* ~~Chapter~~ Chapter 29 :

$\lambda_{laser} = 633\ nm$

$\boxed{from}$ air $\longrightarrow$ skin $\longrightarrow$ glass

$n_{air} = 1.008$

$n_{skin} = 1.7$

$n_{glass} = 1.381$

$* \; n_m = \frac{\lambda_{vacum}}{\lambda_m}$

ⓐ $f_{air} = f_{skin} = f_{glass}$

$\lambda_{air} = \frac{633 \times 10^{-9}}{1.008}$

$\boxed{\lambda_{air} = 627.97\ nm}$

$f_{air} = \frac{c}{\lambda_{air}} = \frac{3 \times 10^{8}}{627.97 \times 10^{-9}}$

$* \; \boxed{f_{air} = 4.77 \times 10^{14}\ Hz}$

ⓑ. ⓒ

$\lambda_{air} = 627.97\ nm$

$n_{glass} = \frac{633 \times 10^{-9}}{\lambda_{skin}}$

$\boxed{\lambda_{glass} = 372.2\ nm}$

$1.7 = \frac{633 \times 10^{-9}}{\lambda}$

$$\lambda_{skin} = \frac{633 \times 10^{-1}}{1.381}$$

$\cancel{\lambda_{glass} = 458.36 \text{ nm}}$

$$\boxed{\lambda_{skin} = 458.4 \text{ nm}}$$

$n_{solution} : 1.35$

$n_{air} : 1$

c

$$v_{skin} = \frac{c}{n_{skin}}$$

$$= \frac{2.99 \times 10^{8}}{1.7} = 1.76 \times 10^{8} \text{ m/s}$$

$$v_{glass} = \frac{2.99 \times 10^{8}}{1.381} = 2.17 \times 10^{8} \text{ m/s}$$

Q2

$n_{solution} : 1.35$

$n_{air} : 1$

→ we can see an object, if the size of the object is same as the wavelength of light used.

$$\lambda_{solution} = \frac{\lambda_{air}}{n}$$

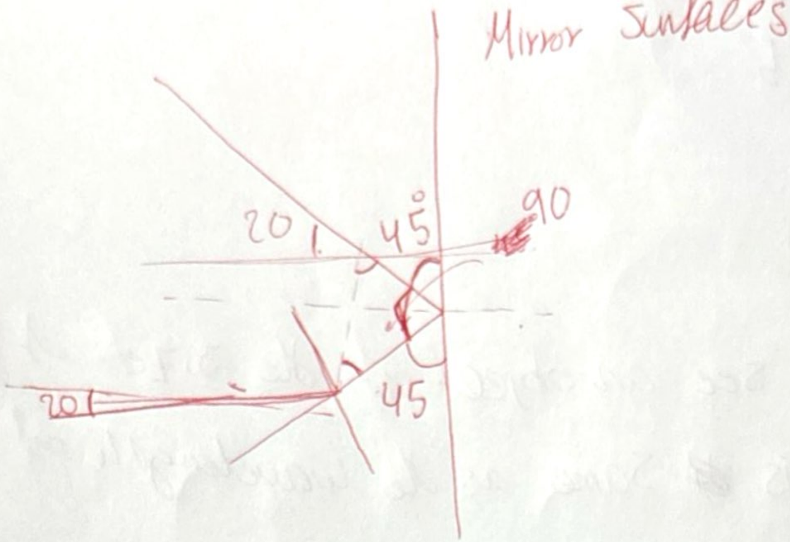
$$\lambda_{air} = \lambda_{solution} \times n_{solution}$$

$$= 1.2 \times 10^{-6} \times 1.35$$

$$\boxed{\lambda_{air} = 1.62 \times 10^{-6}\ m}$$

→ This is the minimum size of bacterium that can be seen using this optical system.

## Q3




## Q4

red light $\Rightarrow$ $\theta_c = 36.78^\circ$

blue light $\Rightarrow$ $\theta_c = 36.28$

ⓐ

$n_1 \sin\theta_1 = n_2 \sin\theta_2$ $\qquad \theta_1 = \theta_c$

$n_g \sin\theta_c = n_{air} \sin\theta_2$ $\qquad \theta_2 = 90$

$$n_g = \frac{n_{air}\sin\theta_2}{\sin\theta_c} = \frac{1 \sin(90)}{\sin(36.78)}$$

for red Light $\leftarrow$ $\boxed{n_g = 1.67}$

ⓑ

for blue Light $\leftarrow$ $n_g = \dfrac{1 \sin(90)}{\sin(36.28)} = 1.69$

## Q29.5

$\theta_i : 45^\circ$

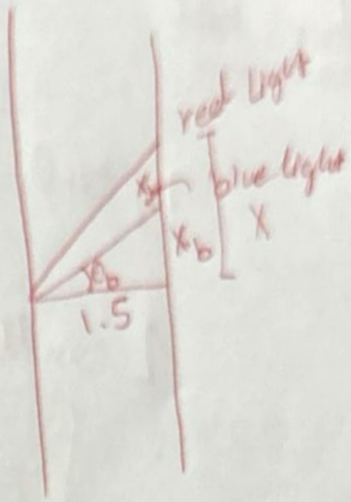
$d : 1.5$ cm

blue $\lambda : 470$ nm

red $\lambda : 630$ nm

$n_g : 1.66$

$n_g : 1.60$




For:

