GemVine

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MULTICOLOUR GEMS

HOW DO WE PERCEIVE COLOR IN GEMSTONES?

Your red could be someone else's blue

> "Of all the properties that objects appear to have, color hovers uneasily between the subjective world of sensation and the objective world of fact."
>
> *Mazviita Chirimuuta*

At gem trade shows, exhibitors like to show their stones with lots of lights. Bright lights not only draw a crowd, but experienced sellers know how to set them up and which lights work best for which stones.

Lights with bluish and greenish attributes will accentuate sapphires and emeralds, while lights with reddish components will highlight rubies, tourmalines and red garnets.

This doesn't mean that the lights are red or blue when we look at them, but if those lights are beamed upon a white sheet of paper, the paper will respectively appear yellowish or slightly blue.

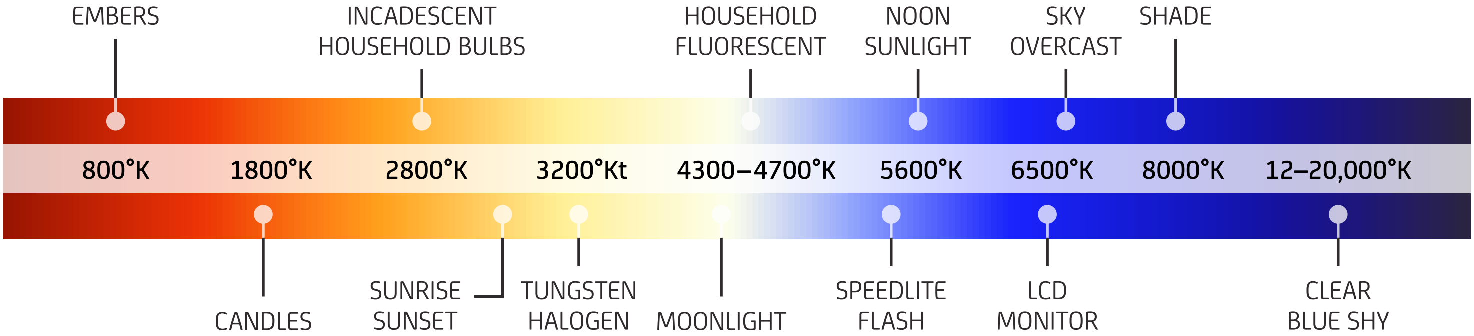
WE CANNOT SEE THE COLOR OF A LIGHT WITHOUT OBSERVING ITS REFLECTION.

The color we observe is related to the way light interacts with the objects we are viewing. Although visible light only occurs in a small segment of the electromagnetic spectrum, it is this light that is responsible for color sensation. We can only see light with wavelengths within the visible electromagnetic spectrum; red, orange, yellow, green, blue, indigo and violet.

In scientific terms visible light is usually defined as having wavelengths in the range of 400–700 nanometers. On the scale, it is positioned between warm (red) infrared light with longer wavelengths and cool ultraviolet (blueish) light with shorter wavelengths.

When light illuminates a transparent object like a gemstone, specific wavelengths are absorbed while other wavelengths are transmitted and reflected, and since we can only see the transmitted and reflected portions of the light, this is what determines the color we perceive.

There are a number of ways to describe lighting in terms of voltage, intensity and power consumption, but color temperature is the parameter that best defines the quality of the color.



Color temperature is specified in terms of degrees K (Kelvin) and incandescent light is measured around 3300K or less, while daylights start at around 5500K and extends to 6500K and beyond.

In general, blue and green gemstones look best in daylight, while red stones look best with lower color temperatures as we would see in the early morning or at sunset.

A blue sapphire is blue because blue is the only wavelength that can be transmitted by the stone. Under candlelight, which is rich in red wavelengths and poor in blue wavelengths, the same blue sapphire will look black since the blue wavelengths do not exist and are not available for transmission.

Therefore, emeralds are green primarily because most of the light transmission occurs in the green wavelengths while other wavelengths are absorbed.

For colored stones however, the color is not only determined by the properties of the light source, but also by their transparency and distinctive chemistry.

In most cases, these definitive factors relate to the basic chemistry of the gemstones along with their trace elements and ionic states. A ruby may contain less than 1% chromium and it will look pink or red, but the same stone without chromium would be completely colorless. Moreover, the valences of these trace elements may also affect a variety of colorations. For example, in the case of sapphires, iron can take the form Fe^{2+} or Fe^{3+} and induce blueish hues in the case of Fe^{2+} or yellowish colors from Fe^{3+}.

Alexandrite is the variety of chrysoberyl which changes color from green in daylight to red under incandescent light. Chemically, alexandrite can be differentiated from normal chrysoberyl by the presence of chromium. Chromium affects light absorption and when alexandrite is illuminated, it absorbs certain wavelengths while reflecting others.

