

# Physics 30 – Lesson 11

## Interference of Light

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### Practice problems

1)

$$d = 0.10 \times 10^{-3} m$$

$$l = 3.20 m$$

$$\lambda = 500 \times 10^{-9} m$$

$$n = 9$$

$$x_9 = ?$$

$$n_{\max} = ?$$

$$\lambda = \frac{dx}{nl}$$

$$x = \frac{n\lambda l}{d}$$

$$x_9 = \frac{9(500 \times 10^{-9} m)(3.20)}{0.10 \times 10^{-3} m}$$

$$\boxed{x_9 = 0.144 m}$$

To find max. fringes set  $\theta = 90^\circ$

$$\lambda = \frac{d \sin \theta}{n}$$

$$n = \frac{d \sin \theta}{\lambda}$$

$$n_{\max} = \frac{(0.10 \times 10^{-3} m) \sin 90}{500 \times 10^{-9} m}$$

$$\boxed{n_{\max} = 200}$$

2)

$$d = 0.04 \times 10^{-3} m$$

$$l = 2.0 m$$

$$\lambda = ?$$

$$f = ?$$

$$n = 3$$

$$x_3 = 0.083 m$$

$$x_{2-\frac{1}{2}} = ?$$

$$\lambda = \frac{dx}{nl}$$

$$\lambda = \frac{0.04 \times 10^{-3} m(0.083 m)}{3(2.0 m)}$$

$$\lambda = 5.53 \times 10^{-7} m$$

$$v = f \lambda$$

$$f = \frac{v}{\lambda}$$

$$f = \frac{3.00 \times 10^8 m/s}{5.53 \times 10^{-7} m}$$

$$\boxed{f = 5.42 \times 10^{14} Hz}$$

$$\lambda = \frac{dx}{nl}$$

$$x = \frac{n\lambda l}{d}$$

$$x_{2-\frac{1}{2}} = \frac{(2-\frac{1}{2})(5.53 \times 10^{-7} m)(2.0 m)}{0.04 \times 10^{-3} m}$$

$$\boxed{x_{2-\frac{1}{2}} = 4.15 cm}$$

### Assignment

1)

$$n_{\max} \rightarrow \text{occurs when } \theta = 90^\circ$$

$$f = 6.0 \times 10^{14} Hz$$

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$$d = 5.0 \times 10^{-5} m$$

$$v = f \lambda$$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{3.00 \times 10^8 m/s}{6.0 \times 10^{14} Hz}$$

$$\lambda = 5.0 \times 10^{-7} m$$

$$\lambda = \frac{d \sin \theta}{n}$$

$$n = \frac{d \sin \theta}{\lambda}$$

$$n = \frac{5.0 \times 10^{-5} m \sin(90)}{5.0 \times 10^{-7} m}$$

$$\boxed{n_{\max} = 100}$$

2)  $\lambda = 615\text{nm} = 6.15 \times 10^{-7} \text{ m}$   
 $d = 1.3\text{mm} = 1.3 \times 10^{-3} \text{ m}$   
 /4  $n = 5$   
 $\theta = ?$

$$\lambda = \frac{d \sin \theta}{n}$$

$$\sin \theta = \frac{n\lambda}{d}$$

$$\theta = \sin^{-1} \frac{5(6.15 \times 10^{-7} \text{ m})}{1.3 \times 10^{-3} \text{ m}}$$

$$\boxed{\theta = 0.14^\circ}$$

3)  $\lambda = 555\text{nm} = 5.55 \times 10^{-7} \text{ m}$   
 $d = 0.10\text{mm} = 1.0 \times 10^{-4} \text{ m}$   
 /4  $n_{\text{max}} = ?$   
 $\theta = 90^\circ$

$$\lambda = \frac{d \sin \theta}{n}$$

$$n = \frac{d \sin \theta}{\lambda}$$

$$n = \frac{(1.0 \times 10^{-4} \text{ m}) \sin 90^\circ}{5.55 \times 10^{-7} \text{ m}}$$

$$\boxed{n = 180}$$

4)  $f = 6.09 \times 10^{14} \text{ Hz}$   
 $L = 7.0\text{m}$   
 /5  $\Delta x = 0.025\text{m} (n = 1)$   
 $d = ?$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{6.09 \times 10^{14} \text{ Hz}}$$

