DL-methionine in animals treated with carcinogen is under investigation. It is thought possible that increased utilization of S^{35} DL-methionine may be associated with a greater potential for growth or regeneration of tissues, a hypothesis that is being tested in normal and protein-depleted rats.

References

1. WASE, A. W., and ALLISON, J. B. *Proc. Soc. Exptl. Biol. Med.*, **73**, 147 (1950).
2. ALLISON, J. B., *et al. Cancer Research*, **10**, 266 (1950).
3. WASE, A. W., and ALLISON, J. B. Abstr., *119th Meeting Am. Chem. Soc.* (April 1951).
4. WILSON, R. H., DEEDS, F., and COX, A. J. *Cancer Research*, **1**, 595 (1941).
5. BIELSCHOWSKY, F., and GREEN, H. N. *Nature*, **149**, 526 (1942).
6. WASE, A. W., ALLISON, J. B., and MIGLIARESE, J. F. *Federation Proc.*, **11**, 307 (1952).

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On the Anomaly in the Heat Capacity of Manganous Oxide[1]

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Recent work of Todd and Bonnickson (*1*) on very pure samples of MnO shows that as the temperature increases in the range from 100° to 122° K the heat capacity of MnO rises from about 7 cal/(mole deg) to a peak of 76.7 and then drops sharply to about 7.5. The total heat absorbed is 246 cal/mole. The average Debye heat capacity is about 7, so that $7 \times 22 = 154$ cal/mole are absorbed by lattice oscillations. One can estimate the additional heat capacity associated with the disappearance of the spontaneous magnetization to be R (*2*), so that the heat ascribable to this effect is 44 cal/mole. Thus, there is an amount of heat $q = 48$ cal/mole (nearly 20% of the total) which cannot be accounted for by the usual mechanisms.

MnO is antiferromagnetic with $\theta = -610°$ K and $T_c \simeq 122°$ K, where θ and T_c are the characteristic temperature of the Curie-Weiss law and the Curie temperature, respectively (*3*). The fact that $-\theta/T_c$ is equal to 5 rather than unity, as predicted by the simple theory, has been discussed by means of an extension of the molecular field theory to include the effects of nearest and next-nearest neighbor interactions in more complicated orderings of the elementary moments contained in the magnetic sublattices (*4*). If γ_1 and γ_2 are the molecular field coefficients for nearest and next-nearest neighbor interactions, respectively, then the ratio $-\theta/T_c$ for MnO determines $\rho = \gamma_2/\gamma_1$, to be 0.75; this value is compatible with two different orderings known as ordering of the second or third kind, which can occur if ρ is greater or less than 3/4, respectively. Neutron diffraction experiments have shown the ordering below the Curie temperature to be of the second kind (*5*).

It has been found (*6*) that the lattice constants of MnO change in this temperature range, and since γ_1 and γ_2 (and thence ρ) presumably depend strongly upon distance, it is suggested that the anomalous behavior can be further interpreted as a change from the second to the third kind of order as the temperature is increased. To correspond to the neutron diffraction results, we should have $\rho = (3/4) + \delta$ below the Curie temperature, and $\rho = (3/4) - \varepsilon$ throughout the transition region to conform to this suggestion (δ and ε are small positive numbers). The following calculations provide some quantitative support for this interpretation.

If T_i is the Curie temperature for the ith kind of ordering, one finds that

$$T_2 = C\,\rho\,\gamma_1,\; T_3 = C\,\gamma_1\,[1 - (1/3)\,\rho],$$

and

$$-\theta = 3C\,\gamma_1\,[1 + (1/3)\,\rho]$$

where C is the Curie constant (*4*). A reasonable expression for the range ΔT of the anomalous behavior is $T_3 - T_2$, so that we obtain

$$\Delta T = -(\theta/3)\left(1 - \frac{4}{3}\rho\right)\left(1 + \frac{1}{3}\rho\right)^{-1} \simeq (16/9)\,T_c\varepsilon.$$

Using the experimental values of ΔT and T_c, we find the estimated value of ε to be 0.1. This corresponds to a 13% change in ρ which is satisfactorily small considering the nature of the calculation.

The energy which must be supplied to the system when in the ith kind of ordering in order to destroy the magnetization is of the order of RT_i. Thus, for the heat absorbed during the change of ordering, we can write

$$q = R(T_3 - T_2) = (16/9)RT_c\varepsilon.$$

From this we find that $q = 43$ cal/mole, which agrees quite well with the value of 48 given above.

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References

1. TODD, S. S., and BONNICKSON, K. R. *J. Am. Chem. Soc.*, **73**, 3894 (1951).
2. LI, Y. Y. *Phys. Rev.*, **84**, 721 (1951).
3. BIZETTE, H. *Ann. phys.*, **1**, 306 (1946).
4. NÉEL, L. *Ibid.*, **3**, 137 (1948); ANDERSON, P. W. *Phys. Rev.*, **79**, 705 (1950); VAN VLECK, J. H. *J. phys. radium*, **12**, 262 (1951); SMART, J. S. *Phys. Rev.*, **86**, 968 (1952).
5. SHULL, C. G., STRAUSER, W. A., and WOLLAN, E. O. *Phys. Rev.*, **83**, 333 (1951).
6. RUHEMANN, B. *Phys. Z. USSR*, **7**, 590 (1935); TOMBS, N. C., and ROOKSBY, H. P. *Nature*, **165**, 442 (1950).

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Ammoniated Dentifrices and Hamster Caries: Further Studies on the Effects of Ingestion[1]

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Controversy exists concerning the efficacy of ammoniated dentifrices in dental caries prevention. *In*

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