Daylight contains high proportions of blue and green light, and incandescent lighting contains a higher balance of red light. In daylight, when a greater proportion of green light is reflected alexandrites appear green or blueish. Conversely, under incandescent light where more red light is reflected alexandrites will look red.

Our inability to define and measure gemstone colors the same way we measure primary attributes like shape and size, has always led to subjectivity and confusion. Some Gemological Labs create their own color designations and standards and nowadays even the formerly mythical names like “pigeon’s blood red” or “royal blue” have become the norm.. Simply reducing colors to wavelengths is not a way to convey color because the gemstone colors as we observe them cannot be measured with a digital receptor and when we try to replicate color vision this way, we get far too many colors, and too many shades and reflections that vary with the lighting environment.

Black Opals from the Stayish mine in Ethiopia. The blue body color is in part a function of longer-exposure photography and high color temperature lighting. This blue body color is not visible to the naked eye and depending on the illumination will look either black or very dark gray

People are better able to judge color in gemstones better than computers or cameras can and scientists aren’t sure how. Modern digital cameras can capture most of the colors, but many gemstone photographs require editing to more accurately depict the color. Its not that the images need to be improved, but rather that the cameras cannot capture the color as good as the eye. Colombian emeralds are a good example of a color that digital cameras cannot capture correctly and the colors of emeralds (especially from Colombia) always need photo edits.

Beyond photography, there are several ways to model and describe colors, but they require master sets with both the sender and the receiver. Without having a gemstone on hand, a photograph or a video is still the easiest way to communicate colors.

A CHANGE IN COLOR, A CHANGE OF HEART

Change of color is not the same as the changes in color we can observe from crystal orientation. Stones like tourmaline, tanzanite and iolite show different colors depending on the angles we view them at and this property is known as pleochroism. Of the well known gemstones, only garnets, sapphires, spinels and chrysoberyls can absorb light selectively such that their body color will change with the nature of the light source.

ALEXANDRITE

THE MOST FAMOUS

The traditional view is that the best alexandrites shift from emerald green to ruby red, but this hardly ever occurs. Most alexandrites seem to show a good green or blue in daylight or a beautiful red under incandescent light, but very few stones look great under every kind of light.

COLOR CHANGE GARNET

THE MOST PHENOMENAL

Thought by some to be “a poor man’s alexandrite”, color change garnets may be less expensive, but nice stones are not cheap. They are the most phenomenal of all the garnets and the only examples of blue garnets. In the past, gemological literature referred to garnet as occurring in every color but blue, but this is clearly not the case anymore and some Madagascan and Tanzanian color change garnets are indeed blue under the right light conditions. The color change can be intense and equal to the color change of top quality alexandrite. The color changing phenomena is caused by a relatively high presence of vanadium or chromium in the crystal matrix.

COLOR CHANGE SAPPHIRE

THE MOST UNEXPECTED

A rare variety of natural sapphire, known as color change sapphire, exhibits different colors in different kinds of light. Color change sapphires are usually blue in outdoor light and purple under incandescent light, but some are green to gray-green in daylight and pink to reddish violet under incandescent light.

They belong to one of two groups depending on their color change: the green to red (alexandrite type), and the blue to purple kind. Both types are quite rare and treatment would not improve the strength of color change so they don’t need to be heated.

RELICS & RARITIES

Most chrysoprase is dark and opaque and often grayish or olive colored. Here we have some unusually transparent bluish green stones sometimes referred to as "Australian Jade" due to their resemblance to Burmese imperial jade.

This material is from the Yerilla deposit in Western Australia, some 100 miles north of Kalgoorlie. Little historical information is available, but it has been confirmed that the area was mined as early as 1995 and possibly before that.

The chrysoprase at Yerilla occurs in swarms of green throughout an ironstone caprock. It is found as ellipitcal pods from a few centimetres in length to longer seams of up to one meter long. Veins of white to grey chalcedony and bright green chrysoprase along with nodules of white magnesite are intertwined in gem bearing layers.

PROSPECTOR'S CORNER

Scientifically referred to as "blue zoisite", the gemstone was renamed as "Tanzanite" by Tiffany & Co. who wanted to capitalize on the rarity and single location of the gem.

Tanzanite is trichroic and orientation is an important consideration for cutters who need to consider both yield and the resulting color. It is generally enhanced by heat unless otherwise specified. The unheated crystals can be green, violet, yellowish or light blue, but a brownish root beer color is most common. Heating at 380 degrees C will produce the intense top blue sapphire color. Surprisingly, it is the dark brown crystals that produce the most valuable dark blue stones after heating. The treatment is permanent and accepted in the trade.

Tanzanite prices have always been volatile and there has invariably been a mismatch between supply and demand. As miners went deeper underground, mining became more dangerous and more expensive effectively slowing the production of new material. Still, although production costs may have increased, a lot of old stock exists and prices are limited to what consumers are willing to pay.

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