Halliday, Resnick, and Walker, *Fundamentals of Physics 10e* Question Answers

Chapter 33 Answers

1	(a) positive direction of z; (b) x
2	c
3	(a) same; (b) increase; (c) decrease
4	into
5	(a) and (b) $A = 1$, $n = 4$, $\theta = 30°$
6	20° and 90°
7	a, b, c
8	b 30°; c 60°; d 60°; e 30°; f 60°
9	B
10	n_3, n_2, n_1
11	none
12	d, b, a, c

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Halliday/Resnick/Walker Fundamentals of Physics

Classroom Response System Questions

Chapter 33 Electromagnetic Waves

Reading Quiz Questions

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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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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

WILEY

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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

WILEY

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WILEY

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.

WILEY

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WILEY

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

WILEY

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WILEY

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.

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WILEY

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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WILEY

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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WILEY

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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WILEY

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.

WILEY

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WILEY

33.5.5. What units are associated with the Poynting vector?

a) J/m

b) J/s

c) N/m^2

d) W/m^2

e) W/s

WILEY

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b) J/s

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WILEY

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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WILEY

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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WILEY

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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WILEY

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

WILEY

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WILEY

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

WILEY

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b) twenty-five percent

c) fifty percent

d) seventy-five percent

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WILEY

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

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c) fifty percent

d) seventy-five percent

e) zero percent

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WILEY

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

WILEY

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WILEY

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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WILEY

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 θ_1 as shown. Which of the rays shown is the most likely for the refracted ray?

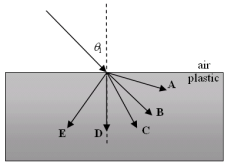
a) A

b) B

c) C

d) D

e) E



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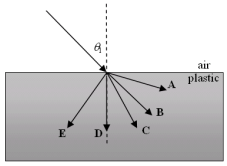

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33.8.3. Which one of the following statements concerning Snell's law of refraction is false?

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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WILEY

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

WILEY

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d) green

e) violet

WILEY

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.

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WILEY

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

WILEY

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WILEY

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.

WILEY

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WILEY

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.

WILEY

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d) ninety degrees

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WILEY

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.

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WILEY

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

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WILEY

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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Halliday/Resnick/Walker Fundamentals of Physics

Classroom Response System Questions

Chapter 33 Electromagnetic Waves

Interactive Lecture Questions

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33.2.1. Consider the region of space that you are occupying. Which of the following types of electromagnetic waves are present around you?

a) visible light waves

b) radio waves

c) microwaves

d) infrared waves

e) all of the above

WILEY

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33.2.2. For which one of the following properties do visible light and ultraviolet waves have the same value?

a) wavelength

b) frequency

c) speed

d) energy

e) period

WILEY

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a) wavelength

b) frequency

c) speed

d) energy

e) period

WILEY

33.2.3. What is the correct order, beginning with longest wavelength and extending to the shortest wavelength, of the following colors in the visible light spectrum: blue, green, red, violet, and yellow?

a) red, yellow, green, blue, violet

b) violet, blue, green, yellow, red

c) red, blue, violet, green, yellow

d) red, yellow, blue, green, violet

e) violet, blue, yellow, red, green

WILEY

33.2.3. What is the correct order, beginning with longest wavelength and extending to the shortest wavelength, of the following colors in the visible light spectrum: blue, green, red, violet, and yellow?

a) red, yellow, green, blue, violet

b) violet, blue, green, yellow, red

c) red, blue, violet, green, yellow

d) red, yellow, blue, green, violet

e) violet, blue, yellow, red, green

WILEY

33.3.1. At a point far from an antenna, the electric field of a radio wave is directed in the positive *y* direction as the wave travels in the negative *x* direction. Which one of the following statements correctly describes the magnetic field component of the wave at that same location?

a) The magnetic field component is out of phase with the electric field component and it is directed in the positive *z* direction.

b) The magnetic field component is in phase with the electric field component and it is directed in the positive *z* direction.

c) The magnetic field component is out of phase with the electric field component and it is directed in the negative *z* direction.

d) The magnetic field component is in phase with the electric field component and it is directed in the negative *z* direction.

e) The magnetic field component is out of phase with the electric field component and it is directed in the negative *y* direction.

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d) The magnetic field component is in phase with the electric field component and it is directed in the negative *z* direction.

e) The magnetic field component is out of phase with the electric field component and it is directed in the negative *y* direction.

