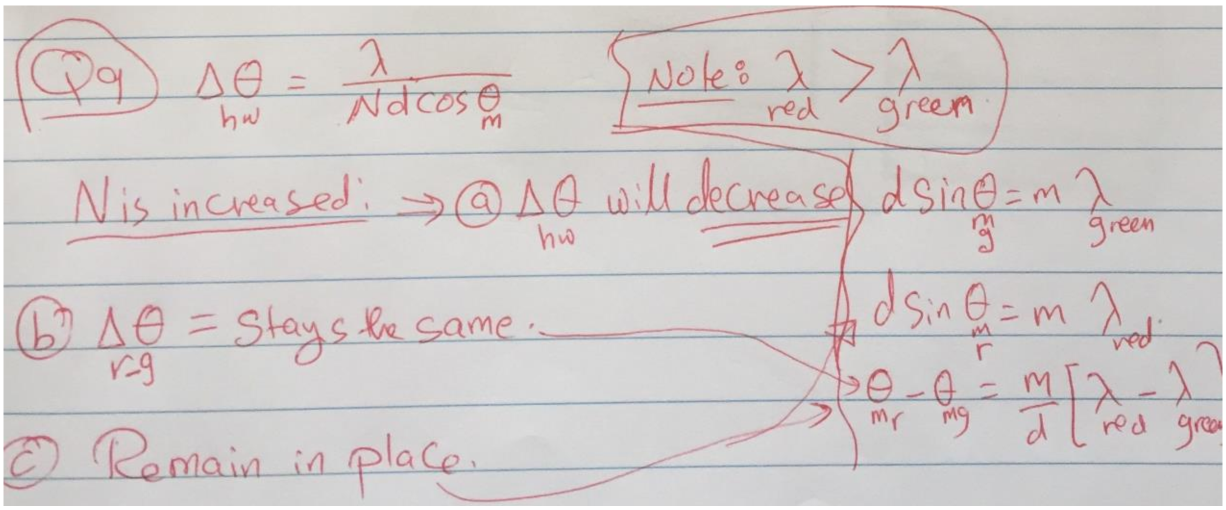
# Ch 36: Diffraction

**Q9** Figure 36-33 shows a red line and a green line of the same order in the pattern produced by a diffraction grating. If we increased the number of rulings in the grating—say, by removing tape that had covered the outer half of the rulings—would (a) the half-widths of the lines and (b) the separation of the lines increase, decrease, or remain the same? (c) Would the lines shift to the right, shift to the left, or remain in place?

**Figure 36-33** Questions 9 and 10.



**Q10** For the situation of Question 9 and Fig. 36-33, if instead we increased the grating spacing, would (a) the half-widths of the lines and (b) the separation of the lines increase, decrease, or remain the same? (c) Would the lines shift to the right, shift to the left, or remain in place?

Q10 if $d$ increased:

