# 25C Magnification and Mixing Pigments

*How is the magnification of a lens determined? What happens when you mix different colors of pigments?*

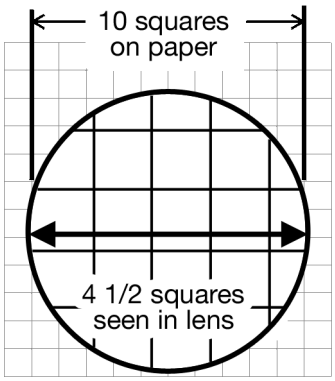
In optics, lenses are optical devices that use refraction to bend light. Some lenses can be used to produce images that are larger than the object they are collecting light from. This process is called magnification and it is used in equipment like microscopes and telescopes to investigate objects that are difficult to see with the naked eye. In this Investigation you will look at how distance can affect magnification, and also how mixing materials colored by pigments, paints, or dyes are different than mixing different colors of light.

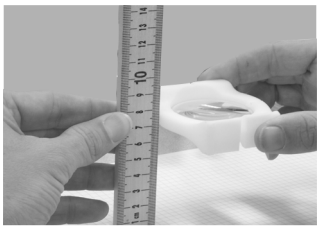
*Materials*

- Optics with Light & Color
- Metric ruler
- Cyan, Magenta, and Yellow clay

## 1 Finding the magnification of a lens

1. Set your light blue lens directly on the graph paper and count the number of *unmagnified* squares that cross the diameter of the lens. In the example, the lens is 10 squares wide.
2. Next, examine a section of graph paper with your lens held above the paper. Move the lens closer and farther away until you have the biggest squares you can still see clearly in the lens.
3. Count the number of *magnified* squares that cross the diameter of the lens. For example, the picture shows 4 1/2 squares across the lens.
4. The magnification can be calculated by dividing the number of *unmagnified* squares by the number of *magnified* squares. In the example, you see 10 *unmagnified* squares and 4.5 *magnified* squares. The magnification is 10 /4.5, or 2.22.
5. Try the experiment again using a ruler to measure the distance between the lens and the paper. Notice that the magnification changes with different distances.



Measuring the distance from the lens to the paper

6. Fill in the table by measuring the magnification of your lens for at least four different distances. The number of squares on the graph paper will be the same for all distances.

**Table 1: Magnification of a lens**

| Distance to paper | # of squares on graph paper (unmagnified squares) | # of squares in lens (magnified squares) | Magnification |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |

## 2 Thinking about what you observed

**a.** Is the image in a magnifying glass inverted or upright?

**b.** At what distances will the lens act like a magnifying glass? What happens when the object is more than a focal length away?

**c.** Describe something that looks completely different under a magnifying glass than when seen with the un-aided eye.

**d.** Try the same activity with the dark blue lens. What happens to the image in the lens when you lift it up from the paper?

## 3 The subtractive color model (CMYK)

1. You have three colors of clay: cyan, magenta, and yellow. Take a portion the size of your fingertip of the both cyan and the magenta. Mix them together. What color do you get?

2. Mix equal amounts of cyan and yellow. What color do you get?

3. Mix equal amounts of yellow and magenta. What color do you get?

**The subtractive color model (CMYK)**

| | Cyan | Magenta | Yellow | Black |
|---|---|---|---|---|
| **Absorbs** | Red | Green | Blue | Red, Green, Blue |
| **Reflects** | Blue, Green | Blue, Red | Red, Green | None |


Mix equal amounts of the three subtractive primary colors
*(two colors at a time)*

## 4 Thinking about what you observed

**a.** Explain how the mixture of magenta and cyan makes its color when seen in white light.

**b.** Explain how the mixture of cyan and yellow makes its color when seen in white light.

**c.** Explain how the mixture of yellow and magenta makes its color when seen in white light.

**d.** Why don't the mixed colors produce full red, green, or blue?

**e.** What color would you see if you looked at a mixture of magenta and cyan under a lamp that only made blue light?

**f.** Research how printers make colors. Do they use red, green, and blue (RGB) or cyan, magenta, yellow, and black (CMYK)? Explain why printed pictures need to use one or the other.

**g.** Research how computer monitors and televisions make colors. Do they use red, green, and blue (RGB) or cyan, magenta, yellow, and black (CMYK)? Explain why TV's and computer screens need to use one or the other.

**h.** Explain why mixing the primary colors of light is referred to as the "Additive Color Mixing Process", while mixing materials colored with pigments, paints or dyes is referred to as the "Subtractive Color Mixing Process".