Note that creating materials differs greatly between Blender’s Internal and Cycles renderers. In the Internal renderer materials are created in the Properties window; in Cycles they begin in the Properties materials tab but are refined in the Node Editor window. This is because Internal uses scanline and raytracing rendering based on lines shot out from the camera, whereas Cycles uses a more accurate physically based rendering based on rays emitted from the light sources in the scene. This is also the reason Cycles is so much slower to produce images: very few rays emerging from the lights end up in the camera. Only a small proportion will enter the camera to define a pixel color, so millions need to be calculated to create a noise-free image. By contrast scanline and ray traced images are based on lines shot out from every pixel in the image to determine its color. This means they are highly efficient; for each pixel in the render there is just one set of calculations.

We’ll only look at Internal materials here; Cycles is covered in unit 029. Guides to Internal materials and some things you can do with them are at https://users.soe.ucsc.edu/~yonge/02_PDF_guides/011_Materials_1.pdf and https://users.soe.ucsc.edu/~yonge/02_PDF_guides/011_Materials_2.pdf.

The Diffuse and Specular components
A Diffuse color is the color of a surface under diffuse (non-directional) lighting. The Specular color is the color of the highlight on that surface when a directional or point light is present. Generally you want to keep the Specular as white. Raising or lowering the Intensity will make the material look more or less shiny. Changing the Shader from CookTorr to WardIso will give it a billiard ball look. Shaders are the mathematical procedures used to represent surface finishes; for now we’ll stay with the defaults.

The Shading panel
The two controls that we may need just now are Emit (see below for glowing materials) and Shadeless. Shadeless creates a flat color across the object and is frequently used as part of a cartoon (“toon”) shading setup.

Glowing materials
If you want a material to glow in Blender Internal – Cycles handles this automatically – increase the Emit value in the Shading panel in Materials. However, you’ll notice that this does not by itself change the lighting of the scene in Blender Internal. To have the object’s glow affect nearby objects, first go to the World tab and enable Indirect Lighting. Then choose the Approximate gather option in the panel below. You may need to increase the number of
Bounces from the default 1 to 4 or more for a realistic, strong result.

**The Transparency panel**
When you enable Transparency in Blender there are three main options. **Mask**, which acts as a knockout – in other words, any object with Mask transparency cuts its outline from the render to show the background. Note that for this to work Alpha must be set to zero, not the default 1.000.

In the center is **Z Transparency**, which is a fast, non-raytraced transparency that gives the effect of a balloon filled with air. This is a good option for items such as windows, which don’t noticeably refract light rays, as it is a fast transparency that only uses scanline rendering. This time you may want to take your Alpha value down to, but not quite, zero.

Finally there is **Raytrace** transparency. As the name indicates, this uses ray tracing in the scene, and will slow your render in the areas in which it is used. There are also many more controls, but the most important is IOR. This is the Index of Refraction (often called Refractive Index): the amount light is bent due to its changing speed as it enters another transparent material at other than a ninety degree angle. You can find some IORs at [https://en.wikipedia.org/wiki/Refractive_index#Typical_values](https://en.wikipedia.org/wiki/Refractive_index#Typical_values). Note that indices of refraction for liquids and gases vary with temperature and (for gases) pressure. This refraction change with temperature is the reason for air and water appearing to shimmer as they are heated.

If you find odd black areas in your transparent material render, increase the Depth value from the default 2. The Depth specifies the number of times the traced ray is reflected internally – after that Blender Internal gives up calculating ray traces and makes it the sky color. Try a value of 8 and see if that looks better.

Although it is far beyond the scope of this class, you might find it interesting that materials are being developed that mean light can be stopped and stored – [http://www.extremetech.com/extreme/162289-light-stopped-completely-for-a-minute-inside-a-crystal-the-basis-of-quantum-memory](http://www.extremetech.com/extreme/162289-light-stopped-completely-for-a-minute-inside-a-crystal-the-basis-of-quantum-memory).

**Fresnel effect**
You’ll find a value for Fresnel in all three kinds of transparency (though it’s only of use in Z and Raytrace transparency). This effect, named after the French physicist Augustin-Jean Fresnel (1788-1827), describes how materials (all materials, not just metallic) change in reflectance depending on the angle of viewing. A piece of glass looked at straight on is transparent; when seen from a glancing angle it behaves like a mirror. All realistic materials should include this effect, though in practice it’s only added to reflective ones (see below).

**The Mirror panel**
This is another feature that required ray tracing and will slow your renders down in the areas where it is used. When enabled, this defined the reflectance of the mirror surface. Nothing is perfectly reflective; in practice the maximum value is around 0.950. Fresnel value and Depth are as defined for the Transparency panel. The Maximum Distance limits the distance of things that are reflected, and Gloss values of less than one makes the surface look frosted. It’s worth experimenting with this. Glass materials should have Raytrace transparency and Mirror enabled.

**Subsurface Scattering (generally known as SSS)**
If you look at the SSS Presets in this panel you’ll get the idea of what this simulates. These
are waxy materials that scatter transmitted light under the surface, and a typical use is to show the glow from a backlight through a character’s ears. If you’re interested in using this in a project I recommend practicing with a subdivided Suzanne head with a light behind it.

**Multimaterials**
A multimaterial is a way to change materials between faces in a mesh. There is a one-minute guide to this simple procedure at [https://youtu.be/n-ZC155hC7Q](https://youtu.be/n-ZC155hC7Q).

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