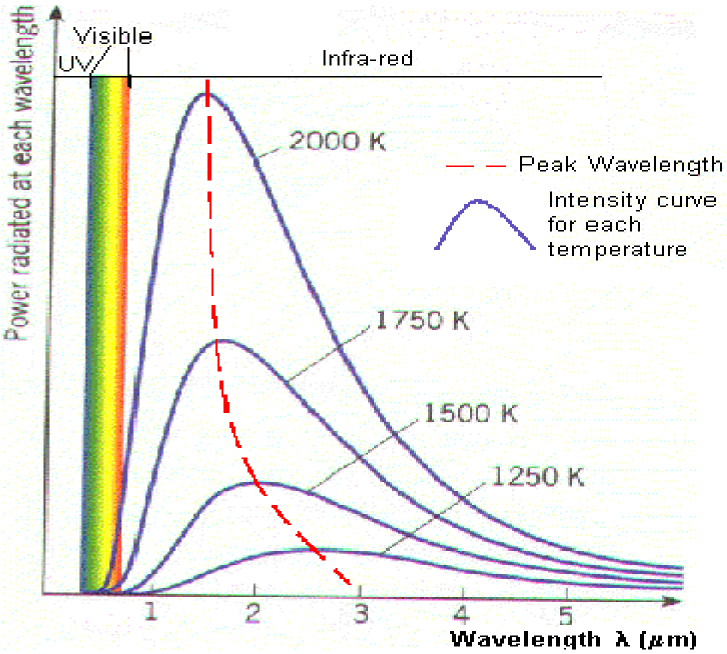
<4.1>

(a)



(b) When $\lambda \to 0$, $\lambda^5 e^{\frac{hc}{\lambda kT}} \to \infty$, so $I(\lambda,T) \to 0$.

When $\lambda \to \infty$, $\lambda^5 e^{\frac{hc}{\lambda kT}} \to \infty$, again $I(\lambda,T) \to 0$.

<4.4>

(a) (b)

$$I=\frac{2\pi hc^2}{\lambda^5}\int_0^\infty \frac{\lambda^{-5}}{e^{\frac{hc}{\lambda kT}}-1}d\lambda=\frac{2\pi hc^2}{\lambda^5}\int_\infty^0 \frac{(\frac{hc}{kT})^{-5}x^5}{e^x-1}\frac{-1}{x^2}dx=\frac{2\pi k^4T^4}{h^3c^2}\int_0^\infty \frac{x^3}{e^x-1}dx=\frac{2\pi^5k^4T^4}{15h^3c^2}$$

(c) $p=\sigma T^4 4\pi R^2=7.95w$

<4.5>

(a) $E_{400}=\frac{hc}{\lambda_{400}}=3.1eV$, $E_{700}=\frac{hc}{\lambda_{700}}=1.8eV$

(b)UV: E>3.1eV, IR: E<1.8eV.

<4.12>

(a) $E=\frac{hc}{\lambda}=\frac{6.63\times10^{-34}\times3.0\times10^{8}}{\lambda}\frac{1}{1.60\times10^{-9}}=1.9eV$, $\lambda=653nm$

(b) $K=\frac{hc}{\lambda}-1.9=0.58eV$

<4.14>

(a) $N = \dfrac{p \cdot t}{\dfrac{hc}{\lambda}} = \dfrac{3}{\dfrac{6.63\times10^{-34}\times3.0\times10^{8}}{550\times10^{-9}}} = 2.49\times10^{19}$

(b) $N' = N\dfrac{\pi(0.5\times10^{-3})^2}{\pi(\dfrac{10}{3.28})^2} = 6.69\times10^{11}$

(c) $N'' = \log\dfrac{N'}{100} = 9.83$

<4.17>

The slope of the graph is "h", so we have $h \approx 4.0\times10^{-15} eV\cdot s = 6.4\times10^{-34} J\cdot s$

<4.22>

$$E = \frac{hc}{\lambda} = \frac{6.63\times10^{-34}\times3.0\times10^{8}}{\lambda}\frac{1}{1.60\times10^{-9}} = 10KV\cdot1e,\quad \lambda = 1.24\times10^{-10} m$$

<5.1>

$\dfrac{1}{\lambda} = R(\dfrac{1}{3^2} - \dfrac{1}{4^2}) \;\Rightarrow\; \lambda = 1.87\mu m$. IR

<5.3>

$$E = \frac{hc}{\lambda} = hcR(\frac{1}{n^2} - \frac{1}{n'^2}) = hcR(\frac{1}{1} - \frac{1}{\infty}) = 13.6eV$$

No lower limit.

