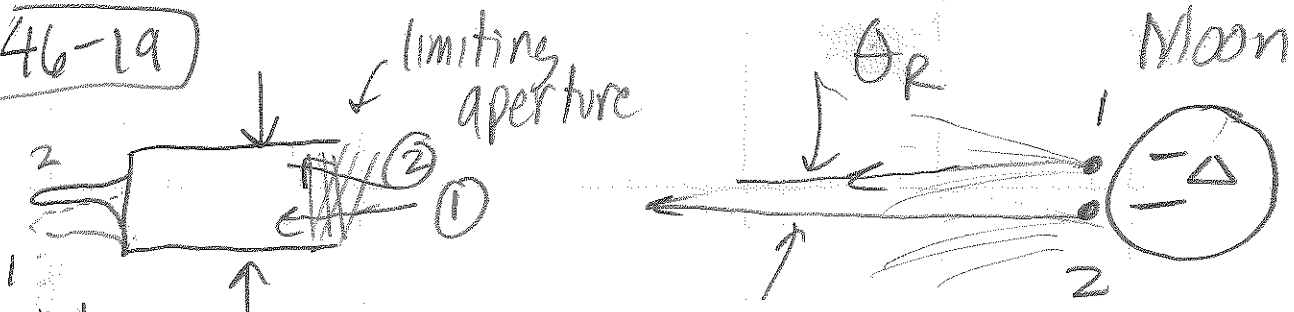
46-19



$d = 5.08\,m$ $\quad D = 3.82 \cdot 10^8\,m$

$$\theta_R \approx 1.22 \frac{\lambda}{d} \qquad \lambda = 565\,nm = 565 \cdot 10^{-9}\,m$$

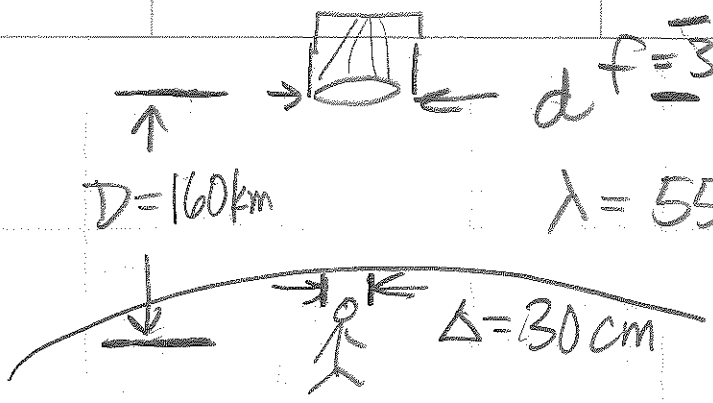
$$\frac{\Delta}{D} = 1.22 \frac{\lambda}{d}$$

$$\Delta = 1.22 \times D \times \frac{\lambda}{d}$$

$$= 1.22 \cdot 3.82 \cdot 10^8\,m \cdot \frac{565 \cdot 10^{-9}\,m}{5.09}$$

$$\Delta = \frac{1.22 \cdot 3.82 \cdot 56.5}{5.09}\,m = 51.7\,m$$

46.24



$$\frac{\Delta}{D} = 1.22\frac{\lambda}{d}$$

$$d = 1.22\frac{\lambda D}{\Delta} = 1.22 \cdot \frac{550\cdot 10^{-9}\cdot 160\cdot 10^{3}}{0.3}\ m^2$$

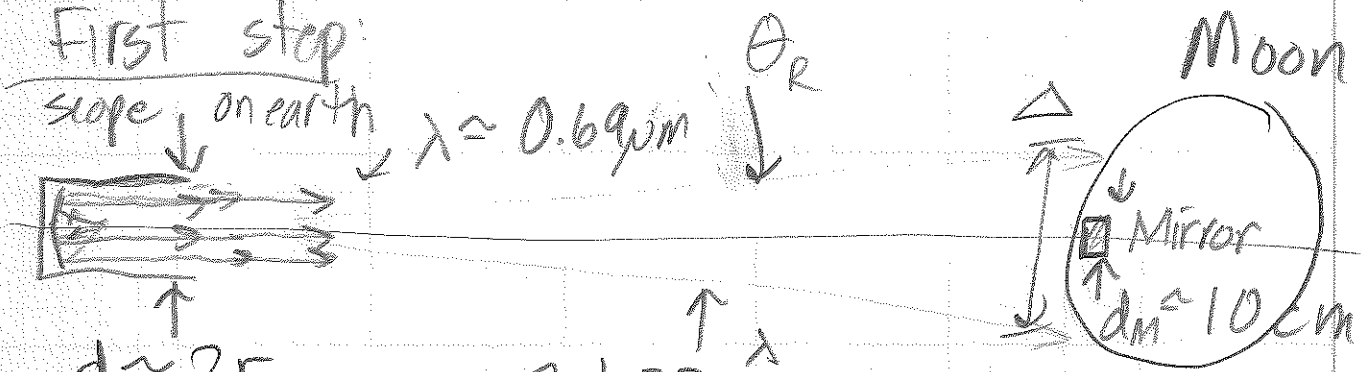
(10^{-1}, 10^{-4}, 10^{-6})

