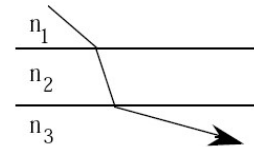


AP Physics Multiple Choice Practice – Optics

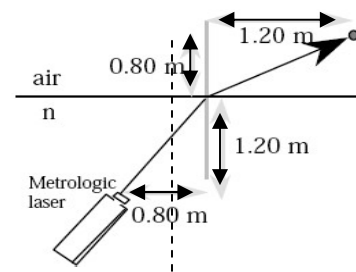
SECTION A – Geometric Optics

- An object is located 0.20 meters from a converging lens which has a focal length of 0.15 meters. Relative to the object, the image formed by the lens will be:
 (A) virtual, inverted, smaller (B) real, inverted, smaller. (C) real, inverted, larger
 (D) virtual, upright, larger
- Light that has a wavelength of 500 nm in air has a wavelength 400 nm in a transparent material. What is the index of refraction of the material?
 (A) 0.64 (B) 0.80 (C) 1.00 (D) 1.25

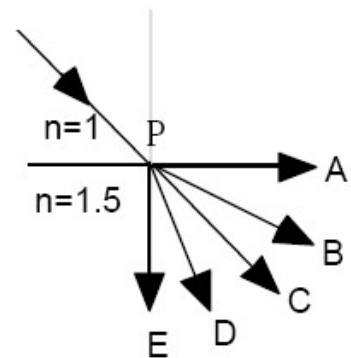
- A beam of light passes from medium 1 to medium 2 to medium 3 as shown in the accompanying figure. What is true about the respective indices of refraction (n_1 , n_2 , and n_3)
 (A) $n_1 > n_2 > n_3$ (B) $n_1 > n_3 > n_2$ (C) $n_2 > n_3 > n_1$
 (D) $n_2 > n_1 > n_3$



- A laser is embedded in a material of index of refraction n . The laser beam emerges from the material and hits a target. See the accompanying figure for the position parameters of the laser and target. The value of n is:
 (A) 1.4 (B) 1.5 (C) 2.1 (D) 3.5



- A beam of light is directed toward point P on a boundary as shown to the right. Which segment best represents the refracted ray?
 (A) PA (B) PB (C) PC (D) PD

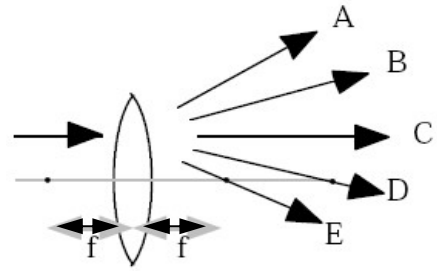


- Multi Correct.** Which of the following are possible for the images formed by the lens in the accompanying figure? Select two answers.

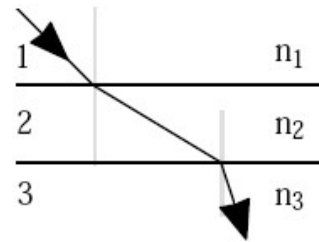
- (A) real and inverted
- (B) real and smaller in size
- (C) real and upright
- (E) virtual and smaller in size



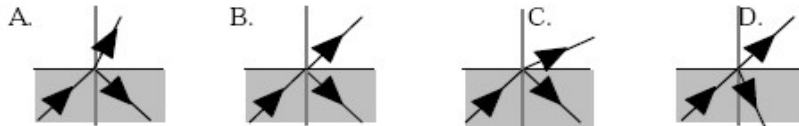
7. A narrow beam of monochromatic light enters a lens parallel to the optic axis, as shown in the accompanying diagram. Which arrow best represents the direction of the light after leaving the lens?
 (A) arrow A (B) arrow B
 (C) arrow D (D) arrow E



