CHE 107 # EXAMINATION III **23 April, 1998**

University of Kentucky **Department of Chemistry**

Name: _____ SID: _____ Seat No.: _____ Room:

	1.	For which process is ΔS_{sys} **positive**?
		A. liquid water turning to ice B. water at 25 °C is cooled to 15 °C C. sucrose is dissolved in water D. compression of a gas from 4 liters to 1 liter at constant temperature

	2.	Arrange the following reactions according to **increasing** $\Delta S°$ values (from smallest to largest). 1. $2\ KClO_4(s) \rightarrow 2\ KClO_3(s) + O_2(g)$ 2. $H_2(g) + CuO(s) \rightarrow Cu(s) + H_2O(g)$ 3. $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(2)$
		A. $3 < 2 < 1$ B. $2 < 1 < 3$ C. $2 < 3 < 1$ D. $1 < 2 < 3$

	3.	If the entropy of the universe always increases in a spontaneous process, why is it possible for sugar to crystallize out of solution, a spontaneous process that involves ordering of particles?
		A. The Second Law of Thermodynamics is only an approximation and can be violated under special circumstances. B. The entropy of a system can decrease during a spontaneous process as long as the entropy of the surroundings is increased by a greater amount. C. Crystallization always has a positive value of G, and this free energy is used to order the sugar molecules. D. The entropy of the universe **does not** always increase for spontaneous processes.

	4.	The standard enthalpy of formation of $CO(g)$ refers to the $\Delta H°$ of which reaction below?
		A. $2\ C\ (graphite) + O_2(g) \rightarrow 2\ CO(g)$ B. $C\ (diamond) + O_2(g) \rightarrow CO(g)$ C. $C(g) + O_2(g) \rightarrow CO(g)$ D. $C\ (graphite) + O_2(g) \rightarrow CO(g)$

5. The normal boiling point of benzene, C_6H_6, is 80.1 °C. Predict the signs of ΔH, ΔS, and ΔG for $C_6H_6(2)$ ---> $C_6H_6(g)$ at 75 °C and 1 atm.

	ΔH	ΔS	ΔG
A.	+	+	+
B.	–	–	–
C.	+	+	–
D.	–	–	+

6. Which response describes the thermodynamic spontaneity of the following reaction?

$$NH_4Br(s) \text{ ----> } NH_3(g) + HBr(g) \qquad \Delta H = +188 \text{ kJ}$$

A. spontaneous at all temperatures
B. spontaneous only at relatively high temperatures
C. spontaneous only at relatively low temperatures
D. non spontaneous at all temperatures

7. The equilibrium constant, K_p, for the reaction

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

is 5.62×10^{35} at 25 °C. What is ΔG° for the above reaction?

A. 204 kJ/mol B. 17.1 kJ/mol C. –204 kJ/mol D. –17.1 kJ/mol

8. The ΔG at 25 °C of gaseous mercury is 31.85 kJ/mol. What is the vapor pressure of mercury at 25 °C?

A. 750 torr B. 207 torr C. 1.99×10^{-3} torr D. 3.91×10^{-6} torr

9. Hydrogen peroxide (H_2O_2) decomposes according to the equation

$$2\ H_2O_2(2) \text{ ----> } 2\ H_2O(2) + O_2(g)$$

From the following data at 25 °C, calculate the value of K_p at 400 K for the above reaction,

$H_{xn} = -196.0$ kJ $S_{xn} = 125.65$ J/K $G_{xn} = -233.6$ kJ

A. 3.21×10^{30} B. 3.11×10^{-31} C. 6.93×10^{-33} D. 1.44×10^{32}

10. Calculate the free energy, ΔG, at 298 K for the reaction

$$N_2(g, 5\ atm) + O_2(g, 2\ atm) \rightleftharpoons 2\ NO(g, 0.10\ atm)$$

Given that: ΔG (NO) = 86.7 kJ/mol

A. 156 kJ B. 174 kJ C. –1,830 kJ D. -1.69×10^4 kJ

11. The following reaction occurs in **basic** solution:

$$MnO + I^- \text{---> } MnO_2 + I_2$$

When the equation is correctly balanced the sum of **all** the coefficients is and the charge on **each** side of the equation is _____.

	Sum of coefficients	Charge
A.	11	0
B.	17	-4
C.	22	–6
D.	25	–8

12. Arrange the following substances in order of **increasing** strength as oxidizing agents under standard–state conditions:

$$Br_2(2),\ Fe^{3+}(aq),\ Cr_2O^-(aq)$$

A. $Fe^{3+}(aq) < Br_2(2) < Cr_2O^-$ C. $Cr_2O^- < Fe^{3+}(aq) < Br_2(2)$

B. $Br_2(2) < Fe^{3+}(aq) < Cr_2O^-$ D. $Cr_2O^- < Br_2(2) < Fe^{3+}(aq)$

13. Considering the following electrochemical cell

$$Cd(s)|CdSO_4(aq, 1\ M)|KCl(sat^-d)|CuSO_4(aq, 1\ M)|Cu(s)$$

What is the cell potential for this cell?

A. –0.06 V B. 0.74 V C. 0.89 V D. 1.09

14. Which of the following statements below are **true** for the following electrochemical cell?

$$Mg|Mg^{2+}(aq)|KCl\ (sat^{-}d)|NO\ (acid\ solution)|NO(g)|Pt$$

1. Magnesium is the oxidizing agent.
2. Mg^{2+} is produced at the anode.
3. NO is produced at the cathode.
4. NO is the oxidizing agent.