$$= \frac{1.22\cdot 5.5\times 0.16\cdot 10^{-1}}{0.3} = 0.36\,m$$

$$\lambda = 0.36\,m = 36\,cm$$

46.28 Two steps... diffraction on way to moon, and on the way back

First step:



$$\Delta \simeq D\theta_R \simeq 1.22\frac{D}{d}\lambda \simeq 1.22\frac{3.82\cdot10^8}{2.6}\times 0.69\cdot10^{-6}$$

$$\Delta \simeq 124\,m$$

$$f_{E1} \simeq \frac{\pi(d_m/2)^2}{\pi(\Delta/2)^2} \simeq \left(\frac{d_m}{\Delta}\right)^2 \simeq \left(\frac{0.1}{124}\right)^2$$

$$f_{E1} \simeq 6.5\cdot10^{-7}$$

Second Step

since d_m smaller than d,

$$\Delta' \simeq 1.22\frac{D}{d_m}\lambda \simeq 1.22\times\frac{3.82\cdot10^8}{0.1}\times 0.69\cdot10^{-6}$$

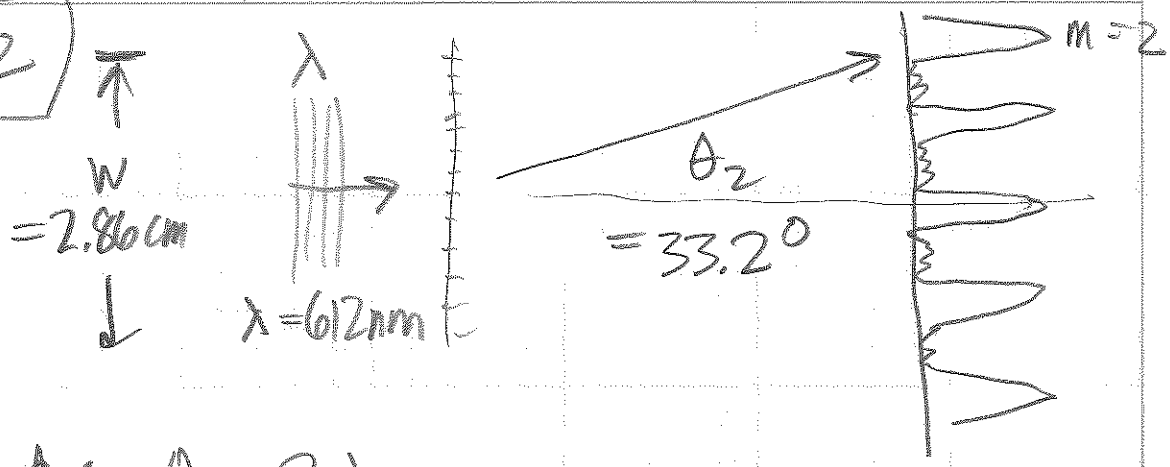
$$\Delta' \simeq 3220\,m$$

$$f_{E2} \simeq \left(\frac{d}{\Delta'}\right)^2 \simeq \left(\frac{2.6}{3220}\right)^2 = 6.5\cdot10^{-7} = f_{E1}!$$

