SNC 1D

Physics: Electricity

	Topic	Learning Goals	Homework
1	Electrostatics	- explain the characteristics of conductors and insulators - state the Laws of Electric Charges and how they apply to charged materials	PG 401 Q#1-5
2	3 methods of Generating a Static Charge	- explain how static charges are built up in a substance through friction, contact and induction	Lab: Charging by Friction, Contact & Induction PG 398 Q#1-5
3	Discharging Objects	- summarize how charged objects can be discharged via 3 methods - understand how lightning works	PG 409 Q#1-5
4	Electrostatics: Application	- describe how static electricity can be used to enhance our life	PG 420 Q#1-5 PG 426 Q#1-5
	Video	- explain the principles of lightning and how it is a danger to humans	WS: Video Sheet
5	Electricity and Electric Circuits	- identify components of a simple DC circuit - contrast static electricity and current electricity - explain the concept of electric current and the use of an ammeter - identify differences between wet and dry cells, as well as the importance of secondary cells - contrast the difference in energy available from series and parallel cells Type equation here.	Lab: Building a Circuit PG426 Q#1-5
6	Circuit Diagrams	- be able to properly draw electrical circuits using proper techniques	
7	Electric Potential, Electrical Resistance, Ohm's Law	- explain the concept of potential difference as related to available energy and electrons - identify potential difference units and symbol - explain how various factors can influence the resistance of an electrical circuit - describe the relationship between current, potential difference and resistance (Ohm's Law)	WS: Ohm's Law PG446Q#2-11
8	Electric Circuits with Loads in Series & Parallel	- analyze the effect of adding an identical load in series or parallel in a simple circuit - explain how electric current, potential difference and resistance change in series and parallel circuits	A: Multiple Load Qs
9	Measuring Electrical Energy & Power	- understand that energy is transformed, never lost - calculate total electrical energy consumption using $E = VxIx\Delta t$ - calculate the total power of electrical appliances as related to current, electrical energy, voltage and resistance -	WS: Electrical Energy & Power
10	Energy Analysis	- be able to analyze energy consumption in a home - understand how appliances can be more efficient	A: Home Energy Audit
11	Review	PG 502 – UNIT OVERVIEW PG 506 Q#1-8, 10-15, 17-25, 43-50	
12	Test	Electricity	

SNC 1D

Lesson 1: Electricity

All material contains charges. Recall from chemistry,

The same is true for electricity. Electricity is created by the _____ through an object. Remember that the _____, only the electrons.

Some matter tends to _____ through it. We call this type of matter _____. In turn, some matter _____ through it. We call this type of matter _____.

There are varying degrees of insulators and conductors. For example, gold and aluminum are both conductors, however gold is a better conductor.

Electrostatics

Electrostatics is the _____. We usually refer to it as _____.

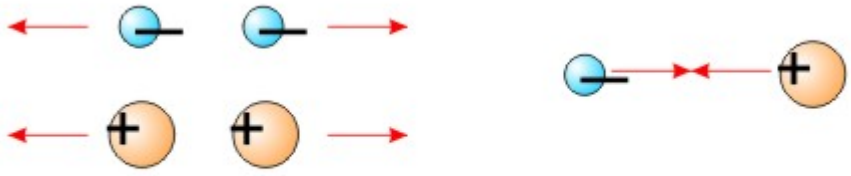
e.g. clothes removed from dryer or when brushing hair

Electrostatics looks at how neutral and charged objects interact with themselves and with each other. Based on the interactions of positively and negatively charged objects, the **Laws of Electric Charge** were established.

