The **Energy Interactions** Virtual Field Trip gives students the chance to visit the Michigan Science Center from home or the classroom. This field trip has 4 components, or lessons, that explore the concepts of atomic interactions and energy transfer.

This field trip is designed for Detroit Public Schools Community District 9th grade students taking Next Gen Physical Science, utilizing the Interactions curriculum developed by the CREATE for STEM Institute at Michigan State University. However, the material covered in this field trip may be applicable to students in grades 9-12 in other districts, as well.

I. Content Areas of Focus

This virtual field trip will focus on the concepts of **energy transfer** and **atomic interactions**.

The following Units' and Investigations' driving questions and concluding statements are where we will make connections to the content on display at the Michigan Science Center.

Unit 1 Investigation 5:

- 5.1: What is the effect of changing the composition of an atom?
  - What makes one element different from another?
  - How do atoms become charged?

Unit 2 Investigation 1:

- 1.1: Can my finger start a fire?
  - Questions about sparks and fire
- 1.3: If moving objects have kinetic energy, do moving atoms have kinetic energy?
  - Simulating diffusion
- 1.4: If energy cannot go away, why don't things move forever?
  - Pendulum and energy

Unit 2 Investigation 2:

- 2.2: Where does the energy that was used to charge the Van de Graaff generator go?
  - Magnets and springs
  - Electric charge simulation
- 2.3: Why is lightning so much bigger than a spark from the Van de Graaff generator?
  - Factors that affect magnetic potential energy
  - Factors that affect potential energy in a magnetic field
- 2.4: Why do I get shocked if I am too close to the Van de Graaff generator?
  - Charge, distance, and potential energy
  - Sparks

II. Vocabulary

FIELD - the area around a charged particle or object in which a force is exerted on other particles or objects (examples of forces: attraction, repulsion)

IONIZATION - the process by which an atom gains or loses electrons to become an ion, or charged particle

VOLTAGE - the force that moves electrons in a circuit; the difference in electric potential energy (measured in volts)

- voltage can be measured using a voltmeter

CURRENT - the rate of flow of electric charge (measured in amps)

- amperage can be measured using an ammeter

INDUCE - to create an electric current from a changing magnetic field

III. Virtual Field Trip Lessons

WELCOME TO MISCI

This lesson serves to initiate the virtual field trip experience and get students familiar with the functionality of the Nearpod platform. There are also a few slides with supplemental information, including vocabulary terms, a periodic table of elements, and two activities to be completed. The focused section of the lesson will begin with a Driving Question Board in the form of a *Collaborate.* Students will respond to the following questions in anticipation for the topics to be covered.

Indicate which question you are responding to by including the question number: 1) What is energy? 2) How is energy transferred? 3) How can energy transform?

Sample responses:
1) the ability to do work; an amount of something that can be transferred or transformed; everything and anything that influences other things
2) movement of atoms; reactions; moves from one thing to another
3) heat from friction; sound because of vibrations; light

The bulk of the material that the virtual field trip is based on comes from Unit 2 of the Interactions curriculum. However, the lessons will reinforce what students have already learned about the composition of an atom from Unit 1 Investigation 5.

Students will identify the correct answer to the following questions:

1. What is the atomic symbol for iron?
    a. Ir
    b. Lo
    c. Fe
    d. On
2. Co is the atomic symbol for which element?
    a. Cobalt
    b. Copper
    c. Carbon
    d. Corundum
3. How many protons are in an atom of nickel?
    a. 5
    b. 15
    c. 20
    d. 28

STATES OF MATTER

This lesson is designed to reinforce and/or scaffold the concept of atomic interactions. It begins with a slide welcoming them to Nearpod and outlines some of the features that they will encounter. Like the start of a lesson or unit in the classroom, students will engage with a Driving Question Board in the form of a *Collaborate.* Students will respond to the prompt, and their responses will appear in the form of a sticky note (students can also react to their peers' responses to validate what other students have said).

What kinds of interactions happen at the atomic level?

This question, as expected, will guide us through this brief lesson. Before the students begin the investigation, they will have a brief review of some of the terms that they learned about in Unit 1, as well as reiterate the definitions of kinetic and potential energy. In a *Matching Pairs* activity, the students will match up the terms with their definitions:

- atom = the smallest unit of matter
- proton = the part of the atom that has a positive charge
- electron = the part of the atom that has a negative charge
- neutron = the part of the atom that has a neutral charge
- repel = objects that have the same charge
- attract = objects that have different charges
- kinetic energy = the energy an object has due to its motion
- potential energy = the stored energy an object has due to its position

It will then take us to the next slide in the form of a Sway (a Microsoft Office app) that provides some background information about atomic interactions. **It is important that students review this information before accessing the rest of the Nearpod lessons.** This will serve as a basis for understanding some of the material covered during the DTE Energy Sparks Theater Nearpod lesson. Students will need to be familiar with how particle collisions release energy, and that temperature is a measure of these collisions.

