

* Chemical Metallurgy: - Is the extraction and refining of metals, liquid metal treatments, and Corrosion protection and surface treatment of metals, As study of each of these topics demands an ~~understanding~~ understanding of the principles of thermodynamics, reaction kinetics and electrochemistry.

* Thermodynamics: The science of the relations between heat and mechanical work, but it might more usefully be defined as the study of the changes in energy accompanying chemical and physical changes.

Temperature

$$T_K = T_C + 273$$

$$T_R = 1.8 (T_K)$$

$$T_F = 1.8 (T_C) + 32$$

Energy: The energy of a body can be defined as its capacity for doing work; based on the fact that this energy can be translated into mechanical work.

type of energy (Heat, electrical, chemical and surface energy) - (kinetic)

unit of energy joule: The work done when a force of 1 newton acts through a distance of 1 meters.

$$\text{Cal} = 4.184 \text{ Joules}$$

السجرة

Calorie: is the amount of energy required to raise the temperature of 1g water from 14.5 to 15.5 C°.

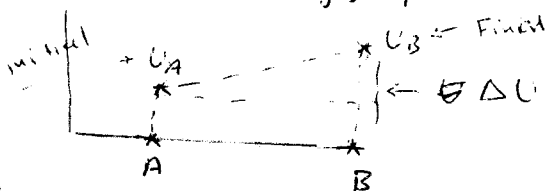
First Law of thermodynamics:

It is an ^{extension} ~~extension~~ of principle of conservation of energy, which states that energy cannot be created or destroyed, but it can only be converted from one form to another.

The first law of thermodynamics, states that the total energy of a system and its surroundings remains constant, even if it may be changed from one form of energy to another.

U (called ^{الداخلي} internal or ^{الذاتي} intrinsic energy) change in energy ~~change~~ (ΔU), which can ~~measured~~ be measured if the state of system change from A to B as a result of a change in temperature then we say that the change in internal energy is the internal energy in final state U_B minus the internal energy of initial state U_A

$$\Delta U = U_B - U_A$$



if the internal energy of the system in final state is greater than in the initial state ΔU is positive. if the system loses energy ΔU is negative.

The first law of thermodynamics can be expressed mathematically by considering a change in a system involving only two forms of energy change (heat and mechanical work).

if we represent the work done by the system as W and the heat absorbed by the system as Q

$$\Delta U = Q - W$$

(if ΔU is to be expressed in calories, the units of W must be changed from mechanical to heat energy units by the use of the mechanical equivalent of heat).

مع توصيف الجزيئات في تطبيق هذه الفكرة
الآن نوصف الجزيئات في تطبيق هذه الفكرة

cal

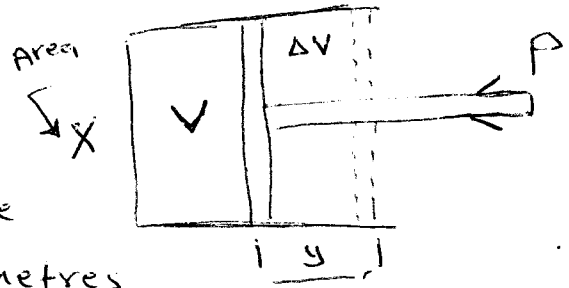
The Expansion of a Gas: Thermodynamic Variables:

The work done in a given physical change can be measured and is illustrated by considering the simple example of an ideal gas, which obeys the Ideal Gas equation.

$PV = RT$ where: P is the pressure in N/m^2 .
 V is the volume in m^3/mol ← *الحجم المولي*
 R = the gas constant $8.314 J/K \cdot mol$
 T = the absolute temperature in degree K.

Figure shows the gas enclosed in cylinder by a weightless frictionless piston.

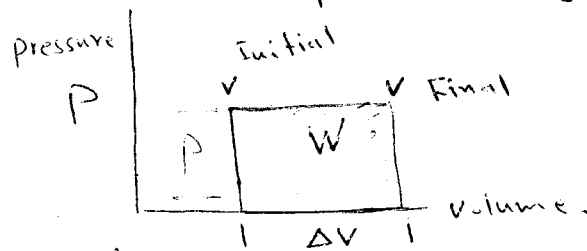
Assuming that the cross-section area of the cylinder is X square metres, the force on the piston is PX (newtons) if the gas expands so that the piston moves y metres, then the work done by the gas against the pressure on the piston is PXY joule



$W = F \cdot dl \Rightarrow P \cdot Xy$ but $Xy = \Delta V$

$W = P \Delta V$ at constant pressure.

can be expressed by plotting a graph of pressure against volume where the work done in the expansion is represented by the shaded area under the graph.



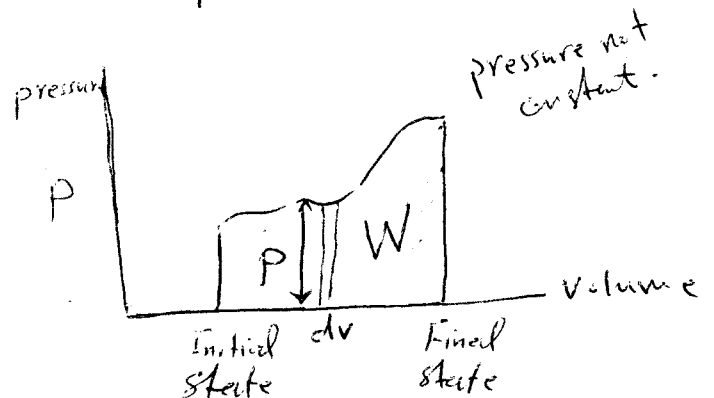
if the pressure does not constant throughout the expansion, then the work done is obtained by integrating the expression $p dv$.

