Chapter 10 Review Questions

Solutions can be found in Chapter 12.

Section I: Multiple Choice

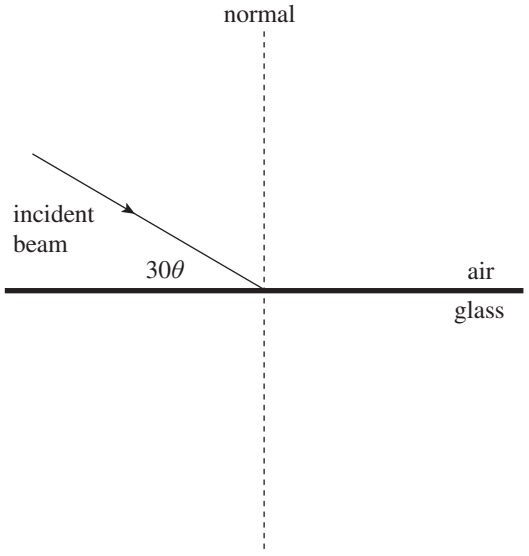
1. What is the wavelength of an X-ray whose frequency is 1.0×10^{18} Hz ?

   (A) 3.3×10^{-11} m
   (B) 3.0×10^{-10} m
   (C) 3.3×10^{-9} m
   (D) 3.0×10^{-8} m

2. In Young's double-slit interference experiment, what is the difference in path length of the light waves from the two slits at the center of the first bright fringe above the central maximum?

   (A $\frac{1}{4}\lambda$
   (B) $\frac{1}{2}\lambda$
   (C) λ
   (D) $\frac{3}{2}\lambda$

3. A beam of light in air is incident upon the smooth surface of a piece of flint glass, as shown:



   If the reflected beam and refracted beam are perpendicular to each other, what is the index of refraction of the glass?

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

4. When green light (wavelength = 500 nm in air) travels through diamond (refractive index = 2.5), what is its wavelength?

   (A) 200 nm
   (B) 300 nm
   (C) 500 nm
   (D) 1250 nm

5. A beam of light traveling in Medium 1 strikes the interface to another transparent medium, Medium 2. If the speed of light is less in Medium 2 than in Medium 1, the beam will

   (A) refract toward the normal
   (B) refract away from the normal
   (C) undergo total internal reflection
   (D) have an angle of reflection smaller than the angle of incidence

6. If a clear liquid has a refractive index of 1.45 and a transparent solid has an index of 2.90 then, for total internal reflection to occur at the interface between these two media, which of the following must be true?

	incident beam originates in	at an angle of incidence greater than
(A)	The solid	30°
(B)	The liquid	30°
(C)	The liquid	60°
(D)	Total internal reflection cannot occur.	

7. An object is placed 60 cm in front of a concave spherical mirror whose focal length is 40 cm. Which of the following best describes the image?

	Nature of image	Distance from mirror
(A)	Virtual	24 cm
(B)	Real	24 cm
(C)	Virtual	120 cm
(D)	Real	120 cm

8. An object is placed 60 cm from a spherical convex mirror. If the mirror forms a virtual image 20 cm from the mirror, what's the magnitude of the mirror's radius of curvature?

   (A) 7.5 cm
   (B) 15 cm
   (C) 30 cm
   (D) 60 cm

9. The image created by a converging lens is projected onto a screen that's 60 cm from the lens. If the height of the image is 1/4 the height of the object, what's the focal length of the lens?

