1) ⇒ A Color Model is a method for explaining the properties or behavior of color within some particular context. No single color can explain all aspect of color so different models were used to describe the different perceived characteristics of color.

2) ⇒ Properties of light: What we perceive as "light" or different color, is a narrow frequency band within electromagnetic spectrum.

3) ⇒ Each frequency value within the visible band corresponds to a distinct color.

⇒ At low frequency end is red color (4.3×10^{14} Hz)

→ highest freq. violet color (7.5×10^{14} Hz)

4) ⇒ Since light is an electromagnetic wave, various colors can be described in terms of either freq (f) or wavelength (λ) of the wave.

$C = \lambda f$ [freq: is constant for all materials, but speed of light & wavelength are material dependent]

($1A^0 = 10^{-8}$ cm)

$C = 3 \times 10^{8}$ cm/sec. in vacuum

light wavelength are very small.

violet → λ → 4000nm

⇒ spectral colors are typically specified in terms of wavelength.

5) A light source such as sun or light bulb emits all frequencies within the visible range to produce white light.

white light → Object → frequency reflected

some frequencies are absorbed

⇒ The combination of frequencies present in the reflected light determines what we perceive as the color of the object.

6) ⇒ perceived light has a dominant frequency or (dominant wavelength) ~~at~~ the red end of the spectrum. The dominant freq. is also called the hue, or simply the color of light.

7) Other properties beside frequency are needed to describe the various characteristics of light. When we view a source of light, our eyes respond to the color (or dominant freq.) and other two basic sensations.

saturation or (purity)

⇒ Pastels & Pale color ↑ less pure ~~low pure~~

brightness

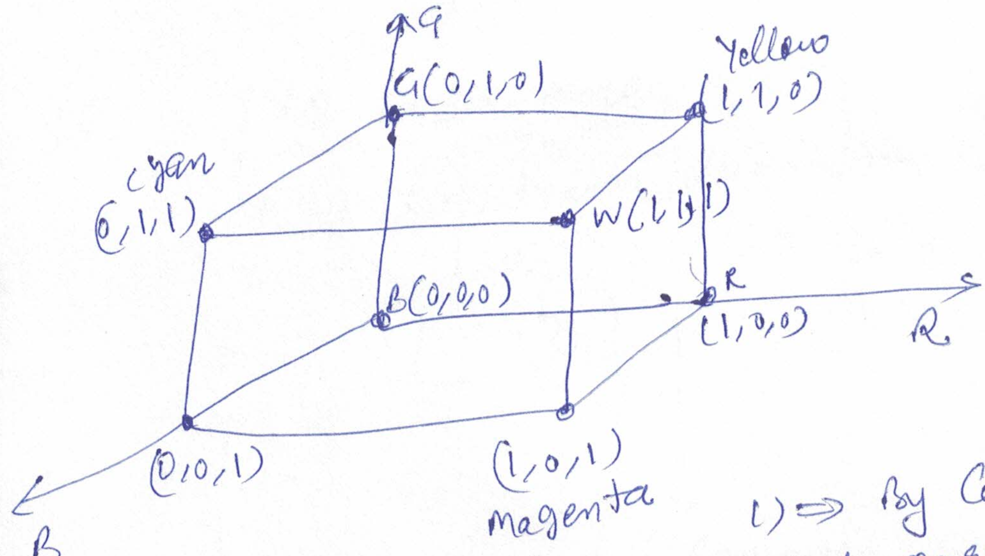
perceived intensity ← Radiant energy / luminance

) These three characteristics ← DF, Brightness → and Purity

commonly used to describe the different properties we perceive in light source.

9) The term chromaticity is used to refer collectively to the two properties describing color characteristics : purity & dominant freq.

1) RGB Color Model:



$C_\lambda = RR + GG + BB$

1) ⇒ By comparing intensities in a light source, we perceive the color of the light. This theory of ~~digital~~ vision is the basis for displaying color output on a video monitor using three ~~colo~~ color primaries, red, green, & blue, referred to as RGB Color Model.

