# THE SCIENCE OF "FRINGE"

## EXPLORING: ELECTROMAGNETS

A SCIENCE OLYMPIAD THEMED LESSON PLAN
EPISODE 404: Subject 9

**Overview:**
Students will learn about electromagnets and how they can be created and utilized.

**Grade Level:** 9-12

**Episode Summary:**
Olivia encounters a strange energy field that appears to be attracted to her, yet is dangerous because it attracts metallic objects and causes burns. Walter hypothesizes this phenomenon may be an unintentional side effect of a Cortexiphan subject reaching out to Olivia. Olivia and Walter go to visit the subject, only to find he isn't creating the field but is able to use his abilities to discharge it temporarily. They then devise a plan to permanently discharge it by utilizing a significant amount of electricity from a power substation.

**Related Science Olympiad Event:**
Technical Problem Solving - Teams will gather and process data to solve problems.

**Learning Objectives:**
Students will understand the following:

- Electromagnets produce a magnetic field due to the flow of electricity through them.
- In a typical electromagnet, the field is concentrated by winding a lot of wire into a coil.
- Electromagnets are widely used in electrical and electronic devices, in the form of things such as motors, relays, hard drives, and speakers.

FOX CODE
FOR SMARTPHONES

**Episode Scenes of Relevance:**
- Walter, Olivia and Astrid discuss the energy field that appeared in Olivia's room (4:50 'any more dreams' – 5:25 'like it was collecting')
- Walter, Olivia and Cameron discuss how to destroy the energy field (48:00 'it is possible' – 49:05 'shatter it')

**Online Resources:**
- Fringe "Subject 9" full episode: www.fox.com/fringe/full-episodes
- Science Olympiad Technical Problem Solving event: http://soinc.org/tech_prob_c
- National High Magnetic Field Laboratory: http://www.magnet.fsu.edu/education/tutorials/magnetacademy/magnets/page4.html
- Wikipedia page on electromagnets: http://en.wikipedia.org/wiki/Electromagnet
- PhET Magnets and Electromagnets Interactive Simulation: http://phet.colorado.edu/en/simulation/magnets-and-electromagnets

**Procedures:**
1. Tell your students that they are going to learn about electromagnets and how they work.
2. Have your students research electromagnets in resources such as physics textbooks and websites and discuss what they have learned.
3. Divide your class into small groups. Have each group complete the following activity:
    a. Materials: several feet of thin single strand insulated wire, large steel bolt, "D" batteries, scissors, rulers, paperclips, tape
    b. The problem for the group to solve is to determine how to maximize the strength of an electromagnet using only a set amount of wire to create it
    c. Use the scissors to strip an inch of insulation off each end of the wire
    d. Wrap the wire tightly around the steel bolt, leave enough to allow the ends to be attached to the batteries
    e. Tape the ends of the wire to the terminals of a battery so that an electric circuit is formed
    f. Hold the head of the bolt high over a pile of paperclips and slowly lower it
    g. Once the paperclips start attracting to the electromagnet, record the height of the electromagnet
    h. Use 2 batteries in a series instead of only one with the electromagnet and repeat the attraction force experiment; record the height
    i. Wire the 2 batteries in parallel and repeat the measurements
    j. Recreate the electromagnet, but wrap the wire in many more layers using only half of the length of the bolt. Repeat the measurements
    k. Create a summary of the characteristics of the electromagnets and present to the class
4. Discuss with the class the results of the activity. Be sure to address:
    a. How did the number of batteries used and the configuration impact the strength of the electromagnet?
    b. How did the method of wrapping the wire around the bolt impact the strength?
    c. Did the strength change if more or less paperclips were in the pile?

**Additional Discussion Suggestions:**

- How many electromagnets do the students think are in the classroom right now? Try to list the various devices that contain them, including speakers, hard drives, motors, etc.
- What other common objects could the electromagnet have picked up?
- Could the multiple electromagnets created by the class be brought in proximity to each other to either to increase or decrease the net strength of them somehow?

**Extension to Other Subjects:**

Health Sciences: Superconducting electromagnets are an important component in MRI machines. Research the principles behind MRI and what role the superconducting magnets play in it.

Politics: Particle accelerators, such as the CERN Large Hadron Collider, are among the most expensive and biggest scale devices created by man. As a result they often require funding and staffing from a consortium of countries. Research the collaborators involved in CERN and some of the decisions that have been made due to international politics.

History: The first significant historical use of electromagnets was in the telegraph system, which revolutionized communications. Research what function they served and the impact it had on society.

**National Science Standards Alignment:**

A. Science as Inquiry – Science as inquiry requires students to combine processes and scientific knowledge with scientific reasoning and critical thinking to develop their understanding of science.

H.A.1 Abilities necessary to do scientific inquiry

c. Use technology and mathematics to improve investigations and communications.
d. Formulate and revise scientific explanations and models using logic and evidence.
e. Recognize and analyze alternative explanations and models.
f. Communicate and defend a scientific argument.