Ministry of Higher Education and Scientific Research
AL-Mustaqbal University College of Science
Department of Biochemistry

Physical chemistry

Lecture 6

First Law of Thermodynamics

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First Law of Thermodynamics

Please hand in your Labs at the front of room

Take out a piece of paper

No need for notes!

Thermodynamic Process

A ***thermodynamic process*** is one in which heat is added to or taken away from a system. **ΔQ = change in heat**

Zeroth Law of Thermodynamics

Zeroth : *Two systems are at thermal equilibrium if they have the same temperature*.

The significant consequence of the Zeroth Law is that, when a hotter object and a colder object are placed in contact with one another, heat will flow from the hotter object to the colder object until they are in thermal equilibrium.

First Law of Thermodynamics

First : also known as Law of Conservation of Energy, states that energy can not be created or destroyed; it can only be redistributed or changed from one form to another.

$$\Delta U = Q + W$$

ΔU is the change in internal energy of the system, Q is the heat added to the system, and W is the work added to the system

Q is positive when it is added to the system and negative if it is taken out of the system.

Output Work (done on other systems) is negative

Input Work (done on the system) is positive

Sign Convention

$$\Delta U = Q + W$$

- +Q when **heat is added** to the system.
- - Q when **heat is lost** from the system.
- +W when **work is done on the system** .
- - W when **work is done by the system** .

Second Law of Thermodynamics

Second: The entropy of a closed system never decreases as time goes by. Reversible processes do not change the entropy of a system, while irreversible processes increase a system's entropy.

$$S \geq 0$$

S = Entropy of a System

When we discuss these Laws think of….

Zeroth: **Temperature Exists and therefore you must play the game** .

First: **You can't win** .

Second: **You can't break even** .

First Law Question

In a thermodynamic process, a system absorbs 450 kJ of heat and does 87 kJ of work on its surroundings. By what amount did the system's internal energy change?

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In a thermodynamic process, a system absorbs 450 kJ of heat and does 87 kJ of work on its surroundings. By what amount did the system's internal energy change?

$$\Delta U = Q + W$$

$$\Delta U = \quad 450\ kJ - 87\ kJ \quad = \quad \boxed{360\ kJ}$$

Note that the work done by the system ON the surroundings is negative.

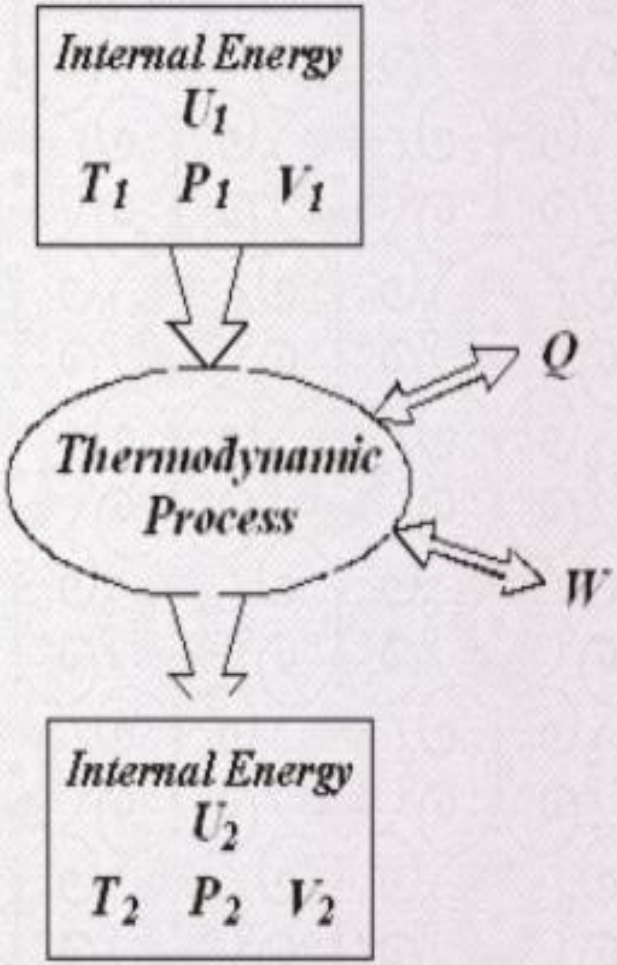
First Law in a "Nutshell"

Here is a diagram of a generic thermodynamic process.

A system has an initial internal energy.