f_{E} total $= f_{E1}\cdot f_{E2} = f_{E1}^2$

$\simeq 4\cdot10^{-13}$

47-2

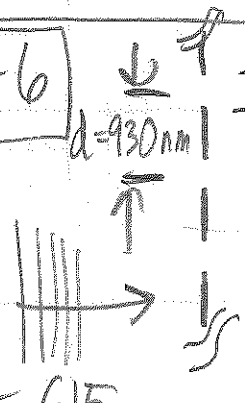


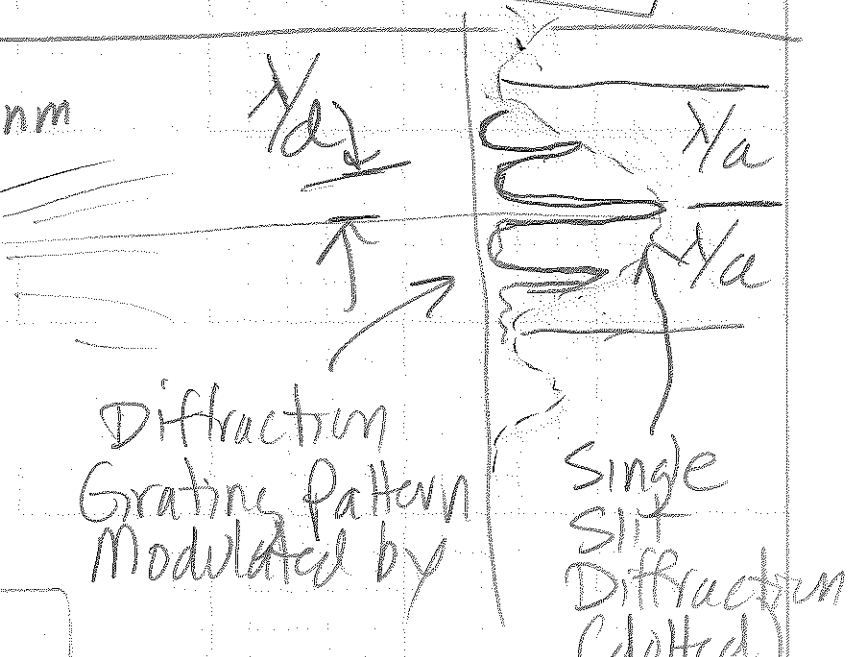
$$d \sin\theta_2 = 2\lambda$$

$$d = \frac{2\lambda}{\sin\theta_2} = \frac{2 \times 612 \cdot 10^{-9}}{(\sin(33.2) = 0.54)} = 2.23 \cdot 10^{-6}\ m$$

$$N = \frac{W}{d} = \frac{2.86 \cdot 10^{-2}\ m}{2.23 \cdot 10^{-6}\ m} = 12{,}800$$

47-6





(a) $N_{max} \simeq \frac{2\lambda/a}{\lambda/d} = \frac{2d}{a}$

$$N_{max} \simeq \frac{2 \times 930}{310} \simeq 6$$

(b) $$\delta\theta = \frac{\lambda}{N d \cos\theta} \simeq \frac{\lambda}{N d} \simeq \frac{615}{1120 \cdot 930} \simeq 5.9 \cdot 10^{-4}$$

47-12 $d = \frac{1\text{ mm}}{200} = 5\cdot10^{-6}\text{ mm}$

$\theta = 28^\circ$

$d\sin\theta = m\lambda$

so $\lambda = \frac{d\sin\theta}{m} = \frac{5\cdot10^{-6}\cdot(\sin 28^\circ = 0.47)}{m}$

$\lambda = \frac{2350\text{ nm}}{m}$

↑ visible range: 400 – 700 nm

so $m_A = \frac{2350\text{ nm}}{700\text{ nm}} = 3.35$

$m_B = \frac{2350\text{ nm}}{400\text{ nm}} = 5.88$

so m is either 4 or 5

then $\lambda_1 = \frac{2350\text{ nm}}{4}$ $\lambda_2 = \frac{2350\text{ nm}}{5}$

$\lambda = 588\text{ nm}, 470\text{ nm}$

↑ yellow ↑ blue

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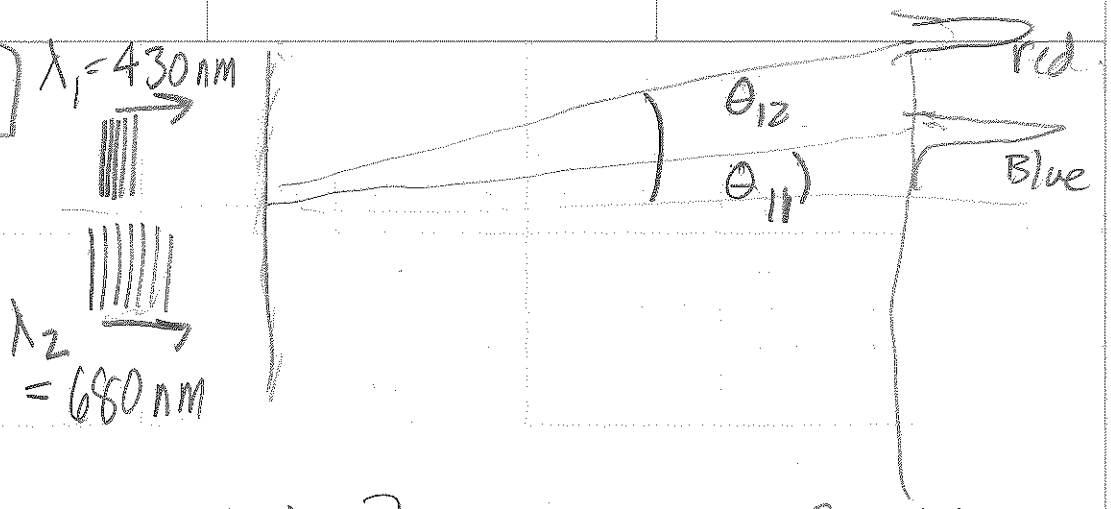
47-18 $\lambda_1 = 430\,nm$



$$d\sin\theta_{11} = 1\cdot\lambda_1$$
$$d\sin\theta_{12} = 1\cdot\lambda_2$$
$$\theta_{12} - \theta_{11} = 20^\circ$$

