

can calculate the one atmosphere value from

$$\theta_0 = \left(\frac{V_p}{V_0} \right)^\gamma \theta_p \quad (27)$$

where γ is the Grüneisen constant.

The resultant values for θ are listed in Table I. Since the f number measures a mean value of $\langle \omega^{-2} \rangle$ where ω is the lattice vibrational

TABLE I. Mössbauer and Grüneisen constants for copper, vanadium and titanium

Element	50 kb		Atmospheric		γ
	$\theta_f(^{\circ}\text{K})$	$\theta_{\text{host}}(^{\circ}\text{K})$	$\theta_f(^{\circ}\text{K})$	$\theta_{\text{host}}(^{\circ}\text{K})$	
Cu	350 ± 14	331 ± 14	327 ± 14	309 ± 14	1.998
V	268 ± 10	284 ± 11	258 ± 10	274 ± 11	1.257
Ti	339 ± 35	370 ± 40	321 ± 35	350 ± 40	1.232

frequency, it is most meaningful to compare these θ 's with θ obtained from X-ray diffraction measurements. Unfortunately, this can only be done for copper. Table II summarizes the available data for this metal. It can be seen that the X-ray results are in excellent agreement with the predictions from high pressure Mössbauer data.

TABLE II. θ_D from X-ray measurements for copper

Investigators	Debye parameter ($^{\circ}\text{K}$)
Owen and Williams (1947)	314
Burie (1956)	299
Chipman and Paskin (1959)	307 (327) ^a
Flinn <i>et al.</i> (1961)	322
Graevskaya <i>et al.</i> (1965)	310

^a Parenthetic value corrected for one and two phonon generation.

A direct comparison of these results with other data for vanadium is more difficult. The values of θ available are from low temperature specific heat measurements and are listed in Table III. It should be kept in mind that vanadium is superconducting below 5.4°K so that measurements must be made in a field 5–10 kgauss. Further, a large correction for electronic specific heat is necessary. The results in Table IV show a rather distinct trend with sample purity, with the more impure samples agreeing with our result. This is perhaps

TABLE III. θ_D from specific heat measurements for vanadium

Investigators	Sample purity (%)	$\gamma c (^{\circ}\text{K})$
Wolcott (1955)	> 99.98	380
Worley <i>et al.</i> (1955)	sample 1: 99.50	308
	sample 2: 99.80	273
Corak <i>et al.</i> (1956)	≈ 99.80	338
Clusius <i>et al.</i> (1960)	99.50	425 ^a
Radebaugh and Keesom (1966)	> 99.99	382

^a Experiment performed in temperature range 11–23°K.

reasonable, as our samples contained ^{57}Co (^{57}Fe) impurity. It must be remembered that θ_{C_v} is a distinct function of temperature and may be 50° or more lower at room temperature.

For titanium, Wolcott (1957) and Johnson and Kothen (1953) have made C_v measurements over a long temperature range. At low temperatures they obtain $\theta = 430^{\circ}\text{K}$ and near room temperature a value of 360°K, in very good agreement with these results.

The results for these three metals demonstrate that, to a good approximation, γ is independent of density at least to 100 kb, which validates the Grüneisen equation of state over this range and permits the prediction of θ as a function of pressure to 100 kb at least.

TABLE IV. Constants A and B for relationship $K = AP_B$

Compound	A	B
FeCl_3	0.265	0.56
FeBr_3	0.076	0.43
KFeCl_4	0.092	0.50
FePO_4	0.078	0.46
Phosphate Glass	0.048	0.31
Ferric Acetate (418°K)	0.022	0.98
Ferric Citrate	0.112	0.35
$\text{K}_3\text{Fe}(\text{CN})_6$	0.109	2.06

E. CONVERSION OF Fe^{III} TO Fe^{II}

As has been emphasized in the earlier sections, the Mössbauer spectra of high spin ferrous and high spin ferric iron are entirely different, both as regards isomer shift and quadrupole splitting. It is therefore easy to discern the appearance of one oxidation state in the