Intermediate General and Applied Science

Physics Module: Lecture Manual

Developed by Christine Miller © 2018

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Welcome and the Scientific Method

Learning Objectives

At the end of this unit, you will be able to:

- Describe the nature of science and the scientific method, including its limitations.
- List the stages in the cycle of the scientific method
- Identify, in a given experiment:
  - the hypothesis.
  - the independent variable.
  - the dependent variable.
  - the control(s).
- Identify some of the techniques and skills used in scientific investigation.
- Describe some of the methods of dissemination of scientific research.
- Describe examples of tools and technologies we use in everyday life that were developed through scientific research.

Science and its Limits

Science is	**Science is not**

Scientific Method

The **scientific method** is an organized way of ______________________________ __________________________.

It generally beings with an _________________, the formation of a ________________, and the creation of an ______________________ specifically designed to determine if the hypothesis is correct or incorrect.

Experimental Design

- An experiment is an activity or procedure designed to test a _____________.
- A hypothesis is typically an ________ / _________ statement.
  Example: ***If*** I do my homework, ***then*** I will get a good grade.

- A hypothesis is the starting point for designing an experiment.

Organizing Data

Once you have run your experiment and recorded your results, organize your data in a way that makes sense to you and to others. Then see if your data shows any trends or relationships.

Try It Out

How would you organize this data?

Talk It Out

Which method of organizing the data would you choose for:

- A promotional brochure used for convincing people to buy your product?
- Communicating your company's need for extra resources from a governmental organization?
- Sharing the information with another company in your sector?

Which parts of this set of information would be most important if:

- Your company ships livestock?
- Your company ships selfie sticks?
- Your company ships Christmas trees?

What other factors might you want to include in your data if:

- Your company ships donor organs for transplant?
- Your company ships card copies of credit application information?
- Your company ships furniture?
- Your company ships chemicals?

Physics in Real Life

Cancer treatment

Physicists came up with:

It's important because:

Discipline of physics required:

The space industry

Physicists came up with:

It's important because:

Discipline of physics required:

Liquid Crystal Displays

Physicists came up with:

It's important because:

Discipline of physics required:

Fiber Optics

Physicists came up with:

It's important because:

Discipline of physics required:

Energy Efficiency

Physicists came up with:

It's important because:

Discipline of physics required:

Look it up and Write it out

My topic choice is ____.

Physicists came up with:

It's important because:

Discipline of physics required:

Machines

Learning Objectives

At the end of this unit, you will be able to:

- Define force and work.
- Solve quantitative problems by applying the concept of work to simple machines.
- Solve problems involving simple machines, levers, inclined planes, wedges, pulleys, wheels and axles.
- Solve problems involving other machines: gears, pulley systems, and hydraulic systems.

