Exam 3  Chapters 23 - 26 in Young 9e

On the following problems show all your work. Partial credit will be given, if earned. Write your answers in the blanks provided. All answers must include the correct plus or minus sign and the correct units.

(10 pts) 1. Unpolarized light with intensity 4.00 W/m² is incident to two polarizing filters. The axis of the first filter is vertical. What is the angle between the vertical direction and the axis of the second filter if the intensity of the light after it passes through the second filter is 1.25 W/m²?

Ans. __________

(10 pts) 2. A ray of light traveling in air is incident at angle θ on one face of a 90° prism made of glass. Part of the light refracts into the prism as shown in the sketch and strikes the opposite face at point A. If the ray at point A is at the critical angle, what is the angle θ?

Ans. __________

![Diagram of light ray through prism with angles labeled θ, 30°, 90°, and A.](image)
(10 pts) 3. A person can see clearly up close but cannot focus on an object farther than 1.50 m from her eye. What focal length contact lens is needed to allow her to see distant objects clearly? Is the required lens converging or diverging?

Ans. \( f = \) \_

converging or diverging? \_

(12 pts) 4. A cylindrical laser beam has diameter 8.00 mm. The average energy density in the beam is \( 8.00 \times 10^{-3} \text{ J/m}^3 \).

(a) What is the amplitude of the magnetic field in the beam?

Ans. \_

b) What is the power output of the laser?

Ans. \_

(10 pts) 5. Coherent light of wavelength 600 nm is incident on a narrow slit. The diffraction pattern is observed on a screen that is 4.00 m from the slit. On the screen the width of the central maximum of the diffraction pattern is 3.00 mm. What is the width of the slit?

Ans. \_

\[ \text{Diagram of diffraction pattern with a slit and an arrow indicating 3 mm.} \]
(14 pts) 6. A very thin sheet of glass is below a layer of water in a container. There is air below the glass. A ray of light traveling in the water strikes the glass at normal incidence. The ray has wavelength 500 nm in air. What is the smallest nonzero thickness $t$ of the sheet of glass if there is constrictive interference between light reflected at the top and bottom surfaces of the glass? The refractive index of water is 1.33 and the refractive index of the glass is 1.50.

\[
\begin{array}{c}
\text{water} \\
\downarrow \\
\text{glass} \\
\downarrow \\
\text{air}
\end{array}
\]

Answer: __________

(16 pts) 7. An object 2.00 mm tall is placed 12.0 cm to the left of a concave mirror and a screen is placed to the left of the object. The mirror forms an image of the object on the screen. The height of the image is 6.00 mm.

\[
\begin{array}{c}
\text{object} \\
\uparrow \\
\text{mirror} \\
\downarrow \\
\text{screen}
\end{array}
\]

a) Is the image upright or inverted?  
Answer: __________

b) What is the focal length of the mirror?  
Answer: __________
(18 pts) 8. A 2.00 mm tall object is placed 6.0 cm to the left of a diverging lens that has $f_1 = -12.0$ cm. A converging lens with focal length $f_2 = 18.0$ cm is placed 5.0 cm to the right of the diverging lens.

![Diagram of two lenses with distances and focal lengths labeled.]

a) What is the object distance for the converging lens, lens 2?  
   Ans. ____________

b) Is the final image real or virtual?  
   Ans. ____________

c) Is the final image upright or inverted?  
   Ans. ____________

d) What is the height of the final image?  
   Ans. ____________

e) How far is the final image from the object?  
   Ans. ____________