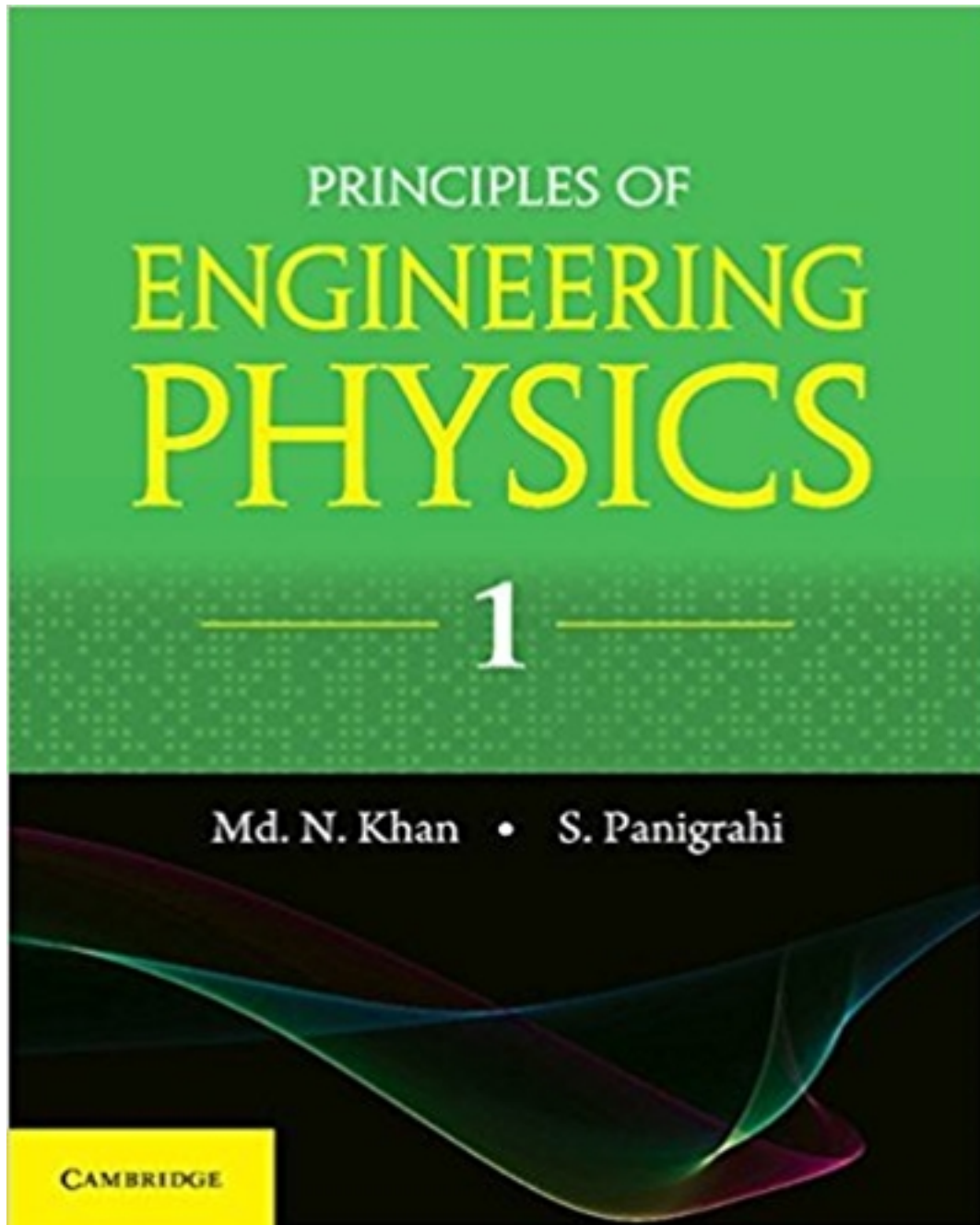


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Solutions

CHAPTER-2

INTERFERENCE

$$2.1 \quad \mu = \frac{c}{v} = \frac{v\lambda_o}{v\lambda_m} = \frac{\lambda_o}{\lambda_m} \Rightarrow \lambda_m = \frac{\lambda_o}{\mu} = \frac{6500 \text{ Å}}{1.5} = 4333 \text{ Å}$$

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

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

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

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

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

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

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

$$y_n = \frac{D(2n+1)\lambda}{4d} \Rightarrow \lambda = \frac{y_n \times 4d}{D(2n+1)} = \frac{0.8\text{cm} \times 0.14\text{cm}}{120\text{cm} \times 17} = 5.49 \times 10^{-5} \text{cm} = 5490 \text{ Å}$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