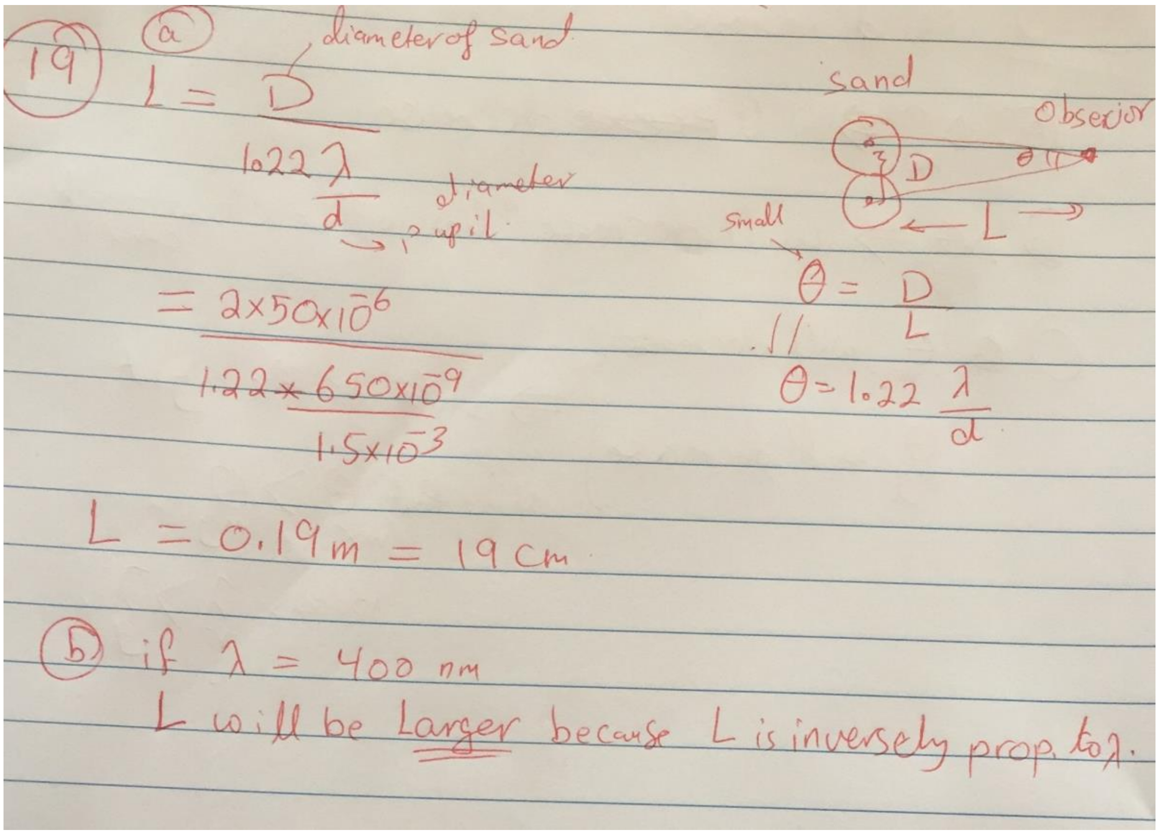
(a) $\Delta\theta_{hw} \Rightarrow$ will ~~increase~~ decrease

(b) $\Delta\theta_{r-g} \Rightarrow$ will decrease "lines will be close to each other"

