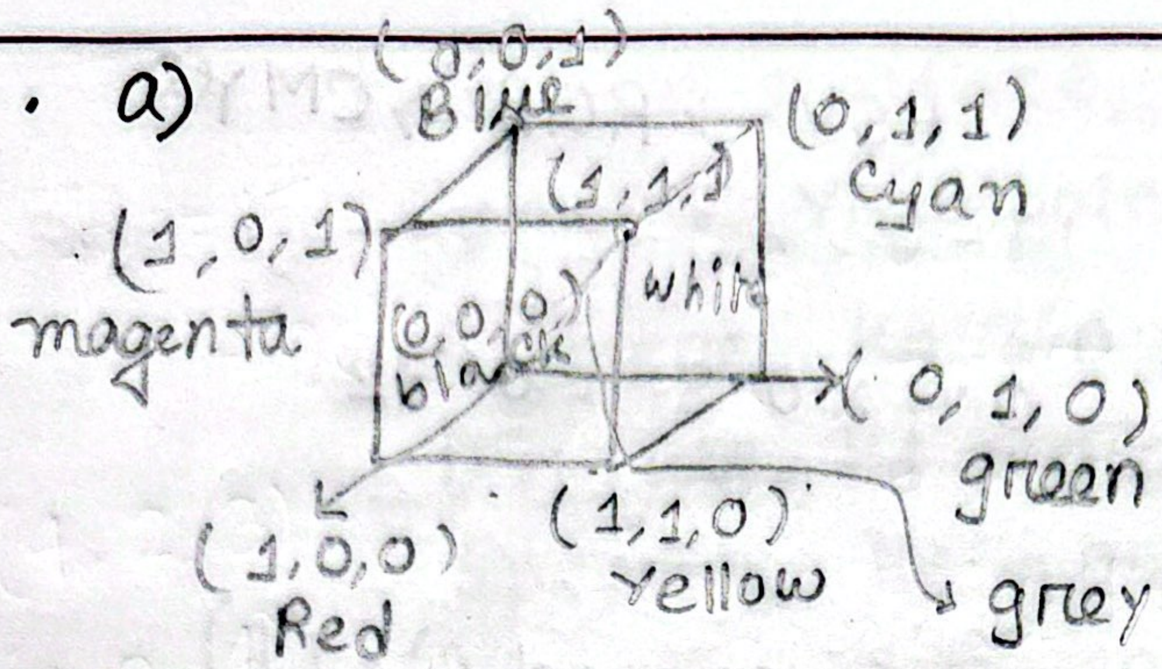
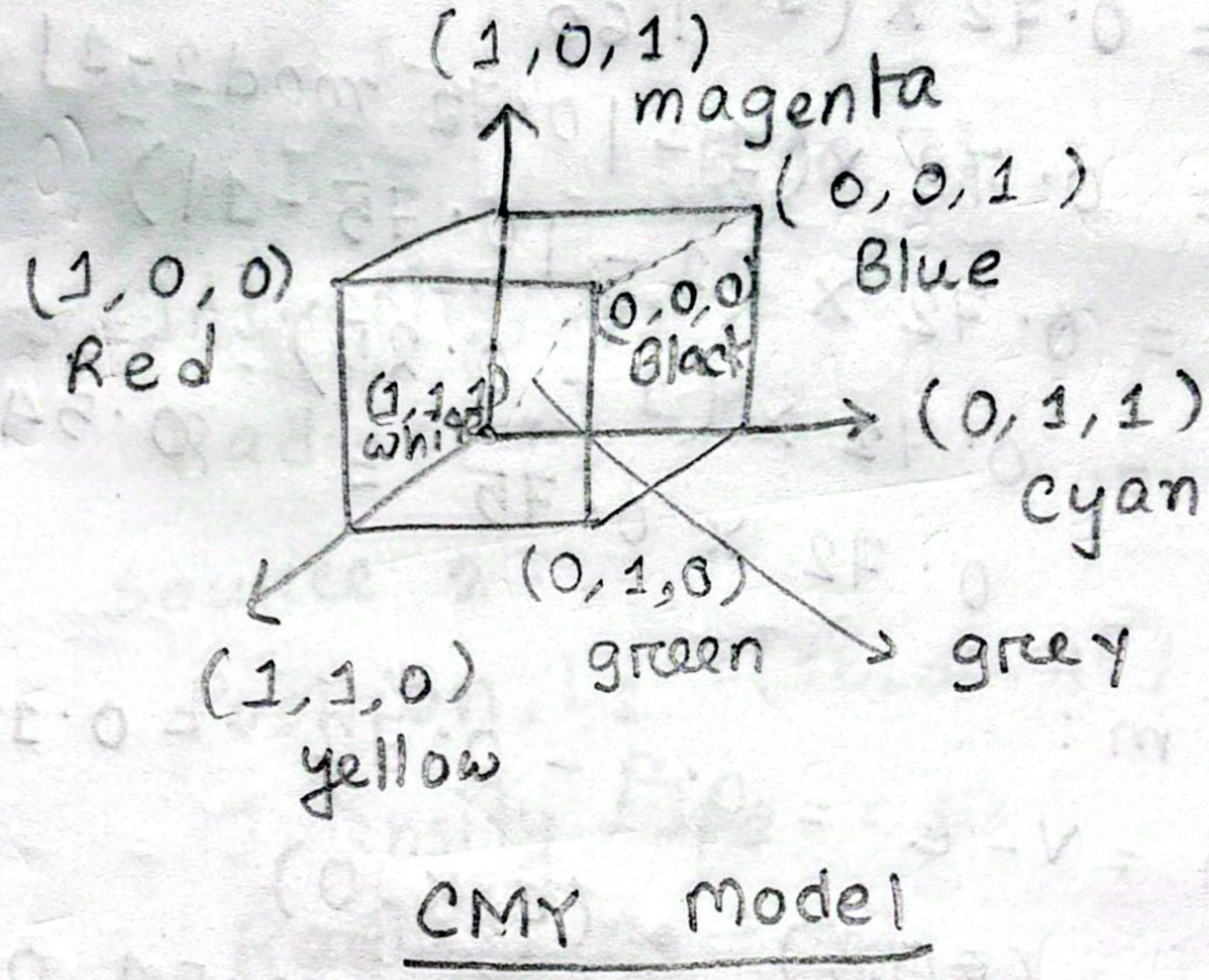
