Name _____
Review

1 Two points on a transverse wave that have the same magnitude of displacement from equilibrium are in phase if the points also have the

1 same direction of displacement and the same direction of motion
2 same direction of displacement and the opposite direction of motion
3 opposite direction of displacement and the same direction of motion
4 opposite direction of displacement and the opposite direction of motion

2 A periodic wave travels through a rope, as shown in the diagram below.
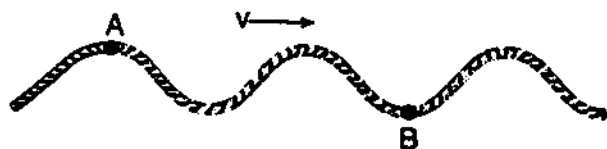
As the wave travels, what is transferred between points A and B?

1 mass, only
2 energy, only
3 both mass and energy
4 neither mass nor energy

3 When an opera singer hits a high-pitch note, a glass on the opposite side of the opera hall shatters. Which statement best explains this phenomenon?

1 The frequency of the note and natural vibration frequency of the glass are equal.
2 The vibrations of the note are polarized by the shape of the opera hall.
3 The amplitude of the note increases before it reaches the glass.
4 The singer and glass are separated by an integral number of wavelengths.

4 The amplitude of a sound wave is to its loudness as the amplitude of a light wave is to its

1 brightness   3 color
2 frequency   4 speed

5 What is the angle between the direction of propagation of a transverse wave and the direction in which the amplitude of the wave is measured?

(1) 0°   (3) 90°
(2) 45°   (4) 180°
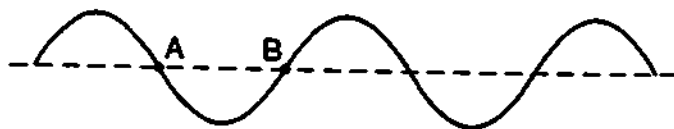
6 The diagram below represents wave movement.
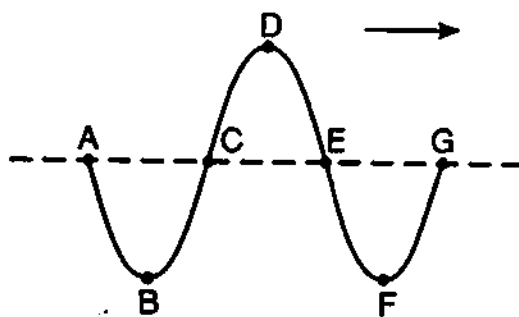
Which two points are in phase?

(1) A and G   (3) C and E
(2) B and F   (4) D and F

7 In the diagram below, the distance between points A and B on a wave is 0.10 meter.

This wave must have

1 an amplitude of 0.10 m
2 an amplitude of 0.20 m
3 a wavelength of 0.10 m
4 a wavelength of 0.20 m

8 The driver of a car sounds the horn while traveling toward a stationary person. Compared to the sound of the horn heard by the driver, the sound heard by the stationary person has

1 lower pitch and shorter wavelength
2 lower pitch and longer wavelength
3 higher pitch and shorter wavelength
4 higher pitch and longer wavelength

9 As shown in the diagram below, speakers S_1 and S_2, separated by a distance of 0.50 meter, are producing sound of the same constant frequency. A person walking along a path 4.0 meters in front of the speakers hears the sound reach a maximum intensity every 2.0 meters.
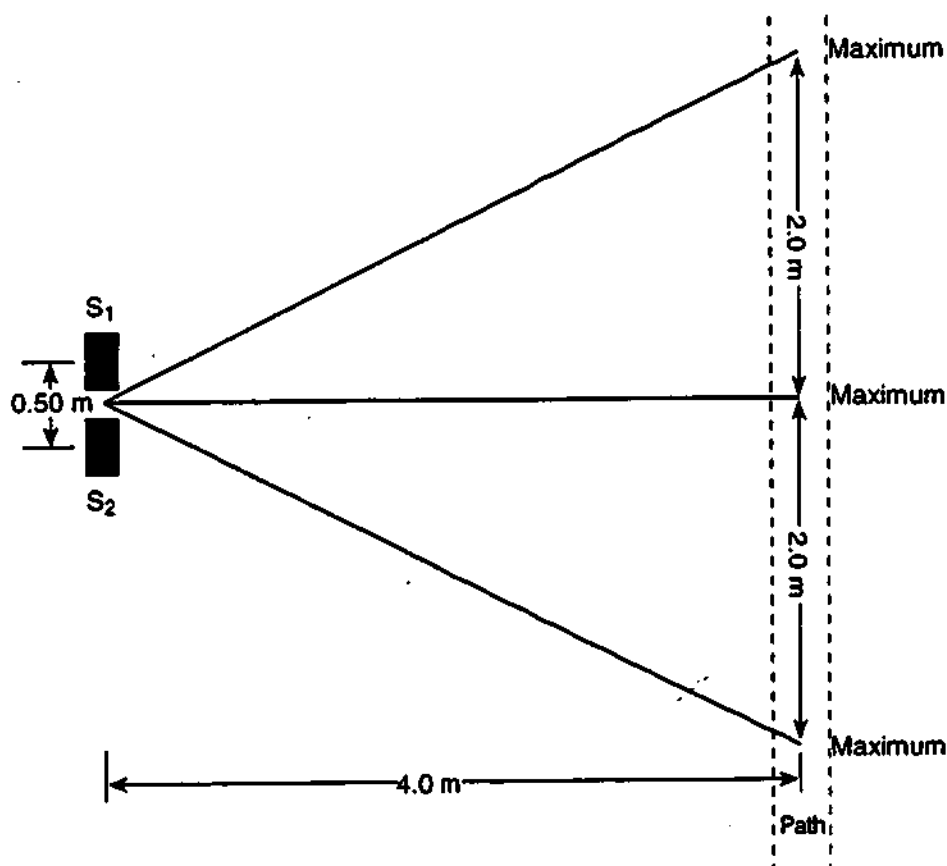
What is the wavelength of the sound produced by the speakers?
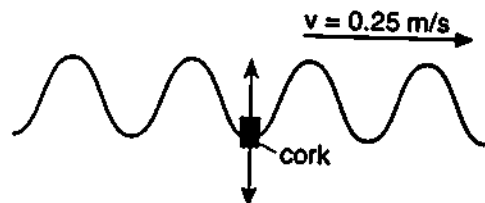
(1) 1.0 m

