





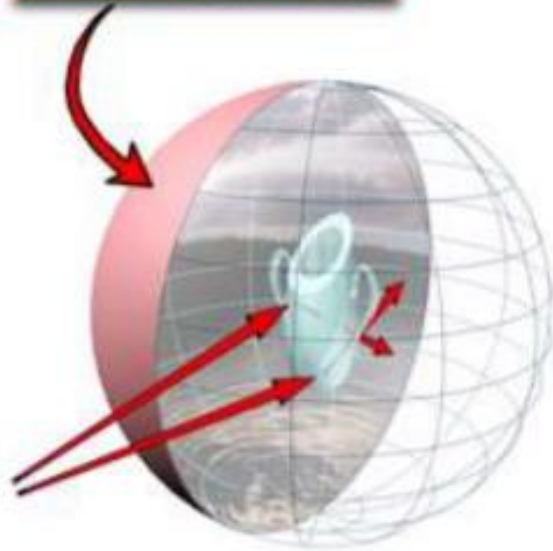
มหาวิทยาลัยราชภัฏนครปฐม
Nakhon Pathom Rajabhat University

Lesson-4-Refraction

Refraction Map

You can use a bitmap file or a procedural map such as Reflect/Refract to control an object's refraction.

-   Material Editor > Standard Material > Maps rollout > Refraction button
-   Material Editor > Arch & Design Material > General Maps rollout > Main Maps group > Refraction Color button
-   Material Editor > Other materials that have a Refraction component



Refractions show the scene or background through a refractive object.

Usage of Refraction maps is similar to that of Reflection maps. Refraction maps the view onto the surface in such a way that the image looks like you're seeing it through the surface, rather than being reflected off it.

Like a Reflection map, a Refraction map does not require mapping coordinates because its orientation is locked to the world coordinate system rather than to the object. That is, as you move or rotate the object, the position of the refracted image remains fixed.

Setting the Index of Refraction

The physical properties of refractive objects often distort the image. This parameter is controlled by the parent material.

Index of Refraction

The index of refraction (IOR) controls the amount by which the material refracts transmitted light. The IOR of air, 1.0, causes no distortion of objects behind the transparent object. At 1.5 the object behind distorts greatly (like a glass marble). At an IOR slightly less than 1.0, the object reflects along its edges, like a bubble seen from under water. Default=1.5 (the IOR of typical glass).

Common IOR values (assuming the camera is in air or a vacuum) are:

Material	IOR Value
Vacuum	1.0 (exactly)
Air	1.0003
Water	1.333
Glass	1.5 to 1.7
Diamond	2.418

In the physical world, the IOR results from the relative speeds of light through the transparent material and the medium the eye or the camera is in. Typically this is related to the object's density. The higher the IOR, the denser the object.

You can also use a map to control the index of refraction. IOR maps always interpolate between 1.0 (the IOR of air) and the setting in the IOR parameter. For example, if you set the IOR to 3.55 and use a black-and-white Noise map to control IOR, the IORs rendered on the object will be set to values between 1.0 and 3.55; the object will appear denser than air. If, on the other hand, you set the IOR to 0.5, then the same map values will render between 0.5 and 1.0: As if the camera is under water and the object is less dense than the water.



Here are some more IOR values for various materials:

Material	IOR Value
Carbon Dioxide, Liquid	1.200
Ice	1.309
Acetone	1.360
Ethyl Alcohol	1.360
Sugar Solution 30%	1.380
Alcohol	1.329
Flourite	1.434
Quartz, Fused	1.460
Cal spar2	1.486
Sugar Solution 80%	1.490
Glass	1.500
Glass, Zinc Crown	1.517
Glass, Crown	1.520
Sodium Chloride	1.530
Sodium Chloride (Salt) 1	1.544
Polystyrene	1.550



Material	IOR Value
Quartz 2	1.553
Emerald	1.570
Glass, Light Flint	1.575
Lapis Lazuli	1.610
Topaz	1.610
Carbon Bisulfide	1.630
Quartz 1	1.644
Sodium Chloride (Salt) 2	1.644
Glass, Heavy Flint	1.650
Methylene Iodide	1.740
Ruby	1.770
Sapphire	1.770
Glass, Heaviest Flint	1.890
Crystal	2.000
Diamond	2.418
Chromium Oxide	2.705
Copper Oxide	2.705
Amorphous Selenium	2.920
Iodine Crystal	3.340

Tip: The Reflect/Refract map type used as a Refraction map doesn't effectively model a material surrounding an object, such as a pencil in a glass of water. For this effect, use either the Thin Wall Refraction or the Raytrace map type.

Procedures

To create an automatic refraction:

1. Click the map button labeled Refraction.

3ds Max opens the Material/Map Browser.

2. Choose Maps ➤ Standard ➤ Reflect/Refract, and then click OK.



Alternatively, you can use the Slate Material Editor to wire a Reflect/Refract map node to the Refraction component.

3. On the parent materials' Maps rollout, adjust the Amount to control how refractive the material is.

At a Refraction Amount of 100 percent, the material is extremely refractive, regardless of the material's Opacity setting.

At a Refraction Amount of 0 percent, the map is turned off. When the Amount is less than 100 percent, both the Reflect/Refract map and the Opacity setting control transparency.

To assign a bitmap as a refraction map:

1. In the Maps rollout, click the Refraction map button.

3ds Max opens the Material/Map Browser.

2. Choose Maps ➤ Standard ➤ Bitmap, and then click OK.



Alternatively, you can use the Slate Material Editor to wire a Bitmap node to the Refraction component.

3ds Max opens a file dialog.

3. Use the file dialog to choose the bitmap file.
4. On the parent materials' Maps rollout, adjust the Amount to control how refractive the material is.

For bitmapped refractions, you don't necessarily want to reduce the map Amount.