

Thermodynamics I

The field of Thermodynamics is the study of energy and its connection to the microscopic world. We must develop scientific definitions for properties like temperature by considering how energy can be stored and transferred on a microscopic level.

I. Internal Energy – U

All matter is made up of atoms and molecules. When we studied the energy of a block previously, we only considered the macroscopic kinetic and potential energy of the block due to speed and location of its center-of-mass and not the kinetic and potential energies of all the molecules that make up the block. We are now going to look at the energy contained inside systems due to this atomic motion.

1. Definition: Internal energy is the sum of all the _____ and _____ energy of the molecules that make up a system.

2. Units:

Example: A gas composed of particles with only kinetic energy

II. Extensive & Intensive Properties

In Thermodynamics, we talk about extensive and intensive properties.

1. Extensive properties of a system are properties that depend on how many atoms are in the system.

Mass and internal energy are extensive properties.

2. Intensive properties of a system are properties that do not depend on how many atoms a system has.

Density and temperature are intensive properties.

We can always convert an extensive property to an intensive property by dividing by the number of atoms.

III. Average Energy Per Molecule – u

If we take a cup of water out of the ocean, the internal energy of the cup of water is less than the internal energy of the remaining water in the ocean since the cup of water has fewer molecules.

However, the average energy of a molecule of water in the cup is the same as the average energy per molecule of water left in the ocean. Thus, the average energy per molecule is an intensive property of the system as it doesn't depend on the number of atoms.

Let us consider what happens when we let two objects interact whose average energy per molecule is different.

When the system reaches thermal equilibrium, what can we say about the average energy per molecule for each system?

Thus, we see that there is a relationship between the average energy per molecule and the object's _____.

The _____ is directly proportional to the average energy per molecule and therefore a way of measuring the internal energy of the object if we know the number of atoms.

IV. Heat – Q

1. Definition: Heat is the _____ of _____ due to a _____ difference.

2. It is wrong to say that an object contains heat!!!

3. An object contains internal energy!!!

4. When two objects reach thermal equilibrium, heat stops.