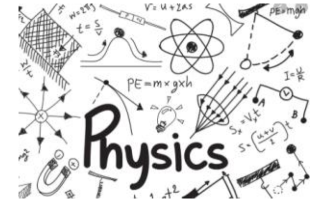
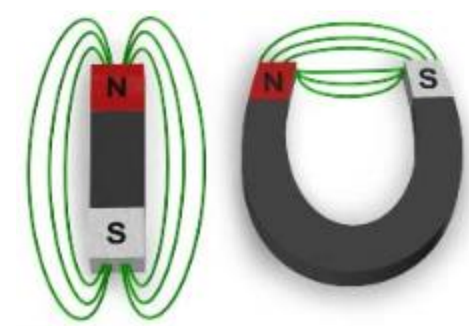
St. Louis Public Schools
Continuous Learning for Students
High School Physics



Welcome to Distant Learning for Physics STUDENTS!
(Hybrid of Online and Offline Materials)

Students are encouraged to maintain contact with their home school and classroom teacher(s). If you have not already done so, please visit your child's school website to access individual teacher web pages for specific learning/assignment information. If you cannot reach your teacher and have elected to use these resources, please be mindful that some learning activities may require students to reply online, while others may require students to respond using paper and pencil. In the event online access is not available and the teacher cannot be reached, responses should be recorded on paper and completed work should be dropped off at your child's school. Please contact your child's school for the dates and times to drop off your child's work.
If you need additional resources to support virtual learning, please visit: https://www.slps.org/extendedresources



Overview of Weeks 6 and 7 (April 27-May 8): With this learning plan, you will engage with concepts of electrostatic and gravitational forces, electric and magnetic fields, and learn about how magnets and generators work. You can choose between offline or online assignments based on availability of technology and internet. Please keep in mind that the print packet contains only offline materials. **Daily breakdown of tasks is only a suggestion of pacing and resources.**

To access all pdf files in this document go HERE. To access only offline files go HERE.

For additional information on Continuous Learning go to https://www.slps.org/keeponlearning

Login Information for CPO Online Textbook: Username: MirkaROO PW:ilovephysics

For questions related to this instructional plan, please contact:

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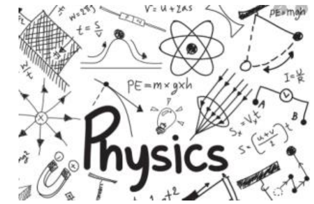

WEEK 6	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material? What needs to be turned in?*
Monday April 27, Tuesday April 28	Use mathematical thinking using Newton's Law of Universal Gravitation to describe the cause and effect relationship between distance and gravitational attraction.	Choose between: **Offline Assignment:** 1. Read Lesson 1 Notes 2. Write/type your responses in Gravity Graph pdf and Law of Gravitation Calculations editable pdf or word doc OR **Online Assignment**: 1. Read Lesson 1 Notes 2. For additional support on instruction, access the Slides to Lesson 1 3. Engage with PhET Simulation: Gravitational Force Lab 3. Type your responses in PhET Simulation Gravity Lab editable pdf or word doc	Complete and turn in either the Offline Assignments or the Online Assignment. Both of these activities will take two days of work.
Wednesday April 29, Thursday April 30	Use mathematical thinking using Coulomb's Law to describe the cause and effect relationships between distance and electrostatic attraction.	Choose between: **Offline Assignment:** 1. Read Lesson 2 Notes 2. Write/type your responses in Coulomb's Law Practice CPO Science Worksheet editable pdf or word doc OR **Online Assignment:** 1. Read Lesson 2 Notes 2. For additional support on instruction, access the Slides to Lesson 2 3. Engage with PhET Simulation: Coulomb's Law 4. Type your responses in PhET Simulation Coulomb's Law PhET Lab editable pdf or word doc	Complete and turn in either the Offline Assignments or the Online Assignment. Both of these activities will take two days of work.

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Friday May 1	Demonstrate concepts learned about Coulomb's Law and the Law of Universal Gravitation	1. Review the PowerPoint Slides or Notes 2. Complete the assessment **Offline**: Coulomb's Law and Law of Universal Gravitation Quiz pdf or word doc OR **Online**: Coulomb's Law and Law of Universal Gravitation Quiz Form	Complete the mastery quiz and submit it on time. You may use any resources on this quiz.

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WEEK 7	**Lesson Objective** *What will you know and be able to do at the conclusion of this lesson?*	**Instructional Activities** *What needs to be done in order to learn the material?*	**Assessment / Assignment*** *How will you show your teacher that you learned the material?*
Monday May 4	Draw a model of a magnetic field around a magnet or several magnets	Choose between: **Offline Assignment:** 1. Read Lesson 3 Notes 2. Draw your responses in Magnetic Fields Worksheet pdf or word doc OR **Online:** 1. Read Lesson 3 Notes 2. For additional support on instruction, access the Slides to Lesson 3 3. Engage with the PhET Simulation: Magnets and Electromagnets 4. Type in Investigating Magnetic Fields PhET Lab editable pdf or word doc *NOTE: This lab requires the computer/tablet to be able to run Java. If this cannot be done, complete the offline assignment.*	Complete and turn in either the Offline Assignments or the Online Assignment. Some of the questions will require you to draw fields, if you cannot figure out a way to draw digitally (you may use google draw or pdfescape.com), do it on a separate sheet of paper and attach/send a picture.
Tuesday, May 5	Define and label the structure of an electromagnet and describe how to make the magnetic field stronger	**Offline Assignment:** 1. Read Lesson 4 Notes 2. Read the Electromagnets article and write/type your responses using editable pdf or word doc **OPTIONAL ACTIVITY** Build Your Own Electromagnet Directions and Lab editable pdf or word doc	Turn either the Offline Assignments or the by completing the optional activity. Some of the questions will require you to draw, if you cannot figure out a way to draw digitally (you may use google draw or pdfescape.com), do it on a separate sheet of paper and attach/send a picture.
Wednesday May 6, Thursday May 7	Describe how a generator works and how the structure of magnets	Choose between: **Offline**: 1. Read Lesson 5 Notes 2. Read the article and write/type your responses in Generator Article Reading and Questions editable pdf or word doc	Complete and turn in either the Offline Assignments or the Online Assignment. Both of these activities will take two days of work.

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	contributes to its electricity generation	OR **Online:** 1. Read Lesson 5 Notes 2. For additional support on instruction, access the Slides to Lesson 5 3. Engage with PhET Simulation: Faraday's Law and Generators Simulations 4. Type in Generator PhET Lab editable pdf or word doc	
Friday May 8	Demonstrate concepts learned about Magnetic Fields, Generators and Electromagnets	1. Review the PowerPoint Slides or Notes 2. Complete assessment **Offline**: Magnetic Fields, Generators and Electromagnets Quiz pdf or word doc OR **Online**: Magnetic Fields, Generators and Electromagnets Quiz Form	Complete the mastery quiz and submit it on time. You may use any resources on this quiz.

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Student Notes Part

Continuous Learning Weeks April 27-May 8

LESSON 1 NOTES
TOPIC: LAW OF UNIVERSAL GRAVITATION

KEY VOCABULARY:

Gravity: the force by which a planet or other body draws objects toward its center.

Law of Universal Gravitation: ALL objects attract each other with a force of gravitational attraction. Gravity is universal. This force of gravitational attraction is directly dependent upon the masses of both objects and inversely proportional to the square of the distance that separates their centers.

Inverse Square Law: the strength of an effect such as light or gravitational force changes in inverse proportion to the square of the distance from the source.

NOTES:

Sir Isaac Newton is often credited with the discovery of gravity, but this is not quite true. It is his discovery of the universal nature of gravitational attraction which his claim to fame. State simply:

ALL OBJECTS ATTRACT OTHER OBJECTS TO THEMSELVES

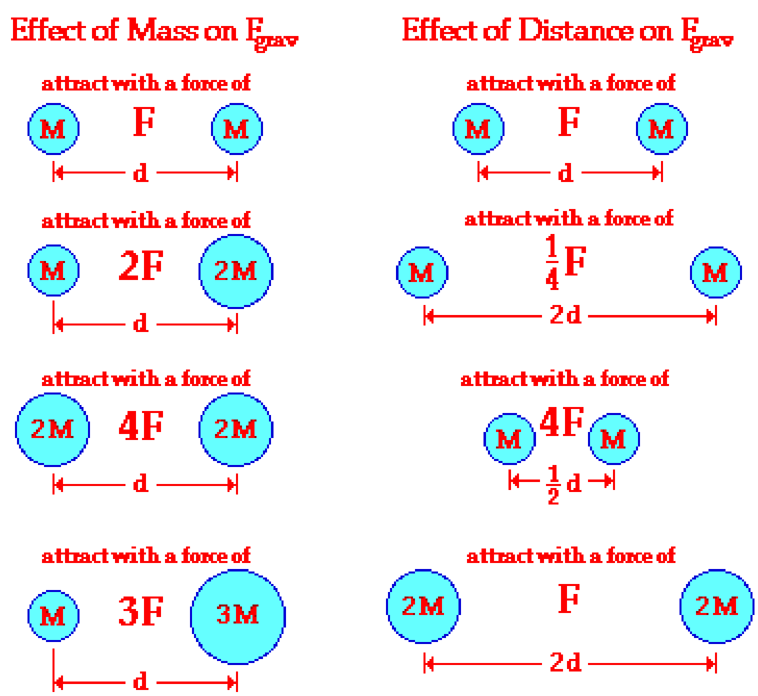
The reason we don't feel gravity between each other as strongly as we feel gravity pulling us toward the earth is that our masses are actually quite small, so we don't feel the attraction at all.

