EXPLORE ENERGY

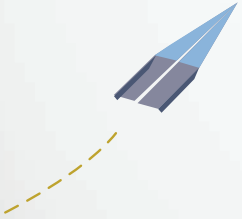
EXPLORE ENERGY

YOUR MISSION:

It's easy to take energy for granted when we can flip a switch and turn on a light. With these exhibits, we want students to be amazed by the invisible force that powers our lives. Energy use and energy sources are changing, and you can inspire these students to lead the charge!

ADVICE ON VOLUNTEERING

SAFETY CHECK: Look for this symbol in the scripts. Our exhibits are hands-on, but **some require close supervision.** Make sure students explore safely (no running, no poking each other in the eye, etc.) and follow instructions from the facilitator.



ENCOURAGE EXPLORATION: Ask questions about what they see, hear, and feel and make sure everyone gets a chance to participate. A little positive feedback goes a long way.

GET EXCITED! You don't have to be an expert. Your curiosity and enthusiasm inspire kids to learn.

AREA OVERVIEW

WHAT DO YOU USE ENERGY FOR? You use it to turn on lights, but you also use it to run fast. You use energy to cook food or to power a car. Energy is the ability to do work.

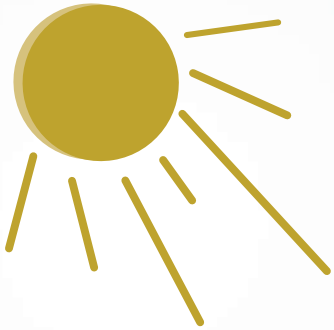
BUT WHAT DOES IT LOOK LIKE? Is it solid or liquid (neither, or both)? Is there a difference between the kind of energy that powers a light bulb and the kind of energy you get from eating a healthy meal?

EXPLORE ENERGY

- Fossil fuels (oil, coal, and natural gas) are the remains of plants and animals from millions of years ago. The oil we use today started forming before the dinosaurs lived on Earth. And those dinosaurs are slowly turning into fuel!
- The sun is almost halfway through its life. It formed 4.57 billion years ago, and has about 5 billion years before it becomes a white dwarf.
- Enough energy comes from the sun every hour to power 2,880 trillion light bulbs.

GRAND CHALLENGES

If you could do one thing to make life on Earth better, what would that thing be? Here's a **GRAND CHALLENGE:** according to some of the world's smartest people, this is a challenge that humans will face in the next 100 years. **What would you do to help solve it?**



THE SUN is an excellent source of power, but so far, solar energy is only providing 1% of the world's energy.

CAN YOU IMPROVE SOLAR TECHNOLOGY TO HELP CAPTURE AND USE MORE OF THE SUN'S ENERGY?

JOKES

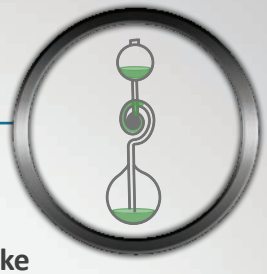
Why did the gardener plant a light bulb?

She wanted a power plant.

What happened to the wire whose behavior was shocking?

He was grounded.

HAND BOILER



AREA: ENERGY

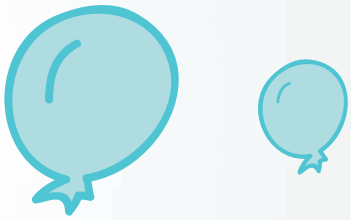
SAFETY FIRST: HOW TO USE

- Okay for students to touch with supervision, but **be careful as the Hand Boiler is fragile. Suggest that students hold it like an egg and don't squeeze or drop it.**
- Have them put one hand under the glass bottom, and ask them to very gently wrap their hand around (but do NOT squeeze).
- Hold one hand nearby, as the Hand Boiler is glass and can break if dropped.
- Watch as the liquid travels up the glass tube and ask the related questions.

CONCEPT BREAKDOWN

- Although it is called the Hand Boiler, **the liquid is not actually boiled.**
- The liquid inside is Ethyl Alcohol, which boils at 173.1° F. The temperature of the human body is 98.6° F.
- The "boiling" is caused by the relationship between the temperature and pressure of a gas. As the temperature of a gas in a closed container rises, the pressure also rises.
- The heat in our hand transfers through the glass. As the gas inside warms up, the molecules move faster, causing the gas to expand and push the liquid upwards. This chain of events is known as Charles' law.
- **As the gas continues to expand, the gas then bubbles through the liquid, making it appear to boil.**

RELATE TO REAL LIFE!