Heat **(Q):** *can be added to the system, or taken away from the system or there may be no heat transfer.*

Work **(W):** *may be done on the system or the system may do work or there may be no work involved at all.*



For everything we are about to do….
Always keep in mind the Ideal Gas Law…

$$PV = nRT$$

Isobaric Process

Greek for…

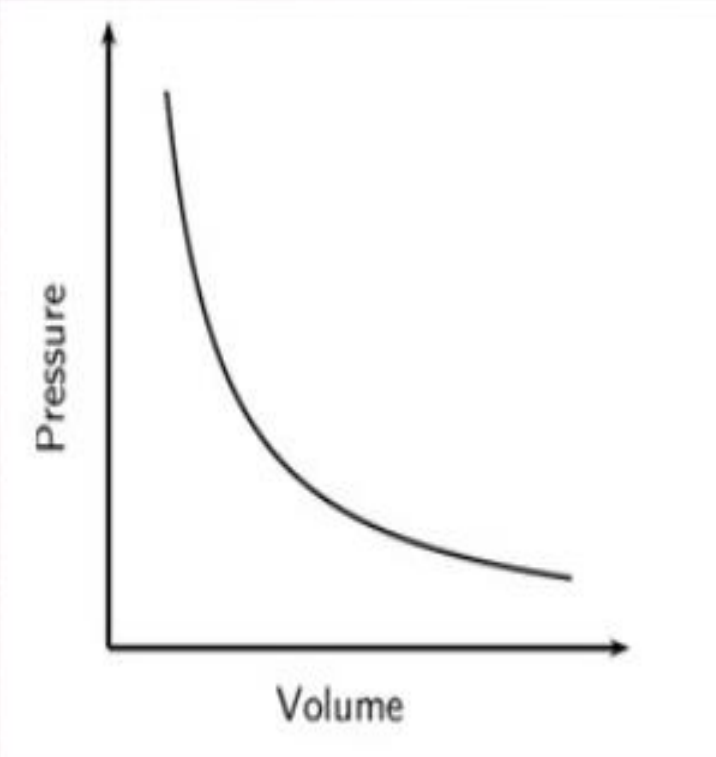
"Iso" – refers to something remaining constant

"Baric" refers to ***pressure***

Collect and read the handout from the front and read the

Please collect a Whiteboard and Pens and draw the following!

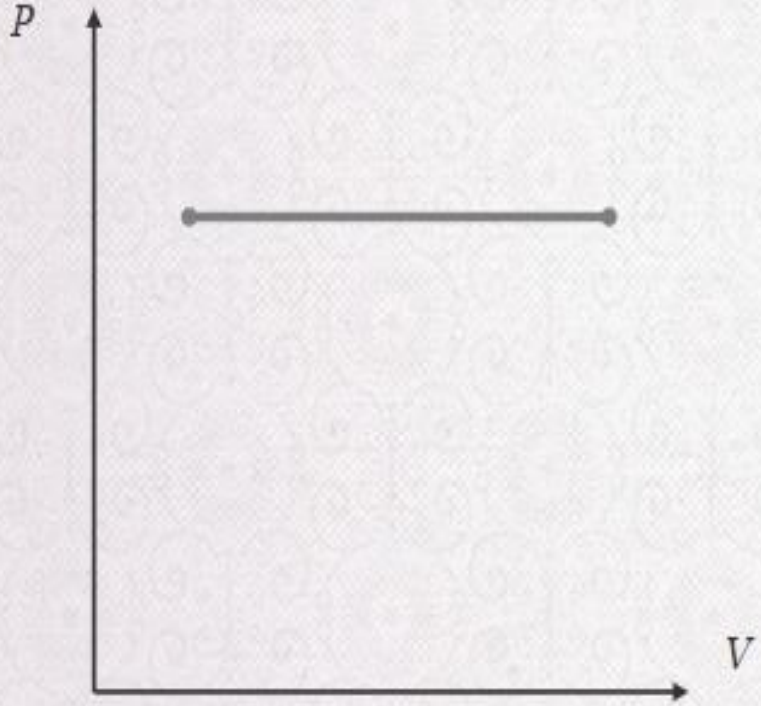
PV = nRT



PV = nRT

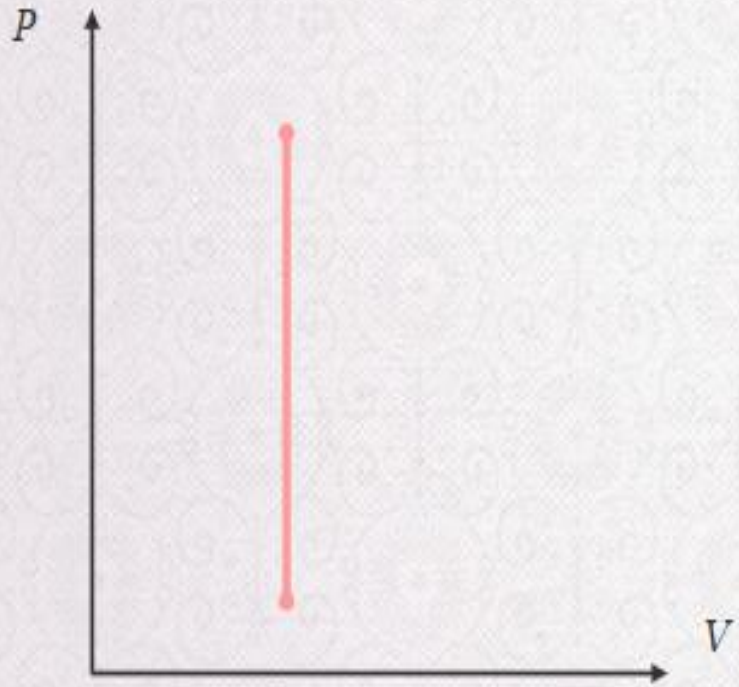
For the following P vs. V diagram… determine which of the Special Cases applies

A.