CIE → International Commission on Illumination referred to as CIE (Commission Internationale de l'Éclairage)

⇒ NTSC → National Television System Committee

- RGB (X, Y) CHROMACITY COORDINATES:

	NTSC	CIE	Approx. Color Monitor values)
R	(0.670, 0.330)	(0.735, 0.265)	(0.628, 0.346)
G	(0.210, 0.710)	(0.274, 0.717)	(0.268, 0.588)
B	(0.140, 0.080)	(0.167, 0.009)	(0.150, 0.070)

II) YIQ Color Model:

Y → Brightness (Luminance) → B/W Television monitor uses a Y signal. The largest bandwidth in the NTSC video signal (about 4 MHz) is assigned to Y

I → (hue)

Q → (purity)

(I): Parameter I contains orange-cyan hue information that provides the flesh-tone shading, & occupies Bandwidth (1.5 MHz)

(Q): Carries green-magenta hue information in a bandwidth of about 0.6 MHz.

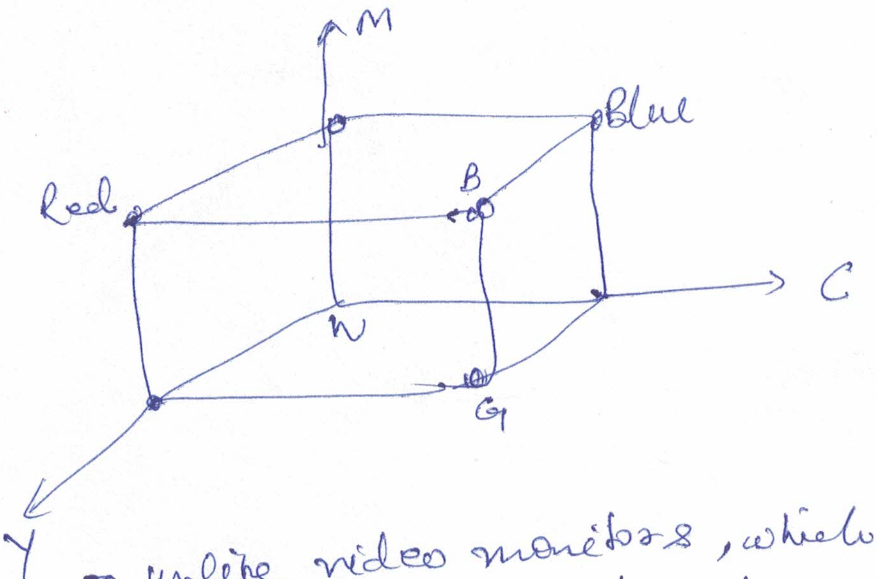
$$\begin{bmatrix} Y \\ I \\ \ldots \end{bmatrix} = \begin{bmatrix} 0.299 & 0.587 & 0.114 \\ 0.596 & -0.275 & -0.321 \\ [illegible] & -0.528 & 0.311 \end{bmatrix} \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

An NTSC video signal can be converted to an RGB signal using an NTSC decoder.

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1.000 & 0.956 & 0.620 \\ 1.000 & -0.272 & -0.647 \\ 1.000 & -1.108 & 1.705 \end{bmatrix} \begin{bmatrix} Y \\ I \\ Q \end{bmatrix}$$

II: CMY Color model: → is useful for describing color output to hard copy devices.

cyan, magenta, yellow



$$\begin{bmatrix} C \\ M \\ Y \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} R \\ G \\ B \end{bmatrix}$$

$$\begin{bmatrix} R \\ G \\ B \end{bmatrix} = \begin{bmatrix} 1 \\ 1 \\ 1 \end{bmatrix} - \begin{bmatrix} C \\ M \\ Y \end{bmatrix}$$

