1.

$\lambda = 5.80 \times 10^{-7}$ m

$d = 5.30 \times 10^{-4}$ m

$a = 3.20 \times 10^{-4}$ m

a. $d \sin\theta_1 = \lambda$

$\theta_1 = \sin^{-1}\left(\frac{\lambda}{d}\right)$

$\theta_1 = 0.0627°$

$d \sin\theta_2 = 2\lambda$

$\theta_2 = \sin^{-1}\left(\frac{2\lambda}{d}\right)$

$\theta_2 = 0.125°$

b. $\alpha_1 = \frac{\pi a}{\lambda} \sin\theta_1$

$= 1.90$

$\alpha_2 = \frac{\pi a}{\lambda} \sin\theta_2$

$= 3.78$

$I(\theta_1) = \cos^2\left(\frac{\pi d \theta_1}{\lambda}\right) \cdot \frac{\sin^2\alpha_1}{\alpha_1^2} \cdot I_0$

$I(\theta_1) = 0.2\% I_0$

$I(\theta_2) = \cos^2\left(\frac{\pi d \theta_2}{\lambda}\right) \cdot \frac{\sin^2\alpha_2}{\alpha_2^2} \cdot I_0$

$I(\theta_2) = 0.0144 I_0$

2.

$l = 5.93 \times 10^{11}\ m$

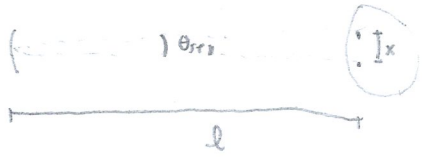
$x = 2.50 \times 10^{5}\ m$

$\lambda = 5.00 \times 10^{-7}\ m$

$\sin\theta_{sep} = \frac{x}{l}$

$\theta_{sep} = \sin^{-1}\left(\frac{x}{l}\right)$

$\theta_{sep} \approx 1.22\frac{\lambda}{a}$



$\sin^{-1}\left(\frac{x}{l}\right) = 1.22\frac{\lambda}{a}$

$a = \frac{1.22\lambda}{\sin^{-1}\left(\frac{x}{l}\right)}$

$a = 1.45\ m$

3.

$V = 0.900\ L$

$P = 1.00\ atm$

$T = 295\ K$

$M_{air} = 28.97\ g/mol$

$R = 0.0821\ \frac{L\ atm}{mol\ K}$

$M_{He} = 4.003\ g/mol$

a. $pV = nRT$

$= \frac{m}{M} RT$

$m = \frac{pVM_{air}}{RT}$

$\boxed{m = 1.07\ g}$

$m = \frac{pVM_{He}}{RT}$

$\boxed{m = 0.149\ g}$

4.

$P = 9.00 \times 10^{-14}$ atm

$T = 300.0$ K

$V = 1.00 \times 10^{-3}$ L

$N_A = 6.02 \times 10^{23}$

$R = 0.0821 \frac{L\,atm}{mol\,K}$

$P_2 = 1.00$ atm

a.

$P_1 V = n RT$

$P_1 V = \frac{N}{N_A} RT$

$N = \frac{P_1 V N_A}{RT}$

$N = 2,200,000$ molecules

b.

$N = \frac{P_2 V N_A}{RT}$

$N = 2.44 \times 10^{19}$ molecules

6.

$\Delta Q_v = 300\ J$

$\Delta T_{H_2} = 2.50\ K$

$R = 8.314\ J/mol\ k$

$$C_{V_{H_2}} = \frac{5}{2}R = \frac{1}{n}\frac{\Delta Q_v}{\Delta T_{H_2}}$$

$$n = \frac{2\Delta Q_v}{5R\Delta T_{H_2}}$$

$$n = 5.77$$

$$C_{V_{Ne}} = \frac{3}{2}R = \frac{1}{n}\frac{\Delta Q_v}{\Delta T_{Ne}}$$

$$\Delta T_{Ne} = \frac{2\Delta Q_v}{3Rn}$$

$$\boxed{\Delta T_{Ne} = 4.17\ ^\circ C}$$

6.

