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4. SOLUTIONS

4.1. a) Fe^{2+} $3d^6$, $4\mu_B$, Fe^{3+} $3d^5$, $5\mu_B$, Mn^{2+} $3d^5$, $5\mu_B$, and Zn^{2+} $3d^{10}$, $0\mu_B$

b) Mn^{2+} prefers the A sites even more than Fe^{3+} does, so unlike the other transition metal ferrites, Mn occupies A site and $2Fe^{3+}$ occupy B sites. However, this makes no difference to the moment per FU because Mn^{2+} and Fe^{3+} have the same moment. Net moment is $5\mu_B$ per FU.

c) As Zn replaces Mn, there is no change in iron B-site occupation but the reduction of the moment on the A sublattice, Mn_{1-x} + Zn_x, allows the net moment to increase linearly because a smaller A-site moment is subtracted from the 10 Bohr magnetons on the B sublattice. At some value of x, the weaker moment on the A sites will allow the antiferromagnetic interaction between the two moments on B sites to take precedence. Beyond this Zn concentration, the net moment decreases as the moment on the B sites decreases rapidly from 10 Bohr magnetons.

4.2 Substitution of Zn for Ni in Fe_2NiO_4. Ni^{2+} has less tetrahedral (A) preference than Fe^{3+} so site distribution is as indicated in table. But Zn^{2+} has stronger A preference than Fe^{3+} so while it substitutes for Ni, it displaces Fe^{3+} from A sites to B sites.

	A	B
Fe_2NiO_4	Fe^{3+}	Fe^{3+} Ni^{2+}
$Fe_2Ni_{1-x}Zn_xO_4$	$(1-x)Fe^{3+}$ $x\,Zn^{2+}$	$(1+x)Fe^{3+}$ $(1-x)Ni^{2+}$
Moment	$-(1-x)5 - 0x$	$+(1+x)5 + (1-x)2$

$$\mu_m = [2 + 8x]\ \mu_B$$

This is the initial linear increase shown in Fig.4.15.

4.3 a) There are two Ni atoms per unit cell so $C = N_v\mu_o\mu m^2/k_B \approx 0.48$. Hence, for $T_C = 630$K, $\lambda = T_C/C = 1300$.

b) Use $\chi = C/(T - T_C)$. For $T = 730$ and 930K, $\chi \approx 3.3 \times 10^{-3}$ and 1.1×10^{-3}, respectively. Thus, $C = 0.99$ and 0.11 respectively and $\lambda = 5730$ and 636, respectively.