FORMS OF ENERGY – LESSON PLAN 2.5

Light Energy & Solar Energy

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	• The "Modeling" Section contains teaching content. • While in class, students can do "Guided Practice," complete the "Recommended Item(s)" and any additional guided practice items the teacher might select from "Other Resources." • NOTE: Some lesson plans do and some do not contain "Other Resources." • At home or on their own in class, students can do "Independent Practice," complete the "Recommended Item(s)" and any additional independent practice items the teacher selects from "Other Resources" (if provided in the plan).
Average class size, student ability, and class length	• The "Modeling" Section contains teaching content. • While in class, students complete "Recommended Item(s)" from "Guided Practice" section. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.
Larger class size, lower student ability, and/or shorter class length	• The "Modeling" Section contains teaching content. • At home or on their own in class, students complete "Recommended Item(s)" from "Independent Practice" section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- **Describe how light is a form of energy and that it can be characterized as a wave.**
- **Explain how we see light, *e.g.* incandescent, fluorescent, etc.**
- **Identify different forms of light bulbs.**
- **Explain why we cannot see the entire spectrum of electromagnetic waves.**

Public School System Teaching Standards Covered

State Science Standards
- GA S4P1 4th
- NC 4.P.3.2 4th
- VA 5.3 5th

Common Core Language Arts/Reading
- ELA.CCSS.W.4.1 GA, NC 4th

I. Anticipatory Set (Attention Grabber)

Essential Question

How is energy converted into something that is visible, like light?

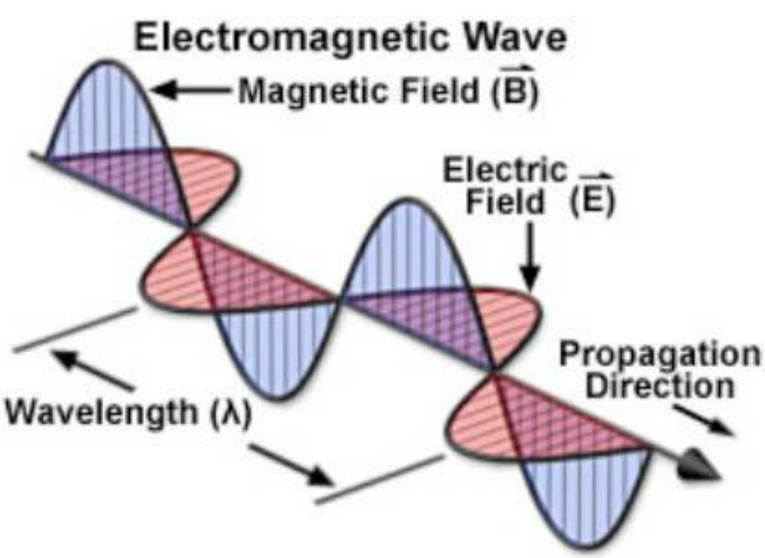
Videos

Video of Light and Color: http://pbskids.org/dragonflytv/show/lightandcolor.html
Explanation Video of Light and Color:
http://www.pbslearningmedia.org/resource/lsps07.sci.phys.energy.lightcolor/light-and-color/

II. Modeling (Concepts to Teach)

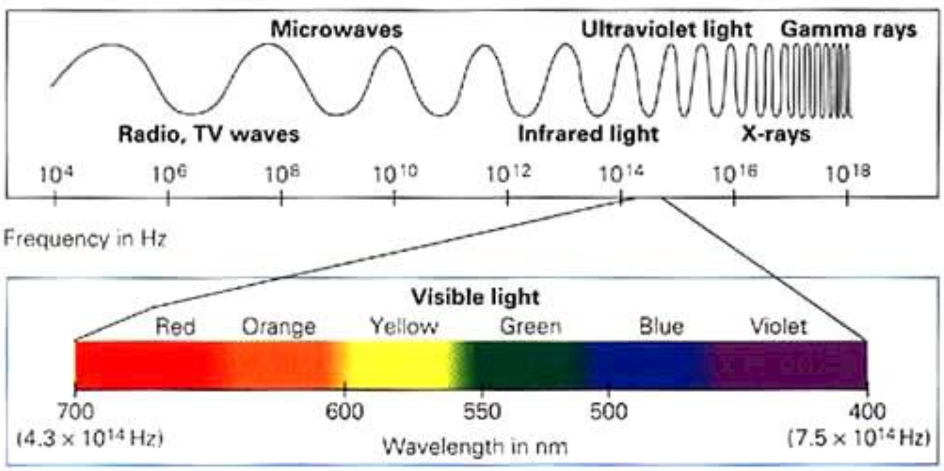
Light (Radiant) Energy is the energy of electromagnetic (EM) radiation. All light is created by vibrating electrical charges (electrons) in atoms. This wave is partly electric and partly magnetic in nature. The various types of electromagnetic radiation all share identical and fundamental wave-like properties. Every category of electromagnetic radiation, including visible light, oscillates in a periodic fashion with peaks and valleys (or troughs), and displays a characteristic **amplitude**, **wavelength**, and **frequency** that together define the direction, energy, and intensity of the radiation.

