Period 3 Exercise Answers

E.1 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

Photons with more energy (shorter wavelength) than green light could produce energy from the solar cell.

E.1 = b and c

E.2 The part of the electromagnetic spectrum that causes tanning is

a) the infrared.  
b) the ultraviolet.  
c) the yellow end of the visible spectrum.  
d) radio waves.  
e) All of the above cause tanning.

E.2 = b
E.3 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.3 = c
E.4 A signal with an average energy of 4,000 joules has a signal-to-noise ratio of 200. The average energy of the noise is then reduced so that it is 4 times smaller. What is the new signal-to-noise ratio?

a) 20  
b) 50  
c) 200  
d) 800  
e) 1,000

Using ratio reasoning: If we decrease the noise by \( \frac{1}{4} \), then the SNR is 4 times larger. The SNR is now \( 4 \times 200 = 800 \).

Using the equation:

\[
\text{SNR} = \frac{\text{average energy in the signal}}{\text{average energy in the noise}}
\]

\[
\text{noise} = \frac{\text{signal}}{\text{SNR}} = \frac{4,000 \text{ J}}{200} = 20 \text{ J}
\]

making the noise 4 times smaller = \( \frac{1}{4} (20 \text{ J}) = 5 \text{ J} \)

\[
\text{SNR} = \frac{4,000 \text{ J}}{5 \text{ J}} = 800
\]

E.4 = d
In broadcasting, the term “carrier wave” refers to the sine wave being sent out from a radio station at its operating frequency. Which of the following techniques could be used to encode a signal on a carrier wave?

a) modulation of the amplitude of the carrier wave

b) modulation of the frequency of the carrier wave

c) modulation of the speed of the carrier wave

d) Either a) and b) could be used to encode a signal.

e) All of the above techniques could be used to encode a signal.

Carrier waves are waves of electromagnetic radiation that travel at the same speed \((3 \times 10^8 \text{ m/ s or } 186,000 \text{ miles/ s})\).

\[E.5 = d\]
E.6 A radio station broadcasts at a frequency of 105.7 megahertz (MHz). What is the wavelength of the station’s carrier wave?

a) 0.35 meters  
b) 2.8 meters  
c) 5.6 meters  
d) 28 meters  
e) 105.7 meters

\[ L = \frac{s}{f} = \frac{3 \times 10^8 \text{ m/s}}{105.7 \times 10^6 \text{ 1/s}} = \frac{3 \times 10^8 \text{ m/s}}{1.057 \times 10^8 \text{ 1/s}} = 2.8 \text{ m} \]

E.6 = b
E.7 You are attending a concert and have a seat at the back of the auditorium. Your friend is listing to the same concert on her radio at home, 50 miles from the concert hall. If there is no delay in the broadcast of the concert, who do you think hears the sound first?

Find the time for the radio waves to travel 50 miles. Speed of radio waves = $3 \times 10^8$ m/s or 186,000 miles/s.

\[
S = D \quad \text{or} \quad t = \frac{D}{S} = \frac{50 \text{ miles}}{186,000 \text{ miles/s}} = 0.00027 \text{ s}
\]

Find the time for the sound waves to travel the distance across an auditorium. Speed of sound waves is 340 m/s. The sound waves could travel 50 meters in a large auditorium.

\[
t = \frac{D}{S} = \frac{50 \text{ meters}}{340 \text{ meters/s}} = 0.15 \text{ s}
\]
Period 3 Exercise Answers

E.1 = b and c

E.2 = b

E.3 = c

E.4 = d

E.5 = d

E.6 = b

E.7 = your friend at home