3055 BA SANGAM COLLEGE

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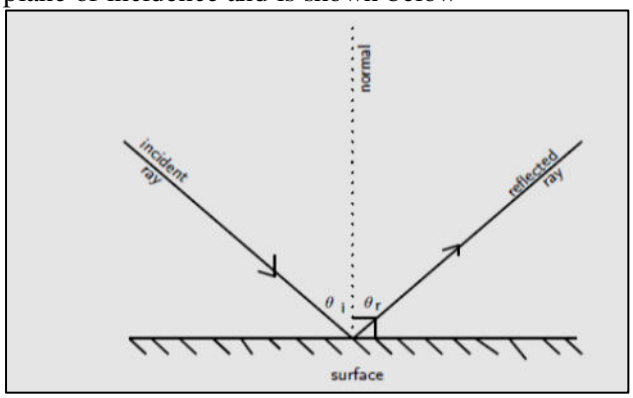
WORKSHEET 8

SCHOOL:BA SANGAM COLLEGE YEAR 12
SUBJECT: PHYSICS NAME OF STUDENT: _____

STRAND	***GEOMETRICAL OPTICS AND WAVE MOTION***
SUB-STRAND	*Light*
Content Learning Outcome	➢ *Analyze situations in which light is refracted and relate to particle model*

Reflection

The incoming light ray is called the **incident ray.** Thelight ray moving away from the surface is the **reflected ray**. The most important characteristic of these rays is their angles in relation to the reflecting surface. These angles are measured with respect to the **normal** of the surface. The normal is an imaginary line perpendicular tothe surface. The angle of incidence, θ_i is measured between the incident ray and the surface normal. The angle of reflection, θ_r is measured between the reflected ray and the surfacenormal. This is shown in Figure below. When a ray of light is reflected, the reflected ray lies in the same plane as the incident ray and the normal. This plane is called the plane of incidence and is shown below



The angles of incidence and reflection are measured with respect to the surface normal.

Law of Reflection

The Law of Reflection states that the angles of incidence and reflection are always equal and that the reflected ray always lies in the plane of incidence.

Definition: Law of Reflection

The Law of Reflection states that the angle of incidence is equal to the angle of reflection.

$$\Theta_i = \theta_r$$

Example

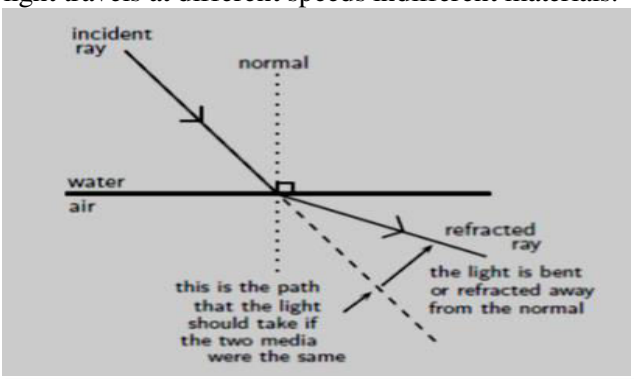
An incident ray strikes a smooth reflective surface at an angle of 33° to the surface normal. Calculate the angle of reflection.

Answer

We are given the angle of incidence to be 33°.
Therefore, the angle of reflection isalso 33^0.

Refraction

Refraction is the bending of light that occurs because light travels at different speeds indifferent materials.



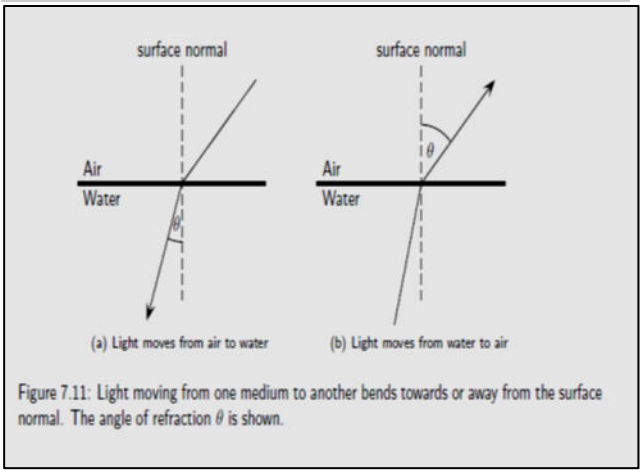


Figure 7.11: Light moving from one medium to another bends towards or away from the surface normal. The angle of refraction θ is shown.