(2) 0.063 m

(3) 0.25 m

(4) 4.0 m

10 The diagram below shows a piston being moved back and forth to generate a wave. The piston produces a compression, C, every 0.50 second.
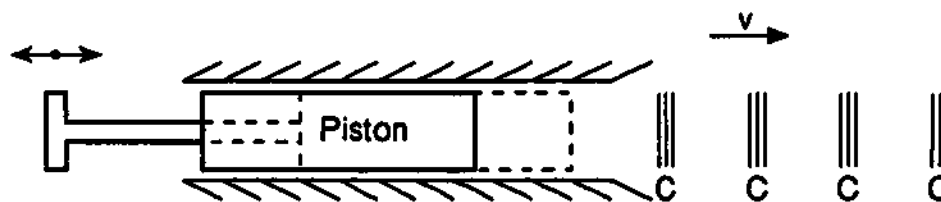
The frequency of this wave is

(1) 1.0 Hz
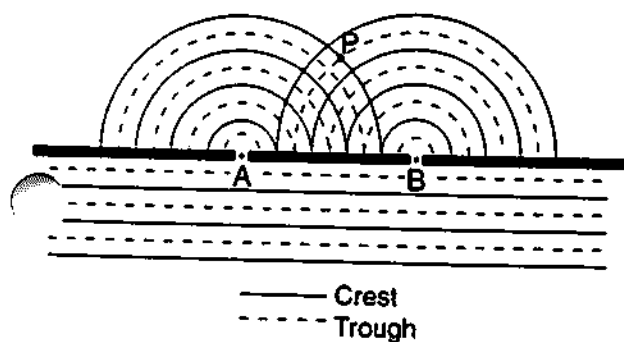
(2) 2.0 Hz

(3) 5.0×10^{-1} Hz

(4) 3.3×10^2 Hz

11. In the diagram below, a water wave having a speed of 0.25 meter per second causes a cork to move up and down 4.0 times in 8.0 seconds.

$$v = 0.25 \text{ m/s}$$

cork

What is the wavelength of the water wave?
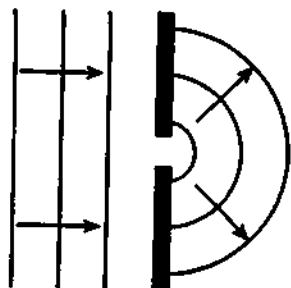
(1) 1.0 m
(2) 2.0 m
(3) 8.0 m
(4) 0.50 m

12. The diagram below represents shallow water waves of wavelength λ passing through two small openings, A and B, in a barrier.

———— Crest
- - - - Trough

Compared to the length of path BP, the length of path AP is

(1) 1λ longer
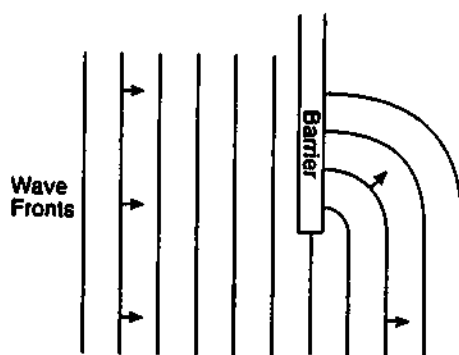(2) 2λ longer
(3) $\frac{1}{2}\lambda$ longer
(4) the same

13. The diagram below shows straight wave fronts passing through an opening in a barrier.

This wave phenomenon is called

1 reflection
2 refraction
3 polarization
4 diffraction

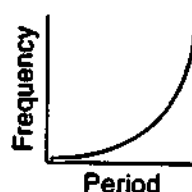14. The diagram below shows a wave phenomenon.

Wave Fronts

Barrier

The pattern of waves shown behind the barrier is the result of
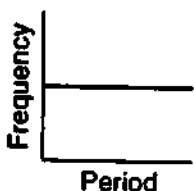
1 reflection
2 refraction
3 diffraction
4 interference

15. Which graph best represents the relationship between the frequency and period of a wave?

(1)
Frequency / Period

(3)
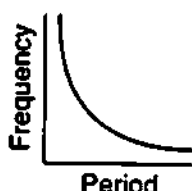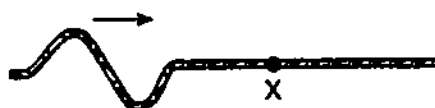Frequency / Period

(2)
Frequency / Period

(4)
Frequency / Period
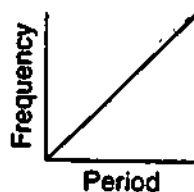
16. The diagram below shows a transverse wave moving to the right along a rope.

X

As the wave passes point X, the motion of X will be

1 up, then down
2 down, then up
3 left, then right
4 in a circle

Base your answers to questions 17 through 19 on the diagram below which shows a parked police car with a siren on top. The siren is producing a sound with a frequency of 680 hertz, which travels first through point A and then through point B, as shown. The speed of the sound is 340 meters per second.

(not drawn to scale)
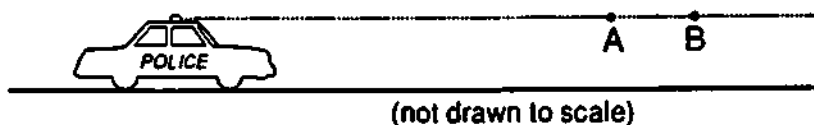
17 If the sound waves are in phase at points A and B, the distance between the points could be

(1) 1λ

(3) $\frac{3}{2}\lambda$

(2) $\frac{1}{2}\lambda$

(4) $\frac{1}{4}\lambda$

18 What is the wavelength of the sound produced by the car's siren?

(1) 0.50 m

(3) 2.3×10^5 m

(2) 2.0 m

(4) 2.3×10^{-6} m

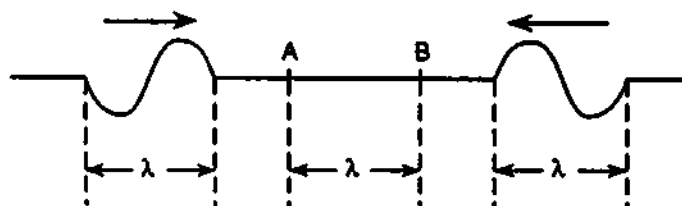Note that question   has only three choices.

19 If the car were to accelerate toward point A, the frequency of the sound heard by an observer at point A would

1 decrease

2 increase

3 remain the same

20 The diagram below shows two pulses, each of length λ, traveling toward each other at equal speed in a rope.

Which diagram best represents the shape of the rope when both pulses are in region AB?