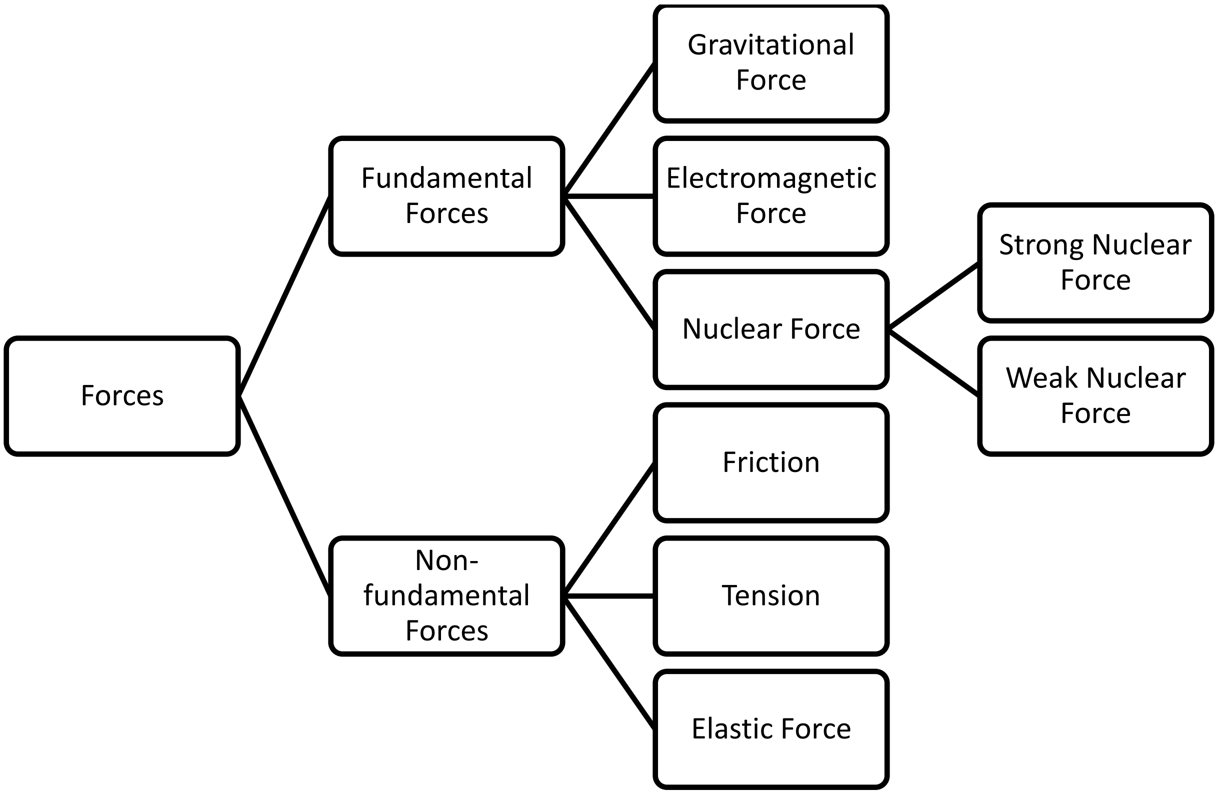
Force

- In physics, a force is any interaction that will change the motion of an object.
- A more simple definition is that force is a _____________ or a _____________**.**
- Force is often measured in a unit called ____________**,** and is represented in formulas by the letter **F.**

- Force has two parts to it:
    - _____________: how strong the push or pull is.
    - _____________: the direction of push or pull.
- A measurement that includes both magnitude and direction is considered a _____________**.**
- Forces _____________ **—** they speed things up, slow them down, change their direction, or distort their shape.

Types of Forces

We will be looking at different types of forces:



Fundamental	Non-Fundamental
Fundamental forces are the known forces of the universe that are _______________ into more basic interactions.	Non-Fundamental forces are _______________ fundamental forces.

Types of Forces: Fundamental

Gravitational Force

- Gravitational force is a natural phenomenon.
- All things in this universe which have _______________ and/or _______________, are brought toward one another.
- The _______________ of gravitational force is in direct proportion to an objects _______________ and its _______________ from another object.

Electromagnetic Force

- Electromagnetic force is a physical interaction between electrically charged particles.
- Examples include:

- ________________
- ________________
- ________________

Nuclear Forces

- Nuclear forces have to do with ________________ particles and their interactions with one another.
  - Strong nuclear forces hold ________________ to one another.
  - Weak nuclear forces keep _______________ and _______________ intact.

Types of Forces: Non-Fundamental

Friction

- Friction is a force that _________________________.

- Friction occurs at the place where two solid objects are in _____________________.

- Friction is the force _________________ the relative motion of solid surfaces.

- The amount of friction depends on the _________________ of the two surfaces.

Tension

- Tension is a _____________ force that has been _______________ to a cable, string, or chain.

Elastic Force

- Elastic force is the ability of a material to resist a distorting force and return to its original shape once the force is removed.

Newton's Laws of Motion

- Force tends to cause motion (but not always).
- The branch of physics describing motion is called _______________.
- Isaac Newton (born in 1642) developed, through the Scientific Method, the Laws of Motion, which are still used today.
- Newton's observations are grouped into three Laws.

Newton's First Law — Inertia

Objects at rest tend to stay at rest, and objects in motion stay in motion, u*nless* acted upon by an outside force.

Newton's Second Law – Force is Equal to Mass Times Acceleration

- If an unbalanced force acts on an object, the object accelerates in the direction of the force.

The formula to represent this is:

Force = mass × acceleration

or F = ma

- Force is measured in newtons, mass in kilograms, and acceleration in metres per second squared.

You can manipulate the formula to solve for any of the three variables:

F=ma   a=F/m   m=F/a

Newton's Third Law – Every Action has an Equal and Opposite Reaction

- For every force there is an equal and opposite force.
- The first force is call the ______________ force.
- The second force is called the ______________ force.
  Examples:
  - Firing a gun – the bullet goes forward and the gun recoils back.
  - Swimming – your arm pulls backward but you go forward.
  - Climbing stairs – your foot pushes down and you move up.
  - Boat – oars push back and the boat moves forward.

TRY IT OUT

1.
   a. What force will give a 40 kg grocery cart an acceleration of 2.4 m/s^2?

   b. If you add 20 more kg to the grocery cart, what force do you need now to get an acceleration of 2.4 m/s2?