8. The accompanying diagram shows the path that a light ray takes passing through three transparent materials. The indices of refraction in materials 1, 2, and 3 are n_1 , n_2 , and n_3 , respectively. Which of the following best describes the relation between the indices of refraction?
 (A) $n_1 > n_2 > n_3$ (B) $n_1 > n_3 > n_2$ (C) $n_2 > n_1 > n_3$ (D) $n_3 > n_1 > n_2$

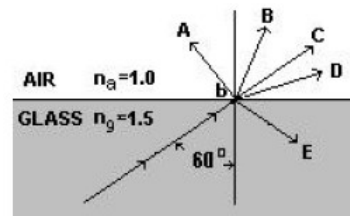


9. Which diagram best represents what happens to a ray of light entering air from water? Air is at the top in all diagrams.



10. In order to produce an enlarged, upright image of an object, you could use a
 (A) converging lens more than one focal length from the object.
 (B) converging lens less than one focal length from the object.
 (C) diverging lens more than one focal length from the object.
 (D) diverging lens exactly one focal length from the object..

11. A beam of light traveling in glass ($n_g = 1.5$) strikes a boundary with air ($n_a = 1.0$) at point P. The angle of incidence is 60° as shown in the diagram. Which ray would best indicate the beam's path after point P?
 (A) A (B) B (C) D (D) E



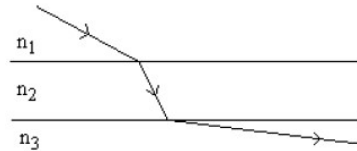
12. **Multiple Correct.** A small light bulb is placed 20 cm to the right of a converging lens of focal length 10 cm. Which of the following statements are true about the image of the bulb formed by the lens? Select two answers.
 (A) It is virtual
 (B) It is inverted
 (C) It is one-half the size of the bulb
 (D) It is 20 cm to the left of the lens

13. An image is formed on a screen by a convergent lens. If the top half of the lens is then covered what will happen to the image?

- (A) the image is dimmer but otherwise unchanged
- (B) the image becomes half as big
- (C) only the top half of the image is produced
- (D) only the bottom half of the image is produced

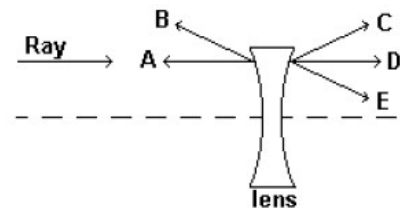
14. A beam of light passes from medium 1 to medium 2 to medium 3 as shown in the diagram. What may be concluded about the speed of light in each medium?

- (A) $v_3 > v_1 > v_2$
- (B) $v_1 > v_2 > v_3$
- (C) $v_1 > v_3 < v_2$
- (D) $v_2 > v_3 > v_1$



15. After striking the lens shown in the diagram at right, the light ray will most likely follow which path?

- (A) path B
- (B) path C
- (C) path D
- (D) path E



16. An object is placed 10 cm in front of the center of a concave curved mirror with a radius of curvature of 10 cm. About how far from the mirror will the real image of the object be formed?

- (A) 0 cm
- (B) 5 cm
- (C) 10 cm
- (D) 20 cm

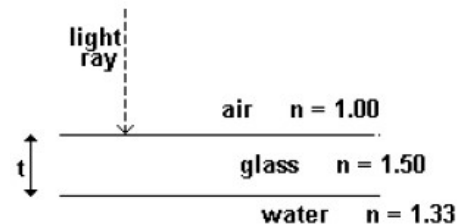
17. Light travels from material X with an index of refraction of $n=1.5$ to material Y with an index of refraction of $n=2.0$. If the speed of light in material Y is v , what is the speed of light in material X?

