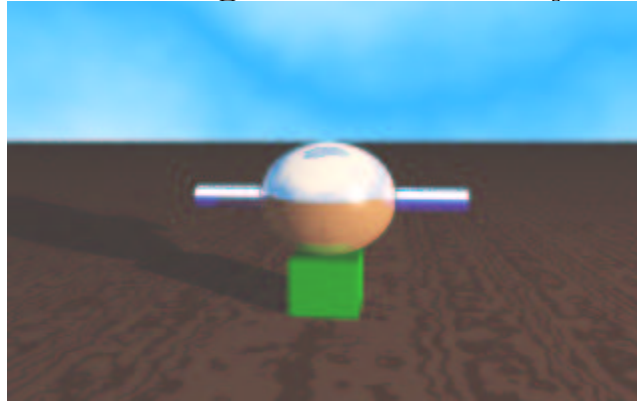# Working with PovRay 2

Understanding vectors.

In PovRay, coordinates in three dimensions are represented by vectors. A vector is a multi−dimensional number, and is noted by < and >.

For example <3,4,5> means 3 units to the right, 4 units up, and 5 units back.
<−3,−4,−5> means 3 units to the left, 4 units down, and 5 units forward.

As an example, lets first set up the scene:

```
camera
{
    location <10,10,−70>
    look_at <0,0,0>
}

light_source
{
    <30,30,−30> color rgb <1,1,1>
}

sphere
{
    <0,0,0>,10
    pigment {color rgb<1,.6,.3>}
}
```

Render this scene to see what it looks like.

Questions:
1) What do the location and look_at arguments of camera mean? Where in 3−space are they?
2) Describe the meaning of the two vectors in light_source.
3) Describe the meaning of the two vectors in sphere. What does the 10 mean?

Lets add an object... maybe a box:

```
box
{
    <-5,-10,-5>,<5,-20,5>
    pigment {color rgb<0,1,0>}
}
```

and two cylinders:

```
cylinder
{
    <10,0,0>,<20,0,0>,2
    pigment {color rgb<0,0,1>}
}
cylinder
{
    <-10,0,0>,<-20,0,0>,2
    pigment {color rgb<0,0,1>}
}
```

Questions:
4) Using the help file lookup what the two vectors in box mean.
5) Using the help file lookup what the two vectors in cylinder mean. What is the number after the two vectors?
6) Write the cylinder statement that would place a cylinder on top of the sphere with a radius of 1 unit and a length of 20 units colored completely red.

Now, lets play with some textures. First, lets shine up the sphere. The way that a surface reflects light in povray is called the finish. In this case we're going to change the finish to be 60% reflective, and have a 60% glare. Change the sphere statement to match:

```
sphere
{
            <0,0,0>,10
            pigment {color rgb<1,.6,.3>}
            finish {
                        reflection .6
                        phong .6
                }
}
```

Notice how the sphere has become shiny.

Questions:
7) What other finishes are there? What do they do?
8) Change the cylinder definitions to make them perfect mirrors

Now add the following statement to the end of your file?
```
plane
{
     <0,1,0>,−20
     pigment {wood}
}
```

Questions:
9) The vector in plane means something quite different from vectors in other primitives. What does it mean in this case.
10) What did the wood pigment do? What other pigment types are there, and what do they do?

To make the wood surface look more real, change the plane statement to:
```
plane
{
     <0,1,0>,−20
     pigment {
          wood
          turbulence .2
          scale 3
          }
}
```

Note how the texture changes.

Questions:
11) What did the turbulence argument do?
12) Where else can you use turbulence?
13) What does scale do?

The scene still looks rather dark. A solution to this is to add a sky. The sky_sphere primitive creates a sphere that is infinitely big. You can apply any texture you like to the inside of it. For example, add the following code:
```
sky_sphere
{
          pigment{color rgb<0,.5,1>}
}
```

Note how the scene changes. This still doesn't look much like a sky, so lets change the definition to:
```
sky_sphere
{
  pigment{
        gradient y
        color_map{
                (0 color rgb <0,.5,1>)(.7 color rgb <1,1,1>)
                }
         turbulence .5
        }
}
```

Questions:
14) What is a gradient?
15) What is a color map and why do you need one?
16) What is the purpose of the turbulence statement?

Assignments:
1) Change the light to make the scene brighter.
2) Make the sphere less reflective.
3) Give the plane 70% bumps, and a 20% reflectivity.
4) Add at least 5 more primitives to the scene. (These objects should make the scene more meaningful.)