Laws of Electric Charge

1. Law of Repulsion – _____.

2. Law of Attraction – _____.



Like Charges Repel

Unlike Charges Attract

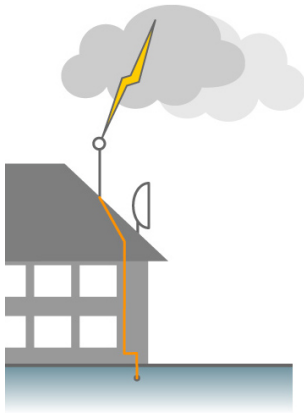
SNC 1D

Lesson 2: 3 methods to Charge an Object

Method	How?	Outcome

SNC 1D
Lesson 3: Discharging Objects

Discharged or *neutralized* – a charged object has all excess electric charges removed. Several methods are used to discharge objects, such as grounding.



Grounding

The simplest way to discharge an object is to _____ (such as a wire) to a metal rod buried in the ground. The _____ that it effectively _____ from the object.

Examples of grounding: People who assemble sensitive electronic equipment (such as computers) wear metal straps on one of their wrists

Discharge at a Point

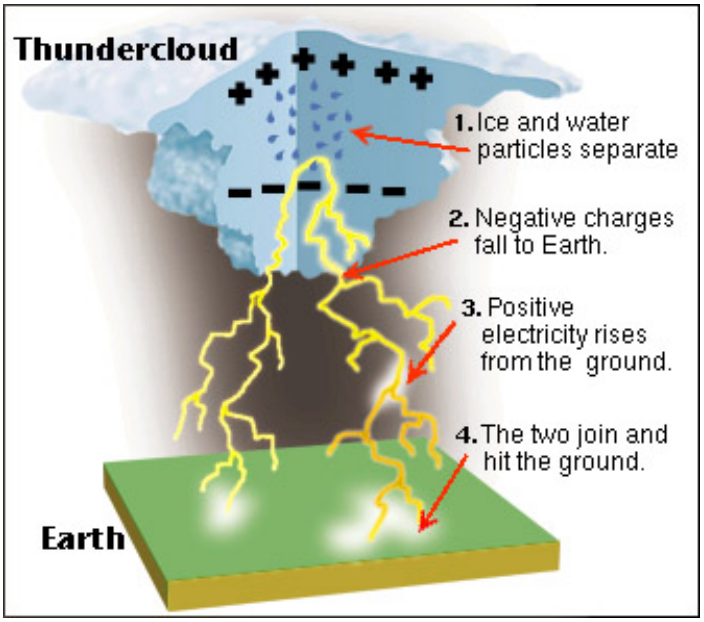
Grounding an airplane may be impractical (i.e. attaching it to a wire that is in turn attached to a rod in the ground may be limiting!)

The static wicks on an airplane are an example of a _____. Electrons are _____, where electrons _____ into the air.

Other Ways to Discharge Objects

Over time, objects can be discharged by _____. On a _____ day (high number of water molecules in the air) the _____ so rapidly that static electricity is not overly evident. In turn, on a _____ the charge _____.

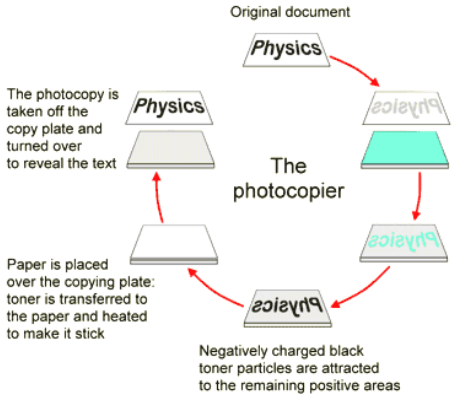
How Lightning Works



SNC 1D

Lesson 4: Applications of Static Electricity

Photocopier An electrostatic copier works by _____ _____ to be copied on surface of a non-conducting drum, and then _____ dry toner particles the drum. The toner particles temporarily stick to the pattern on the drum and are later transferred to the paper 'melted' to produce the copy.