- (A) $0.56 v$
- (B) $0.75 v$
- (C) $1.33 v$
- (D) $1.78 v$

18. A light ray is incident normal to a thin layer of glass. Given the figure, what is the minimum thickness of the glass that gives the reflected light an orange like color

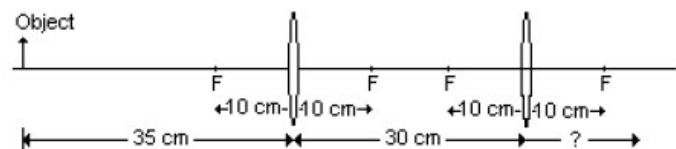
($\lambda(\text{air})$ orange light = 600nm)

- (A) 50 nm
- (B) 100 nm
- (C) 150 nm
- (D) 200 nm



19. Two thin lenses each with a focal length of +10 cm are located 30 cm apart with their optical axes aligned as shown. An object is placed 35 cm from the first lens. After the light has passed through both lenses, at what distance from the second lens will the final image be formed?

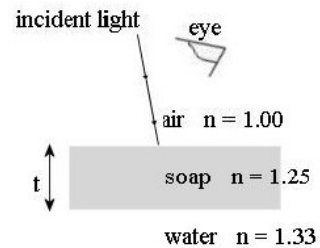
- (A) 65 cm
- (B) 35 cm
- (C) 27 cm
- (D) 17 cm



20. A converging lens forms a virtual image of a real object that is two times the objects size. The converging lens is replaced with a diverging lens having the same size focal length. What is the magnification of the image formed by the diverging lens?
 (A) -1 (B) $-2/5$ (C) $2/3$ (D) $3/2$

21. An object is in front of a convex lens, at a distance less than the focal length from the lens. Its image is
 (A) virtual and larger than the object.
 (B) real and smaller than the object.
 (C) virtual and smaller than the object.
 (D) real and larger than the object.

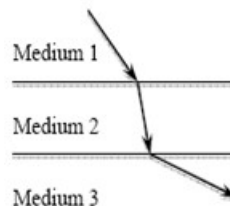
22. Light is incident normal to a thin layer of soap. Given the figure, what is the minimum thickness of the soap film that gives the soap a blue like color ($\lambda_{\text{air}}(\text{blue}) = 500 \text{ nm}$)?
 (A) 100 nm (B) 200 nm (C) 250 nm (D) 400 nm



23. For which of the following does one obtain an image of increased size from a real object? Take all focus and radius of curvature values as positive.
 (A) The object is placed at a position outside the radius of curvature for a converging lens.
 (B) The object is placed at a position outside the radius of curvature for a diverging lens.
 (C) The object is placed at a position inside the magnitude of the focus for a concave lens.
 (D) The object is placed at a position between the focus and radius of curvature for a concave mirror.
24. A sound wave generated from a tuning fork of single frequency travels from air (with speed of sound 340 m/s) into rock (with speed of sound 1500 m/s). Which statement is true about the wavelength and frequency of the sound as it passes from air to rock?
 A) The frequency of the sound increases and the wavelength increases.
 B) The frequency of the sound increases and the wavelength is unchanged.
 C) The frequency of the sound is unchanged and the wavelength is decreased.
 D) The frequency of the sound is unchanged and the wavelength is increased.
25. A diverging lens produces an image of a real object. This image is
 (A) virtual, larger than the object, and upright.
 (B) virtual, smaller than the object, and upright.
 (C) virtual, smaller than the object, and inverted.
 (D) real, smaller than the object, and inverted.
26. A light beam passes through the air and strikes the surface of a plastic block. Which pair of statements correctly describes the phase changes for the reflected wave and the transmitted wave?
- | <u>Reflected wave</u> | <u>Transmitted wave</u> |
|-----------------------|-------------------------|
| (A) 90° | 90° |
| (B) No phase change | 180° |
| (C) No phase change | No phase change |
| (D) 180° | No phase change |

27. **Multiple Correct.** The diagram below shows the path taken by a monochromatic light ray traveling through three media. The symbols $v_1, \lambda_1,$ and f_1 represent the speed, wavelength, and frequency of the light in Medium 1, respectively. Which of the following relationships for the light in the three media is true? Select two answers:

- (A) $v_3 > v_1 > v_2$
 (B) $f_1 = f_2 = f_3$
 (C) $\lambda_1 > \lambda_2 > \lambda_3$
 (D) $v_1 > v_2 > v_3$

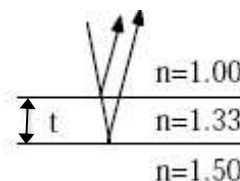


28. A real object is located in front of a convex lens at a distance greater than the focal length of the lens. What type of image is formed and what is true of the image's size compared to that of the object?