See diagram below:



Electromagnetic wave types differ in their wavelength and frequency. The electromagnetic spectrum is the range of all possible wavelengths and frequencies of electromagnetic radiation.

See EM Spectrum below:
http://web.princeton.edu/sites/ehs/laserguide/



One can notice that only a very small part of the EM Spectrum is light that humans are capable of seeing. This part of the spectrum is referred to as the Visible Spectrum and includes all of the colors that human eyes are able to see: Red, Orange, Yellow, Green, Blue, Indigo, and Violet (ROY G. BIV).

Longer and lower frequency electromagnetic waves contain less energy. For example, Radio waves, Microwaves, and Infrared Waves have less energy than Visible waves, Ultraviolet waves, X-rays, and Gamma rays.

In addition to being referred to as waves, scientists agree that light can also be considered a particle, called a photon. Photons are massless bundles of concentrated electromagnetic energy. In 1905, Albert Einstein published a theory concerning the particle-nature of light called the Photoelectric Effect. Around the same time, Max Plank discovered that light energy can only exist is certain amounts, or “chunks.” In other words, light energy is quantized.

Light Bulbs

All light is created by vibrating electrical charges (electrons) in atoms. The descriptions below will show the difference between the light created by incandescent light bulbs, compact fluorescent light bulbs, and VLED (Visible Light Emitting Diodes).

Incandescent Light Bulbs

The light energy is created by an electrical current traveling through a filament, usually made of an inert metal such as Tungsten. The filament gets hot, the electrons get excited and start to vibrate, and light radiation is emitted. In addition to light being emitted, a lot of heat is generated, too. A lot of the electrical potential energy is transformed into heat energy instead of being transformed into light energy.

CFL (Compact Fluorescent Light Bulbs): http://en.wikipedia.org/wiki/Compact_fluorescent_lamp

CFLs produce light differently than incandescent bulbs. In a CFL, an electric current is driven through a tube containing Argon and a small amount of Mercury vapor. This generates invisible Ultraviolet light that excites a fluorescent coating (Phosphor) on the inside of the tube, which then emits visible light. Very little electrical potential energy is transformed into heat. Compared to general-service incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer.

VLED (Visible Light Emitting Diodes) Light Bulbs: http://electronics.howstuffworks.com/led3.htm

LEDs are illuminated solely by the movement of electrons in a semiconductor material. The lifespan of an LED surpasses the short life of an incandescent bulb by thousands of hours. While LEDs are used in everything from remote controls to the digital displays on electronics, visible LEDs are growing in popularity and use thanks to their long lifetimes and miniature size. Depending on the materials used in LEDs, they can be built to shine in infrared, ultraviolet, and all the colors of the visible spectrum. But the main advantage is **efficiency**. In conventional incandescent bulbs, the light-production process involves generating a lot of heat (the filament must be warmed). This is completely wasted energy, unless one is using the lamp as a heater, because a huge portion of the available electricity isn't going toward producing visible light. LEDs generate very little heat, relatively speaking.

Capturing and Using Radiant (Solar) Energy

See National Geographic Article:
http://environment.nationalgeographic.com/environment/global-warming/solar-power-profile/

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts.