WILEY

33.3.2. About how many times faster is the speed of light when compared to the speed of sound?

a) 100 times faster

b) 1000 times faster

c) 10 000 times faster

d) 100 000 times faster

e) 1 000 000 times faster

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WILEY

33.3.3. In 1667, Galileo attempted to measure the speed of light by having two people hold covered lanterns on hills that were about 1.5 km apart. One person would measure time. One of the people with a lantern would uncover it. The other person would then uncover his lantern when he saw the light from the first lantern. Repeated attempts failed. To see why, determine the approximate time it takes light to travel the 1.5 km distance.

a) 5 μs

b) 50 μs

c) 5 ms

d) 50 ns

e) 5 ns

WILEY

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a) 5 μs

b) 50 μs

c) 5 ms

d) 50 ns

e) 5 ns

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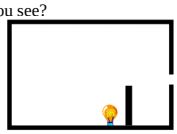
33.3.4. You are standing on the right side of a closed opaque box. There is a hole through which you can look inside. The drawing shows a small light bulb inside that is on. There is also a wall inside the box as shown. All of the surfaces of the box are rough surfaces that are painted black. As you look through the hole, what can you see?



a) a bright beam of light from the bulb

b) the light bulb

c) the walls will appear to be the same color as the light bulb

d) the black walls of the box

e) nothing

WILEY

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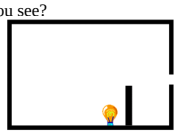

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d) the black walls of the box

e) nothing

WILEY

33.5.1. Monochromatic electromagnetic radiation illuminates an area of a surface. The electric and magnetic fields of the waves are then doubled in magnitude. How is the total energy incident on the surface per unit time affected by this increase in the electric and magnetic fields?

a) The total energy is not affected by this change.

b) The total energy will increase by a factor of two.

c) The total energy will increase by a factor of four.

d) The total energy will decrease by a factor of two.

e) The total energy will decrease by a factor of four.

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a) The total energy is not affected by this change.

b) The total energy will increase by a factor of two.

c) The total energy will increase by a factor of four.

d) The total energy will decrease by a factor of two.

e) The total energy will decrease by a factor of four.

WILEY

33.5.2. The amplitude of the magnetic field component of electromagnetic wave "one" is B. If the amplitude for wave "two" is $2B$, how does the intensity of wave two compare to that of wave one?

a) The intensity of wave two is four times larger than that of wave one.

b) The intensity of wave two is two times larger than that of wave one.

c) The intensity of wave two is the same as that of wave one.

d) The intensity of wave two is one half that of wave one.

e) The intensity of wave two is one fourth that of wave one.

WILEY

33.5.2. The amplitude of the magnetic field component of electromagnetic wave "one" is B. If the amplitude for wave "two" is $2B$, how does the intensity of wave two compare to that of wave one?

a) The intensity of wave two is four times larger than that of wave one.

b) The intensity of wave two is two times larger than that of wave one.

c) The intensity of wave two is the same as that of wave one.

d) The intensity of wave two is one half that of wave one.

e) The intensity of wave two is one fourth that of wave one.

WILEY

33.5.3. The intensity of electromagnetic wave A is one fourth that of wave B. How does the magnitude of the electric field of wave A compare to that of wave B?

a) The electric field amplitude of wave A is one fourth that of wave B.

b) The electric field amplitude of wave A is one half that of wave B.

c) The electric field amplitude of wave A is one half that of wave B.

d) The electric field amplitude of wave A is two times that of wave B.

e) The electric field amplitude of wave A is four times that of wave B.

WILEY

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e) The electric field amplitude of wave A is four times that of wave B.