After reviewing the background information on atomic interactions, they will begin the virtual investigation. They will first make predictions about the interactions between matter and energy, and then they will explore the concept further using the States of Matter PhET interactive simulation.

The activities that accompany this simulation are borrowed from the Teacher-Submitted Activities that are associated with the PhET simulation. The worksheet has been converted into slides for Nearpod. Once you have a copy of the lesson in your library, you are welcome to add or eliminate slides.

(Credit: [Nathan] Mahoney https://phet.colorado.edu/en/contributions/view/4930)

ENERGY INVESTIGATION

This lesson features demonstrations from several pieces of equipment that highlight concepts of electricity, including the Van de Graaff generator, the plasma globe, and the Tesla coil. We recognize that the Van de Graaff generator will be very familiar to the students after spending a lot of time experimenting with it in their classrooms during Unit 1. In addition to a review of what the Van de Graaff generator is, students will see several static electricity demonstrations.

Following each video are a set of questions or activities aimed to make connections across the content in their curriculum, the content presented in the demonstrations, and beyond.

Van de Graaff generator

1. Students will first participate in a *Fill in the Blank* activity regarding the inner workings of how charges are transferred in the Van de Graaff generator.

   A Van de Graaff generator uses static electricity and a moving belt to charge a large metal sphere to a very high voltage and results in a difference in electrical potential energy.

   The Van de Graaff generator creates a positive charge as the rubber belt brushes over the rollers, carrying the electrons along with it. The lower roller becomes negatively charged and the upper roller becomes positively charged.

2. Students will then respond to the observations that they saw with the three static electricity demonstrations in a *Collaborate*.
   a. Barbie's hair and the Van de Graaff generator
   b. Bubbles and the Van de Graaff generator
   c. Packing peanuts and the Van de Graaff generator

   What type of interaction did you observe? ATTRACTION or REPULSION or BOTH?

Plasma Globe

1. A slide with the following information leads into a *Draw It* activity. Using the *Draw It* feature, students will draw a model based on the phenomena that they are observing. These will introduce terms or concepts that may not be covered directly by the curriculum, but will have enough information to help them create a simple model.

   Since the students will be using their fingers to draw on the screen of their device, the models may not look perfect but should resemble something close to the examples provided.

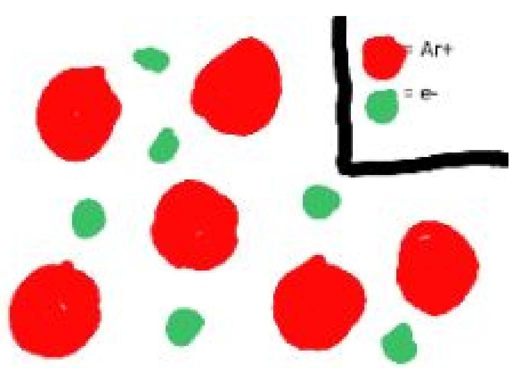
   Plasma is a charged gas made up of a mixture of positively charged ions and free electrons.

   ON THE NEXT SLIDE →

   Draw a model that represents the composition of the plasma in the globe that contains argon (Ar) gas.

   Include a key that describes each component.

   Sample response:



Students will infer their response based on the material covered in Unit 1 Investigation 5 of the Interactions curriculum. The composition of the atom includes protons and neutrons in the nucleus and electrons in a cloud around the atom. An atom becomes positively charged when electrons are removed and the overall charge associated with the atom is positive. When an atom becomes **negatively or positively charged,** or ionized, the atom is referred to as an **ion**.

Within the prompt is a big clue about the composition of plasma, in that it is a mixture of electrons and positively charged ions. Therefore, there should be two different substances in their drawings that correspond to the two items mentioned in the mixture.

2. The students are then asked to compare field strength of the plasma globe to that of the Tesla coil:

   CLAIM: There is a field of energy around the plasma globe.

   List your EVIDENCE and then provide your REASONING

   Sample response: The light tube lit up when it was close to the plasma globe, but not touching. This shows that the plasma globe has a field of energy around it..

Tesla Coil

1. The students are then asked to compare field strength of the plasma globe to that of the Tesla coil:

   CLAIM: The field of the Tesla Coil is stronger than the Plasma Globe. What EVIDENCE do you have to support this CLAIM?

   Sample response: the light tube lit up only when it was close to the plasma globe, but the light tube lit up when she was holding the light tube from further away from the Tesla Coil. This shows that the field of the Tesla Coil is stronger than the Plasma Globe.

EXHIBIT EXPLORATION

The Michigan Science Center has over 250 hands-on exhibits, and many of them have some connection to energy transformation and/or atomic interactions. We have picked two exhibits to highlight.