Refractive Index

The refractive index of a material is the ratio of the speed of light in a vacuum to its speed in the medium.

Definition: Refractive Index

The refractive index (symbol n) of a material is the ratio of the speed of light in a vacuum to its speed in the material and gives an indication of how difficult it is for light to get through the material.

$$n = \frac{c}{v}$$

where
n = refractive index (no unit)
c = speed of light in a vacuum ($3{,}00\times 10^{8}$ m/s)
v = speed of light in a given medium (m /s)

we can also examine how the speed of light changes in different media, because the speed of light in a vacuum (c) is constant. If the refractive index n increases, the speed of light in the material v must decrease. Light therefore travels slowly through materials of high n.

Snell's Law

$$n_1 \sin\Theta_1 = n_2 \sin\Theta_2$$

Where: n_1 = absolute refractive index of medium of medium 1.

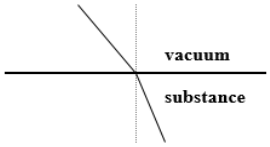
θ_1 = angle of incidence in medium 1.

N_2 = absolute refractive index of medium 2.

θ_2 = angle of refraction in medium 2.

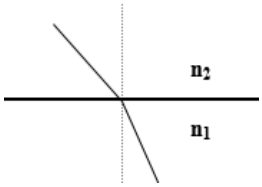
The ***absolute refractive index*** of a substance is given by:

$$n = \frac{\sin i}{\sin r}$$



The ***relative refractive index*** of two media when light goes from one substance to another is given by:

$$n_{12} = \frac{\sin i}{\sin r} = \frac{n_2}{n_1}$$



Refractive index of some substances

Substance	*n*
Air	*1*
Water	*1.33*
Ice	*1.31*
glass	*1.5*
Diamond	*2.42*
Paraffin oil	*1.44*

Example

1. A light ray with an angle of incidence of 35◦ passes from water to air.

$N_1 \sin\Theta_1 = n_2 \sin\Theta_2$

$1{,}33 \sin 35^0 = 1 \sin \Theta_2$

$\sin \Theta_2 = 0{,}763$

$\Theta_2 = 49.7^0$

2. A light ray passes from water to diamond with an angle of incidence of 75^0. Calculate the angle of refraction

$n_1 \sin\Theta_1 = n_2 \sin\Theta_2$

$1{,}33 \sin 75^0 = 2.42 \sin \Theta_2$

$\sin \Theta_2 = 0.531$

$\Theta_2 = 32.1^0$

Exercise

1. A ray of light travels from air to glass. If the angle of refraction is 40°, find the angle of incidence.

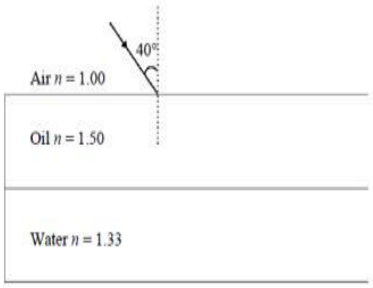
(2 Marks)

2. A ray of light traveling from toluene has an angle of incidence of 27°. If the angle of refraction is 42.5°, find the refractive index of toluene?

(2 Marks)

3.

Neelam noticed a puddle of water with oil floating on top. The diagram below shows a ray of light travelling from air as it meets the air-oil interface.



(i) Complete the path of the ray of light in the diagram provided in the **Answer Book** to show what happens to the ray as it enters the oil, and then the water. **(1 mark)**

(ii) The ray of light meets the air-oil interface at an angle of incidence of 40°, as shown above. Calculate the angle of refraction when the ray goes into the water. **(1½ marks)**

Note:

When a ray of light passes through a block of material then the ray emerging from the block is parallel to the incident ray but is displaced by a small distance.