

$$\frac{12-1}{d} = \frac{1 \text{ cm}}{5000 \text{ grooves}} = 2 \mu\text{m/groove}$$

$$\sin \theta = \frac{m\lambda}{d}, \quad m=2$$

$$\text{So } \Delta\theta = \sin^{-1}\left(\frac{2 \cdot 0.6 \mu\text{m}}{2 \mu\text{m}}\right) - \sin^{-1}\left(\frac{2 \cdot 0.4 \mu\text{m}}{2 \mu\text{m}}\right) = 0.232 \sim 13^\circ 18'$$

$$\frac{12-4}{N} = \frac{\lambda}{m\Delta\lambda} \quad (\text{Eqs 12-8 and 12-11})$$

$$= \frac{589.3 \text{ nm}}{1 \cdot 0.6 \text{ nm}} = 982 \quad \text{or } 491 \text{ for } 2^{\text{nd}} \text{ order}$$

$$\frac{12-7}{\textcircled{a}} m = \frac{\lambda}{N\Delta\lambda} = \frac{589.3 \text{ nm}}{400 \cdot 0.6 \text{ nm}} \sim 2.5 \quad \text{So } 3^{\text{rd}} \text{ order needed}$$

$\textcircled{b}$  Both the linewidth and dispersion scale as  $\frac{1}{d}$ , so as long as all grooves are illuminated, you are OK.

12-10

$$\textcircled{a} \frac{\lambda}{\Delta\lambda} = mN, \quad m=1$$

$$\frac{700 \text{ nm}}{0.1 \text{ nm}} = 7000 \text{ grooves}$$

$$\textcircled{b} \Delta\theta \cdot L \sim \frac{\Delta\lambda}{d} \cdot L = \frac{10^{-8} \text{ cm}}{2 \text{ cm}/7000} \cdot 50 \text{ cm} = 18 \text{ mm}$$

12-15

$$\textcircled{a} k_{11} = |k| \sin\theta = \frac{2\pi}{\lambda} \sin\theta, \quad \text{so} \quad \lambda_{11} = \frac{2\pi}{k_{11}} = \frac{\lambda}{\sin\theta}. \quad \text{Since intensity is } \propto E^2,$$

The periodicity is half:  $d = \frac{\lambda}{2 \sin\theta}$

$$\textcircled{b} d = \frac{488 \times 10^{-7} \text{ cm}}{2 \sin 60^\circ} = 282 \text{ nm}$$

$$N = \frac{10^{-1} \text{ cm}}{282 \times 10^{-7} \text{ cm}} = 3550 \text{ grooves}$$

$\textcircled{c}$  high  $n$  reduces  $\lambda$  though  $\lambda v = c/n$ , so  $d$  will decrease.