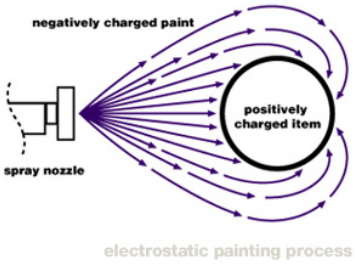


the

onto

and

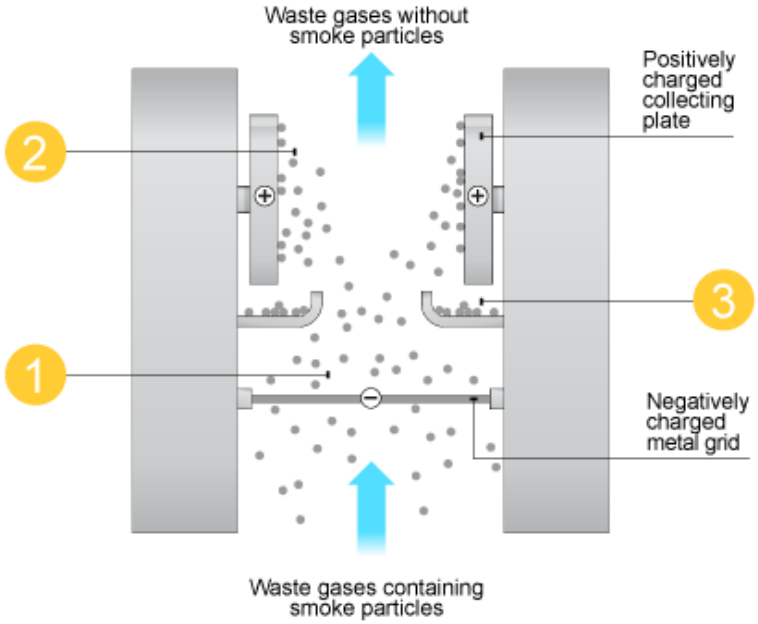
Spray Painting In spray painting, particles of paint are _____ _____ as they leave the nozzle of a spray gun. The object to is _____ between the nozzle and The _____ follow the field lines are _____ of the object.



be painted

the object.

Electrostatic Precipitator Tiny particles of soot, ash, and dust are major components of the airborne _____ _____ power plants and from many industrial processing plants. Electrostatic precipitators can remove nearly all of these particles from the emissions. The flue gas containing the particles is _____ _____ and _____. The strong electric field around the wires creates negative ions in the particles. The _____ _____are attracted by _____ and collect on them. Periodically, the plates are shaken so that the collected soot, ash, and dust slide down into a collection hopper.



SNC 1D

Nova - Lightning

1. Describe a lightning bolt.

2. Explain the charge distribution before a lightning strike. Which direction does lightning travel?

3. How does the electrical charge develop inside a thundercloud? Why can this distribution of charge be likened to a battery?

