Lesson A2–7

Understanding Light, Temperature, Air, and Water Effects on Plant Growth

Unit A. Horticultural Science

Problem Area 2. Plant Anatomy and Physiology

Lesson 7. Understanding Light, Temperature, Air, and Water Effects on Plant Growth

New Mexico Content Standard:

Pathway Strand: Plant Systems

Standard: **I:** Apply principles of anatomy and physiology to produce and manage plants in both a domesticated and natural environment.

Benchmark: **I-A:** Analyze and evaluate nutritional requirements and environmental conditions to develop and implement a fertilization plan.

Performance Standard: **4.** Determine the environmental factors that influence and optimize plant growth.

Student Learning Objectives. Instruction in this lesson should result in students achieving the following objectives:

1. Describe the effect of light on plants.
2. Describe a plant's temperature needs.
3. Explain how the quality of air affects plants.
4. Describe a plant's water needs.

List of Resources.

The following resources may be useful in teaching this lesson:

Recommended Resources. One of the following resources should be selected to accompany the lesson:

Biondo, Ronald J. and Jasper S. Lee. *Introduction to Plant and Soil Science and Technology,* Second Edition. Danville, Illinois: Interstate Publishers, Inc., 2003.

Schroeder, Charles B., et al. *Introduction to Horticulture*, Third Edition. Danville, Illinois: Interstate Publishers, Inc., 2000.

List of Equipment, Tools, Supplies, and Facilities

Writing surface
Overhead projector
Transparencies from attached masters
Copies of student lab sheet
10 to 15 small plants
Optical prism
USDA plant hardiness zone maps

Terms.

The following terms are presented in this lesson (shown in bold italics):

Day neutral plant (DNP)
Foot-candles
Hardiness
Long day plant (LDP)
Photoperiod
Short day plant (SDP)
Visible light spectrum
Wilted

Interest Approach.

Use an interest approach that will prepare the students for the lesson. Teachers often develop approaches for their unique class and student situations. A possible approach is included here.

Students love to set up experiments. This is your chance to allow them to set up their own. Allow the class 10 to 15 plants. This can be done by groups or by the whole class together. Tell the students they need to study the effects of light, temperature, air, and water on plants. For example, you might use four plants and put one in a bright window, one on the teacher's desk, one in a greenhouse or under a bright light, and one in a dark closet to study the effects of light. Allow students to be creative. Within a week you will start to see some serious differences. Students can check and measure the progress of the plants at the beginning of each class as a gathering and interest activity. You may ask students to draw conclusions from their data. This can take the form of a discussion, paper, or an oral presentation.

Summary of Content And Teaching Strategies

Objective 1: Describe the effect of light on plants.

Anticipated Problem: How does light affect plants?

I. Plants have adapted, over millions of years, to use sunlight as their source of energy. As previously covered in the previous lesson, they do this using a pigment called chlorophyll to photosynthesize.

A. Plants use light in the ***visible light spectrum***, a narrow band of radiant energy that we can see with our eyes. Plants need mostly the colors blue and red to activate the chlorophyll. Other pigments collect other colors of light and pass that energy to the chlorophyll to make more sugar. The fact that plants need a lot of both blue and red light means that neither regular light bulbs nor regular fluorescent tubes provide adequate light for most plants. Light bulbs are deficient in blue and tubes are deficient in red. Special grow-lights are made which have more of the correct wavelengths of light.

B. The intensity of the light matters a great deal to the plant. Light intensity in measured in ***foot-candles***, the amount of light given off by a candle a foot away. Plants have adapted to a wide variety of light intensities. Many plants require full sun. Most plants that do well in a house can survive or even thrive in lower light intensities.

C. Plants also respond to the length of time they are exposed to light, or ***photoperiod***. Plants can generally be separated into three groups by how they respond to photoperiod.

1. ***Short day plants (SDP)*** are plants that begin to flower when the nights are over 12 hours long.
2. ***Long day plants (LDP)*** are plants that begin to flower when the nights are under 12 hours long.
3. ***Day neutral plants (DNP)*** are plants whose flowering response is unaffected by photoperiod.

