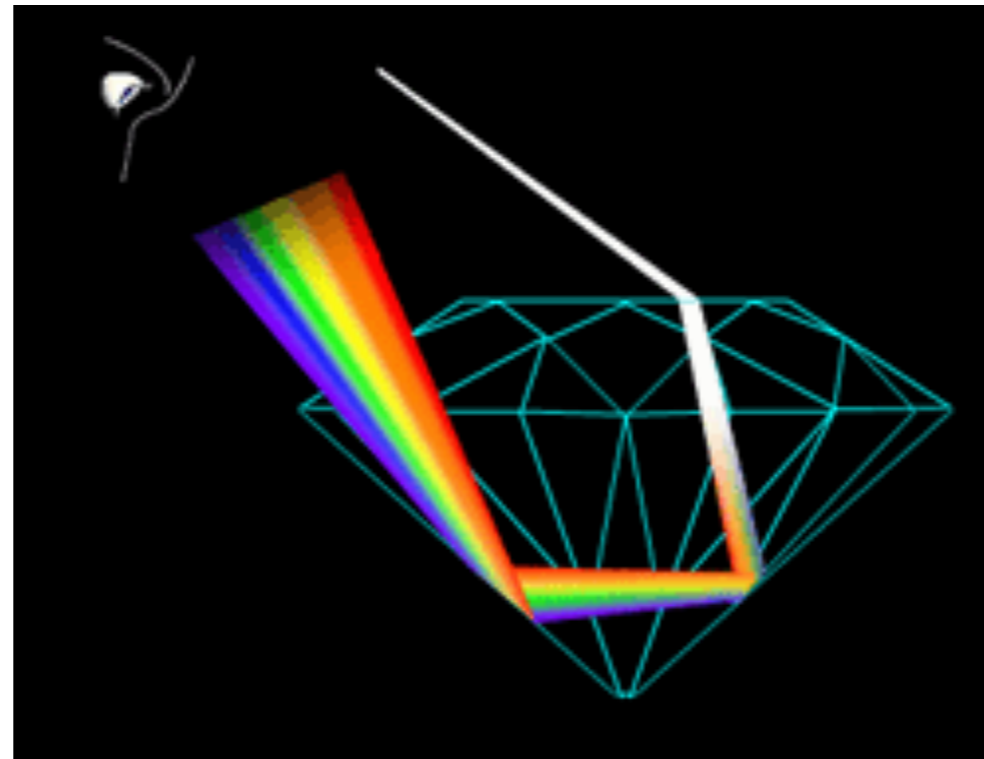