2. What force will give a 120 kg person an acceleration of 3.2 m/s?

3. A force of 20 N was applied to an object of 15 Kg. What would be the acceleration of this object in m/s?

4. A force of 8 N was applied to an object producing an acceleration of 1.6 m/s. What is the mass of the object?

More Practice – Force

F=ma a=F/m m=F/a

1. You are pulling a child in a sled with a total mass of 8 kilograms. Your acceleration is 2 m/s^2. What is the amount of force you are applying?

2. A baseball accelerates 15 m/s^2 and weighs 0.5 kilograms. What force was applied?

3. An archer applies a force of 10 newtons to an arrow with the mass of 0.25 Kg. What is the acceleration of the arrow?

4. You are trying to move a dresser with a mass of 75 kilograms. You apply 25 newtons of force. What is your acceleration?

5. You apply 60 newtons of force to move an object which accelerates 10 m/s^2. What is the mass of the object?

Work

- Work has a particular meaning in physics: work is done when a force applied to an object has caused that object to _________________.
- It is important not to confuse work with output of energy (force). Sometimes you exert force, but ________________________ has been done.
- Work is typically measured in units called ______________________**.**
- The amount of work done is calculated by multiplying the change in position by the amount of force applied.
- Since work is a value obtained by determining how force changes the position of an object, the formula for calculating work is:

Work = Force × distance

or W = F × d

- You can manipulate the formula to solve for any of the three variables:

W = Fd **d = W/F** **F = W/d**

TRY IT OUT

1. A newspaper delivery person uses 20 N of force to pull a wagon full of newspapers 10 m.. How much work was done?

2. An 800 Newton rock climber scales a 160 m cliff. How much work was done by the mountain climber?

3. A shopper pushes a 300 Newton shopping cart from one end of Costco to the other (about 300 metres). How much work was done?

4. Santa's reindeer pull his sled with a force of 120 newtons and end up completing 500 joules of work. What distance did the sled travel?

5. Your pet cat does 15 Joules of work when he pushed his food dish one meter towards the fridge. How much force did he use?

6. You decide to carry all your grocery bags in one trip, and end up using a force of 40 newtons to do 120 Joules of work. How far did you carry the grocery bags?

More Practice – Work

W = Fd **d = W/F** **F = W/d**

1. A mover pushes a piano 30 metres and the amount of work done was 2,100 joules. How much force did the mover exert?

2. You carry you backpack, weighing 20 newtons from your car to your classroom, about 300 metres. How much work did you do?

3. You lift your sandwich, weighing 1 Newton, from the table to your mouth (about 0.3 metres). How much work did you do?

4. Your cat exerts 60 Joules of work to move her cat toy 2 metres. How much, in newtons, does the cat toy weigh?

5. A bulldozer pushes a mound of dirt 12 metres with a force of 150 newtons. How much work has been done?

Simple Machines

Simple Machines change the ____________ or _______________ (amount) of force.

Direction of force	Magnitude of force
This can allow you to leverage your weight to do work, or to apply force in hard-to-reach spaces.	This can allow you to "spread out" the force —instead of doing the work all at once, do it little bits at a time. This can also allow you mechanical advantage, which means amplifying the force you apply to do work.

Lever

- A lever consists of two parts: a ____________ and a ___________**.**
- A lever amplifies the input source to move a ____________ output source.
- The further your input source is from the fulcrum, the greater the amplification of force — this is called ______________________.

Wheel and Axle

- The wheel and axle amplify force similarly to a lever; however, instead of comparing distances to the fulcrum, we compare perimeter of two unequal circles.
- In addition:
    - Wheels reduce the friction between objects and the ground.
    - Friction is a force that resists change.
    - Friction occurs when two surfaces are in contact.

Inclined Plane

- Inclined planes are also known as _____________.

- They are used to raise or lower a load.
- Moving an object up an inclined plane requires less force than lifting it straight up, at a cost of an increase in the distance moved.

Wedge

- Wedges are triangular shaped tools which change the direction of force by transferring force applied to the blunt end to its inclined surfaces.
- Axes, chisels, knives and drill bits are all example of wedges.

Pulley

- A pulley changes the direction of force in order to move a load.
- A counterweight can be used in conjunction with a pulley in order to lift very heavy loads.

Mechanical Advantage

- Mechanical advantage is a measure of force amplification achieved by using a simple machine.
- We have a formula to determine mechanical advantage:

Mechanical Advantage = Output force/input force

or $\mathbf{MA = F_o/F_i}$

- With certain types of levers we can also calculate how far away from the fulcrum weights must be in order to balance each other. The formula for this is:

mass of object 1 x distance a = mass of object 2 x distance b

Or $\mathbf{M_1a = M_2b}$

TRY IT OUT

1. You are lifting a manhole cover using a pry bar. You have to exert 50 newtons of force for the output force of 250 newtons required to move the cover. What is your mechanical advantage?

