

# HQT Physical Science Workshops

## Lesson #1: Properties of Matter

### Session Description:

In this session we will actively investigate the fascinating properties of matter. An understanding of these basic properties provides a foundation for understanding most all other science topics. Concepts will be developed in a logical, orderly manner, and as many properties of matter will be made “visible” (observable) as possible. Specifically, participants will investigate properties of the three common states of matter, seek evidence for the particle nature of matter, classify substances according to observable properties, measure and compare properties of various substances, explore both fundamental and derived units of measure, consider multiple systems of measurement, consider the strengths and weaknesses of and differences between quantitative and qualitative measures, and use tools to probe properties of matter for which human senses alone are too crude.

### State Frameworks addressed:

#### 1. Science as Inquiry

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### 2. Science, Technology, and Society

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### 5. Physical Science

5a. Students will demonstrate an increasing ability to distinguish among materials by utilizing observable properties.

5b. Students will demonstrate an increasing ability to understand that matter is composed of dynamic interactive units or particles, that all the properties and changes in

matter can be explained in terms of the forces involved in the interactions of these units, and that matter is conserved in ordinary chemical reactions.

## **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

6d. Students will increasingly quantify their interactions with phenomena in the natural world, use these results to understand differences of scale in objects and systems, and determine how changes in scale affect various properties of those objects and systems.

## **Properties of Matter**

- Three common states of matter
- Evidence for particle nature of matter
- Classification of matter using observable properties
- Measurements: fundamental versus derived, multiple systems of, using tools

### **I. Properties of Matter**

\*identify three common states of matter

\*investigate evidence for particle nature of matter

\*classify of matter using observable properties

\*make measurements using both fundamental and derived units

\*examine physical properties of matter such as area, volume, mass, weight, and density

## **II. Pressure & Fluids**

- \*make measurements using both fundamental and derived units
- \*investigate the pressure a force exerts on different areas
- \*experiment with pressure differences caused by moving fluids
- \*predict which objects will float or sink in water

## **Lesson #3: Static Electricity and Magnetism**

### **Session Description:**

Building on concepts discussed in Session 1 (Properties of Matter), we will look more in-depth at particles, and pursue the idea that matter is made of different kinds of charges. These tiny, invisible charges cause visible phenomena. Although we can't see the charges, we can investigate which materials allow these charges to move through, and we can learn how to charge and discharge various materials. We will also investigate properties of magnetism and what causes a magnet to be a magnet. Can we turn a non-magnet into a magnet? Can we de-magnetize a magnet? Which materials can shield magnetism? Electric fields and magnetic fields extend invisibly into space; however, we can still detect and measure these fields.

### **State Frameworks addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### **5. Physical Science**

5a. Students will demonstrate an increasing ability to distinguish among materials by utilizing observable properties.

5b. Students will demonstrate an increasing ability to understand that matter is composed of dynamic interactive units or particles, that all the properties and changes in matter can be explained in terms of the forces involved in the interactions of these units, and that matter is conserved in ordinary chemical reactions.

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5d. Students will demonstrate an increasing understanding of how electrical and magnetic systems interact with matter and energy.

## **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

## **Static Electricity and Magnetism**

- Design activity to discover which materials attract to magnets
- Charge and discharge materials
- Magnetize and de-magnetize materials
- Investigate electric and magnetic fields

### **III. Static Electricity & Magnetism**

\*charge and discharge materials

\*investigate electric and magnetic fields

\*magnetize and de-magnetize materials

\*design activity to discover which materials attract to magnets

## **Lesson #4: Current Electricity & Electromagnetism**

### **Session Description:**

Session 2 (Static Electricity & Magnetism) considered electricity and magnetism as separate phenomena. This is how humans first understood them. In this session, we will explore flowing charges (current electricity) and discover that a magnetic field is created when there are moving charges. We will identify the components needed to produce an electric current, investigate how to measure and control the strength of electric currents, build series and parallel circuits, and investigate the fascinating topic of electromagnetism. Motors, generators, electrical multi-meters and various other common devices will be discussed and manipulated.

### **State Frameworks addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### **5. Physical Science**

5a. Students will demonstrate an increasing ability to distinguish among materials by utilizing observable properties.