(1) A B

(3) A B

(2) A B

(4) A _____ B

21 The diagram below shows two waves traveling in the same medium for the same length of time.
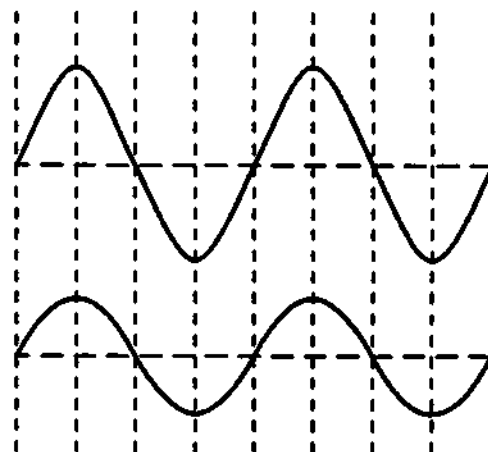
The two waves have different

1 amplitudes

3 speeds

2 frequencies

4 wavelengths

22 A stationary radar gun can determine the speed of a pitched baseball by measuring the difference in frequency between incident and reflected radar waves. This process illustrates

1 the Doppler effect   3 the critical angle
2 standing waves   4 diffraction

23 The diagram below represents a rope along which two pulses of equal amplitude, A, approach point P.

When the two pulses meet at P, the vertical displacement of the rope at point P will be

(1) A   (3) 0

(2) 2A   (4) $\frac{A}{2}$

24 A characteristic common to sound waves and light waves is that they

1 are longitudinal   3 transfer energy
2 are transverse   4 travel in a vacuum

25 As a longitudinal wave passes through a medium, the particles of the medium move

1 in circles
2 in ellipses
3 parallel to the direction of wave travel
4 perpendicular to the direction of wave travel

26 A wave traveling at 5.0×10^4 meters per second has a wavelength of 2.5×10^3 meters. What is the frequency of the wave?

(1) 1.25×10^6 Hz   (3) 5.0×10^{-4} Hz
(2) 2.0×10^3 Hz   (4) 5.0×10^3 Hz

27 Which pair of waves will produce a resultant wave with the smallest amplitude?
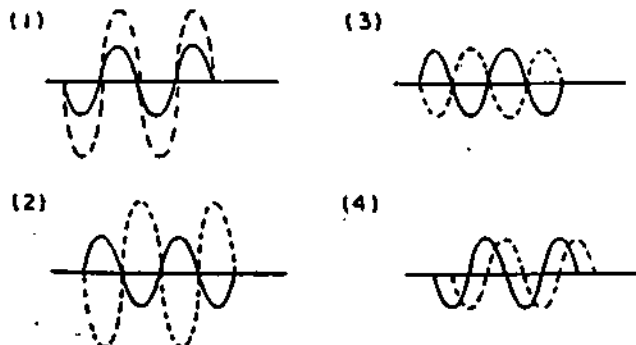
Base your answers to questions 28 through 31 on the diagram below which represents the wave pattern produced by a vibrating source moving linearly in a shallow tank of water. The pattern is viewed from above and the lines represent wave crests.
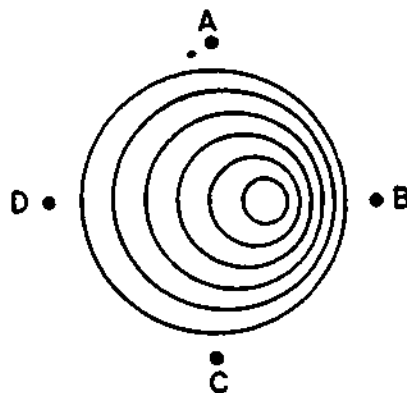
28 The source is moving toward point

(1) A   (3) C
(2) B   (4) D

29 The wave pattern is an illustration of

1 diffraction   3 dispersion
2 interference   4 the Doppler effect

Note that questions 30 and 31 have only three choices.

30 Compared to the frequency of the waves observed at point D, the frequency of the waves observed at point B is

1 lower
2 higher
3 the same

31 The velocity of the source is increased. The wavelength of the waves observed at point D will

1 decrease
2 increase
3 remain the same

32 As a wave is refracted, which characteristic of the wave will remain unchanged?

1 velocity   3 frequency
2 wavelength   4 direction

Base your answers to questions 33 through 36 in the diagram below which represents a transverse wave.
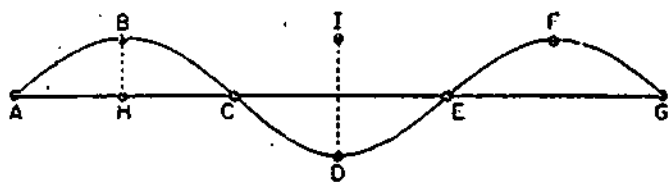
33 Which two points are in phase?
(1) A and C   (2) B and D   (3) C and E   (4) B and F

34 The amplitude of the wave is the distance between points
(1) A and C   (2) A and E   (3) B and H   (4) I and D

35 How many cycles are shown in the diagram?
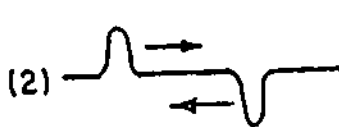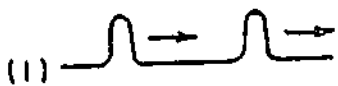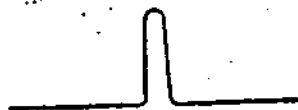(1) 1   (2) 2   (3) 3   (4) 1.5

36 A wavelength is the distance between points
(1) A and C   (2) A and E   (3) B and H   (4) I and D

37 If the period of the wave is 2 seconds, its frequency is
(1) 0.5 cycle/sec   (3) 3.0 cycles/sec
(2) 2.5 cycles/sec   (4) 1.5 cycles/sec

38 Which pair of pulses represented below, moving through the same medium, will produce the pulse shown at the right when they are superimposed?

39 Maximum destructive interference between two waves occurs when the waves are out of phase by
(1) 45 degrees   (3) 180 degrees
(2) 90 degrees   (4) 360 degrees

40 As a wave enters a medium, there may be a change in the wave's
1 frequency   3 period
2 speed   4 phase

41 Standing waves are produced by two waves traveling in opposite directions in the same medium. These two waves must have
1 the same amplitude and the same frequency
2 the same amplitude and different frequencies
3 different amplitudes and the same frequency
4 different amplitudes and different frequencies

42 A wave is generated in a rope which is represented by the solid line in the diagram below. As the wave moves to the right, point P on the rope is moving toward which position?
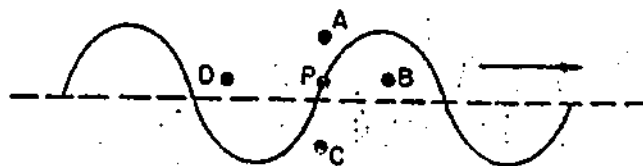
(1) A   (3) C
(2) B   (4) D

43 A sound wave can not be
1 reflected   3 diffracted
2 refracted   4 polarized

44 Only coherent wave sources produce waves that
1 are the same in frequency
2 have the same speed
3 have a constant phase relation
4 are polarized in the same plane

45 Which is an example of a longitudinal wave?
(1) gamma ray   (3) sound wave
(2) X-ray   (4) water wave

1 The distance from the Moon to Earth is 3.9×10^8 meters. What is the time required for a light ray to travel from the Moon to Earth?

