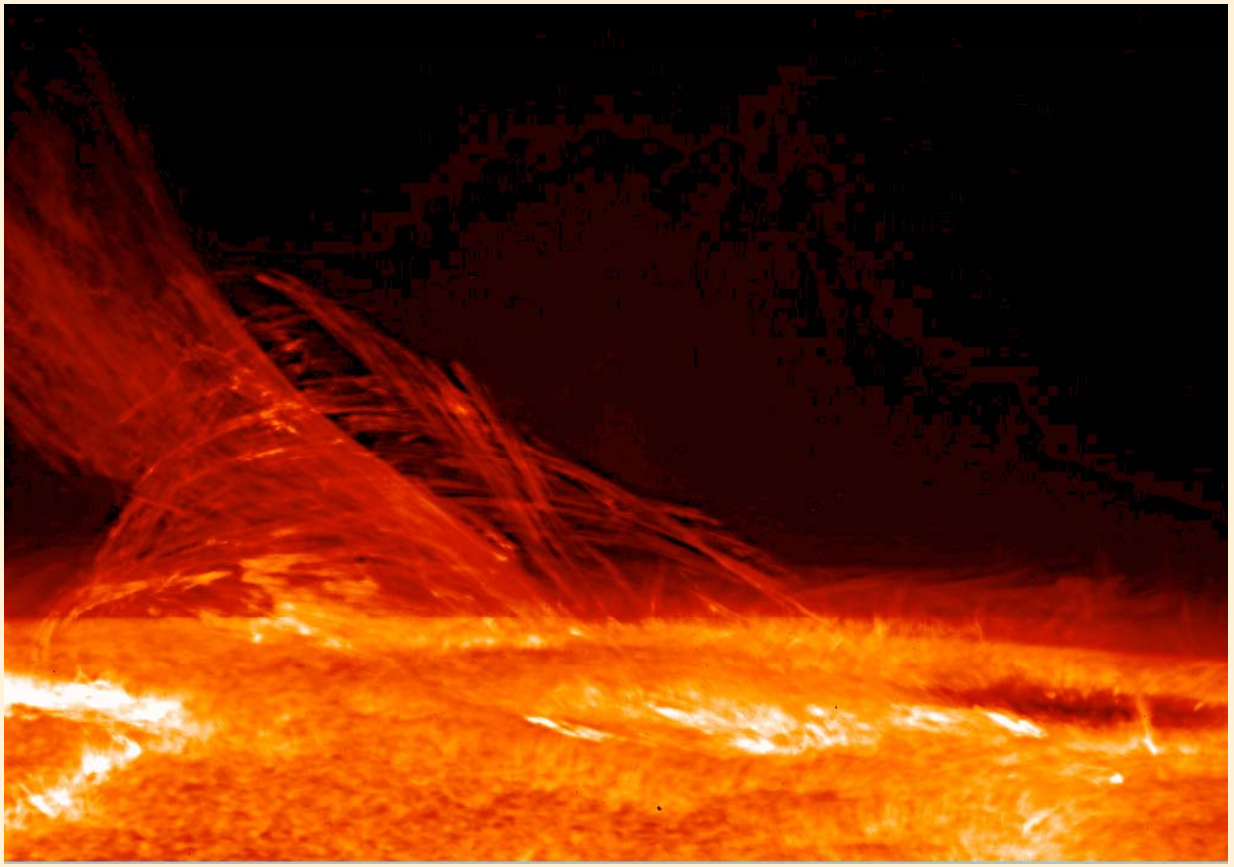
Energy

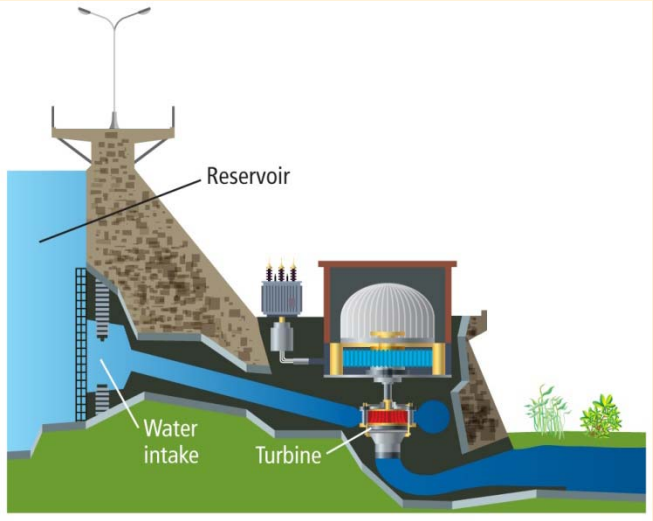
Notes 15 – Energy and Heat



Energy

The Nature of Energy

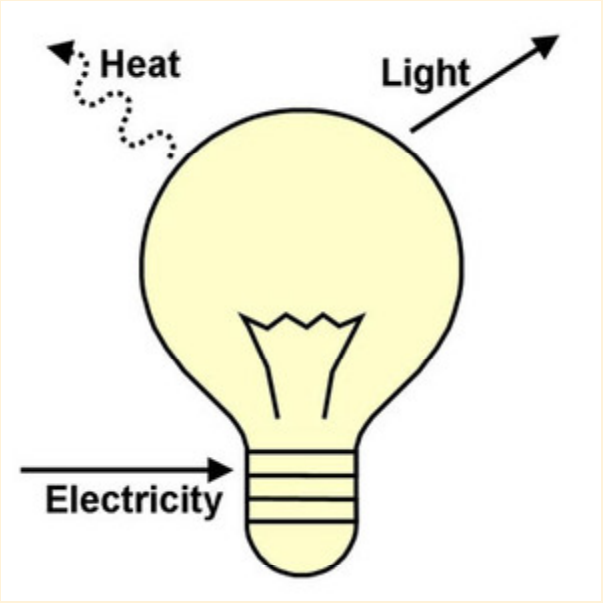
- **Energy** is the ability to do work or produce heat.
- Energy exists in two basic forms: potential energy and kinetic energy.
- Potential energy is energy due to composition or position.
- Kinetic energy is energy of motion.



Energy

