$$\Delta V = 0 \Rightarrow W = 0$$

$$\Delta U = Q = n C_{v,m} \Delta T$$

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

Isobaric Process

$$\Delta P = 0 \Rightarrow W = -P(V_2 - V_1) = -nR\Delta T$$

$$\Delta U = Q + W \Rightarrow n C_{v,m} \Delta T = n C_{p,m} \Delta T + (-P \Delta V)$$

$$\frac{V_1}{V_2} = \frac{T_1}{T_2}$$

Isothermal Process

$$\Delta T = 0 \Rightarrow \Delta U = 0 \Rightarrow Q = -W$$

$$P_1V_1=P_2V_2$$

$$W = \int_{V_1}^{V_2} -P dV = -\int_{V_1}^{V_2} rac{nRT}{V} dV = -nRT \ln rac{V_2}{V_1} = -PV \ln rac{V_2}{V_1}$$

Adiabatic Process

$$\Delta Q = 0 \Rightarrow \Delta U = W$$

$$TV^{\gamma-1} = constant \Rightarrow PV^{\gamma} = constant$$

$$W = \int_{V_1}^{V_2} -P dV = -P V^{\gamma} \int_{V_1}^{V_2} V^{-\gamma} dV = -rac{P_2 V_2 - P_1 V_1}{1-\gamma}$$

Isothermal vs Adiabatic

Isothermal

Adiabatic

$$\frac{dF}{dV} = -\frac{F}{V}$$

$$rac{dP}{dV} = -\gamma rac{P}{V}$$

$$\left| rac{dP}{dV}
ight|_{adia} > \left| rac{dP}{dV}
ight|_{iso}$$

Kelvin-Plank Statement

It is impossible for any device that operates in a cycle to receive heat from a single reservoir and produce a net amount of work



Thermodynamics

1

Processes

Third Law of Thermodynamics

Definition

The entropy of a system approaches a constant value as its temperature approaches absolute zero.

Definition

In a closed system, the total amount of energy of all kinds is constant.

 $\Delta U = Q + W$ ($\Delta U = ext{change in internal energy}, Q = ext{heat supplied to system}, W = ext{work done on gas}$

Work Done On Gas

$$W=\int_{V_1}^{V_2}-PdV$$

Molar Heat Capacity of Gas

Constant Volume

 $C_{v,m}\colon$ Molar heat capacity at constant volume, i.e. heat required to warm 1 mol of gas through 1K at constant volume

First Law of

Thermodynamics

$$\Delta U = Q_v = n C_{v,m} \Delta T$$

Constant Pressure

 $C_{p,m}\colon$ Molar heat capacity at constant pressure, i.e. heat required to warm 1 mol of gas through 1K at constant pressure

$$\Delta U = Q_p + W = n C_{p,m} \Delta T$$

$$Q_p>Q_v$$

$$C_p - C_v = R$$

$$\gamma = rac{C_p}{C_v} = 1 + rac{2}{f}$$