CLASSROOM VISIT
NATURE OF SCIENCE

NATIONAL HIGH MAGNETIC FIELD LABORATORY

Center for Integrating Research & Learning
1800 East Paul Dirac Drive
Tallahassee, FL 32310
(850) 644-7191
nationalmaglab.org/education

Pre-Outreach Activity: What Do We Already Know?

Teacher Background: A simple, yet effective learning strategy, a K-W-L chart, is used to help students clarify their ideas. The chart itself is divided into three columns:

K	W	L
WHAT WE KNOW	WHAT WE WANT TO KNOW	WHAT WE LEARNED

MATERIALS: > Chart Paper > Markers

ACTIVITY INSTRUCTIONS

1. Copy the K-W-L chart and pass out so that each student has their own sheet. Explain how the chart is to be filled out, then brainstorm with the class and have the students list everything that they know about what science is and how it is done. There are no right or wrong answers.

2. Next have the students list everything that they want to know about magnets and magnetism. You may need to provide prompts such as:

   If scientists were here, what would you ask them about how they do their job?
   If you were a scientist, what would you like to learn about?

3. Keep the chart accessible so that you and the students can enter ideas, new information, and new questions, at any time. The class can return to the K-W-L chart after completing the activities. As students learn the answers to their questions, list the answers in the L column of the chart.

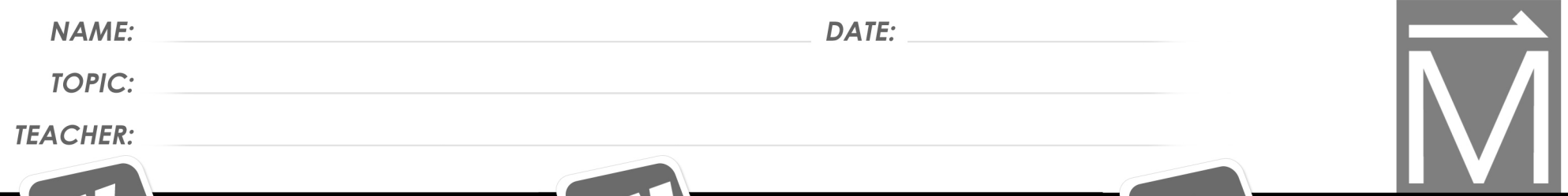
4. K-W-L charts are useful in identifying misconceptions that students have about magnets and magnetism. Once the misconceptions are identified, have students design a way to test their ideas, reflect on what they observe, and refine the original conclusion.

5. Periodically, return to the K-W-L chart during the activities to check off items from the W column and to add to the L column. Students may want to add items to the W column to further their explorations.

NAME: _____ DATE: _____

TOPIC: _____

TEACHER: _____



K — WHAT DO YOU KNOW

W — WHAT DO YOU WANT TO KNOW

L — WHAT HAVE YOU LEARNED

Post-Outreach Activity: Nature of Science Discussion Points

This survey is given to check your students' understanding about the nature of modern science and certain basic science concepts. Please encourage your students to think in the same way a working scientist would. These points are provided in order to spark some discussion with your students and allow them to better understand what science is.

1

Q: Science is primarily a search for truth.
A: Disagree, (or you lean that way)

DISCUSSION POINT: "Truth" means different things to different people. Science seeks to understand natural phenomena, based on critical study and analysis of observed evidence, and tries to get an accurate picture of the real, natural world. Science has been so successful in getting close enough to an accurate understanding of many natural phenomena that it has led to healthier and longer lives, more efficient agriculture, and engineering marvels.

2

Q: Science can solve any problem or answer any question.
A: Disagree, (or you lean that way)

DISCUSSION POINT: Science can only solve problems of the natural world - not the supernatural. If understanding of apparent supernatural phenomena is desired, science must adopt a working hypothesis that there is a natural explanation, which can be tested and studied scientifically.

3

Q: Science is primarily concerned with understanding how the natural world works.
A: Agree, (or you lean that way)

DISCUSSION POINT: Questions about the supernatural, ethics, beauty, opinions or politics are really not suitable subject matter for science. Science can be used to provide understanding about the natural world. But where opinions, beliefs, or feelings are dominant elements, science has limited application. With the progress in neuropsychological studies these days, we may come to understand how such opinions, beliefs, and feelings are generated, but science would probably have little to say about which opinions, beliefs or feelings would be right for any individual.

