CHEMICAL ENGINEERING THERMODYNAMICS I
01. INTRODUCTION

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Outline

- Wisdom
- What is Thermodynamics?
- Thermodynamic Postulates: Energy Transformation Laws
- Thermodynamic Postulates: Property Relationships
- What is Not Thermodynamics?
- Macroscopic Versus Microscopic
- Road Map to Thermodynamics
- Applications of Thermodynamics
- Concept Summary

Wisdom

When a wise man does not understand, he says, '*I do not understand.*' The fool and the uncultured are ashamed of their ignorance. They remain silent when a question could bring them wisdom."

Saying of the ABBODS
from *The God Makers*
by Frank Herbert

A theory is the more impressive the greater the simplicity of its premises is, the more different kinds of things it relates, and the more extended is its area of applicability. Therefore the deep impression which classical thermodynamics made upon me.

Albert Einstein

The Premises:

- First Law: Total energy is conserved.
- Second Law: Entropy increases.

What is Thermodynamics?

- Thermodynamics is the study of the changes in the state or condition of a system when changes in its temperature, state of aggregation, or its internal energy are important.
- Thermodynamics is based upon experimental observation.
- Five postulates (laws) of thermodynamics.
  - Two postulates deal with energy transformation.
  - The other three deal with properties.

Thermodynamic Postulates: Energy Transformation Laws

- **First law of thermodynamics**
  - Conservation of energy – you can't get more than what you invest.
- **Second law of thermodynamics**
  - It is not possible to convert all the energy of a system into useful work – you can eat as much as you want, eventually, something has to come out.

In a game; you can't win, even you can't break even, and the worst thing is that you have to keep on playing.

Thermodynamic Postulates: Property Relationships

- **Zeroth law of thermodynamics**
  - When each of two systems is in thermal equilibrium with a third system, they are also in thermal equilibrium with each other.
- **Third Law of Thermodynamics**
  - The entropy of a perfect crystal is zero at absolute zero temperature.
- **State Postulate**
  - The state of a simple, single phase thermodynamic system is completely specified by two independently variable, intensive properties.

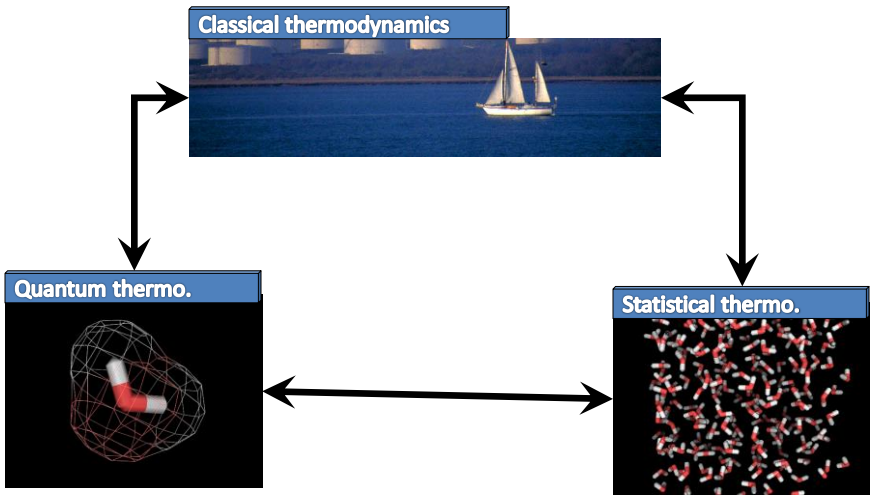
What is Not Thermodynamics?

- **Does not study system dynamics**
  - Not concerned with answering: how fast a system will respond to changes in a constraint or more?
- **Do not establish the rates of chemical or physical processes**
  - Rates depend on both driving forces and resistances. Driving forces are thermodynamic variables, resistances are not.
  - Unable to reveal the microscopic mechanisms of physical or chemical processes.

