| PRINCETON INDEPENDENT SCHOOL DISTRICT | **Campus:** Princeton High School | |
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| **Author(s):** Kyle Lamothe | **Date Created / Revised:** 20 February 2019 | |
| **Six Weeks Period:** 5 th | **Grade Level & Course:** 11th & Physics | |
| **Timeline:** 10-11 Days | **Unit Title:** Electrostatics: Forces, Fields, and Energy | **Lesson** 01 |

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| **Stated Objectives: TEK # and SE** | P.2K Communicate valid conclusions supported by the data through various methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports<br><br>P.5A Research and describe the historical development of the concepts of gravitational, electromagnetic, weak nuclear, and strong nuclear forces.<br><br>P.5C Describe and calculate how the magnitude of the electrical force between two objects depends on their charges and the distance between them.<br><br>P.5E Characterize materials as conductors or insulators based on their electrical properties.<br><br>P.6B Investigate examples of kinetic and potential energy and their transformations. |
| **See Instructional Focus Document (IFD) for TEK Specificity** | |
| **Key Understandings** | The development of electrostatic theory and the atomic model of matter are closely related.<br><br>The experiments of Coulomb, Thomson, and Millikan are crucial to our understanding of electrostatic force theory.<br><br>Distance and electrostatic force have an inverse-square relationship such that increasing distance greatly decreases force.<br><br>Charge and electrostatic force have a direct relationship such that increasing charge proportionally increases force.<br><br>Electrical properties of matter including insulation and conduction are determined by the atomic structure of the individual atoms |
| **Misconceptions** | Students may think every charged object has only one type of charge.<br><br>Students may think charging can only occur through direct contact between objects.<br><br>Students may think that objects with a positive charge have gained protons.<br><br>Students may think that neutral objects can’t be attracted or repelled |
| **Key Vocabulary** | Conductors –material through which heat and electrical charges can be transferred<br><br>Coulomb's law – an equation describing the relationship between electrostatic force, electric charge, and distance between electric charges |

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| | Electric field – a region of space characterized by the existence of a force generated by electric charge<br><br>Electric force – an attractive or repulsive force that occurs between charged objects<br><br>Insulators – material that is a poor conductor of heat and electrical charges<br><br>Law of conservation of energy – the fundamental principle of physics that the total energy of an isolated system is constant, despite internal changes<br><br>Magnitude – an amount, a quantity, or a size | |
| **Suggested Day**<br>**5E Model** | **Instructional Procedures**<br>**(Engage, Explore, Explain, Extend/Elaborate, Evaluate)** | **Materials, Resources, Notes** |
| ***Day 1***<br>***Engage*** | Estatic Handout<br>Engage-<br>Demonstrate pulling an empty coke can with a charged rod using a charged plastic wand. Quickly brainstorm ideas about how this occurs and list on board. (have students write 1 sentence using 1 of the following words to explain what happened)Guide students to use the words force, kinetic energy, potential energy, charge, attraction, repulsion as they describe what they are observing and in their possible explanations.<br>Hand out modified "Electrostatic or Electromagic" activity. Each student is to complete their own.<br>Debrief & discuss<br>Distribute rolls of tape, have students get 2 pieces of tape and do simple experiment that ch 20 section 1 describes.<br><br>Demo electrostatic floating rings like in the following video<br>https://www.youtube.com/watch?v=U6bKDaZiy_k<br><br>Have students draw an atom<br>Discuss where charges come from<br>Leave the class with the questions: why don't electrons fly away? Why don't protons fly away?<br><br>Closing Task : Illustrate charge on macroscopic scale and microscopic | Spinning fork demonstrator<br>Electrostatic or Electromagic handout<br>Balloons, hole punches, salt, running water (use beakers to adjust flow-faucets have too much pressure)<br><br>E statics day 1 slides |
| ***Day 2*** | Objective: Investigate charge and particles<br>What are the essentials for pizza (in your mind, who cares what others say)? (If it didn't have these...we could call it some other food, it just wouldn't be a pizza) What are the non-essentials for pizza? (If it did/didn't have these...you'd still consider it a pizza) *this is to set up the concept of atom/ion...atom of helium must have 2 protons, ion of helium could have more or less electrons*<br><br>Explore-<br><br>Use Charge handout to explore positively and negatively charged particles, how objects become charged, how and what moves to charge objects, the duration of charges. 20 min | McGraw Hill transparency for rules of charged particles and Charge it Up lab<br><br>rubber rods, plastic rods, glass rods, PVC pipe, copper pipe, steel pipe, pencils, pens, wool, silk, plastic wrap, plastic sandwich bags, waxed paper, and aluminum foil<br><br>E statics day 2<br><br>Need to set up pith ball, electroscope and have rods and fabrics to transfer charges. |

