not possible to say whether or not a dispersional phase change at the interface of grating and salt, increasing roughness, and other complications, may be affecting the accuracy of our results.

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Determination of Small Quantities of Radon and Thoron

In the measurement, by the alpha ray method, of less than 2×10^{-12} curies of radon, the limit of precision is imposed by the small statistical variations in the background of residual ionization due to cosmic and local radiation. Thus in the excellent work of Paneth and Koeck[1] a mean deviation of 3 percent in the background would introduce an uncertainty of 50 percent in the measurement of 10^{-13} curies of radon.

The laws of probability indicate that the mean deviation in the background is between 1 and 4 percent for a one hour reading on an ionization chamber of 1.5 liters volume. This is confirmed by measurements on the apparatus outlined below.

The circuit used is common in other branches of physics, but, to the writer's knowledge, has not heretofore been used for the determination of small quantities of radon or thoron, although it is well adapted to this field. It consists of two ionization chambers, identically constructed, both containing the same background gas (air, CO_2, or other), but only one containing the radon or thoron to be measured. A string electrometer is permanently connected to measure only the difference in the ionization in the two chambers. Hence, within the statistical variations of the background and the radon or thoron, the readings are proportional to the quantity of emanation present. Errors such as those due to contact potentials, stray x-radiation, variations of battery voltage, or movement of radioactive material in the vicinity of the apparatus are also eliminated.

This compensation method is used by the writer to measure the radon and thoron liberated from rocks directly heated in a special graphite furnace, without the use of a carbonate flux, as has heretofore been usual.

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February 23, 1932.

[1] Paneth and Koeck, Zeits. f. Physik. Chem. Bodenstein Festband, 1931. p. 145.

The Velocity of Sound in a Fermi-Dirac or Einstein-Bose Ideal Gas

In connection with a study of the hydrodynamics, viscosity and heat conduction of a Fermi-Dirac or Einstein-Bose gas, generalizing the methods of Lorentz, Enskog and others, we have noticed the following simple consequences of the virial theorem:

$$pv = \tfrac{2}{3}E_{\text{kin}} \tag{1}$$

where v is the specific volume and E_{kin} is the kinetic energy per unit mass. We shall consider only gases which consist of point-molecules, so that E_{kin} is also the total energy ϵ. The results we obtain will be valid, like Eq. (1), for all statistics and in all degrees of degeneration. They are perhaps not generally known, and to our knowledge do not appear in the literature.

An immediate *thermodynamic* consequence of (1) is, that for an adiabatic change:

$$\epsilon v^{2/3} = \text{const.} \tag{2}$$

This equation follows also from the fact that for an adiabatic change the number of molecules n_i in the different translational energy levels ϵ_i does not change, and that the ϵ_i are inversely proportional to $v^{2/3}$. Therefore $\epsilon = \Sigma\epsilon_i n_i$ is inversely proportional to $v^{2/3}$. From (1) and (2) follows that the equation of the adiabatic is always:

$$pv^{5/3} = \text{const.} \tag{3}$$

For no degeneration, that is, when the equation of state becomes the Boyle-Gay Lussac law, this reduces to the well-known expression, because in this limiting case $c_p/c_v = 5/3$ for point molecules.

A second thermodynamic consequence of Eq. (1) is that ϵ must have the form:

$$\epsilon = \frac{3}{2}\frac{RT}{M}W(Tv^{2/3}) \tag{4}$$

where M is the molecular weight. This follows from the general equation:

$$\left(\frac{\partial\epsilon}{\partial v}\right)_T = -p + T\left(\frac{\partial p}{\partial T}\right)_v.$$