Section 10.1 Sources and Nature of Light

(Student textbook pages 403 to 410)

Specific Expectations

- **E2.1** use appropriate terminology related to light and optics, including, but not limited to: *angle of incidence, angle of reflection, angle of refraction, focal point, luminescence, magnification, mirage*, and *virtual image*
- **E3.1** describe and explain various types of light emissions
- **E3.2** identify and label the visible and invisible regions of the electromagnetic spectrum

In this section, students survey sources of light and explore the concept that different colours of light are merely variations on a theme. Phenomena as disparate as X rays, microwaves, visible light, infrared light, and radio waves are explored as similar phenomena.

Common Misconceptions

- Students may believe light comes from people's eyes. Ask why they cannot see in a dark room. Light must travel from a source, to the receptor (e.g., eyes).
- Students may think light is always associated with heat. Ask students to check whether the slime in Activity 10-1 Glowing Slime, produced any heat.
- Students may believe light can be stored. (A possible interpretation of phosphorescence.) Explain to students that light is not stored in atoms. Technically, it is not even re-radiated. What really happens is that once electrons have been forced into higher energy levels, they will eventually drop back down. Some materials allow electrons to reach higher energy levels using photons of visible light, and also radiate the light back. In other materials, the electron reaches its natural level through a number of smaller, intermediate steps. This means that the light radiated by the atom will not be at the same frequency (i.e., colour), as when it was absorbed.
- Students may think fluorescent light bulbs do not generate heat. Fluorescent light bulbs transform about 80% of the energy put into them as heat. However, this is about 20 times more efficient than an incandescent bulb (in which most of the energy is released as heat, not light). Students may have noticed that outdoor bulbs have difficulty warming up in temperatures below −30°C.
- Some students link scientific terms to their common meaning. Remind them not to anthropomorphize. For example, "excited atoms" are not enthusiastic; their electrons have moved to a higher energy level.

Background Knowledge

This section is important not just to provide a basis for what light is, but also for the unit on climate change. Both rely on the difference between visible and longwave (infrared) radiation. There are two parts to this section, the part that discusses the generation of light, and the part that discusses the electromagnetic spectrum.

Our eyes interpret energy passing through the atmosphere from the Sun; the electromagnetic radiation called visible light. Other species have eyes that help them see other sorts of EM radiation. Deep-sea fish, for example, do not seem to see red light. In their environment, there is very little red light (except for what is produced by other species as shown in the *National Geographic* feature on page 408 of the student textbook). A more practical, if annoying, example is found in insects such as mosquitoes and horseflies, who can see just far enough into the infrared spectrum to detect the clouds of heat produced by people when they breathe. This allows them to hunt very successfully near dusk and dawn, when there is enough light to let them see inanimate obstacles such as trees, but not enough to impair their ability to see heat.

Literacy Support

Using the Text

- Have students form the framework for new learning by drawing a skeleton ray diagram to which they can add labels and notes as they complete the chapter.

Before Reading

- Have students read the statements on **BLM 10-1 Unit 4 Anticipation Guide,** indicating whether they agree or disagree. Then, have them browse the headings in this section, noting pages on which they might find facts and arguments to support (or refute) their point of view. Ask students to make notes to refer to later.
- Have students list sources of light and then find where these are referenced in Section 10.1.

During Reading

- As they read, students should jot notes related to each statement. Review their opinions when the section is complete. Have any changed? Were any put into question without being resolved?

After Reading

- Have students refer back to their notes on **BLM 10-1 Unit 4 Anticipation Guide.** Ask them if they have changed their opinions, and if so, why?

Using the Images

- As a class, examine the EM spectrum in Figure 10.11. Link the wavy line at the top to the analogies of size below the number line. For example, the 10^2 m wave is as long as a soccer field, and the 10^{-3} m wave is the actual size of the period mark shown. Have students individually locate the range of visible light. Ask what the triangle means (indicating an enlargement of that section). Are students surprised that everything they see lies within that tiny range of the spectrum? Identify the common name and range indicated by the shaded lines for each range of EM waves. As a class, suggest what each type does or is used for.

