7.1.4 e3 Static's the Word Narrative

Time: 30-45 minutes	**Anchor Phenomena:** Wrecking Yard Electromagnets can be turned on and off as needed, allowing a huge amount of metal items to be transferred with little time and energy used.
Big Idea: Forces can be strengthened or weakened.	
CCCs Cause and Effect	**Practices** **Analyzing and Interpreting Data**

EPISODE SNAPSHOT

Students use computer simulations to determine how distance affects the electric force between two objects.

GATHERING

Ask the students how many of them have walked around on the carpet in their house and then were shocked when they touched another person or metal object such as a doorknob or light switch. Ask the students if they know why. They probably know it is static electricity but don't know exactly why. Give the students a minute or two to play around with the John Travoltage simulation to see if they can figure out why they received the shock. (Have the students aim the finger at the doorknob for this portion.) Have them record their observations and then have a few students share their observations with the class. They should observe that when your feet rub on the carpet, you pick up a negative charge. When you touch a metal object or another person, you are shocked because that built up negative charge transfers to the other person/object.

Ask them what they think would happen if the rug was removed and John rubbed his foot on the wood or tile floor instead. They will most likely tell you nothing will happen. Ask why they think this is. Have the students move John's finger up to touch his ear. Have them rub the foot back and forth 2 or 3 times and then lower the finger to the doorknob to remove the charge. Have them repeat this, except this time, tell them to rub the foot back and forth many times. Ask them what the difference is. (Ignore the "ouch", it is difficult to get a consistent result from the "ouch".) They should have observed that a greater charge was built up the more times John rubbed his foot.

Next, students will be trying to see how far away they can move John's finger and still make a shock to the door knob. (His finger can go a little past 45^{o} up or point straight down and still make a shock.) Have them start with the finger pointing at the door knob and slowly move it away after each "zap". Instruct them to gently rub the foot on the carpet just until the "zap" is made, don't just rub the foot like crazy. It is important for them to see how much charge was built up before the zap.

REASONING

Have the students talk in small groups and **interpret their data**. Ask them to create a statement that describes how distance affects the strength of the electric force between objects. Have groups share their findings with the class and come to a class consensus about the relationship between distance and charge. Students should recognize there is a certain distance beyond which the force will not exist, no matter how charged the objects are. They should also recognize that the smaller the distance is between objects, the smaller the charge has to be for the force to have an effect. Smaller charges can only create a force when the distance is small, larger charges are required to cross greater distances.

Have students go to the Balloons and Static Electricity simulation. This simulation will allow them the opportunity to test and explain everything they have learned about how the strength of an electric force can be changes. They will start out with one balloon, giving it a small charge, then a greater charge, and sticking it to the wall. They will slowly move it away from the wall until the balloon starts moving toward the sweater, testing their previous arguments about distance and the strength of the electric force. They should notice that when the balloon has a smaller charge, it takes a longer time to move toward the sweater than when the balloon has a greater charge. However, when the balloon has a smaller charge, it moves faster once it gets close to the sweater.

They will then switch to two balloons. They will charge the balloons unequally and stick them to the wall. They will observe what happens to the charges in the wall when these balloons stick to it and explain how this causes the balloons to stick to the wall, even though the wall is neutral. (The negative charge on the balloon repels the negative charges in the wall, pushing them further back, leaving the positive charge that the balloon is attracted to, making the balloon stick to the wall.)\

Lastly, they will equally charge the two balloons, let one be attracted to the sweater, and then bring the other balloon close to it and observe and explain what happens. (When brought between the wall and the balloon on the sweater, the free balloon quickly moves away from the balloon on the sweater and may even stick to the wall. The free balloon is repelled by the balloon on the sweater because like charges repel, and it moves toward the wall. The closer the free balloon is to the attached balloon, the quicker it moves away and it travels a greater distance. If they move the free balloon to the other side of the balloon on the sweater, the free balloon can chase the attached balloon off of the sweater.)

Optional extension: have the students do a quick experiment with magnets to observe that magnetic force is also affected by distance.

COMMUNICATE

Have some of the students share their findings with the rest of the class. Have a quick class discussion about what the students have learned. Make sure students understand that both the amount of electric charge and the distance between the charged objects can have an effect on the strength of the electric force. Students should write a summary about what they have learned about how the strength of electric or magnetic forces can be changed. They should support their arguments with examples from the simulations.

Assessment:	**Materials, resources, handouts, etc.**
The assessment for this assignment is the summary. A proficient student can explain that the strength of an electric force is affected by the amount of charge an object has and the distance between the objects. Objects with more charge can create a force over greater distances. There is a limit to how far away the charge can be to create a force.	• Computers • PhET “John Travoltage” simulation: https://phet.colorado.edu/sims/html/john-travoltage/latest/john-travoltage_en.html • Resource for teachers: “For Teachers” section on https://phet.colorado.edu/en/simulation/travoltage, the Teacher Tips and Video Primer • Balloons and Static Electricity simulation: https://phet.colorado.edu/sims/html/balloons-and-static-electricity/latest/balloons-and-static-electricity_en.html • 7.1.4b e3 Static's the Word Student Sheet