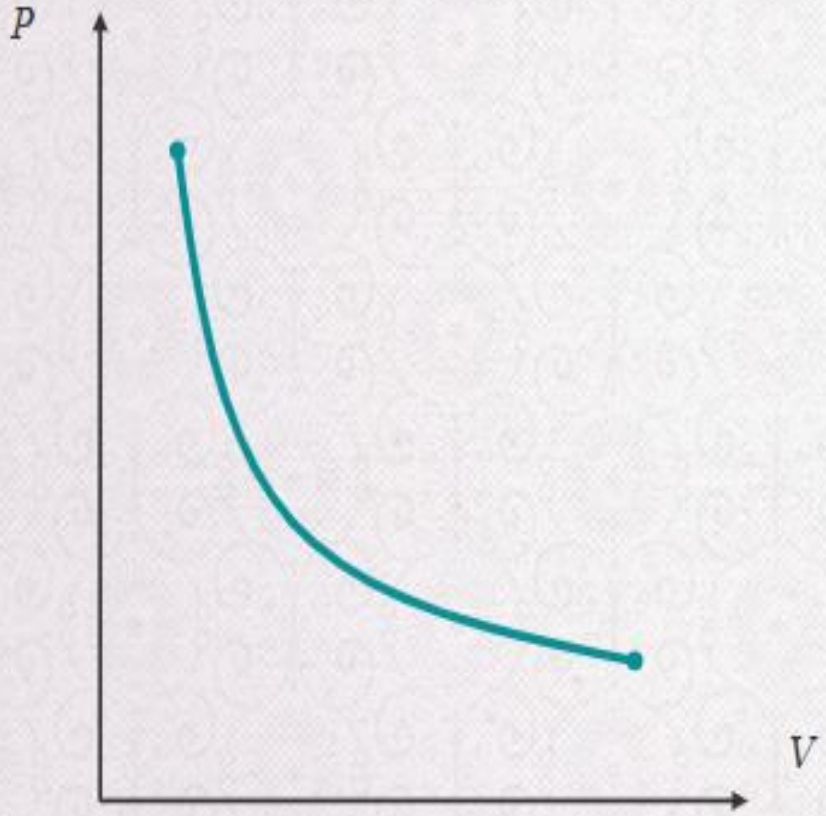
For the following P vs. V diagram… determine which of the Special Cases applies

B



For the following P vs. V diagram is an Adiabatic Process

C.

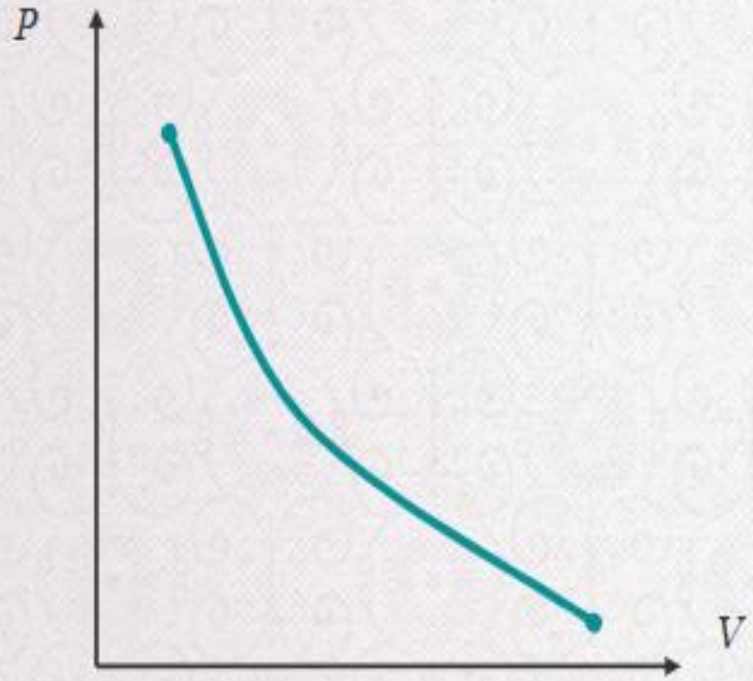


C. **Adiabatic Process:** no heat is exchanged between the system an its environment

How does the 1 st Law Equation change during an Adiabatic process?

For the following P vs. V diagram is an Isothermal Process

D.



D. **Isothermal Process:** Temperature is constant

How does the 1 st Law Equation change during an Isothermal process?

Summary of Processes

Process	Constant	PV Diagram	Ideal Gas Law	First Law of Thermodynamics
Isobaric	Pressure	Horizontal line	$V \propto T$	$\Delta U = Q + W$
Isochoric	Volume	Vertical line	$P \propto T$	$\Delta U = Q$
Isothermal	Temperature	Curved line	$PV \propto T$	$\Delta U = 0$
Adiabatic	No heat exchanged	Curved line (jumps to different isotherm)	$PV = nRT$ (only "nR" are constant)	$\Delta U = W$

Thank you