Critical Thinking Items

15.1 The Electromagnetic Spectrum 8.

Standing in front of a fire, we can sense both its heat and its light. How are the light and heat radiated by the fire the same, and how are they different?

a. Both travel as waves, but only light waves are a form of electromagnetic radiation.
b. Heat and light are both forms of electromagnetic radiation, but light waves have higher frequencies.
c. Heat and light are both forms of electromagnetic radiation, but heat waves have higher frequencies.
d. Heat and light are both forms of electromagnetic radiation, but light waves have higher wavelengths.

9.

Light shines on a picture of the subtractive color wheel. The light is a mixture of red, blue, and green light.
Part A—Which part of the color wheel will look blue? Explain in terms of absorbed and reflected light.
Part B—Which part of the color wheel will look yellow? Explain in terms of absorbed and reflected light.

a. A. The yellow section of the wheel will look blue because it will reflect blue light and absorb red and green.
   B. The blue section of the wheel will look yellow because it will reflect red and green light and absorb blue.
b. A. The blue section of the wheel will look blue because it will absorb blue light and reflect red and green.
   B. The yellow section of the wheel will look yellow because it will absorb red and green light and reflect blue.
c. A. The yellow section of the wheel will look blue because it will absorb blue light and reflect red and green.
   B. The blue section of the wheel will look yellow because it will absorb red and green light and reflect blue.
d. A. The blue section of the wheel will look blue because it will reflect blue light and absorb red and green.
   B. The yellow section of the wheel will look yellow because it will reflect red and green light and absorb blue.

10.

Part A. When you stand in front of an open fire, you can sense light waves with your eyes. You sense another type of electromagnetic radiation as heat. What is this other type of radiation?
Part B. How is this other type of radiation different front light waves?

a. A. X-rays

B. The X-rays have higher frequencies and shorter wavelengths than the light waves.

b. A. X-rays
B. The X-rays have lower frequencies and longer wavelengths than the light waves.

c. A. infrared rays
B. The infrared rays have higher frequencies and shorter wavelengths than the light waves.

d. A. infrared rays
B. The infrared rays have lower frequencies and longer wavelengths than the light waves.

11.

Overexposure to this range of EM radiation is dangerous, and yet it is used by doctors to diagnose medical problems.
Part A—Identify the type of radiation.
Part B—Locate the position of this radiation on the EM spectrum by comparing its frequency and wavelength to visible light.
Part C—Explain why this radiation is both dangerous and therapeutic in terms of its energy, based on your answer to Part B.

a. A. X-rays
B. X-rays have shorter wavelengths (1×10^{-8} – 5×10^{-12} m) and higher frequencies (3×10^{16} – 6×10^{19} Hz) than visible light (7.5×10^{-7} – 4.0×10^{-7} m; 4.0×10^{14} – 7.5×10^{14} Hz).
C. X-rays have low energies because of their high frequencies, and so can penetrate matter to greater depths.

b. A. X-rays
B. X-rays have shorter wavelengths (1×10^{-8} – 5×10^{-12} m) and higher frequencies (3×10^{10} – 6×10^{13} Hz) than visible light (7.5×10^{-7} – 4.0×10^{-7} m; 4.0×10^{14} – 7.5×10^{14} Hz).
C. X-rays have low energies because of their low frequencies, and so can penetrate matter to greater depths.

c. A. X-rays B. X-rays have longer wavelengths (1×10^{-6} – 5×10^{-7} m) and higher frequencies (3×10^{15} – 6×10^{15} Hz) than visible light (7.5×10^{-7} – 4.0×10^{-7} m; 4.0×10^{14} – 7.5×10^{14} Hz).
C. X-rays have high energies because of their high frequencies, and therefore can penetrate matter to greater depths.

d. A. X-rays
B. X-rays have shorter wavelengths (1×10^{-8} – 5×10^{-12} m) and higher frequencies (3×10^{16} – 6×10^{19} Hz) than visible light (7.5×10^{-7} – 4.0×10^{-7} m; 4.0×10^{14} – 7.5×10^{14} Hz).
C. X-rays have high energies because of their high frequencies, and so can penetrate matter to greater depths.

15.2 The Behavior of Electromagnetic Radiation 12.

Explain how thin-film interference occurs. Discuss in terms of the meaning of interference and the pathways of light waves.

a. For a particular thickness of film, light of a given wavelength that reflects from the outer and inner film surfaces is completely in phase, and so undergoes constructive interference.
b. For a particular thickness of film, light of a given wavelength that reflects from the outer and inner surfaces is completely in phase, and so undergoes destructive interference.
c. For a particular thickness of film, light of a given wavelength that reflects from the outer and inner film surfaces is completely out of phase, and so undergoes constructive interference.
d. For a particular thickness of film, light of a given wavelength that reflects from the outer and inner film surfaces is completely out of phase, and so undergoes no interference.

13.

When you move a rope up and down, waves are created. If the waves pass through a slot, they will be affected differently, depending on the orientation of the slot. Using the rope waves and the slot as a model, explain how polarizing glasses affect light waves.

a. If the wave—electric field—is vertical and slit—polarizing molecules in the glass—is horizontal, the wave will pass.
b. If the wave—electric field— is vertical and slit—polarizing molecules in the glass—is vertical, the wave will not pass.
c. If the wave—electric field—is horizontal and slit—polarizing molecules in the glass—is horizontal, the wave will pass.
d. If the wave—electric field—is horizontal and slit—polarizing molecules in the glass—is horizontal, the wave will not pass.