PH253 F13
Exam 3

(1)

$$U_e = -\frac{e^2}{4\pi\epsilon_0 r} \qquad U_G = -\frac{G m_p m_e}{r}$$

$$\frac{1}{4\pi\epsilon_0} \rightarrow G \qquad e^2 \rightarrow m_p m_e \qquad \text{Bohr: } r = \frac{4\pi\epsilon_0 \hbar^2}{m_e e^2} = a_0$$

$$a_g = \frac{(\frac{1}{G})\hbar^2}{(m_p m_e)m_e} = \frac{\hbar^2}{G m_p m_e^2} \simeq 1.2\times10^{29}\,m$$

by direct substitution

$\sim 10^{13}$ light years

~ 1000 size of obsv universe

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2. $\frac{\partial PE}{\partial r} = 0$ for equ, at $r = r_0$ dissoc $= PE(r_0) - PE(\infty) = P_0$

3\. a) from $n=6$, there are $\frac{6!}{2!(6-2)!} = \frac{6!}{4!\,2!} = \frac{6\cdot5}{2} = 15$ ways

or

6-5				
6-4	5-4			
6-3	5-3	4-3	3-2	2-1
6-2	5-2	4-2	3-1	
6-1	5-1	4-1		

$$5 + 4 + 3 + 2 + 1 = 15$$

$$\sum_{m=1}^{n-1} m = \frac{n(n-1)}{2}$$

b) if $\Delta n = 1$ only, only 5 possible - can only go one to next

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4. $R(r) = \frac{1}{\sqrt{3}(2a_0)^{3/2}} \frac{r}{a_0} e^{-r/2a_0}$

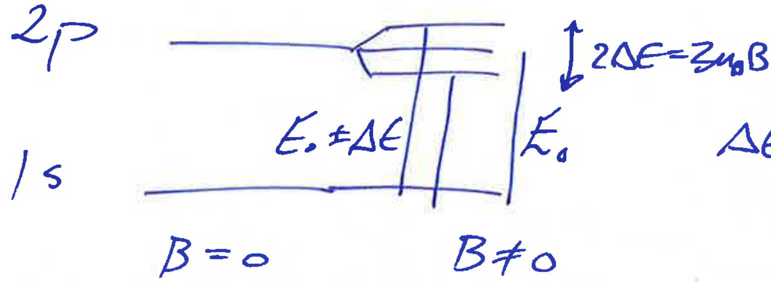
$P(r) = r^2|R|^2 = \frac{r^2}{24a_0^3} \frac{r^2}{a_0^2} e^{-r/a_0} = \frac{r^4}{24a_0^5} e^{-r/a_0}$

$\frac{\partial P}{\partial r} \propto 4r^3 e^{-r/a_0} - \frac{r^4}{a_0} e^{-r/a_0} = 0$

$\Rightarrow 4 - \frac{r}{a_0} = 0 \quad \boxed{r = 4a_0}$

given $n=2$, $\quad E = \frac{-13.6}{n^2} eV \simeq \boxed{3.4 eV}$

5.



$\Delta E = \mu_B B = 2(57.9\,eV/T)(2T)$

$$\Delta\lambda = \frac{\lambda^2}{hc}\Delta E = \frac{hc}{E^2}\Delta E = \frac{1240\,eV\cdot nm}{(10.2\,eV)^2}\cdot(57.9\cdot 2) \simeq 1.38\times10^{-3}\ nm$$

$$\Delta E = (-13.6\,eV)\left(\frac{1}{2^2} - 1\right) = 10.2\,eV$$

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6. (n, l, m_l, m_s)

l: $[0, n-1]$ $\quad$ m_l: $[-l, l]$ $\quad$ m_s: $\pm\frac{1}{2}$

- $l = n$ not allowed
- $m_l > l$ not allowed
- $m_s = \frac{3}{2}$ not allowed
- $l < 0$ not allowed