كلية ألمامون الجامعة
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الميكانيك الهندسي
للمرحلة الثانيه

Thermodynamic

Lecture 5

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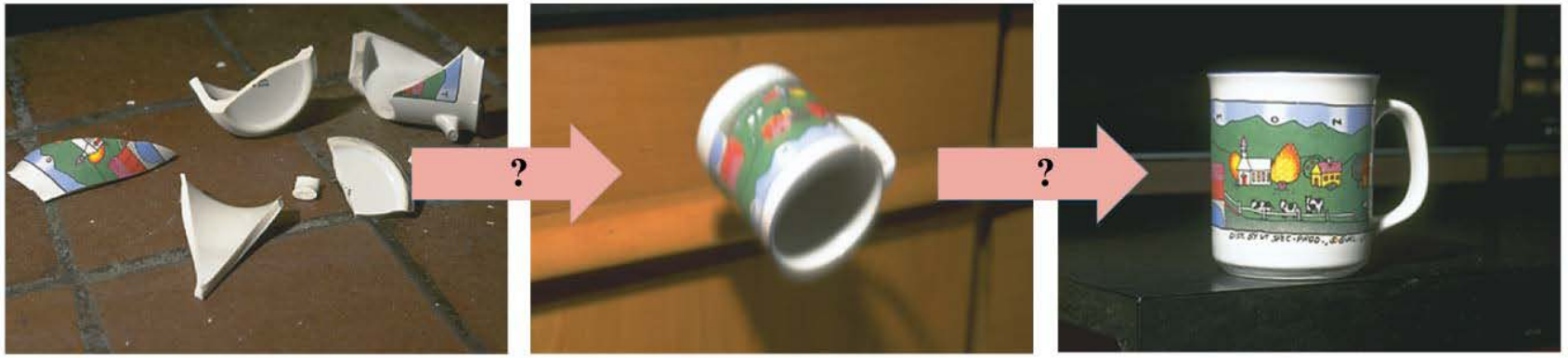
The First Law of Thermodynamics

The change in internal energy of a closed system will be equal to the energy added to the system minus the work done by the system on its surroundings.

$$\Delta U = Q - W$$

This is the law of conservation of energy, written in a form useful to systems involving heat transfer.

The Second Law of Thermodynamics Introduction



(a) Initial state. (b) Later: cup reassembles and rises up. (c) Later still: cup lands on table.

The absence of the process illustrated above indicates that conservation of energy is not the whole story. If it were, movies run backwards would look perfectly normal to us!

The Second Law of Thermodynamics Introduction

(c) Later :Broken on the ground (b) Later: Fall from the table and rises up. (a) Initial state. cup lands on table

#A gas expands to fill the available volume.

#A hot body cools to the temperature of its surroundings.

#A chemical reaction runs in one direction rather than another.

#The direction of change that does not require work to be done to bring the change about is called spontaneous direction of change.

The Second Law of Thermodynamics Introduction

The second law of thermodynamics is a statement about which processes occur and which do not. There are many ways to state the second law; here is one:

Heat can flow spontaneously from a hot object to a cold object; it will not flow spontaneously from a cold object to a hot object.

Entropy and the Second Law of Thermodynamics

Definition of the change in entropy S when an amount of heat Q is added:

$$\Delta S = \frac{Q}{T},$$

Another statement of the second law of thermodynamics:

The total entropy of an isolated system never decreases.

Entropy and the Second Law of Thermodynamics

Entropy is a measure of the disorder of a system. This gives us yet another statement of the second law:

Natural processes tend to move toward a state of greater disorder.

Example: If you put milk and sugar in your coffee and stir it, you wind up with coffee that is uniformly milky and sweet. No amount of stirring will get the milk and sugar to come back out of solution.

Entropy and the Second Law of Thermodynamics

Another example: when a tornado hits a building, there is major damage. You never see a tornado approach a pile of rubble and leave a building behind when it passes.

Thermal equilibrium is a similar process—the uniform final state has more disorder than the separate temperatures in the initial state.

Summary of Lecture 5

- First law of thermodynamics: $\Delta U = Q - W$
- Isothermal process: temperature is constant.
- Adiabatic process: no heat is exchanged.
- Work done by gas at constant pressure:

$$W = P\,\Delta V. \qquad \text{[constant pressure]}$$

Summary of Lecture 5

- Second law of thermodynamics:
  - heat flows spontaneously from a hot object to a cold one, but not the reverse
  - a given amount of heat cannot be changed entirely to work
  - natural processes tend to increase entropy.
- Change in entropy: $\Delta S = \frac{Q}{T}$,
- Entropy is a measure of disorder.
- As time goes on, less and less energy is available to do useful work.