

Thermal Energy, Power, and Energy Resources

Thermal Energy and Heat Transfer

Temperature: Is a measure of the average kinetic energy of the atoms or molecules of a substance. Temperature increases as the motion of the particles increases.

Thermal Energy: The total of kinetic energy and electrical potential energy of the atoms or molecules in a substance. Thermal energy depends on mass, nature of substance, temperature, and state (solid, liquid or gas))

Transfer of Heat

The transfer of heat from one body to another causes either a temperature change or a change of state, or both. This transfer can be accomplished by three different methods:

- **Conduction** - process of transferring heat through a material by the collision of atoms (ex. metal rod held near a flame)
- **Convection** - process of transferring heat by a circulating path of fluid particles (ex. an electric heater in a room)
- **Radiation** - process of transferring heat by electromagnetic waves (no particles required) (ex. sunlight)

Different substances require different amounts of energy to increase the temperature of a given mass of the substance. For example, water has a higher specific heat capacity than steel since it has a higher capacity to hold heat.

Specific Heat Capacity (c): a measure of the amount of energy needed to raise the temperature of 1.0 kg of a substance by 1.0 °C

Calculating the quantity of heat gained or lost by a body:

$$Q = mc\Delta T$$

Quantity	Symbol	SI Unit
quantity of heat gained	Q	J
mass	m	kg
specific heat capacity	c	$\frac{\text{J}}{\text{kg}\cdot^{\circ}\text{C}}$
change in temperature	ΔT	$^{\circ}\text{C}$

Note: Specific heat capacity is a property of a substance. See the chart on p.151 for the specific heat capacities of Common Substances.

Principle of Heat Exchange: When heat is transferred from one body to another, the amount of heat lost by the hot body equals the amount of heat gained by the cold body.

$$Q_{lost} + Q_{gained} = 0$$

$$m_1c_1\Delta T_1 + m_2c_2\Delta T_2 = 0$$

Power

Power is...

- A scalar quantity with units of Watts (W) equivalent to J/s
- 1 horsepower (hp) = 750 W

The rate of
doing work

OR

$$P = \frac{W}{\Delta t} = \frac{\Delta E}{\Delta t}$$

The rate of
transferring energy

Energy Resources

Energy Resource: Raw material obtained from nature that can be used to do work.

Renewable Energy Resource: An energy resource that renews itself in the normal human lifespan.

Non-Renewable Energy Resource: An energy resource that does not renew itself in the normal human lifespan.