

₹ 200

ISSN - 2249-555X

Volume : 1

Issue : 11

Aug 2012



**Journal for All Subjects**

[www.ijar.in](http://www.ijar.in)

Listed in International ISSN Directory, Paris.



ISSN - 2249-555X

# Indian Journal of Applied Research

## Journal for All Subjects

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## The story of colour

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### ABSTRACT

*It is strange that artists have used colour for 25,000 years without knowing much about it. But the simple fact that colour cannot be seen without light cannot have escaped early man. The cave artist used torches to get the necessary light to paint. The first word designations for colour were undoubtedly those for darkness and light. In those years various scientists such as Alcmaeon, Empedocles, Plato, Aristotle, Mauroycus, and Dominis and others, Sir Isaac Newton in the latter half of the 17th century contributed to develop different theories. But till date precisely how colour is perceived is not known and new theories are advanced from time to time. Whether there are one, two, three, or seven kinds of receptors has not been firmly established.*

**Keywords : Colour, 25,000 years, Atoms, Isaac Newton**

### The story of colour

It is strange that artists have used colour for 25,000 years without knowing much about it. But the simple fact that colour cannot be seen without light cannot have escaped early man. The cave artist used torches to get the necessary light to paint. The first word designations for colour were undoubtedly those for darkness and light.

In about 1900 B. C. the Babylonians noted seven colored rings on a film of oil and water but failed to evolve any theory from their observation. First theories on colour were put by scholars of classical Greece. Alcmaeon in the 6th century B.C. stressed black and white as being central to the property of a substance. An all-important correction of this notion was provided by Empedocles (492-431 B. C.), who observed that colour was quality perceived by the eye and was not a resident property of objects. This hint on the subjective nature of the colour phenomenon is fundamental to modern theory. Empedocles mentioned white, black, red and yellow-green as the colours, with red corresponding to air. This latter notion persisted for long time. Democritus (460-360 B. C.) stated that colour is the judgment of men on various arrangements of atoms. He too saw white, black, red, and a yellowish-green, with red related to heat. Speculative theory and direct observation are strangely mixed here. Plato (428-347 B. C.) described black, white, red, and yellow, and Aristotle (384-322 B. C.) identified white, black, red, yellow, brown, violet, green, and blue rare perception in his day. Even so, he saw the rainbow as tricolored (red, yellow and green) and believed that proper mixture of black and white could form all the colours. There was not much to be found in colour theory after this for another 1500 years. Vitello in the 13th century emphasized three colours particularly, red, green and violet-blue. Thylesius in the latter part of the 15th century mentioned 12 shades of colour. Maurolycus (1494-1577) saw red, orange, yellow, green, indigo, blue, and violet, which is modern in terminology. Marco Antonio de Dominis, in experiments performed around 1590 and in 1611, discovered how raindrops reflect the sun's rays to form a rainbow. He explained the additive principle of coloured light, with a mixture of colours forming white light.

Meanwhile artists were using many colour. With the aid of technicians and using the materials at hand, they worked in the wonderfully translucent encaustic, developed the mosaic with its light scattering and additive colour effects, discovered in pigment mixing the subtractive effect and secondary col-

ours, worked with light and stained glass and discovered the difference between transparent and opaque colour effects. This empirically derived knowledge has been rather neglected by scientific investigators who tend toward carefully controlled laboratory experiments. But there is perhaps good ground for believing that artists in the distant past have known more about colour than many of their contemporaries.

Isaac Newton provided the first great breakthrough in colour theory. In 1660 he passed a beam of sunlight through a prism and found it spread out in the rainbow colours. These, the so-called spectrum colours, are red, orange, yellow, green, blue, indigo and violet. With aid of second prism, Newton recombined the beam and the colours disappeared, white light resulting. He went on to combine two blocked-out part of the spectrum, usually to find that a third, midway, colour was formed by the combination.

