# INTERFERENCE

(1) Data:

$d = 0.3 \times 10^{-3}$ m

$FW = 1.5 \times 10^{-3}$ m

$D = 0.75$ m

$\lambda = ?$

Solution:

$$FW = \frac{\lambda D}{d}$$

$$1.5 \times 10^{-3} = \frac{\lambda (0.75)}{0.3 \times 10^{-3}}$$

$$\therefore \lambda = 6 \times 10^{-7} \text{ m}$$
$$= 6000 \text{ Å}$$

(a) $FW \propto D$

$$\therefore \frac{FW_2}{FW_1} = \frac{D_2}{D_1}$$

$$\frac{FW_2}{1.5} = \frac{2D}{D}$$

$$FW_2 = 3 \text{ mm}$$

(b) $FW \propto \frac{1}{d}$

$$\frac{FW_2}{FW_1} = \frac{d_1}{d_2}$$

$$\frac{FW_2}{1.5} = \frac{d}{2d}$$

$$FW_2 = 0.75 \text{ mm}$$

(2) Data:

$d = 0.5$ mm.

$D = \cancel{0.4}\ 1$ m

$x_9^B - x_2^D = 8.835 \times 10^{-3}$ m

$\lambda = ?$

Solution

$$x_9^B - x_2^D = 8.835 \times 10^{-3}$$

$$7.5 FW = 8.835 \times 10^{-3}$$

$$\frac{7.5 \lambda D}{d} = 8.835 \times 10^{-3}$$

$$\lambda = \frac{8.835 \times 10^{-3} \times 0.5 \times 10^{-3}}{7.5 \times 1}$$

$$\lambda = 5.89 \times 10^{-7} \text{ m}$$

$$\lambda = 5890 \text{ Å}$$

(3) Data:

$D = 1.2$ m

$d = 7.5 \times 10^{-4}$ m

$\lambda = ?$

$20 FW = 1.888 \times 10^{-2}$ m

Solution:

$$FW = \frac{1.888 \times 10^{-2}}{20}$$

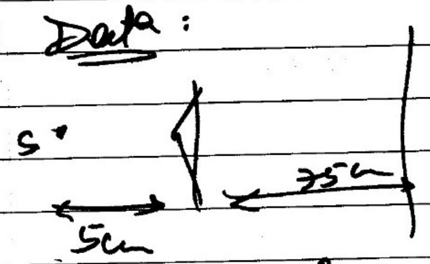
$$\frac{\lambda D}{d} = \frac{1.888 \times 10^{-2}}{20}$$

$$\frac{\lambda \times 1.2}{7.5 \times 10^{-4}} = \frac{1.888 \times 10^{-2}}{20}$$

$$\lambda = 5.9 \times 10^{-7}\ m$$

$$\lambda = 5900\ \mathring{A}$$

(4) Data :




$\lambda = 5890\ \mathring{A}$

$D = 5 + 75 = 80\ cm$

$= 0.8\ m$

$FW = 9.424 \times 10^{-4}\ m$

$d = ?$

Solution

$$FW = \frac{\lambda D}{d}$$

$$9.424 \times 10^{-4} = \frac{5890 \times 10^{-10} \times 0.8}{d}$$

$$\therefore d = \frac{5890 \times 10^{-10} \times 0.8}{9.424 \times 10^{-4}}$$

$= 5 \times 10^{-4}\ m$

$= 0.5\ mm$

(5) Data :

$\Delta = 6.65 - 6.5$

$= 0.15\ cm$

$= 0.15 \times 10^{-2}\ m$

$\lambda = 5000\ \mathring{A}$

Solution

$$\Delta = p\frac{\lambda}{2}$$

$$0.15 \times 10^{-2} = p\left(\frac{5000 \times 10^{-10}}{2}\right)$$

$$p = \frac{0.15 \times 10^{-2}}{2500 \times 10^{-10}}$$

$$p = \frac{15}{25} \times \frac{10^{-4}}{10^{-8}}$$

$$p = \frac{3}{5} \times 10^{4}$$

$$p = 6 \times 10^{3}$$

even $\therefore$ Bright



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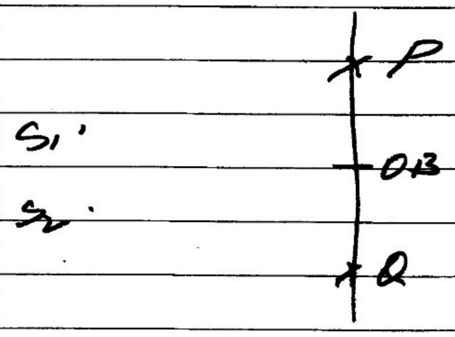
(6) Data :

$\lambda = 6000\ \mathring{A}$

$\Delta_P = 0.0075 \times 10^{-3}$ m

$\Delta_Q = 0.0015 \times 10^{-3}$ m

Solution




$\Delta_P = p\,\lambda/2$

$0.0075 \times 10^{-3} = p\,\frac{6000 \times 10^{-10}}{2}$

$\therefore p = \frac{75 \times 10^{-7}}{3 \times 10^{-7}}$

$p = 25$ (odd)

$\therefore$ dark

$n = \frac{p+1}{2} = \frac{26}{2}$

$= 13$ (dark)

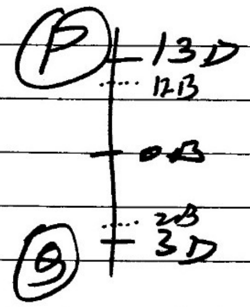
$\Delta_Q = p\,\frac{\lambda}{2}$

$0.0015 \times 10^{-3} = p\left(\frac{6000 \times 10^{-10}}{2}\right)$

$p = \frac{15 \times 10^{-7}}{3 \times 10^{-7}}$

$\therefore p = 5$ (odd) (dark)

