University of Biskra
Faculty of Science and Technology
Master 1 (Metallurgy)
Module: Theory of Metallurgical Processes

E.M.D. N°01

Exercise 1 (10pt)

For magnesium (Mg), the following data are given at 298 K:

	$O_{2(G)}$	$Mg_{(S)}$	$MgO_{(S)}$
$\Delta_f H^0$ (en $KJmol^{-1)}$	0	0	-601,5
S^0 (en J K^{-1} $mol^{-1)}$	205	32,7	27

Melting temperature T_F = 923 K with L_F = 9.2 kJ.mol^{-1}; Boiling (vaporization) temperature T_{VAP} = 1393K with L_{VAP} = 131,8 kJ.mol^{-1}

- Calculate ΔrG°(T) and draw the Ellingham diagram of magnesium.

Exercise 2 (4pt)

At 30°C, the vapor in equilibrium with an ideal solution of a kerosene (K) / MIBK mixture (MIBK = methyl isobutyl ketone, used in liquid–liquid extraction) has:

- Total pressure: P_{tot} = 0.420 atm
- Vapor-phase mole fraction of MIBK: y_{MIBK} = 0.780

At this temperature, the saturated vapor pressure of MIBK is:

- P_{MIBK}^{sat} = 0.610 atm

Calculate the mole fraction of MIBK in the liquid solution x_{MIBK}.

Exercise 3 (6pt)

A quantity of 0.6 mol of calcium carbonate ($CaCO_3$) is introduced into a 30 L vessel kept at constant temperature, initially evacuated (vacuum).
At 1480 K, the standard Gibbs free energy of reaction is $\Delta G° = -8.5$ kJ·mol^{-1}.

1. Write the expression of the equilibrium constant and calculate its value at 1480 K.
2. Deduce the equilibrium CO_2 pressure at 1480 K.
3. Calculate the equilibrium composition of the system.

Given: R =8,31 J mol^{-1} K^{-1}

University of Biskra
Faculty of Science and Technology
Master 1 (Metallurgy)
Module: Theory of Metallurgical Processes