<5.6>

$E = \dfrac{hc}{\lambda} = hcR(\dfrac{1}{n^2} - \dfrac{1}{n'^2}) = 13.6(\dfrac{1}{1} - \dfrac{1}{n'^2})$, $n' = 2,3,4,5,6$

E=10.2eV, 12.09eV, 12.75eV, 13.06eV, 13.22eV.

$E_{n'\to\infty} = hcR = 13.6eV$.

<5.12>

Lyman: $E = 13.6(\dfrac{3}{4} \sim 1) = (10.2 \sim 13.6)$, UV

Balmer: $E = 13.6(\dfrac{1}{4} - \dfrac{1}{9} \sim \dfrac{1}{4}) = (1.89 \sim 3.4)$, UV and visible

Paschen: $E = 13.6(\frac{1}{9} - \frac{1}{16} \sim \frac{1}{9}) = (0.661 \sim 1.511)$, IR

13.6>10.2>3.4>1.89>1.51>0.661 $\Rightarrow$ they do not overlap.

$(\frac{1}{16} - \frac{1}{25} \sim \frac{1}{16})$ does overlap with $(\frac{1}{9} - \frac{1}{16} \sim \frac{1}{9})$ since $\frac{1}{9} - \frac{1}{16} > \frac{1}{16}$

<5.15>

$E_n = Z^2 E_R (1 - \frac{1}{4}) = 6.9KeV$, that is X ray.

<5.23>

$E = \frac{3}{4}(Z-1)^2 \cdot 13.6 = \frac{hc}{\lambda}$ $\Rightarrow$ Z=17, that is Chlorine.

<6.3>

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2m_e K}} = 0.055nm$$

<6.6>

$$\frac{\lambda_e}{\lambda_n} = \frac{\frac{h}{\sqrt{2m_e K}}}{\frac{h}{\sqrt{2m_n K}}} = \sqrt{\frac{m_n}{m_e}} = \sqrt{1836} = 42.85$$

<6.8>

$$\lambda = \frac{h}{p} = \frac{h}{\sqrt{2mK}} \Rightarrow K = \frac{1}{2m}\left(\frac{h}{\lambda}\right)^2$$

$K_e = \frac{1}{2m_e}\left(\frac{h}{\lambda}\right)^2 = 9.65 \times 10^{-17} J$, $K_n = \frac{1}{2m_n}\left(\frac{h}{\lambda}\right)^2 = 5.26 \times 10^{-20} J$.

$$E_p = \frac{hc}{\lambda} = 3.98 \times 10^{-15} J$$

<6.15>

$$2d \sin 15^\circ = \lambda = \frac{hc}{E} \Rightarrow d = 2.74 \times 10^{-10} m$$

<6.21>

$k = \frac{2\pi}{\lambda} = 0.0114 rad/nm$, $\omega = \frac{2\pi c}{\lambda} = 3.4 \times 10^{15} rad/s$

<6.28>

$$\Delta t \Delta f \geq \frac{1}{4\pi} \quad \Rightarrow \quad \Delta t \geq \frac{1}{4\pi \cdot 2500} = 3.18 \times 10^{-5} s\ .$$

<6.30>

(a) $f = \frac{1}{T} = 200 Hz$

(b) $f = 800 Hz$

<6.37>

$$\Delta x \Delta p \geq \frac{\hbar}{2} \quad \Rightarrow \quad \Delta v \geq \frac{\frac{\hbar}{2}}{m_{proton} \cdot 6 \times 10^{-12}} = 0.018c$$

<6.39>

$$\Delta E = \frac{(\Delta p)^2}{2m} \geq \frac{\left(\frac{\frac{\hbar}{2}}{1\mu m}\right)^2}{2m_{golf}} = 2.3 \times 10^{-56} J\ .$$

$$d = \frac{\Delta p}{m} \cdot 365 \cdot 24 \cdot 60 \cdot 60 = 2.7 \times 10^{-20} m$$

<6.42>

(a) $\Delta E = \frac{(\Delta p)^2}{2m} \geq \frac{\left(\frac{\frac{\hbar}{2}}{5\, fm}\right)^2}{2m_{proton}} = 3.3 \times 10^{-14} J$

(b) 3 times bigger.

