Principles of Engineering Physics 1 1st edition Khan Solutions Manual

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CHAPTER-2

INTERFERENCE

2.1 $\mu = \dfrac{c}{v} = \dfrac{\nu\lambda_O}{\nu\lambda_m} = \dfrac{\lambda_O}{\lambda_m} \Rightarrow \lambda_m = \dfrac{\lambda_O}{\mu} = \dfrac{6500\,\text{Å}}{1.5} = 4333\,\text{Å}$

2.2 $2d = 0.19\text{cm}; \beta = 0.031\text{cm}; D = 1\text{m} = 100\text{cm}$,

$$\lambda = \frac{\beta \times 2d}{D} = \frac{0.031 \times 0.19}{100}\text{cm} = 5.89 \times 10^{-5}\text{cm} = 5890\,\text{Å}$$

2.3 $\beta = \dfrac{1\text{cm}}{20} = 0.05\text{cm}$, $D = 200\text{cm}$, $\lambda = 5100\,\text{Å} = 5100 \times 10^{-8}\text{cm}$

$$2d = \frac{\lambda D}{\beta} = \frac{5100 \times 10^{-8} \times 200}{0.05}\text{cm} = 0.204\,\text{cm}$$

2.4 $2d = 0.02\text{cm}$, $D = 80\text{cm}$, n=4, $y_4 = 1.2\text{cm}$, bright fringe

$$\lambda = \frac{y_n \times 2d}{Dn} = \frac{1.2\text{cm} \times 0.02\text{cm}}{80\text{cm} \times 4} = 7.5 \times 10^{-5}\text{cm} = 7500\,\text{Å}$$

2.5 $2d = 0.07\text{cm}$, $D = 120\text{cm}$, n=8, $y_8 = 0.8\text{cm}$, dark fringe

$$y_n = \frac{D(2n+1)\lambda}{4d} \Rightarrow \lambda = \frac{y_n \times 4d}{D(2n+1)} = \frac{0.8\text{cm} \times 0.14\text{cm}}{120\text{cm} \times 17} = 5.49\text{cm} = 5490\,\text{Å}$$

2.6 $R = 3\text{m} = 300\text{cm}$, $\mu = 1$,n=8, $D_8 = 0.72\text{cm}$, Bright fringe, reflected light

$$D_n = \sqrt{(2n+1)\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2 \mu}{2R(2n+1)}$$

$$= \frac{0.5184}{2 \times 300 \times 17}\text{cm} = 5.082 \times 10^{-5}\text{cm} = 5082\,\text{Å}$$

2.7 $R = 2.7\text{m} = 270\text{cm}$, $\mu = 1$, n=10, $D_{10} = 0.8\text{cm}$, Dark fringe, reflected light

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$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2\mu}{2R\times 2n}$$

$$\lambda = \frac{0.64}{2\times 270\times 20}\text{cm} = 5.926\times 10^{-5}\text{cm} = 5926\,\overset{O}{A}$$

2.8 $R = 160\text{cm}$, $\mu = 1.333$,n=8, $D_8 = 0.4\text{cm}$, Dark fringe, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2\mu}{2R\times 2n}$$

$$= \frac{0.16\times 1.333}{2\times 160\times 16}\text{cm} = 4.166\times 10^{-5}\text{cm} = 4166\,\overset{O}{A}$$

2.9 $R = 3\text{m} = 300\text{cm}$, $\mu = 1$,n=9, $D_9 = 0.74\text{cm}$, Bright fringe, transmitted light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2\mu}{2R\times 2n}$$

$$\lambda = \frac{0.5476}{2\times 300\times 18}\text{cm} = 4.8\times 10^{-5}\text{cm} = 5070\,\overset{O}{A}$$

2.10 $R = 2.7\text{m} = 270\text{cm}$, $\mu = 1$,n=10, $D_{10} = 0.8\text{cm}$, Dark fringe, transmitted light

$$D_n = \sqrt{(2n+1)\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2\mu}{2R(2n+1)}$$

$$\lambda = \frac{0.64}{2\times 270\times 21}\text{cm} = 5.644\times 10^{-5}\text{cm} = 5644\,\overset{O}{A}$$

2.11 $R = 250\text{cm}$, $\mu = 1.354$,n=11, $D_{11} = 0.72\text{cm}$, Dark fringe, transmitted light

$$D_n = \sqrt{(2n+1)\frac{2\lambda R}{\mu}} \Rightarrow \lambda = \frac{D_n^2\mu}{2R(2n+1)}$$

$$= \frac{0.5184\times 1.354}{2\times 250\times 23}\text{cm} = 6.104\times 10^{-5}\text{cm} = 6104\,\overset{O}{A}$$

