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THE QUANTUM BEHAVIOUR OF COMPRESSED GASES

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The pressure-volume relationships of hydrogen and deuterium have been studied ...5° K and 78·9° K and at pressures between 150 and 1250 atm. The results show ...ked quantal inflation of the pressure which is in good agreement with the predictions ... quantized Lennard-Jones and Devonshire theory of the gases.

The p—v—T behaviour of the lighter gases is affected by the quantization ... translational motion of their molecules. In an earlier paper [1] this effect ... calculated approximately for a Lennard-Jones and Devonshire [2] (LJD) gas. ... LJD treatment each pair of molecules in a gas has a mutual interaction ...ntial energy

$$\epsilon(r) = 4\epsilon^*[(D/r)^{12} - (D/r)^6], \tag{1}$$

...re D and ϵ^* are characteristic molecular parameters and r is the distance be-...en the centres of the interacting molecules.

It was concluded [1] that the pressure of the gas is higher than it would be if the ...cules behaved classically, by an amount

$$\Delta p = \frac{NkT}{v_0}\left[\frac{v_0}{v} + \frac{3}{2}\frac{\mathrm{d}\log y^*}{\mathrm{d}\,(v/v_0)}\right]\left[\frac{2(2\pi mkT)^{\frac{1}{2}}\sigma}{h}\left(\frac{4\pi}{3}\right)^{\frac{1}{3}} - 1\right]^{-1}, \tag{2}$$

...re N is the number of molecules in the volume v, m is the molecular mass, ... Boltzmann's constant, h is Planck's constant and T is the absolute temperature. ... parameter v_0 is a characteristic volume equal to ND^3; y^* is a function only ... v_0 (given in eqn. (4)), and σ depends on v/v_0 and D.

Some calculations from eqn. (2) suggested that compressed hydrogen and ...terium should show significant quantum effects at temperatures below 100° K. ... example, the pressure of hydrogen at 80° K and a density of 0·04 mole cm^{-3} ...ld be 470 atm deduced from the classical LJD theory † and 830 atm from the ...ntal theory.

In this paper we describe some pressure-density measurements to determine ...ch of the two theories better describes the behaviour of H_2 and D_2 under such ...ditions. It must be emphasized that no high accuracy was sought in these ...surements because the pressures predicted by the two theories were so ...ingly different.

EXPERIMENTAL

For making pressure-density measurements at low temperatures the constant volume ...od of Holborn and Schultze [4] was considered most convenient. An apparatus ...s type had previously been used in this laboratory.[5] The general arrangement can ...en from fig. 1. A 1 ml steel pipette A, mounted in a simple cryostat, was connected ...gh a needle valve B to a manifold leading on one side to the mercury gas com-...ssor [6] C, and on the other to a gas burette D in each case through a high pressure

† This figure was found by interpolation in the extensive tables of the properties of ... classical LJD gas compiled by Wentorf, Buehler, Hirschfelder and Curtiss.[3]