

CHEMISTRY TEST n°1 (1h30)

For all numerical applications, take: $R=8.314 \text{ J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$; $T \text{ (K)} = \theta(^{\circ}\text{C}) + 273 \text{ K}$

$1 \text{ atm} = 760 \text{ Torr} = 101325 \text{ Pa} = 1.013 \text{ bar}$. $P^{\circ} = 1 \text{ bar}$

All gases may be considered as ideal

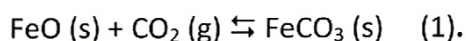
Gaseous carbon dioxide CO_2 released by human activities is the main cause of the increase in the greenhouse effect. To meet the environmental regulations that aim to reduce the emission of CO_2 in the atmosphere and limit its concentration, technical solutions are studied.

The 2 exercises can be treated independently - **All answers must be justified.**

No documents allowed.

Exercise I – Mineral sequestration of gaseous carbon dioxide CO_2 (8 points)

Mineral carbonation is one of the possible alternatives for storing CO_2 . The objective of this study is to determine whether solid iron oxide (FeO) could be used to capture CO_2 , according to reaction (1):



Note that the two solids FeO and FeCO_3 are not miscible at all.

- 1- Give the literal expressions then calculate the standard molar enthalpy change $\Delta_{R1}H_{298}^0$ and standard molar entropy change $\Delta_{R1}S_{298}^0$ of reaction of carbonation of FeO(s) at 298K.
- 2- Give the literal expression then calculate the standard molar free enthalpy change $\Delta_{R1}G_{298}^0$ of reaction of carbonation of FeO(s) at 298K.
- 3- Give the literal expression then calculate the thermodynamic equilibrium constant K_{298K}^0 at 298K.
- 4- Taking into account the composition of air (see data section), calculate the partial pressure of CO_2 (in bar) when the pressure of air is 1 bar.
- 5- Can the reaction of carbonation of FeO occur spontaneously at 25°C with a total pressure of air is 1 bar?
- 6- If not, at which temperature would this reaction become spontaneous under the air pressure of 1 bar? Can this temperature be easily reached in industrial conditions?
- 7- What other experimental condition (s) could you suggest to facilitate the reaction?

Data :

Compound	$\overline{\Delta_f H_{298}^0}$ ($\text{kJ}\cdot\text{mol}^{-1}$)	$\overline{S_{298}^0}$ ($\text{J}\cdot\text{mol}^{-1}\cdot\text{K}^{-1}$)
FeO (s)	-272.0	61.0
FeCO_3 (s)	-737.0	91.0
CO_2 (g)	-393.5	214

The influence of the thermal capacities will be neglected.

Composition of air expressed in volume percentage:

$\text{N}_2 = 78.08$

$\text{O}_2 = 20.95$

$\text{Ar} = 0.93$

$\text{CO}_2 = 0.035$

others= 0.005.

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