



### Applied Optics for Engineers

Exercise 1: **Reflection and refraction of light** (10 points) (10 minutes)

**Background:** Light is reflected, light is refracted. Drawing lines of incident, normal, reflected, refracted and other information comes from ray-lengths, wave fronts

**Given Knowledge:** Reflection (the angle  $\theta_{refl}$  is equal to  $\theta_{inc}$ )

Refraction (the angle  $\theta_{refr}$  is smaller than  $\theta_{inc}$  if the light goes from air to water)

1. What is the angle of reflection of a ray incident on a surface at an angle of  $30^\circ$ ?

The angle of reflection is  $30^\circ$ .

2. How does the refractive index of the surface affect the angle of refraction?

The refractive index of the surface affects the angle of refraction. The angle of refraction is smaller than the angle of incidence if the light goes from air to water.

**Light waves up**

Light can travel through many materials. In **vacuum**, the light is fastest and constant in speed. The speed of light can change when it travels from air to water. This is called refraction. The refractive index of a material is the ratio of the speed of light in vacuum to the speed of light in the material.



Draw a ray diagram showing the reflection and refraction of a ray.

3. A ray of light is incident on a surface at an angle of  $30^\circ$ . The refractive index of the surface is  $1.5$ .

(a) What is the angle of reflection of the ray?

The angle of reflection is  $30^\circ$ .

(b) What is the angle of refraction of the ray?

The angle of refraction is  $19.5^\circ$ .

The bending of the light ray is called **refraction**.

4. A ray of light is incident on a surface at an angle of  $30^\circ$ . The refractive index of the surface is  $1.5$ . The angle of refraction is  $19.5^\circ$ .

# Refraction Gizmo Answer Key

**S Baum**



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