

Answers to Period 2 Exercises

E.1 Which of the following does NOT make use of wave motion?

- a) A bowling ball strikes a bowling pin.
- b) A radio plays music transmitted from a radio station.
- c) A microwave oven heats a slice of pizza.
- d) Jane is reading by the light of an incandescent lamp.
- e) A tennis ball floating on the river bobs up and down as a boat passes by.

E.1 = a

E.2 Each of the following travels, in a vacuum, at the speed of light except

- a) radio waves
- b) sound waves
- c) X-rays
- d) infrared rays
- e) All of the above travel at the speed of light.

All forms of electromagnetic radiation travel at 3×10^8 meters/second in a vacuum. Sound waves travel only about one-millionth as fast as radiation waves.

E.2 = b

E.3 Estimate the wavelength of a 1500 Hz sound wave. What would be the wavelength of an electromagnetic wave of the same frequency?

- a) 0.23 m; 5×10^{-6} m
- b) 0.23 m; 2×10^5 m
- c) 4.4 m; 5×10^{-6} m
- d) 4.4 m; 2×10^5 m
- e) 8.8 m; 6.2×10^5 m

$$s = fL, \text{ so } L = s/f$$

approximate speed of a sound wave = 340 m/s

$$L = \frac{340 \text{ m/s}}{1,500 \text{ 1/s}} = 0.23 \text{ m}$$

speed of electromagnetic wave = 3×10^8 m/s

$$L = \frac{3 \times 10^8 \text{ m/s}}{1.5 \times 10^3 \text{ 1/s}} = 2 \times 10^5 \text{ m}$$

E.3 = b

E.4 The index of refraction of a piece of glass is 1.5. What is the speed of the photons of light in this glass?

- a) 2×10^8 m/s
- b) 3×10^8 m/s
- c) 4.5×10^8 m/s
- d) The speed depends on the period of the electromagnetic wave.
- e) The speed depends on the frequency of the wave.

index of refraction = $n = \frac{\text{speed of light in vacuum}}{\text{speed of light in material}}$

speed of light in glass = $\frac{3 \times 10^8 \text{ m/s}}{1.5} = 2 \times 10^8 \text{ m/s}$

E.4 = a

E.5 How many photons of wavelength 6×10^{-5} meters are required to produce electromagnetic radiation with 3.32×10^{-15} joules of energy?

- a) 1×10^{-6} photons
- b) 1×10^3 photons
- c) 1×10^6 photons
- d) 5×10^6 photons
- e) 1×10^{14} photons

Find the energy of one photon using $E = hc/L$

$$E = \frac{(6.63 \times 10^{-34} \text{ J}\cdot\text{s}) \times (3 \times 10^8 \text{ m/s})}{6 \times 10^{-5} \text{ m}} =$$

$$E = 3.32 \times 10^{-21} \text{ J per photon.}$$

Use ratios to find the number of photons needed.

$$\frac{1 \text{ photon}}{3.32 \times 10^{-21} \text{ J}} \times 3.32 \times 10^{-15} \text{ J} = 1 \times 10^6 \text{ photons}$$

E.5 = c

E.6 Which of the following statements about infrared radiation and ultraviolet radiation is TRUE?

- a) Energy can be transferred by infrared radiation but not by ultraviolet radiation.
- b) The sun emits infrared radiation but not ultraviolet radiation.
- c) An ultraviolet photon carries more radiant energy than an infrared photon.
- d) Ultraviolet radiation has a longer wavelength than infrared radiation.
- e) In vacuum, ultraviolet radiation travels at a greater speed than infrared radiation.

E.6 = c

E.7 If a solar cell produces electricity when illuminated with green light, identify all of the following types of radiation that will definitely produce electricity using the same cell. How can you tell?

- a) red light
- b) blue light
- c) ultraviolet light
- d) radio waves
- e) infrared radiation

Blue light and ultraviolet light will produce electricity in this solar cell because these forms of electromagnetic radiation have more energy per photon than green light.

E.7 = b and c

Period 2 Answers

E.1 = a

E.2 = b

E.3 = b

E.4 = a

E.5 = c

E.6 = c

E.7 = b and c