HOMEWORK #9

CHAPTER 7

7.3 Assume $g(\phi) = Ae^{ih\phi}$ defined $0 < \phi < 2\pi$ (from class)

B.C. : $g(0) = g(2\pi)$

so $Ae^{0} = Ae^{ih2\pi}$ which is only true for $h =$ integer.

7.10 3p state

$$\left.\begin{array}{l} n = 3 \\ l = 1 \end{array}\right\} \quad m_l = 0, \pm 1$$

so $L_z = 0, \pm\hbar$

$$L = \hbar\sqrt{l(l+1)} = \hbar\sqrt{2}$$

L_x and L_y can be anything, but

$L^2 = L_z^2 + L_x^2 + L_y^2$ must be satisfied

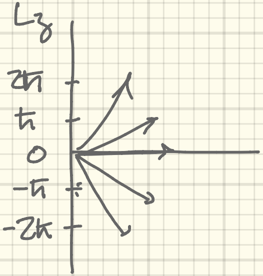
7.14 3d

$n = 3 \quad l = 2$

$L = \hbar\sqrt{2(2+1)}$

$L = \hbar\sqrt{6}$

$m_l = 0, \pm 1, \pm 2$



$L^2 = L_z^2 + L_x^2 + L_y^2 \Rightarrow L_x^2 + L_y^2 = L^2 - L_z^2$

for $m_l = -1$, $L_z = -\hbar$

so $L_x^2 + L_y^2 = \hbar \cdot 6 - \hbar^2$

$= 5\hbar^2$

7-16

max # m_ℓ states $= \underset{\substack{\uparrow \\ \pm m_\ell}}{2\ell} + \underset{\substack{\uparrow \\ m_\ell = 0}}{1}$

max ℓ values: $n-1$

So the degeneracy is

$$\underset{n=1}{1} + \underset{2}{3} + \underset{3}{5} + 2\ell+1 = 1+3+5+\ldots 2n-1 = \sum_{\ell=0}^{n-1}(2\ell+1)$$

an arithmetic series:

$$\sum_{\ell=0}^{n-1}(a+\ell b) = \frac{n}{2}\left[2a+(n-1)b\right]$$

here $b=2$
$a=1$

$$= \frac{n}{2}\left[2+(n-1)2\right]$$

$$= \frac{n}{2}\left[2+2n-2\right] = n^2$$

7-20 4d

$B = 3.5T$

for d, $l = 2$ so $m_l = (-2) - (+2)$

$\Delta m_l = 4$

$V = \mu_B m_l B$

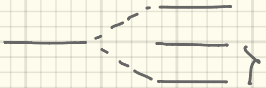
$\Delta V = \mu_B \Delta m_l B$

$= (5.8 \times 10^{-5} eV/_T)(4)(3.5T)$

$\Delta V = 8 \times 10^{-4} eV$

7-24

$\lambda = 656.5$ nm from



$$\Delta E = \mu_B \underset{\substack{\downarrow \\ 1\ \text{(adjacent lines)}}}{\Delta m_\ell} B$$

$$\Delta E = \mu_B B$$

$$E = \frac{hc}{\lambda}$$

$$dE = \frac{hc}{\lambda^2}\, d\lambda \quad \text{so} \quad \Delta E = \frac{hc}{\lambda^2}\Delta\lambda = \mu_B B$$

$$B = \frac{hc\,\Delta\lambda}{\lambda^2 \mu_B}$$

$$= \frac{(1240\ \text{eV}\cdot\text{nm})(0.04\ \text{nm})}{(656.5\ \text{nm})^2 (5.8\times 10^{-5}\ \text{eV}/\text{T})}$$

$$B \mathrel{\hat{=}} 2\ \text{T}$$

D5 From class notes:

$$\underset{\underset{\text{events/sec}}{\uparrow}}{\frac{dN(\theta)}{dt}}\,d\theta = \underset{\underset{\text{beam/sec}}{\uparrow}}{J_b}\,\underset{\underset{\text{density of scattering centers}}{\uparrow}}{n_t}\,\underset{\underset{\text{thickness}}{\uparrow}}{\Delta x}\,\frac{\pi}{4}\left(\frac{\cos\theta/2}{\sin^3\theta/2}\right)c^2\,d\theta \qquad C = \left(\frac{1}{4\pi\epsilon_0}\right)\left(\frac{z_1 z_2 e^2}{K}\right)$$

and

$$\frac{dN(\theta)}{dt} = \frac{d\sigma}{d\Omega}\,J_b\,n_t\,\Delta x\,\Delta\Omega \qquad \Delta\Omega = 2\pi\sin\theta\,\Delta\theta$$

$$= \frac{d\sigma}{d\Omega}\,J_b\,n_t\,\Delta x\,\sin\theta\,\Delta\theta$$

$$= c^2\,\frac{\pi}{4}\left(\frac{\cos\theta/2}{\sin^3\theta/2}\right)2\pi\sin\theta\;J_b\,n_t\,\Delta x\;\Delta\theta$$

$$= c^2\,\frac{\pi}{4}\;\frac{1}{2}\sin$$

$$\sin\theta/2 \cos\theta/2 = \tfrac{1}{2}\sin\theta$$

$$\cos\theta/2 = \frac{1}{2}\ \frac{\sin\theta}{\sin\theta/2}$$

$$\frac{\cos\theta/2}{\sin^3\theta/2}$$

$$\sin\theta\, d\theta = 2\sin\theta/2 \cos\theta/2\, d\theta$$

$$\cos\theta/2 \sin\theta/2 = 1/2 \sin\theta$$

$$\cos\theta/2 = \frac{1}{2}\ \frac{\sin\theta}{\sin\theta/2}$$

$$\frac{\cos\theta/2}{\sin^2\theta/2} \cdot \frac{\sin\theta}{\sin\theta/2}$$

$$\frac{\cos\theta/2}{\sin^3\theta/2} = \frac{1}{2}\ \frac{\sin\theta}{\sin^4\theta/2}$$