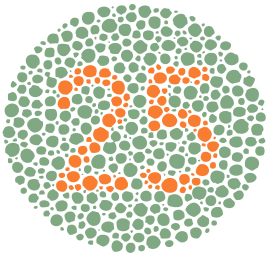
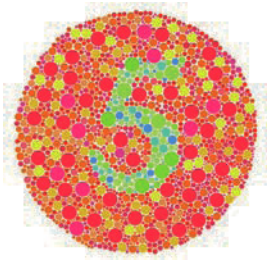


People who are green and yellow colour-blind will not see the number "25."



People who are red and green colour-blind will not see the number "5."

Some people do not see all colours. The cone cells within the eye may be defective causing a condition known as **colour blindness**. Look at the images on the left to determine if you are colour blind.

COMMUNICATE

1 If you stare at one colour for a while, then look at a white page, you will see a different coloured after-image. Use the diagram of colour addition on the previous page to predict which colours you would see after staring at each of the following colours for a while. Explain what is happening within your eye in each case.

a) blue
b) green
c) red
d) yellow (Hint: What colours make up yellow?)

5.3 What Colour Is It?

EXPLORE

Have you ever tried on different pairs of sunglasses? Depending on the colour of their lenses, sunglasses can give the world a coloured tint. Some can make everything look yellowish. Others seem to make greens and blues more intense. Why does this happen? Is this an effect on your eyes or on the light? In your Science Journal, write down what you think might be happening as light passes through a coloured lens or filter.

Sunglasses are not only "cool." They subtract some part of the light.

DEVELOP

Subtracting Colour

A filter lets some parts through and keeps other parts out. A coffee filter lets water and the flavour of coffee pass into a pot, while keeping out the coffee grains. Coloured sunglasses are like filters that act to take out, or subtract, some part of light.

You know that white light contains all of the colours in the spectrum. But why do objects have colour? For example, why is a tomato red or why is the grass green? What would you see if you looked at a red tomato using a filter that allowed only green light to pass through? if you looked at green grass through a filter that allowed only blue light to pass through? Start exploring!

INVESTIGATOR

Looking Through Coloured Filters

The Question

What effect do coloured filters have on coloured objects?

Materials & Equipment

- ray box with a single-slit opening
- coloured filters: red, green, and blue
- white paper to act as a screen
- coloured pencils (optional)
- coloured paper: red, green, and blue
- prism

Procedure

1. Set up your ray box so the beam of light falls on the white screen.
2. Darken the room, and examine the coloured papers in the white light one at a time. Record the colours you see.
3. Use the coloured filters one at a time to focus the light ray onto the white screen. Carefully observe the colour that falls on the screen.

4. Select a coloured filter. Predict the effect that the filter will have on each piece of coloured paper.
5. Look at each piece of coloured paper through this filter. Record your observations.
6. Repeat steps 4 and 5 with the remaining filters.
7. Focus a narrow light ray onto the prism to produce a spectrum of colours on the white screen.
8. Use the coloured filters one at a time to direct a light ray onto the prism. Record what you see.

Keeping Records

9. Make a table of your observations.

Analyzing and Interpreting

10. When white light passes through a coloured filter, what colour do you see? What happens to the other colours of light?
11. When you looked at the red paper through the green filter, what colour did you see? Why do you think this happens?
12. What effect did each coloured filter have on the light passing through the prism? How do you know?
13. Describe or draw what you would see if you looked at a traffic light through each of the following coloured filters: red, green, and yellow.
14. What applications use filters to absorb unwanted light?

Forming Conclusions

15. How do coloured filters work? Write a conclusion that answers the question.

reSEARCH

Graphic artists deal with images for the computer screen such as website layouts and Internet advertisements. Graphic artists also deal with images for printing such as posters, billboards, and business cards. Research which colour model graphic artists use for websites and which model they use for printing.

- What is the difference between 16, 24, and 32-bit display settings for viewing colour?
- What is the optimal display setting?

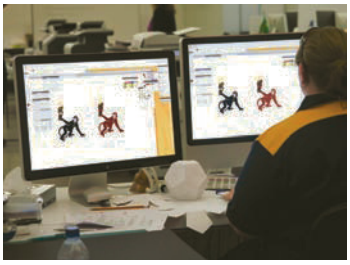


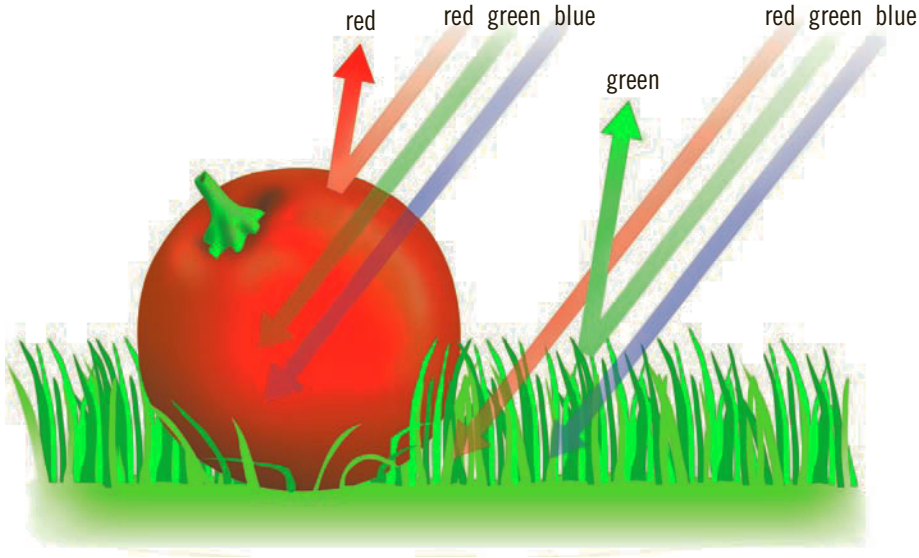
Photo courtesy WorldSkills International

