



The laws of thermodynamics

Thermodynamics is the science that studies the relationship between heat, work, temperature and energy. Heat is a form of energy that corresponds to a definite amount of mechanical work. Thermodynamics deals with the transfer of energy from one place to another and from one form to another. All the changes in the energy state of a system and its ability to perform useful work are described by the laws of thermodynamics, the most important of which are the first, second and third law.

The first law of thermodynamics is also known as law of conservation of energy. It states that energy can only be transferred or changed from one form to another. For example, when we turn on a light, it is electrical energy that is converted. This law is represented by the formula $\Delta E = q + w$

It means that any change in the internal energy (ΔE) of a system is given by the sum of the heat (q) that flows across its boundaries and the work (w) done on the system by the surroundings. According to this law, there are two kinds of processes, heat and work, which can lead to a change in the internal energy of a system. Any change in the energy of a system must result in a corresponding change in the energy of the surroundings outside the system. In other words, energy cannot be created or destroyed. If heat flows into a system or the surroundings do work on it, the internal energy increases and the sign of q and w are positive. Conversely, if heat flows out of the system or some work is done by the sys-

tem (on the surroundings), this will be at the expense of the internal energy, and q and w will therefore be negative.

The second law of thermodynamics is commonly known as the law of increased entropy. It states that the entropy of any isolated system always increases.

Isolated systems spontaneously evolve towards thermal equilibrium, which is the state of maximum entropy of the system. While quantity remains the same (first law), the quality of matter/energy deteriorates gradually over time. This is because usable energy is inevitably used for productivity, growth and repair. In the process, usable energy is converted into unusable energy. Thus, usable energy is irretrievably lost in the form of unusable energy.

Entropy is defined as a measure of unusable energy within a closed or isolated system (the universe for example). As usable energy decreases and unusable energy increases, entropy increases.

The third law of thermodynamics states that the entropy of a system approaches a constant value as the temperature approaches absolute zero. The entropy of a system at absolute zero is typically zero, and in all cases it is determined only by the number of different ground states it has. Specifically, the entropy of a pure crystalline substance (perfect order) at absolute zero temperature is zero. This statement is true if the perfect crystal has only one state with minimum energy.

ACTIVITIES

1 Answer the following questions.

- 1 What is thermodynamics?
- 2 What is heat?
- 3 What do the laws of thermodynamics describe?
- 4 Why is the first law also known as Law of Conservation of Energy?
- 5 Which processes can lead to a change in the energy of a system?
- 6 What happens if heat flows into a system?
- 7 What does the second law state?
- 8 What is entropy?
- 9 When does the entropy of a system approach a constant value?
- 10 What determines the entropy of a system at absolute zero?

2 Match each word with its synonym.

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|-----------------|----------------|
| 1 To convert | A To come near |
| 2 Boundary | B Cost |
| 3 Surrounding | C Border |
| 4 Expense | D Environment |
| 5 Entropy | E Irreparably |
| 6 Irretrievably | F Declaration |
| 7 To approach | G To change |
| 8 Statement | H Disorder |

3 In your group discuss the meaning of the three laws then write a short text to describe them using your own words.