- | | <u>Type of Image</u> | <u>Size of Image</u> |
|-----|----------------------|----------------------------|
| (A) | Real | Larger than object |
| (B) | Real | More information is needed |
| (C) | Virtual | Smaller than object |
| (D) | Virtual | Larger than object |

29. A thin film of thickness t and index of refraction 1.33 coats a glass with index of refraction 1.50 as shown to the right. Which of the following thicknesses t will not reflect light with wavelength 640 nm in air?

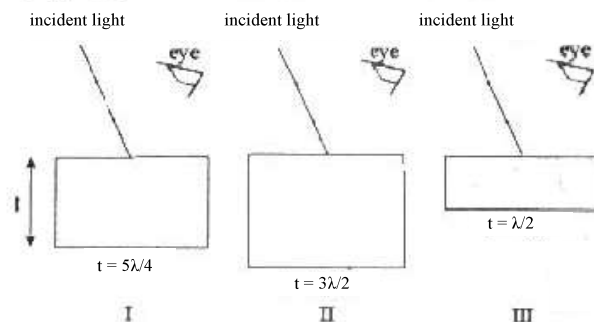
- (A) 160 nm (B) 240 nm (C) 360 nm (D) 480 nm



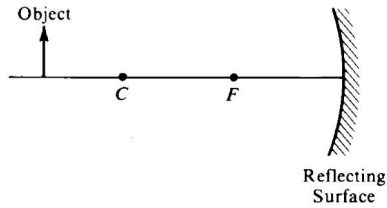
30. Lenses in fine quality cameras are coated to reduce the reflection from the lenses. If the coating material has an index of refraction between that of air and glass, what thickness of coating will produce the least reflection?

- A) one-quarter of the wavelength in the coating
 B) one-third of the wavelength in the coating
 C) one-half of the wavelength in the coating
 D) one wavelength in the coating

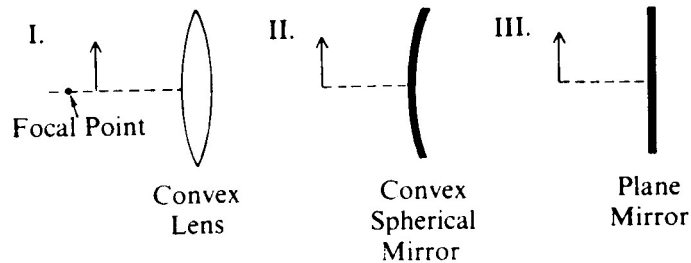
31. Light strikes three different thin films, which are in air, as shown. If t denotes the film thickness and λ denotes the wavelength of the light in the film, which films will produce constructive interference as seen by the observer?