4. What is the theory behind how a lightning bolt is started?

5. What action should you **NOT** take when a storm is about to happen and you are:
   a) outside?

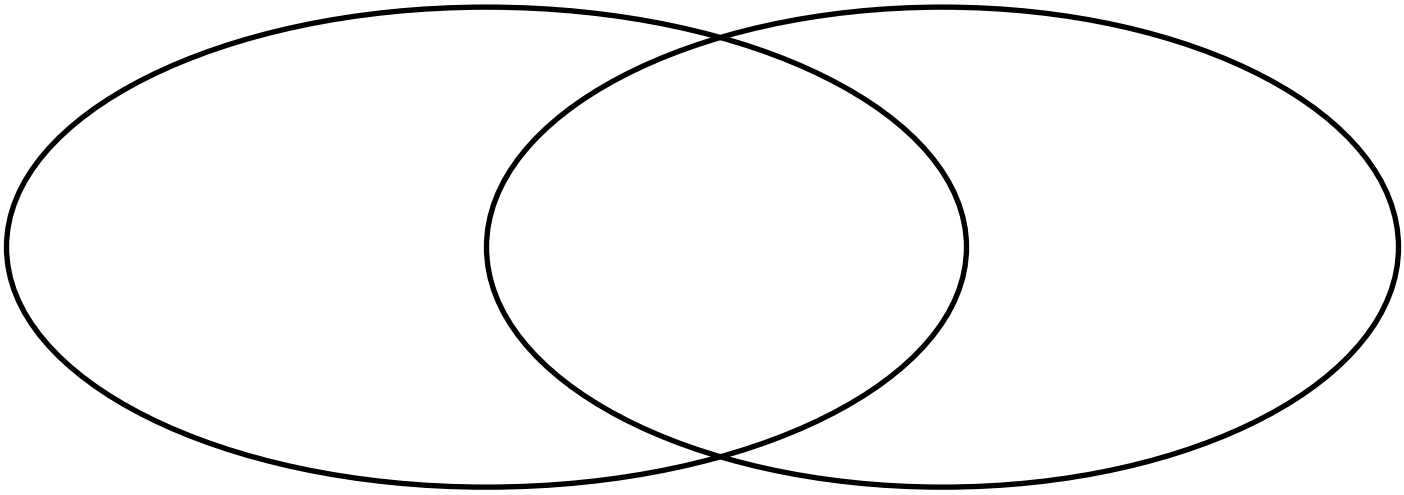
   b) in the house?

6. What are some of the problems that occur when a modern aircraft is struck by lightning?

7. What is a fulgarite and how is it formed?

SNC 1D

Lesson 5: Electricity & Electric Circuits



Electrical devices need a _____. That flow of electrons moves continuously as long as the following conditions are met:

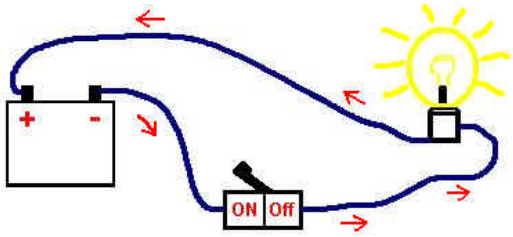
(1) the flow of electrons requires an _____

(2) the electrons will not flow unless they have a _____called an _____

_____is the continuous flow of electrons in a circuit.

Electric Circuits

There are four basic parts found in a simple circuit (labels at right:



(1) _____of Electrical Energy
   a. battery

(2) _____:
   - a device that _____ to _____form of energy
   - the light bulb converts _____ _____.

(3) Electric Circuit _____
   a. a_____can turn the circuit off or on by closing or opening the circuit
   b. when _____the circuit is _____and _____, when _____it means there is a _____in the path so _____ through the circuit

(4) _____
   a. conducting wires

<u>Measuring Electric Current</u>

Remember that _____is a measure of the _____ move past a given point in a circuit.The SI unit used to measure the electric current is the **ampere**. The symbol for the ampere is **A**. Current can be measured _____.

$$I = \frac{Q}{\Delta t}$$

SNC 1D

Electrical Energy is the energy provided by the flow of electrons in an electric circuit.
There are two main _____energy

(1) _____:
- Supply small amounts of electrical energy.

(2) _____:
- Deliver large amounts of electrical energy along thick metal wires called transmission lines to your home.

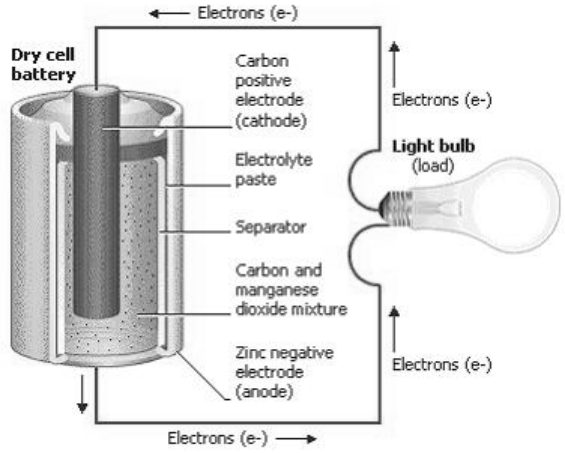
Electric Cells

An electric cell is a _____ . _____ In everyday language, we use the term battery; however in science battery refers to two or more cells in combination.

