## Phys 327 MWZ

Trover Mclastrey Jun 17, 2022

(1) GNGPolles 4.13 a) Normalize the radial Gunetian Rzo and construct the wave Punction 1/200.  $\frac{\left(\frac{c}{2e}\right)^{2} \int r^{2} \left(1 - \frac{r}{2e}\right)^{2} e^{-r/e} dr \qquad u = \frac{r}{e}$   $a du = \frac{r}{e} dr$  $- \frac{|C_0|^2}{2a} \left( \frac{a^2 u^2}{1 - \frac{u}{z}} \right)^2 e^{-u} du = 1$  $\overline{L} = \int u^2 \left(1 + \frac{u^2}{4} - u\right) e^{-u} du = \frac{1}{a} \left(\frac{2}{c_0}\right)^2$ 

$$= \int_{0}^{\infty} \left( u^{2} - u^{3} + \frac{u^{4}}{4} \right) e^{-u} du \qquad \int_{0}^{\infty} x^{n} e^{-\alpha x} = \frac{n!}{\alpha^{n+1}}$$

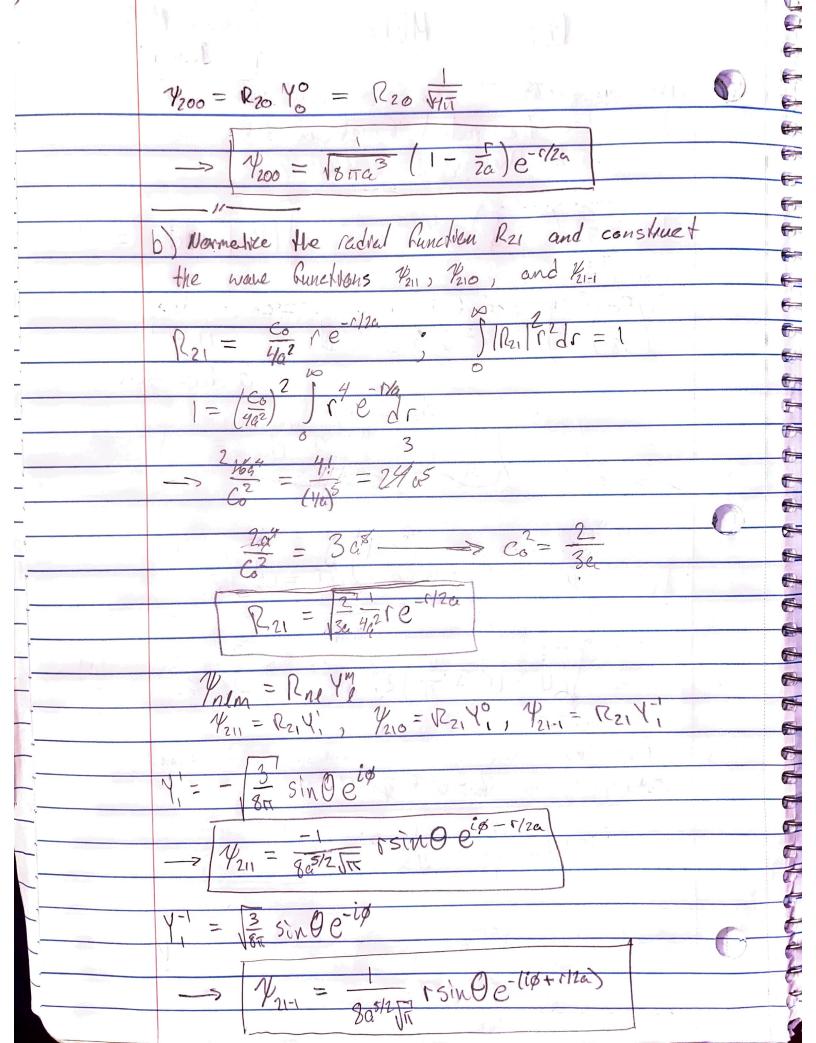
 $-3 + \left(\frac{2}{c_0}\right)^2 = 2 - 6 + \frac{1}{2}(247) = 2$ 