Test Charles' law at home by inflating two balloons to the same size. Put one in the freezer, and leave one out on a table overnight.

The next day, take out the balloon in the freezer and compare it to the balloon left out.

Spoiler alert: the frozen balloon will have shrunk! This happens because the gas inside the balloon takes up less space when it's cold than when it's room temperature, making the frozen balloon shrink down.

EXHIBIT: HAND BOILER

AREA: ENERGY

EXHIBIT: HAND BOILER

HAND BOILER

QUESTIONS

How do you feel after you exercise: colder? warmer? or the same as when you started?

- You probably feel warmer. Our bodies transform chemical energy into mechanical and heat energy when we move around.

Have you ever felt the hood of a car after a long drive?

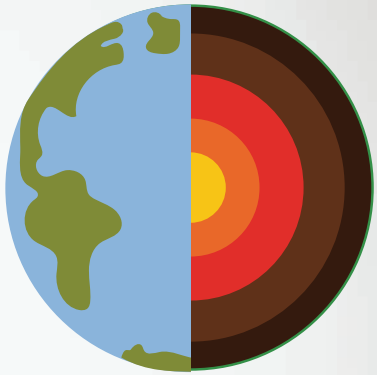
- When a gas-powered car burns the fuel in the engine, the energy is converted from chemical energy in the gasoline to mechanical energy (the car moving) and heat.

How do we use thermal energy in the kitchen?

- When the burner of a stovetop is very hot, it is a source of heat energy. Anything placed onto the stovetop, whether a pot of tea or a skillet for frying eggs, also becomes a temporary source of heat energy.

CAREER

THERMAL ENGINEERS design systems to convert energy from thermal sources into chemical, mechanical or electrical energy. Some find ways to heat homes sustainably using geothermal power, and others create technology to keep computers, phones, and tablets cool.



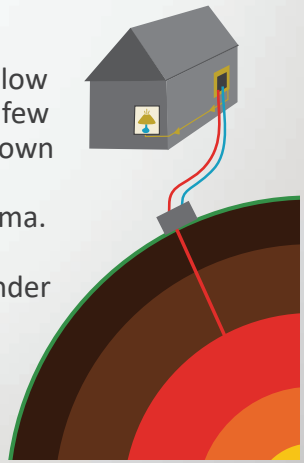
AVERAGE SALARY: $81,000

ADDITIONAL INFORMATION

GEOTHERMAL ENERGY is the heat from the Earth. It's clean and sustainable!

Geothermal energy comes from the shallow ground, hot water, and hot rock found a few miles beneath the Earth's surface, and down even deeper, from the extremely high temperatures of molten rock called magma.

Small-scale geothermal power plants (under 5 megawatts) have the potential for widespread use in rural areas to bring sustainable electricity to homes, businesses, hospitals, and more.



ENERGY CONVERSION: SOLAR

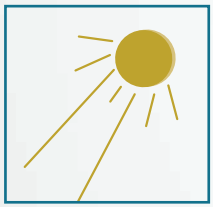
AREA: ENERGY

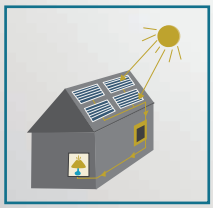
EXHIBIT: ENERGY CONVERSION—SOLAR

SAFETY FIRST: HOW TO USE

- Okay for students to touch.
- To set up for each group of students:
  1. Switch control panel to “solar.”
  2. Switch the bell and fan off, and switch the control panel light on.
  3. Aim the lamp at the solar panel and move the cloud cover out of the way.
- Ask a student to turn on the lamp aimed at the solar panel. Ask the other students what happens to the light on the panel (it should go on).
- Now ask another student to move the cloud so that it blocks the light from reaching the solar panel. Ask the other students to report what happens.

CONCEPT BREAKDOWN





- According to **the Law of Conservation of Energy**, there is a fixed amount of energy in our world.
- You can’t make energy, and you can’t destroy energy, but you CAN transform energy.
- Solar panels like these collect solar energy from the heat of the sun and transform it into light energy.
- The light energy is then converted into electricity to run everything from this tiny light, to hairdryers, computers, and cars, to the International Space Station.

RELATE TO REAL LIFE!

One of the simplest examples of solar power is the solar water heater. All you need is a black plastic bag, some water, a hose, and the sun. Fill the bag with tap water. Put it in the sunshine. Wait a few hours. The water inside will be hot!

