2) 9:45 - 10:10
3) 10:45 - 11:10
7) 3:05 - 3:30

◆ Thermodynamics Practice

Edit

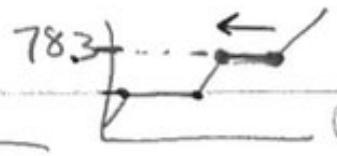
Thermodynamics Practice

Due: 10:10am on Friday, February 5, 2021

You will receive no credit for items you complete after the assignment is due. Grading Policy

Chapter 19 Question 4 - Algorithmic

Description: (a) The normal boiling point of ethanol (C_2H_5(OH)) is 78.3 °C and its molar enthalpy of vaporization is 38.56 kJ/mol. What is the change in entropy in the system in J/K when strings_1 grams of ethanol at 1 atm condenses to a liquid at the normal...



$\Delta H_{vap} = \frac{kJ}{mol}$

Part A

The normal boiling point of ethanol (C_2H_5OH) is 78.3 °C and its molar enthalpy of vaporization is 38.56 kJ/mol. What is the change in entropy in the system in J/K when 112.2 grams of ethanol at 1 atm condenses to a liquid at the normal boiling point?

ANSWER:

-267
-1199
1199
-382
382

equals 0 → $\Delta G = \Delta H - T\Delta S \Rightarrow \Delta H = T\Delta S$

exo → g → l

$\Delta S_{surr} = -\frac{\Delta H_{sys}}{T}$

$\Delta S_{sys} = \frac{\Delta H_{sys}}{T}$

$\Delta H_{sys} = -\Delta H_{surr}$

$\Delta S = \frac{\Delta H}{T} = \frac{38560\ J/mol}{351.3\ K} = 109.8\ J/mol\,K$

$\frac{112.2\ g}{1} \left| \frac{1\ mol}{46.08\ g} \right| \frac{109.8\ J}{mol\,K} = \begin{matrix} 267\ J/K \\ -267 \end{matrix}$ condensing

cond → g → l ↓S $\Delta S = (-)$

Chapter 19 Question 18 - Algorithmic

Description: (a) For the reaction C(s) + H_2O(g) rightarrow (CO)_2(g) + H_2(g) Delta(H) degree(s) = v1 (kJ)/(mol) and Delta(S) degree(s) = v2 J/K * (mol) at 298 K. At temperatures greater than _____ degree(s)(C) this reaction is spontaneous under...

Part A

For the reaction

$$C(s) + H_2O(g) \rightarrow CO_2(g) + H_2(g)$$

$\Delta H^\circ = 133.3\ kJ/mol$ and $\Delta S^\circ = 121.6\ J/K \cdot mol$ at 298 K. At temperatures greater than _____ °C this reaction is spontaneous under standard conditions.

ANSWER:

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$+\Delta G$ nonspont

$0\ \Delta G$ — $T\Delta S = \Delta H$

$-\Delta G$ spont

$T = \frac{\Delta H}{\Delta S} = \frac{133.3\ kJ/mol}{.1216\ kJ/mol\,K}$

$T = 1096\ K = 823°C$

- 273
- 1096
- 552
- 325
- 823

Chapter 19 Question 30 - Algorithmic

Description: (a) The equilibrium constant for the following reaction is v1 * 10^8 at 25 degree(s)(C). N_2(g) + 3 H_2(g) rightleftharpoons 2 (NH)_3(g) The value of Delta(G) degree(s) for this reaction is _____ (kJ)/(mol).

Part A

The equilibrium constant for the following reaction is 2.0×10^8 at $25\ ^\circ\text{C}$.

$$N_2(g) + 3\,H_2(g) \rightleftharpoons 2\,NH_3(g)$$

The value of ΔG° for this reaction is _____ kJ/mol.

ANSWER:

- −47
- −4.0
- −22
- 4.0
- 22

$\Delta G^\circ = -RT \ln K$

$= -8.314\ \text{J/mol K}\ (298\ \text{K})(\ln 2.0 \times 10^8)$

$= -47355\ \text{J}$

$-47\ \text{KJ}$

Chapter 19 Question 11 - Multiple Choice

Description: (a) The second law of thermodynamics states that _____.