Parts of the electrochemical cell

Electrodes
- There are _____electrodes, _____ charges and the _____ _____ charged.
- They are _____.

Electrolyte
- Is a _____that is able to conduct an electric current.
- Sulfuric acid is a good conductor.



Wet and Dry Cells

- electrochemical cells that have a _____ are called _____
  - used in cars and other motorized vehicles
- electrochemical cells that have a _____are called _____
  - used in flashlights, cameras, watches

Types of Electric Cells

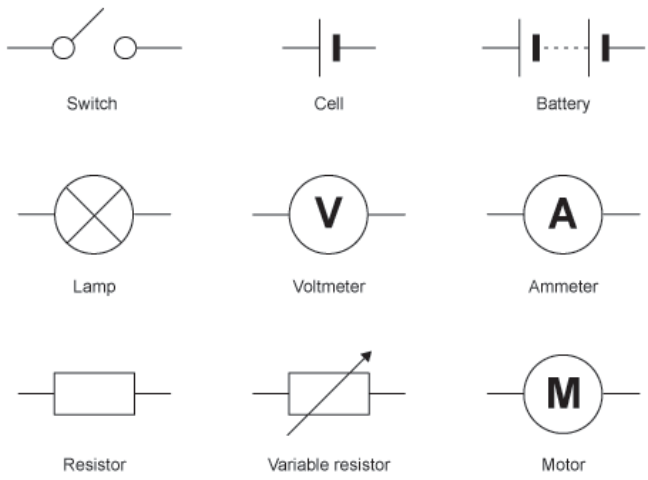
- **Primary Cells**
  - are electric cells that _____because the _____that produce the flow of electrons are _____.
  - Primary cells must be _____.
  - If they are not in use, primary cells have a Shelf life of up to five years.
  - Examples: _____
- **Secondary Cells**
  - are electric cells that _____many times before they are recycled.
  - **Electrical energy** from a wall outlet _____that take place in a secondary cell.
  - Examples:_____batteries (in cars) and _____batteries

All electric cells contain chemicals that are _____. They should always be properly _____, and never thrown in the garbage.

SNC 1D

***Lesson 6:* Circuit Diagrams**

Circuit diagrams show how electronic components are connected together. Each component is represented by a symbol.

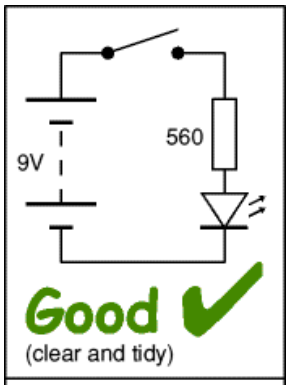


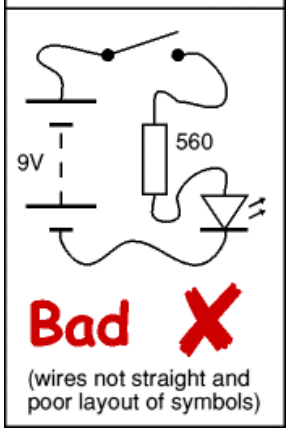
Circuit diagrams show the connections as clearly as possible with all wires drawn neatly as straight lines. The actual layout of the components is usually quite different from the circuit diagram and this can be confusing for the beginner. The secret is to concentrate on the *connections*, not the actual positions of components.

Drawing circuit diagrams is not difficult but it takes a little practice to draw neat, clear diagrams. This is a useful skill for science as well as for electronics.

