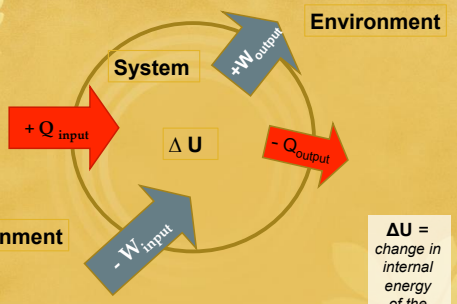
Our Objectives

Describe the First Law of Thermodynamics
Apply the sign convention in the equation of the First Law of Thermodynamics
Solve a sample problem related to the First Law of Thermodynamics
Discuss applications of the First Law of Thermodynamics
- Heat engine
- Refrigerator

State the Second Law of Thermodynamics in several ways



ΔU = *change in internal energy of the atoms and molecules*

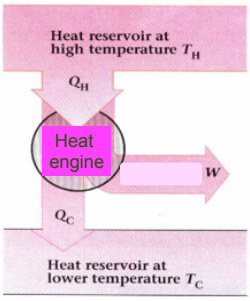
$$Q_{net\ input} = W_{net\ output} + \Delta U$$

Efficiency:

$$\text{Eff} = \frac{\text{useful output}}{\text{input}}$$

$$Eff = \frac{W}{Q_H}$$

Heat Engine

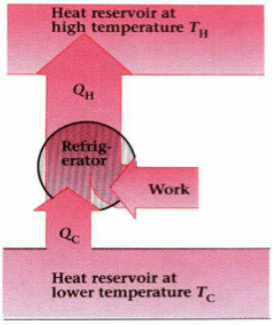


- For an engine operating in a cycle, ΔU = 0

$$Q_H = W_{output} + Q_C$$

Can you cite the three important processes involved in the operation of the heat engine?

Refrigerator



Coefficient of Performance:

$$CP = \frac{Q_C}{W}$$

The Second Law of Thermodynamics

Kelvin-Planck statement:

- **A *100%* efficient heat engine is impossible.**
- **A *workless* refrigerator is impossible.**

The Second Law of Thermodynamics

Clausius statement :

Heat **cannot**, **by itself**, pass from a **colder** to a **warmer** body.

Entropy and
The Second Law of Thermodynamics

$$\Delta S \geq 0$$

- for **all systems taken together** or for the universe

- *S is the symbol for* ***ENTROPY*** *which is a measure of the* disorder *of a system.*