blue $n_i \sin\theta_i = n_{g_b} \sin\theta_b$

$$1 \sin 45 = \overset{1.66}{\cancel{n_{g_b}}} \sin\theta_b$$

$$\boxed{\theta_b = 25.21^\circ}$$

$$\tan\theta_b = \frac{x_b}{d}$$

$$x_b = 1.5 \tan(25.2)$$

$$\boxed{x_b = 7.06 \times 10^{-3}\ m}$$

For red

$n_i \sin\theta_i = n_{r} \sin\theta_r$

$1 \sin 45 = 1.6 \sin\theta_r$

$\boxed{\theta_r = 26.23}$

$\therefore X_r = \tan\theta_r \times d$

$= \tan(26.23) \times 1.5 \times 10^{-2}$

$X = 7.39 \times 10^{-3}\ m$

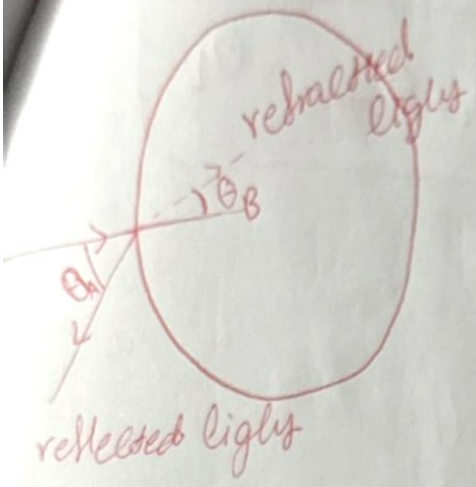
$X_r = X - X_b$

$= (7.39 - 7.06) \times 10^{-3}$

$\boxed{X_r = 0.33 \times 10^{-3}\ m}$

(b) as d ↑ inerease we can see the dispersion by the naked eyes.

(c) 65 cm




(a) $\sin\left(\frac{\theta_A}{2}\right) = \frac{0.5R}{R}$

$\sin\left(\frac{\theta_A}{2}\right) = 0.5$

$\therefore \frac{\theta_A}{2} = \frac{\pi}{6}$

$\boxed{\therefore \theta_A = \frac{\pi}{3} = 60^\circ}$

(b) Snell's law

$n_1 \sin\theta_A = n_2 \sin\theta_B$

$\frac{n_1 \sin\theta_A}{n_2} = \sin\theta_B$

(1) $\frac{\sin\theta_A}{1.33} = \sin\theta_B$

$\frac{\sin\left(\frac{60}{2}\right)}{1.33} = \sin(30 - \theta_B)$

or

$n_1 \sin\theta_A = n_2 \sin(\theta_A - \theta_B)$

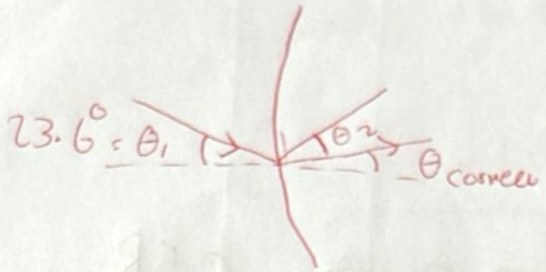
$\theta_B = 7.91^\circ$

$\sin^{-1}(30 - \theta_B) = 2.66$

$\therefore 30 - \theta_B = 22.08$

$\boxed{\therefore \theta_B = 7.91^\circ}$

Q9




$$\boxed{\theta_2 + \theta_{cornea} = \theta_1}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

$$1 \sin(23.6) = 1.38 \sin\theta_2$$

$$\theta_2 = 16.86^\circ$$

$$\therefore \theta_{Cornea} = \theta_1 - \theta_2$$

$$= 23.6 - 16.86$$

$$\boxed{\theta_{cornea} = 6.74^\circ}$$

210

$$\text{Water} \xrightarrow{1} \text{Crystalline} \xrightarrow{2} \text{Cornea}$$

1

$n_1 \sin\theta_i = n_2 \sin\theta_r$

$n_w \sin\theta_i = n_c \sin\theta_r$

$1.33 \sin(23.6^\circ) = 1.41 \sin\theta_r$

$\theta_r = 22.14^\circ$

2

Crystalline $\longrightarrow$ Cornea

$\theta_r = \theta_i$ $\quad\quad$ $\theta_r$

$n_c \sin\theta_i = n_{cornea} \sin\theta_r$

$1.41 \sin(22.14) = 1.38 \sin\theta_r$

$\theta_r = \theta_{cornea} = 22.64$