The first exhibit that the students will investigate (with the help of our staff) is the **thermocouple**. The thermocouple is a type of sensor that produces a temperature-dependent voltage by means of two dissimilar metals. By placing the sensor near an unknown temperature, the electrons within the metals react differently to the temperature, and a voltage is produced. The video demonstrates how students would be able to interact with the exhibit using two buttons. One heats up a coil near the thermocouple, and the other activates a fan to cool down the wire. As people press the buttons, the voltmeter attached to the exhibit moves to show the difference in voltage output due to the temperature of the coil.

Following the video is a Microsoft Sway that provides more in-depth information about voltage (a concept that is not explored deeply in the Interactions curriculum), how the thermocouple works, and what this phenomenon looks like at the atomic level.

Students will take this information and apply their thinking to what they might find at home, and respond to it in an *Open Ended Question:*

Where might you find a temperature sensor, like a thermocouple, in your home?

Sample response: furnace, oven, refrigerator

The second exhibit that the students will investigate is the exposed **piano wires**. Everyone loves to run up and pluck the strings of the piano, and this exploration yields some very interesting findings regarding energy transfer. There are two videos that show some different ways that guests may interact with the exhibit.

Another Microsoft Sway follows the video, only this time the information relates to sound. Sound can be observed on multiple levels with multiple senses, including hearing, sight, and touch. Sound travels via compression (longitudinal) waves; therefore, it needs a medium to travel. Again, we take a deeper dive to look at the atomic interactions that make this phenomenon possible.

What is the relationship between amplitude and kinetic energy in a sound wave?

Sample response: the higher the amplitude, the more kinetic energy.

Can sound travel through space? Why or why not?

Sample response: no, because there are not enough particles for the waves to travel.

After the students have explored the exhibits, they will have the opportunity to discover and explore examples of atomic interactions and/or energy transfer at home. They will first upload a picture or video using the *Draw It* slide, and then they will describe how the example connects to the curriculum and topics we have been discussing.

Included are some suggestions for questions to ask themselves as they are interacting with the examples that they find:

1. What do you notice?
2. What can you try?
3. What does it make you think of?

Sample response: student uploads a picture of a toaster over. The zig zag wires inside the toaster over get red hot when the electricity is flowing. The excess energy is released as heat which toasts my bread.

STATIC RELAY

This segment allows students to experiment with static electricity in a number of different ways. There are four experiments outlined below.

Supply list for Static Relay:

- Balloons
- Aluminum soda cans
- Dish soap
- Water
- Straw
- Tray or plate
- Aluminum foil
- Plastic shopping bag
- You'll also want to look at your clothes tags for items that are 100% of the following: cotton, nylon, or wool. These items are typically t-shirts, sweaters, or socks.

Instructions for setting up and facilitating Static Relay

Can Can Go:

1. Place an aluminum can on its side on a smooth surface.
2. Rub the balloon on your hair or on a material from the triboelectric series to generate a static charge.
3. Hold the balloon close to the can and observe the interaction.

Bubble Trouble:

1. Mix equal parts soap and water gently together to create a bubble solution.
2. Pour the bubble solution onto a tray or plate.
3. Put one end of the straw in the bubble solution and blow a bubble.
4. Rub the balloon on your hair or on a material from the triboelectric series to generate a static charge.
5. Hold the balloon close to the bubble and observe the interaction.

Amaze-balls:

1. Take a small piece of aluminum foil and roll it into a ball.
2. Place the aluminum foil ball on a smooth surface.
3. Rub the balloon on your hair or on a material from the triboelectric series to generate a static charge.
4. Hold the balloon close to the aluminum foil ball and observe the interaction.
5. Alternatively, you can draw a maze on a piece of paper and use the balloon to move the ball through the maze.

Wingardium Leviosa:

1. Cut a small square (4 in x 4 in) out of a plastic shopping bag.
2. Rub the balloon on your hair or on a material from the triboelectric series to generate a static charge.
3. Rub the small piece of the plastic bag on your shirt (made of cotton, nylon, or wool).
4. Hold the balloon in one hand and drop the plastic bag over the balloon. Observe the interaction.

As they discover what type of interaction is occurring, whether it is attraction or repulsion, they will indicate the type of interaction on Nearpod in the form of a *Quiz*. The students can move freely between the questions as they move from one experiment to another.

Can Can Go: How far can you get the can to roll?

What type of interaction do you see?

Attraction

Repulsion

Bubble Trouble: Can you move the bubble only using the rod?

What type of interaction do you see?

Attraction

Repulsion

Amaze-balls: Can you move the aluminum ball around? Can you navigate it through the maze?

What type of interaction do you see?

Attraction

Repulsion

Wingardium Leviosa: How long can you keep the plastic bag in the air? How far can you travel with it levitating?

What type of interaction do you see?

Attraction

Repulsion