2. Using a wheelbarrow, you gain a mechanical advantage of 5. How much force must you use to move a load with the output force of 180 newtons?

3. Sara and Yumi are playing on a see-saw. They are trying to perfectly balance the see-saw by sitting different distances away from the center. Sara weighs (force due to gravity) 30 kg, and Yumi weighs 20 kg. Yumi is sitting 1 meter away from the center of the see-saw. How far away from the center on the other side does Sara need to sit?

More Practice — Mechanical Advantage

$MA = F_o/F_i$ **$M_1a = M_2b$**

1. A crate of unicycles weighing 3,000 N is being unloaded from a cargo ship. The dock worker uses a pulley system and applies a force of 200 N to lift the crate. What is the mechanical advantage of the pulley system?

2. A car jack is used to lift a 4,500 N vehicle. The operator of the jack uses 90 N of force to lift the car. What is the mechanical advantage of the car jack?

3. A pulley system is used to lift a piano to the fourth floor of a building. The pulley system provides a mechanical advantage of 12. If the piano weighs 1,800 N, what force must be applied to lift it?

4. As part of a circus act, a performer is trying to balance on a see-saw with an elephant. The elephant weighs 5,400 kg and the circus performer weighs 90 kg. If the elephant is standing 0.1 m from the fulcrum, how far away must the man stand to balance the see-saw?

Energy

Learning Objectives

At the end of this unit, you will be able to:

- Define basic concepts: force, work energy, conservation law, power.
- Know the law of conservation of energy.
- Distinguish between forms of energy.
- Solve quantitative problems involving thermal energy, electrical energy and conservation of energy
- Describe the transformation of potential and kinetic energy
- Explore First Peoples perspectives on energy

Force

As we learned before, force is:

- Any interaction that will ____.
- A ____________ or a ____________.
- Measured in a unit called ____________ and is represented in formulae by the letter __.

In addition, force:

- Has two parts to it: ________________________.
- ___________________ — speeds things up, slows them down, changes their direction or distorts their shape

Work

As we learned before, work is when a force applied to an object has caused that object to ___________.

It is important not to confuse with output of energy (force). Sometimes you exert force, but __________ has been done.

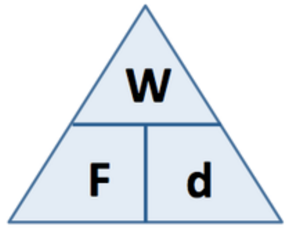
- Work is typically measured in units called **joules.**
- The amount of work done is calculated by multiplying the change in position by the amount of force applied.
- Since work is a value obtained by determining how force changes the position of an object, the formula for calculating work is:

Work = Force × distance

or W = F × d

- You can manipulate the formula to solve for any of the three variables:

W = Fd **d = W/F** **F = W/d**



TRY IT OUT

1. Matty uses 20N of force to push a lawn mower 35 meters. How much work does she do?

2. Richard does 15 Joules of work to push the pencil over 1 meter. How much force did he use?

3. Marguerite uses a force of 25 Newtons to lift her grocery bag while doing 50 Joules of work. How far did she lift the grocery bags?

4. Gage uses 45N of force to stop his shopping cart over 1 meter from running his foot over. How much work does he do?

5. Izzy is climbing a mountain. She weighs 580N and scales a 100m cliff. How much work did she do?

6. How much work does Aaron do while moving a dolly 20 meters with a pulling force of 200N?

7. Yuhan is carrying his backpack from his car to his classroom. If his backpack is 30 Newtons, and he did 7260 Joules of work, how far did he park from the classroom?

8. Hannah is pushing a grocery cart. If she does 670 Joules of work to push the cart 15 meters, how many Newtons is the cart?

9. Alicia carries a pizza from her front door to her kitchen. Her dinner weighs 3.2 N, and she does 38.4 Joules of work to move it. How far did she travel with her pizza?

10. Sarah throws a Frisbee to her friend. The Frisbee weighs 2N and she does 50 Joules of work when she throws it. How far did it travel?

Talk It Out

What do you think of when you hear the word energy?

- One definition of the word “energy” is the ability to do work.
- Since the two terms are often describing the same thing, we use the same units to measure both: Joules.

- We can calculate how much energy is transferred when work is done by using the formula:

$$\mathbf{W = \Delta E}$$

- The symbol "Δ" means ____________________.

Types of Energy

- There are various types of energy.
- Sometimes energy is transferred to an object, as in the case of work being done.
- However, often energy is transformed from one kind to another.
- Anything that can do work is considered energy.

Gravitational Potential Energy

- Any raised object can do work _____________________ due to gravity.
- Potential energy is ________________ until gravity acts on it.

Kinetic Energy

- Any ___________object has energy and can do work on an object with which it ________________.

