Basic Physical Chemistry I

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Q1
Prove the following relation, (p.6)

$$\vec{S^2}\chi_s{}^{\mathrm{III}} = 2\hbar^2\chi_s^{\mathrm{III}}.$$

Q2
Prove the following relation, (p.7)

$$\vec{S^2} = S(S+1)\hbar^2.$$

Q3
Discuss the case that the ferromagnetic states are stable in $3d$ transition metal compounds. (p.9)

Q4
Explain the difference between molecular orbital and valence bond approaches. (p.10)

Q5
Explain the advantage of configuration interaction approach. (p.11,12)

Q6
Prove the relation in $F(x)$.

$$F(x) = \frac{1}{2} + \frac{1-x^2}{4x}\ln\left|\frac{1+x}{1-x}\right|$$

Q7
Prove the Fourier transformation in k-representation of Coulomb potential $U(r) = \frac{1}{4\pi\epsilon}\frac{1}{r}$;

$$\int \frac{e^{-i\vec{k}\cdot\vec{r}}}{|\vec{r}|}d\vec{r} = \frac{4\pi}{k^2}$$

Q8
Explain the essence of Hartree-Fock approximation.

Q9
Summarize the super-exchange interaction.

Q10
Summarize the double-exchange interaction.