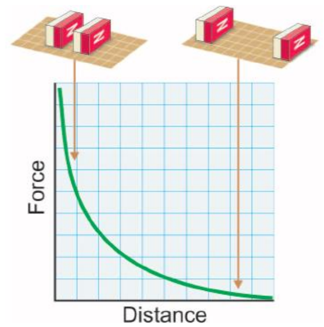
There are two things that affect gravitational attraction: The mass of the objects, and their distance apart.

MASS: When we increase mass by a constant factor, the force changes by that same factor

<u>Example</u>: If we double the mass on one object, the force doubles. If we cut that mass in half, the force is also cut in half

DISTANCE: When we increase the distance, by a factor, the Force is decreased by the inverse of that factor squared, or vice versa. This is called the inverse square law.





Example: If we take the distance times 2, then the force will be multiplied by the inverse of 2 squared (which is 4). This means we would multiply the Force by 1/4.

IF WE INCREASE THE MASS, THE FORCE ALSO INCREASES. IF WE INCREASE THE DISTANCE, THE FORCE DECREASES ACCORDING TO THE INVERSE SQUARE LAW.

UNIVERSAL LAW OF GRAVITATION EQUATION:

$$F_{grav} = \frac{G * m_1 * m_2}{r^2}$$

where G represents the universal gravitation constant

$$(G = 6.67 \times 10^{-11}\ N{\cdot}m^2/kg^2)$$

F_{grav} = the force of gravity, measured in Newtons
G = universal gravitational constant (above)
m_1= mass of object 1, measured in kilograms
m_2= mass of object 2, measured in kilograms
r = distance between objects, measured in meters

Example Problem 1:
Determine the force of gravitational attraction between two 70-kg physics students if the students are standing 1 m apart. SOLVE IN TERMS OF G.

G: $m_1 = 70\text{ kg}$ $m_2 = 70\text{ kg}$ $r = 1\text{ m}$ G
U: $F_{grav} = ?$
E: $F_{grav} = G\,\frac{m_1 m_2}{r^2}$
S: $F_{grav} = G\,\frac{N\cdot m^2}{kg^2} \cdot \frac{(70\text{ kg})(70\text{ kg})}{(1\text{ m}^2)}$
S: $F_{grav} = G\,\frac{N\cdot \cancel{m^2}}{\cancel{kg^2}} \cdot \frac{4{,}900\ \cancel{kg^2}}{1\ \cancel{m^2}}$
$\boxed{F_{grav} = 4{,}900\cdot G\ N}$

LESSON 2 NOTES
TOPIC: COULOMB'S LAW

KEY VOCABULARY:
Electric Charge: is the physical property of matter that causes it to experience a force when placed in an electromagnetic field. There are two types of **electric charge**: positive and negative (commonly carried by protons and electrons respectively). Like **charges** repel each other and unlike **charges** attract each other.

Coulomb's Law: Coulomb's law states that the electrical force between two charged objects is directly proportional to the product of the quantity of charge on the objects and inversely proportional to the square of the separation distance between the two objects

Inverse Square Law: the strength of an effect such as light or gravitational force changes in inverse proportion to the square of the distance from the source.

NOTES:
Coulomb's Law is quite similar to the Law of Universal Gravitation, except that instead of comparing the gravitational attraction of objects based on their masses and distance apart, Coulomb's law measures the electrostatic attraction of objects based on their electric charge and distance apart.

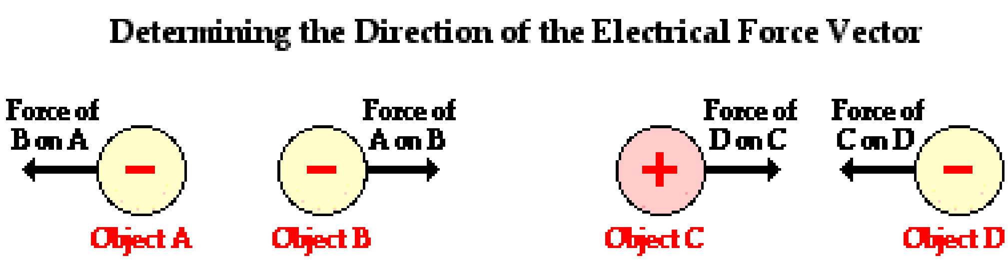
Both Coulomb's Law and the Law of Universal Gravitation obey the Inverse Square Law

Written as an equation, Coulomb's Law can be stated as…

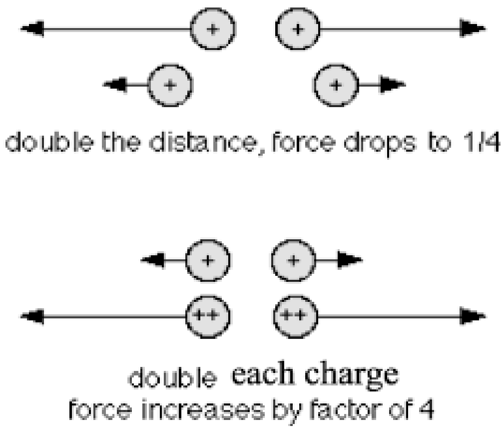
$$F_e = k_e \frac{q_1 q_2}{r^2}$$

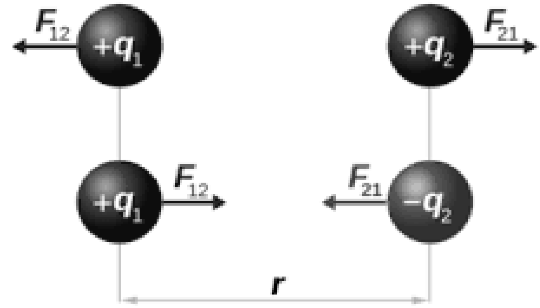
where

- F_e is the force
- k_e is the Coulomb's constant (8.987×10^9 $N.m^2.C^{-2}$)
- q_1 and q_2 are the signed magnitudes of the charges
- r is the distance between the charges



Charges: Opposites attract (a positive and a negative charge), like charges repel.





IF THE ANSWER TO A COULOMB'S LAW PROBLEM IS NEGATIVE: ATTRACTION
IF THE ANSWER TO A COULOMB'S LAW PROBLEM IS POSITIVE: REPULSION

Practice Problem #1

Suppose that two point charges, each with a charge of +1.00 Coulomb are separated by a distance of 1.00 meter. Determine the magnitude of the force between them in terms of k and determine if these charges will repel or attract.

G: $q_1 = +1.00\ C$ $\quad q_2 = +1.00\ C$ $\quad r = 1.00\ m$ $\quad k_c$

U: $F_c = ?$

E: $F_c = k_c \cdot \frac{q_1 q_2}{r^2}$

S: $F_c = k_c \frac{N \cdot m^2}{C^2} \cdot \frac{(+1.00C)(+1.00C)}{(1m)^2}$

S: $F_c = k_c \frac{N \cdot \cancel{m^2}}{\cancel{C^2}} \cdot \frac{1.00\cancel{C^2}}{1\cancel{m^2}}$

$\boxed{F_c = 1 K_c\ N}$ The answer is positive, so these charges will repel.

LESSON 3 NOTES
TOPIC: MAGNETIC FIELDS

KEY VOCABULARY:

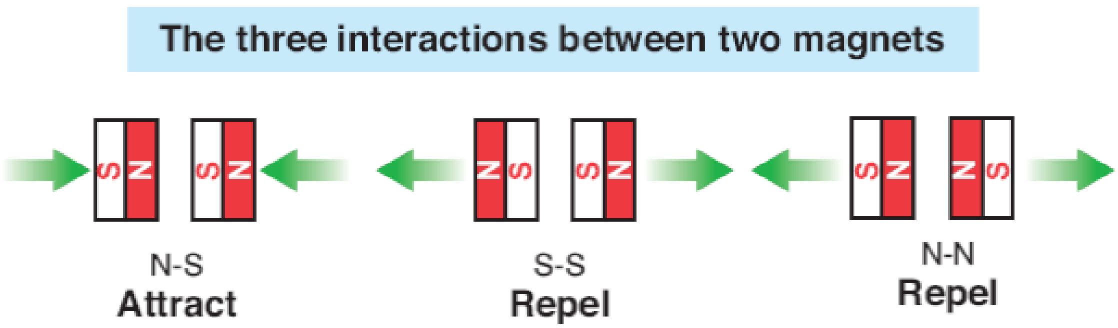
Magnet: A material is magnetic when it can exert (put) forces on a magnet or other magnetic materials.

Magnetic Domains: where all the electrons of atoms in a certain area have the same **magnetic** orientation.