2.12 $R = 290\text{cm}$, $\lambda = 5893\,\overset{O}{A}$, $\mu_O = 1$, $\mu_m = 1.33$, n=7, Bright fringe, transmitted light

$$D_{nO} = \sqrt{2n\frac{2\lambda R}{\mu_o}} \text{ and } D_{nm} = \sqrt{2n\frac{2\lambda R}{\mu_m}}$$

$$D_{nO} - D_{nm} = \sqrt{2n\frac{2\lambda R}{\mu_o}} - \sqrt{2n\frac{2\lambda R}{\mu_m}} = \sqrt{4n\lambda R}\left(\sqrt{\frac{1}{\mu_o}} - \sqrt{\frac{1}{\mu_m}}\right)$$

$$D_{nO} - D_{nm} = \sqrt{4n\lambda R}\left(1 - \sqrt{1/\mu_m}\right)$$

$$= \sqrt{4 \times 7 \times 5.893 \times 10^{-5} \times 290} \times \left(1 - \sqrt{1/1.33}\right)\text{cm} = 0.092\text{cm}$$

2.13 $D_5 = 0.336\text{cm}$, $D_{15} = 0.590\text{cm}$, $R = 100\text{cm}$, p=10

$$D_{n+p}^2 = 4\lambda Rp + D_n^2 \Rightarrow \lambda = \frac{D_{n+p}^2 - D_n^2}{4Rp}$$

$$= \frac{0.59^2 - 0.336^2}{4 \times 100 \times 10}\text{cm} = 5.880 \times 10^{-5}\text{cm} = 5880\,\text{Å}$$

2.14 $D_{10} = 0.372\text{cm}$, $D_{15} = 0.555\text{cm}$, $\lambda = 5893\,\text{Å} = 5.893 \times 10^{-5}\text{cm}$, p=5

$$D_{n+p}^2 = 4\lambda Rp + D_n^2 \Rightarrow R = \frac{D_{n+p}^2 - D_n^2}{4\lambda p}$$

$$= \frac{0.555^2 - 0.372^2}{4 \times 5.893 \times 10^{-5} \times 5}\text{cm} = 143.9\text{cm}$$

2.15 $D_{10} = 0.615\text{cm}$, $\lambda = 5893\,\text{Å} = 5.893 \times 10^{-5}\text{cm}$, n=10 $R = 203\text{cm}$, reflected light, bright fringe

$$D_n = \sqrt{(2n+1)\frac{2\lambda R}{\mu}} \Rightarrow \mu = \frac{2R(2n+1)\lambda}{D_n^2} = \frac{2 \times 203 \times 21 \times 5.893 \times 10^{-5}}{0.378} = 1.33$$

1.16 $\lambda_1 = 6000\,\text{Å} = 6 \times 10^{-5}\text{cm}$, $\lambda_2 = 4500\,\text{Å} = 4.5 \times 10^{-5}\text{cm}$, $D_{n1} = D_{(n+1)2}$, $R = 100\text{cm}$, dark rings, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}}$$

$$D_n^2 = 2n\lambda_1 2R \quad D_{n+1}^2 = 2(n+1)\lambda_2 2R$$

$$(n+1)\lambda_2 = n\lambda_1 \quad n(\lambda_2 - \lambda_1) = -\lambda_2$$

$$n = \frac{\lambda_2}{\lambda_1 - \lambda_2} = \frac{4500}{6000 - 4500} = 3$$

$$D_3^2 = 2n\lambda_1 2R = 12 \times 6 \times 10^{-5} \times 100\text{cm}^2 = 0.072\text{cm}^2$$

$$R_{\lambda 1} = \frac{\sqrt{0.072}}{2} = 0.1342\text{cm}$$

$$D_3^2 = 2n\lambda_1 2R = 12 \times 4.5 \times 10^{-5} \times 100\text{cm}^2 = 0.054\text{cm}^2$$

$$R_{\lambda 2} = \frac{\sqrt{0.054}}{2} = 0.1162\text{cm}$$

1.17 $\lambda_1 = 5890\,\text{Å} = 5.890 \times 10^{-5}\text{cm}$, $\lambda_2 = 5896\,\text{Å} = 5.896 \times 10^{-5}\text{cm}$, $D_{n1} = D_{(n+2)2}$, $R = 200\text{cm}$, dark rings, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}}$$

$$D_n^2 = 2n\lambda_1 2R \quad D_{n+1}^2 = 2(n+2)\lambda_2 2R$$

$$(n+2)\lambda_2 = n\lambda_1$$

$$n = \frac{2\lambda_2}{\lambda_1 - \lambda_2} = \frac{2 \times 5890}{5896 - 5890} = 1963$$

$$R_{\lambda 1} = \frac{1}{2}\sqrt{D_{\lambda 1}^2} = \frac{1}{2}\sqrt{2n\lambda_1 2R} = \frac{1}{2}\sqrt{4 \times 1963 \times 5.89 \times 10^{-5} \times 200\text{cm}^2} = 4.81\text{cm}$$

$$R_{\lambda 2} = \frac{1}{2}\sqrt{D_{\lambda 2}^2} = \frac{1}{2}\sqrt{2n\lambda_2 2R} = \frac{1}{2}\sqrt{4 \times 1963 \times 5.896 \times 10^{-5} \times 200\text{cm}^2} = 4.81\text{cm}$$

