Phy 5521 Fall 2023

Recitation #11 Solutions

1) Since ψ depends only on r,

$$L^2\psi = 0$$

2) $$\frac{p_r^2}{2m}\psi = -\frac{\hbar^2}{2m}\left(\psi'' + \frac{2}{r}\psi'\right)$$

Schrodinger equation is,

$$-\frac{\hbar^2}{2m}\left(\psi'' + \frac{2\psi'}{r}\right) + V\psi = E\psi$$

as $r \to \infty$

$$-\frac{\hbar^2}{2m}\frac{1}{a_0^2}\psi = E\psi$$

$$E = -\frac{\hbar^2}{2ma_0^2}$$

3) then

$$-\frac{\hbar^2}{2m}\left(\psi'' + \frac{2\psi'}{r}\right) + V\psi = E\psi$$

becomes

$$-\frac{\hbar^2}{2m}\left(\frac{1}{a_0} + \frac{2}{a_0 r}\right) + V = -\frac{\hbar^2}{2ma_0}$$

$$V = -\frac{\hbar^2}{2ma_0}\left(\frac{1}{r}\right) = -\frac{\alpha\hbar c}{r}$$