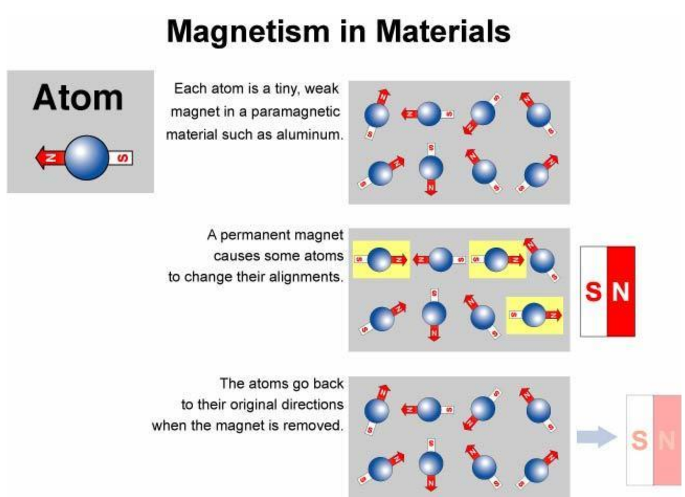
Magnetic Field: All magnets create a magnetic field in the space around them, where a magnetic force can be felt.

NOTES:

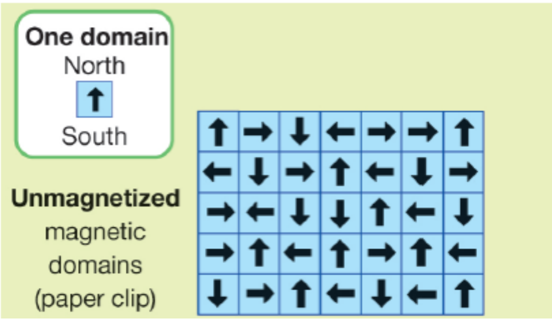
Magnets have two opposite magnetic poles, called the north pole and the south pole

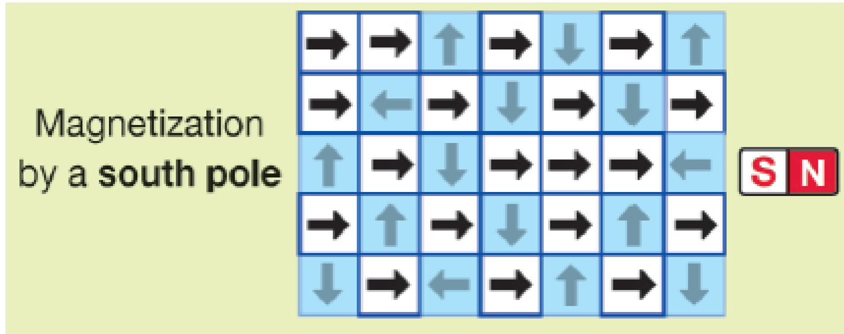


Magnetism In Materials: All atoms have electrons, so you might think that all materials should be magnetic, but there is great variability in the magnetic properties of materials. The electrons in some atoms align to cancel out one another's magnetic influence.



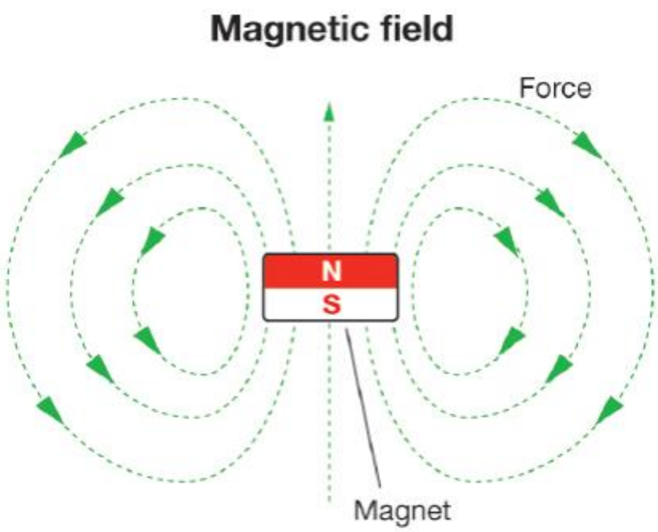
Ferromagnetic Materials: A small group of ferromagnetic metals have very strong magnetic properties. Examples of ferromagnetic materials are iron, nickel, and cobalt. Atoms in ferromagnetic materials align themselves with neighboring atoms in groups called **magnetic domains**.





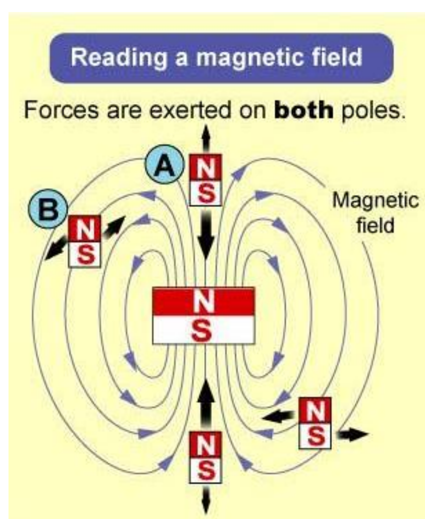
Magnetic Fields:
magnets create a **magnetic field** in the space around them, and the magnetic field creates on other magnets.

How to Draw a Magnetic Field



- The number of field lines in a certain area indicates the relative strength of the magnetic field in that area.
- The arrows on the field lines indicate the direction of the force.
- The closer the lines are together, the stronger the field.
- Magnetic field lines always point away from a magnet's north pole and toward its south pole.
- Magnets A and C feel a net attracting force toward the source magnet.
- Magnets B and D feel a twisting force, or torque, because one pole is repelled and the opposite pole is attracted with approximately the same strength.

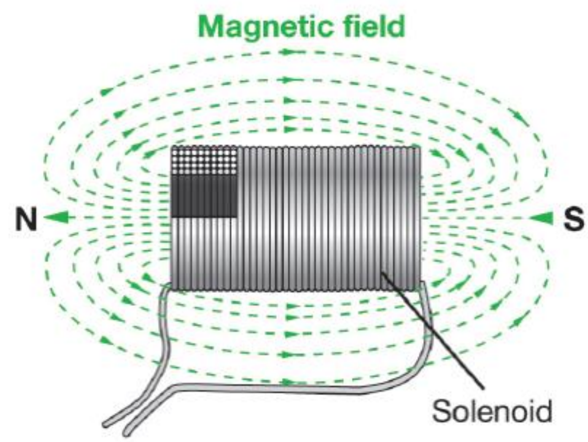
Just like in Coulomb's Law or The Law of Universal Gravitation, the force from a magnet gets weaker as it gets farther away. Separating a pair of magnets by twice the distance reduces the force by 8 times or more.



LESSON 4 NOTES
TOPIC: ELECTROMAGNETS

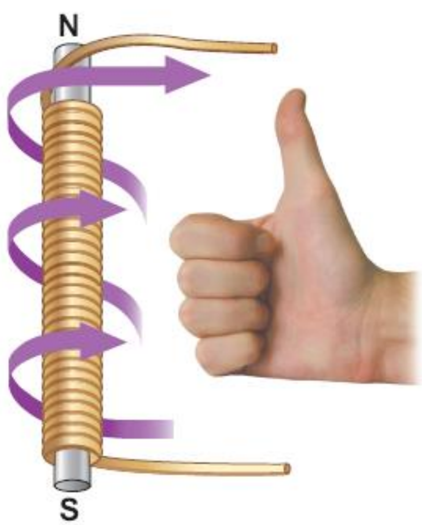
KEY VOCABULARY:
Electromagnet: An **electromagnet** is a type of magnet in which the magnetic field is produced by an electric current. **Electromagnets** usually consist of wire wound into a coil

Solenoid: a cylindrical coil of wire acting as a magnet when carrying electric current.



NOTES:

Electromagnets are magnets that are created when there is electric current flowing in a wire.

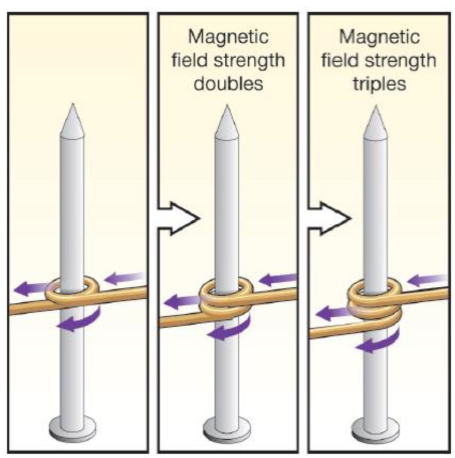


The simplest electromagnet uses a coil of wire wrapped around some iron. This coil of wire is called a solenoid.

To find the north pole of an electromagnet, use the **right hand rule.**

When the fingers of your right hand curl in the direction of the wire, your thumb points toward the magnet's north pole.

Strength of an Electromagnet:
There are <u>two</u> ways to increase the current in an electromagnet:
1. Add more turns of wire around the core.
2. Apply more voltage by increasing the power.



