CHAPTER 19 PRACTICE QUIZ Name_____

MULTIPLE CHOICE – NO CALCULATOR ALLOWED

1. Which of the following reactions is not thermodynamically favored at low temperatures but becomes favored as the temperature increases?

	Reaction	ΔH^o (kJ/mol$_{rxn}$)	ΔS^o (J/mol$_{rxn}$·K)
(A)	$2\ CO(g) + O_2(g) \rightarrow 2\ CO_2(g)$	–566	–173
(B)	$2\ H_2O(g) \rightarrow 2\ H_2(g) + O_2(g)$	484	90.0
(C)	$2\ N_2O(g) \rightarrow 2\ N_2(g) + O_2(g)$	–164	149
(D)	$PbCl_2(s) \rightarrow Pb^{2+}(aq) + 2\ Cl^-(aq)$	23.4	–12.5

C(diamond) → C(graphite)

2. For the reaction represented above, ΔG^o has a value of –2.9 kJ/mol, which indicates that the reaction is thermodynamically favored. However, diamond is a stable substance that does not show any evidence of conversion into graphite at 298 K and 1 atm. Which of the following best accounts for this observation?

   (A) ΔS^o for the reaction is very large.

   (B) ΔH^o for the reaction is very large.

   (C) The equilibrium constant for the reaction is very large.

   (D) The activation energy for the reaction is very large.

$$2\ K(s) + Cl_2(g) \rightarrow 2\ KCl(s) \qquad \Delta H^o = -872\ kJ/mol_{rxn}$$

3. It is observed that the reaction shown above goes essentially to completion. Which of the following is a true statement about the thermodynamic favorability of the reaction?

   (A) The reaction is favorable and driven by an enthalpy change only.

   (B) The reaction is favorable and driven by an entropy change only.

   (C) The reaction is favorable and driven by both enthalpy and entropy changes.

   (D) The reaction is unfavorable due to both enthalpy and entropy changes.

4. Which of the following processes involves the greatest increase in entropy?

(A) $SO_3(g) + H_2(g) \rightarrow SO_2(g) + H_2O(g)$

(B) $N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$

(C) $C_2H_2(g) + 2\ H_2(g) \rightarrow C_2H_6(g)$

(D) $MgSO_3(s) \rightarrow MgO(s) + SO_2(g)$

$$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(g)$$

5. The reaction above is thermodynamically favorable at 25°C. What are the signs of ΔH^o, ΔS^o, and ΔG^o ?

	ΔH^o	ΔS^o	ΔG^o
(A)	–	+	+
(B)	+	+	+
(C)	–	–	–
(D)	+	–	–

$$Sr^{2+}(aq) + F^-(aq) \rightleftharpoons SrF^+(aq)$$

6. At 25°C, the equilibrium constant for the reaction represented above has a value of 1.3. At 50°C, the value of the equilibrium constant is less than 1.3. Based on this information, which of the following must be correct?

(A) The reaction rate decreases as temperature is increased.

(B) At 25°C, ΔG^o for the reaction is positive.

(C) At 25°C, ΔS^o for the reaction is positive.

(D) At 25°C, ΔH^o for the reaction is negative.

7. Under which of the following conditions will an exothermic reaction be thermodynamically favorable?

(A) when ΔG is positive

(B) when ΔS is positive

(C) when ΔS is negative and $T > \dfrac{|\Delta H|}{|\Delta S|}$

(D) An exothermic reaction is thermodynamically favorable at all temperatures.

8. For which of the following processes does the value of ΔS decrease ($\Delta S < 0$) ?

(A) Melting of glucose

(B) Evaporation of liquid bromine

(C) Precipitation of silver chloride

(D) Sublimation of carbon dioxide

$$CH_3OH(g) \rightarrow CO(g) + 2\ H_2(g) \qquad \Delta H^o = +91\ kJ/mol_{rxn}$$

9. The reaction represented above goes essentially to completion. What can be inferred about ΔS^o for the reaction at 298 K?

(A) It must be positive because the reaction is thermodynamically unfavorable at 298 K.

(B) It must be negative because there are more moles of products than reactants.

(C) It must be positive because ΔG^o is negative and ΔH^o is positive.

(D) It must be negative because ΔG^o is positive and ΔH^o is positive.