(1) 0.65 s   (3) 2.6 s

(2) 1.3 s   (4) 3.9 s

2 Parallel light rays are incident on the surface of a plane mirror. Upon reflection from the mirror, the light rays will

1 converge   3 be parallel

2 diverge   4 be scattered

3 In the diagram below, a ray of monochromatic light ($\lambda = 5.9 \times 10^{-7}$ meter) reaches the boundary between medium X and air and follows the path shown.
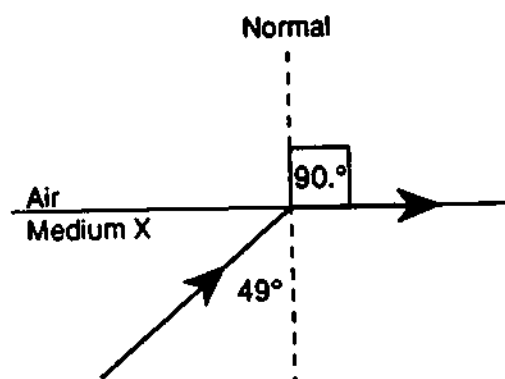
Which medium is most likely medium X?

1 diamond   3 Lucite

2 flint glass   4 water

4 Which phenomenon can *not* be exhibited by longitudinal waves?

1 reflection   3 diffraction

2 refraction   4 polarization

5 As the color of light changes from red to yellow, the frequency of the light

1 decreases

2 increases

3 remains the same

6 The diagram below shows white light being dispersed as it passes from air into a glass prism.
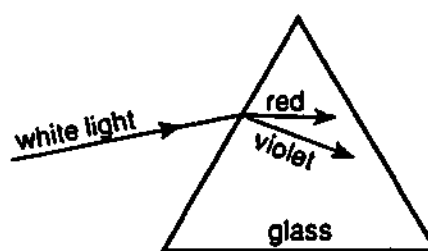
This phenomenon occurs because, in glass, each frequency of light has a different

1 intensity

2 amplitude

3 angle of incidence

4 absolute index of refraction

7 The diagram below represents wave fronts traveling from medium X into medium Y.
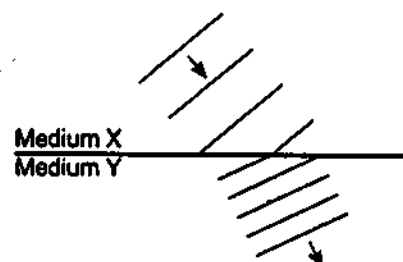
All points on any one wave front shown must be

1 traveling with the same speed

2 traveling in the same medium

3 in phase

4 superposed

8 A laser beam does *not* disperse as it passes through a prism because the laser beam is

1 monochromatic   3 polarized

2 polychromatic   4 longitudinal

9 In a nondispersive medium, the speed of a light wave depends on

1 its wavelength

2 its amplitude

3 its frequency

4 the nature of the medium

10 Which diagram best represents the reflection of light from an irregular surface?


Irregular surface
(1)

Irregular surface
(3)

Irregular surface
(2)

Irregular surface
(4)
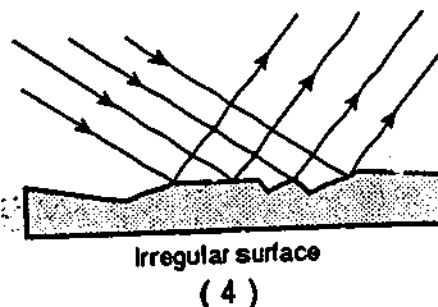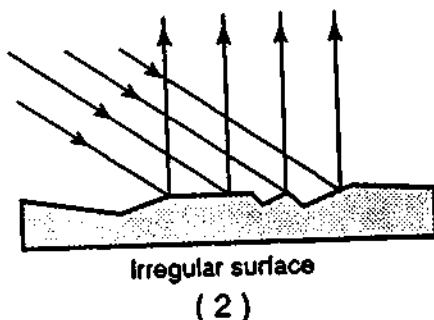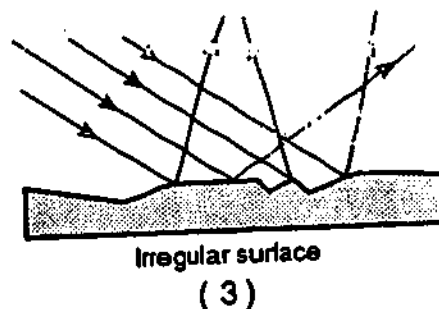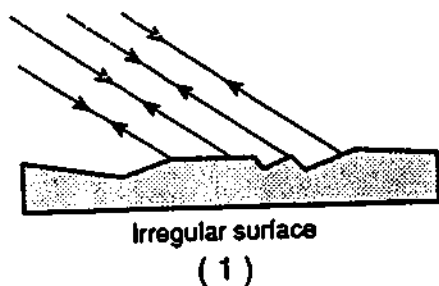
11 Light ($\lambda = 5.9 \times 10^{-7}$ meter) travels through a solution. If the absolute index of refraction of the solution is increased, the critical angle will

1 decrease
2 increase
3 remain the same

12 An astronomer on Earth studying light coming from a star notes that the observed light frequencies are lower than the actual emitted frequencies. The astronomer concludes that the distance between the star and Earth is

1 decreasing
2 increasing
3 not changing

13 The diagram below shows sunglasses being used to eliminate glare.
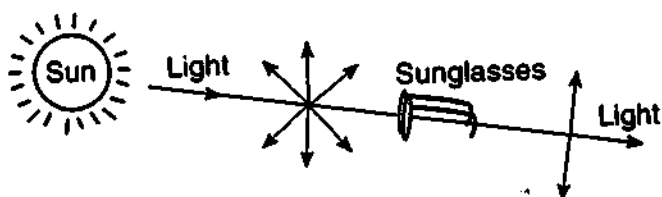
Which phenomenon of light is represented in the diagram?
1 dispersion
2 diffraction
3 internal reflection
4 polarization

14 A beam of light crosses a boundary between two different media. Refraction can occur if

1 the angle of incidence is 0°
2 there is no change in the speed of the wave
3 the media have different indices of refraction
4 all of the light is reflected