WILEY

33.5.4. A laser beam has an intensity of 120 W/m^2. What is the magnitude of the magnetic field component of the electromagnetic waves emitted by this laser?

a) 2.2×10^9 T

b) 4.2×10^6 T

c) 4.5×10^4 T

d) 1200 T

e) 210 T

WILEY

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c) 4.5×10^4 T

d) 1200 T

e) 210 T

WILEY

33.5.5. How does the energy associated with the magnetic field of an electromagnetic wave compare to the energy associated with the electric field?

a) All of the energy is carried by the magnetic field component of an electromagnetic wave.

b) One-half of the energy is carried by the magnetic field component of an electromagnetic wave.

c) None of the energy is carried by the magnetic field component of an electromagnetic wave.

d) The energy carried by the magnetic field is a factor of *c* times larger than that carried by the electric field.

e) The energy carried by the magnetic field is a factor of *c* times smaller than that carried by the electric field

WILEY

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e) The energy carried by the magnetic field is a factor of *c* times smaller than that carried by the electric field

WILEY

33.6.1. In which of the following cases is the largest force exerted on an object by electromagnetic radiation?

a) The radiation is absorbed by the object.

b) Nearly all of the radiation is transmitted through the object because it is transparent.

c) The radiation strikes the surface at a large angle with respect to the normal to the surface.

d) The radiation is reflected back along its incident path.

e) In all of the above cases the force will be the same since it is the same light striking the object.

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WILEY

33.7.1. Unpolarized light with intensity *S* is incident on a series of polarizing sheets. The first sheet has its transmission axis oriented at 0°. A second polarizer has its transmission axis oriented at 45° and a third polarizer oriented with its axis at 90°. Determine the fraction of light intensity exiting the third sheet with and without the second sheet present.

a) 0.5*S*, *S*

b) 0.5*S*, zero

c) 0.25*S*, zero

d) 0.25*S*, 0.5*S*

e) *S*, 0.5*S*

WILEY

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b) 0.5*S*, zero

c) 0.25*S*, zero

d) 0.25*S*, 0.5*S*

e) *S*, 0.5*S*

WILEY

33.7.2. Horizontally polarized light of intensity S is incident on a polarizer with its transmission axis oriented at 45°. Determine the fraction of light intensity exiting the polarizer.

a) zero

b) 0.25S

c) 0.5S

d) 0.71S

e) S

WILEY

33.7.2. Horizontally polarized light of intensity S is incident on a polarizer with its transmission axis oriented at 45°. Determine the fraction of light intensity exiting the polarizer.

a) zero

b) 0.25S

c) 0.5S

d) 0.71S

e) S

WILEY

33.7.3. Unpolarized light of intensity S is directed toward three polarizing sheets. The first sheet is polarized vertically; and the last sheet is oriented horizontally. If the middle sheet is also oriented vertically, what is the intensity of the light exiting the last polarizer?

a) zero

b) 0.25S

c) 0.5S

d) 0.71S

e) S

WILEY

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a) zero

b) 0.25S

c) 0.5S

d) 0.71S

e) S

WILEY

33.8.1. Which one of the following statements most closely describes how humans see objects?

a) Light rays leave the eye, shine on an object, and are reflected back to the eye.

b) All objects are sources of visible light and the eye is sensitive to that light.

c) All objects are seen when visible light is scattered from them and into the eye.

d) Some objects are sources of visible light and others are seen when visible light is scattered from them.

e) The human eye is sensitive to all types of electromagnetic waves that are emitted from all objects.

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e) The human eye is sensitive to all types of electromagnetic waves that are emitted from all objects.

WILEY

33.8.2. You are talking with a friend in a closed room that has no windows, no objects, and no furniture. The only thing in the room is an overhead incandescent light that is turned on. You are looking at your friend and begin thinking about whether you are seeing your friend as a result of reflection. Does reflection play a role in seeing your friend?

a) No, the room is just illuminated by the overhead light.

b) No, visible light is emitted by my friend and enters my eye.

c) Yes, the visible light from the overhead light bulb is specularly reflected (like from a mirror) from my friend and enters my eye.

d) Yes, the visible light from the overhead light bulb is diffusely reflected (not like a mirror) from my friend and enters my eye.

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d) Yes, the visible light from the overhead light bulb is diffusely reflected (not like a mirror) from my friend and enters my eye.

WILEY

33.8.3. In which of the following cases, if any, does the angle of reflection not equal the angle of incidence?

a) Light travels from a material with a lower index of refraction and reflects from the interface with a material of higher index of refraction.

b) Light travels from a material with a higher index of refraction and reflects from the interface with a material of lower index of refraction.

c) None of the light incident on a surface is refracted into the material.

d) Most, but not all, of the light incident on a surface is refracted into the material.

e) In all of the above cases, the angle of reflection will equal the angle of incidence.