This spread of colour by prism takes place because the molecular structure of the prism slows down colours as they pass through, in a selective manner. Red travels through glass faster, with orange next and so on, with violet slowest compared to the others. Thus it was discovered that light consists of a range of energy we perceive as red is carried on a longer wavelength and is least affected by passage through a prism. The hues as lined up in a spectrum with their respective wavelengths in mille microns are as follows:

Violet: 400 mille microns

Blue: 450 mille microns

Green: 520 mille microns

Yellow: 580 mille microns

Red: 650 mille microns

Deeper reds continue to 760. Each colour has a rather wide range of values. When violet, green, and red are added together, as in overlapping beams of light, the result is white light. These key colours are called primary colours. When violet and green are added together they form a colour with an intermediate value in wavelength, blue; when green and red are added together they form the intermediate yellow; violet and red form purple. This in brief is the classical theory concerning coloured light.

When light comes in contact with various substances, certain wavelengths are absorbed, removed from the spectrum, and turned into another kind of energy. This kind of information can be recorded as a photographic image. As sunlight strikes the various materials of our environment, various wavelengths in the spectrum are removed-for example, the green leaf absorbs all wavelengths except those around 520 milli-microns. Black absorbs nearly all of the light energy impinging upon it, while white reflects most of it. Thus most materials subtract something from white light. Thomas Young in 1801 proposed that there were sensitive nerve fibers in the retina, that each fiber consisted of three parts, each one of which was excited by wavelengths of light corresponding to red, green, or violet. He held that the other colour sensations were derived from the first three. Another theory is based upon the observed existence of rods and cones in the retina. Rods are held to be responsive to colourless vibrations, while the cones are held to be responsive to bright light and hues. Scientists have discovered in the rods chemical activity set off by light energy and in turn activating the electrochemical message system to the brain.

**Pigment:** As humans we are in most frequent contact with colour through pigment and coloured materials. Colours in pigments have specific spectrum values. The classical theory gave us a triangular system of pigment organization. This is with red, blue and yellow making up the primary colours. Red mixed with yellow gives the secondary orange, blue and red

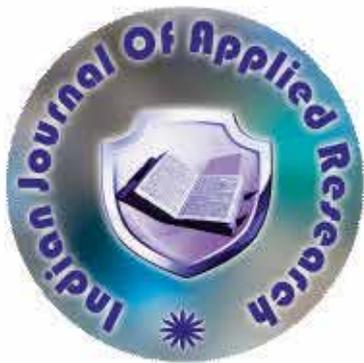
give us violet, and blue and yellow produce green. Ewald Hering, a German scientist, developed a pigment theory based on four complementary colours: red/green and blue/yellow. According to Hering, all other hues and mixture could be derived from these four coupled colours plus black and white.

Precisely how colour is perceived is not known and new theories are advanced from time to time. Whether there are one, two, three, or seven kinds of receptors has not been firmly established. Meantime, the image of the photosensitive electric cell provides a fair analogy of the initiating processes in the retina.

**Conclusions:** Following the fragmentary contributions of Empedocles, Mauroycus, and Dominis and others, Sir Isaac Newton in the latter half of the 17th century began in the investigations which led to the classical colour theory. Red, green and violet light could in mixture from yellow, blue, and purple, and so were called primary colours. The classical theory led to a three-primary system in pigment, with mixture of red, yellow, and blue forming the important hues. Theory now presents a dual system of receptors of rods and cones, with the latter responsible for the reaction leading to the sensation of colour.

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Journal for All Subjects



**Editor,**  
**Indian Journal Of Applied Research**  
8-A, Banans, Opp. SLU Girls College,  
New Congres Bhavan, Paldi, Ahmedabad-380006.  
Contact.: +91-9824097643 E-mail : [editor@ijar.in](mailto:editor@ijar.in)

Printed at Unique Offset, Novatsing Rupam Estate, Opp. Abhay Estate, Tavdipura, Shahibaug, Ahmedabad