

through the expected region; the data show a sharp increase at the temperature where melting first occurs in the neon. This temperature invariably is lower than the temperature which is observed during freezing at constant pressure because the dead space in the bomb above the end of the capillary (Fig. 1) causes a small portion of the freezing to occur at constant volume.

The bomb is cooled slowly to 4 K over a period of 12 hours or so to prevent the generation of strains. Data taking begins at 1 K, with temperature changes during a heat pulse which are of the order of or less than $0.05 T$, where T is the average temperature. The shield temperature always is maintained constant midway between the initial and the final temperature of the heat pulse so that drift rates are positive (warming) before heat is applied and negative (cooling) afterwards. This procedure also makes it plausible to assume that one-half of the heat generated in each of the heater current leads flows into the sample, and indeed we have calculated heat inputs by assuming that one of these leads is a part of the heater. The maximum drift rate is 0.5 mK/min at 1 K, which corresponds to less than 10 erg/min stray heat input. The major source of heat leak is the neon-filled stainless-steel capillary, and a rough estimate suggests that the conductivity of the neon²⁸ (a cylindrical shell 5×10^{-4} in. average thickness, 0.0095 in. in diameter) predominates from 2 to 8 K, with the stainless steel being more important at other temperatures. Data are analyzed graphically using chart-recorder traces from which temperature increments can be determined to better than 0.1%, and the scatter of the experimental results (see below) typically is of this order of magnitude. Above 20 K the measured heat capacities increase by as much as 1% for high rates of heating and for large temperature increments during a heat pulse. The thermal diffusivity of neon is small at these temperatures and the time constants which we observed (that is, the time to achieve a linear drift rate after a heat pulse) become several minutes long, so perhaps local heating occurs under extreme conditions with excess heat leaks during the heat pulses. Data in this region are taken with small heater currents (long time intervals) and small temperature intervals to minimize these effects.

When data taking is completed for a given sample, the melting point is redetermined and a few low-temperature points are retaken to verify that no annealing effects have occurred. The bomb then is maintained at 4 K while the capillary vacuum space is evacuated and the neon in the capillary is released to a set of calibrated volumes as the capillary is heated. As a result, the neon in the "dead space" (room-temperature valves and the major cold portions of the capillary) is released and measured before the solid in the bomb is released, leaving only a small correction (less than 0.1%) to be made for the 5 cm or so of capillary between the end of the vacuum jacket and the bomb itself.

The two standard volumes (nominally 5 liters and 0.5 liters) are maintained at 25°C in a water bath, the temperature of which can be read and kept constant to 2×10^{-3} °C. The temperature is monitored with a platinum resistance thermometer which has been compared to this precision with an NBS-calibrated platinum resistance thermometer. Gas pressures of less than 1 bar are measured to 0.005 % with a wide-bore mercury manometer and a Wild cathetometer, with readings reduced to the density of mercury at 0°C. The ideal gas law is assumed to calculate the number of moles n in the sample since second virial coefficient effects²¹ amount to only 0.03 % at 0.9 bar and 25°C. The accuracy with which n can be determined is assumed to be $\pm .08$ %, or ± 0.01 cm³/mole for solid molar volumes of 12.5 cm³.

The natural neon gas was purchased from Cryogenic Rare Gases, Inc., of Newark, New Jersey, and is specified to have been purified over titanium, with all impurities (N₂, O₂, Ar, CO₂, He) in a concentration of less than 10 ppm. The gas from one of the samples was analyzed by mass spectrometry* after the experiment and was found within the limits of detection to satisfy these specifications, which suggests that our experiments did not contaminate it. The limits for H₂ (less than 0.01 %) and O₂ (less than 0.02 %) are set by the analytical methods. The relative abundances of the neon isotopes are found to be; ²⁰Ne, 91.2; ²¹Ne, 0.3; ²²Ne, 8.5. These differ somewhat from those given by Furukawa²⁹ (90.5, 0.3, 9.2) in his summary of natural neon isotope concentrations from various sources, and the reasons for the differences are difficult to understand.

3. EXPERIMENTAL RESULTS

Experimental specific heat data were obtained for five natural neon samples. The physical data for each of these samples are given in Table I. In each case, an addenda or evacuated bomb heat capacity is subtracted from the raw heat capacities to obtain the heat capacity of the neon, and a molar quantity $C_{\text{meas}}(T)$ is calculated. This heat capacity is not C_V since the bomb expands slightly during a heat pulse as the internal pressure increases. The resulting correction is very similar to that which must be applied to convert C_P measurements to C_V , except that the expansivity of the bomb κ (see the Section 2) replaces the compressibility of the solid. As a result, C_V can be calculated as

$$C_V = C_{\text{meas}} - T(\partial P/\partial T)_V^2 \simeq C_{\text{meas}} - \kappa T(\gamma C_V/V)^2 \quad (1)$$

where the Grüneisen relation $(\partial P/\partial T)_V = \gamma C_V/V$ has been used. The present experiments can be used to show that the Grüneisen parameter γ for neon

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