WILEY

33.8.3. In which of the following cases, if any, does the angle of reflection not equal the angle of incidence?

a) Light travels from a material with a lower index of refraction and reflects from the interface with a material of higher index of refraction.

b) Light travels from a material with a higher index of refraction and reflects from the interface with a material of lower index of refraction.

c) None of the light incident on a surface is refracted into the material.

d) Most, but not all, of the light incident on a surface is refracted into the material.

e) In all of the above cases, the angle of reflection will equal the angle of incidence.

WILEY

33.8.4. Is light bent more, less, or not at all when entering a medium with a larger index of refraction than that of the incident medium?

a) more

b) less

c) not at all

WILEY

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a) more

b) less

c) not at all

WILEY

33.8.5. Is light bent more, less, or not at all when entering a medium with a smaller index of refraction than that of the incident medium?

a) more

b) less

c) not at all

WILEY

33.8.5. Is light bent more, less, or not at all when entering a medium with a smaller index of refraction than that of the incident medium?

a) more

b) less

c) not at all

WILEY

33.8.6. Complete the following statement: Chromatic dispersion occurs in some materials because different wavelengths of light

a) propagate at different speeds.

b) are reflected at different angles.

c) are transmitted in differing amounts.

d) have differing indices of refraction.

e) Two of the above answers are correct.

WILEY

33.8.6. Complete the following statement: Chromatic dispersion occurs in some materials because different wavelengths of light

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b) are reflected at different angles.

c) are transmitted in differing amounts.

d) have differing indices of refraction.

e) Two of the above answers are correct.

WILEY

33.8.7. Which of the following is an example of chromatic dispersion?

a) A rainbow seems to connect two mountain peaks.

b) A magnifying glass is used to focus light to start a fire.

c) A spoon in a glass of water looks bent.

d) Snell's law is a direct result from chromatic dispersion.

e) Laser light is used to accurately cut parts for an automobile.

WILEY

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e) Laser light is used to accurately cut parts for an automobile.

WILEY

33.8.8. You are in a closed room that has no windows and only one source of light, an overhead incandescent light bulb. Around the room, you notice various objects: a yellow banana, a red apple, and a green cucumber. Which of the following best explains what influences the color and brightness of the banana?

a) Color is a property of each object, independent of any light shining on it. The brightness is only dependent on the brightness of the light bulb.

b) Some of the white light is absorbed by the banana, but the portion of the spectrum that is yellow is reflected from the banana. The brightness also depends on the roughness of the surface of the banana.

c) Color is a property of each object, independent of any light shining on it. The brightness is only dependent on the roughness of the surface of the banana.

d) Some of the white light is absorbed by the banana, but the portion of the spectrum that is yellow is reflected from the banana. The brightness is only dependent on the brightness of the light bulb.

e) The banana only emits light that has wavelengths in the yellow light portion of the visible light spectrum. The brightness is only dependent on the brightness of the light bulb.

WILEY

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e) The banana only emits light that has wavelengths in the yellow light portion of the visible light spectrum. The brightness is only dependent on the brightness of the light bulb.

WILEY

33.8.9. In which one of the following substances does light have the largest speed?

a) diamond

b) quartz

c) carbon disulfide

d) water

e) None of the above. The speed of light has the same value everywhere in the Universe.

WILEY

33.8.9. In which one of the following substances does light have the largest speed?

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WILEY

33.8.10. You are standing directly above a fish in an aquarium. The actual depth of the fish is one-half the distance from the surface to the bottom. As you look down at it, where does the fish appear to be?

a) I see it at its actual depth.

b) I see it at the surface of the water.

c) I see it below its actual depth, but above the bottom of the aquarium.

d) I see it above its actual depth, but below the surface of the water.

e) I see it at the bottom of the aquarium.

WILEY

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c) I see it below its actual depth, but above the bottom of the aquarium.

d) I see it above its actual depth, but below the surface of the water.

e) I see it at the bottom of the aquarium.

WILEY

33.8.11. A laser beam is directed at the left side of a plastic block as shown. Through which side and at what angle does the light leave the block?