Follow these tips for best results:

- Make sure you use the correct symbol for each component.
- Draw connecting wires as straight lines (use a ruler).
- Put a 'blob' (●) at each junction between wires.
- Label components such as resistors and capacitors with their values.
- The positive (+) supply should be at the top and the negative (-) supply at the bottom. The negative supply is usually labelled 0V, zero volts.





Practice

Draw the following circuit diagrams on another piece of paper.

1. A battery (two cells), on open switch, and one light bulb.
2. One cell, two motors, and one light bulb, all wired in parallel. A switch is connected in series with the light bulb so that it can be turned on and off without affecting the rest of the circuit.
3. A battery (three cells), one closed switch, a motor, a light bulb, and a resistor wired in series. A voltmeter is connected to the battery to measure its voltage.
4. One cell is connected to two lights in series. A third light is connected in parallel with the other two. One closed switch controls all three lights.
5. A three cell battery connected to two resistors in series. A motor is connected in parallel with the resistors. Include a voltmeter to measure the voltage of the source and an ammeter to measure the current leaving the source.
6. A 2 cell battery is connected to two resistors in parallel. A third resistor is in series with both other resistors.
7. A circuit contains two light bulbs, a motor, and one switch, and is powered by a 3 cell battery. The motor must stay on at all times. The two light bulbs can be turned on and off together by the same switch. Include a voltmeter to measure the voltage of the source, and an ammeter to measure the current going through the motor.

SNC 1D

Lesson 7: Potential Energy, Resistance & Circuits

Potential Energy

Potential energy is the _____. Each electron has _____.

A battery has _____ in the electrolyte of the electrochemical cell. The chemicals in the electrolyte react with the electrodes _____ _____.

- One terminal will have mainly negative charges (electrons) and the other has mainly positive charges
- A _____such as a copper wire attached to the electrodes _____ _____from the _____terminal to the _____ terminal
- The _____ _____is called the **POTENTIAL DIFFERENCE** or _____ **(V)**. This difference causes current to flow in a closed circuit
- The _____the potential difference in a circuit the greater the potential energy of each electron.

Resistance

Resistance is the degree to which a substance _____ through it.

- All substances resist the flow of electrons to some extent.
- _____, such as metals, allow the flow of electrons _____ and have _____
- _____electron flow greatly and have _____

Resistance (R) is measured in ohms (Ω) using an ohmmeter

- When a substance resists the flow of electrons, _____ and _____.
- The more resistance an object has the more energy it gains from electrons moving through it
- The _____by the substance is radiated to its surroundings as _____.

Resistance in a circuit

The _____of a component the smaller it's _____

Example: Current in a circuit passes through a filament in a light bulb (_____). The filaments high resistance to electrons electrical energy causes it to _____.

- resistors can be used to _____the current or potential difference in a circuit
- in a circuit electrons have a _____as they _____ compared to when they exit

Ohm's Law

- The **Electrical Potential Difference (V)** between two points in an electric circuit is **proportional (equal)** to the **current (I) times the resistance (R)** flowing through the conductor.

Potential Difference = Electric Current x Electrical Resistanc $V = I \; x \; R$

SNC 1D

Short Circuits

If a _____, with no load to use up the _____, it can become very hot and _____.

Example: keys in a purse come in contact with both the positive and negative terminals of a battery at the same time. The keys become hot and can start a fire.

Solving Problems

Example: What is the voltage drop across the tungsten filament in a 100-W light bulb? The resistance of filament is 144 Ω and a current of 0.833 A flowing through it.

Problems – Ohm's Law

Answer the following questions on another piece of paper. Show all your work.