- (A) I only (B) II only (C) III only (D) II and III only

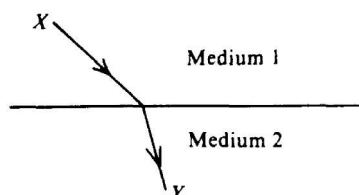


32. An object is placed as shown in the figure above. The center of curvature C and the focal point F of the reflecting surface are marked. As compared with the object, the image formed by the reflecting surface is
 (A) erect and larger (B) erect and the same size (C) erect and smaller
 (D) inverted and larger
33. When one uses a magnifying glass to read fine print, one uses a
 (A) converging lens to produce a virtual image of the print
 (B) converging lens to produce a real image of the print
 (C) mirror to produce a virtual image of the print
 (D) diverging lens to produce a real image of the print
34. An illuminated object is placed 0.30 meter from a lens whose focal length is -0.15 meter. The image is
 (A) inverted, real, and 0.30 meter from the lens on the opposite side from the object
 (B) upright, virtual, and 0.30 meter from the lens on the opposite side from the object
 (C) upright, real, and 0.10 meter from the lens on the same side as the object
 (D) upright, virtual, and 0.10 meter from the lens on the same side as the object
35. Which of the following CANNOT be accomplished by a single converging lens with spherical surfaces?
 (A) Converting a spherical wave front into a plane wave front
 (B) Converting a plane wave front into a spherical wave front
 (C) Forming a virtual image of a real object
 (D) Forming a real upright image of a real upright object
36. The image of the arrow is larger than the arrow itself in which of the following cases?

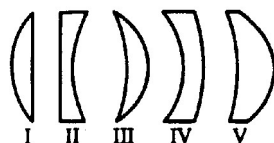


- (A) I only (B) II only (C) I and III only (D) II and III only

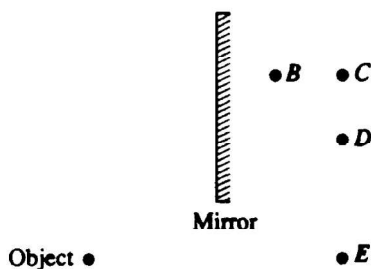
37. A postage stamp is placed 30 centimeters to the left of a converging lens of focal length 60 centimeters. Where is the image of the stamp located?
 (A) 60 cm to the left of the lens (B) 20 cm to the left of the lens
 (C) 20 cm to the right of the lens (D) 30 cm to the right of the lens



38. Light leaves a source at X and travels to Y along the path shown above. Which of the following statements is correct?
- (A) The index of refraction is the same for the two media.
 (B) Light travels faster in medium 2 than in medium 1.
 (C) Light would arrive at Y in less time by taking a straight line path from X to Y than it does taking the path shown above.
 (D) Light leaving a source at Y and traveling to X would follow the same path shown above, but in reverse.



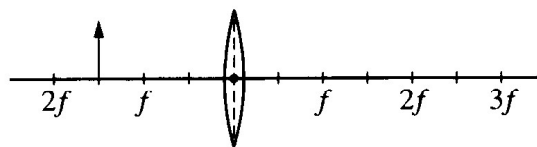
39. Which three of the glass lenses above, when placed in air, will cause parallel rays of light to converge?
- (A) I, II, and III (B) I, III, and V (C) I, IV, and V (D) II, III, and IV



40. An object is placed near a plane mirror, as shown above. Which of the labeled points is the position of the image?
- (A) point B (B) point C (C) point D (D) point E
41. Observations that indicate that visible light has a wavelength much shorter than a centimeter include which of the following?
- I. The colored pattern seen in a soap bubble
 II. The colored pattern seen when light passes through a diffraction grating
 III. The bending of light when it passes from one medium to another medium
- (A) I only (B) III only (C) I and II only (D) II and III only
42. If the object distance for a converging thin lens is more than twice the focal length of the lens, the image is
- (A) virtual and erect (B) larger than the object (C) located inside the focal point (D) located at a distance between f and $2f$ from the lens
43. A concave mirror with a radius of curvature of 1.0 m is used to collect light from a distant star. The distance between the mirror and the image of the star is most nearly
- (A) 0.25 m (B) 0.50 m (C) 0.75 m (D) 1.0 m
44. When light passes from air into water, the frequency of the light remains the same. What happens to the speed and the wavelength of light as it crosses the boundary in going from air into water?
- | <u>Speed</u> | <u>Wavelength</u> |
|----------------------|-------------------|
| (A) Increases | Remains the same |
| (B) Remains the same | Decreases |
| (C) Remains the same | Remains the same |
| (D) Decreases | Decreases |

