18.15

$$\psi(r,\theta,\phi) = C_0\, r\, e^{-\frac{\mu\omega}{\hbar} r^2/2}\, Y_{00}\, |\text{SPIN OR}\rangle$$

ODD — MUST BE EVEN ⇒ TRIPLET

w/ $\int \psi^2 r^2 dr d\Omega = 1 \Rightarrow C_0^2$

c) $\delta E = \langle\psi|H'|\psi\rangle$

$$\delta E \propto \int dr\,(r^3)\; r^2 e^{-\frac{\mu\omega}{\hbar} r^2}\; \frac{\delta(r)}{r^2}$$

$$\Rightarrow \boxed{\delta E = 0}$$

18.15

$$H = \frac{p_1^2}{2m} + \frac{p_2^2}{2m} + \frac{1}{2} m\omega^2 (r_1 - r_2)^2$$

USE COM VARIABLES

$$R = \frac{r_1 + r_2}{2}$$

$$r = r_1 - r_2$$

$$P = p_1 + p_2$$

$$p = (p_1 - p_2)/2$$

FOR $P = 0$ (SEE GA., p169)

$$H = \frac{p^2}{2\mu} + \frac{1}{2}\mu\omega^2 r^2$$

$$H\psi = E\psi$$

SOLUTIONS ARE SHO ψ's

NOTE WE ARE IN 3-DIMS

(a) $\psi(x,y,z) = H_0(x) H_0(y) H_0(z) e^{-\frac{\mu\omega}{2\hbar}(x^2+y^2+z^2)/2}$

*100%

10.15:

ALSO NOTE

$H_1(x) \propto x$

$H_1(y) \propto y$

$H_1(z) \propto z$

FURTHERMORE, FROM PROPS OF SPHERICAL HARMONICS,

$$z = \sqrt{\frac{4\pi}{3}}\, r\, Y_{10}(\theta,\varphi)$$

$$x = \sqrt{\frac{4\pi}{3}}\, \frac{r}{\sqrt{2}} (Y_{1-1} - Y_{11})$$

$$y = i\sqrt{\frac{4\pi}{3}}\, \frac{r}{\sqrt{2}} (Y_{1-1} + Y_{11})$$

SO, 1ST EXCITED STATE w/ $\ell = 0$:

$\psi(x,y,z) \propto H_0(x) H_0(y) H_1(z)\, e^{-\frac{m\omega}{2\hbar}(x^2+y^2+z^2)}$ * |SPATIAL>

$\Rightarrow \psi(r,\theta,\varphi) \propto r\, e^{-\frac{m\omega}{2\hbar} r^2/2}\, Y_{10}$ |SPATIAL>

SPACE PART ODD, $\Rightarrow$ |SPIN> = EVEN = TRIPLET

17.17.

SEE Gr. p41 FOR NORMALIZATION.

$H_0(x) = 1$

FOR SPHERICAL COORDS

$$\psi(r,\theta,\phi) = \left(\frac{\mu\omega}{\pi\hbar}\right)^{3/4} e^{-\frac{\mu\omega}{\hbar} r^2/2} Y_{0,0}(\theta,\phi) \; |00\rangle$$

sym — Asymptotic

(b). NOTE $l = 0$.

FROM CARTESIAN, EXCITED TO SPHERICAL SOL'S.

CARTESIAN. $\psi(x) \propto H_n(x) e^{-\frac{\mu\omega}{\hbar} x^2/2}$

$\psi(y) \propto H_m(y) e^{-\frac{\mu\omega}{\hbar} y^2/2}$

$\psi(z) \propto H_n(z) e^{-\frac{\mu\omega}{\hbar} z^2/2}$

FIRST EXCITED STATE IMPLIES

$n_x = n_y = 0$, $n_z = 1$. OTHER CHOICES POSSIBLE.