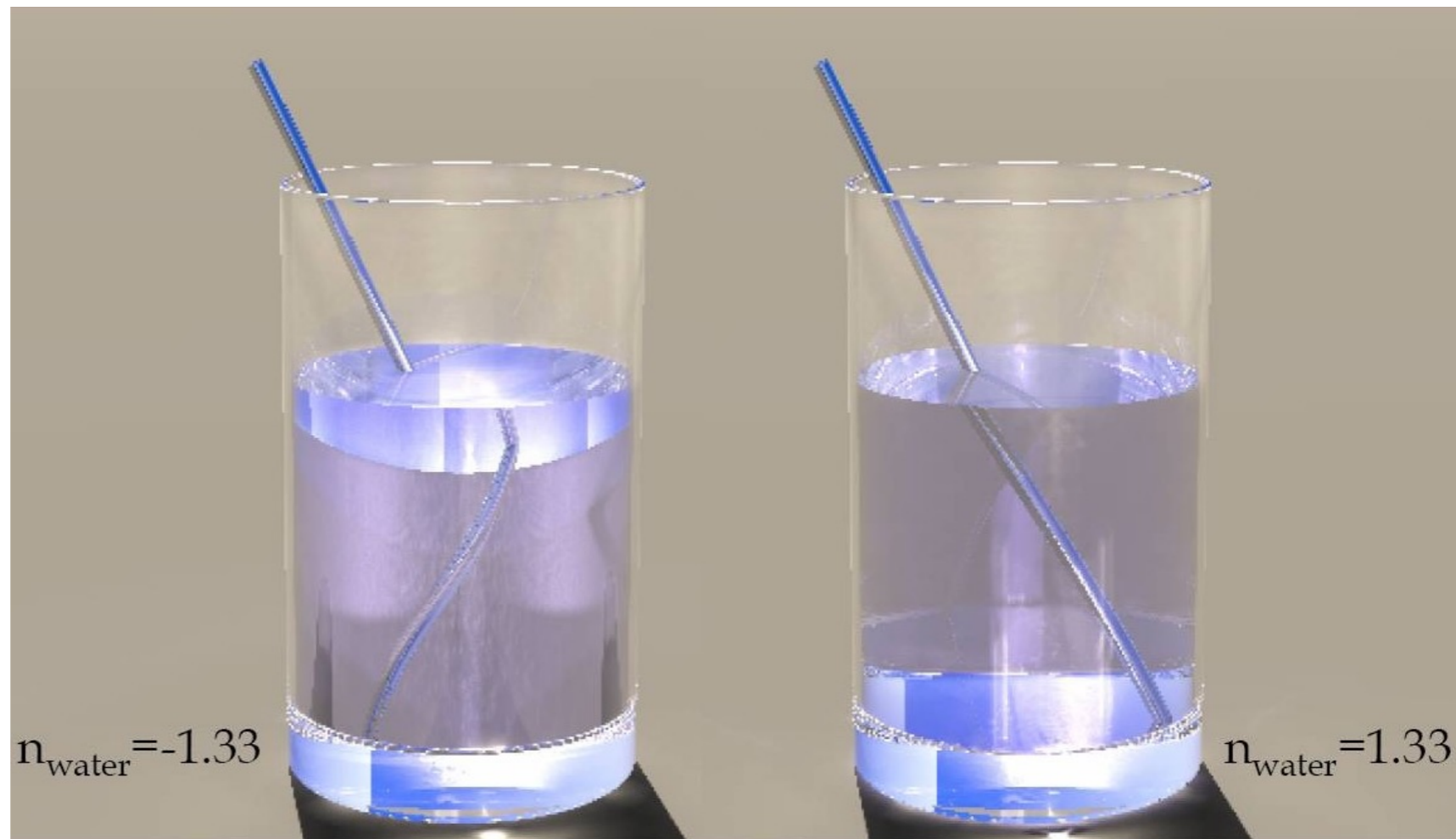# Refraction Index
(Snell's Law)