15 What is the energy of a photon with a frequency of 5.0×10^{14} hertz?

(1) 3.3 eV
(2) 3.2×10^{-6} eV
(3) 3.0×10^{45} J
(4) 3.3×10^{-19} J

16 Which diagram best represents light emitted from a coherent light source?

(1)
(3)
(2)
(4)
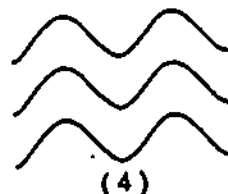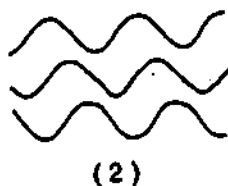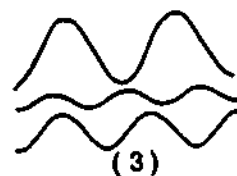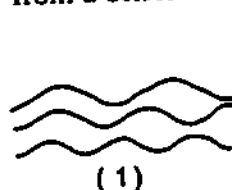
17 A ray of light ($\lambda = 5.9 \times 10^{-7}$ meter) traveling in crown glass is incident on a diamond interface at an angle of 30.°, as shown in the diagram below.
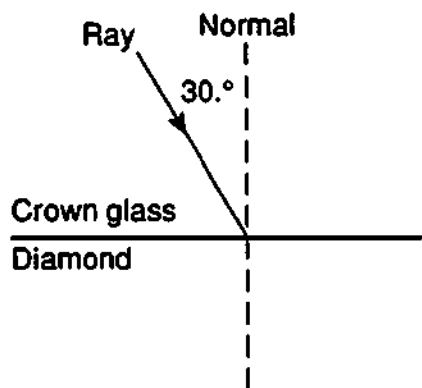
The angle of refraction for the light ray is closest to
(1) 12°   (3) 30.°
(2) 18°   (4) 53°

18 The diagram below shows a ray of monochromatic light incident on an alcohol-flint glass interface.

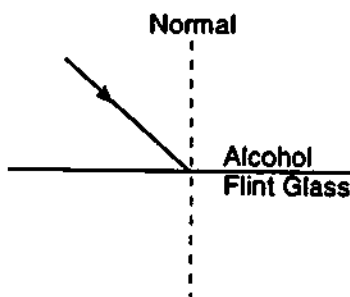What occurs as the light travels from alcohol into flint glass?

1 The speed of the light decreases and the ray bends toward the normal.
2 The speed of the light decreases and the ray bends away from the normal.
3 The speed of the light increases and the ray bends toward the normal.
4 The speed of the light increases and the ray bends away from the normal.

19 In a vacuum, a monochromatic beam of light has a frequency of 6.3×10^{14} hertz. What color is the light?

1 red   3 green
2 yellow   4 blue

20 The absolute index of refraction for a substance is 2.0 for light having a wavelength of 5.9×10^{-7} meter. In this substance, what is the critical angle for light incident on a boundary with air?
(1) 30.°   (3) 60.°
(2) 45°   (4) 90.°

21 A ray of monochromatic light ($\lambda = 5.9 \times 10^{-7}$ meter) traveling in air is incident on an interface with a liquid at an angle of 45°, as shown in the diagram below.
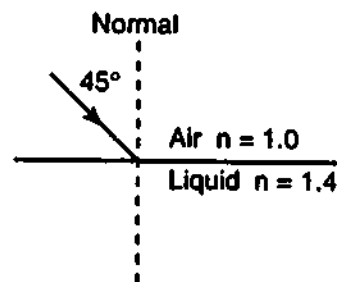
If the absolute index of refraction of the liquid is 1.4, the angle of refraction for the light ray is closest to
(1) 10.°   (3) 30.°
(2) 20.°   (4) 40.°

22 Which phenomenon can occur with light, but not with sound?

1 interference   3 refraction
2 polarization   4 the Doppler effect

23 The speed of light in glycerol is approximately
(1) 1.0×10^7 m/s   (3) 3.0×10^8 m/s
(2) 2.0×10^8 m/s   (4) 4.4×10^8 m/s

24 How long will it take a light wave to travel a distance of 100. meters?
(1) 3.00×10^{10} s   (3) 3.33×10^{-7} s
(2) 3.00×10^8 s   (4) 3.33×10^7 s

Base your answers to questions 25 through 29 on the diagram below which represents a ray of yellow light ($\lambda = 5.9 \times 10^{-7}$ meter in air) passing from air into Lucite. Angle θ_1 is 45°.
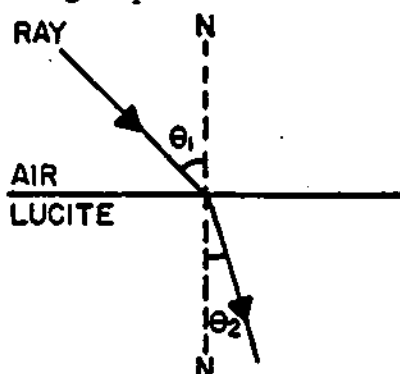
25 If the light ray were reversed in direction with the angle in the Lucite remaining the same, the angle in the air would be
(1) less than 45°
(2) 45°
(3) between 45° and 72°
(4) between 72° and 90°

26 What is the approximate speed of light in the Lucite?
(1) 1.5×10^8 m/s   (3) 3.0×10^8 m/s
(2) 2.0×10^8 m/s   (4) 4.5×10^8 m/s

27 The sine of θ_2 equals
(1) 0.707   (3) 0.471
(2) 0.577   (4) 0.333

28 What is the sine of the critical angle for a ray passing from Lucite into air?
(1) 0.866   (3) 0.667
(2) 0.707   (4) 0.500

Note that question 29 has only three choices.

29 Lucite is replaced by medium X, which makes θ_2 smaller for the same θ_1 in air. Compared to the speed of the yellow light in Lucite, the speed of the yellow light in medium X is
1 less
2 greater
3 the same

Base your answers to questions 30 through 34 on the diagram and the information below.

Red light passing through a double slit is producing a stationary interference pattern on a screen as shown on the diagram.
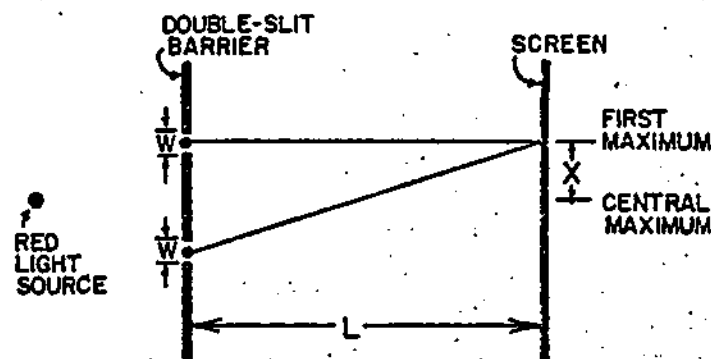
30 The interference pattern is produced because the light passing through the two slits is
1 dispersed   3 diffracted
2 polarized   4 refracted

Note that questions 31 through 33 have only three choices.