Use TM: A2–7A as a visual aid to show the visible spectrum of light. A prism will break up the visible spectrum into its individual colors (red, orange, yellow, green, blue, indigo, and violet) for students to see. Go to a window and break up some light. If a light meter is available, measure differences of light intensity between light and darker areas in your room. Then, measure light intensities in your greenhouse or outside.

Objective 2: Describe a plant's temperature needs.

Anticipated Problem: What temperatures are best for plants?

II. Plants have adapted to a wide range of temperatures. There are plants which thrive within the arctic circle and others that can survive in the blazing sun of a desert. Plants tend to adapt for higher temperatures with smaller leaves in lighter colors with thicker cuticles. Plants adapt to low temperatures by growing lower to the ground with short life cycles and

parabolic dish-shaped flowers to collect light and heat. Although plants can survive higher and lower extremes, plants don't really grow at temperatures below 32 degrees Fahrenheit or above 100 degrees Fahrenheit.

A. A plant's ability to withstand low temperatures is called its ***hardiness***. A plant which is very hardy can survive in a cold climate. Hardiness is measured using the USDA plant hardiness zone map. Each area of the country is assigned a zone numbered from one to ten. Hardiness zones are derived from the average coldest temperatures for the year.

B. Plants have difficulties growing at extremely high temperatures. This usually has to do with the ability to pick up and move enough water to keep up with the higher rate of photosynthesis. When it gets too hot, the plant starts to lose water and become flat, a condition known as ***wilted***. The guard cells also wilt, causing the stomata to close, thus effectively shutting the plant down.

Use the recommended resources to reinforce student understanding of the information. Show the students plants which have wilted or have been damaged by low temperatures. Show students the hardiness zone map on TM: A2–7B.

Objective 3: Explain how the quality of air affects plants.

Anticipated Problem: How does the quality of air affect plants?

III. Air contains carbon dioxide and oxygen, both of which are necessary for plant growth.

A. Oxygen is necessary for cellular respiration to occur in a normal manner. Oxygen is picked up mainly by the roots of the plant.

B. Carbon dioxide is used for photosynthesis in very high amounts. Carbon dioxide usually enters the plant through the leaves via the stomata. In greenhouses, we often try to boost the level of carbon dioxide to speed up photosynthesis.

Use the recommended resources to strengthen student understanding of the concepts.

Objective 4: Describe a plant's water needs.

Anticipated Problem: How do plants get water?

IV. Plants get most of their water through the root system. In some situations, plants can soak up water through their stems or take in water through their leaves.

A. One of the most difficult things about watering plants is that the roots need both water and oxygen. While some plants are very adept at removing the oxygen they need from the water, others drown in a very short time.

B. Plants should be watered all the way through the root zone to encourage even root growth.

C. Plants should be grown in pots with drainage holes, so the water can drain and allow oxygen into the root zone.

Use the recommended resources to reinforce student understanding of the concepts.

Review/Summary. Compile results from experiments designed in the interest approach. Have class discussion, presentations, or papers on the findings.

Application. Use LS: A2–7A to apply the information.

Answers to Sample Test:

Part One: Matching

1. c 2. b 3. d 4. g 5. a 6. f 7. e

Part Two: Completion

1. Roots
2. Photoperiod.
3. Red, blue
4. 32°F, 100°F

Part Three: Short Answer

1. Drainage holes are necessary to allow the soil to get some oxygen in it.

Sample Test Name _____

Test

Lesson A2–7: Understanding Light, Temperature, Air, and Water Effects on Plant Growth

Part One: Matching

Instructions. Match the term with the correct response. Write the letter of the term by the definition.

a. Visible light spectrum
b. Foot-candles
c. Short day plant
d. Long day plant
e. Day neutral plant
f. Hardiness
g. Wilting

_____ 1. A plant which flowers when nights are longer than 12 hours.

_____ 2. The unit of measure for light intensity.

_____ 3. A plant which flowers when nights are shorter than 12 hours.

_____ 4. What happens when a plant doesn't get enough water.

_____ 5. Red, orange, yellow, green, blue, indigo and violet.

_____ 6. The ability of a plant to withstand low temperatures.

_____ 7. A plant which is unaffected by photoperiodism.

Part Two: Completion

Instructions. Provide the word or words to complete the following statements.