I solved on spreadsheet

$$\boxed{d = 914.2\,nm}$$

47-24 p. 992

$$\frac{m\Delta\lambda}{d\cos\theta} = \frac{\lambda}{Nd\cos\theta}$$

(a) or $N = \frac{1}{m}\frac{\lambda}{\Delta\lambda} = \frac{1}{2}\cdot\frac{415.492}{.009}$

$415.496 - 415.487$

$$\boxed{N = 23083}$$

(b) $d = \frac{w}{N} = \frac{415\cdot10^{-2}}{23083} = 1798\,nm$

$$\theta = \sin^{-1}\left(\frac{\lambda}{d}\right) \simeq \sin^{-1}\left(\frac{415.492}{1798}\right) = 13.4^\circ$$

47-27 (a) $d = \frac{76 \cdot 10^{-3}}{40000} = 1.9\,\mu m = 1900\,nm$

$d \sin\theta_m = m\lambda, \quad \theta_m = \sin^{-1}\left(\frac{m\lambda}{d}\right)$

$D_m = \frac{m}{d\cos(\theta_m)} = \frac{m}{d\cos(\sin^{-1}(\frac{m\lambda}{d}))}$

$\lambda = 589\,nm$

m	Dm
1	$0.55 \cdot 10^{-3}\,rad/nm = 0.032°/nm$
2	$1.34 \cdot 10^{-3}\,rad/nm = 0.077°/nm$
3	$4.30 \cdot 10^{-3}\,rad/nm = 0.246°/nm$

(b) $R = Nm \qquad N = 40000$

m	R
1	40,000
2	80,000
3	120,000

47-30

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

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

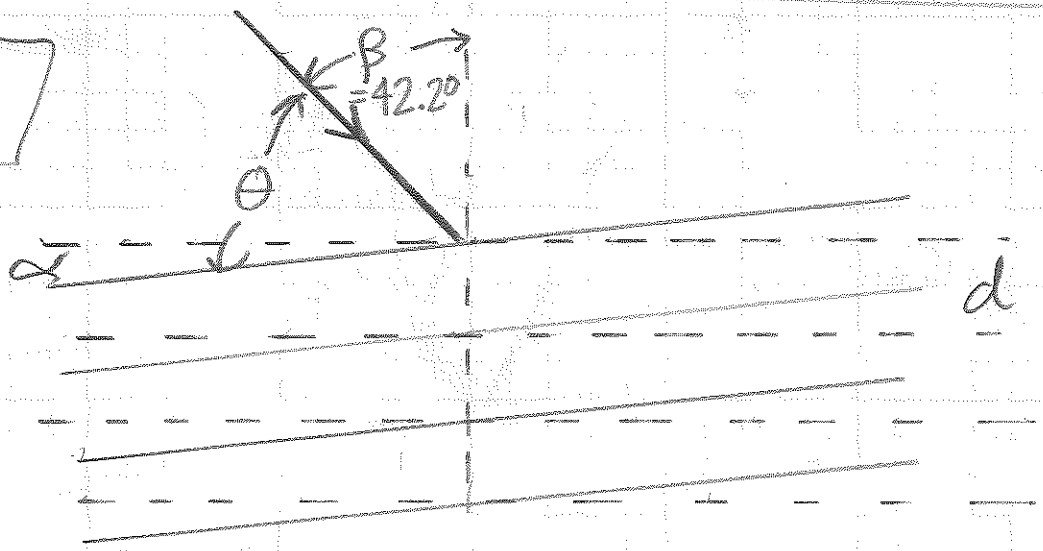
$\lambda = 0.122\ nm$

$m = 2$

$\theta = 28.1^\circ$

$$d = \frac{2 \times 0.122\ nm}{2(\sin(28.1^\circ))} = 0.259\ nm$$

47-40



tilt by α degrees

$\lambda = 0.125\ nm$

$d = 0.252\ nm$

$\theta = 90 - \beta + \alpha$

want $2d\sin\theta = m\lambda$

so $\sin(90 - \beta + \alpha) = \frac{m\lambda}{2d}$

or $\alpha = \beta - 90 + \sin^{-1}\left(\frac{m\lambda}{2d}\right)$

$m=1,\ \alpha = -33.4^\circ$ $\quad m=3,\ \alpha = 0.28^\circ$

$m=2,\ \alpha = -18.1^\circ$ $\quad m=4,\ \alpha = 35.0^\circ$