Thermal Energy

Thermal energy is the Kinetic energy of the molecules and atoms in a substance.

As a substance "heats up" the molecules and atoms that make up the substance move and vibrate more, thus increasing their kinetic energy.

Temperature is the average kinetic energy of a substance.

Thermal energy, like all energy is measured in joules

Temperature is measured in degrees Fahrenheit or Celsius or in Kelvin.

Kelvin is based on absolute zero which is the lowest possible temperature, at 0K there is no movement.

0 K = -273 °C

Specific Heat Capacity

The amount of energy needed to raise the temperature of a substance depends on the chemical structure of that substance. For instance, if you applied 5000 J of heat energy to 1kg of water, copper iron or concrete.

Water would increase 1°C
Copper " 12°C
Iron " 11°C
Concrete " 6°C

The ability to absorb heat energy is a property of matter called specific heat capacity

The symbol for it is C.

The table to the right shows specific heat capacities for several substances. For copper c = $430 \frac{J}{kg \cdot °C}$. This means

430 J of energy is needed to raise the temp of 1 kg of copper 1°C

Material	Specific Heat Capacity (J/(kg·C))
Water	4200
Ice	2040
Alcohol	2380
Concrete	880
Aluminum	900
Copper	430
Iron	450
Steel	480
Lead	130

The formula for solving problems with specific heat capacity is

$\Delta E_h = mc\Delta T$

where ΔE_h = change in heat energy
m = mass
c = specific heat capacity
ΔT = change in temperature

EXAMPLE: How much energy is needed to heat 2.5 kg of copper from 19° C to its melting point of 1085°C?

$\Delta T = 1085 - 19 = 1066°C$

$E_h = 2.5 kg \times 430 \frac{J}{kg \cdot °C} \times 1066 °C$

$= 1\,145\,950 J$

$= 1.1 \times 10^6 J$

EXAMPLE: How much would the temperature of a 2.0 kg block of aluminum change if 3500 J of energy is applied to it.

$$E_h = mc\Delta T$$

$$\frac{E_h}{mc} = \Delta T$$

$$\frac{3500\,J}{2.0 \times 900} = 1.9\,^{\circ}C$$

EXAMPLE: What is the heat capacity of zinc if a 1.41 kg sample required 3.82×10^3J of energy to raise its temperature from 20.0°C to 26.0°C

$$E_h = mc\Delta T$$

$$\frac{E_h}{m\Delta T} = c$$

$$\frac{3.82 \times 10^3}{1.141 \times 6^{\circ}} = 450\,\frac{J}{kg\cdot{}^{\circ}C}$$