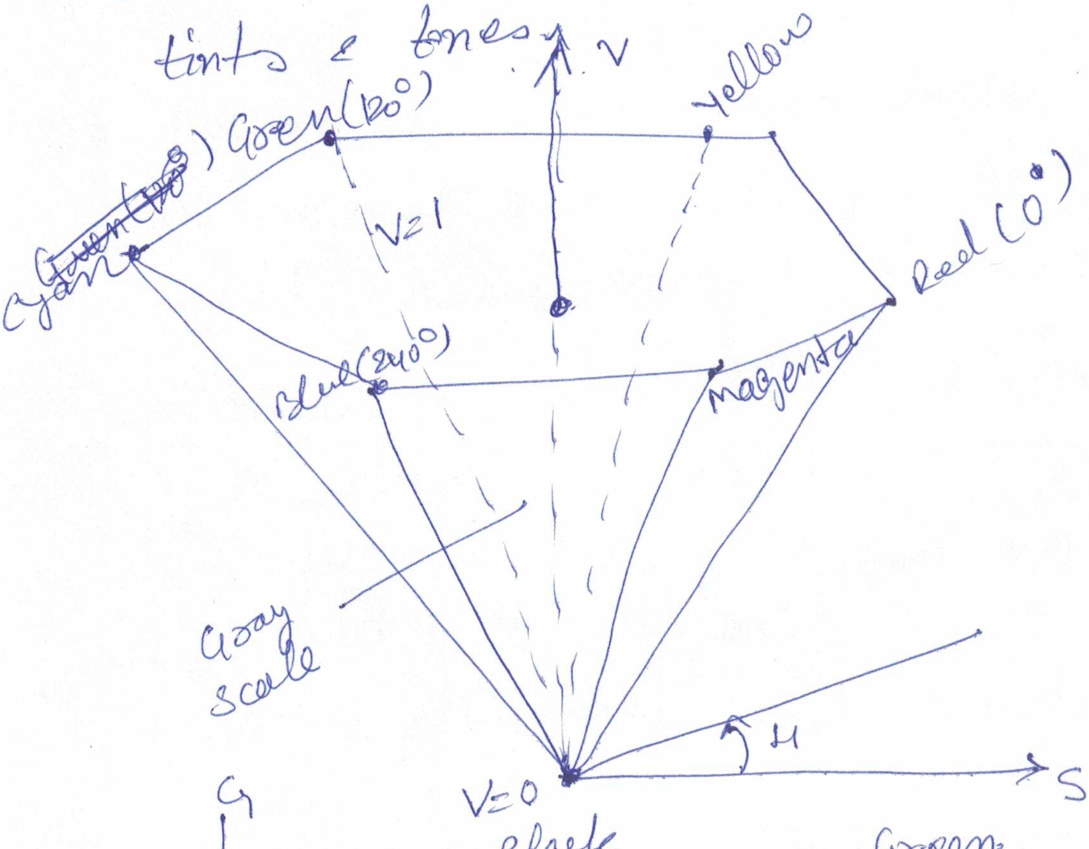
→ unlike video monitors, which produce a color pattern by combining light from the screen phosphors, hard-copy devices such as plotters produce a color picture by coating a paper with color pigments. We see the colors by reflected light a subtractive process.

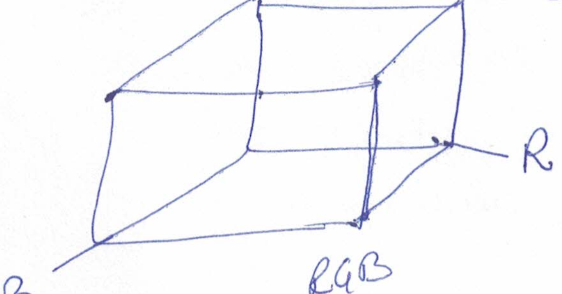
IV) HSV:

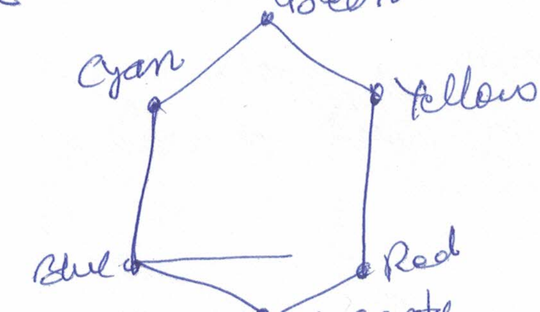
(Value)

