Cutnell/Johnson
Physics 7th edition

Classroom Response System Questions

Chapter 33 Electromagnetic Waves

Reading Quiz Questions
33.2.1. Which one of the following statements concerning electromagnetic waves is false?

a) One form of electromagnetic radiation is visible light.

b) All electromagnetic waves travel through a vacuum region at the speed of light.

c) All electromagnetic waves are transverse waves.

d) All electromagnetic waves have the same frequency.

e) Electromagnetic waves can travel through solids, liquids, gases, and vacuum regions.
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**d) All electromagnetic waves have the same frequency.**

e) Electromagnetic waves can travel through solids, liquids, gases, and vacuum regions.
33.2.2. Which scientist is credited with showing that electric and magnetic fields can fluctuate together to form a propagating electromagnetic wave?

a) Maxwell

b) Bose

c) Huygens

d) Crick

e) Watson
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33.2.3. Which of the following types of waves is not part of the electromagnetic spectrum?

a) microwaves

b) gamma rays

c) ultraviolet radiation

d) radio waves

e) sound waves
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e) sound waves
33.3.1. One type of antenna can be made that is composed of two straight wires connected to an ac generator. Which one of the following statements concerning this type of antenna and electromagnetic waves is false?

a) As the potential difference at the terminals varies sinusoidally, electrons move between the ends of the wires.

b) When one of the wires has a net positive charge, the other wire has a net negative charge.

c) The generator continually injects electrons into the wires.

d) The electric field and magnetic field vectors of the electromagnetic waves generated are perpendicular to each other when they are far from the antenna.

e) At each position far from the antenna, the amplitude of the electric and magnetic fields is the same.
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33.3.2. What is the speed of light in a vacuum?

a) 300 000 000 m/s

b) 299 792 458 m/s

c) 274 584 211 m/s

d) 268 078 972 m/s

e) 219 424 557 m/s
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33.3.3. Complete the following statement: The speed of light in a vacuum is

a) larger for short wavelength electromagnetic waves.

b) larger for higher energy electromagnetic waves.

c) smaller for higher energy electromagnetic waves.

d) a constant value everywhere in the universe.

e) larger for higher frequency electromagnetic waves.
33.3.3. Complete the following statement: The speed of light in a vacuum is

a) larger for short wavelength electromagnetic waves.

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33.5.1. Complete the following statement: The energy carried by an electromagnetic wave is

a) carried only by the electric field.

b) carried only by the magnetic field.

c) too small to have any practical application.

d) carried by both the electric and magnetic fields.

e) larger for infrared radiation than it is for gamma radiation.
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33.5.2. Which one of the following expressions gives the correct relationship between the magnitudes of the electric and magnetic fields of an electromagnetic wave?

a) \( E = B \)

b) \( B = cE \)

c) \( E = cB \)

d) \( B^2 = \mu_0 E \)

e) \( E = \mu_0 B \)
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33.5.3. What are the units of light intensity?

a) watts/meter\(^2\) (W/m\(^2\))

b) joules/meter\(^2\) (J/m\(^2\))

c) newtons/coulomb (N/C)

d) tesla/meter\(^3\) (T/m\(^3\))

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e) joules/meter$^3$ ($J/m^3$)
33.5.4. What does the Poynting vector at a given point describe?

a) the direction of the electric field

b) the direction of the magnetic field

c) the direction the wave is traveling

d) the direction in which energy is transported

e) Both (c) and (d) are correct.
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33.5.5. What units are associated with the Poynting vector?

a) J/m

b) J/s

c) N/m²

d) W/m²

e) W/s
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b) J/s

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e) W/s
33.6.1. Electromagnetic waves have linear momentum as well as energy. What does this imply about electromagnetic waves?

a) Electromagnetic waves must have mass.

b) Electromagnetic waves can interact with each other.

c) Electromagnetic waves can exert pressure on an object.

d) Electromagnetic waves have inertia.

e) Electromagnetic waves are the same as sound waves.
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a) Electromagnetic waves must have mass.