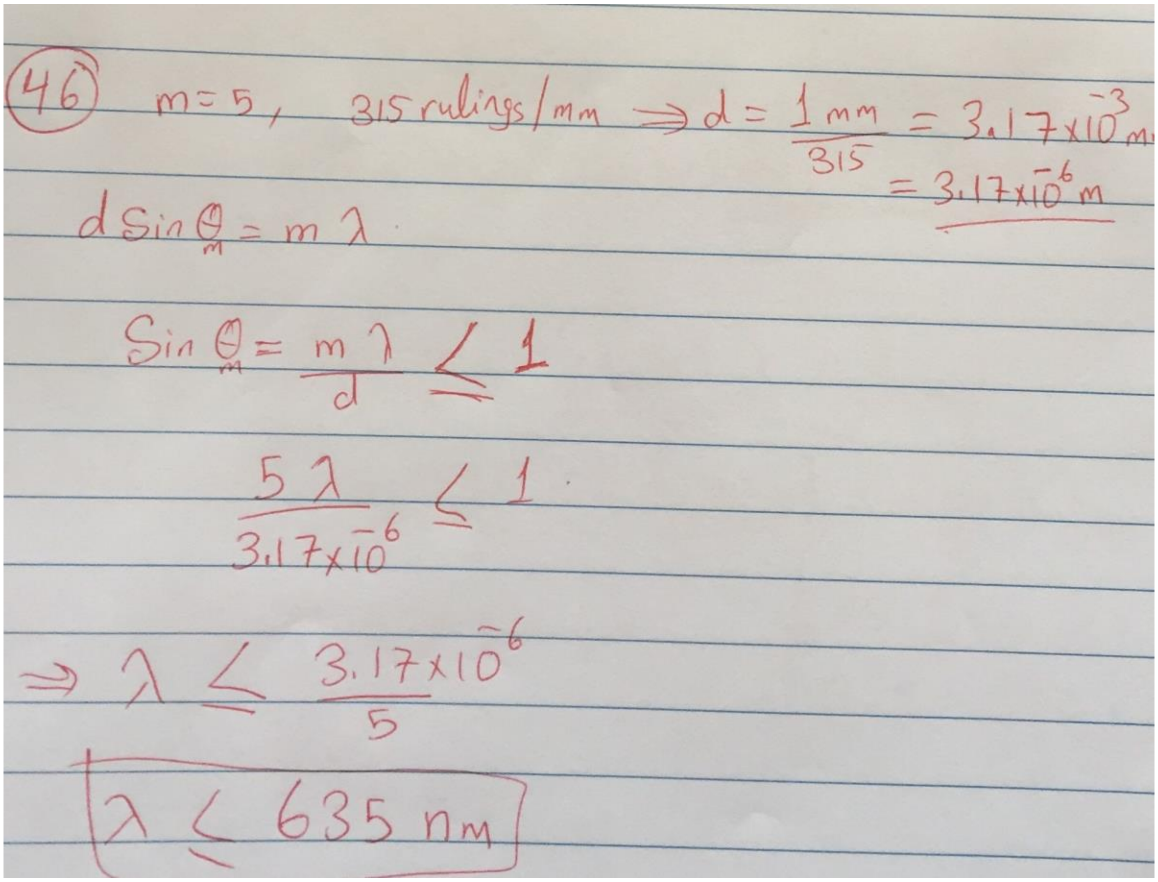
(c) $\theta_{mr}$ will decrease; $\theta_{mg}$ will decrease $\Rightarrow$ shift to the right

Note that $\theta_{mr} > \theta_{mg}$ because $\lambda_r > \lambda_g$.

**•19** (a) How far from grains of red sand must you be to position yourself just at the limit of resolving the grains if your pupil diameter is 1.5 mm, the grains are spherical with radius 50 $\mu$m, and the light from the grains has wavelength 650 nm? (b) If the grains were blue and the light from them had wavelength 400 nm, would the answer to (a) be larger or smaller?



**•46** Visible light is incident perpendicularly on a grating with 315 rulings/mm. What is the longest wavelength that can be seen in the fifth-order diffraction?



(46) $m = 5$, 315 rulings/mm $\Rightarrow d = \frac{1\text{ mm}}{315} = 3.17\times10^{-3}$ mm $= 3.17\times10^{-6}$ m

$d \sin\theta_m = m\lambda$.

$\sin\theta_m = \frac{m\lambda}{d} \leq 1$

$\frac{5\lambda}{3.17\times10^{-6}} \leq 1$.

$\Rightarrow \lambda \leq \frac{3.17\times10^{-6}}{5}$

$\lambda \leq 635$ nm

**•47** A grating has 400 lines/mm. How many orders of the entire visible spectrum (400–700 nm) can it produce in a diffraction experiment, in addition to the $m$ = 0 order?

(47) 400 lines/mm $\Rightarrow d = \frac{1}{400}$ mm $= 2.5 \times 10^{-6}$ m

$\lambda \in [400 - 700]$ nm

$d \sin\theta_m = m\lambda$

$\sin\theta_m = \frac{m\lambda}{d} \leq 1$

$m \leq \frac{d}{\lambda}$

$\lambda = 400$ mm

$m_{400} \leq \frac{2.5 \times 10^{-6}}{400 \times 10^{-9}}$

$m_{400} \leq 6.25$

$\lambda = 700$ nm $\quad m_{700} \leq \frac{2.5 \times 10^{-6}}{700 \times 10^{-9}}$

$m_{700} \leq 3.57$

$\Rightarrow$ whole spectrum can be seen for: $m = 0, 1, 2, 3$ only