CHE 107 # EXAMINATION III **3 DEC. 1998**

University of Kentucky **Department of Chemistry**

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

	1.	What is the work done when 16.3 g of zinc dissolves in excess acid at 1.00 atm and 25 °C? $Zn(s) + 2\ H^+(aq) \text{ ----> } Zn^{2+}(aq) + H_2(g)$ Assume ideal gas behavior. A. -4.04×10^5 J B. –617 J C. –6.12 J D. –907 J

	2.	For which of the following reactions does the ΔH of the reaction correspond to the enthalpy of formation of $HNO_3(l)$? A. $H_2(g) + N_2(g) + 3\ O_2(g) \text{ ----> } 2\ HNO_3(l)$ B. $H_2(g) + N_2(g) + O_3(g) \text{ ----> } HNO_3(l)$ C. $H(g) + N(g) + O_3(g) \text{ ----> } HNO_3(l)$ D. $H_2(g) + N_2(g) + O_2(g) \text{ ----> } HNO_3(l)$

	3.	Which of these thermodynamic quantities is *not* a state function of a system? A. Enthalpy C. Entropy B. Gibbs free energy D. Work performed

	4.	Which of these reactions has $\Delta S < 0$? A. $2\ NO_2(g) \text{ ---> } 2\ NO(g) + O_2(g)$ B. $Fe(s) + 5\ CO(g) \text{ ----> } Fe(CO)_5(l)$ C. $Hg(s) \text{ ----> } Hg(l)$ D. $NaCl(s) \text{ ----> } Na^+(aq) + Cl^-(aq)$

	5.	Using the following information, find the standard entropy change for the following reaction at 25 °C. $CH_3COCH_3(2) + 4\ O_2(g) \text{ ----> } 3\ CO_2(g) + 3\ H_2O(2)$ **S%(J/K-mol)** CH_3COCH_3 198.74 O_2 205.0 $CO_2(g)$ 213.6 $H_2O(2)$ 69.9 A. 687.2 J/K B. –120.2 J/K C. –168.2 J/K D. –336.5 J/K
	6.	What is K_p for the following reaction at 25 °C? $N_2(g) + O_2(g) \rightleftharpoons 2\ NO(g)$ ΔH of $NO(g)$ = 90.4 kJ/mol, S° of $N_2(g)$ = 191.5 J/K•mol, S° of $O_2(g)$ = 205.0 J/K•mol, S° of $NO(g)$ = 210.6 J/K•mol. A. 4.0×10^{-31} B. 6.3×10^{-16} C. 2.5×10^{30} D. 2.8×10^{-15}
	7.	Sodium carbonate, Na_2CO_3, can be made by heating sodium hydrogen carbonate $2\ NaHCO_3(s) \text{ ----> } Na_2CO_3(s) + CO_2(g) + H_2O(g)$ $\Delta H°$ for the reaction is 129 kJ. Which of the following statements is true? A. The reaction is spontaneous at all temperatures. B. The reaction is never spontaneous. C. The reaction is spontaneous at high temperatures. D. The reaction is spontaneous at low temperatures.
	8.	What is $\Delta G°$ at 1500 °C for the reaction $CO(g) + 2\ H_2(g) \rightleftharpoons CH_3OH(g)$ if the equilibrium constant for the reaction at 1500 °C is 1.4×10^{-7}? A. –233 kJ B. 39.1 kJ C. –197 kJ D. 233 kJ
	9.	Hydrogen iodine has an enthalpy of vaporization of 21.16 kJ/mol and an entropy of vaporization of 89.0 J/K•mol. What is the normal boiling point of hydrogen iodide? A. 238 °C B. 100 °C C. –35 °C D. 42 °C

10. Which statement is true about any system with $\Delta G = 0$?

A. $\Delta H = -T\Delta S$
B. $K_{eq} = 0$
C. All of the components are in their standard states.
D. $\Delta G° = -RT \ln K_{eq}$

11. What is ΔG at 25 °C for the following reaction

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

when $P_{N2} = 0.10$ atm, $P_{H2} = 2.0$ atm and $P_{NH3} = 1.5$ atm?

$\Delta G°$ for the reaction is –33.2 kJ.

A. –35.8 kJ B. –30.6 kJ C. 2.53×10^3 kJ D. 182 kJ

12. A negative sign for the Gibbs free energy of a reaction indicates that

A. the entropy change of the **universe** is negative.
B. the reaction is exothermic.
C. the reaction is spontaneous.
D. the entropy change of the system is positive.

13. Which statement is **true**?

A. Standard entropies of formation of pure elements are always equal to zero.
B. "Standard heat of formation" is a synonym for "standard entropy of formation."
C. $\Delta H°$ for the reaction C(graphite) + 2 H_2(g) ----> CH_4(g) defines $\Delta H_f°$ of CH_4(g).
D. The standard enthalpy of formation of N_2 (g) is greater than zero.