**31** If the distance L from the slits to the screen were increased, the distance X between the bright lines of the pattern on the screen would
1 decrease
2 increase
3 remain the same

32 If blue light were substituted for the red light source, the distance X between the bright lines of the pattern on the screen would
1 decrease
2 increase
3 remain the same

33 If a single slit with the same width (W) as one of the double slits were used, the width of the central maximum of the interference pattern on the screen would
1 decrease
2 increase
3 remain the same

34 If a ray of light in glass is incident upon an air surface at an angle greater than the critical angle, the ray will
1 reflect, only
2 refract, only
3 partly refract and partly reflect
4 partly refract and partly diffract

Base your answers to questions 35 through 39 on the diagram below. The diagram shows two light rays originating from source S in medium y. The dashed line represents a normal to each surface.
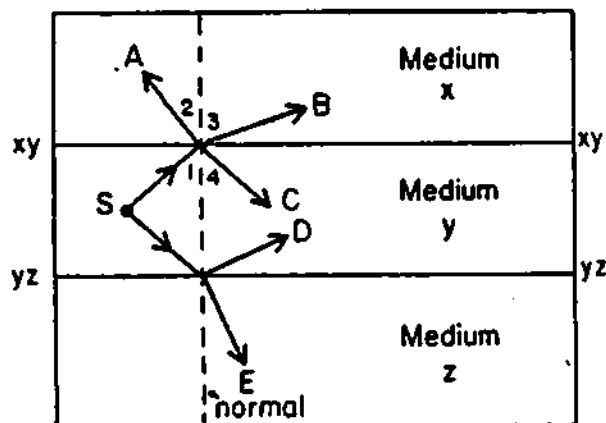
35 Which light ray would *not* be produced in this situation?

(1) A   (2) B   (3) C   (4) E

36 A reflected light ray is ray

(1) A   (2) B   (3) C   (4) E

37 Which two angles must be equal?

(1) 1 and 2   (3) 3 and 4
(2) 2 and 3   (4) 1 and 4

Note that questions 38 and 39 have only three choices.

38 Light originating from source S could produce total internal reflection at

1 surface yz, only
2 surface xy, only
3 neither surface xy nor yz

_____

39 Compared to the speed of light in medium x, the speed of light in medium z is

1 less
2 greater
3 the same

Base your answers to questions 40 through 44 on the diagram below which represents a ray of light moving from air through substance B, through substance C, and back into air. The surfaces of substances B and C are parallel.
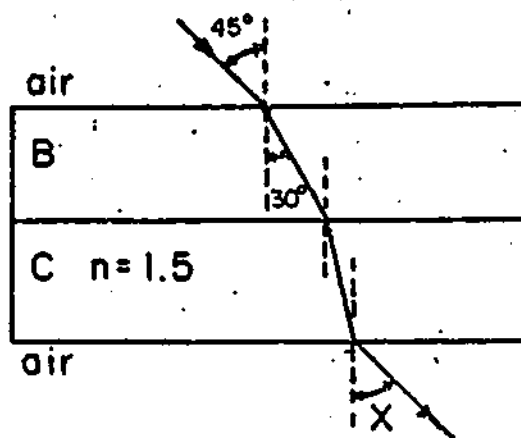
40 What is the index of refraction of substance B?

(1) 0.75   (3) 1.4
(2) 1.2   (4) 1.5

41 What is the velocity of light in substance C?

(1) 1.0 × 10⁸ m/s   (3) 3.0 × 10⁸ m/s
(2) 2.0 × 10⁸ m/s   (4) 4.5 × 10⁸ m/s

42 At the boundary between substance C and air, what is the sine of the critical angle?

(1) 0.866   (3) 0.667
(2) 0.707   (4) 0.500

Note that questions 43 and 44 have only three choices.

43 If the angle of incidence of the light ray in air is increased, the angle of refraction in substance B will

1 decrease
2 increase
3 remain the same

44 Compared to the wavelength of the light in air, the wavelength of the light in substance C is

1 shorter
2 longer
3 the same

1. A truck has the letters **OWOW** painted on the front of its hood. A person in a car driving ahead of the truck views these letters in the rear-view mirror. How do the letters appear?

(1) WOWO   (3) OMOM

(2) OWOW   (4) MOMO

2. A concave mirror has a radius of curvature of 0.60 meter. When an object is placed 0.40 meter from the reflecting surface, the image distance will be

(1) 0.10 m   (3) 0.83 m
(2) 0.20 m   (4) 1.2 m

3. The diagram below shows parallel monochromatic incident light rays being reflected from a concave mirror.
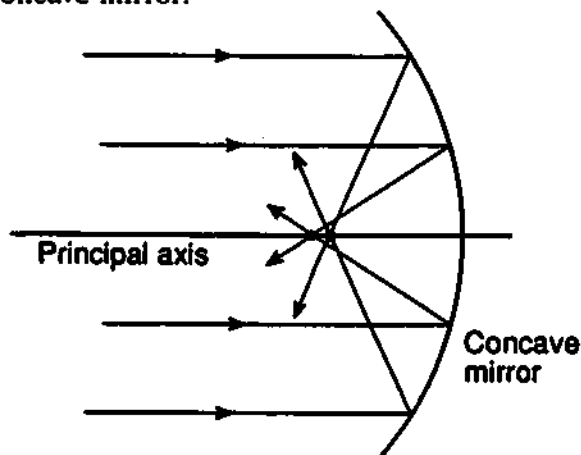
Which phenomenon does the diagram illustrate?
1 chromatic aberration
2 spherical aberration
3 refraction
4 dispersion

4. Which piece of glass could be used to focus parallel rays of sunlight to a small spot of light?
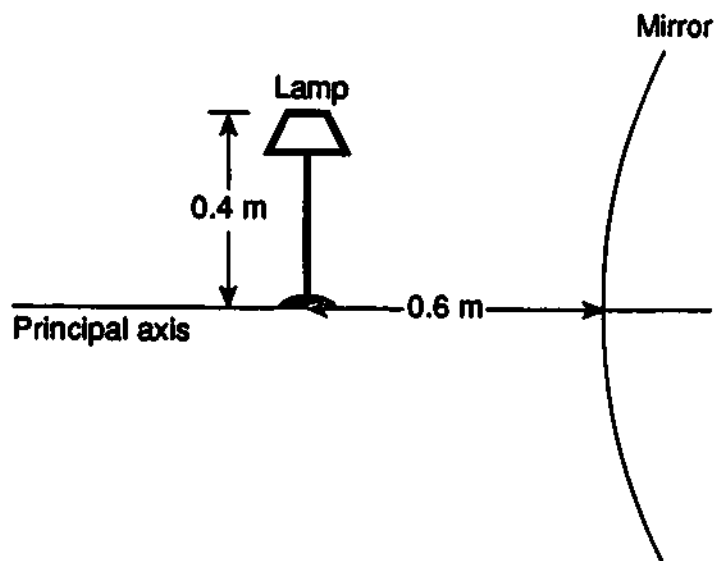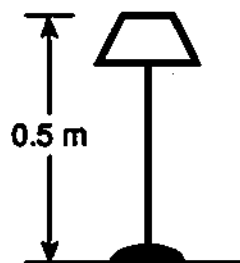