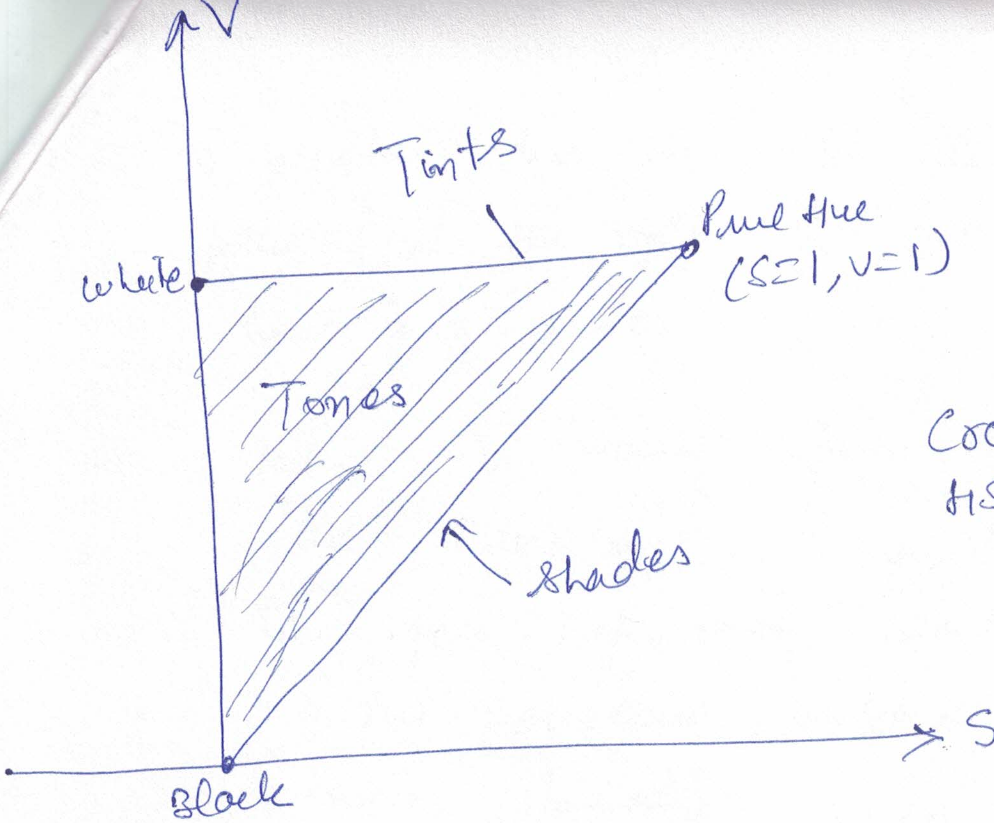
Hue (H) Saturation (S)

⇒ Instead of a set of color primaries the HSV model uses color description that have more intuitive appeal to a user. To give a color specification, a user selects a spectral color & the amounts of white & Black that are to be added to obtain different ~~colors~~ shades, tints & tones.









Cross section of HSV hexacone showing regions for shades, tints & tones.

⇒ Hue is represented as an angle about the vertical axis, ranging from 0° at red through 360°.

⇒ vertices of the hexagons are seperated by 60° intervals. Yellow is at 60°, Green at 120°, & cyan opposite red at H = 180°.

⇒ Complementary Colors are 180° apart.

⇒ Saturation S varies from 0 to 1. It is represented in the model as the ratio of the purity of a selected hue to its maximum purity at S = 1.

⇒ A selected hue is said to be one-quarter pure at the value $S = 0.25$. at $S = 0$, we have gray scale.

⇒ Value V varies from 0 at apex of the hexacone at 1 at the top. The apex represents black. At the top of the hexacone, colors have their max. intensity. when $V = 1$ & $S = 1$, we have "pure" hues.

⇒ White is the point at $V = 1$ and $S = 0$.

⇒ This is more intuitive model for most users. Starting with a selection for a pure hue, which specifies the hue angle H & sets $V = S = 1$, we describe the color we want in terms of adding either white or black to the pure hue.

→ Adding Black decreases the setting for V while S is held constant.

⇒ To get dark blue, V could be set to 0.4, with $S = 1$ & $H = 240°$.

⇒ Similarly when white is added to the hue selected, parameter S is selected, ... S is decreased, while keeping

= designated with $S = 0.3$, while $V = 1$ & $H = 240°$.

⇒ By adding some black & some white we decrease both V & S.

= Thus various shades are represented with values $S = 1$ & $0 < V \leq 1$.

⇒ The human eye can distinguish about 128 different hues and about 130 different tints (saturation levels).