

How many colors are there in the world?



Sun dogs on each side of the rising sun are caused by ice crystals in the sky on a very cold morning. Dispersion of light in the ice crystals also produces the rainbows. Since there are ice crystals in the air between the barn and the camera, the rainbow is also visible in front of the barn. There are many colors in this scene, produced in many different ways — lights, objects, and scattering volumes.

The best answer is infinity!

Careful measurements of our visual system's best performance have been made by psychophysicists (people who study human responses, like seeing color, to things in the world, like light). They have shown that we can see about 1000 levels of light-dark, 100 levels of red-green, and 100 levels of yellow-blue for a single viewing condition in a laboratory. This means that the total number of colors we can see is about $1000 \times 100 \times 100 = 10,000,000$ (10 million). A computer displays about 16.8 million colors to create full-color pictures, really more than necessary for most situations.

However, the answer is not quite so simple. What color looks like is greatly affected by the viewing conditions. These conditions include the color of the lighting, the amount of lighting, and other colors in the scene. Colors also appear in different modes when they appear on different objects such as surfaces, light sources, or within volumes. Different people also have slight differences in the way they see color.

Since we can see at least 10-million colors in a single viewing condition and the variety of viewing conditions and observers is endless, then the only truly correct answer is infinity. If we have 10-million colors, times 10-million lighting types, times 10-million lighting levels, times 10-million surrounding colors, times 6-billion people in the world, times 3 modes of viewing we get a really huge number. The result of that multiplication is 18 followed by 33 zeros (18,000,000,000,000,000,000,000,000,000,000), or 18 decillion. That might not quite be infinity, but is close enough since all those estimated numbers are probably on the low side. And there is no way to exactly measure each of them. To learn more about the names of really big numbers, visit www.jimloy.com/math/billion.htm.



There are just 24 crayons in this box, but imagine all the colors you can make with them, some creativity, and different objects to color on.

Photos: M. Fairchild