The black plastic absorbs the sun's rays and heats up the water. Of course, this method doesn't work at night. Engineers design systems to store the energy from the sun in batteries, so that it can be used when it's needed—even in the middle of the night.

AREA: ENERGY

EXHIBIT: ENERGY CONVERSION—SOLAR

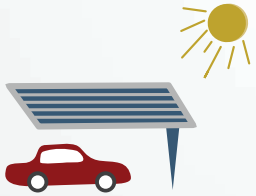
ENERGY CONVERSION: SOLAR

QUESTIONS

Would you rather live next to a field of solar panels or a coal power plant? Why?

What are some advantages of solar power, compared to other energy sources?

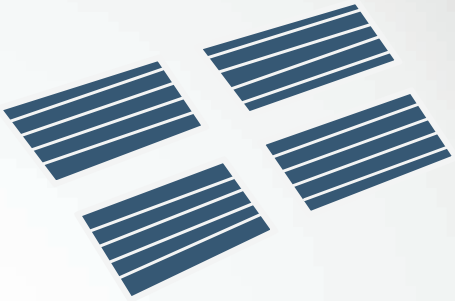
- Sunlight is a renewable energy source that will not run out.
- Solar panels can be added to buildings or shaded parking.



What are some disadvantages?

- The creation of photovoltaic (solar) panels can involve the use of toxic chemicals.
- Energy needs to be stored for times when the sun isn't shining.

CAREER



SOLAR ENERGY SYSTEMS ENGINEERS design photovoltaic panels to transform sun energy and power homes, businesses, even satellites orbiting Earth.

AVERAGE SALARY: $95,000

ADDITIONAL INFORMATION

The very first **SOLAR-POWERED HOUSE** in America was designed by two women, physicist and solar power pioneer Dr. Maria Telkes and architect Eleanor Raymond.

The single-story house, called Solar 1, was the first of an ongoing experiment on the campus of MIT.

Built in 1939, the house used **SOLAR RADIATION** as a heat source for the winter. The designers also experimented with summer air conditioning and power generation.

(Can you imagine a Texas summer without air conditioning? 1939 was also the first year you could buy a car with air conditioning.)

ENERGY CONVERSION: WIND

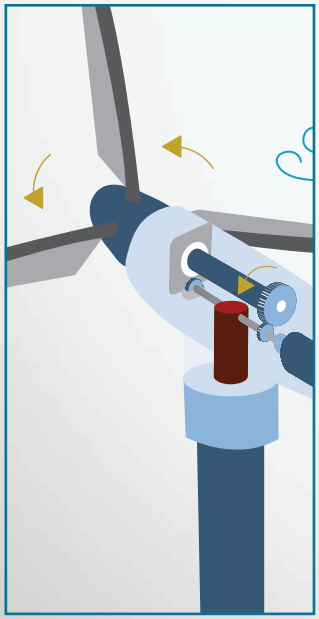
AREA: ENERGY

EXHIBIT: ENERGY CONVERSION—WIND

SAFETY FIRST: HOW TO USE

- Okay for students to touch.
- For each group:
    1. Switch control panel to “crank.”
    2. Make sure the switch for light is on, and the switches for the bell and the fan are off.
- Ask one student to use the hand crank to generate power. (Please allow as many students as possible to take a turn).
- Once the student has turned on the light, switch on the fan, then the bell. Ask what happens (it gets harder) and why (more energy is needed to power all three items). What happens when the bell and fan are turned off? (The light gets brighter). Why? (More energy is available to power the light).
- Ask all students to think of what else could be used to create the same motion (for example, a wind turbine).

CONCEPT BREAKDOWN



- Like the solar panels, this machine is an example of the transformation of energy.
- **Kinetic energy,** a type of mechanical energy, comes from movement: for example, air moving in wind, water moving in a river, or your foot pushing on a pedal.
- Dams collect energy from moving water and transform it into electricity. Similarly, wind turbines use blades to collect kinetic energy from the wind.
- Wind flowing over the blades creates lift (just like what happens with airplane wings). Lift causes the blades to turn.
- Energy is produced by blades that are connected to a drive shaft that turns an electric generator.
- Wind turbines currently generate almost 5% of all the electricity in the U.S. — a small percentage, but enough to power about 17 million households.
- A single 3-bladed wind turbine, like the ones you see in Texas, produces enough energy to power about 500 homes.

