Teacher Toolkit - Charge, Charge Interactions, Charging Methods

Objectives:

1. To use and understanding of atomic structure to describe how objects become charged by the additional or removal of electrons.
2. To identify the type of charge on an object by observing its interactions with other charged and neutral objects.
3. To describe what charge polarization is and to use an understanding of the distinction between insulators and conductors to explain how and why polarization occurs.
4. To describe the *charging by friction* process, to explain the result of such a process, and to use such an understanding to predict the charges two objects would acquire when rubbed together.
5. To describe the charging by induction process, to explain the result of such a process, and to use such an understanding to predict the charge an object would acquire when charged by induction.
6. To describe the charging by conduction process, to explain the result of such a process, and to use such an understanding to predict the charge an object would acquire when charged by conduction.
7. To describe the grounding process and to explain how it occurs in terms of electron movement.

Readings:

The Physics Classroom Tutorial, Static Elecricity Chapter: Lesson 1 || Lesson 2

Interactive Simulations:

1. Charging http://www.physicsclassroom.com/Physics-Interactives/Static-Electricity/Charging
   The Charging Interactive allows users to explore charge interactions, the charging of objects by conduction and induction, and the grounding of objects. Includes two modes - Practice mode and Play mode.
2. The Concord Consortium: Modeling Electrostatics http://concord.org/stem-resources/electrostatics
   This robust, completely turn-key package features 8 interactive models to explore attraction/repulsion, Coulomb's Law, and charge interaction at the atomic scale. Accompanied by a lesson plan with objectives.
3. Name That Charge http://www.physicsclassroom.com/Physics-Interactives/Static-Electricity/Name-That-Charge
   The Name That Charge Interactive is a skill building exercise that provides the learner with an interactive self-assessment of electrostatic charging methods. Includes built-in help and score-keeping functions.
4. Aluminum Can Polarization http://www.physicsclassroom.com/Physics-Interactives/Static-Electricity/Aluminum-Can-Polarization
   The Aluminum Can Polarization Interactive allows learners to visualize the underlying cause for the attraction between a charged and an uncharged object. A classroom-ready activity sheet is provided.
5. The Concord Consortium: Atomic Structure http://concord.org/stem-resources/atomic-structure
   Engage in modeling atomic structures by adding or removing protons, electrons, and neutrons to construct ions and isotopes, explore the mass/charge relationship, and investigate what gives atoms charge.
6. PhET: Build An Atom Interactive Simulation and Game
   https://phet.colorado.edu/sims/html/build-an-atom/latest/build-an-atom_en.html
   Newly rewritten to HTML, this PhET simulation could be ideal for conceptual physics or a Physics First curriculum. It lets you build atoms by adding protons, electrons, and neutrons.

Video and Animation:

1. Creation of a Dipole http://web.mit.edu/8.02t/www/802TEAL3D/visualizations/electrostatics/PithBallsCreate/PithBallsCreate.htm
   This animation from MIT's *TEAL Project* starts with two opposite point charges being separated to form a classic electric dipole field configuration.
2. Science Off the Sphere – Dancing Droplets http://www.physicscentral.com/explore/sots/episode1.cfm
   Don Pettit, an astronaut aboard the ISS, places a charge on knitting needles made of two substances (nylon and Teflon). Then he uses a small syringe to squirt water droplets. What happens is mind-bending. Check it out.
3. Physlet Physics Explorations: Electrostatics http://www.compadre.org/Physlets/electromagnetism/ex22_3.cfm
   This set of ranking tasks from Physlet Physics presents one positively-charged moveable test object in a field with 5 fixed charges. Your task: rank the fixed charges from most negative to most positive.
4. Charging Objects and Static Cling http://www.compadre.org/Physlets/electromagnetism/illustration22_4.cfm
   This step-by-step animation set shows three ways to charge objects: friction (rubbing), induction (with and without grounding), and through "static cling".
5. *"Nature"* Video: Have You Ever Seen an Atom? https://www.youtube.com/watch?v=yqLlgIaz1L0
   In 2012, physicists at UCLA figured out how to create high-resolution 3D images of platinum nanoparticles that measure only a few nanometers across. View their results.

