

Scientific Methods & Models of Science and Technology Development and Its Applications



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Heat and the Second Law of Thermodynamics

Chapter 4

Great Idea:

Heat is a form of energy that flows from warmer to cooler objects

Chapter Outline

Nature's
Direction

Coming to
Terms with
Heat

Heat Transfer

The Second
Law of
Thermodyna
mics

Consequences
of the Second
Law

NATURE'S DIRECTION

Nature's Direction

- First Law of Thermodynamics
- Tendency for disorder
- Evolution to a more probable state



COMING TO TERMS WITH HEAT

Heat and Temperature

➤ Heat

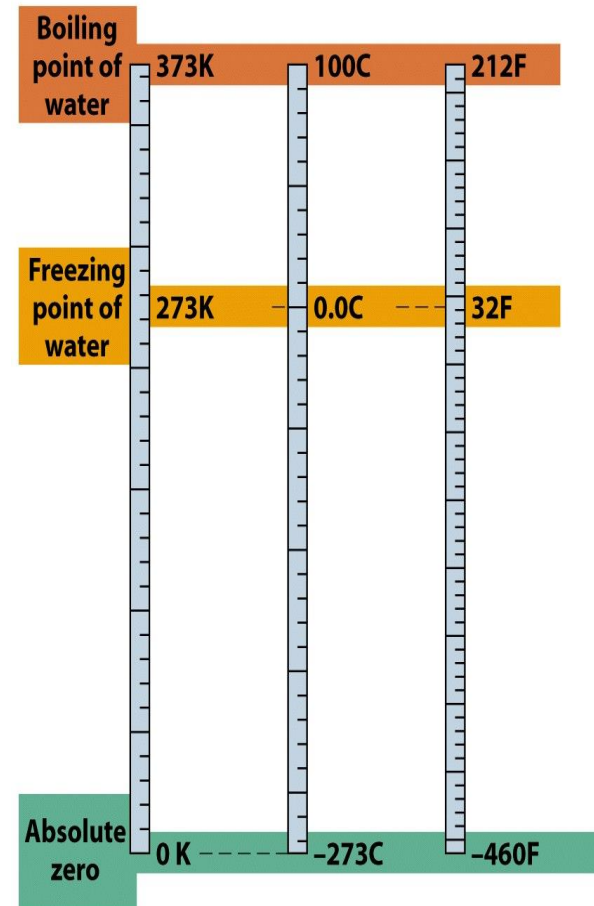
- Energy in motion
- Warm to cool

➤ Temperature

- Atomic movement

➤ Temperature

- Fahrenheit scale
- Celsius
- Kelvin
 - Absolute zero



Temperature Conversions

➤ Conversion to Fahrenheit:

$$- \text{ } ^\circ\text{F} = (1.8 \times \text{ } ^\circ\text{C}) + 32$$

➤ Conversion to Celsius:

$$- \text{ } ^\circ\text{C} = (\text{ } ^\circ\text{F} - 32) / 1.8$$



Specific Heat Capacity

- Specific heat capacity:

- Quantity of heat needed to raise 1g of a substance by 1 °C

- Water

- Highest specific heat
- 1 cal/g °C

HEAT TRANSFER

Heat Transfer

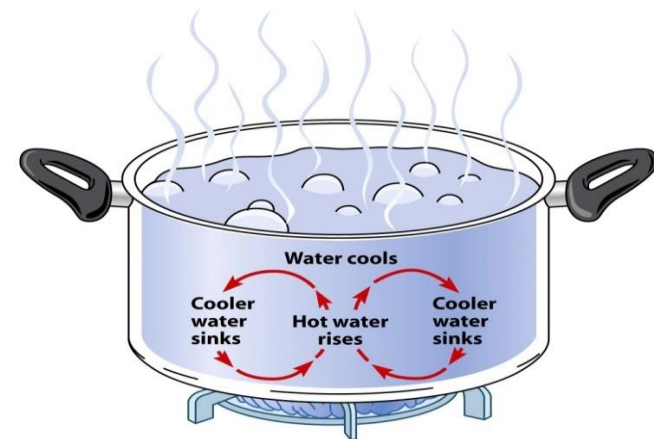
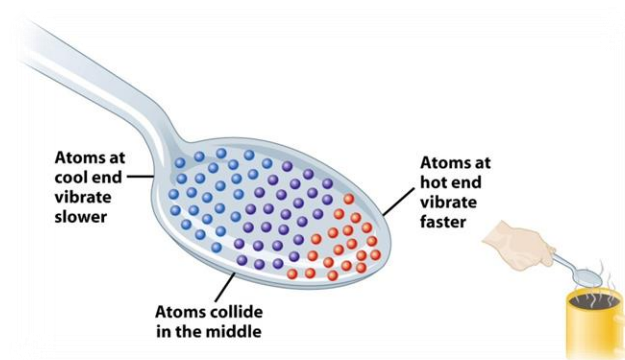
➤ Conduction

- Movement of heat by atomic-scale collision
- Thermal conductivity

➤ Convection

- Bulk transfer of molecules
- Convection cell

➤ Radiation



THE SECOND LAW OF THERMODYNAMICS

The Second Law of Thermodynamics

3 Statements of the Law :

-
- Heat does not flow spontaneously from cold to hot
-
- No engine can exclusively convert heat to work
-
- Every isolated system tends toward disorder