AREA: ENERGY

EXHIBIT: ENERGY CONVERSION—WIND

ENERGY CONVERSION: WIND

QUESTIONS

What gives your body ENERGY?

- Food! You eat food, and your body transforms the food calories into mechanical energy. You can use your mechanical energy to ride a bike, run a race, dance -- or crank this handle to make the light turn on.

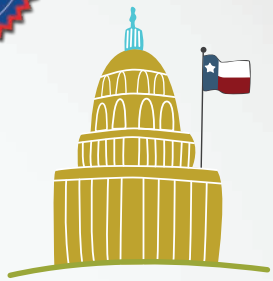
What kind of food gives you the most ENERGY?

- Your body needs a mixture of elements, like proteins and carbohydrates, to give you the right fuel. If you are an athlete, you need to eat more than the average person, because you are using a lot of mechanical energy for your physical movement.

RELATE TO REAL LIFE!

Humans have been using wind power for a very long time. Sails catch wind to push boats across water. Windmills catch wind to turn cranks to grind grain or pump water. Today, wind turbines can also transform wind power into electrical energy.

CAREERS



ENVIRONMENTAL ENGINEERS develop cleaner ways to power buildings and cars.

AVERAGE SALARY: $80,000

ADDITIONAL INFORMATION

This is a great opportunity to point out where the **ENERGY** comes from to run all of the exhibits in the Trailblazer.

There is a generator in the front of the trailer (behind the cabinets) that runs on diesel fuel and provides all of the **ENERGY** needed to run the exhibits, lights, heat, and air conditioning. Ask the students what other sources we could use to power the Trailblazer. For example, we could install solar panels on the roof. Could we install wind turbines on the roof? Why would that be difficult?

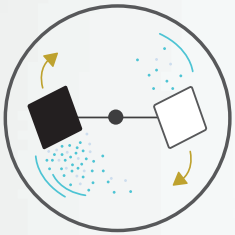
RADIOMETER

AREA: ENERGY

EXHIBIT: RADIOMETER

SAFETY FIRST: HOW TO USE

- Okay for students to touch with supervision, but **be careful as the lamp grows hot with time.**
- Tell a student to shine the light on the glass globe with the vanes inside. Ask the students what happens.
- Ask the students how this works. (If no one guesses, shine the light on their hands and ask what they are feeling. At that point, they usually figure out that the heat from the light causes the vanes to spin.)
- Move the light in and out to show how distance from the light source affects the speed of the spinning vanes.



CONCEPT BREAKDOWN

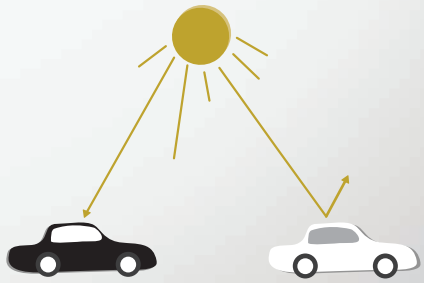
- Light from the lamp makes this radiometer spin. If we put it outside, sunlight would make it spin, too.

- How does it work? The inside of the bulb is a vacuum – more than 99% of the air molecules have been removed. That means that there is very little air resistance for the blades to push against. However, there are still just a few air molecules inside.
- These few air molecules are what move the blades. The thermal energy from the light makes the air molecules "kick off" from the dark side of the blade. This movement forms convection currents, which causes the blades to spin.
- **DARK COLORS** absorb energy and **LIGHT COLORS** reflect energy. When light shines on the blades inside the bulb, the dark side of the blade heats up.
- The more light that shines onto the blades, the more heat is absorbed on the dark side of the blades, and the faster they spin.

RELATE TO REAL LIFE!

Have you ever stood barefoot on the black asphalt of a street or parking lot on a really hot day? What happens? It's hot, right? What if you step onto a concrete sidewalk? It's less hot. That's because darker colors absorb heat, while lighter colors reflect it.

Which do you think needs to use more energy for air conditioning: a car with white paint or black paint?



AREA: ENERGY

EXHIBIT: RADIOMETER

RADIOMETER

QUESTIONS

What things need energy to work?

- Examples could include lights, TVs, cars, cell phones, videogames. How about the International Space Station? How about the Trailblazer?

Which of these things could be powered by solar power?

- All of them, but we need to improve solar technology to be more efficient.

Ask students to imagine:

- If a small light bulb can create this much movement, imagine what all the energy from the sun can do!