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| | (notes for electricity portion: highlight protons stuck together by a much stronger force as a connection to last day's ciffhanger question; for charge portion: consider using a voting analogy; for ground portion: why does positive object take electrons? opposites attract, why does a negative give electrons? similar charges repel)<br>Have students answer 1-6 on the back<br>Then go to insulators & conductors and have students draw a neutral Helium atom. then add or remove electron and ask what the charge is, then say it has become an ION<br><br>Demo wimhurst machine for breakdown voltage<br><br>As soon as students finish worksheet, have them read & Begin Charged Objects Triboelectric MH (be sure to white out a few samples from triboelectric series on the back) | |
| ***Day 3*** | Explore-<br>demo physicsclassroom sim with aluminum can to show that both a positive & negative charged object can attract a neutral object<br><br>Complete Charged Objects Lab & Discuss Triboelectric series<br>Charged Objects Lab<br>Demo balloon sticking to wall & polarization<br><br>Alternate assignment if absent Polarization of can activity on physicsclassroom.com | McGraw Hill transparency for rules of charged particles and Charge it Up lab<br><br>Stephen Murray Separating Charge worksheet<br><br>alternate assignment<br>Physicsclassroom poloarization |
| ***Day 4*** | Group up students in lab groups to complete the backside of yesterday's labsheet. Project a more complete triboelectric series for reference.<br><br>Complete & Check worksheet<br><br>Begin Charge it Up Lab<br>Complete Charge It Up lab. Provide students with guiding questions for them to infer the transfer of charges and determine resulting charges, how to ground, and how attraction and repulsion can be supporting evidence of charge transfer by contact (conduction) and induction and polarization.<br><br>show https://www.youtube.com/watch?v=J-Le9yg_qvo to show what is happening with induction<br>https://www.youtube.com/watch?v=vQ0WGPB8Dvc<br>Explain-<br>Use Stephen Murray worksheet Separating Charge/ MH induction animation to clarify and explain what students observed during the lab. Review the front with students and then allow students to work first with their lab teams to edit and modify any of their explanations from the lab. After they submit the lab, allow students to work in partners to complete the back of the activity sheet/<br><br>Conduction, Induction, & Polarization worksheet | • https://www.youtube.com/watch?v=tuZxFL9cGkI<br>• Stephen Murray worksheets of Charge and Electricity and Electric Charge<br>• https://www.youtube.com/watch?v=VjrkwxMhc4s<br><br>E statics Day 4 |

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| | Homework : page 552 # 2-7 & p. 561 #18-21 | |
| ***Day 5*** | Objective: To analyze the factors of electrostatic charge.<br><br>Bellringer: Read 555 on lighning & have 5 minutes to read Videos<br>Dry Erase Board Review<br><br>Finish off with mythbusters 5 minute clip on static discharge<br><br>Closing Task: E-static Quiz | • McGraw-Hill animation and Stephen Murray worksheets |
| ***Day 6*** | Exploration-<br>https://www.youtube.com/watch?v=tuZxFL9cGkI&t=2s video of gas station fire to emphasize static charge buildup. Transition into when charge is separated, each experiences a force.<br>Extend-<br>View animation of Coulomb's law from McGraw Hill. Use pages 557-558 to identify importance of distance and value of charge for equation. Identify that it is a vector quantity. And review the problem-solving strategies at the bottom of page 558. Introduce microcoulombs and how to read and convert them. Model Example 1. Then complete the Electric Charge and Force Skill Sheet from Stephen Murray. Students complete first 6 in partners then check with class. (10 minutes) Class works through 6-9 together for correct model. | • Text book and calculators.<br>• E statics Day 6 |
| ***Day 7*** | Engage-Evaluate-<br>Bellringer:<br><br>Have students get out phones & open up interactive: challenge: Find 3 different combinations of charges & distance to have a force of 1.5 N<br><br>Group students into fours. Assign each student 9, 10, 11, or 12 from Physicsclassroom.com coulombs law practice.<br>Students follow Problem-Solving strategies from page 558 and solve their problem. (5-8 minutes) Students then work within their groups to answer all four questions correctly. Students must explain their thought process to their teammates and all should redo the math to check for conversions, correct reorientation of the algebraic formula, and correct units. Submit.<br><br>omit 13-14 on Physicsclassroom.com coulombs law practice | • EStatics Day 7 |
| ***Day 8*** | Bellringer:What is your favorite smelling food? (we'll relate it to field forces) Draw arrows that represent the gravitational force from a perspective on the earth vs. from outer space.<br>Electric Field introduction: Demo Ionosphere compare to gravitational field<br>Extend-<br>VDG Handout<br>Demo globe with bulbs.<br>What does it mean to ionize? to take a neutral atom and rip off | • Van De Graaf handout and materials to be charged by Van De Graaf generator.<br><br>Week 2 statics ppt |

