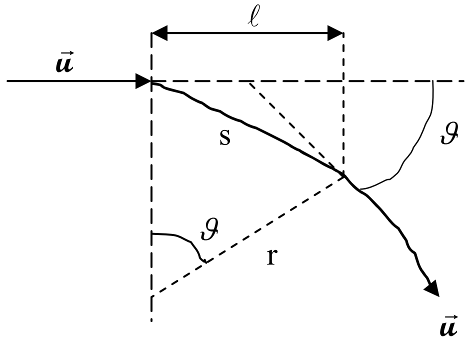
3-2.




For small values of $\vartheta$, $s \approx \ell$; therefore, $\vartheta = \frac{s}{r} \approx \frac{\ell}{r}$

Recalling that $euB = \frac{mu^2}{r} \quad \Rightarrow \quad r = \frac{mu}{eB} \qquad \therefore \quad \vartheta \approx \frac{\ell}{mu/eB} = \frac{eB\ell}{mu}$

3-6. (a) $1/2mu^2 = E_k$, so $u = \sqrt{(2E_k/e)(e/m)}$

$$\therefore \quad u = \left[(2)(2000eV/e)(1.76\times10^{11}C/kg)\right]^{1/2} = 2.65\times10^7 m/s$$

(b) $$\Delta t_1 = \frac{x_1}{u} = \frac{0.05m}{2.65\times10^7 m/s} = 1.89\times10^{-9}s = 1.89ns$$

(c) $mu_y = F\Delta t_1 = e\mathcal{E}\Delta t_1$

$$\therefore \quad u_y = (e/m)\mathcal{E}\Delta t_1 = (1.76\times10^{11}C/kg)(3.33\times10^3 V/m)(1.89\times10^{-9}s) = 1.11\times10^6 m/s$$

8-1. (a) $$v_{rms} = \sqrt{\frac{3RT}{M}} = \left[\frac{3(8.31J/mole\cdot K)(300K)}{2(.0079\times10^{-3}kg/mole)}\right]^{1/2} = 1930m/s$$

(b) $$T = \frac{Mv_{rms}^2}{3R} = \frac{2(1.0079\times10^{-3}kg/mole)(11.2\times10^3 m/s)^2}{3(8.31J/mole\cdot K)} = 1.01\times10^4 K$$

8-5. (a) $$E_K = n\times\frac{3}{2}RT = (1\ mole)\frac{3}{2}(8.31J/mole\cdot K)(273) = 3400J$$

(b) One mole of any gas has the same translational energy at the same temperature.

8-6. $\langle v^2\rangle = \frac{1}{N}\int_0^\infty v^2 n(v)\,dv = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2}\int_0^\infty v^4 e^{-\lambda v^2}dv$ where $\lambda = m/2kT$

$$\langle v^2\rangle = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2} I_4 \text{ where } I_4 \text{ is given in Table B1-1.}$$

$$I_4 = \frac{3}{8}\pi^{1/2}\lambda^{-5/2} = \frac{3}{8}\pi^{1/2}\left(m/2kT\right)^{-5/2}$$

$$\langle v^2\rangle = 4\pi\left(\frac{m}{2\pi kT}\right)^{3/2}\left(\frac{3}{8}\right)\pi^{1/2}\left(\frac{2kT}{m}\right)^{5/2} = \frac{3kT}{m} = \frac{3RT}{mN_A} = \frac{3RT}{M}$$

$$v_{rms} = \sqrt{\langle v^2\rangle} = \sqrt{\frac{3RT}{M}}$$

8-7. $\langle v\rangle = \sqrt{\frac{8kT}{\pi m}} = \left[\frac{8\left(1.381\times10^{-23}J/K\right)\left(300K\right)}{\pi\left(1.009u\right)\left(1.66\times10^{-27}kg/u\right)}\right]^{1/2} = 2510m/s$

$$v_m = \sqrt{\frac{2kT}{m}} = \left[\frac{2\left(1.381\times10^{-23}J/K\right)\left(300K\right)}{\pi\left(1.009u\right)\left(1.66\times10^{-27}kg/u\right)}\right]^{1/2} = 2220m/s$$

$$n(v) = 4\pi N\left(m/2\pi kT\right)^{3/2}v^2e^{-mv^2/kT} \quad \text{(Equation 8-28)}$$

At the maximum: $\frac{dn}{dv} = 0 = 4\pi N\left(m/2\pi kT\right)^{3/2}\left\{2v + v^2\left(-mv/kT\right)\right\}e^{-mv^2/2kT}$

$$0 = ve^{-mv^2/2kT}\left(2 - mv^2/kT\right)$$

The maximum corresponds to the vanishing of the last factor. (The other two factors give

minima at $v = 0$ and $v = \infty$.) So $2 - mv^2/kT = 0$ and $v_m = \left(2kT/m\right)^{1/2}$.

