T.E.C.

GA 8.7

Let e's BE in $|1,+1\rangle$ TRIPLET STATE

$$\psi \propto \begin{vmatrix} \varphi_1(x_1) & \varphi_2(x_1) \\ \varphi_1(x_2) & \varphi_2(x_2) \end{vmatrix}$$

$$\psi = N\left[\varphi_1(x_1)\varphi_2(x_2) - \varphi_1(x_2)\varphi_2(x_1)\right]$$

$$= N\frac{\pi}{\mu^2}\Big[e^{-\mu^2(x_1-a)^2/2}\, e^{-\mu^2(x_2+a)^2/2}$$

$$- e^{-\mu^2(x_2-a)^2/2}\, e^{-\mu^2(x_1+a)^2/2}\Big]$$

$$= \frac{N\pi}{\mu^2}\Big[e^{-\mu^2\left[\frac{x_1^2+a^2-2x_1a}{2} + \frac{x_2^2+2x_2a+a^2}{2}\right]}$$

$$- e^{-\mu^2\left[\frac{x_2^2-2x_2a+a^2+x_1^2+2x_1a+a^2}{2}\right]}\Big]$$

$$= \frac{N\pi}{\mu^2}\Big[e^{-\mu^2\left[\frac{x_1^2+x_2^2}{2} + a^2 + (x_2-x_1)a\right.}$$

$$- e^{-\mu^2\left(\frac{x_1^2+x_2^2}{2} + a^2 + (x_2-x_1)a\right]}\Big]$$

$$= \frac{N\pi}{\mu^2}\, e^{-\mu^2 a^2}\, e^{-\mu^2\frac{(x_1^2+x_2^2)}{2}}\Big[e^{-\mu^2(x_2-x_1)a}$$

$$- e^{-\mu^2(x_1-x_2)a}\Big]$$

GA 8.7

SET $x_1 = \overline{X} + x/2$

$x_2 = \overline{X} - x/2$

w/ $\overline{X}$ = c.o.m. position

x = pos wrt to c.o.m.

So,

$$\psi = \frac{N\pi}{\mu^2} e^{-\mu^2 a^2} e^{-\mu^2 \frac{(x_1^2+x_2^2)}{2}} \left[e^{\mu^2 x a} - e^{-\mu^2 x a} \right]$$

Now,

$$x_1^2 = \overline{X}^2 + \frac{x^2}{4} + \overline{X} x$$

$$x_2^2 = \overline{X}^2 + \frac{x^2}{4} - \overline{X} x$$

$$x_1^2 + x_2^2 = 2\overline{X}^2 + x^2/2$$

HENCE,

$$\psi = \frac{2N\pi}{\mu^2} e^{-\mu^2 a^2} e^{-\mu^2 \overline{X}^2} e^{-\mu^2 x^2/4} \sinh \mu^2 x a$$

GA 8.7

IMPOSE NORMALIZATION

$$\int_{-\infty}^{\infty}\int_{-\infty}^{\infty} \psi^2 \, dx \, d\bar{X} = 1$$

$$\frac{4N^2\pi^2}{\mu^4} e^{-2\mu^2 a^2} \left(\frac{\pi}{2\mu^2}\right)^{1/2} \underbrace{\int_{-\infty}^{\infty} dx \, e^{-\mu^2 x^2/2} \sinh^2 \mu x a}_{=\sqrt{\frac{\pi}{2\mu^2}}\left[\exp(2\mu^2 a^2 - 1)\right]} = 1$$

$$\Rightarrow N^2 = \frac{2\mu^2}{\pi} \frac{\mu^4}{4\pi^2} \left[1 - e^{-2\mu^2 a^2}\right]^{-1}$$

$$N = \frac{\mu^3}{\sqrt{2\pi^3}} \left[1 - e^{-2\mu^2 a^2}\right]^{-1/2}$$

$$\psi(x, \bar{X}) = \sqrt{\frac{2}{\pi}} \mu \left[1 - e^{-2\mu^2 a^2}\right]^{-1/2} \quad (1)$$

$$* \left[e^{-\mu^2 a^2} e^{-\mu^2 \bar{X}^2} e^{-\mu^2 x^2/4} \sinh^2 \mu^2 x a \right]$$

TERM (1) = 1 IF NO PAULI EX. P.