b) Electromagnetic waves can interact with each other.

c) Electromagnetic waves can exert pressure on an object.

d) Electromagnetic waves have inertia.

e) Electromagnetic waves are the same as sound waves.
33.6.2. In which one of the following cases does the radiation pressure have the largest value?

a) Electromagnetic waves are directed toward a transparent object and transmitted through it.

b) All of the electromagnetic waves directed toward an object are absorbed by it.

c) All of the electromagnetic waves directed toward an object are reflected by it.

d) One half of the electromagnetic waves directed toward an object are absorbed by it and the other half are reflected by it.
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d) One half of the electromagnetic waves directed toward an object are absorbed by it and the other half are reflected by it.
33.7.1. Complete the following statement: The polarization direction of an electromagnetic wave is determined by

a) the direction the wave is traveling.

b) the frequency of the electromagnetic radiation.

c) the direction of the magnetic field component.

d) the wavelength of the electromagnetic radiation.

e) the direction of the electric field component.
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a) the direction the wave is traveling.

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c) the direction of the magnetic field component.

d) the wavelength of the electromagnetic radiation.

e) the direction of the electric field component.
33.7.2. When unpolarized light is incident on a sheet of polarizing material with a transmission axis oriented vertically, what percentage of the light is transmitted through the material?

a) ten percent

b) twenty-five percent

c) fifty percent

d) seventy-five percent

e) zero percent
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a) ten percent

b) twenty-five percent

c) fifty percent

d) seventy-five percent

e) zero percent
33.7.3. When vertically polarized light is incident on a sheet of polarizing material with a transmission axis oriented vertically, what percentage of the light is transmitted through the material?

a) ten percent

b) twenty-five percent

c) fifty percent

d) seventy-five percent

e) one hundred percent
33.7.3. When vertically polarized light is incident on a sheet of polarizing material with a transmission axis oriented vertically, what percentage of the light is transmitted through the material?

a) ten percent

b) twenty-five percent

c) fifty percent

d) seventy-five percent

e) one hundred percent
33.7.4. When horizontally polarized light is incident on a sheet of polarizing material with a transmission axis oriented vertically, what percentage of the light is transmitted through the material?

a) ten percent
b) twenty-five percent
c) fifty percent
d) seventy-five percent
e) zero percent
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a) ten percent

b) twenty-five percent

c) fifty percent

d) seventy-five percent

e) zero percent
33.7.5. What is the name for the principle or law that allows one to determine the average intensity of polarized light that will be transmitted through a sheet of polarizing material?

a) Lenz’s law

b) Feynmann’s principle

c) Morley principle

d) cosine-squared rule

e) law of polarization
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d) cosine-squared rule

e) law of polarization
33.8.1. Which one of the following statements relating to index of refraction $n$ is false?

a) Values of $n$ are always greater than or equal to one.

b) The speed of light in gases is only slightly less than that in a vacuum.

c) The index of refraction tends to be larger for solids than for gases.

d) Values of $n$ for solids and liquids indicate that the speed of light in these substances is greater than that in gases.

e) The index of refraction is an important parameter in Snell’s law of refraction.
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d) Values of \( n \) for solids and liquids indicate that the speed of light in these substances is greater than that in gases.

e) The index of refraction is an important parameter in Snell’s law of refraction.
33.8.2. A ray of light travels through air toward a glass block with an index of refraction $n = 1.5$ at an angle $\theta_1$ as shown. Which of the rays shown is the most likely for the refracted ray?

a) A  

b) B  

c) C  

d) D  

e) E
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a) A

b) B

c) C

d) D

e) E
33.8.3. Which one of the following statements concerning Snell’s law of refraction is false?

a) Incident and refracted rays obey the principle of reversibility.

b) When light travel from a medium of higher index of refraction into a medium of lower index, the ray bends away from the normal.

c) Dutch mathematician Willebrord Snell discovered the law of refraction by doing experiments.

