

# Unit 4: Electricity and Gravity

Content Area: **Science**  
Course(s): **Physics/Lab Honors**  
Time Period: **6 weeks**  
Length: **Weeks**  
Status: **Published**

## Unit Overview

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This unit will explain the basics of static electricity then take a deeper look at Electric Forces and Electric Fields. Students will then work with the universal law of gravitation, comparing the gravitational force with the electric force. After this the students will take a practical look at circuits and complete their own electric house.

## Application of Knowledge and Skill

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- 1) Students will be able trouble shoot basic wiring in their home.
- 2) Students will be able to construct their own electric house with switches and lights.

## Students will know...

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- 1) The three types of static charging.
- 2) That a static charge is a transfer of electrons.
- 3) What it means to be grounded.
- 4) What the electric force depends on.
- 5) How a charge produces an electric field and the properties of that field.
- 6) How a charge will act in the presence of an electric field.
- 7) How to draw an electric field interaction between two or more charges.
- 8) How resistance, current, voltage relate.
- 9) The difference between a series and parallel circuit.
- 10) The basics principles of physically wiring a circuit.
- 11) What the universal law of gravitation states and how to solve it.
- 12) What affects the acceleration due to gravity on a given planet.

## **Students will be skilled at...**

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- 1) Producing a static charge on an object.
- 2) Solving for the electric force acting on a charged particle.
- 3) Drawing the electric forces between charged particles.
- 4) Drawing the electric field lines leaving a particle or interacting between particles.
- 5) Solving for the electric field strength produced from a charged particle at a certain point.
- 6) Solving for the force applied to a charged particle in an electric field at a specific point.
- 7) Trouble shooting a basic circuit.
- 8) Building their own basic circuit.
- 9) Solving Ohm's Law for current, resistance, and voltage.
- 10) Solving for the electric power consumed by a circuit.
- 11) Adding resistors in parallel and series.
- 12) Using the basics of Kirchoff's Laws to solve for current, voltage and resistance in a circuit.
- 13) Solving for the acceleration due to gravity on a new planet.
- 14) Using the universal law of gravitation to solve for different masses and forces between two bodies.

## **Transfer**

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SWBAT perform different tricks using the laws of static electricity such as bending water, rolling a can, picking up lose paper scraps.

SWBAT wire parallel and series circuits.

SWBAT wire their own electric houses showing their abilities with circuits.

SWBAT solve for the acceleration due to gravity on different planets, including what their weight would be.

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For more information, read the following article by Grant Wiggins.

[http://www.authenticeducation.org/ae\\_bigideas/article.lasso?artid=60](http://www.authenticeducation.org/ae_bigideas/article.lasso?artid=60)

## **Meaning**

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## **Understandings**

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- 1) Students will understand an unbalance of electrons can cause a static charge and how easily these electrons can be passed.
- 2) Students will understand what causes an electric force and how an electric force can affect charged objects.
- 3) Students will understand that every charged object creates its own electric field.
- 4) Students will understand how charged objects will act in the presence of an electric field.
- 5) Students will understand the difference between a parallel and series circuit.
- 6) Why the gravitational acceleration changes on different planets.
- 7) Why all things on the surface of the same planet fall at the same rate.

## **Essential Questions**

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- 1) So after walking around the carpet with no shoes on, touched to door knob and got shocked...what gives?
- 2) What determined the electric force acting on a charged object and how could you solve for it.
- 3) How can the presence of an electric field affect an object? How can a charged object affect the electric field that surrounds it?
- 4) If I want to wire my own house, should I use a series or parallel circuit? If I am Lazy? If I am Cheap? If I am smart?

5) Why do a brick and feather fall at the same rate (in a vacuum) even though the brick experiences a greater force?

6) What determines the acceleration due to gravity on a certain planet?

## **Academic Vocabulary**

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Academic Vocabulary	Application Vocabulary
Coulomb's Law	electricity
electric force	electrons
electric field	protons
static charge	grounding
conduction	voltage
induction	current
Ohm's Law	resistance
parallel circuit	power
series circuit	charge
kirchoff's law	radius
	gravitational field

## **Learning Goal 1**

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SWBAT solve law of gravitation problems and use this equation to derive other equations such as an equation for the gravitational field.

### Proficiency Scale

- SWBAT solve law of gravitation problems and use this equation to derive other equations such as an equation for the gravitational field.

SCI.HS-ESS1-4 Use mathematical or computational representations to predict the motion of orbiting objects in the solar system.