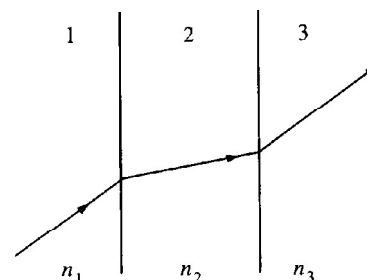
45. A physics student places an object 6.0 cm from a converging lens of focal length 9.0 cm. What is the magnitude of the magnification of the image produced?
 (A) 0.6 (B) 1.5 (C) 2.0 (D) 3.0

46. An object is placed at a distance of $1.5f$ from a converging lens of focal length f , as shown. What type of image is formed and what is its size relative to the object?



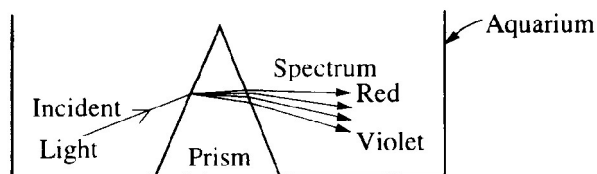
- | Type | Size |
|-------------|-----------|
| (A) Virtual | Larger |
| (B) Virtual | Same size |
| (C) Real | Smaller |
| (D) Real | Larger |

47. A light ray passes through substances 1, 2, and 3, as shown. The indices of refraction for these three substances are n_1 , n_2 , and n_3 , respectively. Ray segments in 1 and 3 are parallel. From the directions of the ray, one can conclude that



- (A) n_3 must be the same as n_1
 (B) n_2 must be less than n_1
 (C) n_2 must be less than n_3
 (D) all three indices must be the same

48. A beam of white light is incident on a triangular glass prism with an index of refraction of about 1.5 for visible light, producing a spectrum. Initially, the prism is in a glass aquarium filled with air, as shown above. If the aquarium is filled with water with an index of refraction of 1.3, which of the following is true?

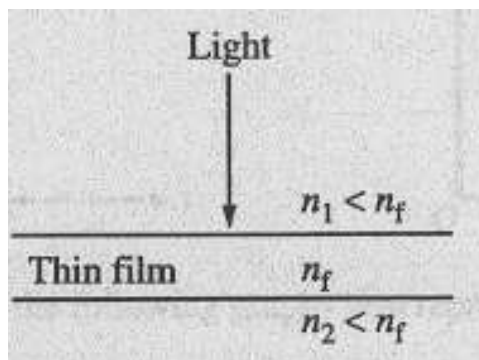


- (A) A spectrum is produced, but the deviation of the beam is opposite to that in air.
 (B) The positions of red and violet are reversed in the spectrum.
 (C) The spectrum produced has greater separation between red and violet than that produced in air.
 (D) The spectrum produced has less separation between red and violet than that produced in air.

49. An object is placed in front of a converging thin lens at a distance from the center of the lens equal to half the focal length. Compared to the object, the image is

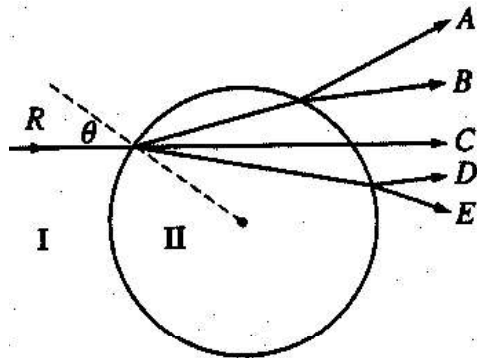
- (A) upright and larger
 (B) upright and smaller
 (C) inverted and larger
 (D) inverted and smaller

50. A thin film with index of refraction n_f separates two materials, each of which has an index of refraction less than n_f . A monochromatic beam of light is incident normally on the film, as shown above. If the light has wavelength λ within the film, maximum constructive interference between the incident beam and the reflected beam occurs for which of the following film thicknesses?



