Module 6: Hydrogen Atom and Other Two Body Problem

6.1 For a spherically symmetric potential, the radial part of the Schrodinger equation is given by:

$\frac{d^2R}{dr^2}+\frac{2}{r}\frac{dR(r)}{dr}+\frac{2\mu}{\hbar^2}\left[E-V(r)+F(r)\right]R(r)=0$. The function $F(r)$ is given by

(a) $-\frac{l(l+1)\hbar^2}{2\mu r^2}$

(b) $+\frac{l(l+1)\hbar^2}{2\mu r^2}$

(c) $-l(l+1)\hbar^2$

(d) $+l(l+1)\hbar^2$

[Answer (a)]

6.2 In the hydrogen atom problem the radial part of the Schrodinger equation can be written in the from

$$\frac{1}{\rho^2}\frac{d}{d\rho}\left(\rho^2\frac{dR}{d\rho}\right)+\left(\frac{\lambda}{\rho}-\frac{1}{4}-\frac{l(l+1)}{\rho^2}\right)R(\rho)=0$$

where $\rho=\gamma r$. The quantity γ is given by

(a) $\left(+\frac{2\mu E}{\hbar^2}\right)^{1/2}$

(b) $\left(-\frac{2\mu E}{\hbar^2}\right)^{1/2}$

(c) $\left(+\frac{8\mu E}{\hbar^2}\right)^{1/2}$

(d) $\left(-\frac{8\mu E}{\hbar^2}\right)^{1/2}$

[Answer (d)]

6.3 In the hydrogen atom problem the radial part of the Schrodinger equation can be written in the from

$$\frac{1}{\rho^2}\frac{d}{d\rho}\left(\rho^2\frac{dR}{d\rho}\right)+\left(\frac{\lambda}{\rho}-\frac{1}{4}-\frac{l\ l+1}{\rho^2}\right)R\ \rho\ =0$$

where $\rho=\gamma r$. The quantity λ is given by

(a) $Z\alpha\left(-\frac{\mu c^2}{8E}\right)^{1/2}$

(b) $Z\alpha\left(+\frac{\mu c^2}{8E}\right)^{1/2}$

(c) $Z\alpha\left(-\frac{\mu c^2}{2E}\right)^{1/2}$

(d) $Z\alpha\left(+\frac{\mu c^2}{2E}\right)^{1/2}$

where α is the fine structure constant.
[Answer (c)]

6.4 In the hydrogen atom problem, the radial part of the Schrodinger equation can be written in the from

$$R_{nl}\ \rho\ =N\rho^l\, e^{-\rho/2}\,{}_1F_1\ \ a,c,\rho$$

where ${}_1F_1\ \ a,c,\rho$ is the confluent hypergeometric function. The infinite series ${}_1F_1\ \ a,c,\rho$ must be made into a polynomial because ${}_1F_1\ \ a,c,\rho$

(a) is a divergent series for all values of ρ.

(b) is a divergent series only for $\rho>1$

(c) is a convergent series but behaves $\rho^{a-c}e^{+\rho/3}$ as $\rho\to\infty$.

(d) is a convergent series but behaves $\rho^{a-c}e^{+\rho}$ as $\rho\to\infty$.

[Answer (d)]

6.5 In the hydrogen atom problem, the radial part of the Schrodinger equation can be written in the from

$$R_{nl}\ \rho\ =N\rho^l\, e^{-\rho/2}\,{}_1F_1\ \ a,c,\rho$$

where $_1F_1(a,c,\rho)$ is the confluent hypergeometric function. The infinite series $_1F_1(a,c,\rho)$ becomes a polynomial

(a) when *a* becomes a positive integer
(b) when *a* becomes a negative integer
(c) when *c* becomes a positive integer
(d) when *c* becomes a negative integer
[Answer (b)]

6.6 In the hydrogen atom problem, the radial part of the Schrodinger equation can be written in the from

$$R_{nl}(\rho) = N\rho^l e^{-\rho/2}{}_1F_1(a,c,\rho)$$

where $_1F_1(a,c,\rho)$ is the confluent hypergeometric function. The quantity *a* is given by
(a) $a = l+1-n$
(b) $a = n-l+1$
(c) $a = 2l+1$
(d) $a = 2l+2$
where n is the total quantum number.

[Answer (a)]

6.7 In the hydrogen atom problem, the radial part of the Schrodinger equation can be written in the from

$$R_{nl}(\rho) = N\rho^l e^{-\rho/2}{}_1F_1(a,c,\rho)$$

where $_1F_1(a,c,\rho)$ is the confluent hypergeometric function. The quantity *c* is given by
(a) $c = l+1-n$
(b) $c = n-l+1$
(c) $c = 2l+1$
(d) $c = 2l+2$
where n is the total quantum number.
[Answer (d)]