Thermal Energy

- Thermal energy is energy that comes from _____________.
- Thermal energy is difficult to convert to other forms of energy, so in order to do this, an engine is often needed.

Chemical Potential Energy

- When atoms bond together to form _________________, energy is stored in these ______________. When you break these ___________, energy is released.
- A typical example is burning fuel – burning coal, gasoline, or even firewood releases energy stored in chemical bonds.

Electrical Energy

- Electric charges can do work as they move through a ____________.
- Some electric devices, called _________ convert electrical energy to motion, to do _______________.

- Other electric devices change electrical energy to another form, perhaps ___________ or ____________.

TALK IT OUT

What types of electrical appliances or tools do you have? What types of energy conversions take place in each of them?

Appliance or Tool:	Electricity is changed to:

More Types of Energy

There are more types of energy than the ones we have covered, including:

- Elastic energy
- Nuclear energy
- Radiant energy

Energy Conversion

As mentioned, energy conversion takes place when one type of energy is transferred to another type of energy. Some examples include:

Images: openclipart.org [public domain]

- When energy is changed from one form to another, the ________________________ in a ______________ does not change.
- This is referred to as ____________________.

- This is part of the ___________________________________ — energy can neither be created nor destroyed, in can only ____________________.
- This means that in a transfer of energy, the ____________________________________.

Generation of Electricity

- In order to generate the electricity that powers our homes, energy must be converted ___ electric energy _____ one of the other types.
- What are some example you can think of? (What ways do we generate electricity?)

Kinetic and Potential Energy

- Potential energy is due to position and the force of gravity.
- Kinetic energy is movement.
- When you ride down a roller coaster, potential energy is converted to kinetic energy.

TRY IT OUT

Try out the Interactive Rollercoaster Model from PhysicsClassroom.com.[1]

- When this hammer is raised, it has _________________________**,** due to gravity
- When the hammer is falling, it has ____________________**,** due to motion
- Other examples of PE are:
  - Fuel and ______________
  - A coiled ______________
  - A drawn ______________
- Other examples of KE are:
  - A moving _____________

[1] https://www.physicsclassroom.com/Physics-Interactives/Work-and-Energy/Roller-Coaster-Model/Roller-Coaster-Model-Interactive

- A falling _______________
- A _______________ moving through space

Calculations of Potential Energy

- Potential energy due to gravity can be calculated with the formula:

$$PE = m \cdot g \cdot h$$

- Where:
  - m = the mass of the object in Kg
  - g = the gravitational field strength (9.8 m/s^2)
  - h = height in meters

TRY IT OUT

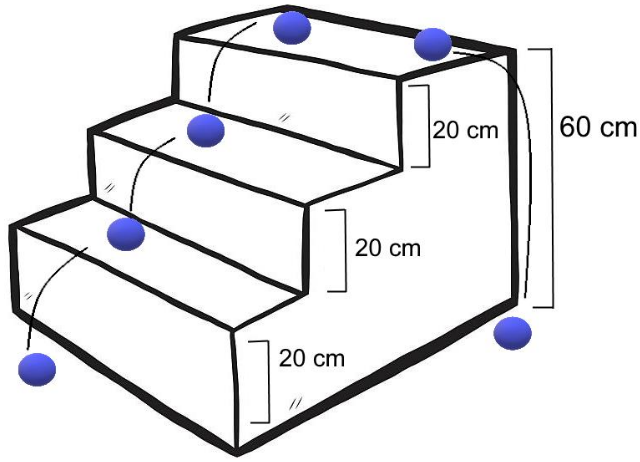
1. A lifeguard sits on a lifeguard tower while watching swimmers in a pool. The lifeguard weighs 40Kg and is sitting 2 meters above the pool deck. What is the lifeguard's potential energy?

2. A poorly-behaved tourist is thinking about throwing a loonie over the edge of the CN tower. If the loonie weighs .007 Kg, and the top of the CN tower is 550m, what is the potential energy of the loonie?

3. A skydiver about to jump out of a plane weighs 60Kg. The plane is 4000m in the air. What is the skydiver's potential energy?

4.

a. If the ball weighs 0.2 Kilograms, what is the potential energy of the ball when it is at the top of the steps?
b. What happens to the PE when the ball falls from the top step, directly to the ground?
c. What happens to the PE when the ball falls from one step to the next, until it reaches the ground?



Transfer of Potential Energy to Kinetic Energy

- As an object falls, ___________ energy is converted to ___________ energy
- As an object is raised from the ground, ___________ energy is converted to ___________ energy

What is the ratio of the potential:kinetic energy of the ball at each of the locations?