1. Plants usually get oxygen through their _____.
2. The length of the sunlight a plant gets is called a _____.
3. The colors of light that plants most often use are _____ and _____.
4. Plants usually do not grow well when the temperature is below _____ or above _____.

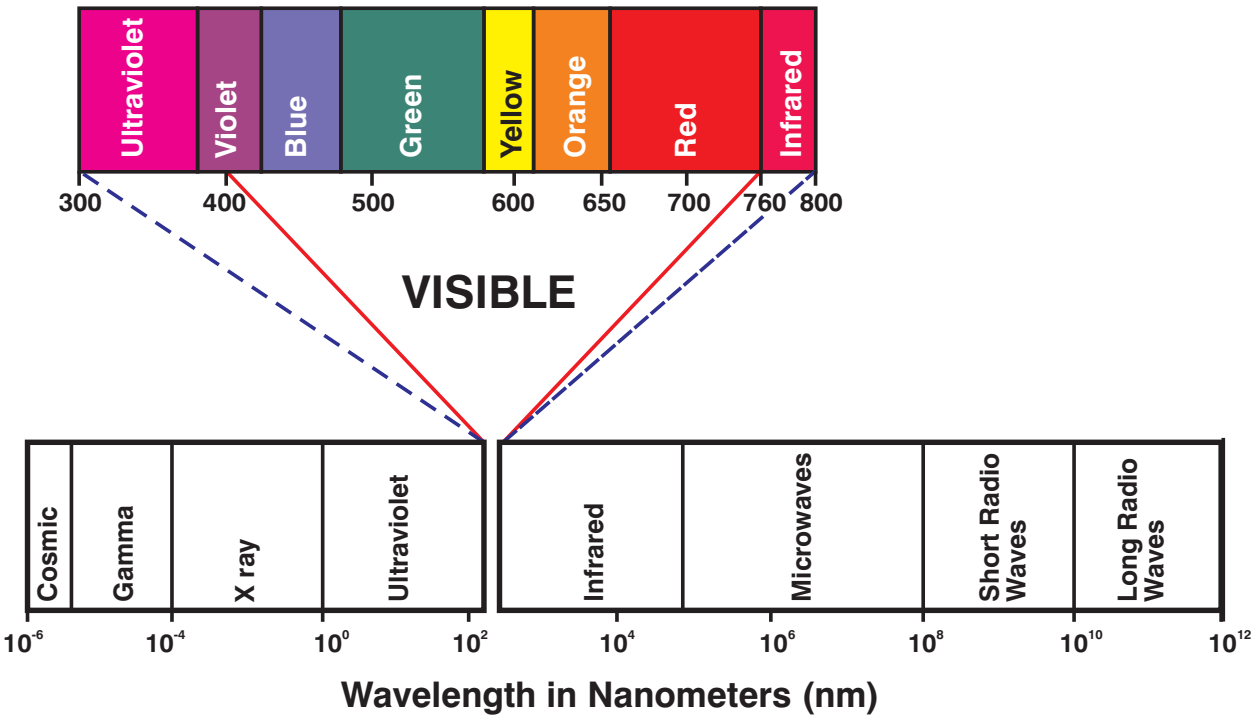
Part Three: Short Answer

Instructions. Provide information to answer the following question.

