



Lesson 3: Lighting and Photosynthesis



Instructor:

Grade level: 9-12

Created/last edited/submitted:

Lesson Summary:

In this lesson plan, students will use engineering design to design a lighting system to best support plants to do photosynthesis to have a best production. As described in the lesson three that plants need light to conduct light-dependent reactions. The pigments in the thylakoid membranes, which inside chlorophylls, facilitate to absorb the photons of light. Photons provide energy to excited electron of chlorophyll molecules in photosystem II complex. Most pigments absorb red, blue and other visible wavelengths of light, but reflect green wavelengths of light. That is why leaves in general are green.

Red, blue, green and other colors that people's eyes can see are called visible light. The visible light corresponds to a wavelength range from approximately 400-700 nanometers (nm) and color range of violet through red. Low range of short wavelength means high frequency, which contains high-energy. In visible light spectrum, the shortest wave, which contains the highest energy, is a violet like color, and the longest wave is generally a red like color, which has the lowest energy.

Certain colors in light rays are important for proper plant growth. Various plant pigments help use different lights. Chlorophyll is a green pigment and carotenoids are yellow, orange or red pigments. All plants have chlorophyll *a*, which absorbs most strongly at ~450nm, or a bright blue color. However, many plants take cues for germination, flowering, and growth from the presence of red light as well (Photosystem II best occurs at ~680nm, and Photosystem I best occurs at ~700nm). Therefore, the red and blue parts of the light spectrum are the most important energy sources for plants. Most people are familiar with the incandescent light produced by ordinary light bulbs in our homes. Incandescent light is a good source of red rays but a poor source of blue. In addition, they produce too much heat for most plants. As for fluorescent tubes, cool white tubes produce a small amount of red rays in addition to orange and blue rays.

Lesson Objectives:

Students will be able to

1. Describe the electromagnetic spectrum in terms of frequency, wavelength, and energy.
2. Draw the spectrum of various light bulbs, and explain what light bulbs provide the best light energy (wavelength) for plants to conduct photosynthesis.

Curriculum Unit Name

3. Analyze plant responses to varied light color, intensity and duration to recommend a lighting system that may have the best production of vegetable.

Vocabulary:

Electromagnetic spectrum: The spectrum is typically divided into seven regions in order to decreasing wavelength and increasing energy and frequency. The common designations are radio waves, microwaves, infrared, visible light, ultraviolet, X-rays, and gamma-rays.

Light: Light is a type of electromagnetic wave that stimulates the retina of people's eyes.

Nanometer: 1 nanometer (nm)= 40 billionths of 1 inch, a very tiny unit of length.

Visible light: Visible light is defined as wavelengths that are visible to most human eyes.

Wavelength: One wavelength equals the distance between two successive wave crests or troughs.

Materials:

1. Various light bulbs, such as incandescent light bulbs, fluorescent light, LDEs, sodium lamps, and so on, that have same watts.
2. Spectrum scopes
3. Light bulb cord set (to put light bulbs on)
4. Color markers/pencils
5. Spectrum observation sheet
6. Thermometers (optional).

Time Required:

1 hour

Standards/Benchmarks Addressed:

1. Indiana Science Standards Biology

B.2.1. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

2. Indiana Science Standards Physics

PII. 9.1. Develop the relationship among frequency, wavelength, and energy for electromagnetic waves across the entire spectrum.

3. Next Generation Science Standards

HS-LS1-5. Use a model to illustrate how photosynthesis transforms light energy into stored chemical energy.

Classroom Instruction:

Introduction:	Comments:
1. Ask question, "Why plants need light to conduct photosynthesis?" Review photosynthesis light dependent cycle with students. 2. Ask question, "Have you learned light (electromagnetic) spectrum at physics class?"	<i>This is a place for teacher notes and/or helpful hints</i>

Curriculum Unit Name

3. Connect visible lights with plant pigments, and discuss what type of lights plants need for proper plant growth.	
Activity (Science/Math/Design or Engineering): 1. Put various light bulbs in the light bulb cord set. Plug in outlets and turn on the lights. 2. Turn off the classroom light and shut the blinds. 3. Have students look the light bulbs through spectrum scopes. 4. Have students filled the spectrum observation sheets. 5. Have students touched each light bulbs to feel the heat. 6. After students finish draw the spectrum of all the light bulbs, have students discussed the differences among all the light bulbs.	Comments: 1. Keep some distance between different light bulbs to avoid interference between two light bulbs. 2. The spectrum could be find on the side of the spectrum scopes. 3. If it is hard to see, students can also take pictures from their cell phone through the spectrum scopes. In this way, it may show a clear picture of the spectrum.
Closure: 1. Have students connected what they learned about light with photosynthesis light dependent cycle. 2. Ask students to discuss which light bulb provides the best light rays for plants to grow? Why?	Comments:

Assessment:

Pre-Activity Assessment

Activity Embedded Assessment

Post-Activity Assessment

Support Materials

Student Handout/Worksheet

Design Brief/Story/Context

References:

Curriculum Unit Name

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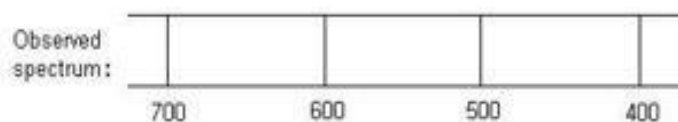
Observing light spectrum

Use colored pencils provided to record the spectral pattern of each light source that you observe.

1. Light source: _____
Colour of light : _____



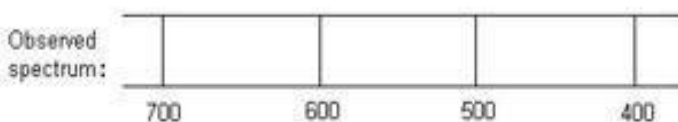
2. Light source: _____
Colour of light : _____



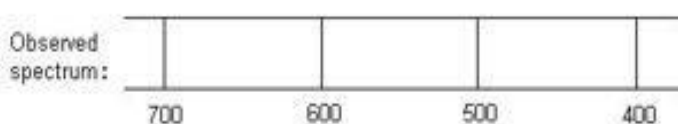
3. Light source: _____
Colour of light : _____



4. Light source: _____
Colour of light : _____



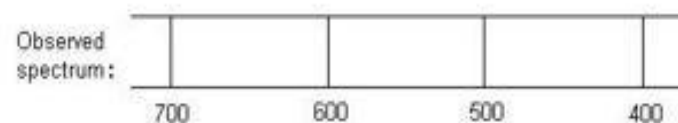
5. Light source: _____
Colour of light : _____



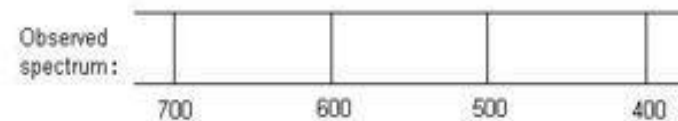
6. Light source: _____
Colour of light : _____



7. Light source: _____
Colour of light : _____



8. Light source: _____
Colour of light : _____



9. Light source: _____
Colour of light : _____

