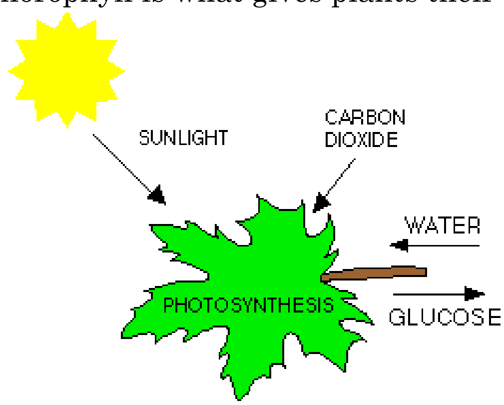
Sound of Science
理聲
Newsletter of Science Promotion Team
Dec, 2009 零九年十二月號

Science of Color

Autumn Leaf Color: Why Do Leaves Change Color in the Fall?

We all enjoy the colors of autumn leaves. Did you ever wonder how and why a fall leaf changes color? Why a maple leaf turns bright red? Where do the yellows and oranges come from? To answer all these questions, first we have to understand what leaves are and what they do.

Leaves are nature's food factories. Plants take water from the ground through their roots. They take a gas called carbon dioxide from the air. Plants use sunlight to turn water and carbon dioxide into oxygen and glucose. Oxygen is a gas in the air that we need to breathe. Glucose is a kind of sugar. Plants use glucose as food for energy and as a building block for growing. The way plants turn water and carbon dioxide into oxygen and sugar is called photosynthesis. That means "putting together with light". A chemical called chlorophyll helps make photosynthesis happen. Chlorophyll is what gives plants their green color.



As summer ends and autumn comes, the days get shorter and shorter. This is how the trees "know" to begin getting ready for winter.

During winter, there is not enough light or water for photosynthesis. The trees will rest, and live off the food they stored during the summer. They begin to shut down their food-making factories. The green chlorophyll disappears from the leaves. As the bright green fades away, we begin to see yellow and orange colors. Small amounts of these colors have been in the leaves all along. We just can't see them in the summer, because they are covered up by the green chlorophyll.

The bright reds and purples we see in leaves are made mostly in the fall. In some trees, like maples, glucose is trapped in the leaves after photosynthesis stops. Sunlight and the cool nights of autumn cause the leaves turn this glucose into a red color. The brown color of trees like oaks is made from wastes left in the leaves.

It is the combination of all these things that make the beautiful colors we enjoy in the fall.

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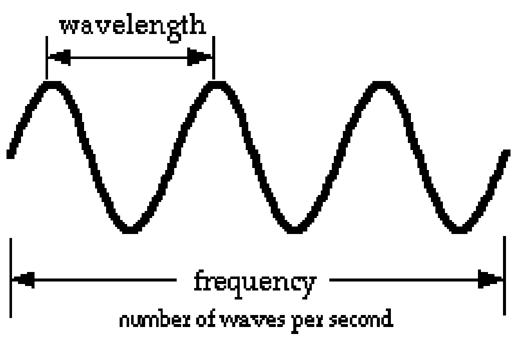
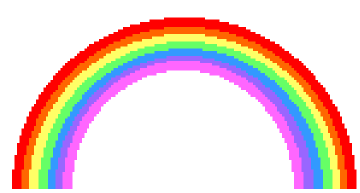
WHY THE SKY IS BLUE?

On a clear sunny day, the sky above us looks bright blue. In the evening, the sunset puts on a brilliant show of reds, pinks and oranges. Why is the sky blue? What makes the sunset red?
To answer these questions, we must learn about light, and the Earth's atmosphere.

THE ATMOSPHERE
The atmosphere is the mixture of gas molecules and other materials surrounding the earth. It is made mostly of the gases nitrogen (78%), and oxygen (21%). Argon gas and water (in the form of vapor, droplets and ice crystals) are the next most common things. There are also small amounts of other gases, plus many small solid particles, like dust, soot and ashes, pollen, and salt from the oceans.
The composition of the atmosphere varies, depending on your location, the weather, and many other things. There may be more water in the air after a rainstorm, or near the ocean. Volcanoes can put large amounts of dust particles high into the atmosphere. Pollution can add different gases or dust and soot.
The atmosphere is densest (thickest) at the bottom, near the Earth. It gradually thins out as you go higher and higher up. There is no sharp break between the atmosphere and space.