d) When using Snell’s law, the subscript “1” applies to the medium of the incident ray.

e) The angle of refraction equals the sum of the angle of incidence and the angle of reflection.
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e) The angle of refraction equals the sum of the angle of incidence and the angle of reflection.
33.8.4. A ray of monochromatic light traveling through the air is incident on the surface of a crown glass block at an angle of 45°. Assuming the monochromatic light is one of the colors below, which one would have the smallest angle of refraction?

a) red
b) orange
c) yellow
d) green
e) violet
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a) red

b) orange

c) yellow

d) green

e) violet
33.8.5. Which one of the following statements concerning the formation of a rainbow is true?

a) An observer can see a rainbow if the sun is on the opposite side of water droplets in the atmosphere.

b) A rainbow may be observed when the sky is completely overcast and the sun is not directly visible.

c) Since violet light is bent most in a water drop, violet appears at the top of the rainbow.

d) Only seven colors are visible in a rainbow.

e) The different colors seen in a rainbow originate from water droplets at different angles of elevation.
33.8.5. Which one of the following statements concerning the formation of a rainbow is true?

a) An observer can see a rainbow if the sun is on the opposite side of water droplets in the atmosphere.

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33.8.6. When does dispersion occur?

a) the index of refraction varies with the wavelength of light

b) the incident angle is equal to the Brewster angle

c) total internal reflection occurs at the surface

d) the principal of reversibility is violated

e) when the incident ray is polarized
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c) total internal reflection occurs at the surface

d) the principal of reversibility is violated

e) when the incident ray is polarized
33.8.7. Which one of the following sentences best describes the term *refraction*?

a) Light is reflected at the interface between two transparent media.

b) The angle of incidence does not equal the angle of reflection at the interface between two materials.

c) Light is divided along two paths at an interface between two materials.

d) The direction of light is along a straight line as it passes from one material into another, regardless of the angle of incidence.

e) Light travels through the boundary of two different materials.
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e) Light travels through the boundary of two different materials.
33.9.1. What is the angle of refraction when the angle of incidence is equal to the critical angle?

a) zero degrees

b) thirty degrees

c) forty-five degrees

d) ninety degrees

e) It depends on the index of refraction.
33.9.1. What is the angle of refraction when the angle of incidence is equal to the critical angle?

a) zero degrees

b) thirty degrees

c) forty-five degrees

d) ninety degrees

e) It depends on the index of refraction.
33.9.2. In which one of the following cases will total internal reflection occur?

a) Light is traveling in a material that has a smaller index of refraction than material surrounding it.

b) Light is traveling in a material that has a larger index of refraction than material surrounding it.

c) Light is traveling from a material that has a larger index of refraction into a material that has a smaller index of refraction.

d) Light is traveling through a material with a high degree of chromatic dispersion.
33.9.2. In which one of the following cases will total internal reflection occur?

a) Light is traveling in a material that has a smaller index of refraction than material surrounding it.

b) Light is traveling in a material that has a larger index of refraction than material surrounding it.

c) Light is traveling from a material that has a larger index of refraction into a material that has a smaller index of refraction.

d) Light is traveling through a material with a high degree of chromatic dispersion.
33.10.1. What name is given to the angle of incidence of unpolarized light at which reflected light is completely polarized parallel to the surface and the refracted ray is partially polarized?

a) Critical angle

b) Snell’s angle

c) Brewster angle

d) angle of polarization

e) Newton angle
33.10.1. What name is given to the angle of incidence of unpolarized light at which reflected light is completely polarized parallel to the surface and the refracted ray is partially polarized?

a) Critical angle

b) Snell’s angle

c) Brewster angle

d) angle of polarization

e) Newton angle
33.10.2. Which one of the following expressions is Brewster’s law?

a) \( \sin \theta_B = \frac{n_1}{n_2} \)

b) \( \tan \theta_B = \frac{n_2}{n_1} \)

c) \( \cos \theta_B = n_1 n_2 \)

d) \( \tan \theta_B = n_1 n_2 \)

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