Nucl. Chem Cumulative Exam 1/20/2010

Q1 (+1 each)

	Range (m)	Force Carrier	Relative Strength
Strong	10^{-15}	gluon	1
Weak	10^{-18}	$W^{\pm}, Z^{0}$	10^{-5}
EM	∞	photon	$\alpha = 1/137$
gravity	∞	graviton	10^{-38}

Q2

strong force attractive T (+2)
strong force changes with charge F (+2)
[strong force is charge independent]
strong force saturates T (+2)
strong force spin independent F (+2)

Q3 Why are structures of $^{50}_{26}Fe_{24}$ and $^{50}_{24}Cr_{26}$ similar?

⇒ charge independence of nuclear force. Nuclei are mirror partners, differ by exchange of proton and neutron number (+4)

Why are level energies lower in ^{50}Fe?

⇒ larger proton number, Coulomb force larger, and has impact on nuclear stability (decreases stability, hence "collapsing" the energy levels)

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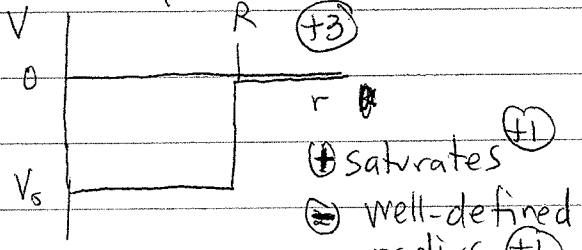
Q4

Square well

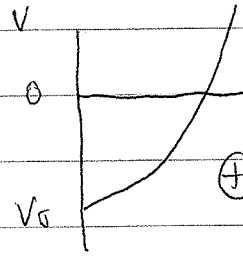


+3

⊕ saturates +1

⊖ well-defined radius +1

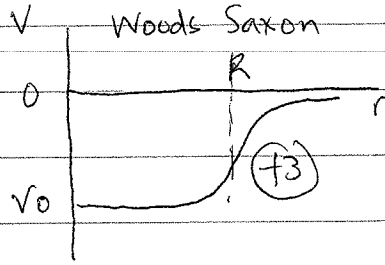
harmonic oscillator +1



⊕ diffuse radius

⊖ $V \to \infty$ at $r \to \infty$ +1

+3

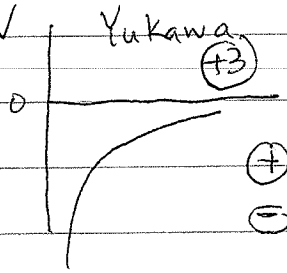


+3

+1

⊕ diffuse radius

⊖ no repulsive core +1



+3

+1

⊕ diffuse radius

⊖ does not saturate at $r=0$ +1

Q5 What is degeneracy of $1p_{3/2}$?

⇒ 4 $(2J+1)$ +3

What are J^π for ^{15}O and ^{17}O?

⇒ $^{15}_{8}O_7$, odd n is in $1p_{1/2}$ $1/2^-$ +3

⇒ $^{17}_{8}O_9$, odd n is in $1d_{5/2}$ $5/2^+$ +3

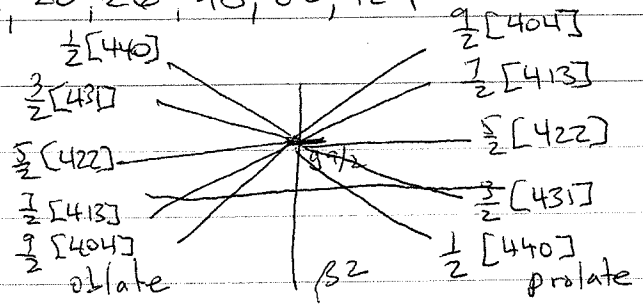
How is 0^+ for all even even ground states explained?

⇒ all nucleons (p and n) paired to J=0, have then symmetric wavefunctions (+ parity)

Q6 Magic #s for force with opposite sign of spin orbit?

2, 8, 20, 26, 48, 80, 124

Q7



Ω = quantum number for L along symmetry axis

$\Omega[Nn_z\Lambda]$

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Q8 $D = \frac{M}{V} = \frac{A}{\frac{4}{3}\pi R^3}$ $R = r_0 A^{1/3}$

$= \frac{A}{\frac{4}{3}\pi (r_0 A^{1/3})^3} = \frac{A}{\frac{4}{3}\pi r_0^3 A} = \boxed{\frac{3}{4\pi r_0^3}}$

Q9 Isospin → quantum number reflecting charge independence of nuclear force. ~~If so~~ Can Then designate nucleons as projections of isospin quantum number proton $\tau = -1/2$ neutron $\tau = +1/2$

$T_3 (T_z) = \frac{N-Z}{2}$

$T_z \leq |T| \leq \frac{A}{2}$

$^{17}_{9}F_{8}$ $T_z = \frac{8-9}{2} = -\frac{1}{2}$

$\frac{1}{2} \leq T \leq \frac{17}{2}$, most likely $T = 1/2$ for ground state