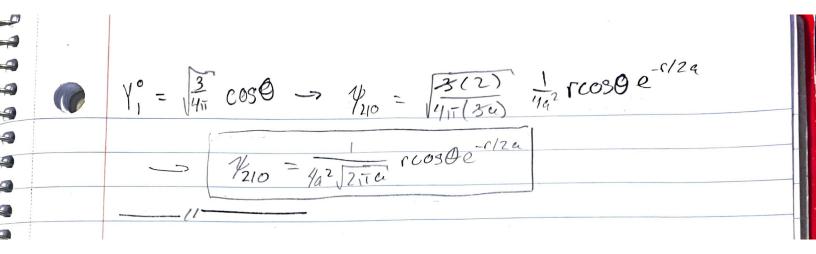
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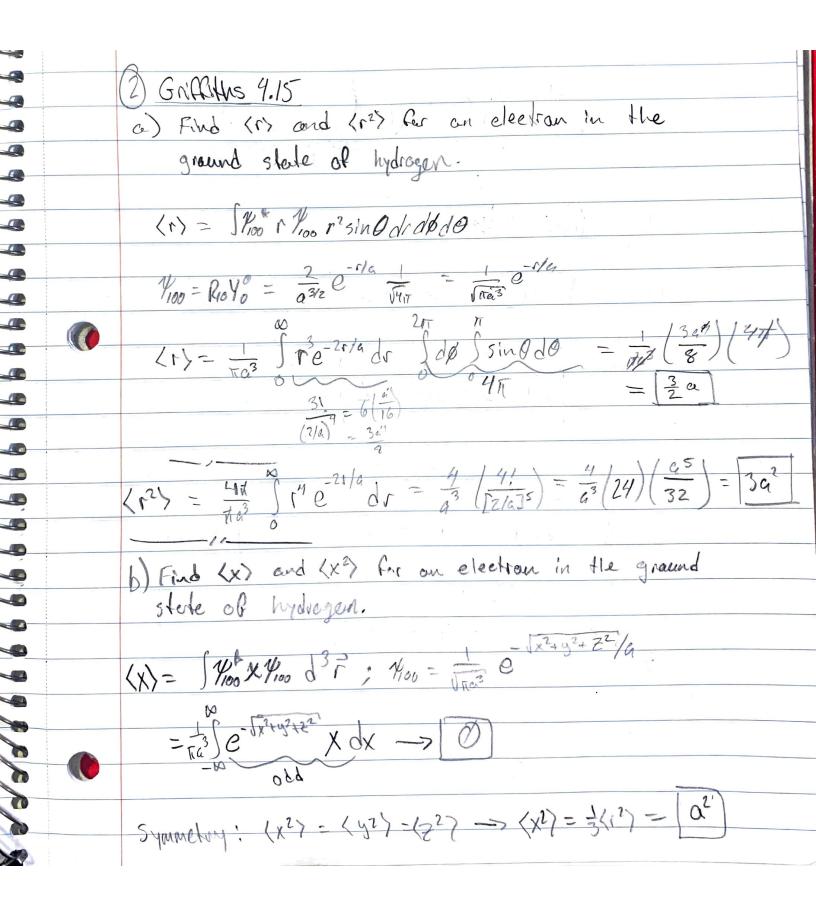
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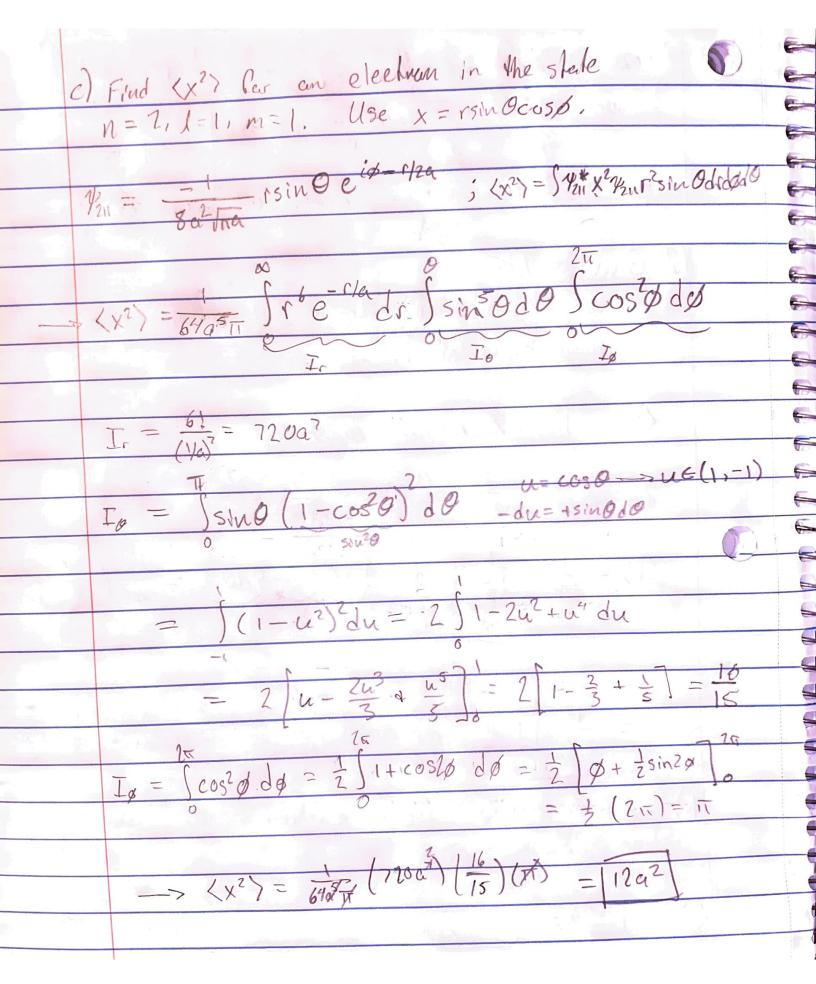
$$\left|\frac{c_0}{2}\right|^2 = \sqrt{2}$$