5b. Students will demonstrate an increasing ability to understand that matter is composed of dynamic interactive units or particles, that all the properties and changes in matter can be explained in terms of the forces involved in the interactions of these units, and that matter is conserved in ordinary chemical reactions.

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5d. Students will demonstrate an increasing understanding of how electrical and magnetic systems interact with matter and energy.

#### **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

### **Current Electricity & Electromagnetism**

- Components needed to produce electric current
- Measure and control strength of electric current
- Build series and parallel circuits

Use motors, generators, electrical multi-meters and other devices to explore electromagnetism

#### **IV. Current Electricity & Electromagnetism**

- \*identify components necessary for electric current
- \*measure and control strength of current
- \*build series and parallel circuits
- \*use motors, generators, and other unusual devices to explore electromagnetism

## **Lesson #5: Sound**

### **Session Description:**

Sessions 2 and 3 (Static electricity & Magnetism; Current Electricity & Electromagnetism) may appear completely unrelated to this session's topic of Sound. However Sound, like electricity, is a type of energy. In this session we will learn what creates sound. We will actively investigate the relationship between frequency and pitch, discover how a change in amplitude changes a sound, learn about key features of waves (this will lead us naturally into Sessions 5 & 6 on Light), and experiment with the transmission ability of a variety of materials. As always, an inquiry approach will be taken in this session.

### **State Frameworks addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### **5. Physical Science**

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5g. Students will demonstrate an increasing understanding that energy can be transmitted by waves, using light and sound as examples.

#### **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

## **Sound**

- What creates sound?
- Investigate relationship between frequency and pitch
- Discover how a change in amplitude changes a sound
- Observe key features of waves
- Experiment with the ability of different materials to transmit sound

### **V. Sound**

- \*learn what creates sound
- \*observe and identify key features of waves
- \*investigate relationship between frequency and pitch
- \*experiment with the ability of different materials to transmit sound
- \*discover how a change in amplitude changes a sound

## **Lesson #6: Light I**

### **Session Description:**

Light, like electricity and sound, is a form of energy. And like sound, light travels in waves. In this session, we will compare and contrast sound waves with light waves. We will discover how a change in a light wave's amplitude changes the light and explore the relationship between a light wave's frequency and its color. Most types of "light" are invisible to human eyes. We will investigate different types of energy on the electromagnetic spectrum, will classify materials as transparent, translucent or opaque and will explore different types of mirrors.

### **State Frameworks Addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### **5. Physical Science**

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5g. Students will demonstrate an increasing understanding that energy can be transmitted by waves, using light and sound as examples.

#### **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

## **Light I**

- Investigate relationship between frequency and color
- Discover how a change in amplitude changes light
- Review (from Sound session) key features of waves
- Classify materials as transparent, translucent or opaque
- Experiment with concave, convex and plane mirrors

### **VI. Light I.**

- \*classify materials as transparent, translucent, or opaque
- \*investigate the role of light in the process of vision
- \*experiment with concave, convex and plane mirrors
- \*review (from sound session) key features of waves
- \*discover how a change in amplitude changes light
- \*explore different types of energy on the electromagnetic spectrum

## **Lesson #7: Light II**

### **Session Description:**

Building on what was learned in Session V (Light I), in this second session on light we will separate “white light” into the colors of the rainbow. We will also combine different colors of light to form new colors. Through investigations with lenses, we will discover principals of refraction. Without this phenomena, not only could there be no cameras, microscopes or telescopes, there would be no vision, as we know it!

### **State Frameworks Addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature

#### **5. Physical Science**

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5g. Students will demonstrate an increasing understanding that energy can be transmitted by waves, using light and sound as examples.

#### **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

## **Light II**

- Separate “white light” into the colors of the rainbow
- Combine individual colors to produce different colors
- Explore the electromagnetic spectrum
- Investigate convex and concave lenses to learn the principles of refraction

### **VII. Light II.**

(note: Light I. is not a pre-requisite for Light II.)

