Energy

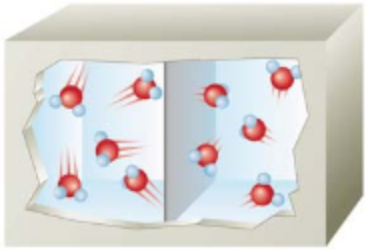




Energy, Temperature, and Heat

Temperature and Heat

- **Temperature** → measure of the random motions (average kinetic energy) of the components of a substance.



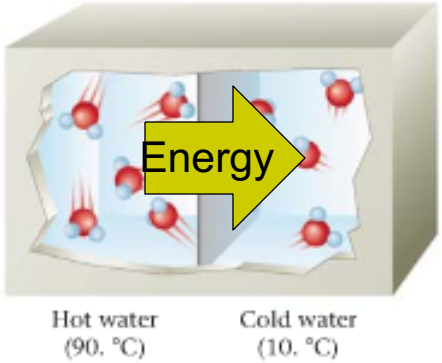
- H_2O molecules in warm water move more rapidly than H_2O molecules in cold water



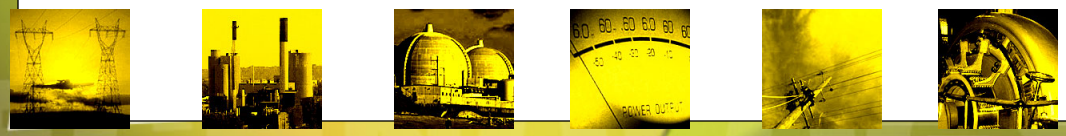



Temperature and Heat

- **If 1.00 kg of hot water (90 °C) is placed next to 1.00 kg of cold water (10 °C) in an insulated box, separated by a thin metal plate, what would happen?**

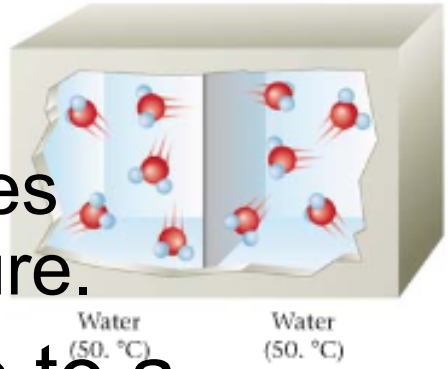


- Energy will be transferred through the metal plate from the hot water to the cold water because the hot H_2O molecules are moving faster.



Temperature and Heat

- This energy transfer will cause the H_2O molecules in the hot water to slow down and the H_2O molecules in the cold water to speed up.
  - The flow of energy is called heat.
  - Eventually, the 2 water samples will reach the same temperature.

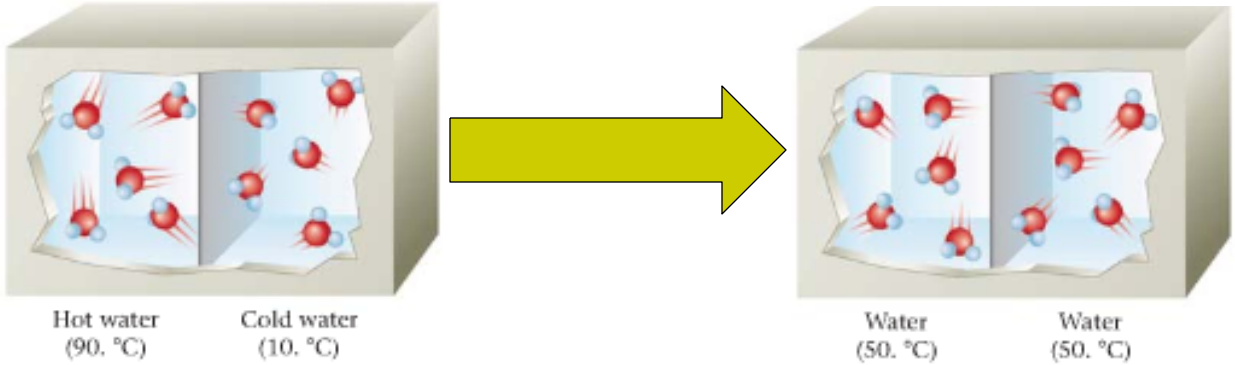


- **Heat** → a flow of energy due to a temperature difference.






Temperature and Heat



The final temperature is the average of the original temperatures.

Temperature and Heat

Let's Review

Temperature and Heat

- Temperature is a measure of the random motions of the components of an object.
- Heat is a *flow* of energy due to a temperature difference.
- The random motions of the components of an object constitute the *thermal energy* of that object.
- The flow of energy called heat is the way in which thermal energy is transferred from a hot object to a colder object.