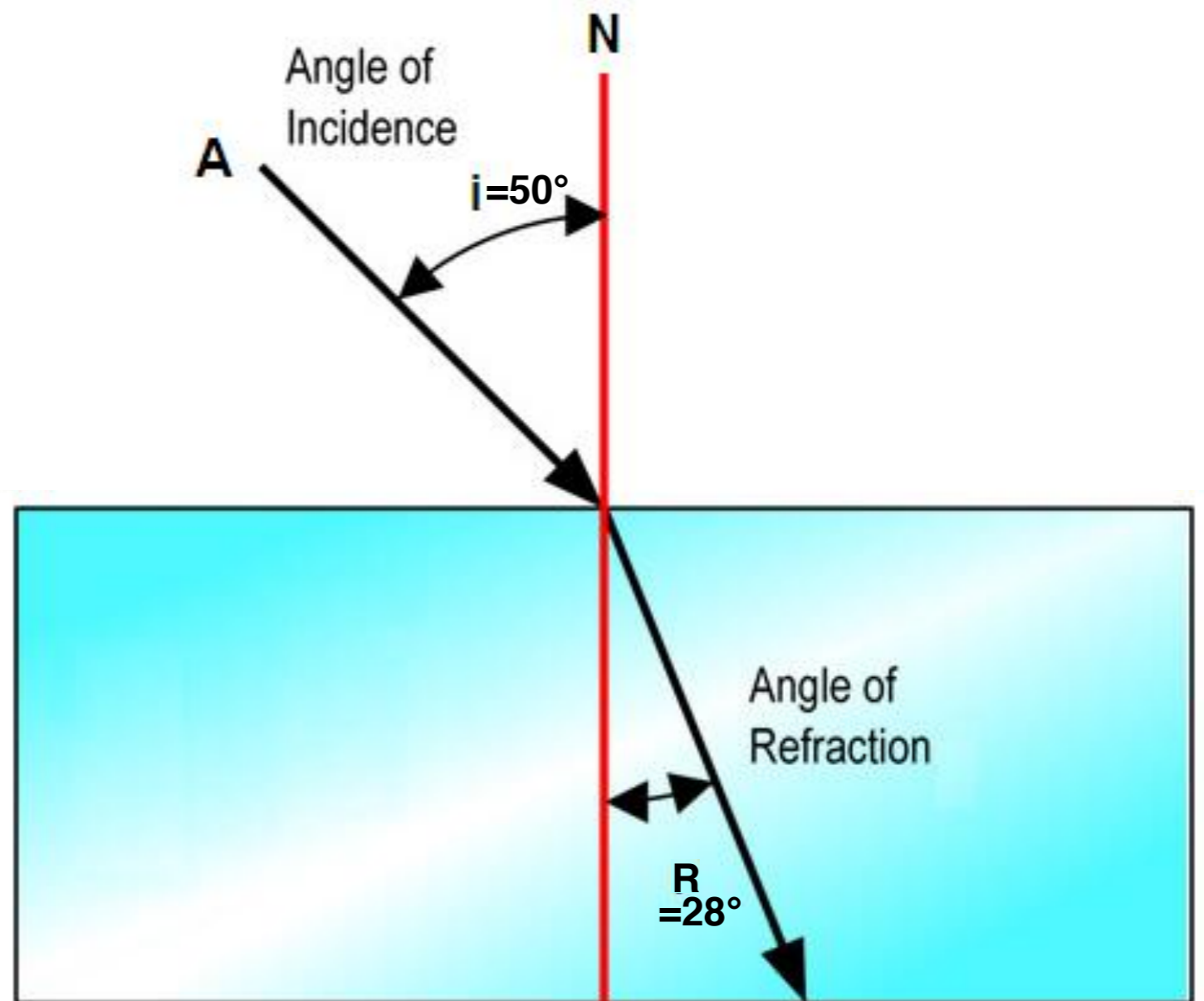
The Index of Refraction