4

Q: Astrology (predicting your future from the stars and planets) is a science.
A: Disagree, (or you lean that way)

DISCUSSION POINT: Astrology is a pseudoscience that is often presented as being supported by scientific evidence. All such "evidence" has been fully discredited upon critical examination. Be careful not to confuse astrology with the legitimate science of astronomy.

5

Q: Science requires a lot of creative activity.
A: Agree, (or you lean that way)

DISCUSSION POINT: Much creativity is needed for suggesting possible natural explanations (hypotheses), as well as for developing logical ways to test those explanations.

6

Q: A "hypothesis" is just an "educated guess" about anything.
A: Disagree, (or you lean that way)

DISCUSSION POINT: A hypothesis is typically a tentative, testable explanation. It cannot be overly simplified to "an educated guess." Make a clear distinction between a hypothesis and a prediction: they are not the same thing. An educated guess could be about anything; guessing that your teacher's age is 34 is not a hypothesis. It is not an explanation, tentative or otherwise.

7

Q: Science is most concerned with collecting facts.
A: Disagree, (or you lean that way)

DISCUSSION POINT: Because scientific understanding must be based on real-world observations, observed facts and data are an important part of scientific work. However, its major concern is with what the facts show us and how the facts help us to understand how our natural world works? Facts are just one of the tools used to get there.

8

Q: A scientific fact is absolute, fixed, and permanent.
A: Disagree, (or you lean that way)

DISCUSSION POINT: A scientific fact is typically defined as an observation confirmed repeatedly by many critical observers. With improved tools, or new ways of observing, some scientific facts can be replaced with new facts. At one time, it was generally accepted as a fact that humans had 48 chromosomes in each cell. Later studies using improved techniques showed that there are only 46 chromosomes. The fact changed.

9

Q: A scientific theory is merely a guess.
A: Disagree, (or you lean that way)

DISCUSSION POINT: A scientific theory is a well-substantiated explanation of some aspect of the natural world, incorporating facts, laws, inferences and well-tested hypotheses. Outside of science, "theory" means a guess or speculation, far different from its scientific use.

10

Q: Scientists have solved most of the major mysteries of nature.
A: Disagree, (or you lean that way)

DISCUSSION POINT: Every scientific study that attempts to increase our understanding of some natural phenomenon always raises new questions and new problems. It has been estimated that science has just "scratched the surface" of the depths of our knowledge about the natural universe.

11

Q: Science can study and explain events that happened millions of years ago.
A: Agree, (or you lean that way)

DISCUSSION POINT: Just as forensic scientists (CSI) can often come to learn who committed the crime in a fairly recent event, by seeking and analyzing the evidence, paleontologists and astronomers can determine with fairly high confidence what happened in the distant past to produce what we see today. This form of "historical" science often lacks the steps implied by the Scientific Method (or experimental science). However, the methods of historical science are just as effective in getting reliable answers as the experimental sciences.

12

Q: Scientists have observed that nature follows the same "rules" throughout the universe.
A: Agree, (or you lean that way)

DISCUSSION POINT: This was once just a basic assumption of science, but over the years, repeated observations have confirmed the correctness of that assumption. We've had to refine and modify some old ideas (for example, Newton's laws of motion to Einstein's rules of relativity at velocities near the speed of light), but they are clearly and universally observed as far as we can tell.

13

Q: Scientists often try to test or disprove possible explanations.
A: Agree, (or you lean that way)

DISCUSSION POINT: This is the heart and soul of science. If a possible explanation cannot be subjected to testing then the explanation is unverifiable. Likewise, if the hypothesis survives the testing, it's probably a good one.

14

Q: Science can be influenced by the race, gender, nationality, or religion of the scientists.
A: Agree, (or you lean that way)

DISCUSSION POINT: Science is done by people, who have the same biases anyone might have, and these biases do influence how we see the world, and what explanations might come to mind to help us understand that world. The beauty of science is that its rules tend to minimize the impact of bias and personal opinions on its solutions.

15

Q: All scientific problems must be studied with The Scientific Method.
A: Disagree, (or you lean that way)

DISCUSSION POINT: It has been said that there is only one "Scientific Method" and it includes several steps, as if that was the only way real science could be done. The many variations in approaches are ignored when one focuses on "one scientific method". Also often overlooked, are the several critical aspects of science collectively termed "The Nature of Science" or NOS. This includes a clarification of what science is and is not, its realm (limited to the natural world), its limits, rules and assumptions, its tentativeness, the role of biases, and its social nature (collaboration and peer-reviewed publishing).

