Equipartition of Energy Encyclopedia Article

Equipartition of Energy

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Equipartition of Energy

In an ideal gas, each **atom** can move in three directions. The atoms's ability to move in each of these directions is counted as one degree of freedom; hence each atom is said to have three degrees of freedom. According to the principle of equipartition of **energy**, the energy per degree of freedom for this kind of motion (called translational motion) is equal to 0.5RT, where R is the molar gas constant and T is the absolute **temperature**. The equipartition principle further predicts a measurable molar **heat** capacity for such an atom of 0.5R (about 1 cal/°C-mole) per degree of freedom. Thus, for the case of an ideal gas, since each atom has three degrees of freedom, and the equipartition principle predicts a molar heat capacity of 1.5R.

In the case of a rigid **diatomic molecule**, the molecule can rotate and change the position of its center of **mass**; in this case there are three translational and two rotational degrees of freedom. Thus the equipartition theorem predicts the molar heat capacity of this system to be 2.5R. If the molecule is not rigid, it will have two extra vibrational degrees of freedom, and the molar heat capacity will be 3.5R.

Actual experimental values for many **gases** bear out the predictions of this theory. Data for monatomic gases like **argon** and **helium** give exact agreement, and many diatomic gases (e.g., **carbon** dioxide, **hydrogen** chloride, **nitrogen**, nitric **oxide**, oxygen) show experimental results in close accord with the theory.

Dulong and Petit's law is easily derived from the equipartition theorem by assuming that the internal energy of a solid consists of the vibrational energy of the molecules. This model predicts that there are six degrees of freedom for such systems, for which the molar heat capacity should be 3R.