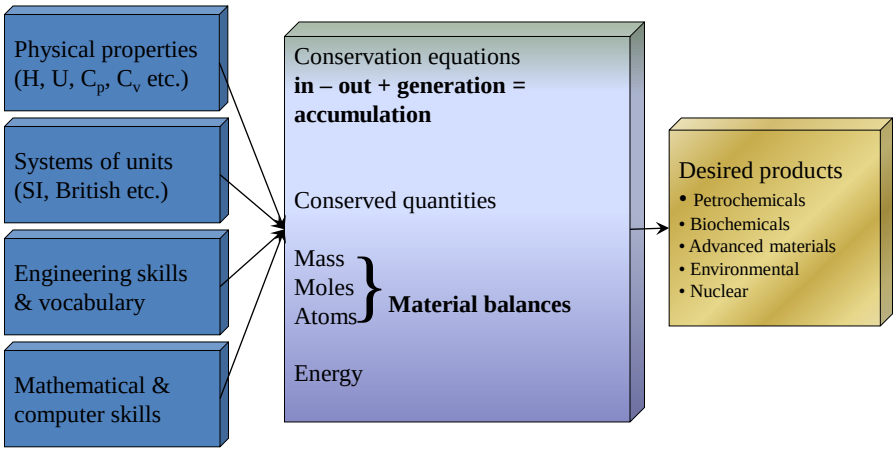
Macroscopic Versus Microscopic

- Any (thermodynamic) system can be described macroscopically or microscopically.
  - **Macroscopic approach**
    - system is considered as a continuum.
    - The system is described by few variables e.g. P, T, ρ etc.
    - Domain of classical thermodynamics.
  - **Microscopic approach**
    - Considers the detailed molecular nature of the system.
    - The system is described by a huge number of variables (specify at least the coordinates and the momenta of the molecules)
    - Domain of statistical and quantum mechanics.

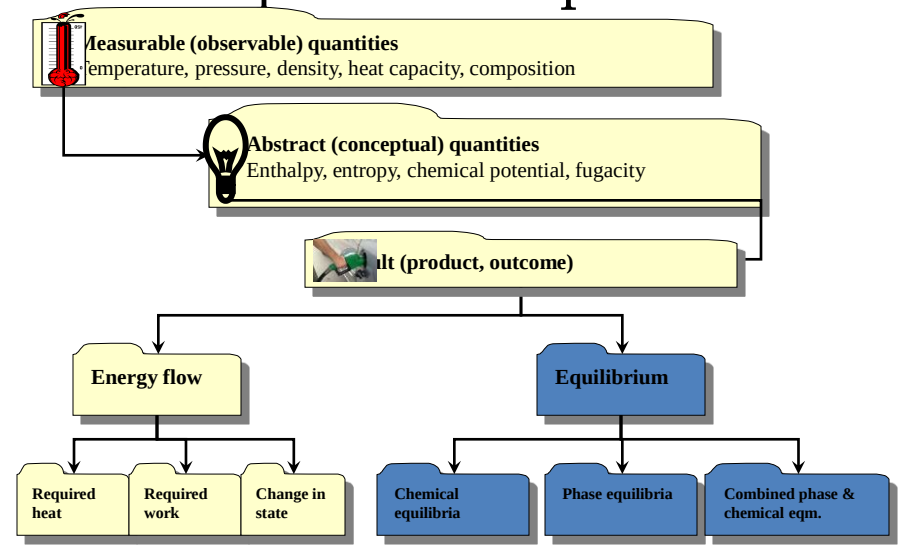
Many Faceted Science



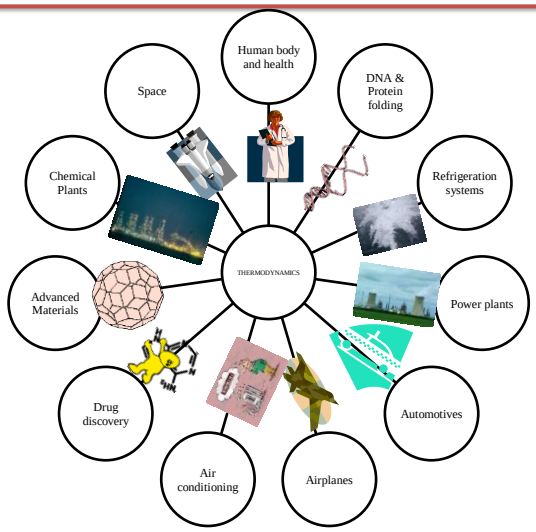
Road Map to Thermodynamics



Road Map to Concepts

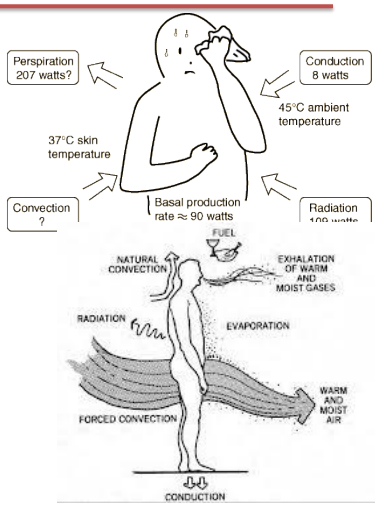


Applications of Thermodynamics



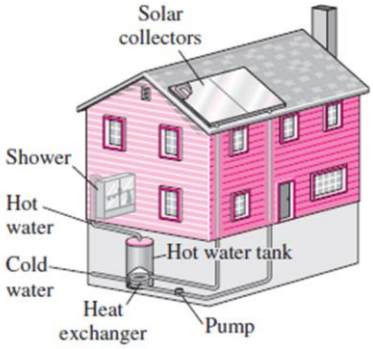
Biomedical Applications

- The heart is constantly pumping blood
- Various energy conversions occur in trillions of body cells, and the body heat generated is constantly rejected to the environment.
- The **human comfort** is closely tied to the rate of this metabolic heat rejection. We try to control this heat transfer rate by adjusting our clothing to the environmental conditions.



