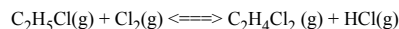


AP Practice Questions

1)

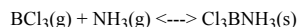
Standard Free Energies of Formation at 298 K		Average Bond Dissociation Energies at 298 K	
Substance	ΔG_f° 298 K, kJ mol ⁻¹	Bond	Energy, kJ mol ⁻¹
C ₂ H ₄ Cl ₂ (g)	-80.3	C-H	414
C ₂ H ₅ Cl(g)	-60.5	C-C	347
HCl(g)	-95.3	C-Cl	377
Cl ₂ (g)	0	Cl-Cl	243
		H-Cl	431

The tables above contain information for determining thermodynamic properties of the reaction below.



- Calculate ΔH° for the reaction above, using the table of average bond dissociation energies.
- Calculate ΔS° for the reaction at 298 K, using data from either table as needed.
- Calculate the value for K_{eq} for the reaction at 298 K.
- What is the effect of an increase in temperature on the value of the equilibrium constant? Explain your answer.

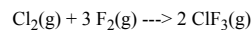
2)



The reaction represented above is a reversible reaction.

- Predict the sign of the entropy change, ΔS , as the reaction proceeds to the right. Explain your prediction.
- If the reaction spontaneously proceeds to the right, predict the sign of the enthalpy change, ΔH . Explain your prediction.
- The direction in which the reaction spontaneously proceeds changes as the temperature is increased above a specific temperature. Explain.
- What is the value of the equilibrium constant at the temperature referred to in (c); that is, the specific temperature at which the direction of the spontaneous reaction changes? Explain.

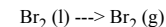
3)



ClF_3 can be prepared by the reaction represented by the equation above. For ClF_3 the standard enthalpy of formation, ΔH_f° , is -163.2 kilojoules/mole and the standard free energy of formation, ΔG_f° , is -123.0 kilojoules/mole.

- Calculate the value of the equilibrium constant for the reaction at 298 K.
- Calculate the standard entropy change, ΔS° , for the reaction at 298 K.
- If ClF_3 were produced as a liquid rather than as a gas, how would the sign and magnitude of ΔS for the reaction be affected? Explain.
- at 298 K the absolute entropies of $\text{Cl}_2(\text{g})$ and $\text{ClF}_3(\text{g})$ are 222.96 joules per mole-Kelvin and 281.50 joules per mole-Kelvin, respectively.
 - Account for the larger entropy of $\text{ClF}_3(\text{g})$ relative to that of $\text{Cl}_2(\text{g})$.
 - Calculate the value of the absolute entropy of $\text{F}_2(\text{g})$ at 298 K.

4)



At 25 °C the equilibrium constant, K_p , for the reaction above is 0.281 atmosphere.

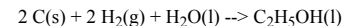
- What is ΔG°_{298} for this reaction?
- It takes 193 joules to vaporize 1.00 gram of $\text{Br}_2(\text{l})$ at 25 °C and 1.00 atmosphere pressure. What are the values of ΔH°_{298} and of ΔS°_{298} for this reaction?
- Calculate the normal boiling point of bromine. Assume that ΔH° and ΔS° remain constant as the temperature is changed.
- What is the equilibrium vapor pressure of bromine at 25 °C ?

5)

Substance	Enthalpy of Combustion ΔH° Kilojoules/mole	Absolute Entropy, S° Joules/mole-K
C(s)	-393.5	5.740
H ₂ (g)	-285.8	130.6
C ₂ H ₅ OH(l)	-1366.7	160.7
H ₂ O(l)	-----	69.91

(a) Write a separate, balanced chemical equation for the combustion of each of the following: C(s), H₂(g), and C₂H₅OH(l). Consider the only products to be CO₂(g) and/or H₂O(l).

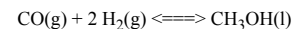
(b) In principle, ethanol can be prepared by the following reaction.



Calculate the standard enthalpy change, ΔH° , for the preparation of ethanol, as shown in the reaction above.

- Calculate the standard entropy change, ΔS° , for the reaction given in part (b).
- Calculate the value of the equilibrium constant at 25 °C for the reaction represented by the equation in part (b).

6)



For this reaction, $\Delta H^\circ = -128.1$ kilojoules

	ΔH_f° (kJ mol ⁻¹)	ΔG_f° (kJ mol ⁻¹)	S° (J mol ⁻¹ K ⁻¹)
CO(g)	-110.5	-137.3	+197.9
CH ₃ OH(l)	-238.6	-166.2	+126.8

The data in the table above were determined at 25 °C.

- Calculate ΔG° for the reaction above at 25 °C.
- Calculate K_{eq} for the reaction above at 25 °C.
- Calculate ΔS° for the reaction above at 25 °C.
- In the table above, there are no data for H₂. What are the values of ΔH_f° , ΔG_f° , and of the absolute entropy, S° , for H₂ at 25 °C?