14. When this redox reaction carried out in acidic, aqueous solution is balanced, what are the minimum integral coefficients for the indicated reagents?

$$Cr_2O^- + C_2O^- + H^+ \rightleftharpoons Cr^{3+} + CO_2 + H_2O$$

	Cr_2O^-	H^+	CO_2
A.	1	14	6
B.	2	14	6
C.	1	7	3
D.	2	7	3

15. Which statement is *not* correct about this redox reaction?

$$3\ Cu(s) + 2\ HNO_3(aq) + 6\ H^+(aq) \rightleftharpoons 3\ Cu^{2+}(aq) + 2\ NO(g) + 4\ H_2O(l)$$

A. Cu is oxidized.
B. H^+ is oxidized
C. HNO_3 is reduced
D. The number of electrons transferred is 6.

16. Which of the following statements is true for the electrochemical cell below?

$$Pt(s) \mid H_2(g) \mid H^+(aq) \mid KCl(sat^-d) \mid Ag^+(aq) \mid Ag(s)$$

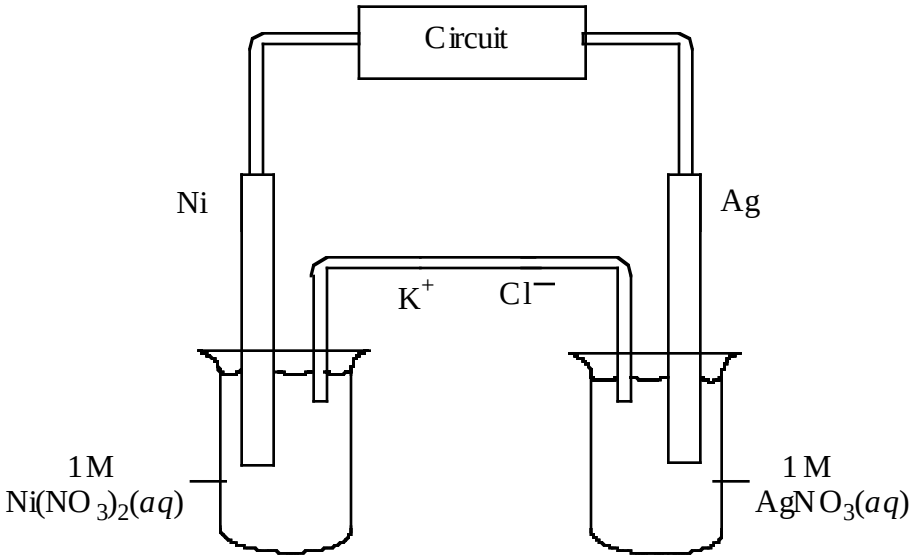
A. Platinum is produced at the anode and Ag^+ is produced at the cathode.
B. H_2 is oxidized at the cathode and Ag^+ is reduced at the anode.
C. H_2 is the reducing agent and Ag^+ is the oxidizing agent.
D. H^+ is produced at the anode and Ag^+ is produced at the cathode.

17. Calculate the standard cell emf of this cell at 25 °C.

$$Cd(s) \mid Cd^{2+}(1.0\ M) \mid\mid Ag^+(1.0\ M) \mid Ag(s)$$

A. +2.00 V B. +1.20 V C. +0.40 V D. –0.40 V

18. Which statement is correct about the illustrated galvanic cell? Use the table of standard reduction potentials.



A. The nickel electrode is the anode.
B. Electrons flow into the nickel electrode from the external circuit.
C. Nickel metal will plate out on the nickel electrode.
D. In the salt bridge, K^+ ions will migrate toward the nickel electrode.

19. What is the cell emf (E) at 25 °C for the reaction

$$Cu^{2+}(aq) + H_2(g) \rightleftharpoons Cu(s) + 2\,H^+(aq)$$

when $[Cu^{2+}] = 0.25$ M, $P_{H2} = 1.00$ atm and $[H^+] = 1.00 \times 10^{-3}$ M?

A. 0.18 V B. 0.27 V C. 0.41 V D. 0.50 V

20. Which statement is true about the protection of an iron object from corrosion by connecting it to a piece of a different metal? Consult the table of standard reduction potentials.

A. A piece of calcium connected to the iron object would act as the cathode and the iron object as the anode.
B. If a piece of magnesium were connected, the reaction which would occur at the iron object is $O_2(g) + 4\,H^+(aq) + 4\,e^- \text{----> } 2\,H_2O(2)$.
C. A piece of silver would provide cathodic protection of the iron object.
D. If a piece of zinc were connected, the reaction which would occur at the zinc object is $Zn^{2+}(aq) + 2\,e^- \text{----> } Zn(s)$.

21. A 1.0 *M* aqueous solution of KCl is electrolyzed using platinum electrodes at a potential of 2.0 V. What are the products formed at the anode and cathode?

	Anode	Cathode
A.	Cl_2 (*g*)	H_2 (*g*)
B.	Cl_2 (*g*)	K (*s*)
C.	H_2 (*g*)	O_2 (*g*)
D.	K (*s*)	Cl_2 (*g*)

22. Calculate the standard free–energy change for this reaction carried out at 25 °C with $[Al^{3+}] = [Fe^{2+}] = 1.00$ *M*.

$$2\,Al(s) + 3\,Fe^{2+}(aq) \rightleftharpoons 2\,Al^{3+}(aq) + 3\,Fe(s)$$

A. –118 kJ B. –706 kJ C. 118 kJ D. –1158 kJ

23. Two electrolytic cells are connected in series, the first containing 1.0 *M* aqueous $AgNO_3$ and the second containing 1.0 *M* aqueous $Cu(NO_3)_2$. A reducing current is passed through both cells and 0.108 g of Ag metal is deposited. How much copper metal is deposited?

A. 0.032 g B. 0.108 g C. 0.064 g D. 0.094 g

	24.	Which one of these substances can oxidize $H_2O(2)$ to $O_2(g)$ according to the reaction $2\ H_2O(2)\ \text{----}>\ O_2(g)\ +\ 4\ H^+(aq)\ +\ 4\ e^-$ under standard conditions? Consult the table of standard reduction potentials.
		A. $Cl^-(aq)$ B. $Ag(s)$ C. $Pb^{2+}(aq)$ D. $Cl_2(g)$

	25.	A current of 0.50 A is passed through an electrolytic cell containing molten $MgCl_2$ for 2.00 h. How much magnesium metal is produced, assuming 100% electrochemical efficiency?
		A. 0.45 g B. 0.91 g C. 3.6 g D. 49 g