- The amount by which a transparent medium decreases the speed of light is called the **refractive index**.

- **Larger refractive indexes decreases the speed of light the most.**

$n_{water}=-1.33$

$n_{water}=1.33$

Calculating Index of Refraction Using Angles

- The refractive index **(n)** can be calculated using the following;

$$n = \frac{\sin\angle i}{\sin\angle R}$$
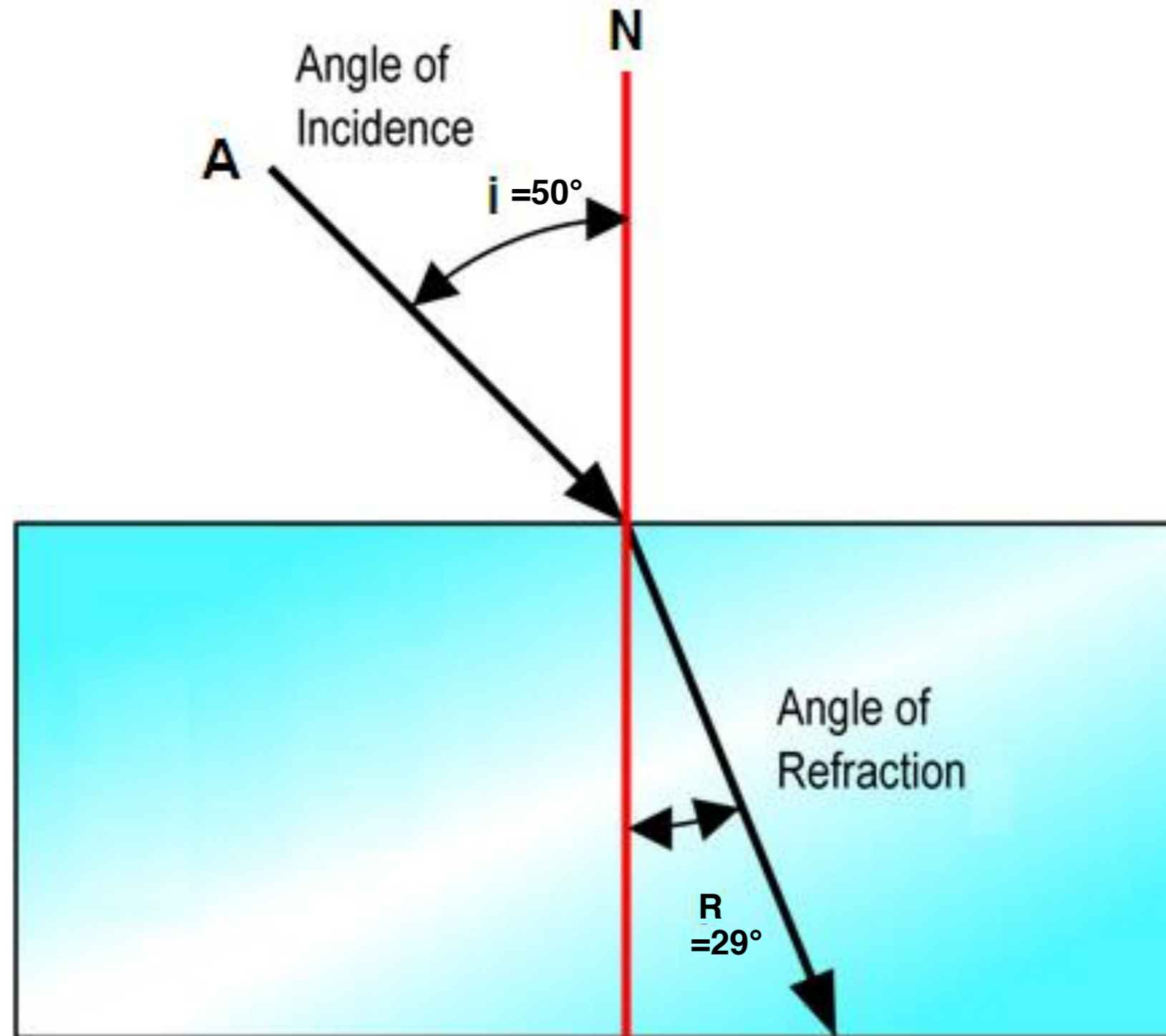
The Index of Refraction