Exothermic and Endothermic Processes

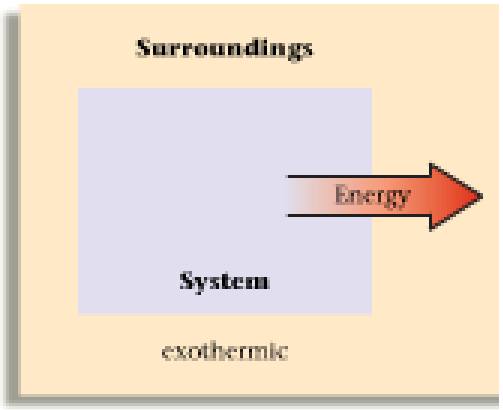
- The universe is divided into two parts: the system and the surroundings.
  - **System** → that part of the universe on which attention is to be focused.
    - Reactants and products of a reaction.
  - **Surroundings** → everything in the universe surrounding a thermodynamic system.
    - The air in the room and anything else other than the reactants and products.

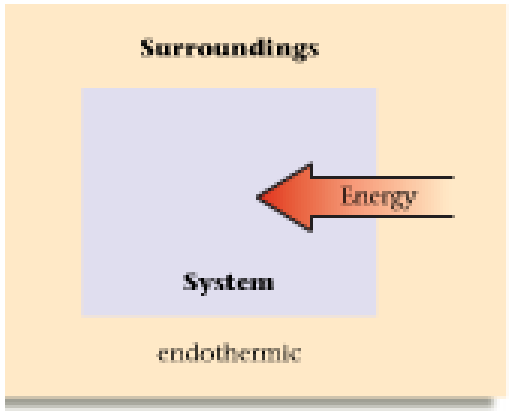


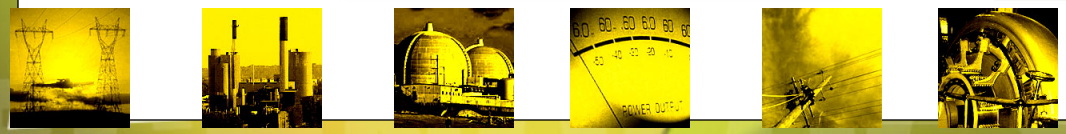


Exothermic and Endothermic Processes

- **Exothermic** → process in which energy (as heat) *flows out of the system* into the surroundings.
- **Endothermic** → process in which energy (as heat) flows from the surroundings *into the system*.







Exothermic and Endothermic Processes

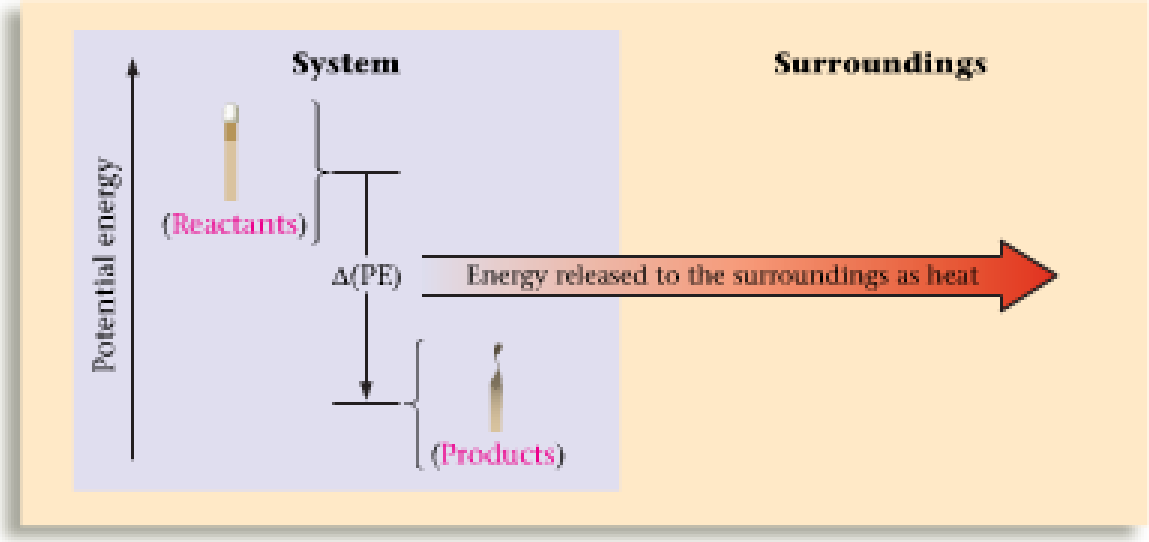
- The energy gained by the surroundings must be equal to the energy lost by the system.
  - PE is stored in the bonds of the reactants and lost (transferred through heat to the surroundings) when they are broken.
  - The heat flow into the surroundings results from the lowering of the PE of the reaction system.






Exothermic and Endothermic Processes

- In any exothermic reaction, some of the PE stored in the chemical bonds is converted to thermal energy (random KE) via heat.








- The End