8-42. (a) $f(u)\,du = Ce^{-E/kT}du = Ce^{-Au^2/kT}du$ (from Equation 8-5)

$$1 = \int_{-\infty}^{+\infty} f(u)\,du = \int_{-\infty}^{+\infty} Ce^{-Au^2/kT}du = 2C\int_{-\infty}^{+\infty} e^{-Au^2/kT}du$$

$$= 2CI_0 = 2C\sqrt{\pi}\,\lambda^{-1/2}/2 \quad \text{where } \lambda = A/kT$$

$$= C\sqrt{\pi}\sqrt{kT/A} \rightarrow C = \sqrt{A/\pi kT}$$

(b) $$\langle E\rangle = \langle Au^2\rangle = \int_{-\infty}^{+\infty} Au^2 f(u)\,du = \int_{-\infty}^{+\infty} Au^2\sqrt{A/\pi kT}\,e^{-Au^2/kT}du$$

$$= A\sqrt{A/\pi kT}\,(2I_2) = A\sqrt{A/\pi kT}\,2\times\left(\sqrt{\pi}/4\right)\lambda^{-3/2} \quad \text{where } \lambda = A/kT$$

$$= \frac{1}{2}A\sqrt{A/kT}\,(kT/A)^{3/2} = \frac{1}{2}kT$$

3-26. (a) $\lambda_t = \dfrac{hc}{\phi} = \dfrac{1240eV\cdot nm}{1.9ev} = 653nm,\quad f_t = \dfrac{\phi}{h} = \dfrac{1.9eV}{4.136\times10^{-15}eV\cdot s} = 4.59\times10^{4}\,Hz$

(b) $V_0 = \dfrac{1}{e}\left(\dfrac{hc}{\lambda} - \phi\right) = \dfrac{1}{e}\left(\dfrac{1240eV\cdot nm}{300nm} - 1.9eV\right) = 2.23V$

(c) $V_0 = \dfrac{1}{e}\left(\dfrac{hc}{\lambda} - \phi\right) = \dfrac{1}{e}\left(\dfrac{1240eV\cdot nm}{400nm} - 1.9eV\right) = 1.20V$

3-27. (a) Choose λ =550*nm* for visible light. $nhf = E \quad \rightarrow \quad \dfrac{dn}{dt}hf = \dfrac{dE}{dt} = P$

$$\frac{dn}{dt} = \frac{P}{hf} = \frac{P\lambda}{hc} = \frac{(0.05\times100W)(550\times10^{-9}m)}{(6.63\times10^{-34}J\cdot s)(3.00\times10\ \ m/s)} = 1.38\times10^{19}/s$$

(b) $flux = \dfrac{number\ \ radiated\ /\ unit\ time}{area\ of\ \ the\ sphere} = \dfrac{1.38\times10^{19}/s}{4\pi(2m)^2} = 2.75\times10^{17}/m^2\cdot s$

3-30. Using Equation 3-21,

(1) $0.95 = \frac{h}{e}\left(\frac{c}{435.8\times10^{-9}m}\right) - \frac{\phi}{e}$

(2) $0.38 = \frac{h}{e}\left(\frac{c}{546.1\times10^{-9}m}\right) - \frac{\phi}{e}$

Subtracting (2) from (1), $0.57 = \frac{hc}{e\times10^{-9}}\left(\frac{1}{435.8} - \frac{1}{546.1}\right)$

Solving for *h* yields: $h = 6.56\times10^{-34} J\cdot s$. Substituting *h* into either (1) or (2) and solving for $\phi/e$ yields: $\phi/e$ = 1.87*eV*. Threshold frequency is given by $hf/e = \phi/e$ or

$$f = \left(\frac{\phi}{e}\right)\left(\frac{e}{h}\right) = \frac{(1.87eV)(1.60\times10^{-19}C)}{6.56\times10^{-34} J\cdot s} = 4.57\times10^{14} Hz$$

3-32. (a) $\phi = \frac{hc}{\lambda} = \frac{1240eV\cdot nm}{653nm} = 1.90eV$

(b) $E_k = \frac{hc}{\lambda} - \phi = \frac{1240eV\cdot nm}{300nm} - 1.90eV = 2.23eV$

3-12. $\lambda_m T = 2.898\times10^{-3} m\cdot K$

(a) $\lambda_m = \frac{2.898\times10^{-3} m\cdot K}{3K} = 9.66\times10^{-4} m = 0.966mm$

(b) $\lambda_m = \frac{2.898\times10^{-3} m\cdot K}{300K} = 9.66\times10^{-6} m = 9.66\mu m$

(c) $\lambda_m = \frac{2.898\times10^{-3} m\cdot K}{3000K} = 9.66\times10^{-7} m = 966nm$

3-16. $\lambda_m T = 2.898\times10^{-3}\,m\cdot K$

(a) $T = \dfrac{2.898\times10^{-3}\,m\cdot K}{700\times10^{-9}\,m} = 4140K$

(b) $T = \dfrac{2.898\times10^{-3}\,m\cdot K}{3\times10^{-2}\,m} = 9.66\times10^{-2}\,K$

(c) $T = \dfrac{2.898\times10^{-3}\,m\cdot K}{3m} = 9.66\times10^{-4}\,K$

3-17. Equation 3-4: $R_1 = \sigma T_1^4$ $\quad R_2 = \sigma T_2^4 = \sigma\left(2T_1\right)^4 = 16\sigma T_1^4 = 16R_1$

3-19. (a) $\lambda_m T = 2.898\times10^{-3}\,m\cdot K \quad \therefore \quad T_1 = \dfrac{2.898\times10^{-3}\,m\cdot K}{27.0\times10^{-6}\,m} = 107K$

$R_1 = \sigma T_1^4$ and $R_2 = \sigma T_2^4 = 2R_1 = 2\sigma T_1^4$

$\therefore \quad T_2^4 = 2T_1^4$ or $T_2 = 2^{1/4}T_1 = \left(2^{1/4}\right)\left(107K\right) = 128K$

(b) $\lambda_m = \dfrac{2.898\times10^{-3}\,m\cdot K}{128K} = 23\times10^{-6}\,m$