The Nature of Energy (cont.)

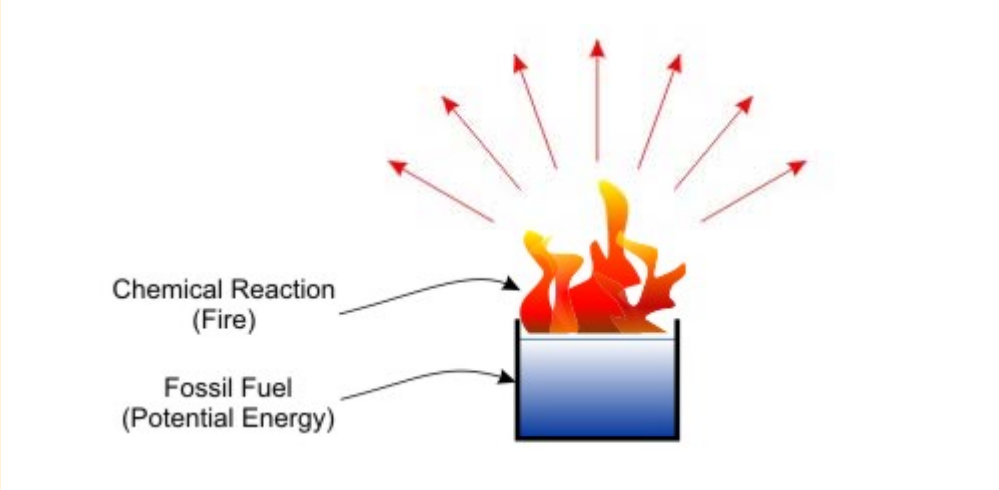
- The **law of conservation of energy** states that in any chemical reaction or physical process, energy can be converted from one form to another, but it is neither created nor destroyed—also known as the first law of thermodynamics.



Energy

The Nature of Energy (cont.)

- **Chemical potential energy** is energy stored in a substance because of its composition.