1. Why do we put drainage holes in the bottom of pots?

TM: A2–7A

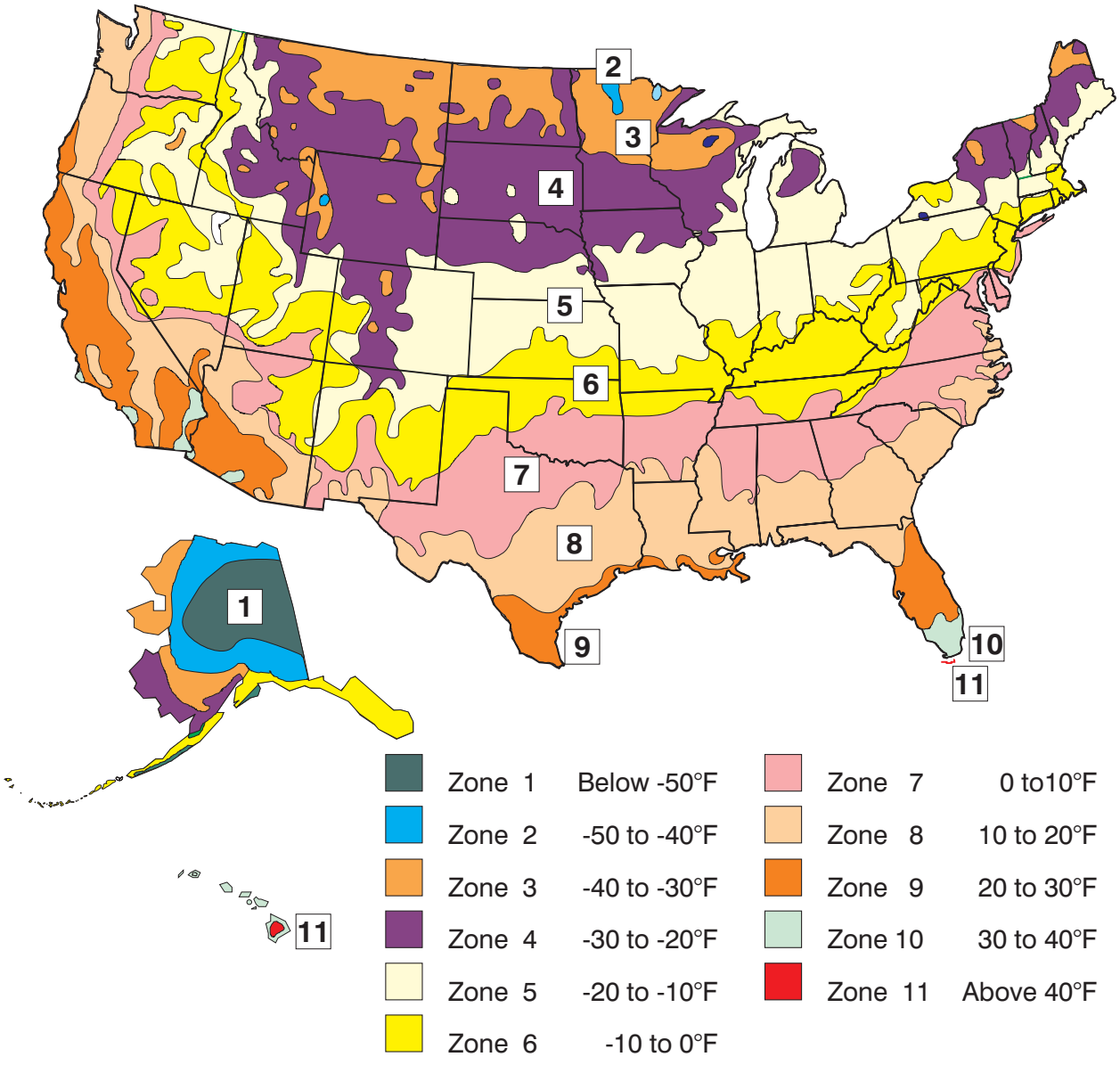
THE LIGHT SPECTRUM



(Courtesy, Interstate Publishers, Inc.)