Electrical Circuits

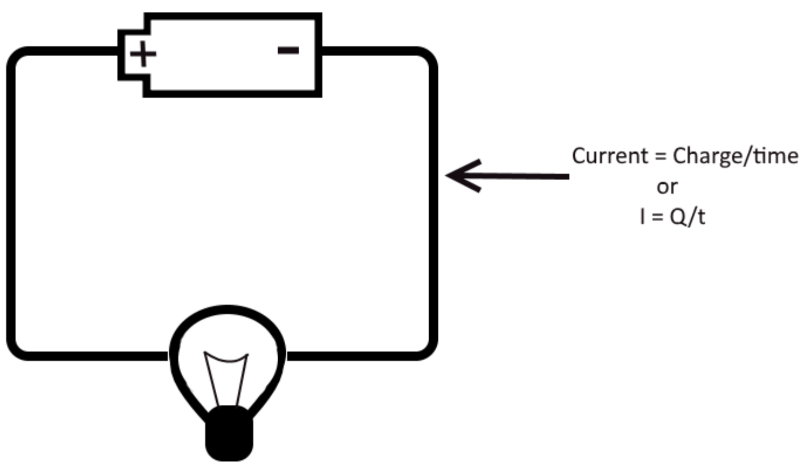
Learning Objectives

At the end of this unit, you will be able to:

- Distinguish between AC and DC circuits.
- Choose and use appropriate instruments to measure voltage and current.
- Solve quantitative problems involving Ohm's Law.
- Solve quantitative problems involving circuits.
- Explain the use of switches, fuses, and other components of an electrical circuit.
- Demonstrate appropriate safety precautions.

Current Electricity and Electric Current

An electric current is
____.



- Electric current is the ________________ that moves past a given point in a conductor per second.
- The charge is measured in a unit called ____________, with is often represented by a *Q* in formulae.
- The unit of time used to calculate electric current is seconds (t).
- Electric current is measured in amperes (A).
- One ampere (or amp) is equal to 1 Coulomb per second:

1 A = 1 C/s

TALK IT OUT

Which of the diagrams above shows a higher current? How do you know? How could you modify the bottom diagram to make it have a higher or lower current?

Measuring Electric Current

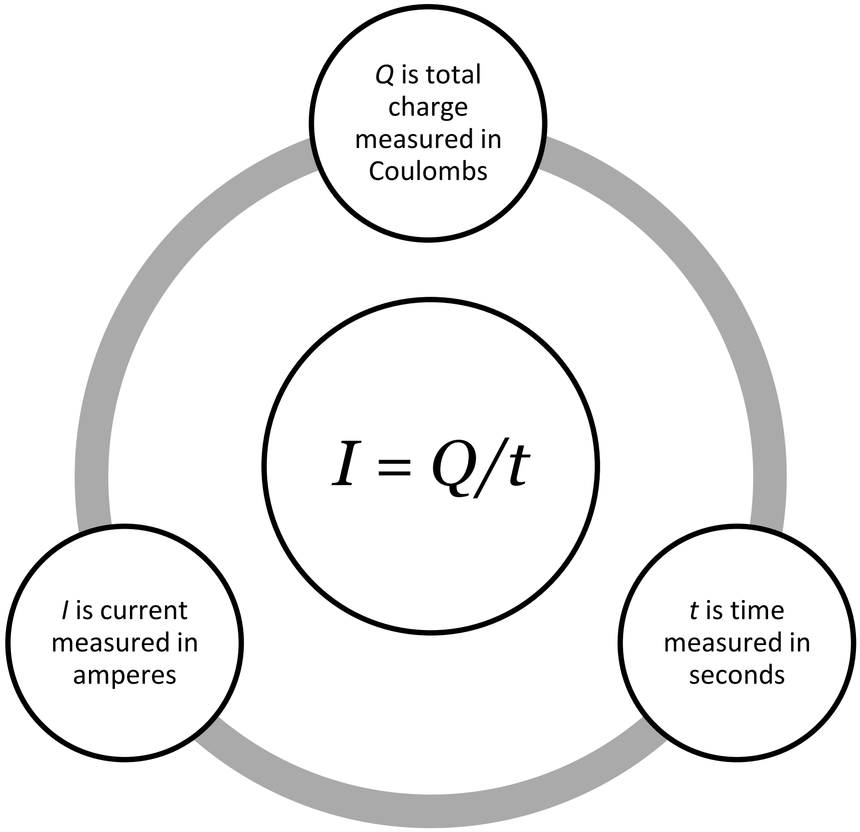
- Galvanometers are used to measure weak electric current.
- Ammeters are used to measure larger currents.
- A multimeter can measure current as well as other quantities such as voltage.