1.18 $\lambda_1 = 5600\,\overset{O}{A} = 5.6\times10^{-5}cm$, $\lambda_2 = 4800\,\overset{O}{A} = 4.8\times10^{-5}cm$, $D_{n1} = D_{(n+2)2}$, $R = 90cm$, dark rings, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}}$$

$$D_n^2 = 2n\lambda_1 2R \quad D_{n+1}^2 = 2(n+2)\lambda_2 2R$$

$$(n+2)\lambda_2 = n\lambda_1$$

$$n = \frac{2\lambda_2}{\lambda_1 - \lambda_2} = \frac{2\times4800}{5600-4800} = 12$$

$$R_{\lambda1} = \frac{1}{2}\sqrt{D_{\lambda1}^2} = \frac{1}{2}\sqrt{2n\lambda_1 2R} = \frac{1}{2}\sqrt{4\times12\times5.6\times10^{-5}\times90cm^2} = 0.2459cm$$

$$R_{\lambda2} = \frac{1}{2}\sqrt{D_{\lambda2}^2} = \sqrt{2n\lambda_2 2R} = \sqrt{4\times12\times4.8\times10^{-5}\times90cm^2} = 0.2277cm$$

2.19 $\lambda = 5896\,\overset{O}{A} = 5.896\times10^{-5}cm$,n=20, $D_{20} = 0.73cm$, Dark fringe, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow R = \frac{D_n^2\mu}{2\lambda\times2n} = \frac{0.73^2\times1}{2\times5.896\times10^{-5}\times40}cm = 112.98cm$$

For nth dark fringe thickness

$$e = 2n(\frac{\lambda}{4\mu}) = \frac{n\lambda}{2\mu} = \frac{20\times5.896\times10^{-5}}{2\times1}cm = 5.896\times10^{-4}cm$$

2.20 $\lambda = 7000\,\overset{O}{A} = 7\times10^{-5}cm$, n=15, $\mu = 1.354$, $D_{15} = 0.565cm$, Dark fringe, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow R = \frac{D_n^2\mu}{2\lambda\times2n} = \frac{0.565^2\times1.354}{2\times7\times10^{-5}\times30}cm = 102.91cm$$

For nth dark fringe thickness

$$e = 2n(\frac{\lambda}{4\mu}) = \frac{n\lambda}{2\mu} = \frac{15\times7\times10^{-5}}{2\times1.354}cm = 3.877\times10^{-4}cm$$

2.21 $\lambda = 6500\,\text{Å} = 6.5\times10^{-5}\text{cm}$, n=12, $D_{12} = 0.374\text{cm}$, $R = 65.5\text{cm}$ Dark fringe, reflected light

$$D_n = \sqrt{2n\frac{2\lambda R}{\mu}} \Rightarrow \mu = \frac{4\lambda nR}{D_n^2} = \frac{4\times6.5\times10^{-5}\times12\times65.5}{0.374^2} = 1.461$$

2.22 D=100cm, 2d=0.075cm, $\beta = 0.0845\text{cm}$

$$\lambda = \frac{\beta\times 2d}{D} = \frac{0.0845\times0.075}{100}\text{cm} = 6338\,\text{Å} = 6338\times10^{-8}\text{cm}$$

2.23 b=175cm, a=25cm,D=a+b=200cm, 2d=0.4974cm, $\mu = 1.5$,

$\lambda = 5000\,\text{Å} = 5\times10^{-5}\text{cm}$

$$\alpha = \frac{2d}{2a(\mu-1)} = \left(\frac{0.4974}{50(1.5-1)}\times\frac{180}{\pi}\right)^{\circ} = 1.14^{\circ}$$

2.24 x=0.1732mm=0.01732, n=500, $\lambda = \frac{2x}{n}$

$$\lambda = \frac{2\times0.01732}{500}\text{cm} = 6.928\times10^{-5}\text{cm} = 6928\,\text{Å}$$

2.25. $\lambda_1 = 575\text{nm}$, $\lambda_2 = 580\text{nm}$, x=?

$$x = \frac{\lambda_1\lambda_2}{2(\lambda_1-\lambda_2)} = \frac{575\times580}{2(580-575)}\text{nm} = 33350\text{nm} = 0.03335\text{mm}$$

2.26 t=0.5cm, n=500, $\varphi = 45^{\circ}$ $\lambda = 5893\,\text{Å} = 5.893\times10^{-5}\text{cm}$

$$\mu \approx \frac{(2t-n\lambda)-(1-\cos\varphi)}{2t(1-\cos\varphi)-n\lambda} = \frac{(1-500\times5.893\times10^{-5})-(1-0.7071)}{(1-0.7071)-500\times5.893\times10^{-5}} = 2.571$$