LESSON 5 NOTES
TOPIC: GENERATORS AND ELECTROMAGNETIC INDUCTION

KEY VOCABULARY:
Electromagnetic Induction: is the production of an electromotive force (i.e., voltage) across an electrical conductor in a changing magnetic field.

Generator: a device that uses induction to convert mechanical energy into electrical energy.

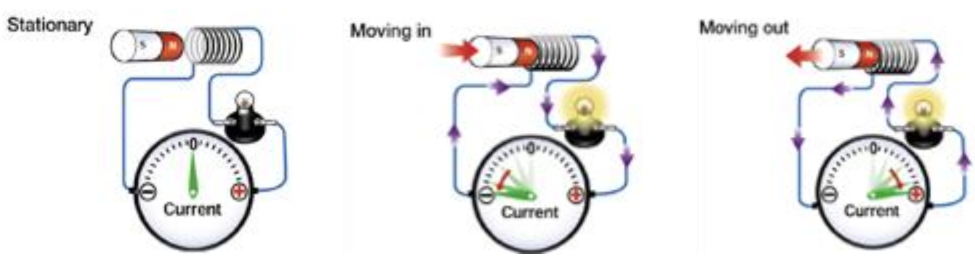
Rotor: the rotating assembly in a turbine, especially a wind turbine. Contains magnets to produce a changing magnetic field

Faraday's Law: Any change in the magnetic environment of a coil of wire will cause a voltage to be "induced" in the coil

NOTES:

Electromagnetic Induction: If you move a magnet near a coil of wire, a current will be produced. This process is called **electromagnetic induction**, because a moving magnet induces electric current to flow. Moving electric charge creates magnetism and conversely, changing magnetic fields also can cause electric charge to move.

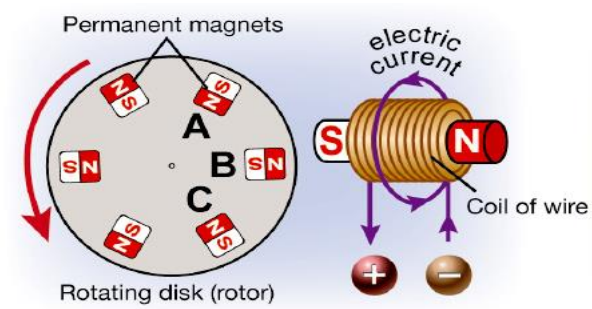
Current is only produced if the magnet is moving because a changing magnetic field is what creates current. If the magnetic field does not change, such as when the magnet is stationary, the current is zero. If the magnetic field is increasing, the induced current is in one direction. If the field is decreasing, the induced current is in the opposite direction.



Generators

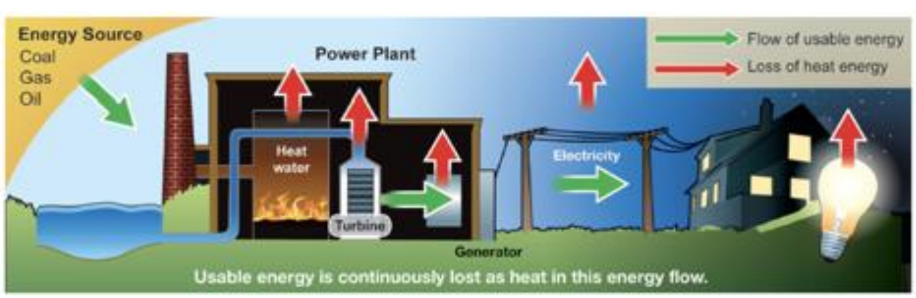
A **generator** is a device that uses induction to convert mechanical energy into electrical energy. The electrical energy created by a generator is not created from nothing. Energy must continually be supplied to keep the rotating coil or magnetic disk turning. In hydroelectric generators, falling water turns a **turbine** which spins a generator to produce electricity.

Energy from other Sources: In addition to water, other nonrenewable resources can be used to power the rotor. A nonrenewable resource is not replaced as it is used. Any fossil fuel is a good example of nonrenewable resource. Besides their growing scarcity, burning fossil fuels produces sulfur oxide emissions that reduce air quality and may be accelerating climate change.



Energy Transfer in a Power Plant

With each transformation (green arrows), some energy is lost to the system in the form of heat (red arrows).



Scientist Name:

Asteroid Avoidance - Gravity Force Lab

Part 1:

Watch this video (5 min): https://www.youtube.com/watch?v=lY3XV_GGV0M

What are three things about gravity you learned from this video?

1.

2.

3.

Navigate to:
https://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_en.html
(English version)
https://phet.colorado.edu/sims/html/gravity-force-lab/latest/gravity-force-lab_es.html
(Spanish version)

Take 5 minutes to explore the simulation. Record at least two observations:

What are two ways you can change the amount of force (gravity) the objects are experiencing?

Which way do you think has the biggest effect on the amount of force (gravity)?

<u>Part 2</u>:

Reset your simulation by clicking the orange circle arrow in the bottom right:

Complete the table:

Mass of 1 (kg)	Position of 1 (m)	Mass of 2 (kg)	Position of 2 (m)	Force (1 on 2) (N)	Force (2 on 1) (N)
10	0	10	10		
10	0	10	5		
100	0	100	10		
100	0	100	5		
1000	0	1000	10		
1000	0	1000	5		
140	3	200	7		
fill	in	your	own	values	here
?	?	?	?	0.000000720801	0.000000720801

What do you notice about Force (1 on 2) and Force (2 on 1) for each scenario? Why do you think that is the case?

What do you think has a stronger effect on the amount of force (gravity)? Use data from your table to support your reasoning:

Part 3:

Determine whether these statements are True or False. If the statement is false, write the correct version of the statement below.

____ The force of gravity increases when two objects move closer together.

____The force of gravity increases when the mass of an object decreases.

____The two objects have different masses, the more massive object pulls with a greater force.

____The force of gravity depends on the mass of objects and the distance between them.

The Earth's gravity is pulling you down. Are you pulling up on the Earth? Explain your reasoning (3-5 sentences):

Gravity is a force of attraction based upon the mass of two objects and the distance between them. Why aren't other objects, like the pencil on your desk, being pulled toward you right now? Explain your reasoning (at least 4 sentences):

Write down three more things about gravity you learned from this simulation:

1.

2.

3.

You are trying to protect Earth from incoming Asteroids. What do you think are important factors to consider when designing a plan to save us?

Challenge: *An Asteroid weighing 10,000,000 kg is coming toward Earth. Using the things you learned from this simulation, design a way to save us.*

Name: ____ Period: ____

Lesson 2 Online Assignment

Coulomb's Law PhET Lab

Background: When charged particles are brought near each other, they interact and result in attraction or repulsion. We can see this in action.

1. OPTIONAL (if you have a Balloon): Take a balloon and rub it on a shirt or hair. Place the balloon against an object and observe the interaction.
   a. What happens to the balloon?

   b. Can you come up with an explanation for why this interaction occurs?

2. OPTIONAL (If you have Sticky Tape): Take a piece of tape and place most of it onto a desk or binder (keep one end off the surface so it can peeled off easily). Quickly peel the tape off.
   a. When the tape is brought near your finger, what happens? Why do you think this happens?

   b. When the tape is brought near another piece of tape, also peeled from a surface what happens? Why do you think this interaction occurs?

3. Coulomb's Law PhET

   So clearly there are forces being exerted on this electrically charged objects. The question is what variables affect that force. To determine that answer, we will be using a PhET simulation.

   a. **Type of Charge:** Objects can be positively or negatively charged. Vary the charges of the two objects and determine a rule for when the force is attractive or repulsive.

b. **Magnitude of Charge:** Place the left charge at the 2 cm position and the right one at the 4 cm position. Vary the left and right charge to the values provided below and record the resulting forces.

Left Charge	Right Charge	Resulting force (N)
1 μC	4 μC	
4 μC	1 μC	
2 μC	2 μC	
1 μC	2 μC	
1 μC	8 μC	
2 μC	8 μC	

a.

I. Compare the forces that each charged object feels from the other? What Law explains this observation?

II. Look how the forces changed when you changed the charges. What can you conclude about the relationship of the 2 charges to the resulting force? (Hint: is it about the Sum? Difference? Product? Factor?)

c. **Distance:** Set the charge for both object to 5μC. Place the left object at 0 cm. Move the right object to the locations before and record the resulting forces.

Distance (cm)	Resulting Force (N)
2	
4	
6	
8	
10	

a.

I. What happened to the force when the distance doubled? By what factor did it change?

II. What about when the distance tripled?

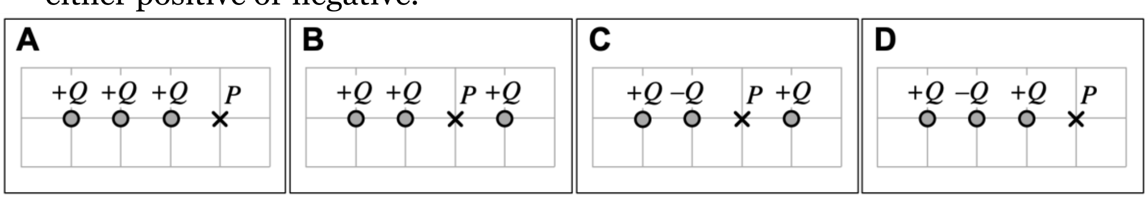
III. Quadrupled?