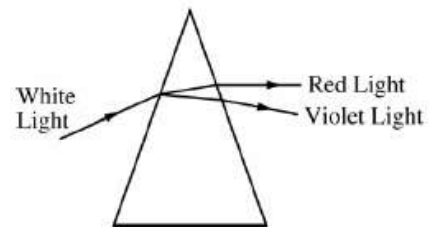
- (A) 2λ (B) λ (C) $\lambda/2$ (D) $\lambda/4$

Questions 51-52

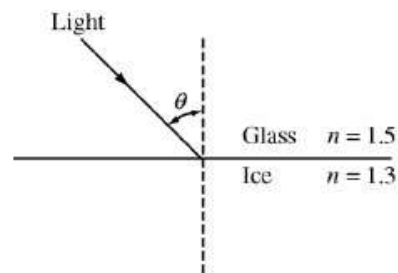


A light ray R in medium I strikes a sphere of medium II with angle of incidence θ , as shown above. The figure shows five possible subsequent paths for the light ray.

51. Which path is possible if medium I is air and medium II is glass?
 (A) path A (B) path C (C) path D (D) path E
52. Which path is possible if medium I is glass and medium II is air?
 (A) A (B) B (C) C (D) D
53. A large lens is used to focus an image of an object onto a screen. If the left half of the lens is covered with a dark card, which of the following occurs
 (A) The left half of the image disappears
 (B) The right half of the image disappears
 (C) The image becomes blurred
 (D) The image becomes dimmer
54. Which of the following statements are true for both sound waves and electromagnetic waves?
 I. They can undergo refraction.
 II. They can undergo diffraction.
 III. They can produce a two-slit interference pattern.
 IV. They can produce standing waves.
 (A) I and II only (B) III and IV only (C) I, II, III and IV (D) II, III, and IV only
55. **Multiple Correct:** As shown, a beam of white light is separated into separate colors when it passes through a glass prism. Red light is refracted through a smaller angle than violet light because red light has a: Select two answers.
 (A) slower speed in glass than violet light
 (B) faster speed in glass than violet light
 (C) slower speed in the incident beam than violet light
 (D) lower index of refraction in glass than violet light



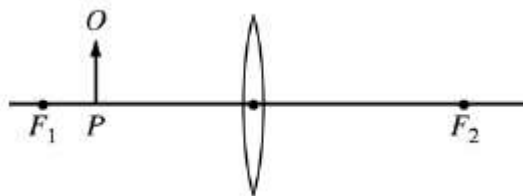
56. A ray of light in glass that is incident on an interface with ice, as shown, is partially reflected and partially refracted. The index of refraction n for each of the two media is given in the figure. How do the angle of reflection and the angle of refraction compare with the angle of incidence θ ?



- | Angle of
Reflection | Angle of
Refraction |
|------------------------|------------------------|
| (A) Same | Larger |
| (B) Same | Smaller |
| (C) Smaller | Same |
| (D) Smaller | Smaller |

Questions 57-58:

An object O is located at point P to the left of a converging lens, as shown in the figure. F_1 and F_2 are the focal points of the lens.



57. If the focal length of the lens is 0.40 m and point P is 0.30 m to the left of the lens, where is the image of the object located?
- (A) 1.2 m to the left of the lens
(B) 0.17 m to the left of the lens
(C) At the lens
(D) 0.17 m to the right of the lens
58. Which of the following characterizes the image when the object is in the position shown?
- (A) Real, inverted, and smaller than the object
(B) Real, upright, and larger than the object
(C) Real, inverted, and larger than the object
(D) Virtual, upright, and larger than the object
59. A ray of light in air is incident on a $30^\circ\text{-}60^\circ\text{-}90^\circ$ prism, perpendicular to face ab , as shown in the diagram. The ray enters the prism and strikes face ac at the critical angle. What is the index of refraction of the prism?

- A) $\frac{1}{2}$ B) $\sqrt{\frac{3}{2}}$ C) $\frac{2\sqrt{3}}{3}$ D) 2