Assessment FOR Learning		
Tool	**Evidence of Student Understanding**	**Supporting Learning**
Learning Check questions, page 407	Students identify luminescence as light without heat.	Using a jigsaw format, have students complete **BLM 10-4 Sources of Light** to summarize qualities of different sources of light.
Section 10.1 Review questions 6–7, page 410	Students identify the range of visible light in the electromagnetic spectrum.	Review Figure 10.11 as a class, deciphering the features together. Select additional questions for practice and reinforcement from **BLM 10-5 Section 10.1 Review (Alternative Format).**

Instructional Strategies

- DI To help bodily-kinesthetic learners understand that a wide range of EM radiation is emitted by the Sun (not just light), have students place a hand on a sunny window. Do they feel the heat? Now, block the light with a blackout blind or other opaque material and place their hand against the blind. Do they see light? Do they feel heat? The blind blocks only a range of EM radiation, the heat still transmits.
- In a jigsaw or other group-learning format, have students complete **BLM 10-4 Sources of Light;** detecting and correcting each other's misconceptions.
- Survey the class for personal experiences with fluorescence. Some students may have the chance to use fluorescent detectors in checking for counterfeit money at their jobs. They may also have seen such devices on television crime dramas, where ultraviolet lights are used to detect presence of semen and blood. The *National Geographic* feature may remind students of bioluminescence they have seen in nature.

- To engage student interest, examine the bioluminescent marine organisms shown in the *National Geographic* feature (student textbook page 408) and show a video such as the *Blue Planet* episode "The Deep."
- To assess students' diagrams, use **BLM A-7 Scientific Drawing Checklist** or **BLM A-40 Scientific Drawing Rubric.**

Learning Check Answers (Student textbook page 407)

1. An excited atom means that an atom has absorbed some type of energy. Then, almost immediately, the excited atom releases the energy, which is often in the form of light.
2. Incandescence means light is emitted by a very hot object. Electrical energy heats and excites the atoms in the material, and light is emitted.
3. Students' drawings should be similar to Figure 10.5. Electrical energy excites mercury atoms in the gas in an electric discharge tube. Ultraviolet light is discharged, and this energy excites the atoms on the phosphor coating, which we can see as light.
4. Yes, as long as the organisms are not harmed. OR No, we should leave nature as is.

Section 10.1 Review Answers (Student textbook page 410)

Please also see **BLM 10-5 Section 10.1 Review (Alternative Format).**

1. Drawings should be similar to Figure 10.5: 1. Electrical energy causes electrons to be emitted from an electrode; 2. The electron collides with a mercury atom in the vapour and excites it; 3. The excited mercury atom emits ultraviolet light; 4. The phosphor in the inner surface of the bulb absorbs the ultraviolet light and becomes excited; 5. The phosphor releases its excess energy in the form of visible light.
2. Advantage: inexpensive, readily available; Disadvantage: use a lot of energy, burn out quickly
3. Venn diagrams should show luminescence as the type of light emission, and separate circles within for the types of luminescence. In fluorescence, the excited atom in the phosphor releases its energy as light immediately after it absorbed the energy from ultraviolet light. In phosphorescence, the excited phosphor retains the energy for a much longer time, sometimes for several hours, before releasing it as light.
4. Bioluminescence occurs inside living cells and requires an enzyme in order to proceed fast enough to make the light visible. Chemiluminescence occurs anywhere that certain chemicals are mixed.
5. Students' answers should focus on bioluminescence. The cells in a firefly's abdomen contain chemicals that mix with special chemicals that are released during courtship, and the flashes of light attract a mate.
6. Drawings should be similar to Figure 10.11, showing the number line, the names of the waves, and visible and invisible regions.
7. Short wavelengths appear on the right side of the number line, and have negative powers of ten. Some objects with short lengths include cells and molecules.
8. Answers will vary. Sample answer: Unhealthy tissue can be detected by bioluminescence that occurs during medical testing. Early detection of diseases such as cancer allow for more successful treatments.