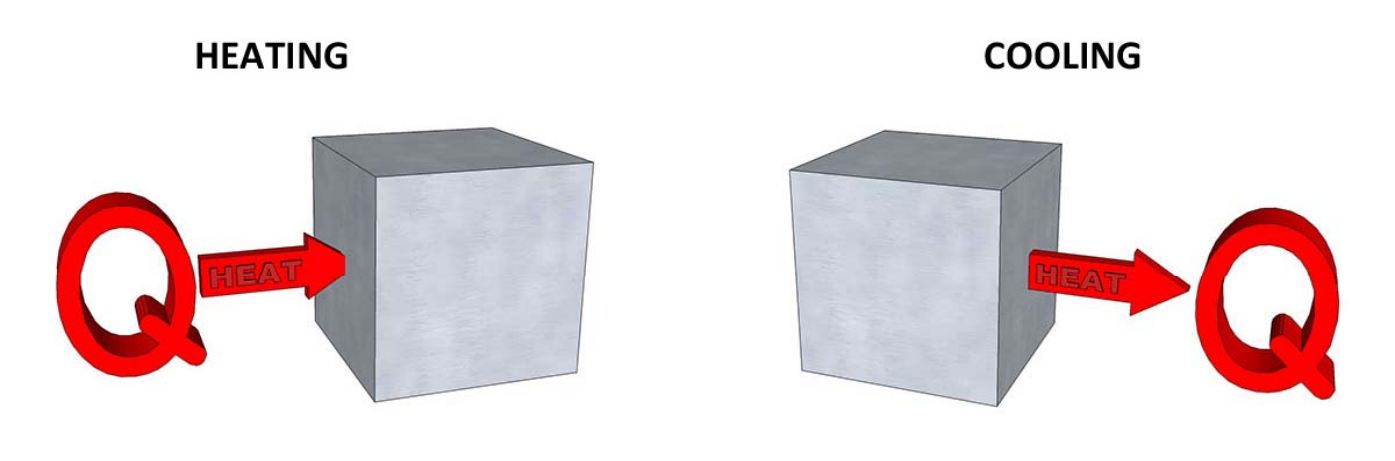


- Chemical potential energy is important in chemical reactions.

Energy

The Nature of Energy (cont.)

- **Heat** is energy that is in the process of flowing from a warmer object to a cooler object.
- *q* is used to symbolize heat.



Energy

Measuring Heat

- A **calorie** is defined as the amount of energy required to raise the temperature of one gram of water one degree Celsius.
- The energy content of food is measured in Calories, or 1000 calories (kilocalorie).
- A **joule** is the SI unit of heat and energy, equivalent to 0.2390 calories.

Energy

Measuring Heat (cont.)

Table 15.1 Relationships Among Energy Units

Relationship	Conversion Factors
1 J = 0.2390 cal	$\frac{1\ \text{J}}{0.2390\ \text{cal}}$ $\frac{0.2390\ \text{cal}}{1\ \text{J}}$
1 cal = 4.184 J	$\frac{1\ \text{cal}}{4.184\ \text{J}}$ $\frac{4.184\ \text{J}}{1\ \text{cal}}$
1 Calorie = 1 kcal	$\frac{1\ \text{Calorie}}{1000\ \text{cal}}$ $\frac{1000\ \text{cal}}{1\ \text{Calorie}}$

Energy

Specific Heat

- The **specific heat** of any substance is the amount of heat required to raise one gram of that substance one degree Celsius.
- Some objects require more heat than others to raise their temperatures.

Table 15.2 Specific Heats at 298 K (25°C)

Substance	Specific heat J/(g•°C)
Water(l)	4.184
Ethanol(l)	2.44
Water(s)	2.03
Water(g)	2.01
Beryllium(s)	1.825
Magnesium(s)	1.023
Aluminum(s)	0.897
Concrete(s)	0.84
Granite(s)	0.803
Calcium(s)	0.647
Iron(s)	0.449
Strontium(s)	0.301
Silver(s)	0.235
Barium(s)	0.204
Lead(s)	0.129
Gold(s)	0.129

Energy

Specific Heat (cont.)

- Calculating heat absorbed and released

Equation for Calculating Heat

$$q = c \times m \times \Delta T$$

q represents the heat absorbed or released. *c* represents the specific heat of the substance. *m* represents the mass of the sample in grams. ΔT is the change in temperature in °C, or $T_{final} - T_{initial}$.

The quantity of heat absorbed or released by a substance is equal to the product of its specific heat, the mass of the substance, and the change in its temperature.

Specific Heat (cont.)

- Practice Problem

1. When 3.0 kg of water is cooled from 80.0°C to 10.0°C, how much heat energy is lost?

   Specific heat of water = 4.2×10^3 J/kg

Specific Heat (cont.)

- Practice Problem

2. How much heat is needed to raise a 0.30 kg piece of aluminum from 30°C to 150°C?

   Specific heat of Al = 9.0×10^2 J/kg

Section Check

The heat required to raise one gram of a substance by one degree Celsius is called ____.

A. joule

B. calorie

C. specific heat

D. energy

Section Check

Which of the following is an example of chemical potential energy?

A. the moon orbiting Earth

B. a car battery

C. a compressed spring

D. a roller coaster at the top of a hill