Unit 15 · Refraction at Plane Surfaces

WORKSHEET

Full marks 36

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 36

1 Key words [4]

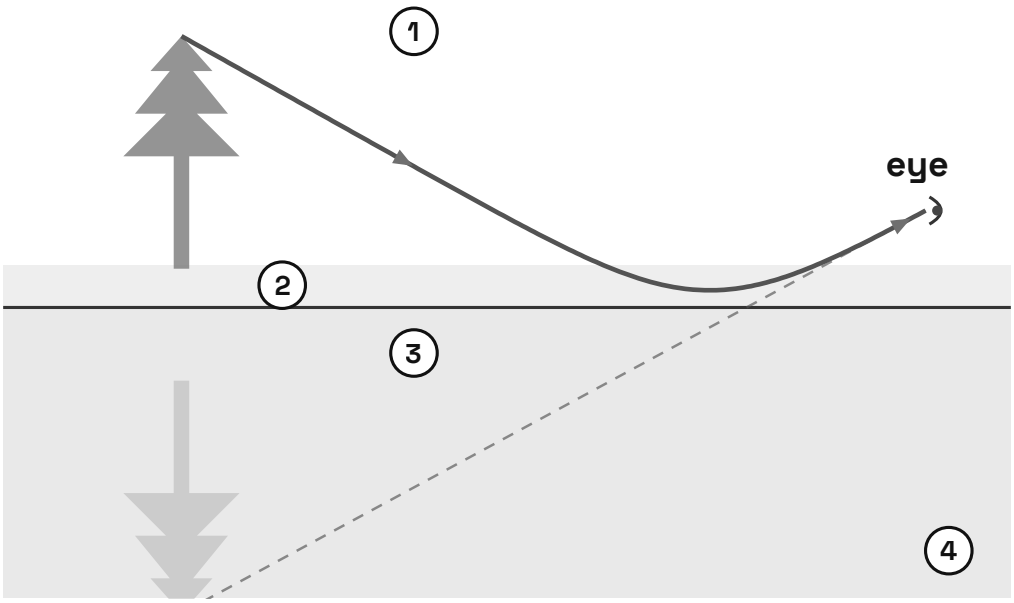
Fill in the blanks with words from the box. Two words in the box are not needed. Each blank carries 0.5 mark.

apparent depth	**critical angle**	**dispersion**	**lateral shift**	**magnification**	**optical fiber**
optically denser	**refraction**	**refractive index**	**total internal reflection**		

The bending of light as it passes from one medium into another is called _____. The ratio of the speed of light in a vacuum to its speed in a medium is the absolute _____ of the medium. A medium in which light travels more slowly is said to be _____. When an object lies under water, its depth seen from above is the _____. A ray passing through a parallel-sided glass slab comes out parallel to the incident ray, displaced by the _____. The angle of incidence in the denser medium for which the angle of refraction is 90° is the _____. Beyond it all the light is reflected back: _____. This guides light along an _____.

2 Label the diagram [2]

The diagram shows how a mirage forms over a hot road. Write the words that belong in place of 1 to 4. Each carries 0.5 mark.



1. _____ **2.** _____

3. _____ **4.** _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. A ray of light passes from glass ($\mu = 1.5$) into water ($\mu = 1.33$). It: [1]

a. goes on without bending
b. bends towards the normal
c. bends away from the normal
d. is always totally reflected

ii. Kerosene floats on water, yet it is optically denser than water, because: [1]

a. its mass per volume is greater
b. light travels more slowly in it
c. light travels faster in it
d. it absorbs more light

iii. The refractive index of glass with respect to air is 1.5. The refractive index of air with respect to glass is: [1]

a. 1.5
b. 0.67
c. 0.5
d. 2.25

iv. Total internal reflection can happen only when light: [1]

a. goes from a rarer into a denser medium at any angle
b. goes from a rarer into a denser medium at more than the critical angle
c. goes from a denser towards a rarer medium at more than the critical angle
d. falls along the normal

v. A mark lies under a glass slab 4.5 cm thick ($\mu = 1.5$). Looking straight down, the mark seems to be raised by: [1]

a. 3.0 cm
b. 2.25 cm
c. 1.5 cm
d. 0.67 cm

4 Very short answers [3]

Write very short answers to the following questions.

a. Define the absolute refractive index of a medium. [1]

b. State the principle of reversibility of light. [1]

c. What happens to the lateral shift through a glass slab as the angle of incidence approaches 90°? [1]

5 Short answers [6]

Write short answers to the following questions.

a. Write two reasons why a totally reflecting prism is better than a plane mirror in a periscope or binoculars. [2]

b. Light goes from medium a into medium b. Show that ${}_a\mu_b = 1/{}_b\mu_a$. [2]

c. A pencil dipped at a slant into a glass of water seems bent at the surface. Explain why. [2]

6 Long answer [4]

Write a long answer to the following question.

A ray of light falls at an angle of incidence i on a parallel-sided glass slab of thickness t and is refracted at an angle r. With a labelled diagram, show that the lateral shift is $L = t \sin(i - r)/\cos r$.

7 Numerical problems [10]

Solve the following problems. Show your working. Take the speed of light in a vacuum as 3×10^8 m/s.

a. Sunlight falls on the water of a glass fish tank at an angle of incidence of 50°. It passes through the water ($\mu = 1.33$) and then into the tank's glass bottom ($\mu = 1.52$). Find the angle of refraction in the water and in the glass. [3]

Answer: _____

b. A ray falls at 60° on a glass slab 5.0 cm thick, of refractive index 1.52. Find the lateral shift. [3]

Answer: _____

c. The critical angle of a kind of glass in air is 40°. Find i. its refractive index, ii. the speed of light in it, and iii. the critical angle at its boundary with water ($\mu = 1.33$). [4]

Answer: _____

8 Think [2]

A fish under the still water of a pond looks up at a bird sitting on a branch. Does the bird look higher or lower above the water than it really is? Explain.

9 Activity: The refractive index of water (not marked)

Stand a coin at the bottom of a tall glass. Pour in water to a depth R and, looking straight down, slide a pencil along the outside of the glass until its tip seems level with the coin; measure the apparent depth a from the water's surface to the pencil's tip. Repeat for three depths.

Real depth R (cm)	Apparent depth a (cm)	$\mu = R \div a$

What is the average of your values of μ?