$$= \frac{1}{2c} = \frac{1}{2c} \sqrt{\frac{2}{c}} \left(1 - \frac{c}{2e}\right) e^{-c/2c}$$









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3 Consider the earth-sun system as a grantertronal analog to the hydrogen atom.

a) What is the potential everyy (replacing eq 4.52)? Let  $m = M_{\odot}$  and  $M = M_{\odot}$ 

U = -GmM

b) What is the "Bohr radius," ag for this system?

$$a = \frac{4\pi \epsilon_0 h^2}{m_e e^2} \longrightarrow \alpha_g = \frac{1}{6} \frac{1}{m^2 M} h^2 \longrightarrow \alpha_g = \frac{1}{6} \frac{1}{m^2 M}$$

ag = GM3 MO (6.67×10-11 M3) (5.97×102/kg) (2×1030/kg)

= (6.62)(5.97)(2) × 10-135 11 m 5 hg 8 mg 3 kg

 $=2.3\times10^{-3}\times10^{-135}$  m

$$a_g = 2.3 \times 10^{-138} \text{ m}$$

c) Write down the growtedword "Bohr Formula" and equaling En to the classical energy of a plenet in a crewler orbit of radius to, Show that n= Violag. From this, estimate the quantum number of earth.  $F_n = -\frac{m}{2t^2} \left( \frac{2}{mMG} \right) \frac{1}{n^2} = \frac{F_1}{n^2} = -\frac{m^3 M^2 G^2}{2t_1^2 n^2}$  $+ \frac{\mathcal{B}MM}{2\pi^2} = + \frac{m^2 M^2 G^2}{2\pi^2 n^2}$  $r_0 = a_0 n^2 \implies n = \sqrt{\frac{r_0}{a_0}}$  $N_{\odot} = \sqrt{\frac{1.5 \times 10^{11} \text{m}}{2.3 \times 10^{-158} \text{m}}} = \sqrt{6.5 \times 10^{-1} \times 10^{195}} = 2.5 \times 10^{14}$ d) Suppose the certir made a transolver to the next loner guartum level (n-1). How much energy (inJantos) would be released? What would be the wavelength of the emitted photon/graviton? Express your ansher in light years. Is the renerhable ansher a cosnaderee?  $= A \left[ \frac{1}{(n-1)^2} - \frac{1}{n^2} \right] = \frac{A}{n^2} \left( \frac{1}{(n-1)^2} - \frac{1}{n^3} \right)$ 

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 $F_{Y} = \frac{m^{3}m^{2}6^{2}}{2\pi^{2}n^{3}} = \frac{(5.97 \times 10^{21}k_{5})^{2}(2 \times 10^{50}k_{5})^{2}(6.67 \times 10^{-11}m^{3}/k_{55}z^{2})^{2}}{2(1.055 \times 10^{-27})^{5}}(2.5 \times 10^{-11}m^{3}/k_{55}z^{2})^{2}}$   $\Rightarrow F_{Y} \approx 2.1 \times 10^{-11/3}$   $E = \frac{hc}{\lambda} \Rightarrow \lambda = \frac{hc}{E} = \frac{6.63 \times 10^{-24}}{2.1 \times 10^{-11/3}} = \frac{9.5 \times 10^{15}m}{9.5 \times 10^{15}m}$  22 | light year|.Yes coincidence?