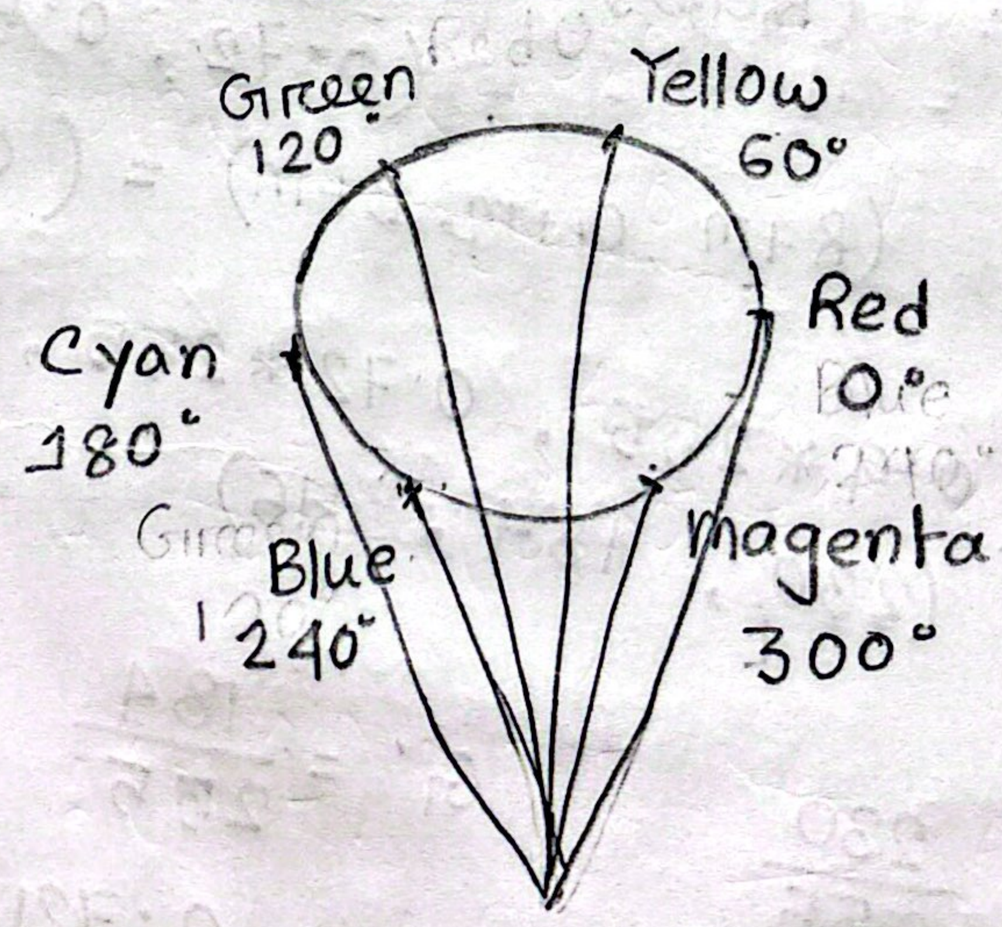
Q1 . a)