IV. Can you arrive at a rule for how the distance between the charged objects relates to the resulting force?

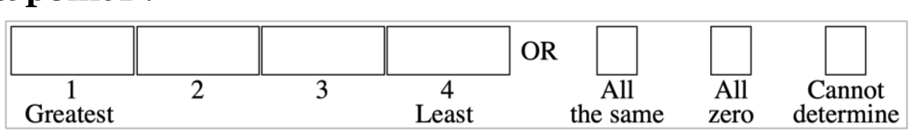
Look up at the board and see if your rules for the b and c agree with the equation on the board. Does the format of this equation look similar to any other equation you have seen before? Maybe another Force that was described by Sir Isaac Newton? Compare the two equations below.

Coulomb's Law Challenge Problems

1. In each figure, three charges are fixed in place on a grid, and a point near those particles is labeled *P*. All of the charges are the same size, *Q*, but they can be either positive or negative.



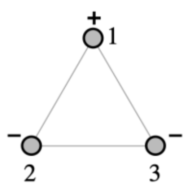
Rank the strength (magnitude) of the net electric force on a charge +*q* that is placed at point *P*.



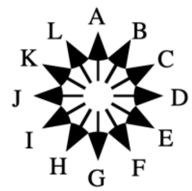
Explain your reasoning.

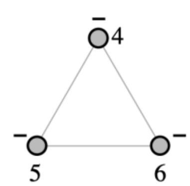
2. Three charges are fixed at the vertices of each equilateral triangle shown below. All charges have the same magnitude. Only charge 1 is positive.

Determine the direction of the net electric force acting on each charge due to the other two charges in the same triangle. Answer by using letters A through L representing directions from the choices below.



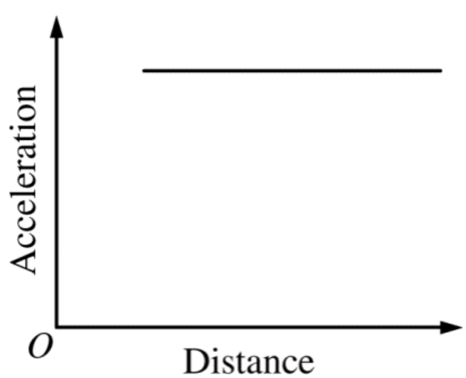
	Net Force Direction
Charge 1	
Charge 2	
Charge 3	





	Net Force Direction
Charge 4	
Charge 5	
Charge 6	

1. A small object with positive charge $+Q$ is fixed in place. A small bead with positive charge $+q$ is released from rest from the position shown above. In the absence of forces other than the electric force, draw what the graph for the acceleration as a function of distance would look like for the +q charge.



Lesson 3 Online Assignment

INVESTIGATING MAGNETIC FIELDS PhET Lab

Name: ____

Purpose:

In this lab you will investigate the properties of magnetic filed around a bar magnet.

Open http://phet.colorado.edu/new/simulations/sims.php?sim=Magnets_and_Electromagnets

1. Label the poles of the magnet and draw the lines of magnetic filed **inside** the magnet clearly marking the direction of the field.

2. Click on the bar **See inside Bar** on the right side menu to check your predictions. Were your predictions correct? ______________________________________

3. *Move the Compass around the bar magnet* Which pole of the magnet does the red compass needle point towards?

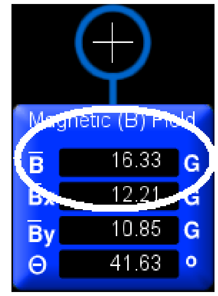
4. True or False:

- The red arrow of the compass points in the direction of magnetic field_____________
- The vector of magnetic field inside the bar magnet is horizontal_________________
- Compass can be used to determine the magnitude of magnetic field______________

On the diagram above, identify points where you anticipate the vector of net magnetic field to to have only:

- Horizontal direction (Label this point H)
- Vertical direction (Label this point V)

4. Use the available compass to verify your predictions.



Check the box "Show Field Meter" in the right menu. A blue box should appear. This measures the Magnetic Field around the magnet (which is known as 'B'). The Magnetic field is measured in Gauss (G). Move the field meter around the magnet.

1. Does the field increase or decrease as you move the meter closer to the magnet?

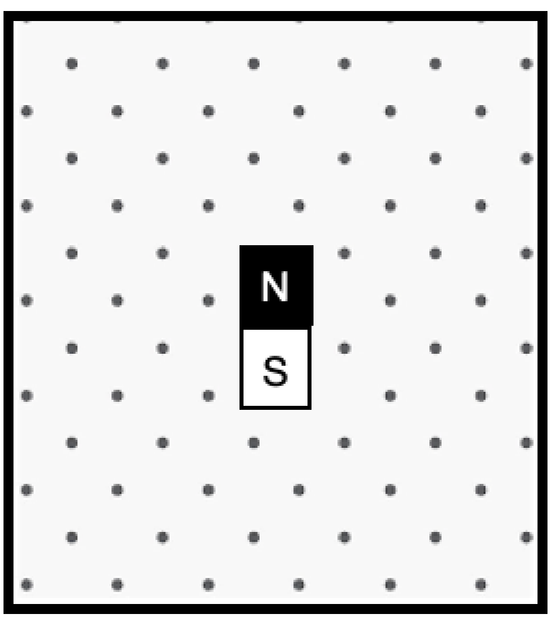
Move your meter so that it is about one inch (on your computer screen) away from the North end of your magnet.

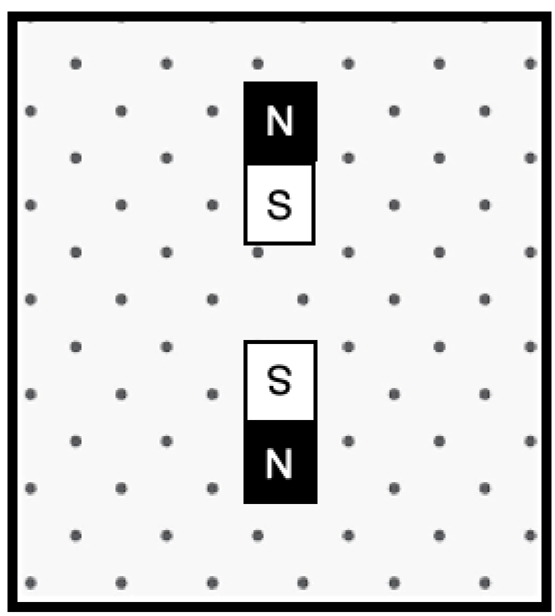
2. What is the magnitude of field strength (B) in Gauss?

Now move the meter the same distance away from the South end of your magnet.

3. Is the amount of magnetic field the same for both North and South ends of a magnet?

Draw the Magnetic Fields around the Following Magnetic Configurations:





Name ___________________________________ Period _______

Lesson 4

Electromagnets

(Adapted from cK12)

Summary

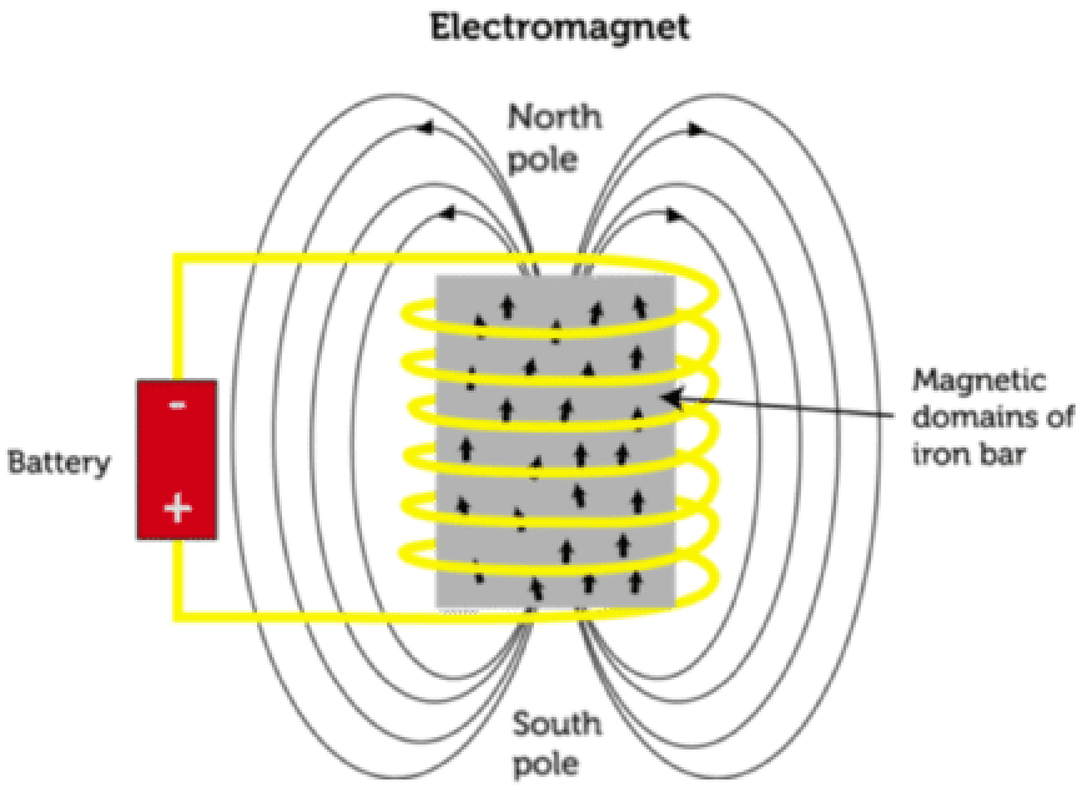
- An electromagnet is a solenoid wrapped around a bar of iron or other ferromagnetic material. The magnetic field of the solenoid magnetizes the iron bar.
- The combined magnetic force of the magnetized wire coil and iron bar makes an electromagnet very strong.
- Electromagnets can be turned on or off and their strength can be changed by controlling the electric current.