$n = \dfrac{\sin \angle i}{\sin \angle R}$

$n = \dfrac{\sin 50°}{\sin 29°}$

$n = \dfrac{.766}{.485}$
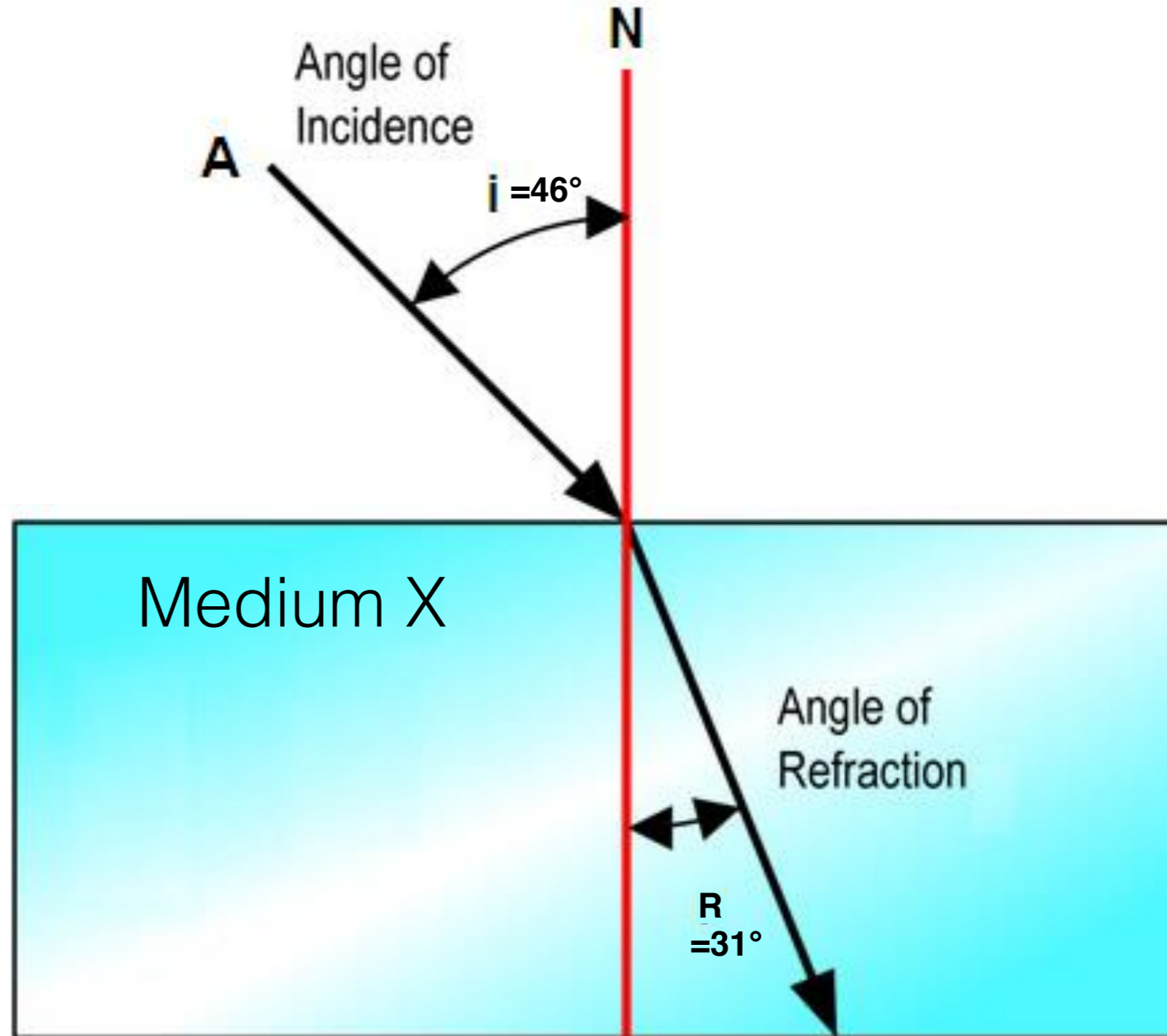
$n = 1.58$

N

Angle of
Incidence

A

i = 50°

Angle of
Refraction

R
= 29°
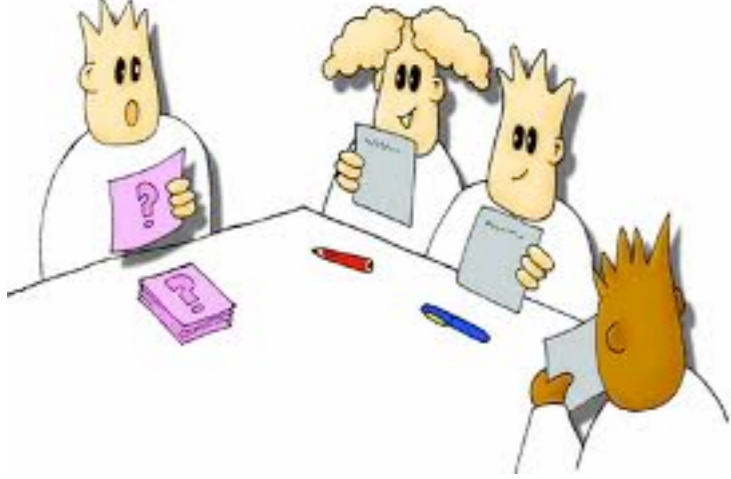
What is the refractive index, **n** of this medium Y, if the incident ray is travelling through air?

Calculating Index of Refraction using Light Speeds

- The refractive index **n** can also be calculated if you know;
  - -speed of light in the medium, **(v)**
  - **-**speed of light in a vacuum, **(c)**   **c =** 3.00×10^8 m/s