$$\lambda = 4.93 \times 10^{-7} \text{ m}$$

$$d = \frac{Ln\lambda}{x}$$

$$d = \frac{7.0\text{m}(1)(4.93 \times 10^{-7} \text{ m})}{0.025\text{m}}$$

$$\boxed{d = 1.38 \times 10^{-4} \text{ m}}$$

5)  $f = 4.6 \times 10^{14} \text{ Hz}$   
 $d = 0.16\text{mm} = 1.6 \times 10^{-4} \text{ m}$   
 $L = 8.0\text{m}$   
 /5  $n = 4$   
 $x = ?$

$$\lambda = \frac{v}{f}$$

$$\lambda = \frac{3.00 \times 10^8 \text{ m/s}}{4.6 \times 10^{14} \text{ Hz}}$$

$$\lambda = 6.52 \times 10^{-7} \text{ m}$$

$$x = \frac{\lambda n L}{d}$$

$$x = \frac{6.52 \times 10^{-7} \text{ m}(4)(8.0\text{m})}{1.6 \times 10^{-4} \text{ m}}$$

$$\boxed{x_4 = 0.13\text{m}}$$

6)  $L = 4.5\text{m}$   
 $x_1 = 0.037\text{m}$   
 /3  $\lambda = 480\text{nm} = 4.90 \times 10^{-7} \text{ m}$   
 $d = ?$   
 $n = 1$

$$d = \frac{\lambda n L}{x}$$

$$d = \frac{4.90 \times 10^{-7} \text{ m}(1)(4.5\text{m})}{0.037\text{m}}$$

$$\boxed{d = 6.0 \times 10^{-5} \text{ m}}$$

7)  $n = 1$   
 $x_1 = 0.0240m$   
 $x_2 = ?$

/5  $\lambda_1 = 475nm$   
 $\lambda_2 = 611nm$

$n, d$  and  $L$  are common

$$\frac{\lambda_1}{x_1} = \frac{d}{nL} \quad \frac{\lambda_2}{x_2} = \frac{d}{nL}$$

$$\therefore \frac{\lambda_1}{x_1} = \frac{\lambda_2}{x_2}$$

$$x_2 = \frac{\lambda_2 x_1}{\lambda_1}$$

$$x_2 = \frac{611nm(0.024m)}{475nm}$$

$$\boxed{x_2 = 3.09 \times 10^{-2} m}$$

8)  $n = ?$   
 $\theta = 2.0^\circ$

/3  $d = 3.8 \times 10^{-5} m$   
 $\lambda = ?$

$$\lambda = \frac{d \sin \theta}{n}$$

$$\lambda = \frac{(3.8 \times 10^{-5} m) \sin 2.0^\circ}{2}$$

$$\boxed{\lambda = 6.6 \times 10^{-7} m}$$

9)  $\lambda = 600nm = 6.00 \times 10^{-7} m$   
 $L = 3.0m$

/5  $x_{10} - x_1 = 0.050m$   
 $n_{10} - n_1 = 9$   
 $d = ?$

$$\Delta x = \frac{0.050m}{9}$$

$$\Delta x = 0.00555m$$

$$d = \frac{L\lambda}{\Delta x}$$

$$d = \frac{3.0m(6.00 \times 10^{-7} m)}{0.00555m}$$

$$\boxed{d = 3.2 \times 10^{-4} m}$$

10)  $\lambda = 6.0 \times 10^{-7} m$   
 $L = 1.5m$   
 $x_{11} - x_1 = 2.00cm$   
 $n_{11} - n_1 = 10$

a)  $d = \frac{\lambda L}{\Delta x}$   
 $d = \frac{(6.0 \times 10^{-7} m)(1.5m)}{0.0020m}$   
 $\boxed{d = 4.5 \times 10^{-4} m}$

b)  $\Delta x = \frac{L\lambda}{d}$   
 $\Delta x = \frac{1.5m(4.5 \times 10^{-7} m)}{4.5 \times 10^{-4} m}$   
 $\boxed{\Delta x = 1.5 \times 10^{-3} m}$

/6  $\Delta x = \frac{2.00cm}{10}$   
 $\Delta x = 0.0020m (n = 1)$