Graphic designers work with images to be displayed on the Internet and for printing.

The Subtraction Model of Colour

You have seen what happens when you added different light colours together by projecting coloured light rays on top of each other. When you subtracted light colours by passing light through filters that block, or subtract, certain colours, something quite different was taking place. What determines the colour of something when colour subtraction is used?

Recall that the primary colours of light are red, blue, and green. If an object appears red, then its surface is reflecting red to your eye, and absorbing (subtracting) the other two primary colours, blue and green. If an object appears blue, which colours have been subtracted?



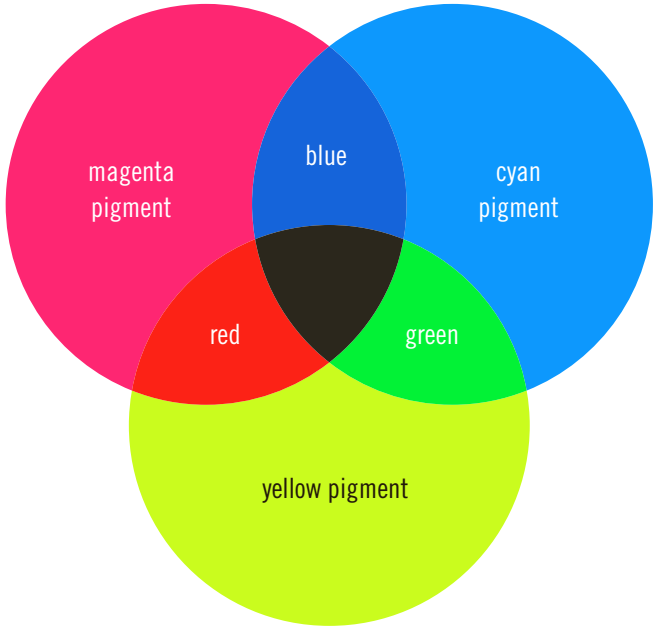
The subtraction model of colour helps explain why objects are coloured. Pigments in objects absorb (subtract) certain colours and reflect others. You see a tomato as red because the chemicals in the tomato's skin absorb all the colours except for red. Only the red light is reflected to your eyes. Green grass absorbs all light except green, which is reflected. Special lights for growing plants look reddish. Why wouldn't they be coloured green?

The primary colours in pigment, however, are different. They are magenta, cyan, and yellow. Look at the illustrations of the colour subtraction model on the next page. What do you notice about how the primary colours for light and pigment are related? Can you explain this relationship? In fact, colour photographs in print media (for example, books and magazines) actually use just four colours: magenta, cyan, yellow, and black. Can you guess why black is used?

When white light shines on these colours, the pigments work in the same way a coloured filter works. Each primary colour of pigment absorbs, or subtracts, one of the primary colours of light and reflects the other two. This explanation of the process is called the **subtraction model of colour.**

Colour subtraction applies to the secondary colours as well. Remember that secondary colours are those produced by mixing any two of the primary colours together. For example, yellow light is a mixture of red and green light. A yellow object reflects a mixture of both colours and absorbs, or subtracts, the colour blue, so your eye sees yellow.

There are many applications of coloured lenses. Glasses have many different lens colours such as yellow, brown, and copper. Yellow lenses are good for night driving or for seeing when skies are overcast. Brown and copper lenses are preferred for activities such as driving or skiing because they reduce bright light and sharpen images. Sunglasses not only enhance vision, they also filter the harmful ultraviolet rays from the Sun.



Notice what is happening when the secondary colours are mixed together. Magenta pigments absorb green light and reflect a mix of red and blue light; cyan pigments absorb red light and reflect a mix of green and blue light; yellow pigments absorb blue light and reflect a mix of red and green light.

COMMUNICATE

1 What are the primary colours of light? What are the secondary colours of light?

2 a) How does the eye detect colour? Explain, using the addition model of colour.
b) How does a painting show a colour image? Explain, using the subtraction mode of colour.

3 Imagine you are an actor in a horror film. Your costume calls for scary, red contact lenses to change the colour of your eyes. When you examine the lenses, you see that they are clear in the centre, with only a ring of red colour. Why do you think this is so? What would you see if the contacts were completely red? completely yellow? Explain, using the subtraction model of colour.

4 In photosynthesis, plant cells convert light energy into chemical energy they can store as food. If a plant has green leaves, which colour(s) of light is (are) being absorbed by the plant? What does this suggest about the type of artificial lighting that should be used to grow plants indoors?