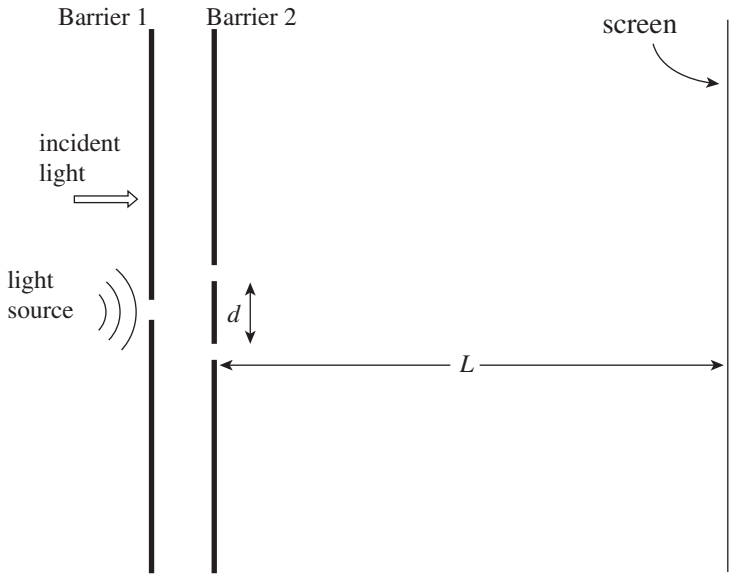
   (A) 36 cm
   (B) 45 cm
   (C) 48 cm
   (D) 72 cm

10. Which of the following is true concerning a bi-concave lens? (A bi-concave lens has both surfaces concave.)

    (A) Its focal length is positive.
    (B) It cannot form real images.
    (C) It cannot form virtual images.
    (D) It can magnify objects.

Section II: Free Response

1. Two trials of a double-slit interference experiment are set up as follows. The slit separation is $d = 0.50$ mm, and the distance to the screen, L, is 4.0 m.



(a) What is the purpose of the first (single-slit) barrier? Why not use two light sources, one at each slit at the second barrier? Explain briefly.

In the first trial, white light is used.

(b) What is the vertical separation on the screen (in mm) between the first-order maxima for red light ($\lambda = 750$ nm) and violet light ($\lambda = 400$ nm)?

(c) Locate the nearest point to the central maximum where an intensity maximum for violet light ($\lambda = 400$ nm) coincides with an intensity maximum for orange-yellow light ($\lambda = 600$ nm).

In the second trial, the entire region between the double-slit barrier and the screen is filled with a large slab of glass of refractive index $n = 1.5$, and monochromatic green light ($\lambda = 500$ nm in air) is used.

(d) What is the separation between adjacent bright fringes on the screen?

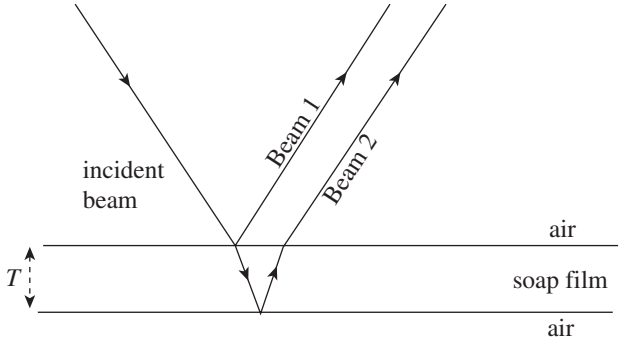
2. In order to determine the criteria for constructive and destructive interference, the following rules are used:

   i) When light strikes the boundary to a medium with a higher refractive index than the incident medium, it undergoes a 180° phase change upon reflection (this is equivalent to a shift by one-half wavelength).

   ii) When light strikes the boundary to a medium with a lower refractive index than the incident medium, it undergoes no phase change upon reflection.

   These rules can be applied to the two situations described below.

   A thin soap film of thickness *T,* consisting of a mixture of water and soap (refractive index = 1.38), has air on both sides. Incident sunlight is reflected off the front face and the back face, causing interference.



   (a) Which beam, 1 or 2, suffers a 180° phase change upon reflection?

   (b) Since the beams are out of phase, destructive interference will occur if the difference in their path lengths, $\Delta\ell \approx 2T$ for near-normal incidence, is equal to a whole number of wavelengths (wavelength as measured in the soap film). What is the criterion for constructive interference? Write your answer as an algebraic equation.

3. An object of height 5 cm is placed 40 cm in front of a spherical concave mirror. An image is formed 72 cm behind the mirror.

   (a) Is the image real or virtual?

   (b) Is the image upright or inverted?

   (c) What's the height of the image?

   (d) What is the mirror's radius of curvature?

   (e) In the figure below, sketch the mirror, labeling its vertex and focal point, and then construct a ray diagram (with a minimum of two rays) showing the formation of the image.