RGB model




CMY model




HSV model

b) $H = 45°$

$S = 0.8$

$V = 0.9$

HSV → RGB → CMY

**HSV → RGB**

$C = V \times S = 0.9 \times 0.8 = 0.72$

Calculate $x$:

$$x = C \times (1 - |(H/60 \bmod 2) - 1|)$$

$$= 0.72 \times (1 - |\tfrac{45}{60} \bmod 2 - 1|)$$

$$= 0.72 \times (1 - |0.75 \bmod 2 - 1|)$$

$$= 0.72 \times (1 - |0.75 - 1|)$$

$$= 0.72 \times (1 - 0.25)$$

$$= 0.72 \times 0.75 = 0.54$$

Calculate $m$:

$$m = V - C = 0.9 - 0.72 = 0.18$$

$0 \leq H < 60$ : $(R, G, B) = (C, X, 0)$

$= (0.72, 0.54, 0)$

$(R+m, G+m, B+m) = (0.9, 0.72, 0.18)$

$(R, G, B) = (0.9 * 255, 0.72 * 255, 0.18 * 255)$

$= (230, 184, 46)$

**RGB → CMY**

$R' = \frac{230}{255} = 0.901$

$G' = \frac{184}{255} = 0.721$

$B' = \frac{46}{255} = 0.180$

$C = 1 - R' = 0.098 \approx 0.1$

$M = 1 - G' = 0.278 \approx 0.28$

$Y = 1 - B' = 0.819 \approx 0.82$

$(C, M, Y) = (0.1, 0.28, 0.82)$

Q2 a) Point on surface, P = (0, 2, 4)

Camera (view point), V = (3, 2, 6)

Ambient, $k_a$ = 0·2

Diffuse, $k_d$ = 0·6

Specular, $k_s$ = 0·4

shininess, n = 10

Ambient light intensity, $I_a$ = 8

Light Source 1 :

Position, $L_1$ = (5, 10, 7)

Intensity, $I_{p1}$ = 20

Radius, $r_1$ = 25

Light Source 2 :

Position, $L_2$ = (15, 30, 45)

Intensity, $I_{p2}$ = 10

Radius, $r_2$ = 60

Point lies on xz-plane, so N = (0, 1, 0)

View Vector, V = (3-0, 2-2, 6-4) = (3, 0, 2)

$|V| = \sqrt{3^2 + 2^2} = \sqrt{13}$

$\hat{V} = \left(\frac{3}{\sqrt{13}}, 0, \frac{2}{\sqrt{13}}\right)$

For Light 1

$L_1 = (5-0, 10-2, 7-4) = (5, 8, 3)$

$|L_1| = \sqrt{5^2 + 8^2 + 3^2} = \sqrt{98}$

$\hat{L_1} = \left(\frac{5}{\sqrt{98}}, \frac{8}{\sqrt{98}}, \frac{3}{\sqrt{98}}\right)$