LIGHT WAVES
Light is a kind of energy that radiates, or travels, in waves. Many different kinds of energy travel in waves. For example, sound is a wave of vibrating air. Light is a wave of vibrating electric and magnetic fields. It is one small part of a larger range of vibrating electromagnetic fields. This range is called the electromagnetic spectrum.
Electromagnetic waves travel through space at 299,792 km/sec. This is called the speed of light.
The energy of the radiation depends on its wavelength and frequency. Wavelength is the distance between the tops (crests) of the waves. Frequency is the number of waves that pass by each second. The longer the wavelength of the light, the lower the frequency, and the less energy it contains.





COLORS OF LIGHT
Visible light is the part of the electromagnetic spectrum that our eyes can see. Light from the sun or a light bulb may look white, but it is actually a combination of many colors. We can see the different colors of the spectrum by splitting the light with a prism. The spectrum is also visible when you see a rainbow in the sky.
The colors blend continuously into one another. At one end of the spectrum are the reds and oranges. These gradually shade into yellow, green, blue, indigo and violet. The colors have different wavelengths, frequencies, and energies. Violet has the shortest wavelength in the visible spectrum. That means it has the highest frequency and energy. Red has the longest wavelength, and lowest frequency and energy.

LIGHT IN THE AIR

Light travels through space in a straight line as long as nothing disturbs it. As light moves through the atmosphere, it continues to go straight until it bumps into a bit of dust or a gas molecule. Then what happens to the light depends on its wavelength and the size of the thing it hits.

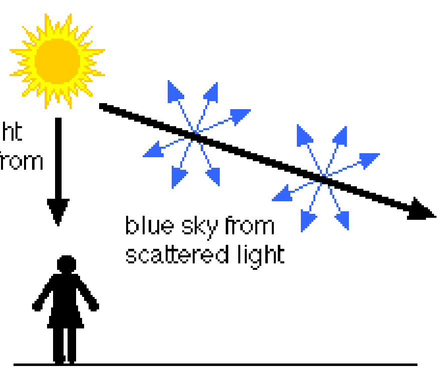
Dust particles and water droplets are much larger than the wavelength of visible light. When light hits these large particles, it gets reflected, or bounced off, in different directions. The different colors of light are all reflected by the particle in the same way. The reflected light appears white because it still contains all of the same colors.

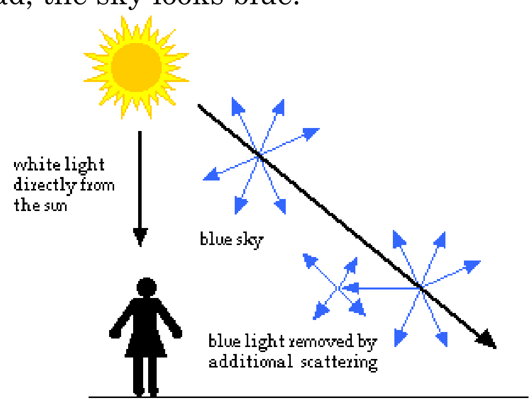
Gas molecules are smaller than the wavelength of visible light. If light bumps into them, it acts differently. When light hits a gas molecule, some of it may get absorbed. After a while, the molecule radiates (releases, or gives off) the light in a different direction. The color that is radiated is the same color that was absorbed. The different colors of light are affected differently. All of the colors can be absorbed. But the higher frequencies (blues) are absorbed more often than the lower frequencies (reds). This process is called Rayleigh scattering. (It is named after Lord John Rayleigh, an English physicist, who first described it in the 1870's.)

WHY THE SKY IS BLUE?

The blue color of the sky is due to Rayleigh scattering. As light moves through the atmosphere, most of the longer wavelengths pass straight through. Little of the red, orange and yellow light is affected by the air.