This crane is dangling a big round magnet that has picked up metal car parts in a junk yard. The parts practically leap up to the magnet because it's so strong. That's because it's an **electromagnet**.

What Is an Electromagnet?

An **electromagnet** is a solenoid wrapped around a bar of iron or other ferromagnetic material. A solenoid is a coil of wire with electric current flowing through it. This gives the coil north and south magnetic poles and a magnetic field. The magnetic field of the solenoid magnetizes the iron bar by aligning its magnetic domains. You can see this in the **Figure** below.

Name ___________________________________ Period _______



Strength of an Electromagnet
The combined magnetic force of the magnetized wire coil and iron bar makes an electromagnet very strong. In fact, electromagnets are the strongest magnets made. An electromagnet is stronger if there are more turns in the coil of wire or there is more current flowing through it. A bigger bar or one made of material that is easier to magnetize also increases an electromagnet's strength.

Easy On/Off
Besides their strength, another pro of electromagnets is the ability to control them by controlling the electric current. Turning the current on or off turns the magnetic field on or off. The amount of current flowing through the coil can also be changed to control the strength of the electromagnet.

Name ___________________________________ Period _______

Article Review Worksheet

This worksheet will guide you through a critical reading of an assigned article or book chapter.

Logic and Argument:

1. The main idea of this article is: (Paraphrase as accurately as possible.)

2. The most important information in the article is: (What supporting evidence, facts, experience, or data do the authors provide to support the main idea?)

3. The key concept(s) we need to understand in the article are:
(What important ideas do you need to understand in order to understand the authors' line of reasoning?)

   1.

   2.

   3.

4. Vocabulary (using the internet or context clues, define the following terms)

   1. Solenoid

   2. Electromagnet

   3. Electric Current

   4. Ferromagnetic

   5. Magnetic Domain

What questions do you have about this article? Do you need more information?

   1.

   2.

   3.

Name ___________________________________ Period _______

Review Questions

1. What is an electromagnet?

2. How could you increase the strength of an electromagnet?

3. Why are electromagnets the strongest of all magnets?

4. How could the crane operator in the opening photo cause the electromagnet to drop the metal parts into the train car?

5. Why might it be useful to be able to turn an electromagnet on and off?

Optional Activity Lesson 4
Electromagnet Lab

Name: ____________________________ Period: ____

Background:
Electricity and magnetism are related. In fact, they are actually the same thing: Electromagnetism. In this lab you will make a device that uses electricity flowing through a circuit to make a magnet. When electricity is flowing through the circuit, we have a magnet. If we stop the electric current, we will no longer have a magnet. This is an electromagnet – a magnet created and controlled by electricity. You are going to make an electromagnet and determine what is able to make it stronger. You will investigate how the number of times you wrap the wire around the metal core affects the strength of the electromagnet. You will also investigate how the size of the metal core affects the strength of the electromagnet.

Materials:

- Bolt
- Paper clips
- D cell battery
- 3 nails
- Wire (copper, no insulation)

Part 1: Investigating the # of wrapped coils

Testable Question: (Read the procedure for this part. What question are you trying to answer?)

____

____

Procedure:

1. Wrap the wire around one metal nail a small number of times.
2. Attach each end of the wire to D cell to send current through the wire, creating a magnetic field, and making the nail magnetized.
3. Determine how strong the electromagnet is by seeing how many paperclips it can pick up. Record the number in the data table below.
4. Wrap the wire around the nail more times and test how strong this electromagnet is.
5. Wrap the wire around the nail as many times as possible and test how strong this electromagnet it.

	# of wraps (coils)	**Strength of the Magnetic Field (# paperclips picked up)**
Small		
Medium		
Large		

Part 2: Size of the metal core

Testable Question: (Read the procedure for this part. What question are you trying to answer?

____

____

Procedure:

1. Wrap one nail with a medium number of coils, remember the number of coils, and attach it to cell to create an electromagnet. Test its strength with the paperclips. Record the number you are able to pick up in the data table below.
2. Wrap two nails with the same number of coils, connect the cell, and test the strength.
3. Wrap three nails with the same number of coils, connect the cell, and test the strength.
4. Wrap the metal bolt with the same number of coils, connect the cell, and test the strength.

Size of the Core	**Strength of the Magnetic Field (# paperclips picked up)**
1 Nail	
2 Nails	
3 Nails	
Bolt	

Results:

1. What is an electric current?

2. What is an electromagnet?

3. Explain how the number of times you wrapped the wire around the metal core affected the strength of the electromagnet.

4. Explain how the size of the metal core affected the strength of the magnetic field.

5. Which had are larger affect on the strength of the electromagnet, the number of times you wrapped the wire or the size of the metal core?

Part 3: Graphing

Using the class data collected, create a line graph correlating the number of wire wraps to the number of paper clips picked up. Use the plot on the back. Make sure to include:

- Appropriate Title
- Appropriate Axis Labels
- Uniform Scales on Both Axes
- Connected Line

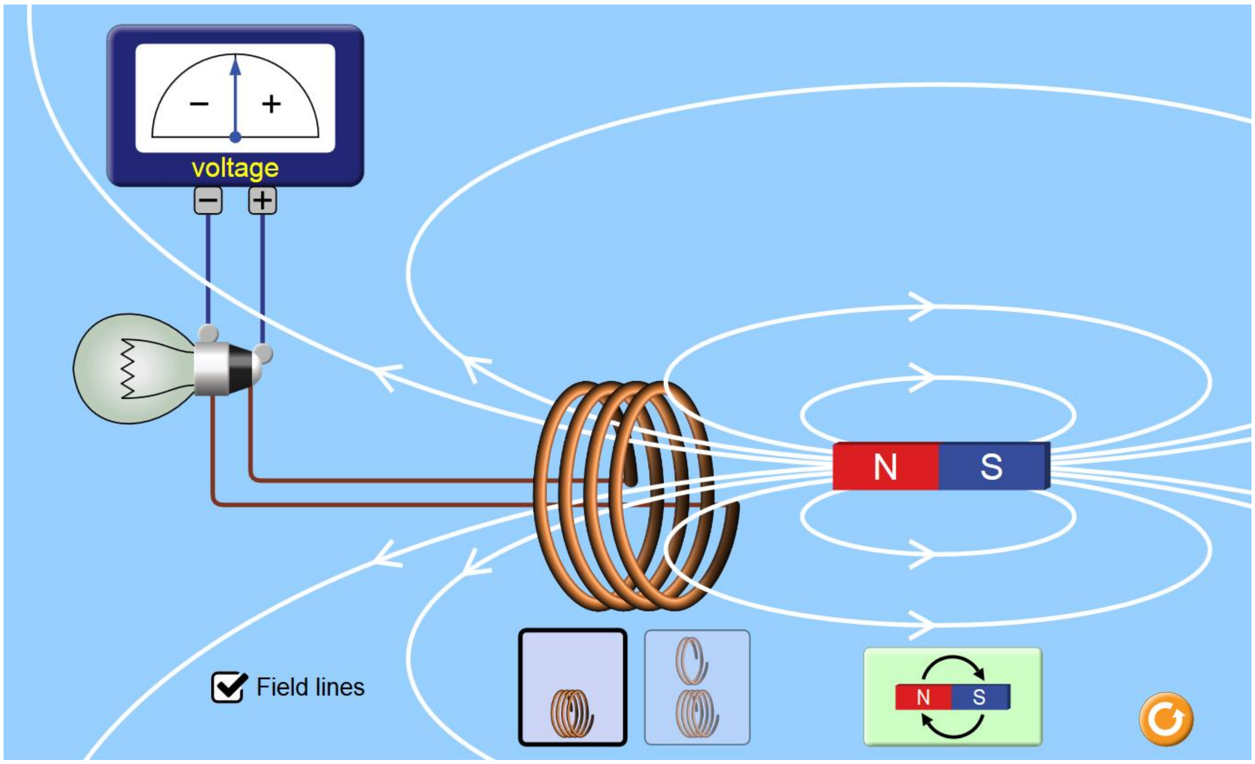
Lesson 5 Online Assignment

Faraday's Law

Name____ Period___________

Introduction:

Michael Faraday was an English scientist that greatly contributed to the study of electromagnetism including building one of the first electric motors. He also contributed to how induction occurs. In this simulation, we will be experimenting with the process of induction.