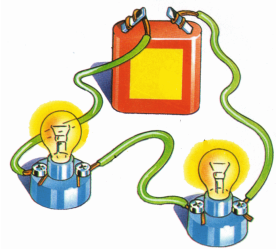
1. Natalie is using a soldering iron, which uses 120 V and has a resistance of 630 Ω. How much electric current is flowing through the soldering iron?
2. Orla is using a hair straightener which has a resistance of 550 Ω and has 0.22 A of current flowing through it. What voltage does the hair straightener use?
3. Richard is playing a NFL video game on X-box, which uses 120 V and has 1.2 A of current flowing through it. What is the resistance of the X-box?
4. Jon is watching basketball on TV. The TV uses 120 V and has a resistance of 1500 Ω. How much electric current is flowing through the TV?
5. An iPod uses a 3.6 V battery and has a resistance of 100 Ω. How much electric current is flowing through the iPod?
6. Sam is using the microwave to make dinner. The microwave uses 120 V and has 3.5 A of current flowing through it. What is the resistance of the microwave?
7. A cordless hairdryer uses 6V battery and has 1.2 A of electrical current flowing through it. What is the resistance of the hairdryer?
8. Jake is using his portable alarm clock, which has a resistance of 60 Ω and has 0.05 A of current flowing through it. What is the voltage drop across the portable alarm clock?

SNC 1D

Lesson 8: Electric Circuits & Multiple Loads

Two basic kinds of electric circuit are used to connect multiple loads: series circuits and parallel circuits.

Series Circuits

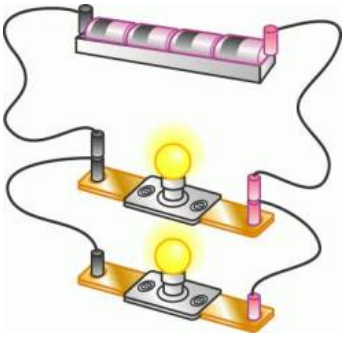


When the parts of an electrical circuit are wired to _____, the circuit is said to be _____.

For example, in the past there were mini bulb sets that were wired in series. When one bulb burnt out the _____ (a bit frustrating….)

A _____acts in the same way as a _____. The _____. The same is true if a bulb is removed from its socket. Applying Ohm's Law to a series circuit, see how the current is affected by the additional loads:

Parallel Circuits

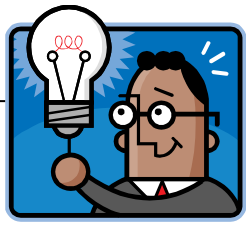


When loads are connected in _____, the current passes through a _____to each bulb. Each separate circuit is called a _____.

Because each load is connected to _____, if one load fails (i.e. bulb burns out…) the _____. If Ohm's Law is applied to parallel circuits, see how the current is now impacted (Think of the equation V=IR …..):

SNC 1D

Practice: Multiple Loads in Series & Parallel



Draw the following circuits and determine the total current and the current going through each branch circuit.

1. 12 V battery, 4 light bulbs in series (resistance for each bulb is 6 ohms), a switch.

2. 15 V battery, 2 light bulbs (resistance for each bulb is 6 ohms) and a motor (resistance is 8 ohms) all in series, a switch.

3. 9 V battery, 2 light bulbs in parallel (resistance is 6 ohms), a switch.

4. 6 V battery, a light bulb (resistance is 6 ohms) and a motor (resistance is ohms) are in parallel, a switch.

5. 12 V battery, 2 light bulbs (resistance for each bulb is 4 ohms) and a motor (resistance is 6 ohms) all in series, a switch.

6. 9 V battery, 3 light bulbs in parallel (resistance is 3 ohms), a switch.

7. 15 V battery, a light bulb (resistance is 6 ohms) and 2 motors (resistance is 4 ohms) are in parallel, a switch.

8. 12 V battery, 2 light bulbs in series followed by 2 lights in parallel (resistance for each bulb is 3 ohms), a switch.

9. 15 V battery, 1 light bulb (resistance is 6 ohms) in parallel with a second identical light with a motor (resistance is 8 ohms) in series, a switch.

10. 9 V battery, 2 parallel branches each with a light bulb (resistance is 2 ohms) and a motor (resistance 3 ohms) in series, a switch.