<6.45>

$$\Delta E = \frac{\frac{\hbar}{2}}{\Delta t} = 6 \times 10^{-3} eV$$

<6.48>

(a) $\Delta E = \frac{\frac{\hbar}{2}}{\Delta t} = 3 \times 10^{-13} eV$

(b) $\Delta E = \frac{\frac{\hbar}{2}}{\Delta t} = \frac{hc}{\Delta \lambda} \quad \Rightarrow \quad \Delta \lambda = 8 \times 10^{-11} nm\ , \quad \frac{\Delta \lambda}{\lambda} = 1.5 \times 10^{-13}$

<7.12>

$$z = re^{-i\omega t} = r[\cos(\omega t) + i\sin(\omega t)] = r[\cos(\omega t) + i\cos(\omega t - \frac{\pi}{2})] = x + iy$$

$$|z| = x^2 + y^2$$

<7.17>

$$E = \frac{n^2\pi^2\hbar^2}{2m_e a^2} = (2.98, 11.9, 26.8) \times 10^{-19} J$$

<7.18>

$$E = \frac{n^2\pi^2\hbar^2}{2m_p a^2} = (8.2, 32.7, 73.5) eV$$

<7.21>

$$\Delta x \Delta p = \frac{a}{2} \cdot \hbar k = \frac{a}{2} \cdot \hbar \cdot \frac{\pi}{a} = \frac{\pi\hbar}{2} > \frac{\hbar}{2}$$

<7.24>

$$\psi'' = A(e^{ikx})'' + B(e^{-ikx})'' = (-Ak^2)e^{ikx} + (-Bk^2)e^{-ikx} = -k^2\psi$$

<7.30>

(a) $p = \left|\sqrt{\frac{2}{a}}\sin(\frac{3\pi x}{a})\right|^2 = \frac{1}{a}(1 - \cos\frac{6\pi x}{a})$

(b) $\frac{dp}{dx} = 0 \quad \Rightarrow \quad x = \frac{a}{6}, \frac{3a}{6}, \frac{5a}{6}$

(c) $P = \int_{x_1}^{x_2} \frac{1}{a}(1 - \cos\frac{6\pi x}{a})dx$

$P_1 = \int_{0.50a}^{0.51a} \frac{1}{a}(1 - \cos\frac{6\pi x}{a})dx \approx 9.94 \times 10^{-3}$, $P_2 = \int_{0.75a}^{0.76a} \frac{1}{a}(1 - \cos\frac{6\pi x}{a})dx \approx 9.40 \times 10^{-4}$

<7.36>

(a), (b) $E = \frac{1}{2}kx^2 \Rightarrow x = \sqrt{\frac{2E}{k}}$

(c) $x' = \sqrt{2}x_0$

<7.39>

<7.52>

$$(-\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2}+\frac{1}{2}kx^2)A_2(1-2\frac{x^2}{b^2})e^{\frac{-x^2}{2b^2}}=\frac{5}{2}\hbar\omega_c A_2(1-2\frac{x^2}{b^2})e^{\frac{-x^2}{2b^2}}$$

<7.55>

$$p=e^{-2\sqrt{\frac{2m_\alpha(u_0-E)}{\hbar^2}}L}=1.04\times10^{-3}$$

$$P=p\cdot5\times10^{21}\cdot365\cdot24\cdot60\cdot60=1.64\times10^{26}$$

<8.21>

$$(-x,-y,-z),\ \ (r,\pi-\theta,2\pi-\theta)$$

<8.24>

(b) 3

(c) $|L|=\sqrt{2}\hbar,\ \ L_z=\hbar,\theta=45^\circ$

<8.40>

$$\frac{1}{r^2}\frac{d}{dr}(r^2\frac{dR(r)}{dr})+[\frac{2m}{\hbar^2}(E+\frac{Ze^2}{r})-\frac{n(n-1)}{r^2}]R(r)=0$$

<8.42>

Most probable radii is given by $\frac{dp}{dr}=0$, and the solution is a_B.

The average value of r is $<r>\neq a_B$

<8.48>

$$\frac{dp}{dr}=const\cdot\frac{d(r^2e^{\frac{-2r}{a_B}})}{dr}=0\ \ \Rightarrow\ \ 2r=r^2(\frac{2}{a_B})\Rightarrow r=a_B$$