REMEMBER	Electromagnetic waves are partly ___________ and partly ____________ in nature. (Answer: electric and magnetic); Do all EM waves have the same wavelength and frequency? (Answer: EM wave types differ in their wavelength and frequency. The electromagnetic spectrum is the **range** of all possible wavelengths and frequencies of electromagnetic radiation.); What are photons? (Answer: Photons are massless bundles of concentrated electromagnetic energy.) (Class discussion)
UNDERSTAND	Compare the energy levels of energy in radio waves and visible waves. (Class discussion)
ANALYZE	Explain how light is created. (Class discussion. Answer: All light is created by vibrating electrical charges (electrons) in atoms.)
CREATE	Compose a Venn diagram to compare and contrast the different types of light bulbs. **http://www.learninggamesforkids.com/graphic_organizers/writing/venn-diagram.html**

IV. Guided Practice Ideas

Recommended Items

Create a Spectrometer and Light Bulb Challenge (see below in Experiments sections)

Other Resources

- Intro PowerPoint: **http://www.astro.virginia.edu/class/whittle/astr1220/05_Light_Matter/light.pdf**

Experiments

- **Create a Spectrometer** to View Spectrum of Light Experiment: **http://www.pinterest.com/pin/450711875177725942/**
- **Light Bulb Challenge**: **http://www.pbs.org/parents/scigirls/activities/light-bulb-challenge/**
- Demonstrate efficiency of different light bulbs: **http://littleshop.physics.colostate.edu/activities/atmos1/DemonstratingEfficiency.pdf**
- Light Bulbs and Thermal Energy Experiment: **http://www.education.com/science-fair/article/heat-produced-from-light-bulbs/**

V. Independent Practice Ideas

Recommended Items

- **At-Home Scavenger Hunt: Lights in your home (see below)**
- **Electromagnetic Spectrum Worksheet and Answer Key provided**

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy the questions and answer them on a sheet of paper: What is light? How does light produce energy?
- Create a list: Teachers write the following question on the board and ask students to copy the question and answer it on a sheet of paper: List objects that give us light.
- Electromagnetic Spectrum Worksheet and Answer Key provided
- At-Home Scavenger Hunt: Lights in Your Home. Students find and list examples of the three different types of lights in their home (incandescent, CFL and LED lights).
- Journal (if the students have a journal). Teachers write the following question on the board and ask students to copy and answer the question in their journals: What are the three types of light bulbs? (Teachers instruct students to name them and then glue or draw pictures of each type – incandescent, CFL and LED lights).

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- Electromagnetic Spectrum Worksheet and Answer Key provided
- Journal (if completed as Independent Practice, as shown above)
- Checklist (if completed as Independent Practice, as shown above)
- Light Bulb Challenge Experiment (if completed as Guided Practice, as shown above)

VII. Materials Needed

The following materials are needed for the **Light Bulb Challenge Experiment** in “Recommended Items” in Guided Practice.

- Incandescent bulb, 60 watts
- Compact fluorescent light (CFL) bulb, 15 watts
- 1 desk lamp, shade included
- 1 Tbsp. cooking oil
- 1 dropper
- 2 half-sheets of paper
- Ruler
- 2 books of equal thickness
- Stopwatch or clock
- Paper and pencil