TM: A2–7B

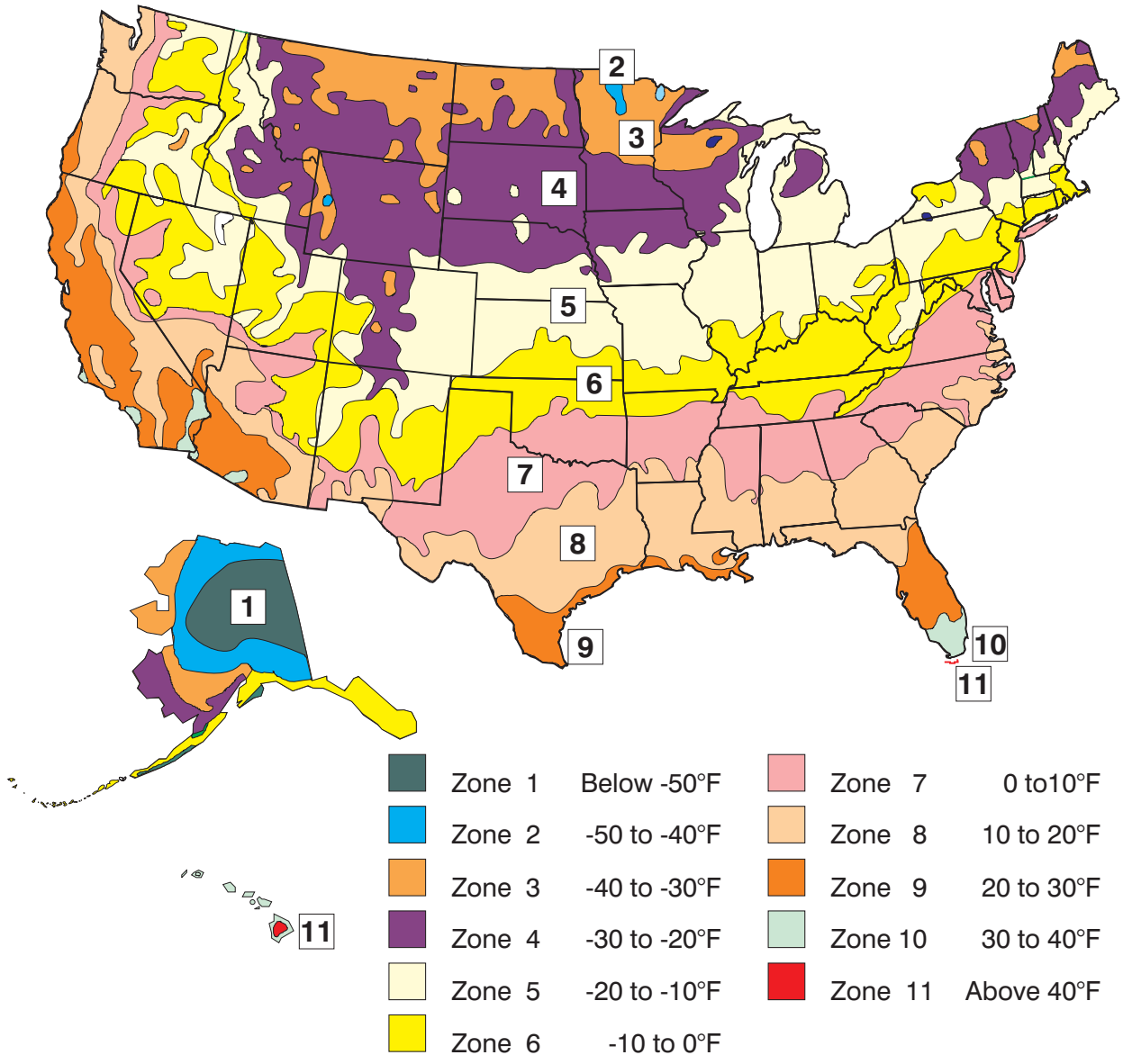
PLANT HARDINESS ZONES



(Courtesy, USDA)

Name _____

Lab Sheet



1. How cold is the average low temperature in zone 6?

2. Can a zone 7 plant survive in Indiana?

3. Can a zone 3 plant survive in Texas?

4. Which state has a place with a warmer winter, New Mexico or Oregon?

5. What is our hardiness zone, according to this map?