University of Mujahid Abdelhafidh Boualsouf – Mila

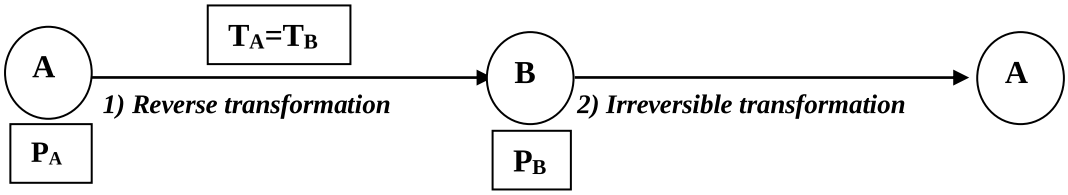
Faculty of Science and Technology ***Academic year 2025/2026***

First year the common core ST and Engineer ***Module: Thermodynamics***

Series N^0 03

Exercise 01:

Perfect gas undergoes a series of transformations as shown in the following diagram:



1)- Select the type of conversion AB, BA.

2)- Draw a Clapyrone diagram for the ABA cycle.

Exercise 02:

1- Calculate the amount of heat required to heat 100 g of copper from 10 °C to 100 °C.

2- If a 100 g mass of aluminium absorbs the same amount of heat as before at 10 °C, which heats up more, copper or aluminium?

Note that the specific heat of copper is 0.39 J/g.°C and that of aluminium is 0.9 J/g.°C.

Exercise 03:

We place a piece of lead with a mass of m_1 = 280 g and a temperature of T_1 = 98 °C inside a calorimeter containing a quantity of water with a mass of m_2 = 350 g at a temperature (water temperature + calorimeter) of T_2 = 16 °C. We measure the equilibrium temperature to obtain Teq = 17.7 °C.

- Calculate the specific heat capacity of lead.

Data: The specific heat of water ce= 4185 J/Kg.K ; the specific heat of the calorimeter c= 209 J/Kg.K

Exercise 04:

1 mole of ideal gas expands from P_1= 100 atm to P_2= 1 atm at a constant temperature of 25°C.

-Calculate the work done in two ways, reversible and irreversible. Represent the work graphically in both cases.

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Exercise 05:

a) Represent the following transformations on a Clapeyron P(V) diagram:

(1) Expansion and compression at constant temperature (isothermal)

(2) Heating and cooling at constant pressure (isobaric).

(3) Heating and cooling at constant volume (isochoric).

(4) Expansion and compression at constant temperature (Adiabatic).

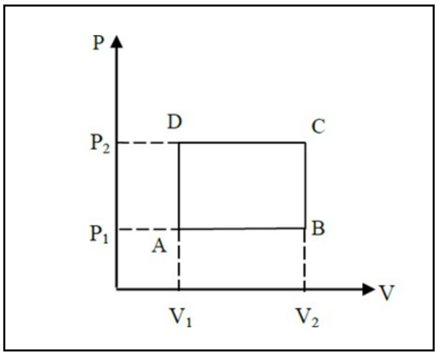
b) Calculate the work produced by compressing 2 moles of oxygen, considered an ideal gas, at a constant temperature (T = 25°C) and initially at a pressure of P_1 =1 atm to a final pressure of P_2 = 5 atm. This can be done in two ways: reversible and irreversible.

c) At equilibrium, we slowly reduce the pressure from P_1=5 atm until it returns to atmospheric pressure P_2=1 atm. Calculate the work done by the gas, noting that the temperature remains constant. If this process is carried out quickly, what is the value of the work done in this case?

d) Represent both transformations on a Calapeyron diagram, showing the values of the work graphically.

Exercise 06:

We achieve the reverse cyclic transformation for 1 mole of ideal gas represented by the rectangle shown in the Clapeyron diagram (PV) shown:



1)Calculate the work exchanged in each transition between the gas system and the external environment, then calculate the work exchanged in the cyclic transition.

2)Find the expression for the heat Q exchanged in transition B A in terms of γ and R, then calculate it.

Data: T_1= 200K; T_2=300K; $P_1=10^5$Pa ; $P_2= 20.10^5$ Pa ; V_1=5L ; V_2=12L ; R=8,31J/mol.K,

$\gamma = \frac{C_p}{C_v} = 1{,}4$; $C_P - C_v = R$.

Exercise 07:

A cylinder with a piston containing 2 g of helium gas (an ideal monatomic gas) is compressed at pressure P_1 and volume V_1. An adiabatic reverse compression transfers the gas to pressure P_2 and volume V_2. Calculate:

1-Final volume V_2.

2-Work gained by the gas.

3-Change in internal energy of the gas.

4-Conclude the increase in temperature without calculating the initial temperature T_1.

Data: P_1=1atm; V_1=10L; P_2=3atm; R=8,3 SI; $\gamma = \frac{C_p}{C_v} = \frac{5}{3}$

Exercise 08:

We submit 1 mole of nitrogen gas to the following series of transformations:

- Isothermal reverse compression AB reduces the volume by half.
- Transformation isobaric reverse BC to the $\frac{T_A}{2}$.
- Isothermal expansion, reverse CA.

1- Represent the ABCA cycle on the Clapeyron diagram.

2- Calculate for the three transformations the changes in internal energy ΔU, work W, and heat Q for each transformation,

3- The change in internal energy ΔU for the cycle.

4-Check whether the first law of thermodynamics is satisfied in this case.

Data: *R= 8.32 J/mol.K =2 cal/mol.K=0,082 L.atm/mol.K;* P_A*=10atm;* T_A*=400K;* n_{azote}*=1mol;* C_v*=5cal/mol.K;* C_p*=7cal/mol.K*

Exercise 09:

An ideal gas occupies a volume of 1 L at a pressure of 10 atm and a temperature of 600 K. It undergoes a reversible transformation consisting of: isothermal expansion followed by isochoric cooling. Represent this transformation on a (P,V) diagram.

-If you know that the gas received an amount of heat equal to 207 cal and produced work equal to 390 cal, calculate the coordinates of the final state reached by the gas.

- We then subject the gas to compression and expansion, returning it to its initial pressure. Represent this transformation on the diagram and calculate the volume and temperature of the gas.

- What type of transformation does the gas undergo to return it to its initial state? Complete the diagram.

Data: C_p*=7cal/mol.K*

Exercise 10:

We submit 3 moles of ideal gas to the following series of reversible transformations starting from point A (T_A= 300 K; P_A= 1 atm)

- Isothermal transformation AB where the system releases heat Q= –3500 cal.

- Isobaric transformation BC where T_C= 450K.

- Adiabatic transformation CD where the system returns to its initial pressure

- Isobaric transformation DA.

1-Calculate P, V, T at each point, then plot these transitions on a PV diagram (Clapeyron diagram).

2- Calculate the work W_{cycle} and heat Q_{cycle} exchanged during the cyclic transition.

Data: C_p*=7cal/mol.K*