Chem 462—Instrumental Analysis

Chapter 7 Solution Set

7.9. $\lambda = \frac{2t\eta}{n}$ $\lambda = 4.54\ \mu m$

a. $n = 1$ $\eta = 1.34$

$$t = \frac{n\lambda}{2\eta} = \frac{1(4.54\ \mu m)}{2(1.34)} = 1.69\ \mu m$$

b. Any wavelength with an integral number of wavelengths that fit within the length of 1.69 μm will also be passed:

$$\frac{\lambda}{2} = 2.27\ \mu m$$

$$\frac{\lambda}{3} = 1.513\ \mu m$$

$$\frac{\lambda}{4} = 1.135\ \mu m$$

and so forth.

7.12. $n\lambda = d[\sin(i) + \sin(r)]$

$$d = \frac{n\lambda}{[\sin(i) + \sin(r)]} = \frac{1(500\ nm)}{[\sin(60) + \sin(10)]} = 480.9\ \frac{nm}{line}$$

$$\frac{1}{d} = \frac{1\ line}{480.9\ nm}\left(\frac{10^6\ nm}{1\ mm}\right) = 2080\ \frac{lines}{mm}$$

7.13.

$R = \frac{\lambda}{\Delta\lambda} = nN$ $n = order$ $N = grating\ lines\ illuminated$

$$n = 1 \qquad N = \left(72.0\ \frac{lines}{mm}\right)(10.0\ mm) = 720.\ lines$$

$$R = 1(720) = 720$$

$$\nu = 1000\ cm^{-1} \qquad \lambda = \frac{1}{1000\ cm^{-1}} = 1.00 \times 10^{-3}\ cm\left(\frac{10^4\ \mu m}{1\ cm}\right) = 10.0\ \mu m$$

$$\Delta\lambda = \frac{\lambda}{R} = \frac{10.0\ \mu m}{720} = 0.014\ \mu m$$

Lines must be separated by $0.8\ cm^{-1}$ to be resolved.

7.18. a. n = 1

$$N = 1250\,\frac{\text{lines}}{\text{mm}}(2.00\text{ cm})\left(\frac{10\text{ mm}}{1\text{ cm}}\right) = 25000\text{ lines}$$

$$R = 25000$$

b. F = 1.6 m

$$d = \frac{1\text{ mm}}{1250\text{ lines}} = 8.0\text{ x }10^{-4}\text{ mm}$$

$$D^{-1} = \frac{d\cos(r)}{nF} \approx \frac{d}{nF} = \frac{8.0\text{ x }10^{-4}\text{ mm}\,(10^{8}\text{ A/mm})}{1(1.6\text{ m})(10^{3}\text{ mm/m})} = 50\text{ A/mm}$$

7.19. a. F = 0.65 m

$$d = \frac{1\text{ mm}}{2000\text{ lines}} = 5.0\text{ x }10^{-4}\text{ mm} = 50000\text{ A}$$

$$D^{-1} \approx \frac{d}{nF} = \frac{50000\text{ A}}{1(650\text{ mm})} = 76.9\text{ A/mm}$$

b. $$N = \left(2000\frac{\text{lines}}{\text{mm}}\right)(3.0\text{ cm})\left(\frac{10\text{ mm}}{\text{cm}}\right) = 60000\text{ lines}$$

$$R = nN = 1(60000\text{ lines}) = 60000$$

c. $\lambda = 560$ nm

$$\Delta\lambda = \frac{\lambda}{R} = \frac{560\text{ nm}}{60000} = 9.00\text{ x }10^{-3}\text{ nm}$$