ave. = 7.5
σ = 1.5

Physics 11
Spring 2026

Name Answer Key

Quiz #9: Ray Optics

Problem 1 (1.5 points)
A fiber optic line is composed of a core with an index of refraction of 1.47 and cladding with and index of refraction of 1.31. Which one of the following relations best describes angles of incidence θ that will result in total internal reflection within the fiber optic line?

B

a) $\theta < 63°$
b) $\theta > 63°$
c) $\theta < 27°$
d) $\theta > 27°$
e) $0° \le \theta \le 90°$

$\theta_c = \sin^{-1}(n_2/n_1) = \sin^{-1}\left(\frac{1.31}{1.47}\right)$

$\theta_c = 63°$

total internal reflection occurs if $\theta > \theta_c$

Problem 2 (1.5 points)
An object in front of a lens produces an image with a magnification of m = -2.50. What type of lens is it?

since $m < 0$, image is inverted (+ real)

since $|m| > 1$, image is enlarged

⇒ only a converging lens produces an enlarged, inverted image

A

a) converging lens
b) diverging lens
c) not enough information given

Problem 3 (3 points)
The image behind a convex mirror (radius of curvature = 68 cm) is located 22 cm from the mirror. (a) Where is the object located and (b) what is the magnification of the mirror? Determine whether the image is (c) upright or inverted and (d) larger or smaller than the object.

$f = -\frac{1}{2}R = -\frac{1}{2}(68\text{cm}) = -34\text{cm}$

$s' = -22\text{cm}$ $\quad \frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \rightarrow \frac{1}{s} = \frac{1}{f} - \frac{1}{s'}$

$\frac{1}{s} = \frac{1}{-34\text{cm}} - \frac{1}{-22\text{cm}} \rightarrow s = 62.3\text{cm}$

62cm

(b) $m = -s'/s = -\frac{(-22\text{cm})}{62.3\text{cm}} \rightarrow m = 0.35$

(c) upright ($m > 0$)

(d) smaller ($|m| < 1$)

Problem 4 (4 points)
The focal length of a converging lens is 35.0 cm. A 5.0 cm tall object is placed 55.0 cm from the lens.

(a) What is the height of the image and where is it located?
(b) Is the image upright or inverted? Is the image real or virtual? Is the image enlarged or reduced?

$f = 35.0\,cm$

$s = 55.0\,cm$

$h = 5.0\,cm$

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \rightarrow \frac{1}{s'} = \frac{1}{f} - \frac{1}{s}$

$\frac{1}{s'} = \frac{1}{35.0\,cm} - \frac{1}{55.0\,cm} \rightarrow \boxed{s' = 96.3\,cm}$

$m = -s'/s = -\frac{(96.3\,cm)}{55.0\,cm} \rightarrow m = -1.75$

$h' = mh = (-1.75)(5.0\,cm) \rightarrow \boxed{h' = 8.75\,cm}$

$(-8.75\,cm$ because image is inverted$)$

(b) Image is $\boxed{\text{inverted}}$ $(m < 0)$

Image is $\boxed{\text{real}}$ $(s' > 0)$

Image is $\boxed{\text{enlarged}}$ $(|m| > 1)$