However, much of the shorter wavelength light is absorbed by the gas molecules. The absorbed blue light is then radiated in different directions. It gets scattered all around the sky. Whichever direction you look, some of this scattered blue light reaches you. Since you see the blue light from everywhere overhead, the sky looks blue.



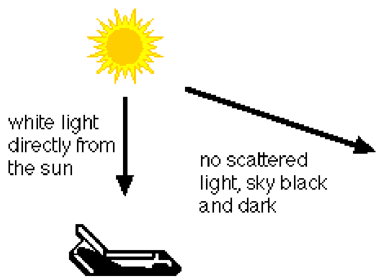


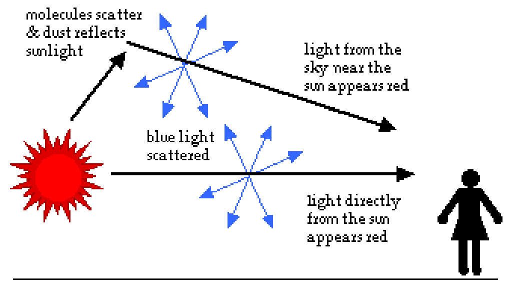
As you look closer to the horizon, the sky appears much paler in color. To reach you, the scattered blue light must pass through more air. Some of it gets scattered away again in other directions. Less blue light reaches your eyes. The color of the sky near the horizon appears paler or white.

THE BLACK SKY AND WHITE SUN

On Earth, the sun appears yellow. If you were out in space, or on the moon, the sun would look white. In space, there is no atmosphere to scatter the sun's light. On Earth, some of the shorter wavelength light (the blues and violets) are removed from the direct rays of the sun by scattering. The remaining colors together appear yellow.

Also, out in space, the sky looks dark and black, instead of blue. This is because there is no atmosphere. There is no scattered light to reach your eyes.





WHY IS THE SUNSET RED?

As the sun begins to set, the light must travel farther through the atmosphere before it gets to you. More of the light is reflected and scattered. As less reaches you directly, the sun appears less bright. The color of the sun itself appears to change, first to orange and then to red. This is because even more of the short wavelength blues and greens are now scattered. Only the longer wavelengths are left in the direct beam that reaches your eyes.

The sky around the setting sun may take on many colors. The most spectacular shows occur when the air contains many small particles of dust or water. These particles reflect light in all directions. Then, as some of the light heads towards you, different amounts of the shorter wavelength colors are scattered out. You see the longer wavelengths, and the sky appears red, pink or orange.

Lunch Time Video Shows:
12:20 p.m. @ Chemistry Laboratory (Room 512)

Date	Name of Program	Phy	Chem	Bio
1/12/2009 (Tue)	Brilliant Beasts – Pigs 世界天才動物 – 豬 (Part 2)			🗁
4/12/2009 (Fri)	Crime Scene University, Chapter 3 鑑識科學教室 (Part 1)	🗁	🗁	
8/12/2009 (Tue)	Crime Scene University, Chapter 3 鑑識科學教室 (Part 2)	🗁	🗁	
11/12/2009 (Fri)	In the Realm of the Red Ape 赤猿領地 (Part 1)			🗁
15/12/2009 (Tue)	In the Realm of the Red Ape 赤猿領地 (Part 2)			🗁

Topic of Science Quiz 你知道唔知道 in December

2nd, 30/11-11/12: **Space**
3rd, 14/12-22/12: **Optical Fiber**
Questions are posted on the notice board of Science Promotion Team near the Staff Common Room.

由九龍社團聯會黃大仙地區委員會及黃大仙區議會合辦之「**金風綠遍東亞運 環保風車創意賽**」已於 2009 年 11 月 14 至 16 日在黃大仙啟德河（近衙前圍村口）圓滿舉行。本校 **2A 班黃冠賢同學、霍情同學、徐樂瑜同學及蘇家樑同學**所設計的風車榮獲**中學組優異獎**，並在啟德河展覽，特此恭賀。