DESIRE $e^{-2\mu^2 a^2} \lesssim 10^{-3}$

$$2\mu^2 a^2 \gtrsim 3 \ln 10$$

GA 8.7.

$$a \gtrsim \left[\frac{3 \ln 10}{3 u^2}\right]^{1/2}$$

$$\boxed{a \gtrsim 0.9\,\text{Å}}$$

#2. USE SLATER DETERMINANTS.

$$\psi_A = \frac{1}{\sqrt{3!}} \begin{vmatrix} \varphi_1(x_1) & \varphi_2(x_1) & \varphi_3(x_1) \\ \varphi_1(x_2) & \varphi_2(x_2) & \varphi_3(x_2) \\ \varphi_1(x_3) & \varphi_2(x_3) & \varphi_3(x_3) \end{vmatrix}$$

w/ $\varphi_1(x_1) = \sqrt{\frac{2}{a}} \sin \frac{\pi x_1}{a} \; \chi_+$

$$\varphi_2(x_1) = \sqrt{\frac{2}{a}} \sin \frac{2\pi x_1}{a} \; \chi_+$$

$$\varphi_3(x_1) = \sqrt{\frac{2}{a}} \sin \frac{3\pi x_1}{a} \; \chi_+$$

OTHER CHOICES FOR SPINOR OK.

$$\psi_A = \frac{1}{\sqrt{6}} \Big[\varphi_1(x_1) \left[\varphi_2(x_2)\varphi_3(x_3) - \varphi_2(x_3)\varphi_3(x_2) \right]$$

$$- \varphi_2(x_1) \left[\varphi_1(x_2)\varphi_3(x_3) - \varphi_1(x_3)\varphi_3(x_2) \right]$$

$$+ \varphi_3(x_1) \left[\varphi_1(x_2)\varphi_2(x_3) - \varphi_1(x_3)\varphi_2(x_2) \right] \Big]$$

#3. FOLLOW PAULI EXCLUSION PRINCIPLE.

e^- PACKING: $\uparrow\downarrow$ $\uparrow\downarrow$ $\uparrow$

$n=1$ $n=2$ $n=3$

$$E = \frac{n^2 \hbar^2 \pi^2}{2 m a^2} \quad ; \quad m = e^- \text{ MASS}$$

$$E = \sum_{n_e=1}^{5} = \frac{\hbar^2 \pi^2}{2 m a^2} \left[2(1) + 2(2)^2 + 3^2 \right]$$

$$\boxed{E_{TOT} = \frac{19}{2} \hbar^2 \pi^2 / m a^2}$$

#4 MOST COMMON ISOTOPE OF As IS ^{75}As, w/ $Z=33$

THIS MEANS As HAS 42 NEUTRONS

As THEREFORE HAS 75 + 33 FERMIONS (NEED TO COUNT n's, p's & e's.)

$\therefore$ $\boxed{\text{As IS A BOSON}}$

#5 ^{195}Pt IS MOST COMMON ISOTOPE OF Pt.

SINCE $Z(Pt) = 78$,

Pt HAS 195 + 78 FERMIONS IN ITS NEUTRAL STATE

$\therefore$ $\boxed{\text{Pt IS A FERMION}}$

GR 5.12

$$\boxed{{}^3I_8 \Rightarrow S=2,\ L=6 \text{ AND } J=8, \text{ ALL IN UNITS OF } \hbar}$$

FOR e^- CONFIGURATION, SEE GA p 320

$$\boxed{\begin{array}{l} Dy:\ (Xe)(6s)^2(4f)^{10} \\ \text{w/ } (Xe) = Xe \text{ CONFIGURATION.} \end{array}}$$