$N \cdot \hat{L_1} = \frac{8}{\sqrt{98}} \approx 0.81$

For Light 2

$$L_2 = (15-0, 30-2, 45-4) = (15, 28, 41)$$

$$|L_2| = \sqrt{2690} = 51.86$$

$$\hat{L}_2 = \left(\frac{15}{51.86}, \frac{28}{51.86}, \frac{41}{51.86}\right)$$

$$N \cdot \hat{L}_2 = \frac{28}{51.86} = 0.54$$

Attenuation for Light 1, $f_{att1} = \max\left(1 - \frac{98}{25^2}, 0\right) = 0.84$

Attenuation " " 2, $f_{att2} = \max\left(1 - \frac{2690}{60^2}, 0\right) = 0.25$

$R = 2(N \cdot L)N - L$

$(R \cdot V)^{10} \approx 0$ ∴ Specular contribution = 0

$I_{ambient} = I_a K_a = 8 \times 0.2 = 1.6$

$I_d = I_p \times K_d \times (N \cdot \hat{L}) \times f_{att}$

Light 1: $I_{d1} = 20 \times 0.6 \times 0.81 \times 0.84$

$= 8.1648$

Light 2: $I_{d2} = 10 \times 0.6 \times 0.54 \times 0.25$

$= 0.813G$

$I = 1.6 + 8.1648 + 0.81$

$= 10.5748$

1b) P on YZ plane → YZ plane means $x=0$

$P(0,5,4)$

$I_a = (5,5,5)$

Light A $= (9,3,-2)$ radius $r_A = 6$

diameter $= 12$

$I_{dA} = (2,5,4)$

$I_{sA} = (4,4,4)$

Light B $= (7,4,8)$ radius $r_B = 12.5$

diameter $= 25$

$I_{dB} = (3,7,10)$

$I_{sB} = (10,10,9)$

$k_a = (0.3, 0.2, 0.7)$

$k_d = (0.4, 0.1, 0.3)$

$k_s = 0.5$

$n = 64$

$V = (-2,7,-1)$

$N = (1,0,0)$

$I_{ambient} = I_a \cdot k_a = (1.5, 1, 3.5)$

Light A, $L_A = A - P = (9,-2,-6)$

$d_A = \sqrt{9^2+(-2)^2+(-6)^2} = 11$

$f_{attA} = \max\left(1 - \frac{11^2}{6^2}, 0\right) = 0$

Light B,

$$L_B = (7, -1, 4)$$

$$d_B = \sqrt{49+1+16} = 8.12$$

$$fatt_B = \max\left(1 - \frac{(8.12)^2}{(12.5)^2}, 0\right) = 0.578$$

$$\hat{L}_B = \left(\frac{7}{\sqrt{66}}, \frac{-1}{\sqrt{66}}, \frac{4}{\sqrt{66}}\right) = (0.86, -0.123, 0.492)$$

$$\hat{V} = \left(\frac{-2}{\sqrt{33}}, \frac{2}{\sqrt{33}}, \frac{-5}{\sqrt{33}}\right) = (-0.348, 0.348, -0.87)$$

$$N \cdot \hat{L}_B = \frac{7}{\sqrt{66}} \simeq 0.86$$

$$I_{diff} = fatt_B \cdot (I_{dB} \cdot k_d) \cdot (N \cdot \hat{L}_B)$$

$$I_{dB} \cdot k_d = (1.2, 0.7, 3)$$

$$I_d = 0.578 \times 0.86 \times (1.2, 0.7, 3)$$

$$= (0.596, 0.347, 1.491)$$

$$H = \frac{L_B + V}{\|L_B + V\|} = (0.746, 0.327, -0.549)$$

$$N \cdot H = 0.746$$

$$I_S = I_{sB} \times fatt_B \times k_S \times (N \cdot H)^{64}$$

$$= (10, 10, 9) \times 0.578 \times 0.5 \times (0.746)$$

$$= (10, 10, 9) \times (2.07) \times 10^{-9}$$

$$= (0.000000002, 0.000000002, 0.000000018)$$

$$I = I_D + I_A + I_S$$

$$= (1.5, 1, 3.5) + (0.596, 0.346, 1.491) + (0.000000002, 0.000000002, 0.000000018)$$

$$= (2.09, 1.346, 4.991)$$