$n = 5$

$T_0 = 400\ K$

$\Delta Q = 1500\ J$

$\Delta W = 2100\ J$

$R = 8.314\ J/mol\ K$

$E_{int_0} = \frac{3}{2} n R T_0$ $\qquad$ $\Delta E_{int} = \Delta Q - \Delta W$

$$E_{int_2} = E_{int_0} + \Delta E_{int}$$

$$\frac{3}{2} n R T_1 = \frac{3}{2} n R T_0 + \Delta Q - \Delta W$$

$$T_1 = T_0 + \frac{2}{3nR} (\Delta Q - \Delta W)$$

$$\boxed{T_1 = 390\ K}$$

7.

$n = 0.0040$ mol

$V_0 = 0.20$ L

$P_0 = 2.0$ atm

$P_1 = 0.50$ atm

$R = 0.0821 \frac{L \cdot atm}{mol \cdot K}$

$R' = 8.314 \frac{J}{mol \cdot K}$

a. $P_0 V_0 = P_1 V_1$

$V_1 = \frac{P_0 V_0}{P_1}$

$\boxed{V_1 = 0.80 \text{ L}}$

b. $P_0 V_0 = nRT_a$

$T_a = \frac{P_0 V_0}{nR}$

$\boxed{T_a = 305 \text{ K}}$

$T_b = T_c = \frac{P_0 V_0}{nR}$

$\boxed{T_b = T_c = 1220 \text{ K}}$

c. $\Delta E_{int_{ab}} = \Delta Q_{ab}$ (Isochoric)

$\Delta Q_{ab} = \frac{5}{2} nR' \Delta T$

$\boxed{\Delta Q_{ab} = 76.1 \text{ J}}$

$\Delta E_{int_{bc}} = 0 = Q - W$ (Isothermal)

$\Delta Q_{bc} = W$

$= nR' T_b \ln\left(\frac{V_1}{V_0}\right)$

$\boxed{\Delta Q_{bc} = 56.2 \text{ J}}$

$\Delta Q_{ca} = C_p n \Delta T$ (Isobaric)

$= \frac{7}{2} nR' (T_a - T_c)$

$\boxed{\Delta Q_{ca} = -107 \text{ J}}$

d. $\Delta E_{int_{ab}} = \Delta Q_{ab}$

$\boxed{\Delta E_{int_{ab}} = +76.1 \text{ J}}$ inc.

$\boxed{\Delta E_{int_{bc}} = 0 \text{ J}}$ (adiabatic)

same

$\Delta E_{int_{ab}} + \Delta E_{int_{bc}} + \Delta E_{int_{ca}} = 0$

$\Delta E_{int_{ca}} = -\Delta E_{int_{ab}}$

$\boxed{\Delta E_{int_{ca}} = -76.1 \text{ J}}$ dec.

8.

$T_F = \frac{9}{5} T_C + 32$ $\quad T_F = T_C$

$T_C = \frac{9}{5} T_C + 32$

$-32 = \frac{4}{5} T_C$

$\boxed{T_C = -40\,^\circ C \text{ or } ^\circ F}$

9.

$l = 0.305$ m

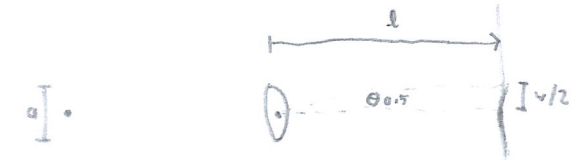
$\lambda = 5.500 \times 10^{-7}$ m

Bundle of rays: For a small hole, approximate parallel rays, making image diameter equal to aperture diameter, i.e., a.

$w = a$

Diffraction:

Let $\theta_{0.5}$ denote $\theta_{\frac{1}{2}}$ width of central max.



$$\tan\theta_{0.5} = \frac{w/2}{l}$$

$$\tan\left(\frac{1.22\lambda}{a}\right) = \frac{w}{2l}$$

$$w = 2l\tan\left(\frac{1.22\lambda}{a}\right)$$

$$a = 2l\tan\left(\frac{1.22\lambda}{a}\right)$$

$$\boxed{a = 6.40 \times 10^{-4}\ \text{m}}$$ - from calculator