A. 1 and 2 B. 1 and 3 C. 3 and 4 D. 2 and 4

15. Calculate $\Delta G°$ for the following reaction at 25 °C.

$$2\ Al(s)\ +\ 3\ Mn^{2+}\ (aq,\ 1\ M) \rightleftharpoons 2\ Al^{3+}\ (aq,\ 1\ M)\ +\ 3\ Mn(s)$$

A. -2.78×10^{2} kJ
B. $+2.53 \times 10^{3}$ kJ
C. $+1.10 \times 10^{3}$ kJ
D. -9.26×10^{1} kJ

16. An electrochemical cell consists of a standard hydrogen electrode and a copper metal electrode placed in a $CuSO_4$ solution of unknown Cu^{2+} concentration. If the measured cell potential at 25 °C is 0.30 V, what is the Cu^{2+} concentration?

A. 23 M B. 4.8 M C. 0.044 M D. 0.21 M

17. How many grams of metallic Ni can be produced by passing a current of 0.350 A through a solution of $NiCl_2$ for 5.00 hours?

A. 0.0600 g B. 1.92 g C. 3.83 g D. 55.3 g

18. Consider the reaction

$$5\ Br^{-}(aq)\ +\ BrO(aq)\ +\ 6\ H^{+}(aq)\ \text{----}>\ 3\ Br_2(aq)\ +\ 3\ H_2O(2)$$

If, in a certain experiment, Br^{-} disappears at a rate of A M/s, what is the rate of formation of Br_2 at the same time?

(the answers did not translate here, sorry)
A. M/s B. M/s C. M/s D. M/s

19. The compound, A, decomposes according to the equation: A ---> 2 B + C with a half–life of 65.0 s. If the initial concentration of A was 0.750 M, what is the concentration of A after 5.00 min? Assume first order kinetics.

A. 0.0306 M B. 0.0408 M C. 0.0469 M D. 0.711 M

20. A reaction is found to be second order in A and third order in B. What is the effect on the rate if the concentration of A is doubled and the concentration of B is halved?

A. The rate doubles.
B. The rate triples.
C. The rate is halved.
D. The rate is unchanged.

21. For the reaction A ---> B, the following data were obtained.

k (s–1)	T (K)
4.54×10^{-5}	100
6.74×10^{-3}	1000

What is the activation energy for this reaction?

A. 0.0462 J/mole B. 4.62 kJ/mole C. 556 kJ/mole D. 50.0 kJ/mole

22. The following data were obtained for the reaction

$$2\ NO + Cl_2 \text{ ----> } 2\ NOCl_2$$

Run #	[NO](M)	$[Cl_2]$(M)	initial rate (M/s)
1	0.0010	0.0020	3.55×10^{-3}
2	0.0010	0.0040	1.42×10^{-2}
3	0.0020	0.0040	2.84×10^{-2}

The reaction is:

A. First order in [NO], first order in $[Cl_2]$ and second order overall.
B. First order in [NO], second order in $[Cl_2]$ and third order overall.
C. Second order in [NO], second order in $[Cl_2]$ and second order overall.
D. Second order in [NO], fourth order in $[Cl_2]$ and fourth order overall.

23. The rate law for the reaction

$$H_2O_2 + 2\ H^+ + 2\ I^- \text{ ----> } I_2 + 2\ H_2O$$

is rate = $k[H_2O_2][I^-]$. The following mechanism has been suggested:

$H_2O_2 + I^- \text{ ---> } HOI + OH^-$	slow
$OH^- + H^+ \text{ ----> } H_2O$	fast
$HOI + H^+ + I^- \text{ ----> } I_2 + H_2O$	fast

Based on this information, which of the following statements are **true**?

1. H_2O_2 is a catalyst.
2. HOI and OH^- are intermediates.
3. The reaction is second–order in H^+.
4. Step 1 is the rate–determining step.

A. 3 and 4 B. 2 and 4 C. 2 and 3 D. 1 and 3

24. Consider the reaction below and its observed rate law.

$2\ NO_2 \text{ ---> } 2\ NO + O_2$ rate = $k[NO_2]^2$

Which of the following proposed mechanisms **are consistent** with the rate law expression?

1. $NO_2 + NO_2 \text{ ---> } N_2O_4$ slow
   $N_2O_4 \text{ ---> } N_2 + 2\ O_2$ fast
   $N_2 + O_2 \text{ ---> } 2\ NO$ fast

2. $NO_2 \text{ ---> } N + O_2$ slow
   $N + NO_2 \text{ ---> } N_2O_2$ fast
   $N_2O_2 \text{ ---> } 2\ NO$ fast

3. $NO_2 \text{ ---> } NO + O$ slow
   $O + NO_2 \text{ ---> } NO + O_2$ fast

A. 1 B. 2 C. 3 D. 1 and 3

25. Which of the following statements is **true**?

A. Catalysts are intermediates in a chemical reaction.
B. The more negative the value of $\Delta G°$ for a given reaction, the faster the rate of the reaction.
C. Enzymes are in a different phase than the reactants.
D. Catalysts lower the activation energy of a chemical reaction.