Heat Will Not Flow Spontaneously from a Cold to a Hot Body

➤ Molecular Level

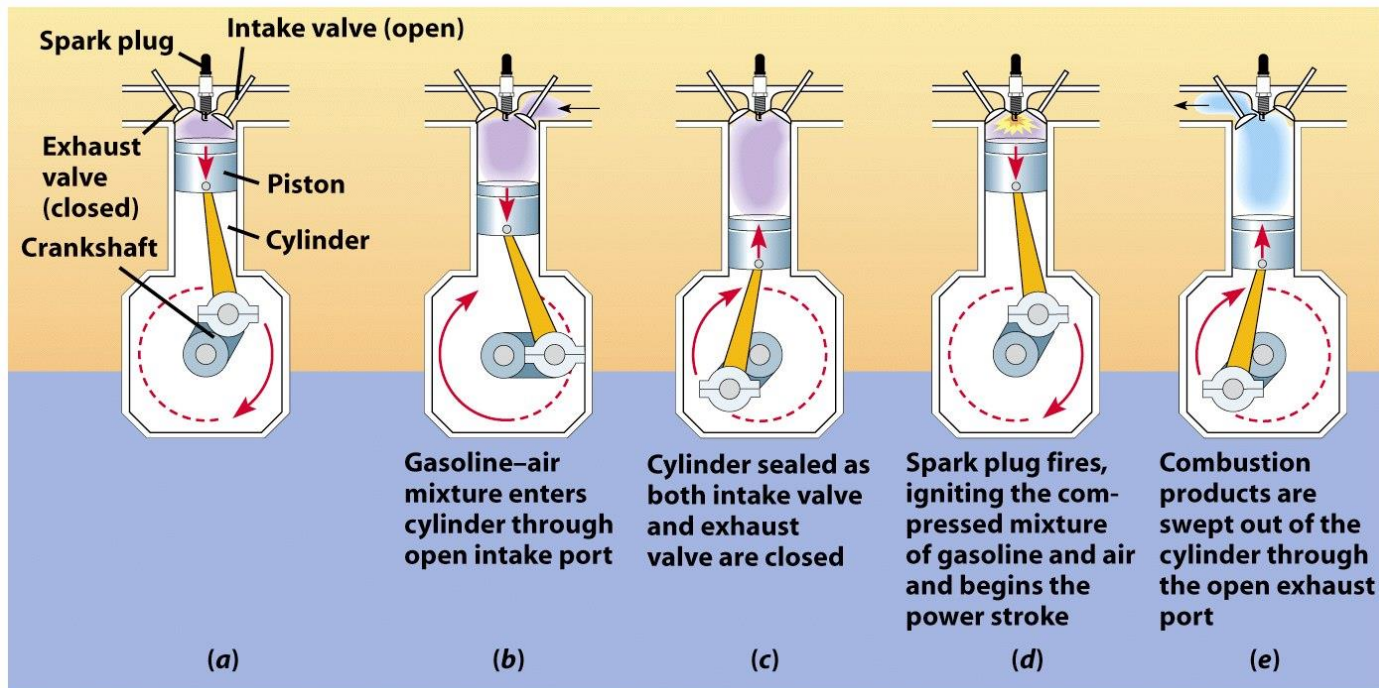
- Faster object shares energy

➤ Energy Required

- To cool an object requires energy

You Cannot Construct an Engine that Does Nothing but Convert Heat to Useful Work

- Efficiency
- High- to Low-temperature reservoirs



Every Isolated System Becomes More Disordered with Time

➤ Ordered System

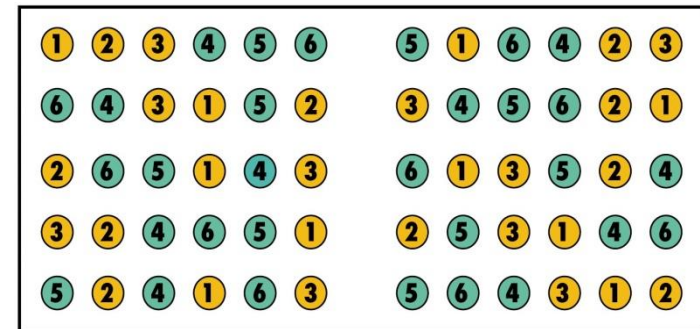
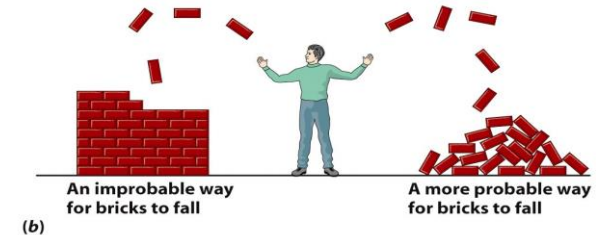
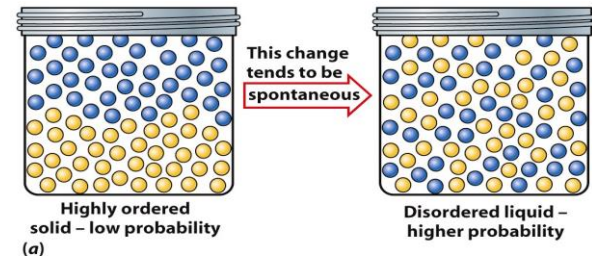
- Regular predictable pattern

➤ Disordered System

- Random

➤ Entropy

- Measure of disorder
- The entropy of an isolated system remains constant or increases



CONSEQUENCES OF THE SECOND LAW

The Arrow of Time

➤ Four dimensions

- 3 have no directionality

- The 4th has direction

➤ Time

- Second law and time

Built-in Limitations of the Universe

The Second Law's Consequences



- Some things
cannot happen



- Fossil fuels



- Hierarchy of energy