10. A certain reaction is thermodynamically favored at temperatures below 400. K, but it is not favored at temperatures above 400. K. The value of ΔH^o for the reaction is –20 kJ/mol. What is the value of ΔS^o for the reaction? (Assume that ΔH^o and ΔS^o do not change with temperature.)

(A) $-50\ J\ mol^{-1}\ K^{-1}$

(B) $-20\ J\ mol^{-1}\ K^{-1}$

(C) $-0.050\ J\ mol^{-1}\ K^{-1}$

(D) $50\ J\ mol^{-1}\ K^{-1}$

$$Pb(s) \rightleftharpoons Pb(l)$$

11. Which of the following is true for the process represented above at 327°C and 1 atm? The normal melting point of Pb is 327°C.

(A) $\Delta H = 0$

(B) $T\Delta S = 0$

(C) $\Delta H = T\Delta S$

(D) $\Delta S < 0$

CHAPTER 19 PRACTICE QUIZ Name_____

FREE RESPONSE – CALCULATOR IS ALLOWED

$$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s) \qquad \Delta H^o_{rxn} = -63.7 \text{ kJ/mol}_{rxn}$$

1. Calcium oxide, CaO(*s*), has been proposed as a substance that can be used to heat water quickly for portable heating packs or for cooking. When placed in water, CaO(*s*) reacts as shown by the equation above.

   (a) A student wants to design a heating pad that could heat a 150.0 g sample of water from 25.0°C to 60.0°C. Calculate the amount of heat, in joules, that the water must absorb for its temperature to change by this amount. Assume that the specific heat capacity of the water is 4.18 J/(g · °C).
   Show the set-up for your calculations in order to receive full credit.
   Round off your answer to three significant figures.

   (b) Calculate the minimum mass of CaO(*s*) that the student would need to use in order to cause the temperature change described in part (a).
   Show the set-up for your calculations in order to receive full credit.
   Round off your answer to three significant figures.

   (c) The student hypothesizes that the design of the heating pad could be changed to enable it to heat 150.0 g of water from 25.0°C to 90.0°C by using a greater mass of CaO(*s*).

      (i) Use the data in the table below to determine the standard entropy change, ΔS^o_{rxn}, in J/(K · mol_{rxn}) for the reaction.

Substance	Absolute Entropy at 25°C (J/(K · mol)
CaO(*s*)	83
$H_2O(l)$	70.
$Ca(OH)_2(s)$	40.

1. (c) (ii) Is the reaction thermodynamically favorable at 90.0°C? Justify your answer with a calculation. Assume that both ΔS^{o}_{rxn} and ΔH^{o}_{rxn} are constant between 25.0°C and 90.0°C.

$$C_2H_4(g) + NH_3(g) \rightarrow CH_3CH_2NH_2(g)$$

2. Ethylene, $C_2H_4(g)$, reacts with ammonia, $NH_3(g)$, to produce ethylamine, $CH_3CH_2NH_2(g)$ as shown by the equation above.

Substance	Enthalpy of Formation at 25°C (kJ/mol)	Absolute Entropy at 25°C (J/(K · mol)
$C_2H_4(g)$	52.3	219.4
$NH_3(g)$	–46.2	192.5
$CH_3CH_2NH_2(g)$	–47.5	283.8

(a) Use the data in the table above to help you determine each of the following quantities.

(i) ΔH^{o}_{rxn} (in kJ/mol$_{rxn}$) for the reaction shown above
Show the set-up for your calculations in order to receive full credit.

(ii) ΔS^{o}_{rxn} (in J/(K · mol$_{rxn}$) for the reaction shown above.
Show the set-up for your calculations in order to receive full credit.

(b) Calculate the value of ΔG^{o}_{rxn} for the reaction shown above at 25°C.
Show the set-up for your calculations in order to receive full credit.
Include units in your answer.

2. (c) Calculate the value of the equilibrium constant (K) for this reaction at 25°C.
Show the set-up for your calculations in order to receive full credit.

(d) Calculate the temperature (in °C) at which the value of ΔG_{rxn} would be equal to zero.
Assume that both ΔS_{rxn} and ΔH_{rxn} do not change with temperature.
Show the set-up for your calculations in order to receive full credit.
Round off your answer to the nearest 1°C.

(e) This reaction is thermodynamically favorable at 25°C. What drives this chemical reaction?
Circle one of the following options.

Enthalpy only Entropy only Both enthalpy and entropy

(f) Justify your selection in part (e) in terms of ΔG^{o}_{rxn}.