2.12 $R = 290 \text{ cm}$, $\lambda = 5893 \text{ \AA}$, $\mu_o = 1$, $\mu_m = 1.33$, $n=7$, Bright fringe, transmitted light

$$D_{n0} = \sqrt{2n \frac{2\lambda R}{\mu_o}} \text{ and } D_{nm} = \sqrt{2n \frac{2\lambda R}{\mu_m}}$$

$$D_{n0} - D_{nm} = \sqrt{2n \frac{2\lambda R}{\mu_o}} - \sqrt{2n \frac{2\lambda R}{\mu_m}} = \sqrt{4n\lambda R} \left(\sqrt{\frac{1}{\mu_o}} - \sqrt{\frac{1}{\mu_m}} \right)$$

$$D_{n0} - D_{nm} = \sqrt{4n\lambda R} (1 - \sqrt{1/\mu_m})$$

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

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

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

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

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

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

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

2.15 $D_{10} = 0.615 \text{ cm}$, $\lambda = 5893 \text{ \AA} = 5.893 \times 10^{-5} \text{ cm}$, $n=10$ $R = 203 \text{ cm}$, 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 $\lambda_1 = 6000 \text{ \AA} = 6 \times 10^{-5} \text{ cm}$, $\lambda_2 = 4500 \text{ \AA} = 4.5 \times 10^{-5} \text{ cm}$, $D_{n1} = D_{(n+1)2}$, $R = 100 \text{ cm}$, 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 $\lambda_1 = 5600 \text{ \AA} = 5.6 \times 10^{-5} \text{ cm}$, $\lambda_2 = 4800 \text{ \AA} = 4.8 \times 10^{-5} \text{ cm}$, $D_{n1} = D_{(n+2)2}$,
 $R = 90 \text{ cm}$, dark rings, reflected light

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

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

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

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

$$R_{\lambda_1} = \frac{1}{2} \sqrt{D_{\lambda_1}^2} = \frac{1}{2} \sqrt{2n\lambda_1 2R} = \frac{1}{2} \sqrt{4 \times 12 \times 5.6 \times 10^{-5} \times 90 \text{ cm}^2} = 0.2459 \text{ cm}$$

$$R_{\lambda_2} = \frac{1}{2} \sqrt{D_{\lambda_2}^2} = \sqrt{2n\lambda_2 2R} = \sqrt{4 \times 12 \times 4.8 \times 10^{-5} \times 90 \text{ cm}^2} = 0.2277 \text{ cm}$$

2.19 $\lambda = 5896 \text{ \AA} = 5.896 \times 10^{-5} \text{ cm}$, $n=20$, $D_{20} = 0.73 \text{ cm}$, Dark fringe, reflected light

$$D_n = \sqrt{2n \frac{2\lambda R}{\mu}} \Rightarrow R = \frac{D_n^2 \mu}{2\lambda \times 2n} = \frac{0.73^2 \times 1}{2 \times 5.896 \times 10^{-5} \times 40} \text{ cm} = 112.98 \text{ cm}$$

For nth dark fringe thickness

$$e = 2n \left(\frac{\lambda}{4\mu} \right) = \frac{n\lambda}{2\mu} = \frac{20 \times 5.896 \times 10^{-5}}{2 \times 1} \text{ cm} = 5.896 \times 10^{-4} \text{ cm}$$

2.20 $\lambda = 7000 \text{ \AA} = 7 \times 10^{-5} \text{ cm}$, $n=15$, $\mu = 1.354$, $D_{15} = 0.565 \text{ cm}$, Dark fringe, reflected light

$$D_n = \sqrt{2n \frac{2\lambda R}{\mu}} \Rightarrow R = \frac{D_n^2 \mu}{2\lambda \times 2n} = \frac{0.565^2 \times 1.354}{2 \times 7 \times 10^{-5} \times 30} \text{ cm} = 102.91 \text{ cm}$$

For nth dark fringe thickness

$$e = 2n \left(\frac{\lambda}{4\mu} \right) = \frac{n\lambda}{2\mu} = \frac{15 \times 7 \times 10^{-5}}{2 \times 1.354} \text{ cm} = 3.877 \times 10^{-4} \text{ cm}$$

2.21 $\lambda = 6500 \text{ \AA} = 6.5 \times 10^{-5} \text{ cm}$, $n=12$, $D_{12} = 0.374 \text{ cm}$, $R = 65.5 \text{ cm}$ Dark fringe, reflected light

$$D_n = \sqrt{2n \frac{2\lambda R}{\mu}} \Rightarrow \mu = \frac{4\lambda n R}{D_n^2} = \frac{4 \times 6.5 \times 10^{-5} \times 12 \times 65.5}{0.374^2} = 1.461$$

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

$$\lambda = \frac{\beta \times 2d}{D} = \frac{0.0845 \times 0.075}{100} \text{ cm} = 6338 \text{ \AA} = 6338 \times 10^{-8} \text{ cm}$$

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

$$\lambda = 5000 \text{ \AA} = 5 \times 10^{-5} \text{ cm}$$

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

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

$$\lambda = \frac{2 \times 0.01732}{500} \text{ cm} = 6.928 \times 10^{-5} \text{ cm} = 6928 \text{ \AA}$$

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

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

2.26 $t=0.5 \text{ cm}$, $n=500$, $\phi = 45^\circ$ $\lambda = 5893 \text{ \AA} = 5.893 \times 10^{-5} \text{ cm}$

$$\mu \approx \frac{(2t - n\lambda) - (1 - \cos \phi)}{2t(1 - \cos \phi) - n\lambda} = \frac{(1 - 500 \times 5.893 \times 10^{-5}) - (1 - 0.7071)}{(1 - 0.7071) - 500 \times 5.893 \times 10^{-5}} = 2.571$$