$n = \frac{p+1}{2} = \frac{6}{3} = 3$ (dark)




Between P & Q

$12D + 2D = \underline{\underline{14D}}$

Between P & Q

$12B + 1B + 2B$

⇑ (for OB)

$= \underline{\underline{15B}}$



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(7) Data :

$\lambda = 6400 \, \mathring{A}$

$\lambda' = ?$

$x_3^B = x_4'^B$

Solution

$x_3^B = x_4'^B$

$3 FW = 4 FW'$

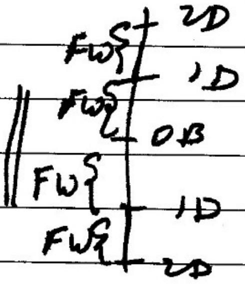
$\frac{3\lambda D}{d} = 4 \frac{\lambda' D}{d}$

$\frac{3 \times 6400}{4} = \lambda'$

$\lambda' = 4800 \, \mathring{A}$

(8) Data :

$2FW = 5.2 \times 10^{-3} m$




$D = 0.8 m$

$\lambda = 5460 \, \mathring{A}$

$d = ?$

Solution :

$2FW = 5.2 \times 10^{-3}$

$FW = 2.6 \times 10^{-3}$

$\frac{\lambda D}{d} = 2.6 \times 10^{-3}$

$\frac{5460 \times 10^{-10} \times 0.8}{d} = 2.6 \times 10^{-3}$

$\therefore d = 1.68 \times 10^{-4} m$

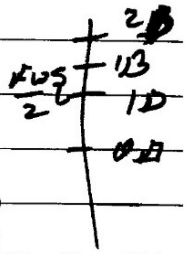
$d = 0.168 mm$

(9) Data :

$d = 0.5 \times 10^{-3} m$

$f = 0.4 m$

$\frac{FW}{2} = ?$




$\lambda = 4890 \, \mathring{A}$

Solution

$D \simeq f = 0.4 m$

$\frac{FW}{2} = \frac{\lambda D}{2d}$

$= \frac{4890 \times 10^{-10} \times 0.4}{2 \times 0.5 \times 10^{-3}}$

$= 1.956 \times 10^{-4} m$

(10) Data

$\alpha = 20^\circ$

$\lambda = 6600\ \text{Å}$

$R.L. = ?$

Solution:

If self luminous then

$$R.L = \frac{1.22\lambda}{2\mu\sin\alpha}$$

$$= \frac{1.22 \times 6600 \times 10^{-10}}{2 \times 1 \times \sin 20^\circ}$$

$$= 1.177 \times 10^{-6}\ m$$

$$= 11770\ \text{Å}$$

If not self luminous

$$R.L = \frac{\lambda}{2\mu\sin\alpha}$$

$$= \frac{6600 \times 10^{-10}}{2 \times 1 \times \sin 20^\circ}$$

$$= 9.649 \times 10^{-7}\ m$$

$$= 9649\ \text{Å}$$

(11) Data:

$d\theta = ?$

$a = 0.20\ m$

$\lambda = 5900\ \text{Å}$

Solution:

(luminous)

$$\therefore d\theta = \frac{1.22\lambda}{a}$$

$$= \frac{1.22 \times 5900 \times 10^{-10}}{0.20}$$

$$= 3.6 \times 10^{-6}\ rad.$$

(12)

$FW_1 = FW_2$

$$\frac{D}{d}(\mu - 1)t = \frac{\lambda(2D)}{d}$$

doubled the screen distance

$\therefore (\mu - 1)t = 2\lambda$

$(1.6 - 1)(1.964 \times 10^{-6}) = 2\lambda$



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$$\frac{0.6 \times 1.964 \times 10^{-6}}{2} = \lambda$$

$$\lambda = 5.892 \times 10^{-7}\ m$$

$$\lambda = 5892\ \text{Å}$$

(13) $\frac{w_1}{w_2} = \frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} = \frac{81}{1}$

$\therefore \frac{A_1}{A_2} = \frac{9}{1}$

(14) $\because$ slits are assumed same width $\therefore I_1 = I_2$

$I = I_1 + I_2 + 2\sqrt{I_1 I_2}\cos\phi$

(i) $I = I_1 + I_1 + 2\sqrt{I_1 I_1}\cos 0$

$I = 4I_1$

$\phi = \frac{2\pi x}{\lambda} = \frac{2\pi \lambda/4}{\lambda} = \frac{\pi}{2}$

(ii) $I' = I_1 + I_1 + 2\sqrt{I_1 I_1}\cos\left(\frac{\pi}{2}\right)$

$= 2I_1$

$\therefore \frac{I}{I'} = \frac{4I_1}{2I_1}$

$= 2$

$\therefore I : I' = 2 : 1$

(15) $\frac{I_1}{I_2} = \frac{A_1^2}{A_2^2} = \frac{81}{1}$

$I_{max} = (A_1 + A_2)^2$

$I_{min} = (A_1 - A_2)^2$

$\therefore \frac{I_{max}}{I_{min}} = \left(\frac{A_1 + A_2}{A_1 - A_2}\right)^2$

$= \left(\frac{\frac{A_1}{A_2} + 1}{\frac{A_1}{A_2} - 1}\right)^2$

$= \left(\frac{9 + 1}{9 - 1}\right)^2$

$= \left(\frac{10}{8}\right)^2 = \left(\frac{5}{4}\right)^2 = \frac{25}{16}$



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