Different appliances use up (or draw) different amounts of current. Fill in the table below:

Appliance	Current (A)
Radio	
	0.8
Television	
	8.8
	11.7
Electric Kettle	
	30
Oven	

Electric Current

We can solve problems about electric current using the formula: I = Q/t



TRY IT OUT

1. Calculate the amount of current through an electric toaster if it takes 1,200 C of charge over two minutes.

2. A light bulb is on for 10 seconds and 40 Coulombs of electrical charge flow through it. What is the electric current?

3. A light bulb with a current of 2.4 A is left on for 30 seconds. How much electric charge passed through the bulb?

4. The average smartphone requires 7,200 Coulombs to charge. The dollar store charger can charge at a current of 0.5 amps, and the super expensive charger from the kiosk can charge at a current of 2.1 amps. What would be the time difference between these two chargers when charging your phone?

More Practice

1. In one minute, 120 C of charge passes through a point in a circuit. Calculate the current.

2. A current of 5 amps runs through a wire for three minutes. How many C of charge has run through the wire?

3. How long will it take 400 C to run through a wire if the current is 5 amps?

Direct Current and Alternating Current

Direct Current

- Direct current means charges flow in only ________________.
- A battery produces direct current in a circuit since the terminals of the battery always have the same sign.
- Electrons move from the _____________ terminal towards the _____________ terminal.

Alternating Current

- Alternating current means that electrons in the circuit are moved ____

____
___________________________.

- A generator or alternator does this by switching the sign at the terminals at a certain frequency.

Direct Current	Alternating Current
Championed by:	Championed by:
Can be generated	Can be generated _______________
Difficult to send long distances	Easy to send long distances
Most devices need DC	Does not require __________
Sometimes requires ____________	Can be changed into DC easily if needed
_____________ generating stations required	Few generating stations required

Watch the video, "Marco Tempest: The electric rise and fall of Nikola Tesla," posted by TED, 2012, on YouTube, https://www.youtube.com/watch?v=V-WkUKP1l3c.
Three neat things about Nikola Tesla:

1.
2.
3.

Current and Voltage

- Electrical current is a measure of _________________ electrons are moving in a circuit.
- In order for these electrons to be moving, there must be some _____________ (a push or a pull) acting on them — in an electrical circuit, this force is called voltage.
- Voltage is measured in ______________:
    - 1 volt = 1 joule (energy unit) per Coulomb or V = j/C.
- In a 12V car battery, the battery does 12 J of work on each coulomb of charge that flows through it.
- Voltage is measured using a _____________ or _________________.

Watch the video "What is Voltage," posted by Sparkfun Electronics, 2016, on YouTube, https://www.youtube.com/watch?v=z8qfhFXjsrw.

Resistance

- As electrons flow through a device that uses their electrical energy, they experience opposition, or ________________ to their flow.
- The energy of these electrons is transferred to the molecules and atoms of the ______________ as they move through it.
- We can calculate resistance as the ________________________________:
  - A material with high resistance requires a high voltage (push) compared to speed of electrons flowing by __________________________.
  - A material with low resistance can use a lower voltage to achieve the same speed of electron flow ______________________________.
- We measure resistance in a unit called "Ohms", represented by the symbol _____.

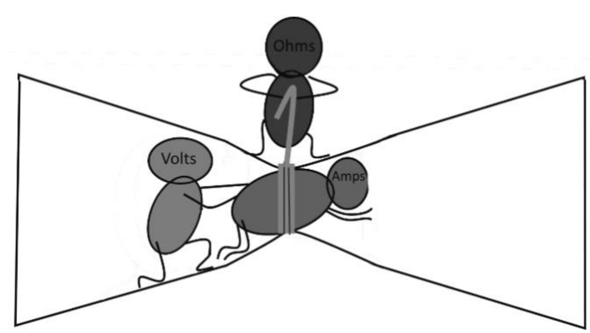
There are four main factors that affect resistance:

1.
2.
3.
4.

Ohm's Law

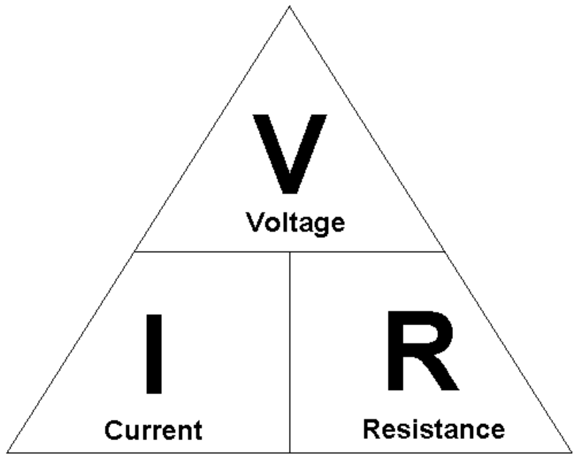
- A German physicist found that there is a relationship between voltage, current and the unique resistance in each and every conductor.
- This relationship can be expressed as: ________________.