Part A

The second law of thermodynamics states that _____.

ANSWER:

- $\Delta H°_{rxn} = \sum n\Delta H°_f$ (products) - $\sum m\Delta H°_f$ (reactants)
- $\Delta S = q_{rev}/T$ at constant temperature
- for any spontaneous process, the entropy of the universe increases
- the entropy of a pure crystalline substance is zero at absolute zero
- $\Delta E = q + w$

Chapter 19 Question 13 - Multiple Choice

Description: (a) Which one of the following processes produces a decrease of the entropy of the system?

Part A

Which one of the following processes produces a decrease of the entropy of the system?

ANSWER:

- explosion of nitroglycerine
- dissolving oxygen in water (g) → (aq)
- dissolving sodium chloride in water
- sublimation of naphthalene
- boiling of alcohol

Chapter 19 Question 25 - Multiple Choice

Description: (a) Delta S is positive for the reaction _____.

Part A

Δ S is positive for the reaction _____.

ANSWER:

- $Pb(NO_3)_2\ (aq) + 2KI(aq) \rightarrow PbI_2\ (s) + 2KNO_3\ (aq)$ ↓
- $Ag^+\ (aq) + Cl^-\ (aq) \rightarrow AgCl\ (s)$ ↓
- $H_2O\ (g) \rightarrow H_2O\ (s)$ ↓
- $NO\ (g) + O_2\ (g) \rightarrow NO_2\ (g)$ ↓ (2 moles → 1 mole)
- $2H_2O\ (g) \rightarrow 2H_2\ (g) + O_2\ (g)$ (2 mol → 3 mol ↑)

more disorder ↑S

Chapter 19 Question 11 - Bimodal

Description: Use the table below to answer the question that follow. Thermodynamic Quantites for Selected Substances at 298.15 K (25°C) Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K·mol) Calcium Ca (s) 0 0 41.4 CaCl2 (s) -795.8 ...

Use the table below to answer the question that follow.

Thermodynamic Quantites for Selected Substances at 298.15 K (25°C)

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S (J/K·mol)
Calcium			
Ca (s)	0	0	41.4
$CaCl_2$ (s)	-795.8	-748.1	104.6
Ca^{2+} (aq)	226.7	209.2	200.8
Clorine			
Cl_2 (g)	0	0	222.96
Cl^-	-167.2	-131.2	56.5
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91
Phosphorus			
P_2	144.3	103.7	218.1
PCl_3 (g)	-288.1	-269.6	311.7
$POCl_3$ (g)	-542.2	-502.5	325
Sulfur			
S (s, rhombic)	0	0	31.88
SO_2 (g)	-269.9	-300.4	248.5
SO_3 (g)	-395.2	-370.4	256.2

Part A

The value of $\Delta S°$ for the oxidation of solid elemental sulfur to gaseous sulfur trioxide,

$2S\ (s, rhombic) + 3O_2\ (g) \rightarrow 2SO_3\ (g)$

$\Delta S = [2(256.2)\ ] - [2(31.88) + 3(205.0)]$

$\Delta S = 512.4 - 63.76 - 615.0$

$\boxed{\Delta S = -166.4\ J/mol\ K}$

is _____ J/K· mol.

ANSWER:

- +493.1
- +19.3
- -493.1
- -166.4
- -19.3

Chapter 19 Question 41 - Bimodal

Description: Use the table below to answer the question that follow. Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C) Substance ΔH°f (kJ/mol) ΔG°f (kJ/mol) S (J/K·mol) Calcium Ca (s) 41.4 CaCl2 (s) -795.8 -748.1 ...

Use the table below to answer the question that follow.