SCI.MS-PS2-3 Ask questions about data to determine the factors that affect the strength of electric and

	magnetic forces.
SCI.MS-PS2-5	Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
SCI.MS-PS2-4	Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.
9-12.HS-ETS1-4.5.1	Use mathematical models and/or computer simulations to predict the effects of a design solution on systems and/or the interactions between systems.

## **Target 1**

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SWBAT solve different problems relating to the law of gravitation as well use these concepts to conceptually explain different characteristics of our universe.

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## **Target 2**

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SWBAT use the law of gravitation to derive and solve equations for the gravitational field on different planets and the speed of a satellite orbiting a planet.

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## **Target 3**

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SWBAT Describe and solve problems using all three of Kepler's Laws.

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## **Learning Goal 2**

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SWBAT mathematically solve Electric Force and Field problems, as well as demonstrate a conceptual understanding of static electricity.

### [Proficiency Scale](#)

- SWBAT mathematically solve Electric Force and Field problems along with demonstrate a conceptual understanding of static electricity

MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
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MA.A-REI.B.3

Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.

SCI.9-12.HS-PS2-4

Use mathematical representations of Newton's Law of Gravitation and Coulomb's Law to describe and predict the gravitational and electrostatic forces between objects.

### **Target 1**

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SWBAT Describe what a static charge is, the three type of static charging and what this imbalance in charge can cause.

- SWBAT Describe what a static charge is, the three type of static charging and what this imbalance in charge can cause.

### **Target 2**

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SWBAT Describe how an electric force can affect an object, what factors the electric force depends on, and use the electric force equation to solve electric force problem involving multiple charges at angles.

- SWBAT Describe how an electric force can affect an object, what factors the electric force depends on, and use the electric force equation to solve electric force problem involving multiple charges at angles.

### **Target 3**

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SWBAT Describe what an electric field is, how it will affect charged particles in the presence of the field, and draw the electric field between charged particles.

- SWBAT Describe what an electric field is, how it will affect charged particles in the presence of the field, and draw the electric field between charged particles.

### **Target 4**

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SWBAT distinguish between the two equations for an electric field, solve for the net electric field acting a point empty space, and solve for the acceleration that will be produced on a charged particle in the presence of an electric field.

- SWBAT distinguish between the two equation for an electric field, solve for the net electric field acting a point empty space, and solve for the acceleration that will be produced on a charged particle in the presence of an electric field.

### **Learning Goal 3**

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SWBAT demonstrate a mathematical and conceptual understanding of electric circuits by wiring their own electric shoe box house

## Proficiency Scale

- SWBAT demonstrate a mathematical and conceptual understanding of electric circuits by wiring their own electric shoe box house

MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
MA.A-REI.B.3	Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters.
SCI.9-12.HS-ETS1-2	Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
SCI.9-12.HS-PS2-5	Plan and conduct an investigation to provide evidence that an electric current can produce a magnetic field and that a changing magnetic field can produce an electric current.
SCI.9-12.HS-PS3-3	Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

### **Target 1**

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SWBAT describe the way resistance, current, and voltage relate to each other in a circuit and how they are used mathematically in Ohm's Law.

- SWBAT describe the way resistance, current, and voltage relate to each other in a circuit and how they are used mathematically in Ohm's Law.

### **Target 2**

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SWBAT define electric power and solve for the electric power consumed by a circuit.

- SWBAT define electric power and solve for the electric power consumed by a circuit.

### **Target 3**

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SWBAT Describe the properties of an open and closed circuit along with the difference between a series and a parallel circuit.

- SWBAT Describe the properties of an open and closed circuit along with the difference between a series and a parallel circuit.

### **Target 4**

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SWBAT build a basic circuit using wires and light bulbs to analyze the difference between series and parallel

circuits in a lab setting.

- SWBAT build a basic circuit using wires and light bulbs to analyze the difference between series and parallel circuits in a lab setting.

### **Target 5**

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SWBAT add resistors in series and parallel.

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### **Target 6**

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SWBAT build a more complex circuit involving lights in parallel and in series controlled by switches. Also draw formal circuit diagram with the correct symbols. This can be done using PHET Physics

- SWBAT build a more complex circuit involving lights in parallel and in series controlled by switches. Also draw formal circuit diagram with the correct symbols.

### **Target 7**

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SWBAT use Kirchoff's Junction and Loop rule to analyze current, voltage and resistance in circuit. This should only use single course circuits with mostly 3-4 resistor circuits.

- SWBAT use Kirchoff's Junction and Loop rule to analyze current, voltage and resistance in circuit. This should only use single course circuits with mostly 3-4 resistor circuits.