Index of refraction(n) = $\underline{\text{Speed of light in vacuum}}$
                                          Speed of light in medium
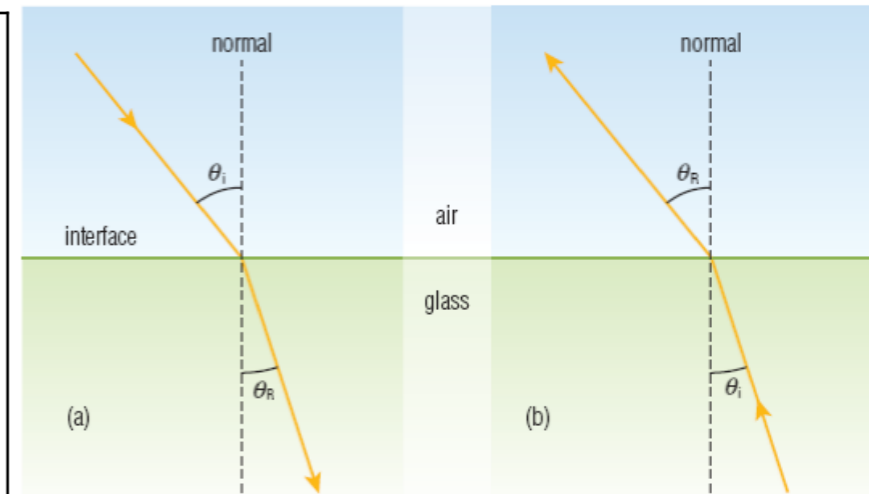
OR

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

The Index of Refraction

Index of refraction of Material = $\dfrac{\text{Speed of light in vacuum}}{\text{Speed of light in medium}}$
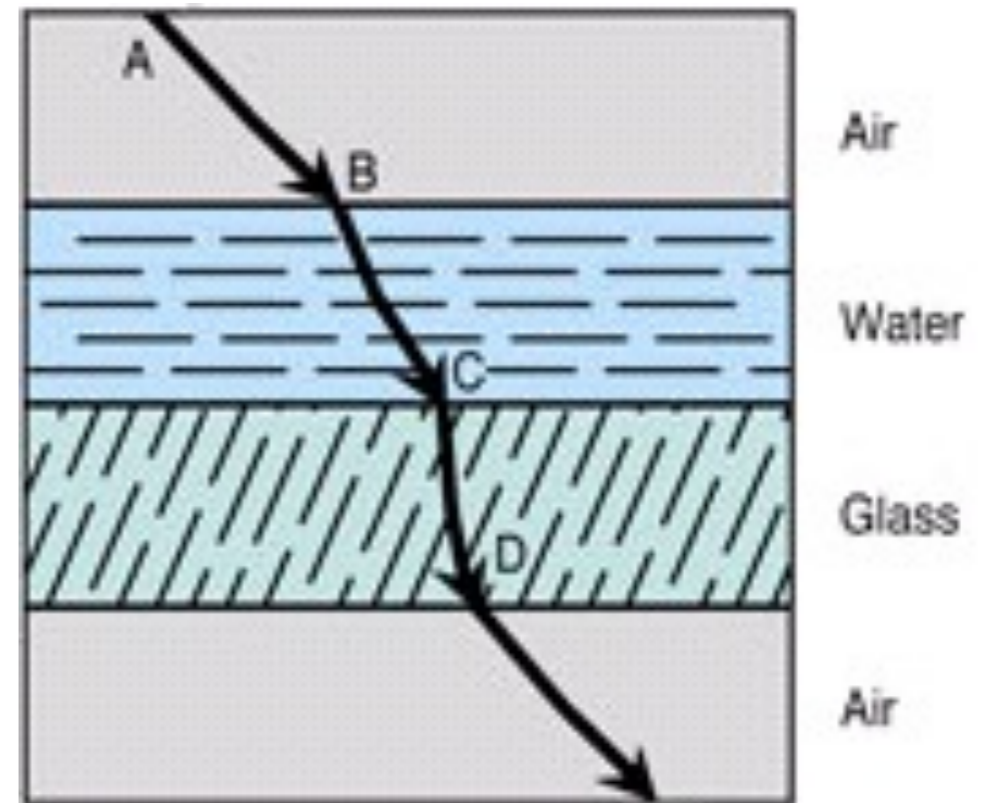
OR

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

also

$$n = \frac{sin<i}{sin<R}$$

Index of Refraction Values

Media	Index of refraction
Vacuum	1.00 (exactly)
Air	1.0003
CO_2 gas	1.0005
Water	1.33
Alcohol	1.36
Pyrex glass	1.47
Plexiglas	1.49
Table Salt	1.51
Flint glass	1.61
Sapphire	1.77
Cubic Zirconia	2.16
Diamond	2.42
Gallium phosphide	3.50

Example Problem 1

- The speed of light in a sample of glass is 1.91×10^8 m/s. The speed of light in a vacuum is 3.00×10^8 m/s.
- What is the refractive index of this glass?