Thermodynamic Quantities for Selected Substances at 298.15 K (25 °C)

Substance	$\Delta H°_f$ (kJ/mol)	$\Delta G°_f$ (kJ/mol)	S (J/K·mol)
Calcium			
Ca (s)	0	0	41.4
$CaCl_2$ (s)	-795.8	-748.1	104.6
Ca^{2+} (aq)	226.7	209.2	200.8
Chlorine			
Cl_2 (g)	0	0	222.96
Cl^- (aq)	-167.2	-131.2	56.5
Oxygen			
O_2 (g)	0	0	205.0
H_2O (l)	-285.83	-237.13	69.91
Phosphorus			
P_2 (g)	144.3	103.7	218.1
PCl_3 (g)	-288.1	-269.6	311.7
$POCl_3$ (g)	-542.2	-502.5	325
Sulfur			
S (s, rhombic)	0	0	31.88
SO_2 (g)	-269.9	-300.4	248.5
SO_3 (g)	-395.2	-370.4	256.2

Part A

298 K

The value of $\Delta G°$ at 375 K for the oxidation of solid elemental sulfur to gaseous sulfur dioxide,

$S\ (s, \text{rhombic}) + O_2\ (g) \rightarrow SO_2\ (g)$

is _____ kJ/mol. At 298 K, $\Delta H°$ for this reaction is -269.9 kJ/mol, and $\Delta S°$ is +11.6 J/K.

ANSWER:

- -4.597
- -300.4
- +300.4
- 274.2
- +4.597

$\Delta G° = \Delta H° - T\Delta S$

$= -269.9\ \frac{kJ}{mol} - (298\ K)(.0116\ \frac{kJ}{K})$

$= -273.4\ kJ/mol$

Chapter 19 Question 44 - Bimodal

Description: (a) The value of Delta G° for a reaction conducted at 25 °C is 3.05 kJ/mol. The equilibrium constant for a reaction is _____ at this temperature.

Part A

The value of Δ G° for a reaction conducted at 25 °C is 3.05 kJ/mol. The equilibrium constant for a reaction is _____ at this temperature.

ANSWER:

- 0.292
- 0.320
- -4.20
- -1.13
- More information is needed.

$\Delta G° = -RT \ln K$

$\ln K = \frac{\Delta G°}{-RT} = \frac{3.05 \times 10^3\ J/mol}{(-8.314\ J/mol\,K)(298\ K)}$

$\ln K = -1.23$

$K = .292$

at equil, R are favored ← $K < 1$ $K = \frac{[P]\downarrow}{[R]\uparrow}$

Chapter 19 Question 46 - Bimodal

Description: (a) Consider the reaction: NH3 (g) + HCl (g) rightarrow NH4Cl (s) Given the following table of thermodynamic data at 298 K: Substance ΔHf° (kJ/mol) S° (J/K·mol) NH3 (g) -46.19 192.5 HCl (g) -92.30 186.69 NH4...

Part A

Consider the reaction:

$NH_3\ (g) + HCl\ (g) \rightarrow NH_4Cl\ (s)$

Given the following table of thermodynamic data at 298 K:

Substance	ΔH_f° (kJ/mol)	S° (J/K·mol)
NH_3 (g)	-46.19	192.5
HCl (g)	-92.30	186.69
NH_4Cl (s)	-314.4	94.6

The value of K for the reaction at 25 °C is _____.

ANSWER:

- $9.3 \cdot 10^{15}$
- $1.1 \cdot 10^{-16}$
- $1.4 \cdot 10^{8}$
- 150
- $8.4 \cdot 10^{4}$

< All Assignments

$NH_3 + HCl \rightarrow NH_4Cl$

$\Delta H_r^\circ = [-314.4\ kJ/mol] - [-46.19 + (-92.30)]$

$= -175.91\ kJ/mol$

$\Delta S^\circ = [94.6\ J/mol] - [192.5 + 196.69]$

$= -284.59\ J/mol$

$= -.284.59\ kJ/mol$

$\Delta G^\circ = \Delta H - T\Delta S$

$= -175.91 - (298)(-.28459)$

$= -91.1\ kJ/mol$

$\ln K = \frac{\Delta G^\circ}{-RT} = \frac{-91.1 \times 10^3\ J/mol}{(-8.314\ J/mol\ k)(298)}$

$\ln K = 36.8$

$K = 9.59 \times 10^{15}$

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