## **Formative Assessment and Performance Opportunities**

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Lab Reports

Worksheets

PowerPoints with Notes

Homework and Classwork Activities

Group Activities

In Class Discussion

Do Nows and Closures

Class Polling

Observation

## **Summative Assessment**

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Unit Assessment will be created collaboratively and used for every student in the course. In addition, there will be other assessments in the form of lab reports, pen and paper tests, and quizzes.

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## **Accommodations/Modifications**

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- All instruction, labs, activities, and assessments will be modified and enhanced to adhere to individual student's IEPs and 504s. As well differentiated classroom management strategies will be utilized as to adhere to these students individual plans as well.
- Pair students for electric house project
- Provide step by step monitoring and assistance for law of gravitation problems as needed

## **Unit Resources**

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Teacher generated PowerPoints, Notes, Labs and Worksheets

Textbooks

Resource Books

Internet Resources

Computer Based Activities

Projector

Smart Board

Calculators

## **21st Century Life and Careers**

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CRP.K-12.CRP1

Act as a responsible and contributing citizen and employee.

CRP.K-12.CRP2.1

Career-ready individuals readily access and use the knowledge and skills acquired through experience and education to be more productive. They make connections between abstract concepts with real-world applications, and they make correct insights about when it is appropriate to apply the use of an academic skill in a workplace situation.

CRP.K-12.CRP4.1

Career-ready individuals communicate thoughts, ideas, and action plans with clarity,

whether using written, verbal, and/or visual methods. They communicate in the workplace with clarity and purpose to make maximum use of their own and others' time. They are excellent writers; they master conventions, word choice, and organization, and use effective tone and presentation skills to articulate ideas. They are skilled at interacting with others; they are active listeners and speak clearly and with purpose. Career-ready individuals think about the audience for their communication and prepare accordingly to ensure the desired outcome.

CRP.K-12.CRP5.1	Career-ready individuals understand the interrelated nature of their actions and regularly make decisions that positively impact and/or mitigate negative impact on other people, organization, and the environment. They are aware of and utilize new technologies, understandings, procedures, materials, and regulations affecting the nature of their work as it relates to the impact on the social condition, the environment and the profitability of the organization.
CRP.K-12.CRP6.1	Career-ready individuals regularly think of ideas that solve problems in new and different ways, and they contribute those ideas in a useful and productive manner to improve their organization. They can consider unconventional ideas and suggestions as solutions to issues, tasks or problems, and they discern which ideas and suggestions will add greatest value. They seek new methods, practices, and ideas from a variety of sources and seek to apply those ideas to their own workplace. They take action on their ideas and understand how to bring innovation to an organization.
CRP.K-12.CRP7.1	Career-ready individuals are discerning in accepting and using new information to make decisions, change practices or inform strategies. They use reliable research process to search for new information. They evaluate the validity of sources when considering the use and adoption of external information or practices in their workplace situation.
CRP.K-12.CRP10.1	Career-ready individuals take personal ownership of their own education and career goals, and they regularly act on a plan to attain these goals. They understand their own career interests, preferences, goals, and requirements. They have perspective regarding the pathways available to them and the time, effort, experience and other requirements to pursue each, including a path of entrepreneurship. They recognize the value of each step in the education and experiential process, and they recognize that nearly all career paths require ongoing education and experience. They seek counselors, mentors, and other experts to assist in the planning and execution of career and personal goals.
CRP.K-12.CRP12.1	Career-ready individuals positively contribute to every team, whether formal or informal. They apply an awareness of cultural difference to avoid barriers to productive and positive interaction. They find ways to increase the engagement and contribution of all team members. They plan and facilitate effective team meetings.

## Interdisciplinary Connections

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MA.K-12.2	Reason abstractly and quantitatively.
MA.A-SSE.A.1	Interpret expressions that represent a quantity in terms of its context.
MA.K-12.4	Model with mathematics.
MA.A-SSE.B.3	Choose and produce an equivalent form of an expression to reveal and explain properties of the quantity represented by the expression.
MA.N-Q.A.1	Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays.
MA.N-Q.A.2	Define appropriate quantities for the purpose of descriptive modeling.
MA.N-Q.A.3	Choose a level of accuracy appropriate to limitations on measurement when reporting quantities.

MA.A-CED.A.2	Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.
MA.A-CED.A.4	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations.
LA.WHST.11-12.7	Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.
LA.WHST.11-12.8	Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.
LA.WHST.11-12.9	Draw evidence from informational texts to support analysis, reflection, and research.