Solutions to Chapter 6 Problems in Principles of Instrumental Analysis

12. The equation relating the variables is

$$\lambda = d(\sin i + \sin r)$$

$$500 \text{ nm} = d(\sin 60 + \sin 10)$$

$$d = 480.9 \text{ nm}$$

This is the spacing per line, the reciprocal of which gives the number of lines per nm, which is 2.079×10^{-3}. Converting this to lines per millimeter, which is the more normal unit, gives a value of 2080 lines/mm.

13. For a grating with 72.0 lines/mm and an illuminated length of 10.0 mm, the number of illuminated lines is 720 lines. The resolution, R, which is $\lambda_{avg}/\Delta\lambda$, is the same as the number of illuminated lines; thus, R is 720. Solving

$$\frac{1000 \text{ cm}^{-1}}{\Delta\lambda} = 720$$

for $\Delta\lambda$ gives a value of 1.39 cm^{-1}.

14. At 72.0 lines/mm, the grating has a line spacing, *d*, of 13. 9 μm/line. For first-order diffraction, we know that

$$\lambda = d(\sin i + \sin r)$$

$$\lambda = 13.9 \text{ μm} \times (\sin 50 + \sin 20) \qquad \lambda = 13.9 \text{ μm} \times (\sin 50 + \sin 0)$$

$$\lambda = 15.4 \text{ μm at } 20^{o} \text{ and } \lambda = 10.6 \text{ μm at } 0^{o}$$

For second-order diffraction, we have

$$2\lambda = d(\sin i + \sin r)$$

$$2\lambda = 13.9 \text{ μm} \times (\sin 50 + \sin 20) \qquad 2\lambda = 13.9 \text{ μm} \times (\sin 50 + \sin 0)$$

$$\lambda = 7.7 \text{ μm at } 20^{o} \text{ and } \lambda = 5.3 \text{ μm at } 0^{o}$$

15. Answers here may be variable, so yours may differ from mine!

wavelength range	optical materials	wavelength selector	radiation source	photon detector
450 – 75 nm	quartz	grating (with higher number of lines/nm)	tungsten	photomultiplier
20 – 50 μm	KBr	grating	globar	pyroelectric
red	quartz	interference filter (want portable device so a grating monochromator is not a good choice)	tungsten	phototube
11.8 μm	KBr	grating	globar	pyroelectric
200 – 700 nm	quartz	grating	none (flame emission)	photomultiplier
vacuum UV	KBr	grating	Ar lamp	photographic plate
near IR	KBr	grating	nichrome	pyroelectric