The work done is represented by shaded area under the curve

$W = \int p dv$

at constant pressure

$\Delta U = q_p - P \Delta V$



where q_p is the heat absorbed by the system at constant pressure.

at constant volume, no external work is done, $\Delta V = 0$

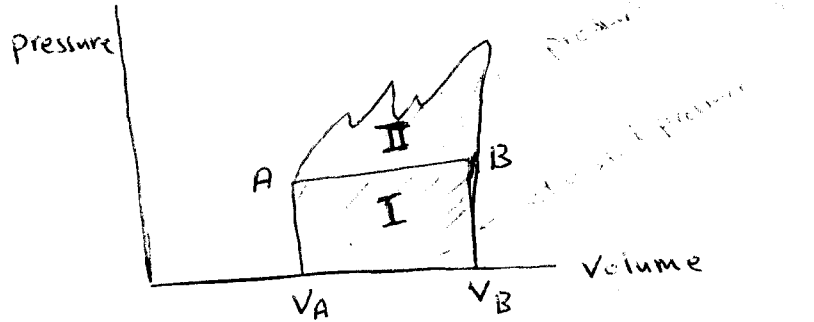
$\Delta U = q_v$

if the system changes from state A to state B the total internal energy change will be the same.

according to

$$\Delta U = \Delta U_I = \Delta U_{II}$$

according to the first law of thermodynamics.



Thermodynamic variable: The change in which is independent of the path taken, depending only on the initial and final state of system.

(U) Thermodynamic variable: $\Delta U = q - W$

properties of state: is the properties of the system independent of its history that is a property used to describe the state of a system.

(Temperature, pressure, volume, U)

if we consider the work done by the gas in the expansions

$W_I = p \Delta V$ which is much less than $W_{II} = \int_{V_A}^{V_B} p dV$ as shown by the area under the two curves I and II

$W_{II} > W_I$ It will clear that the work done by the system is not independent of the path taken during a change in the system and W is not thermodynamic variable.

$\Delta U = q - W$, so that if ΔU is to remain the same whatever the path taken between A and B, q must vary according to the path taken just sufficiently to compensate for the corresponding variations in W and vice versa. Therefore q is not thermodynamic variable.

$$q_{II} > q_I$$

Intensive properties: the properties of a system do not depend on the mass of the system such as Temperature, pressure, surface tension, density, viscosity.

Extensive properties: the properties of a system are dependent on the amount of the substance or substance present in the system such as (Volume, Internal energy).

Thermodynamically reversible: The system at all times remains in equilibrium with its surroundings and the process is necessarily infinitely slow. The system can be returned to its original state without any overall change in either the system or its surroundings.

Thermodynamically ~~reversible~~ irreversible: The system cannot return to its original state without some changes occurring in the surroundings.

Heat content or Enthalpy

المحتوي الحراري، الإنتالبي

at constant pressure

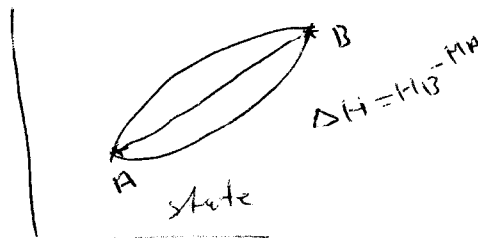
Thermodynamic variable
property of state.

$$\Delta U = q_p - P \Delta V$$

Therefore $q_p = \Delta U + P \Delta V$

$$= (U_B - U_A) + P(V_B - V_A)$$

$$= (U_B + P V_B) - (U_A + P V_A)$$



where A and B are the initial and final states of the system respectively.

we can now introduce a new thermodynamic variable an extensive property of the system called heat content or enthalpy, H, so that

$$H = U + PV$$

Then $H_A = U_A + P_A V_A$

$$H_B = U_B + P_B V_B$$

and at constant pressure $P = P_A = P_B$ so that

$$q_p = H_B - H_A = \Delta H$$

This means that the increase in enthalpy of the system, ΔH , accompanying a change in the system at constant pressure is equal to the heat absorbed by the system q_p ; hence the alternative name 'heat content' for the variable H.

$$\Delta H = \Delta U + P \Delta V$$

at constant pressure and as U , P and V are all thermodynamic variables H must also be a thermodynamic variable and is independent of previous history of the system - depending only on its present state. In other word, it is property of state.

تغير الطاقه الحركيه او الجاذبيه من التصادم الاثري (مجموعه الجزيئات) فقط انما (مجموعه ذراته) يتغير

Gas Expansion: Maximum Work.

The work done by a gas in expansion at constant pressure is

$$W = P \Delta V$$

This is only work produced by the thermodynamically reversible expansion of the gas. If the expansion was irreversible, the pressure against which the gas expanded would be less than P , the pressure inside the cylinder, and therefore the work done would be less than $(P \Delta V)$ the maximum work done would be less than $P \Delta V$, the maximum work done as a result of the expansion.

The work done by reversible processes is always greater than that done by the same processes carried out irreversibly, and is therefore called the Maximum Work for the processes.

* When P is not constant

$$W = \int_{V_A}^{V_B} P dV$$

but $PV = RT$ for 1 mol of ideal gas, so that

$$W = \int_{V_A}^{V_B} \frac{RT}{V} dV = RT \ln \frac{V_B}{V_A}$$

provided that the expansion is "isothermal" (at constant temperature)

But $P_A V_A = P_B V_B$ (from the ideal gas equation) so that

$$W = RT \ln \frac{P_A}{P_B}$$

We have thus obtained expressions for the work done in reversible expansion of gas at constant pressure and at constant temperature.

$$W_{\text{irreversible}} < W_{\text{reversible}}$$