(1)   (2)   (3)   (4)

5. In the diagram below, a lamp 0.4 meter tall is placed 0.6 meter in front of a convex mirror.
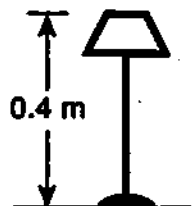

Which diagram best represents an image of the lamp that could be formed by this mirror?
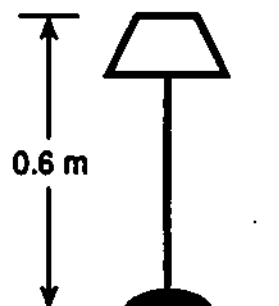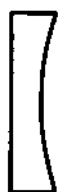

(1)   (3)

(2)   (4)

Base your answers to questions 6 and 7 on the information below.

A crown glass converging lens has a focal length of 0.10 meter.

6. Which cross-sectional diagram best represents this lens?

(1)   (2)   (3)   (4)

7. An object is placed 0.30 meter from the lens. How far from the lens will an image of the object be formed?

(1) 0.30 m   (3) 0.15 m
(2) 0.20 m   (4) 0.10 m

8. An object 0.080 meter high is placed 0.20 meter from a converging (convex) lens. If the distance of the image from the lens is 0.40 meter, the height of the image is

(1) 0.010 m   (3) 0.080 m
(2) 0.040 m   (4) 0.16 m

9. A diverging (concave) lens can form images that are

1 virtual, only
2 inverted, only
3 either virtual or real
4 either inverted or erect

10. What causes chromatic aberration in a crown glass lens?

1 Each wavelength of light reflects from the surface of the lens.
2 Each wavelength of light is refracted a different amount by the lens.
3 White light waves interfere inside the lens.
4 White light waves diffract around the edge of the lens.

11. Which diagram below shows the path of light rays as they pass from an object at $2F$ through a converging lens to the image formed at $2F$?

(1)

(2)

(3)

(4)
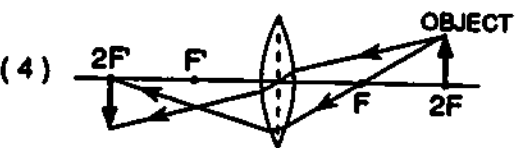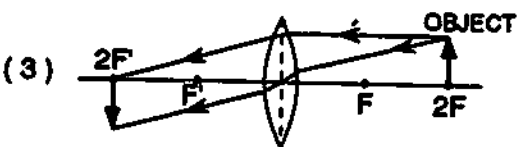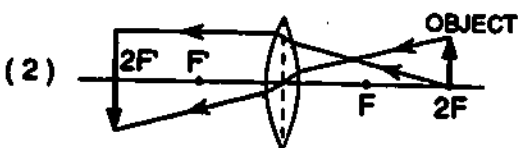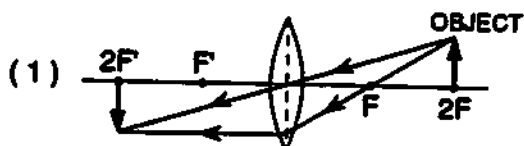
12. A student placed an object at various distances (d_o) from a converging lens. The corresponding image distance (d_i) was measured and recorded in the data table below.

d_o	0.15 m	0.20 m	0.30 m
d_i	0.30 m	0.20 m	0.15 m

What is the focal length of the lens?
(1) 0.10 m   (3) 0.20 m
(2) 0.15 m   (4) 0.30 m

13. A lens forms a real image three times the size of the object when the image is 0.12 meter from the lens. How far from the lens is the object?
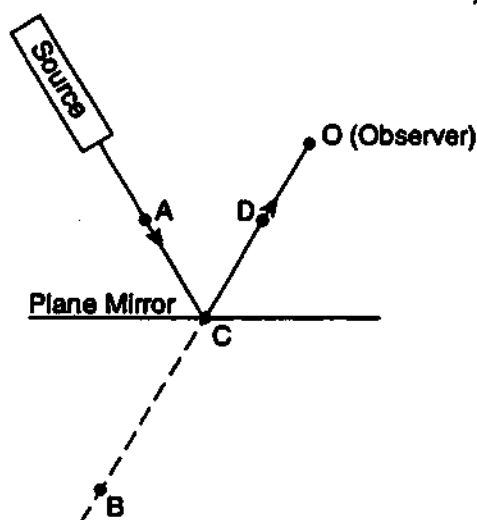(1) 0.36 m   (3) 0.03 m
(2) 0.09 m   (4) 0.04 m

14 In the diagram below, a source produces a light ray that is reflected from a plane mirror.

Source

• O (Observer)

A   D

Plane Mirror

C

B

To an observer at point O, the light appears to originate from point

(1) A   (3) C
(2) B   (4) D

15 A spherical mirror that forms only virtual images has a radius of curvature of 0.50 meter. The focal length of this mirror is

(1) –0.25 m   (3) –0.50 m
(2) +0.25 m   (4) +0.50 m

16 A spherical concave mirror is used in the back of a car headlight. Where must the bulb of the headlight be located to produce a parallel beam of reflected light?

1 between the principal focus and the mirror
2 beyond the center of curvature of the mirror
3 at the principal focus of the mirror
4 at the center of curvature of the mirror

17 Which type of images can be formed by a converging lens?

1 real images, only
2 virtual images, only
3 both real and virtual images
4 neither real nor virtual images

Base your answers to questions 18 through 20 on the information and diagram below.

An object is located at the center of curvature C of a concave spherical mirror with principal focus F. The focal length of the mirror is 0.10 meter.

Concave mirror

Object   0.10 m

Principal
axis

C   F
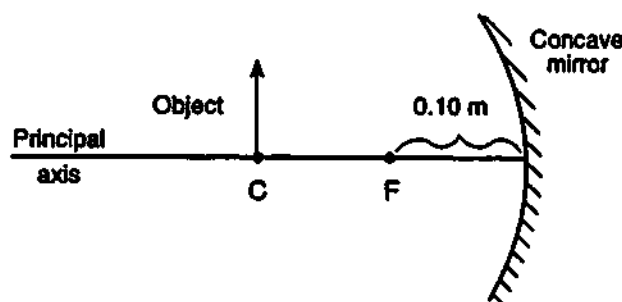
18 At what distance from the mirror is the image located?