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

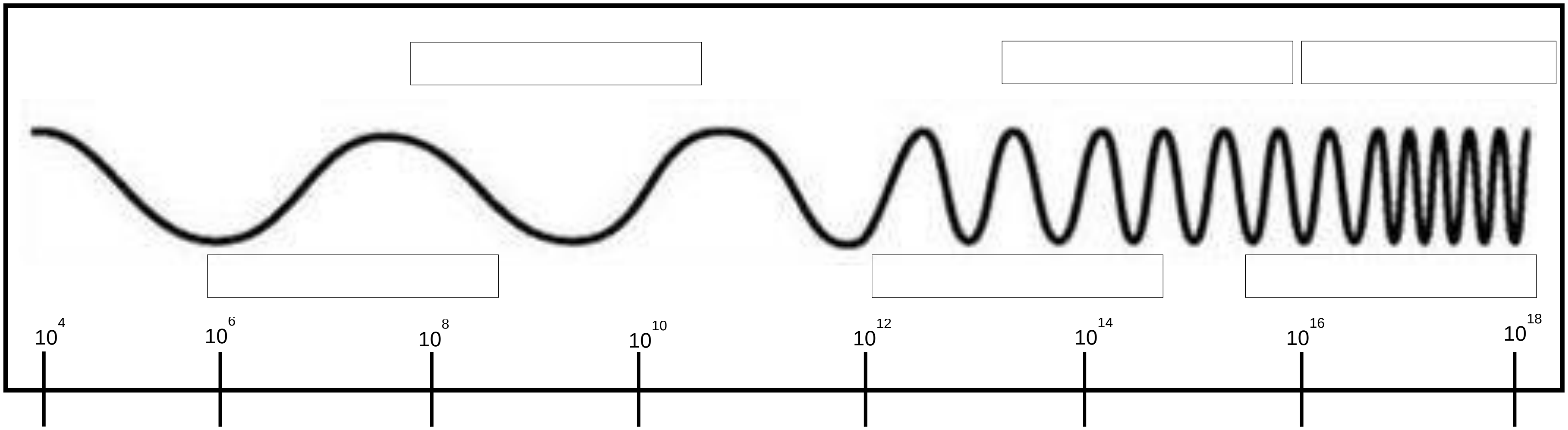
Essential Question

How is energy converted into something that is visible, like light?

WORKSHEET FOR LIGHT ENERGY & SOLAR ENERGY LESSON 2.5 **NAME: ____________________**

Electromagnetic Spectrum

Objective: Students will be able to describe how light is a form of energy and that it can be characterized as a wave, explain how we see light, and identify the different types of waves in the electromagnetic spectrum.



1. Label each box of the electromagnetic spectrum.

2. Where does visible light fall on the spectrum?

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3. Describe the way a wave moves and identify its parts.

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4. The movement of which part of the atom creates light?

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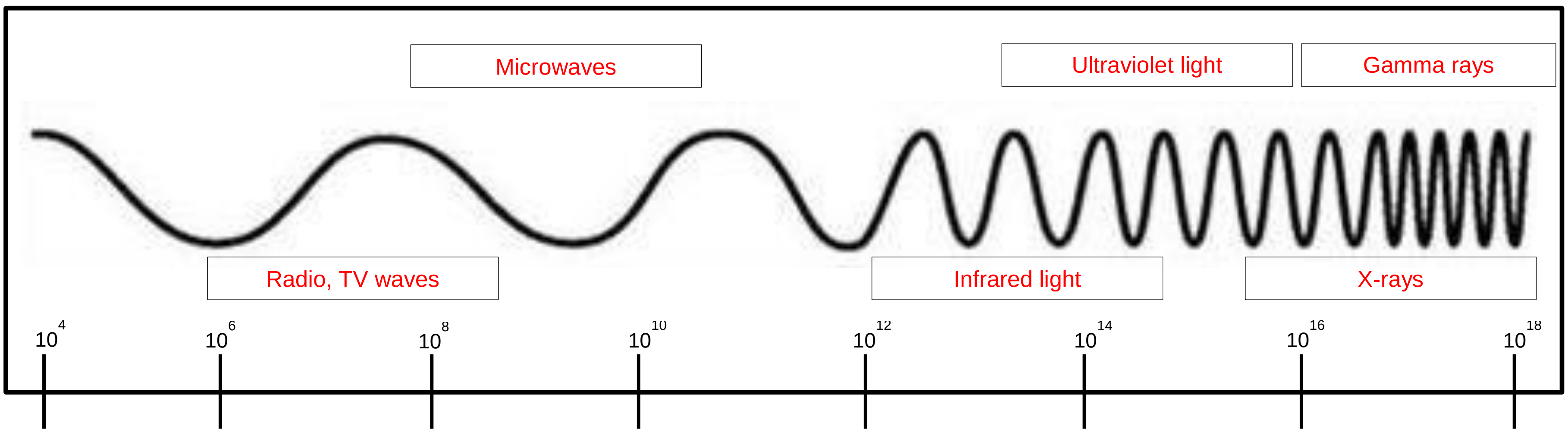
Answer Key

ANSWER KEY FOR WORKSHEET: ELECTROMAGNETIC SPECTRUM



1. Label each box of the electromagnetic spectrum.

2. Where does visible light fall on the spectrum?
   Ex. Visible light falls between ultraviolet, x-rays and gamma rays.

3. Describe the way a wave moves and identify its parts.
   Ex. A wave oscillates in a periodic fashion with peaks and valleys, and displays characteristics like amplitude, wavelength, and frequency.

4. The movement of which part of the atom creates light?
   Ex. All light is created by vibrating electrical charges (electrons) in atoms.