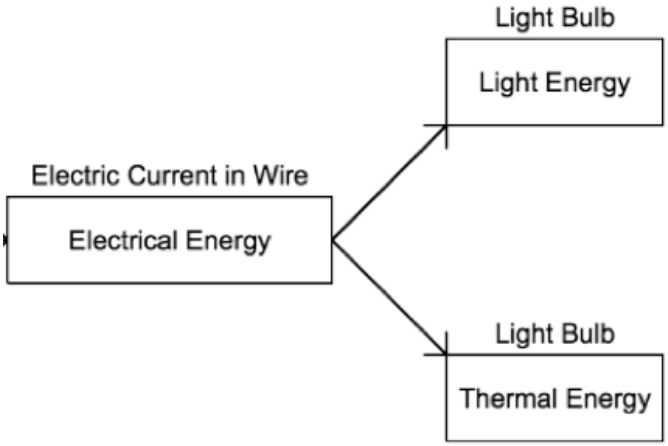


D.13
As voltage increases, current increases.

D.14
As resistance increases, current decreases.

D.15
If current is to high, the circuit will heat up.
(power, or energy dissipated, will also be dangerously high)

D.16



E.1 insulator
E.2 conductor
E.3 conductor
E.4 insulator
E.5 conductor
E.6 insulator
E.7 insulator
E.8 conductor
E.9 current can flow through an insulator but not a conductor.
E.10 True
E.11 True
E.12 True
E.13 False