(1) 0.10 m   (3) 0.30 m
(2) 0.20 m   (4) 0.40 m

19 At what distance from the mirror could the object be placed to produce a virtual image of the object?

(1) 0.05 m   (3) 0.30 m
(2) 0.10 m   (4) 0.50 m

Note that question 20 has only three choices.

20 As the object is moved from point C toward point F, the size of its image

1 decreases
2 increases
3 remains the same

21 A converging lens is used to produce an image of an object. The object distance is twice the image distance. If the object is 0.050 meter tall, the height of its image is

(1) 0.010 m   (3) 0.025 m
(2) 0.020 m   (4) 0.050 m

22 A plane mirror will form an image that is

1 virtual and erect   3 virtual and inverted
2 real and inverted   4 real and erect

23 Which graph best represents the relationship between image distance (d_i) and object distance (d_o) for a plane mirror?
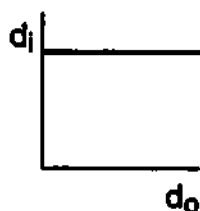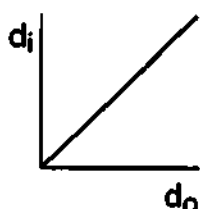

(1)   (3)

(2)   (4)

24 Which lens defect is correctly paired with its cause?

1 chromatic aberration, caused by refraction
2 chromatic aberration, caused by diffraction
3 spherical aberration, caused by wave interference
4 spherical aberration, caused by wave polarization

25 Photographers sometimes use colored filters to restrict the light entering a lens to a single wavelength. The filters are used to eliminate

1 diffusion
2 diffraction
3 polarization effects
4 chromatic aberration

Note that question 26 has only three choices.

26 As an object is moved from 0.2 meter to 0.3 meter away from a plane mirror, the image distance

1 decreases
2 increases
3 remains the same

Base your answers to questions 27 and 28 on the information and diagram below. The diagram shows a concave (converging) spherical mirror having principal focus F and center of curvature C. Point A lies on the principal axis.
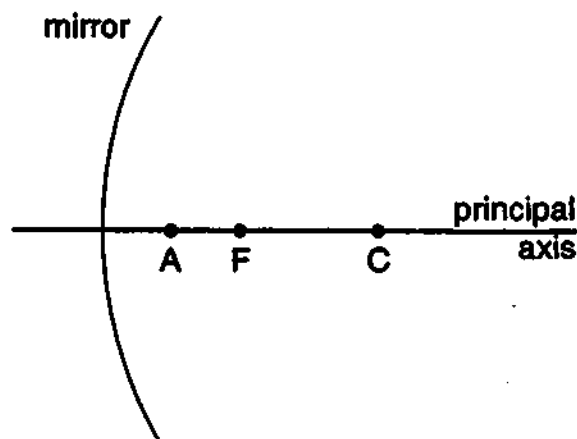
27 When an object is placed at point A, its image is observed

1 at F
2 between F and C
3 to the right of C
4 to the left of the mirror

28 If an object is located at point A, its image is

1 virtual and inverted   3 real and inverted
2 virtual and erect   4 real and erect

29 Which phenomenon allows a lens to focus light?

1 diffraction   3 interference
2 refraction   4 polarization

When an object is placed 0.40 meter from a diverging lens with a focal length of -0.10 meter, the image produced will be

1 virtual and smaller than the object
2 virtual and larger than the object
3 real and smaller than the object
4 real and larger than the object

Base your answers to questions 31 through 35 on the diagram below which represents an object 0.030 meter high placed at point X, 0.60 meter from the center of a lens. An image is formed at point Y, 0.30 meter from the center of the lens.
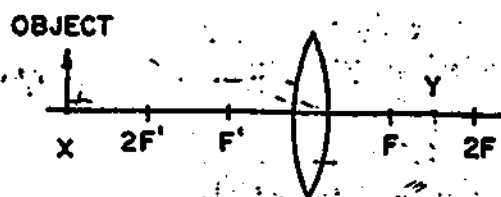
OBJECT

31 The image formed is
1 real and inverted
2 real and erect
3 virtual and inverted
4 virtual and erect

32 What is the focal length of the lens?
(1) 0.15 m   (3) 0.45 m
(2) 0.20 m   (4) 0.60 m

33 What is the height of the image?
(1) 0.060 m   (3) 0.015 m
(2) 0.030 m   (4) 0.010 m

34 As the object is moved closer to the focal point from position X, the image will
1 decrease in size and move farther from the lens
2 decrease in size and move closer to the lens
3 increase in size and move farther from the lens
4 increase in size and move closer to the lens

35 The formation of the image is best explained in terms of
1 reflection   3 polarization
2 diffraction   4 refraction

36 Four identically shaped converging lenses are made of crown glass, flint glass, Lucite, and fused quartz. Which lens would have the *shortest* focal length?
1 crown glass   3 Lucite
2 flint glass   4 quartz

37 The image formed by a diverging lens is
1 enlarged   3 real
2 inverted   4 virtual

38 Which ray diagram illustrates refraction?
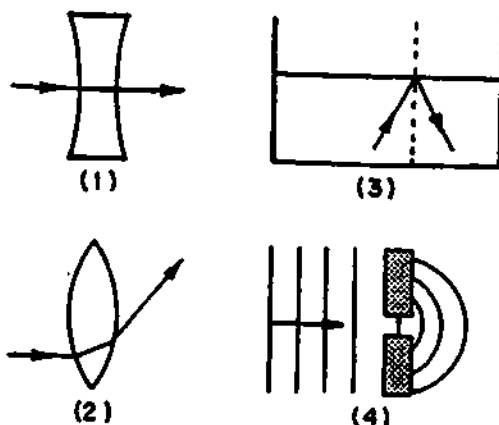
39 Which optical device shown below should be placed in the box indicated by the dotted lines in the diagram at the right to cause the parallel light rays to diverge?
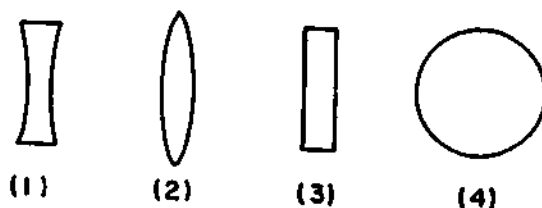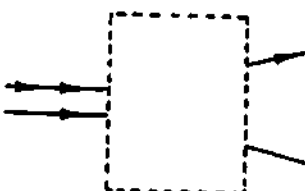
40 The diagram at the right represents light rays approaching a diverging lens parallel to the principal axis. Which diagram below best represents the light rays after they have passed through the diverging lens?