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| | an electron...making it no longer neutral, but positively charged Ions will accelerate opposite direction with lots of energy (some kinetic energy, some light energy which is why we can see sparks)<br><br>Use the Van De Graaf generator and demonstrate charges, pith balls, light bulbs, element tubes, flying pie pans. Students are to record observations and explain. Introduce the idea of a charged field as well as charged particles. Provide students with a handout that has a Van De Graaf generator on it so that they can label and describe its operation.<br>Textbook page 576 has information students may use to help them complete their assignment.<br><br>https://www.youtube.com/watch?v=zhu5pIrPw7U<br><br>Demo: lightning rods pointy edges vs round objects; hair; pin thru straw on meterstick to show that electric fields lines point radially away.<br><br>Use the Stephen Murray worksheet Electric Field Basics to introduce the concept and equation for electric fields. Practice drawing E together and complete the reverse side 1- 3 on their own. Do questions 4 and 5 together. | |
| ***Day 9 Elaborate*** | Elaborate-<br>bellringer: Let's say you're making koolaid and you only have half the sugar it calls for but you really want some koolaid...what do you do? Use analogy of changing something to get same result<br>Pass back Coulomb's Law, Review process:<br>Figure out if you change k,q,q, or d<br>If I don't change it, replace it with a 1<br>(why? Because if you multiply it by 1, it won't affect your answer)<br>If the value does change, replace it with how much it changes by<br>Solve<br><br>Check E field basics<br>drawing e fields<br>huffington post video on spoons vs forks in microwave<br>Draw big balloon & small balloon that have same total charge, thus same number of E field lines. show<br><br>Print & tape Drawing E fields for 6 different stations around room. Challenge students to draw the Electric field of the different charge configurations.<br><br>Stephen Murray Electric Fields Basics or<br>Electric Field Lines Physicsclassroom handout | • Stephen Murray Worksheet Electric Fields<br>E field slides 10&11 |
| ***Day 10*** | Objective: Use a game to demonstrate electric fields.<br><br>Evaluate- | • Electric Field Hockey Hewitt/Baird tech lab<br>• 3-5 word problems from textbook |

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| | Use physicsclassroom sim to check electric field drawings from yesterday<br>Use Electric Field Hockey Colorado Phet sim to gain a sense of the vector nature of the electric field.<br>E fields slides day 10<br>Research applications of E fields in Medical (AED, EKG, EEG) Biology (Gel electrophoresis) & Technology for 10 minutes<br>Kahoot Review for tomorrow's quiz | https://docs.google.com/document/d/1YkYmEfNrvwBdVQM8bJ9C5DiHbRvrtqI9UDnPw__abrl/edit absent work |
| ***Day 11*** | Extend-<br>E Fields & Statics Quiz<br>For students who finish quiz early have a print out that explains how to use multimeter to measure voltage<br>Use slideshow to rank points from lowest to highest potential energy. Identify points that have equal potential energies. Emphasize that multimeter reads difference in potential. Bring multimeter to picture on board and talk about the different readings that might occur when probes placed in different arrangements<br>Construct A Capacitor Mini-Lab as a hands-on transition from electric fields to spark interest in circuits | • Hand-crank generators<br>Multimeters<br>Aluminum Foil<br>Paper<br>• E field Wrap up |
| ***extra work*** | bottom of 560 and 3 paragraphs on 561.<br>In notes, explain 1 benefit/use of static charge from 560 and explain 1 danger/precaution of static charge<br>Page 560 uses applications<br>Page 561 dangers<br><br>TIPERS review of Coulomb's law: Practice 2 as a class<br>Project on board D1-RT03 Induced Charges near a charged rod<br>Bellringer: a) Rank the charges on the projector problem (D1-RT03)<br>b) What type of charge is it if the spheres separate?<br>C) What type of charge is the spheres stay in contact | |

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| **Accommodations for Special Populations** | **Accommodations for instruction will be provided as stated on each student's (IEP) Individual Education Plan for special education, 504, at risk, and ESL/Bilingual.** |