\*investigate relationship between frequency and color

\*separate “white light” into the colors of the rainbow

\*combine individual colors to produce different colors

\*use concave and convex lenses to explore the phenomena of refraction

## **Lesson #8: Forces & Motion**

### **Session Description:**

After spending several sessions concentrating primarily on one type of energy at a time (electricity, sound, light), we will seemingly switch to a very different subject-- Forces & Motion. We will examine and investigate Newton's three Laws of Motion. We will define forces acting on objects in a variety of situations (Is there some force pushing an arrow as it flies through the air?). We will also perform experiments to explore the relationships among friction, object mass, and surface roughness, and we will investigate the more-complicated-that-it-seems phenomena of gravity.

### **State Frameworks Addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

#### **5. Physical Science**

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5e. Students will demonstrate an increasing understanding of how an unbalanced force exerted on an object causes a change in the state of rest or motion of that object in the direction of the unbalanced force.

#### **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

## **Forces & Motion**

- Investigate Newton's three Laws of Motion
- Identify forces acting on objects (moving and at rest)
- Explore relationships among friction, object mass, and surface roughness
- Investigate and experiment with gravity

### **VIII. Forces & Motion**

- \*investigate Newton's three laws of motion
- \*identify forces acting on objects
- \*explore relationships among friction, object mass, and surface roughness
- \*investigate and experiment with gravity

## **Lesson #9 & 10: Integrated Physical Science**

### **Session Description:**

In this eighth and final session activities will be designed in a way that unites all types of physical science. Special attention will be given to fundamental concepts such as the Laws of Conservation of Energy and of Matter, energy transformations, wave properties, and the particle nature of matter. We will see that the divisions among different topics in science blur as one examines them closely. The topics are all inter-related.

### **State Frameworks Addressed:**

#### **1. Science as Inquiry**

1a. Students will demonstrate an increasing understanding of how the scientific enterprise operates.

#### **2. Science, Technology, and Society**

2a. Students will demonstrate an increasing ability to use measuring instruments to gather accurate and/or precise information.

2b. Students will demonstrate an increasing ability to use technology to observe nature.

2c. Students will demonstrate an increasing ability to analyze, synthesize, and communicate scientific information using technology.

#### **5. Physical Science**

5a. Students will demonstrate an increasing ability to distinguish among materials by utilizing observable properties.

5b. Students will demonstrate an increasing ability to understand that matter is composed of dynamic interactive units or particles, that all the properties and changes in matter can be explained in terms of forces involved in the interactions of these units, and that matter is conserved in ordinary chemical reactions.

5c. Students will demonstrate an increasing ability to understand the relationship among different types and form of energy.

5d. Students will demonstrate an increasing understanding of how electrical and magnetic systems interact with matter and energy.

5e. Students will demonstrate an increasing understanding of how an unbalanced force exerted on an object causes a change in the state of rest or motion of that object in the direction of the unbalanced force.

5f. Students will demonstrate an increasing understanding that energy can be transmitted by waves, using light and sound as example.

5g. Students will demonstrate an increasing understanding that heat is the product of many natural processes.

## **6. Unifying Themes and Concepts**

6a. Students will demonstrate an increasing ability to recognize parts of any object or system, and understand how the parts interrelate in the operation of that object or system.

6b. Students will demonstrate their understanding of the meaning of stability and change and will be able to identify and explain change in terms of cause and effect.

6c. Students will understand the meaning of models, their appropriate use and limitations, and how models can help them in understanding the natural world.

6d. Students will increasingly quantify their interactions with phenomena in the natural world, use these results to understand differences of scale in objects and systems, and determine how changes in scale affect various properties of those objects and systems.

## **Integrated Physical Science**

- Law of Conservation of Matter
- Law of Conservation of Energy
- Energy transformations

### **IX. Integrated Physical Science I.**

- \*discuss and examine implications of the Law of Conservation of Energy
- \*identify various types of energy
- \*experiment with a variety of materials that show energy transfer
- \*conduct a variety of inquiry activities that relate to different physical science content

### **X. Integrated Physical Science II.**

(note: IPS I. is not a necessary prerequisite of IPS II.)

\*discuss and examine implications of the Law of Conservation of Energy

\*identify various types of energy

\*experiment with a variety of materials that show energy transfer

\*conduct a variety of inquiry activities that relate to different physical science content