Directions:

1) Search for the PhET website and go to the simulation entitled Faraday's Law (html 5).
2) Click on "Field Lines" to see the magnetic field around the magnet. Draw a sketch of what you notice.

3) What happens as you move the north side of the magnet into the coil?

4) How does the Voltage change as you move the south side in rather than the North?

5) What happens if you move the magnet into the coil very slowly vs. very quickly. What relationship can you make between the motion of the magnet and the current produced?

6) Can you produce a current when the magnet goes up and down in the loops?

7) Next try two rings vs. four rings. What relationship can you make between the number of loops and the current produced.

8) Lastly, try putting the magnet in the loops and click the magnet flip button. What happens as you spin the magnet several times?

9) Look at the Voltage needle as you spin it multiple times. What type of current do you think it is producing? AC or DC?

Name: ______________________________ Period: __________ Date: ________________

Newton's Universal Law of Gravity

$$F = G\frac{m_1 m_2}{r^2}$$

Distance (meters)	Force (Newtons)
0.20	25.00
0.25	16.00
0.30	11.11
0.35	8.16
0.40	6.25
0.45	5.00
0.50	4.00
0.60	2.78
0.70	2.04
0.80	1.56
0.90	1.23
1.00	1.00
1.20	0.69
1.40	0.51
1.60	0.39
1.80	0.31
2.00	0.25

Above is data for how the force of gravity might change between two objects as the distance between them changes.

Plot the data, putting Force on the y-axis and Distance on the x-axis.

Directions:
1. Title the graph (Distance vs. Force)
2. Label the y-axis (don't forget units)
3. Label the x-axis (don't forget units)
4. Determine the scale for both axis.
5. Plot the data points
6. Draw a trend line

Name _____________________________ Period _____

Offline Assignment 1

Law of Universal Gravitation Questions

All answers should be in terms of G. Show work and include units
Reminder: G: 6.67×10^{-11} Nm^2/kg^2

1. What is the force of gravity between a 100 kg box and a 70 kg physics student that are 10 m away?

2. If you took your distance and multiplied it by ½, what is the new force of gravity? What relationship is this answer to your answer in question 1?

3. What is the force of gravity between the Earth and a person standing at the surface that has a mass of 65 kg? The mass of the Earth is 5.972×10^{24} (which is 5,972 followed by 21 zeros) and the distance from the center of the Earth is 6370000 meters.

4. Imagine that the person in question 3 is an astronaut and is orbiting the Earth 300 meters from the Earth's surface. What is the force of gravity now? (HINT: Add 300 to the distance to the center of the Earth from problem 3) How does this answer compare to Problem 3?

5. If the force of gravity is nearly the same, why do you think astronauts float around when they are in space?

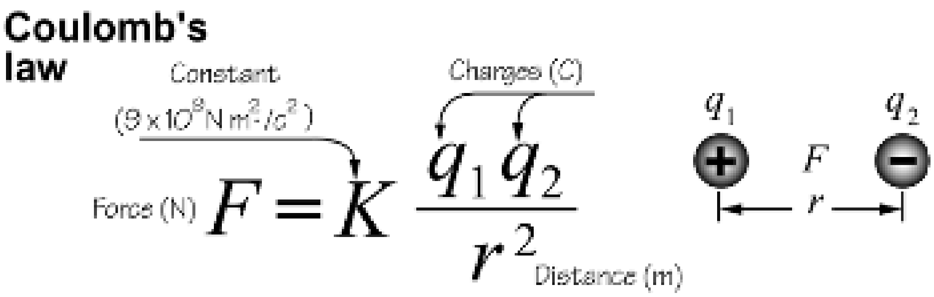
Name ________________________________ Period __________

Lesson 2 Offline Assignment
Coulomb's Law

Coulomb's Law (taken from CPO Science)

In this skill sheet, you will work with Coulomb's law. There are many similarities and some differences between the equation of universal gravitation and the equation for Coulomb's law. They are both inverse square law relationships, and they both have similar arrangements of variables.

When two charges q_1 and q_2 are separated by a distance r, there exists a force between them that is given by:



where F equals the force in newtons and K is a constant equal to 9 10^9 N-m^2/C^2. The units of q_1 and q_2 are the coulombs (C). Distance is given in meters. Here are some important points about the relationships of the variables in Coulomb's law.

- Force is inversely proportional to the square of the distance between the charges. Therefore, if the distance increases by a factor of 2, the force decreases by a factor of 4.
- Force is proportional to the strength of each charge.
- When the two charges have the same sign (positive or negative), the force between them is repulsive because like charges repel.
- When the charges have opposite signs, the force between them is attractive because unlike charges attract.

Practice Problems 1:

1. What happens to the force between two charges if the distance between them is tripled?

Name ______________________________ Period __________

2. What happens to the force between two charges if the distance between them is quadrupled?

3. What happens to the force between two charges if the distance between them is cut in half?

4. What happens to the force between two charges if the magnitude of one charge is doubled?

5. What happens to the force between two charges is the magnitude of both charges is doubled?

6. What happens to the force between two charges if the magnitude of both charges is doubled and the distance between them is doubled?

7. What happens to the force between two charges if the magnitude of both charges is doubled and the distance between them is cut in half?

Practice Problems 2:

1. Two particles, each with a charge of 1 C, are separated by a distance of 1 meter. What is the force between the particles?

What is the force between a 3 C charge and a 2 C charge separated by a distance of 5 meters?

3. Calculate the force between a 0.006 C charge and a 0.001 C charge 4 meters apart.

4. Calculate the force between a 0.05 C charge and a 0.03 C charge 2 meters apart.

CHALLENGE: The force between a pair of 0.001 C charges is 200 N. What is the distance between them?

Name ____ Period ________

Lesson 5 Offline Assignment
Generators
(adapted from cK12)

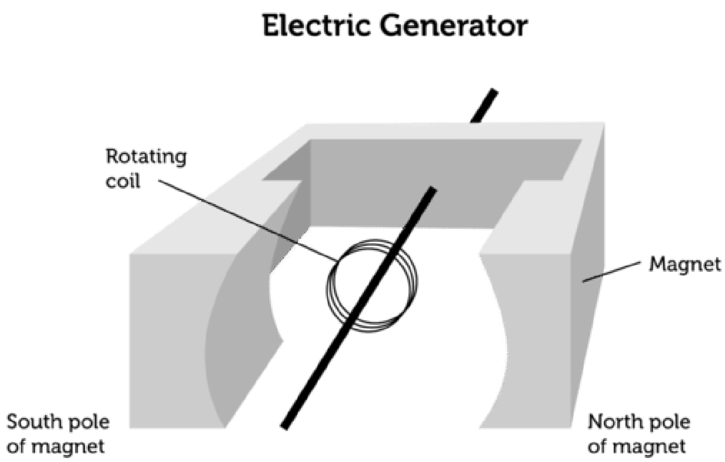
Summary

- An electric generator is a device that produces electricity through electromagnetic induction. Electromagnetic induction is the process of generating electric current with a magnetic field.
- Generators may produce either alternating or direct current, but they all change kinetic energy to electrical energy.

The sprawling machines in this plant aren't factory machines, but they do produce something. They are electric generators in a hydroelectric power plant, and they produce electricity.

Generating Electricity

An **electric generator** is a device that changes kinetic energy to electrical energy through electromagnetic induction. Electromagnetic induction is the process of generating electric current with a magnetic field. It occurs when a magnetic field and an electric conductor, such as a coil of wire, move relative to one another. A simple diagram of an electric generator is shown in the **Figure** below. In any electric generator, some form of energy is applied to turn a shaft. The turning shaft causes a coil of wire to rotate between the opposite poles of a magnet. Because the coil is rotating in a magnetic field, electric current is generated in the wire.