This is the *To Go* version of the Teacher Toolkit; it is an abbreviated version of the complete Toolkit.

Labs and Investigations: http://www.physicsclassroom.com/lab#estatic

From The Laboratory at The Physics Classroom, The Laboratory,

1. Action at a Distance
2. Sticky Tape Experiments
3. Pop Can Induction
4. Charging by Induction

Demonstration Ideas:

1. University of Rochester: Electrostatics Demonstrations http://www.ece.rochester.edu/~jones/demos/
   Engineering professor Thomas Jones has shared detailed "how-tos" for setting up 14 creative classroom demos on electrostatics. Most of them utilize common, inexpensive materials.
2. Jefferson Lab: Static Electricity and Water https://www.youtube.com/watch?v=VhWQ-r1LYXY
   What happens when an electrically charged object is brought near a stream of water? This video from the scientists at Jefferson Lab explains the behavior of polar molecules (such as water) in this situation.
3. MIT Tech TV: Electrostatics Demo http://video.mit.edu/watch/rubber-and-glass-rods-with-tinsel-and-balloon-3510/
   Here's a cool demo you can easily set up in the classroom. All you need is a Plexiglas rod, a rubber rod, animal fur for rubbing, a Mylar balloon, and holiday tinsel.

Historical Connections **See the Complete Toolkit on our website for more details.**

1. American Institute of Physics: Rutherford's Nuclear World https://www.aip.org/history/exhibits/rutherford/
2. How Protons, Electrons, and Neutrons were Discovered https://www.youtube.com/watch?v=kBgIMRV895w
3. Ben Franklin as my Lab Partner: Franklin and Electrostatics http://www.compadre.org/psrc/franklin/
4. Rutherford Gold Foil Experiment https://www.youtube.com/watch?v=XBqHkraf8iE&app=desktop

Minds On Physics Internet Modules: http://www.physicsclassroom.com/mop

The Minds On Physics Internet Modules are a collection of interactive questioning modules that target conceptual understanding. Each question is accompanied by detailed help addressing the various components of the question.

From the **Static Electricity Module:**

Ass't SE1 - Charges and Atoms
Ass't SE2 - Interactions Between Charged Objects
Ass't SE3 - Charging by Friction
Ass't SE4 - Charging by Contact and the Grounding Process
Ass't SE5 - Pop Can Induction
Ass't SE6 - Charging by Induction - A Single Sphere
Ass't SE7 - Charging by Induction - Electrophorus Plate

Concept Building Exercises: http://www.physicsclassroom.com/curriculum/estatics

From The Curriculum Corner, Static Electricity Chapter:

1. Charge
2. Charge Interactions
3. Charging by Friction
4. Insulators, Conductors, and Polarization
5. Charging by Induction
6. Charging by Conduction and Grounding

Science Reasoning Activities: http://www.physicsclassroom.com/reasoning/electrostatics

1. Charge Interactions
2. Sticky Tape Experiments

Common Misconceptions **See the Complete Toolkit on our website for more details.**

1. Proton Movement
2. The Law of Conservation of Charge

Elsewhere on the Web: **See the Complete Toolkit on our website for more details.**

1. NOVA ScienceNOW: Lightning http://www.pbs.org/wgbh/nova/earth/lightning.html

Standards:

A. Next Generation Science Standards (NGSS)

Performance Expectations – Physical Science, Grades 9-12

Matter and Interactions HS-PS1-1 and HS-PS1-3

Forces and Interactions HS-PS2-4

Disciplinary Core Ideas (DCI's) HS-PS1.A.1 HS-PS1.A.3 HS-PS2.B.3 HS-PS2.B.1 HS-PS2.B.2

Crosscutting Concepts - Patterns; Scale, Proportion, and Quantity; Structure and Function

Science and Engineering Practices: #2, #3, #4, #5 #6, #7, #8

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