In this three-way relationship:



- _____________ supplies the push (measured in Volts).
- _____________ opposes the push (measured in Ohms).
- _______________results (measured in Amps).

We can use this triangle to help us be able to solve for any of the variables in the formula from Ohm's Law:

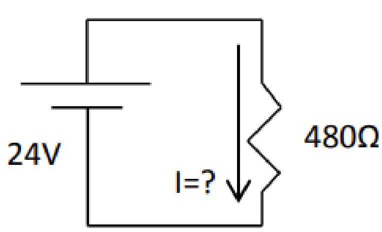


Practice Problems

1. What is the resistance of an electric heater plugged into a 120 V wall outlet if a current of 14 A runs through it?

2. What is the current through an electric clothes dryer with a resistance of 40 Ω and a voltage of 360 V?

3. Using the diagram, solve for the missing value:



More Practice

1. A light bulb has a current of 1 A when 110 volts is applied. What is the resistance of the bulb filament?

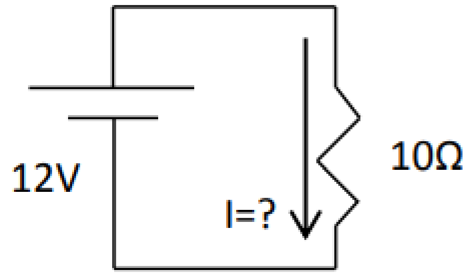
2. In a circuit, the power source is supplying 50 volts and the current is 10 amps. What is the resistance?

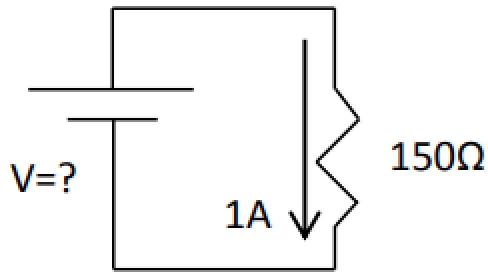
3. An electric iron uses 5 amps to heat it properly. If the resistance of the iron's heating element is 22 ohms, what should the source voltage be?

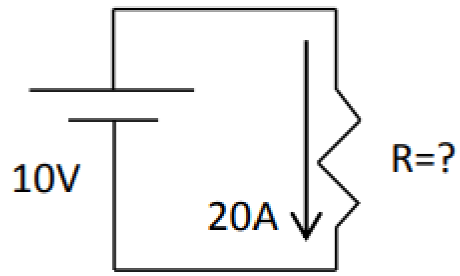
4. If a toaster produces 12 ohms of resistance in a 120-volt circuit, what is the amount of current in the circuit?

5. What happens to the current in a circuit if a 10 Ω resistor is removed and replaced by a 20 Ω resistor?

6. Solve for the unknowns in the diagrams below:







Circuits

- The energy from electrons can be used to produce heat, light and motion as they move through various devices.
- A _________________ provides a continuous pathway for electrons to flow through.
  Electrons can only flow through if the circuit is complete.
- Circuits often include:
  - A ____________: the source of energy.
  - A ________________: the wire through which the current flows.
  - A ____________________: items along the circuit that will convert electricity to another form of energy.

- A ________________: a way to turn the circuit or devices on the circuit on or off.

- Each of these circuit components can be represented by a symbol:

Component	Symbol
Source	
Conductor	
Device(s)	
Switch	

- Schematic diagrams show the components in a circuit and how each of the components are connected.

DRAW IT OUT

Can you draw a circuit with a motor, a switch, a power source and two lights?

What kind of device might this circuit be used in?

Types of Circuits

- The circuits we have looked at so far have all had a single power source, 1-3 load items, and possibly a switch, but in real life, circuits are much more complex.

- There are two basic types of circuits:

  - ______________: have only one path that the current can take. The entire current travels through each component in the circuit

- _______________: have two or more paths for current to take. As electricity moves through the different paths, current is divided through each path

DRAW IT OUT

Series **Parallel**

Parallel Circuits

- Parallel circuits contain nodes.
- _____________ are a junction where current may go in more than one direction.
- Parallel circuits affect ________________________:
    - As the current travels along multiple pathways, it's magnitude ______________.
    - When current reaches a node, some of the current takes one path, and some of the current takes the other path.
    - The sum of the currents along each path adds up to the current coming from the power source.
    - The voltage along each pathway ____________________, since the "push" from the power source is constant.
- Some of the benefits to using parallel circuits include:
    - If the circuit is broken in one of the parallel paths, the others will still continue to function.
    - Each component can have its own switch/function independently.
    - Voltage remains constant across each path.