$v = 1.91 \times 10^8$ m/s $c = 3.00 \times 10^8$ m/s		$n = \dfrac{3.00 \times 10^8 \text{ m/s}}{1.91 \times 10^8 \text{ m/s}} =$ $= 1.57$
Refractive index $n = ?$		Therefore, the index of refraction is 1.57
$n = \dfrac{c}{v}$		

Example Problem 2

- What is the speed of light in water given that water has a refractive index of 1.33?

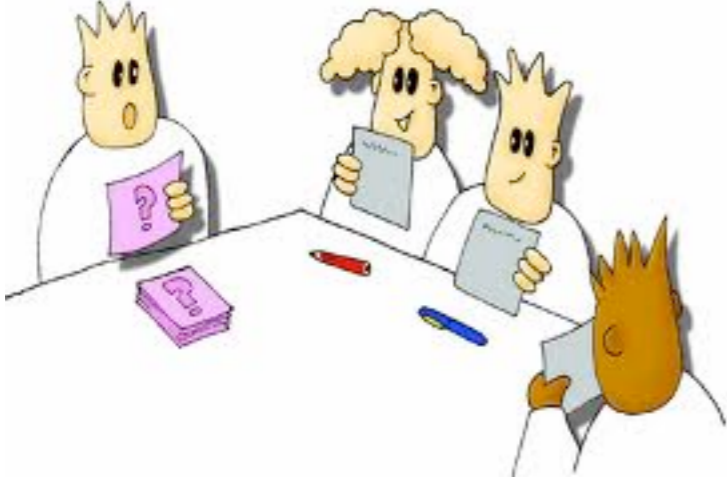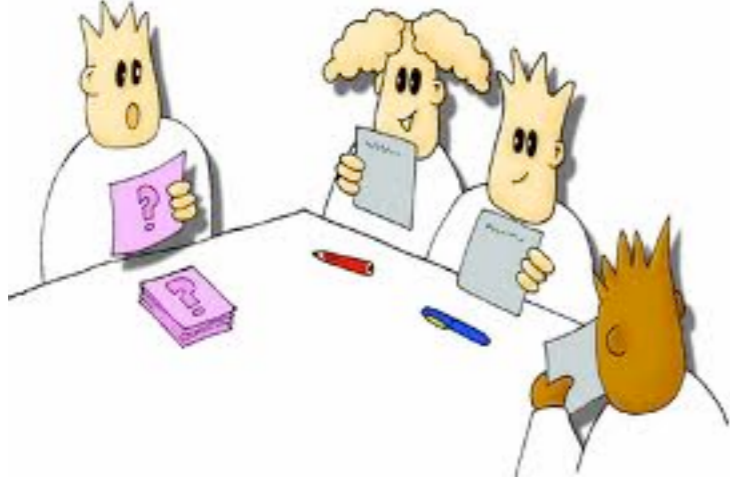|		
Refractive index of water n = 1.33 Speed of light in vacuum c = 3.00×10^8 m/s		$v = \dfrac{3.00 \times 10^8 \text{ m/s}}{1.33}$ $= 2.26 \times 10^8$ m/s
Speed of light in water v = ?		Therefore, the speed of light in water is 2.26×10^8 m/s.
$n = \dfrac{c}{v}$	$v = \dfrac{c}{n}$	

- What is the speed of light in plexiglass given it has a refractive index of 1.49?

a. The speed of light in some solid is 1.863×10^8 m/s. What is its refractive index?

b. What could the substance be based on this chart?

Media	(n)
Vacuum	1.00 (exactly)
Air	1.0003
CO_2 gas	1.0005
Water	1.33
Alcohol	1.36
Pyrex glass	1.47
Plexiglas	1.49
Table Salt	1.51
Flint glass	1.61
Sapphire	1.77
Cubic Zirconia	2.16
Diamond	2.42
Gallium phosphide	3.50