

Chemistry 3

Set of exercises-1

General informations: Gibbs free energy and chemical equilibrium

Exercise 1

At 298K : $\text{H}_{2(g)} + \frac{1}{2} \text{O}_{2(g)} \rightarrow \text{H}_2\text{O}_{(g)}$

Based on the values of absolute entropy given in the table below, calculate the entropy of the reaction at 298K. Comment.

State	Body	S°_{298} (cal/K.mol)
Solid	Ag	10.2
Solid	C	1.37
Liquid	H ₂ O	16.73
Liquid	Hg	18.17
Gas	He	30.13
Gas	H ₂ O	45.1
Gas	H ₂	31.21
Gas	O ₂	49
Gas	CO ₂	51.5

Exercise 2

Consider the decomposition of yellow mercury(II) oxide.



1. Calculate the standard free energy change at room temperature, ΔG°_{298} using (a) standard free energies of formation and

(b) standard enthalpies of formation and standard entropies.

2. Do the results indicate the reaction to be spontaneous or nonspontaneous under standard conditions?

Compound	ΔG°_f (kJ/mol)	ΔH°_f (kJ/mol)	S°_{298} (J/K·mol)
HgO _(s)	-58.43	-90.46	71.13
Hg _(l)	0	0	75.9
O _{2(g)}	0	0	205.2

Exercise 3

Consider the following equilibrium :



Is the reaction spontaneous at $T_0 = 298 \text{ K}$ and at $T_1 = 500 \text{ K}$? Conclude.

Compound	N _{2(g)}	H _{2(g)}	NH _{3(g)}
ΔH°_f (kJ/mol)	0	0	-46

$S_f^\circ(\text{JK}^{-1}\text{mol}^{-1})$	191.61	130.68	192.45
$C_p(\text{JK}^{-1}\text{mol}^{-1})$	29.13	28.82	35.06

Exercise 4 (home work to be returned next week)

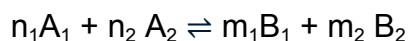
The formation and the decomposition of water molecule is governed by the following data.

Compound	H ₂ O	H ₂	O ₂
Enthalpy	-285.83 kJ/mol	0	0
Entropy	69.91 J/K mol	130.68 J/K mol	205.14 J/K mol

1. Say if the formation and the decomposition reactions are exergonic or endergonic.
2. Discuss the spontaneity in case of electrolysis and fuel cell applications.

Exercise 5

Consider the following reaction for an ideal gas:



1. Give the expressions of the following equilibrium constants K_p , K_c , and K_x .
2. Deduce the relationship between these constants.

Exercise 6

Find out the value of equilibrium constant for the following reaction at 298 K.



Standard energy change, ΔG° at the given temperature is -13.6 kJ/mol.