16

Q: Disagreement between scientists is one of the weaknesses of science.
A: Disagree, (or you lean that way)

DISCUSSION POINT: Quite the contrary. Passionate disagreement leads to mutual critiquing of methods and ideas, and searches for more evidence, ultimately leading to resolutions that bring us closer to a more accurate understanding of the phenomenon. This is a decided strength of science.

Next Generation Sunshine State Science Standards

Kindergarten:
SC.K.N.1.1, SC.K.N.1.2, SC.K.N.1.5, SC.K.P.13.1

1st Grade:
SC.1.N.1.1, SC.1.N.1.2, SC.1.N.1.4, SC.1.P.13.1

2nd Grade:
SC.2.N.1.2, SC.2.N.1.3, SC.2.N.1.4, SC.2.N.1.5, SC.2.N.1.6, SC.2.P.8.1, SC.2.P.10.1, SC.2.P.13.1, SC.2.P.13.2, SC.2.P.13.4

3rd Grade:
SC.3.N.1.2, SC.3.N.1.4, SC.3.N.1.5, SC.3.N.1.6, SC.3.N.1.7, SC.3.P.10.1

4th Grade:
SC.4.N.1.1, SC.4.N.1.2, SC.4.N.1.3, SC.4.N.1.4, SC.4.N.1.5, SC.4.N.1.7, SC.4.N.1.8, SC.4.P.8.1, SC.4.P.8.4

5th Grade:
SC.5.N.1.1, SC.5.N.1.2, SC.5.N.1.3, SC.5.N.1.5, SC.5.N.1.6, SC.5.N.2.1, SC.5.N.2.2, SC.5.P.8.3, SC.5.P.8.4, SC.5.P.10.2, SC.5.P.10.3, SC.5.P.10.4, SC.5.P.11.1, SC.5.P.11.2, SC.5.P.13.1, SC.5.P.13.2, SC.5.P.13.4

6th Grade:
SC.6.N.1.1, SC.6.N.1.2, SC.6.N.1.3, SC.6.N.1.4, SC.6.N.1.5, SC.6.N.2.2, SC.6.N.2.3, SC.6.N.3.1, SC.6.N.3.2, SC.6.P.13.1

7th Grade:
SC.7.N.1.1, SC.7.N.1.2, SC.7.N.1.3, SC.7.N.1.6, SC.7.N.1.7

8th Grade:
SC.8.N.1.1, SC.8.N.1.2, SC.8.N.1.3, SC.8.N.1.4, SC.8.N.1.5, SC.8.N.1.6, SC.8.N.2.1, SC.8.N.4.1, SC.8.P.8.1, SC.8.P.8.4, SC.8.P.8.5, SC.8.P.8.7

High School:
SC.912.N.1.1, SC.912.N.1.2, SC.912.N.1.3, SC.912.N.1.5, SC.912.N.1.6, SC.912.N.1.7, SC.912.N.2.1, SC.912.N.2.4, SC.912.N.3.1, SC.912.P.8.4, SC.912.P.8.5, SC.912.P.10.10, SC.912.P.10.16, SC.912.P.10.17

Next Generation Science Standards

NGSS:
3-5-ETS1-2, 3-5-ETS1-3, 4-PS3-3, 5-PS1-3, MS-ETS1-2, MS-ETS1-3

VOCABULARY LIST

Control	*n.* a standard against which other conditions can be compared in a scientific experiment
Experiment	*1. n.* the act of conducting a controlled test or investigation 2. *v.* to conduct a test or investigation
Fact	*n.* an observation that has been confirmed repeatedly and is accepted as true (although its truth is never final)
Hypothesis	*n.* a proposed explanation for a scientific problem
Inference	*n.* an idea or conclusion that's drawn from evidence and reasoning
Law	*n.* a summarizing statement of observed experimental facts that has been tested many times and is generally accepted as true by the scientific community
Observation	*n.* the act of noticing or paying attention
Theory	*n.* a logical, time-tested explanation for events that occur in the natural world
Variable	*n.* in an experiment, a quantity that can assume any of a set of values