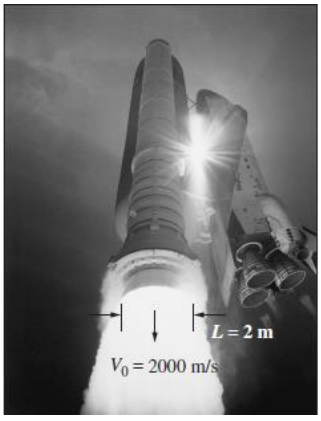
https://ipreciado.wordpress.com/2012/10/23/lechner-thermal-comfort-response/

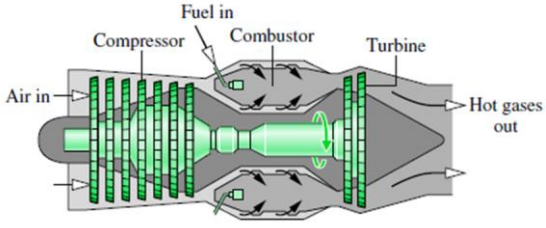
Household Applications



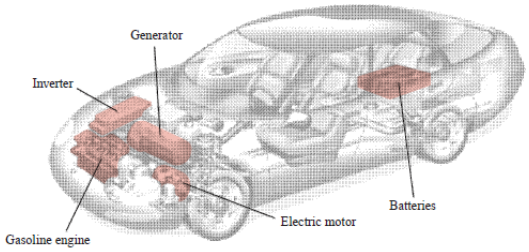
Turbojet and Automobile engines

Rockets and jet engines, and airplanes

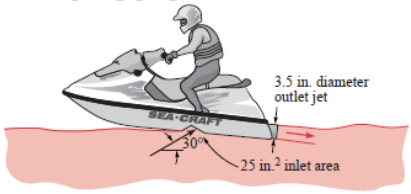




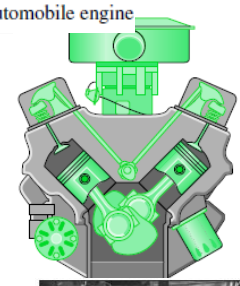
Automobile Engines

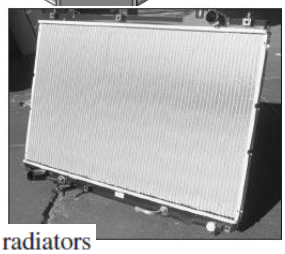


Jet ski water =-pump propulsion



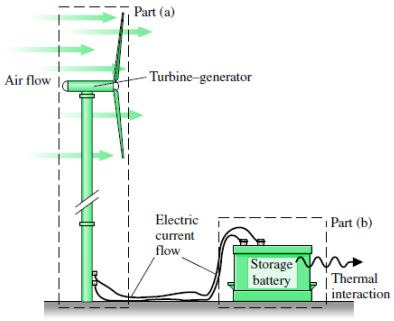
Automobile engine

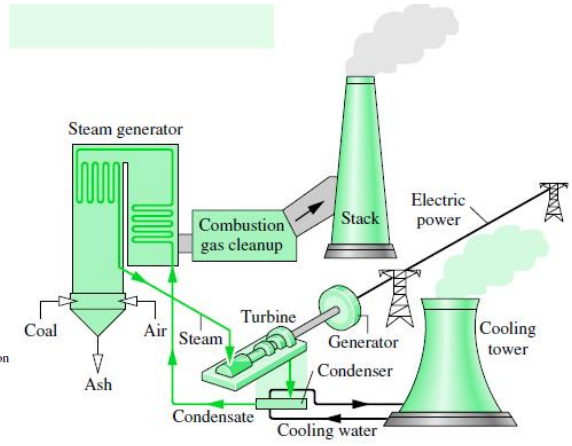




Car radiators

Power Generation





Concept Summary

- Define thermodynamics, and distinguish what is not thermodynamics.
- Know and understand the differences between classical thermodynamics and statistical mechanics.
- Distinguish what is a measurable and what is an abstract quantity.
- Know problems encountered commonly in thermodynamics.