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Phys422-Quiz #2 Ch-5-T162

Student Name: _____ ID# _____

Q#1: Calculate ground state spin of ^{32}Cl using shell model.

$^{32}\text{Cl}_{15} \rightarrow$ 17th proton $1d_{3/2}$ and 15th neutron $2s_{1/2}$

$j_p = \frac{3}{2}, l_p = 1; j_n = \frac{1}{2}, l_n = 0$

$I = j_n + j_p = \frac{1}{2} + \frac{3}{2} = 2$

$\pi = (-1)^{l_n} \cdot (-1)^{l_p} = (-1)(-1) = +$

$I = 2^+$

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Q#2: Calculate magnetic moment of ^{89}Y using shell model.

$^{89}\text{Y}_{39} \rightarrow Z=39, N=50$, 39th Proton $2p_{1/2}, l=1, j=1/2$

for a proton $j = l - 1/2$

$\mu = \left[g_l \left(\frac{j(j+3)}{j+1} \right) - \frac{1}{2} \left(\frac{1}{j+1} \right) g_s \right] \mu_N$; $g_l = 1, g_s = 5.5857$

$\mu = \left[1 \left(\frac{\frac{1}{2}(\frac{1}{2}+3)}{\frac{1}{2}+1} \right) - \frac{1}{2} \left(\frac{1}{\frac{1}{2}+1} \right) 5.5857 \right] \mu_N$

$\mu = -1.196 \mu_N$

Q#3: Calculate shell-model quadrupole moment of ^{51}V :

$^{51}\text{V}_{23} \mu=23, n=28$

3 proton in $1f_{7/2}$ or $(1f_{7/2})^3$, neutron $(1f_{7/2})^8$

Quadrupole moment due to 3 proton in $(1f_{7/2})$ shell

$Q = \langle Q_{sp} \rangle \left[1 - \frac{2(n-1)}{2j-1} \right]$

$\langle Q_{sp} \rangle = - \frac{2j-1}{2(j+1)} \frac{3}{5} R_0^2 A^{2/3} = -2 \frac{2 \times \frac{7}{2} - 1}{2(\frac{7}{2} + 1)} \times \frac{3}{5} (1.25)^2 \times (51)^{2/3}$

$Q = -0.103 \left[1 - 2 \times \frac{3-1}{2 \times \frac{7}{2} - 1} \right] \times (1 - \frac{2}{3}) = -0.034 b$

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