11. 12 V battery, connected to two lights (resistance is 3 ohms) in series. A third light is connected in parallel with the other two, switch.

12. 15 V battery, 2 branches with 2 light bulbs (resistance for each bulb is 1.5 ohms) in series, 2 motors (resistance is 3 ohms) both in series on either side of the battery, a switch.

SNC 1D

Lesson 9: Measuring Electrical Energy & Power

Energy – _____

Electrical Energy - _____

SI Units:

- joule (J) – enough energy to light a 100-W light bulb for a hundredth of a second
- watt hour (W•h) – equal to 3600 joules
- kilowatt hour (kW•h) – equal to 1000 W•h

Electrical energy can be calculated using the following equation:

$$E = V I \Delta t$$

E = electrical energy in joules
V = voltage drop in volts (energy of each electric charge)
I = electric current in amperes (rate at which electric charge flowed out into the circuit)
Δt = time interval (change in time) in seconds

Electrical Power – a measure of the _____. The symbol for electrical power is P, and is measured in watts, W.

Power can be calculated using the following equation:

$$P = \frac{E}{\Delta t}$$

P = power in watts (or kilowatts)
E = electrical energy in joules, watt•hours, etc.
Δt = time interval (change in time)

Sample Problem:

Calculate the power of a toaster that uses 72 000 J of energy in 50 s.

SNC 1D

If we substitute in the electrical energy equation into the power equation we can get the following formula:

Therefore, power is equal to the current times the voltage.

Sample Problem:

Calculate the power of a vacuum cleaner if the operating voltage is 120 V, and the current flowing through it when it is used is 7.90 A.

SNC 1D

Power and Energy Problems

1. An Eveready flashlight is powered by a 1.5 V battery that delivers a power of 3.0 W.;
   a) What is the current produced?
   b) If the energy produced is 6.0 W-h, how long will the flashlight stay lit?

2. If there is a current of 10 amperes in a 120 V circuit for 10 minutes, what quantity of electric energy flows through the circuit? (Remember to convert the time.)

3. How many 100 W light bulbs can be turned on in a household circuit (120 V) before tripping a circuit breaker of 15 A? (Calculate the power in watts available and divide by 100 W to get the number of light bulbs.)

4. A transistor radio operates by means of a 9.0 V battery that supplies it with 0.050 A of current. The battery has a life of 300 hours and costs $1.79.
a) what is the energy produced in watt-hours?
b) what is the energy produced in kilowatt-hours?
c) what is the price per kilowatt-hour? (price divided by kilowatt-hours)
d) if Niagara Mohawk charges $0.10 per kW-h, how much does it cost to operate the radio using household current?
e) compare the costs in a ratio of battery: household current.

5. How much time is required for a 10 V battery in a circuit that is measuring 2 A of current to produce 20 watt-hours of energy?

6. If 100 volts causes a current of 5 amperes in a lamp for 20 seconds,
a) How much energy is used?
b) What power is developed?

7. The potential difference between two points is 100 volts. If the resistance measures 10Ω in the circuit,
a) What current would exist in the circuit?
b) What power would be developed in the circuit?

8. One hundred joules is used to transfer 40 A. from points A to B in 5 seconds.
a) What power is needed for this transfer?
b) What is the potential difference between the two points?

Problems in Conversions

1. How many kilowatts is 250 watts?
2. How many kilowatts is 1.0×10^5 watts?
3. How many joules are in 746 watt-seconds?
4. How many joules are in one kilowatt-hour?

Answers:

1.a) 2A b) 2 h. 2. 200 W-h 3. 18
4. 135 W-h b) 0.135 kW-h
c) $13.76 /kW-h d) $0.0135 = 1.35
e) household current is 1000 x cheaper
5. 1 hour 6. a) 10 000 J
b) 500 J/s 7. 10 A b) 1000 W