Academic year 2025/2026

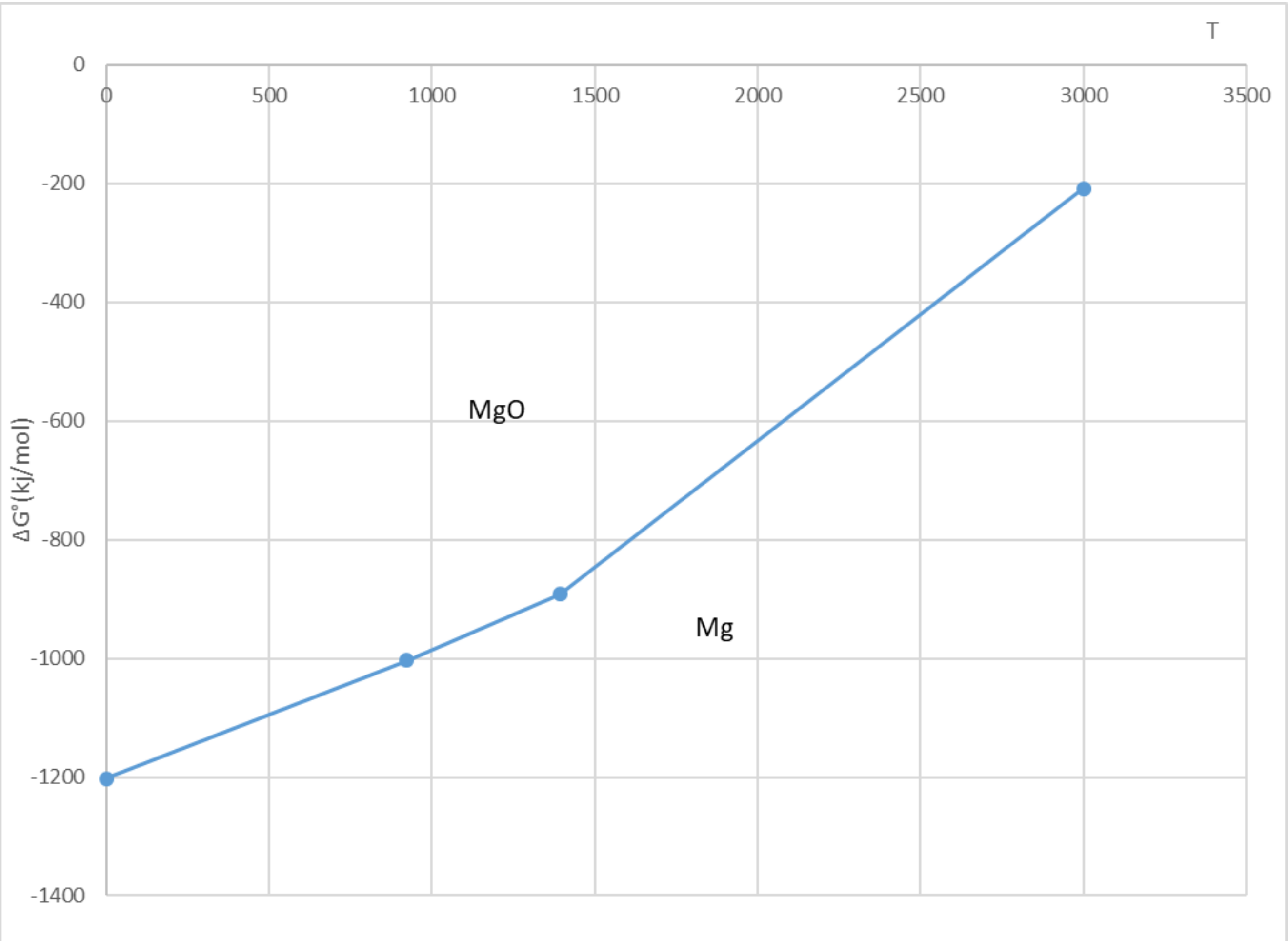
E.M.D. N°01

Exercise (10 pts)

Pour923> T>298 Mg is solid and MgO is solid (2.5 pts)
d'où **$\Delta_r G°2(T) = -1203 + 216{,}4 \cdot 10^{-3}.T$**

Pour923< T<1393 Mg is liquid and MgO is solid (2.5 pts)
d'où **$\Delta_r G°2(T) = -1221{,}4 + 236{,}3 \cdot 10^{-3}.T$**

Pour1393< T Mg is gas and MgO is solid (2.5 pts)
d'où **$\Delta_r G°2(T) = -1485 + 425{,}5 \cdot 10^{-3}.T$**



(2.5 pts)

Exercise 2 (4pt)

1) Vapor phase (Dalton's law):

$y_{MIBK}=P_{MIBK} / P_{tot}$
$P_{MIBK}=y_{MIBK}\cdot P_{tot}=0,780\times 0,420$
$P_{MIBK}=0,328$ atm (2 pts)

2) Liquid phase (Raoult's law):

$P_{MIBK}=x_{MIBK}\cdot P_{MIBK}^{sat}$
$0,328=x_{MIBK}\cdot 0,610$
$x_{MIBK=}.0,328/0,610=0,538$ (2 pts)

Exercise (6pts)

1.

$$K_0^T = e^{\frac{-\Delta_r G^0_{1480}}{RT}}$$ (1 pt)

$$K_0^T = e^{\frac{8500}{8.31x1480}} = e^{0,691} = 1,996$$ (1 pt)

2. $P_{CO_2} = K^0_{1480} x P_0 = 1,996x1 = 1,996\ bar$ (1 pts)

3. Equilibrium composition (ideal gas):.

CO_2 is treated as an ideal gas. x = PV/(RT) = $1.996x10^5$ x0,030/(8,31x1480) =0,487 mol.
(1.5 pt)

	extent of reaction (mol)	$CaCO_3(s)$	$CaO(s)$	$+CO_2(g)$
Initial (mol)	0	0,6	0	0
At equilibrium (mol)	x	0,6-x	x	x
	0,487	0.113	0,487	0,487

(1.5 pt)