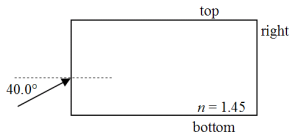
a) top side, 40°

b) right side, 40°

c) top side, 68.8°

d) right side, 68.8°

e) bottom side, 40°



WILEY

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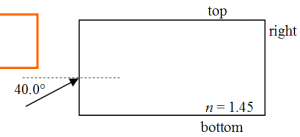

WILEY

33.8.12. Usually when we see a rainbow, we see a single bow with red at the top and violet at the bottom. The process of rainbow formation is described in the text. On rare occasions, we may see a "double rainbow," which is one rainbow below another. The lower one appears to be the usual rainbow, while other has the colors reversed with red at the bottom and violet at the top. Which of the following provides the best explanation of a double rainbow?

a) The upper rainbow is formed from water droplets that are higher than those that form the lower rainbow; and it is formed in the same way as the lower rainbow.

b) The upper rainbow is formed from water droplets that are higher than those that form the lower rainbow; and it is formed by light that is reflected two times within multiple water droplets, unlike the single reflections within multiple droplets that form the lower rainbow.

c) The upper rainbow is formed from the water droplets that form the lower rainbow, but it is formed by light that is reflected two times within multiple water droplets, in addition to the single reflections within the same droplets that form the lower rainbow.

d) The upper rainbow is formed by the light that is transmitted out the each water droplet at the point where the light is also reflected within each droplet. This transmitted light is then reflected from other droplets to our eyes.

WILEY

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WILEY

33.9.1. If total internal reflection is to occur, what must be incident angle be relative to the critical angle?

a) It must be equal to the critical angle.

b) It must be larger than or equal to the critical angle.

c) It must be smaller than or equal to the critical angle.

d) It must be smaller than the critical angle.

e) Total internal reflection only depends on the indices of refraction of the two materials, so it doesn't matter what the incident angle is.

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WILEY

33.9.2. A laser beam is directed at the left side of a plastic block (n = 1.53) as shown at an angle θ. The beam then undergoes total internal reflection as the light strikes the top interface at the critical angle for the block and the surrounding air. What is the value of the angle θ? Note: The drawing is not drawn to scale and the angles shown are not the actual angles.

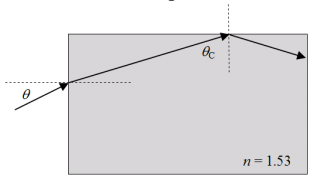
a) 40.8°

b) 49.2°

c) 63.1°

d) 68.7°

e) This is not possible since no angle θ will satisfy this situation.



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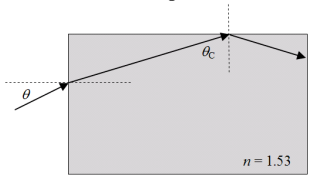

WILEY

33.10.1. A beam of unpolarized light is directed at a liquid within a transparent container. When the light strikes the air-liquid interface, Jason observes that the reflected ray and the refracted ray are perpendicular to one another. Investigating, Jason places a polarizer in the path of the reflected ray. What does Jason observe when the transmission axis of the polarizer is perpendicular to the surface of the water?

a) No light is transmitted through the polarizer.

b) About one quarter of the light is transmitted through the polarizer.

c) About one half of the light is transmitted through the polarizer.

d) About three quarters of the light is transmitted through the polarizer.

e) All of the light is transmitted through the polarizer.

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c) About one half of the light is transmitted through the polarizer.

d) About three quarters of the light is transmitted through the polarizer.

e) All of the light is transmitted through the polarizer.

WILEY

33.10.2. Unpolarized light from a laser is directed toward a horizontal, flat sheet of glass mounted on a stand as shown. Some of the light that reflects from the sheet passes through a polarizer with a vertical transmission axis. Any light that passes through the polarizer may be observed on the wall behind the polarizer. Janet holds the polarizer as shown and observes the wall as Andrew varies the angle of incidence, which equals the angle of reflection θ, of the laser light. What will Janet observe as Andrew gradually varies θ from 80° to 40°?

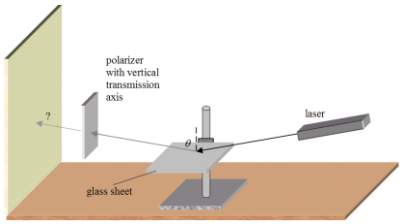
a) The intensity of the light will increase uniformly as the angle is decreased.

b) The intensity of the light will decrease uniformly as the angle is decreased.

c) The intensity of the light will decrease to zero near 60°, but otherwise some light will reach the wall.

d) The light on the wall will appear to be at constant intensity.

e) No light will pass through the polarizer sheet at any of these angles.



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