19. (a) Using the notation of Sample Problem – “Pointillistic paintings use the diffraction of your eye,”

$$L = \frac{D}{1.22\lambda / d} = \frac{2(50\times10^{-6}\ \text{m})(1.5\times10^{-3}\ \text{m})}{1.22(650\times10^{-9}\ \text{m})} = 0.19\ \text{m}\ .$$

(b) The wavelength of the blue light is shorter so $L_{\max} \propto \lambda^{-1}$ will be larger.

20. Using the notation of Sample Problem – “Pointillistic paintings use the diffraction of your eye,” the minimum separation is

$$D = L\theta_R = L\left(\frac{1.22\lambda}{d}\right) = \left(6.2\times10^{3}\ \text{m}\right)\frac{(1.22)\left(1.6\times10^{-2}\ \text{m}\right)}{2.3\,\text{m}} = 53\,\text{m}\ .$$

37. In a manner similar to that discussed in Sample Problem — “Double-slit experiment with diffraction of each slit included,” we find the number is $2(d/a) - 1 = 2(2a/a) - 1 = 3$.

38. We note that the central diffraction envelope contains the central bright interference fringe (corresponding to $m = 0$ in Eq. 36-25) plus ten on either side of it. Since the eleventh order bright interference fringe is not seen in the central envelope, then we conclude the first diffraction minimum (satisfying $\sin\theta = \lambda/a$) coincides with the $m = 11$ instantiation of Eq. 36-25:

$$d = \frac{m\lambda}{\sin\theta} = \frac{11\,\lambda}{\lambda/a} = 11\,a\ .$$

Thus, the ratio d/a is equal to 11.

48. (a) For the maximum with the greatest value of $m = M$ we have $M\lambda = a \sin\theta < d$, so $M < d/\lambda = 900\ \text{nm}/600\ \text{nm} = 1.5$, or $M = 1$. Thus three maxima can be seen, with $m = 0, \pm1$.

(b) From Eq. 36-28, we obtain

$$\Delta\theta_{hw} = \frac{\lambda}{N\,d\cos\theta} = \frac{d\sin\theta}{N\,d\cos\theta} = \frac{\tan\theta}{N} = \frac{1}{N}\tan\left[\sin^{-1}\left(\frac{\lambda}{d}\right)\right]$$

$$= \frac{1}{1000}\tan\left[\sin^{-1}\left(\frac{600\,\text{nm}}{900\,\text{nm}}\right)\right] = 0.051°.$$

55. If a grating just resolves two wavelengths whose average is λ_{avg} and whose separation is $\Delta\lambda$, then its resolving power is defined by $R = \lambda_{avg}/\Delta\lambda$. The text shows this is Nm, where N is the number of rulings in the grating and m is the order of the lines. Thus $\lambda_{avg}/\Delta\lambda = Nm$ and

$$N = \frac{\lambda_{avg}}{m\Delta\lambda} = \frac{656.3\,\text{nm}}{(1)(0.18\,\text{nm})} = 3.65\times10^3\text{ rulings.}$$

58. (a) We find $\Delta\lambda$ from $R = \lambda/\Delta\lambda = Nm$:

$$\Delta\lambda = \frac{\lambda}{Nm} = \frac{500\,\text{nm}}{(600/\text{mm})(5.0\,\text{mm})(3)} = 0.056\,\text{nm} = 56\,\text{pm.}$$

(b) Since $\sin\theta = m_{max}\lambda/d < 1$,

$$m_{max} < \frac{d}{\lambda} = \frac{1}{(600/\text{mm})(500\times10^{-6}\text{ mm})} = 3.3.$$

Therefore, $m_{max} = 3$. No higher orders of maxima can be seen.