CAREERS

AVERAGE $101,000 SALARY

MATERIALS SCIENTISTS develop, process, and test the materials used to create a wide range of products, from computer chips and aircraft wings to skateboards and biomedical devices like artificial limbs.

AVERAGE SALARY: $101,000

ADDITIONAL INFORMATION

The **ENERGY** from sunshine falling on a single acre of land in West Texas in a year is capable of producing the energy equivalent of 800 barrels of oil.

That is enough to produce 56,000 kilowatt hours of energy. Using that, **you could power a house in Texas for more than three years.**

ENERGY STICKS

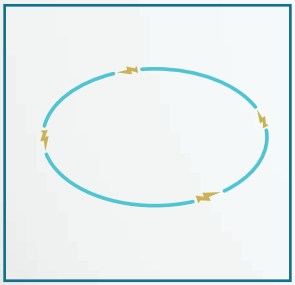
AREA: ENERGY

EXHIBIT: ENERGY STICKS

SAFETY FIRST: HOW TO USE

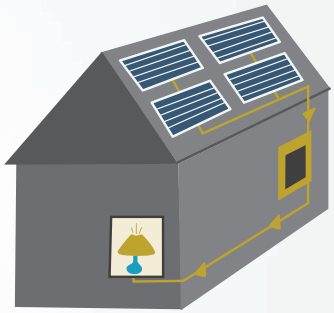
- Okay for students to touch.
- Ask the students to form a circle and hold hands. Then have two students hold opposite ends of the energy stick. When they complete the circuit, the stick will glow and make noise.

CONCEPT BREAKDOWN



- An electrical current moves from atom to atom through a material.
- **CONDUCTORS** are materials like most metals or water that allow a current to move freely through them.
- **INSULATORS** are materials like rubber, glass, or plastic that don't allow a current to move freely.
- Your body is mostly water, so it acts as a conductor.
- When you hold the energy stick, your bodies complete an electrical circuit.
- The word "circuit" is related to the word "circle". An electrical current travels along a closed path, or a circle. When that circle is broken, the electricity can't flow. That's why an electrical switch is sometimes called a circuit breaker.
- When you let go of your friends' hands, you break the circuit.

RELATE TO REAL LIFE!



Wherever there's electricity, there's a circuit. There's a circuit in your cell phone, in your toaster oven, and in your TV.

There are also circuits running in the walls of your house, which – unless your house runs entirely on solar or wind power – are connected to a **power grid**.

AREA: ENERGY

EXHIBIT: ENERGY STICKS

ENERGY STICKS

QUESTIONS

What materials are the best conductors of electricity?

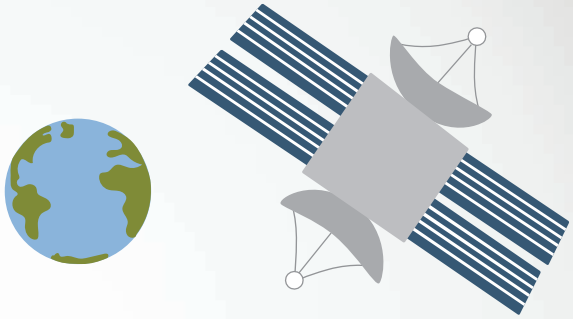
- Metals such as copper, silver, gold, and many others
- Water

What materials are the worst conductors of electricity?

- Rubber
- Glass
- Plastic
- Wood

These **INSULATORS** can protect us from electrical currents.

CAREER



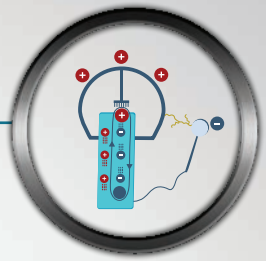
ELECTRONICS ENGINEERS design communications systems like radios and GPS systems.

AVERAGE SALARY: $98,000

ADDITIONAL INFORMATION

Who discovered electricity? The ancient Greeks knew you could make a spark by rubbing a piece of fur, but it wasn't until the 1800s that someone figured out how to make an electrical circuit. Thomas Edison and Nicolas Tesla are both considered inventors of electrical systems, but their electrical systems are different! We are still inventing new ways of using electricity. Can you think of new ways, too?