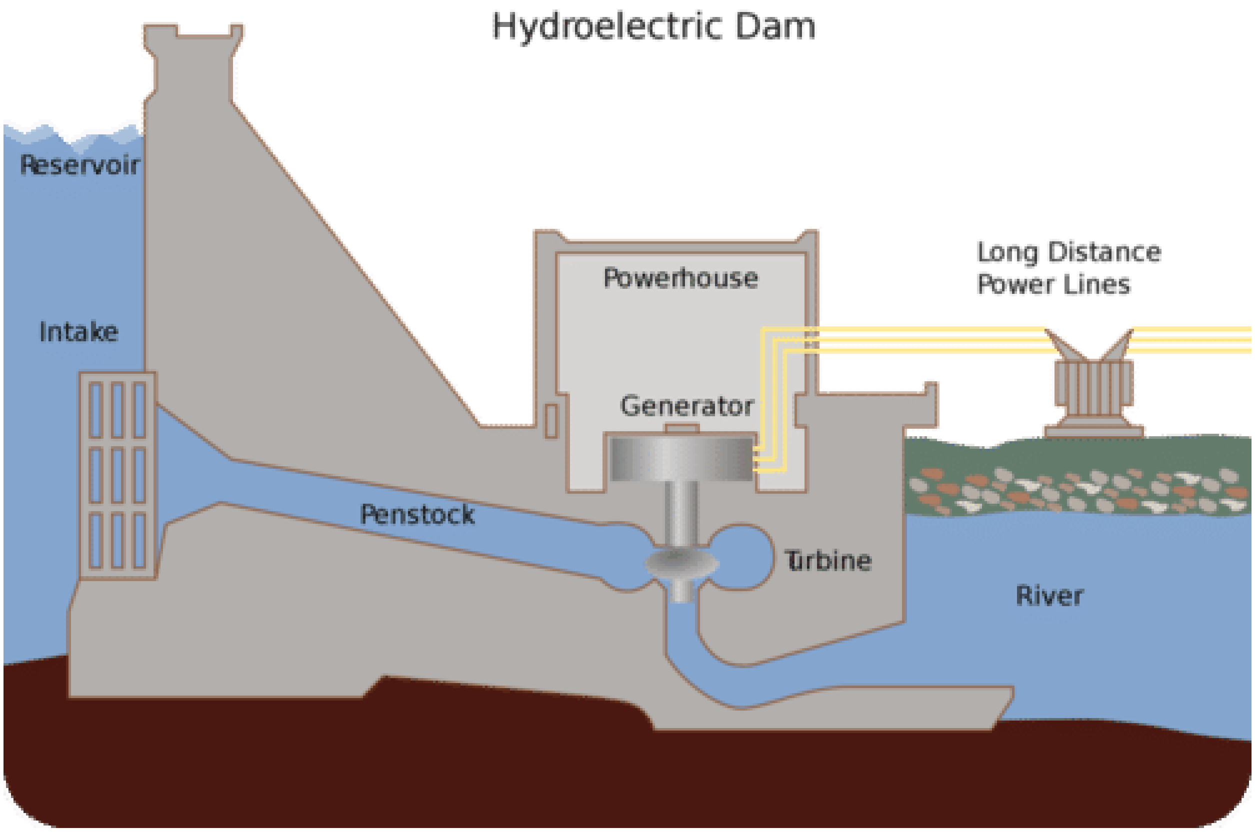


[Figure2]

Name ____ Period ________

From Kinetic to Electrical Energy
Generators may be set up to produce either direct or alternating current. Generators in cars and most power plants produce alternating current. Regardless of the type of current, all generators change kinetic energy to electrical energy.

- A car generator produces electricity with some of the kinetic energy of the turning crankshaft. The electricity is used to run the car's lights, power windows, radio, and other electric devices. Some of the electricity is stored in the car's battery to provide electrical energy when the car isn't running.
- A power plant generator produces electricity with the kinetic energy of a turning turbine. The energy to turn the turbine may come from burning fuel, falling water, or some other energy source. You can see how falling water is used to generate electricity in a hydroelectric power plant in the **Figure** below.



For more information you can watch this video! https://youtu.be/q8HmRLCgDAI

Name ____ Period ________

Article Review Worksheet

This worksheet will guide you through a critical reading of an assigned article or book chapter.

Logic and Argument:

1. The main idea of this article is: (Paraphrase as accurately as possible.)

2. The most important information in the article is: (What supporting evidence, facts, experience, or data do the authors provide to support the main idea?)

3. The key concept(s) we need to understand in the article are:
(What important ideas do you need to understand in order to understand the authors' line of reasoning?)

    1.
    2.
    3.

4. Vocabulary (using the internet or context clues, define the following terms)

    1. Generator
    2. Hydroelectric Power
    3. Turbine
    4. Kinetic Energy
    5. Electric Energy

What questions do you have about this article? Do you need more information?

    1.
    2.
    3.

Name ____ Period ________

Review Questions:

1. Identify the parts of an electric generator and what they do.

2. Explain how an electric generator in a hydroelectric power plant changes kinetic energy to electrical energy.

3. An electric motor is a device that changes electrical energy to kinetic energy. How is an electric generator like an electric motor in reverse?

4. What might happen to the current produced by an electric generator if the poles of the magnet kept reversing?

5. The water flowing through the dam and over the turbine has kinetic energy because it is moving. Where does the water get the energy to move?

Name ______________________________ Period _______________

Coulomb's Law and Law of Universal Gravitation Quiz

Use your notes and your resources to complete this quiz. Take your time and think carefully!

1. Label the following equations as either Coulomb's Law or the Law of Universal Gravitation:

$$F = \frac{kq_1q_2}{r^2} \qquad\qquad F = \frac{GM_1M_2}{r^2}$$

Equation 1: ______________________________ Equation 2: ____________________________

2. Matching: Match the letters to the variable and unit

Letter	Variable	Unit	Variable Choices	Unit Choices
k			1. Force	a. Newtons (N)
F			2. Distance between two objects	b. N m^2/kg^2
M			3. Charge on an object	c. Kilograms (kg)
G			4. Mass of an object	d. Meters (m)
r			5. Coulomb's Constant	e. N m^2/C^2
q			6. Universal Gravitational Constant	f. Coulombs (C)

Problems: Show your work and include units!

3. Two objects are 10 meters apart. One has a charge of 3 C and one has a charge of 2 C. What is the electric force? ($k = 8.9875 \times 10^9$ N m^2/C^2)

Name ______________________________ Period _______________

4. Two spherical objects have masses of 200 kg and 500 kg. They are separated by a distance of 25 m. Find the gravitational attraction. ($G = 6.67 \times 10^{11}\ N\ m^2/kg^2$)

Multiple Choice (Circle the correct answer)

5. What would happen to the electric force if we increased the charge of one of the objects?

Increase Decrease Stay the same

6. What would happen to the electric force if we increased the distance between the objects?

Increase Decrease Stay the same

7. What would happen if charge one is positive and charge 2 is negative

Net Attraction Net Repulsion No Movement

8. For both Coulomb's Law and the Law of Universal Gravitation, what would happen if the distance between the two objects was DOUBLED.

Force would Double Force would Quadruple

Force Would Be Half Force would be a Quarter

Short Answer:

9. Compare and contrast Coulomb's Law and the Law of Universal Gravitation. What is one similarity and what is one difference.

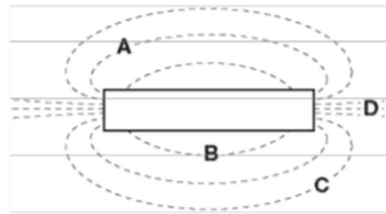
Magnetic Fields, Electromagnets and Generators Quiz

Use your notes and your resources to complete this quiz. Take your time and think carefully!
Part 1 Multiple Choice (circle the correct answer)

1. Placing the north pole of a magnet near the south pole of another magnet results in:

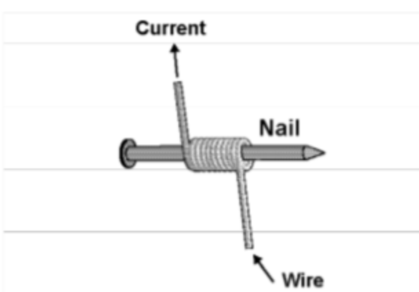
    a. an attractive force between the magnets.
    b. a repulsive force between the magnets.
    c. an electric force between the magnets.
    d. no force between the magnets.

2. In which area of the above picture is the magnetic field strongest?
    A.
    B.
    C.
    D.



3. In the above picture, which direction should the magnetic field lines be pointing?
    a. From South to North
    b. From North to South
    c. From Top to Bottom
    d. From Bottom to Top

4. If you reverse the direction of current flow in an electromagnet:
    a. the north and south poles are reversed.
    b. the magnet is neutralized.
    c. the strength of the magnetic field increases.
    d. short circuit occurs.



5. Using the right hand rule, the magnetic poles of the device in the picture left are located:
    a. North at the “head” and South at the “point.”
    b. North at the “point” and South at the “head.”
    c. East at the “point” and West at the “head.”
    d. East at the “head” and West at the “point.”

6. A simple electromagnetic device consisting of a coil with many turns is known as a:
    a. solenoid
    b. electric motor
    c. semiconductor
    d. commutator

7. When a magnet moves into a coil of wire, electric current is caused to flow by:

a. conduction
b. reduction
c. induction
d. deduction

8. A generator's basic function is to convert ____ to ____.
    a. electrical energy, mechanical energy.
    b. alternating current, direct current.
    c. mechanical energy, electrical energy.
    d. high voltage, low voltage.

9. Electromagnetic induction occurs when:
    a. electromagnets are induced in a wire.
    b. electrons are induced in a magnet by a moving wire.
    c. current is induced in a wire by a moving magnet.
    d. a magnetic field is induced into a coil of wire by a current.

Short Answer:
Use 2-3 complete sentences to answer each question

10. What two pieces of information can you get from a magnetic field diagram?

11. Describe the structure of an electromagnet how it works

12. What are the two ways you can increase the strength of an electromagnet?

13. Describe how a Power Plant produces electricity. Make sure you include the words kinetic, turbine, electromagnetic induction, electric, current and magnet.

14. What are some advantages of an electromagnet vs. a permanent magnet? List at least 2