VAN DE GRAAFF GENERATOR



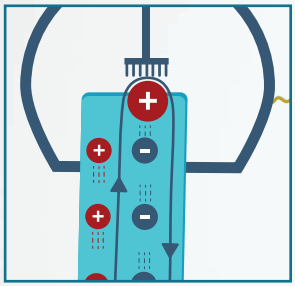
AREA: ENERGY

EXHIBIT: VAN DE GRAAFF GENERATOR

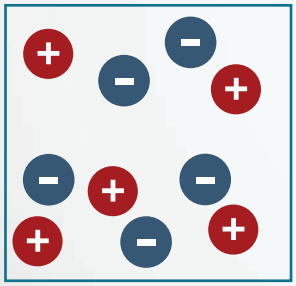
SAFETY FIRST: HOW TO USE

- **Do not touch this exhibit until you have received training from the Trailblazer Facilitator.**
- **Do not touch this exhibit if you have a Pacemaker, ICD (Implantable Cardioverter Defibrillator), hearing aid, insulin pump, or other electronic medical device.**
- We advise storing cell phones/devices away from the Van de Graaff Generator.
- **Students should only touch this exhibit under the supervision of a trained adult.**

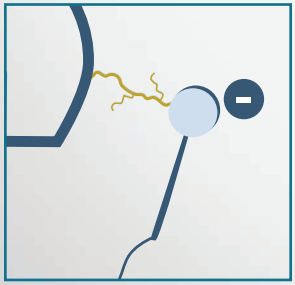
CONCEPT BREAKDOWN



- The machine's moving rubber belt generates static electricity through friction.
- Friction creates positive charges in some atoms and negative charges in other atoms.



- When the charges are separated, this causes an electrostatic charge.
- The belt collects the electrostatic charge.



- The charge is transferred to the metal dome, where it accumulates.
- When you put your hand or the wand near the dome, the charge jumps into it. Can you see and hear the spark?

RELATE TO REAL LIFE!

What happens when you walk on carpet with your socks and reach for a door knob?

What happens to your hair when you've been wearing a hat all day in winter and you take it off?

You've been generating **static electricity** through friction – just like this machine.

AREA: ENERGY

EXHIBIT: VAN DE GRAAFF GENERATOR

VAN DE GRAAFF GENERATOR

QUESTIONS

What part of weather is caused by static electricity?

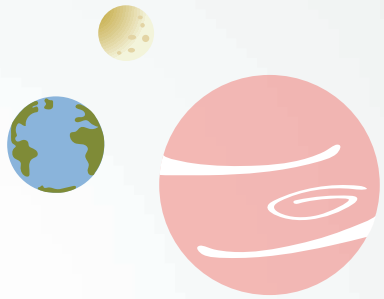
- Lightning!

VAN DE GRAAFF GENERATORS can make your hair stand up. This is especially true for fine hair without a lot of product in it.

What else can you do with a particle accelerator?

- Sterilize food or surfaces
- Perform nuclear physics experiments
- Produce X-ray beams that can be used in nuclear medicine

CAREERS

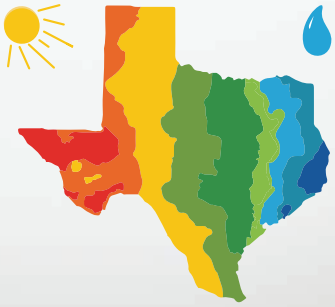


A **PARTICLE PHYSICIST** explores the interactions of elementary particles (like leptons, quarks, etc.) to understand how the universe works.

AVERAGE SALARY: $80,000

ADDITIONAL INFORMATION

VAN DE GRAAFF GENERATORS NEED LOW HUMIDITY to work well. Humidity is the amount of water vapor in the air. Texas has an incredibly wide range of humidity. East Texas is humid and West Texas is dry.



Humid air causes the insulating surfaces on the Van De Graaff to become slightly damp. Moisture affects conductivity. In a humid environment, a perfectly functioning Van De Graaff generator may have no sparks at all because the conductive surfaces are releasing the electricity.

THANK YOU!

Thank you for inspiring students and encouraging them to explore careers in STEM. We could not do this work without you, and we truly appreciate your support.

If you took photos today and plan to post to social media about your experience, please consider tagging the TAME State Office. We would like to recognize your hard work and may share images and stories on TAME.org or with our corporate partners who help bring this experience to different communities around Texas.

Facebook.com/TAMESTEM

Twitter.com/TAMESTEM

#DRIVINGSTEM

Texas Alliance for Minorities in Engineering

Schedule your own Trailblazer experience:

TAME.ORG/TRAILBLAZER