CHM 1046 Exam 4

1. Given the data:
$Ni(CO)_4(g)$, ΔH_f° = -220.0 kJ mol^{-1}, S° = +399 J mol^{-1} K^{-1}
Ni(s), ΔH_f° = 0.00 kJ mol^{-1}, S° = +30 J mol^{-1} K^{-1}
CO (g), ΔH_f° = -110.0 kJ mol^{-1}, S° = +197.9 J mol^{-1} K^{-1}
calculate the standard free energy change, $\Delta G°$ for the reaction,
$Ni(CO)_4(g) \rightarrow Ni(s) + 4\ CO(g)$
A. -94 kJ
B. -169 kJ
C. -271 kJ
*D. -346 kJ
E. -412 kJ

2. Which one of the following reactions is accompanied by an increase in entropy?
A. $C_{12}H_{20}$ (l) + 17 O_2,(g) → 12 CO_2 (g) + 10 H_2O(l)
*B. $NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$
C. 2 C_2H_2(g) + 5 O_2(g) → 4 CO_2(g) + 2 H_2O(s)
D. $Ba(OH)_2(s) + 2\ HCl(g) \rightarrow BaCl_2\ 2H_2O(s)$
E. $(CH_3)_2CO(l) + 4\ O_2$,(g) → 3 CO_2 (g) + 3 H_2O(l)

3. Assuming that, since the physical states do not change, the values of ΔH and ΔS do not change as we shift temperature, and using,
CdO(s), ΔH_f° = -258.2 kJ mol^{-1}, S° = +54.8 J mol^{-1} K^{-1}
$CdSO_4$(s), ΔH_f° = -933.5 kJ mol^{-1}, S° = +123 J mol^{-1} K^{-1}
SO_3(g), ΔH_f° = -396 kJ mol^{-1}, S° = +256 J mol^{-1} K^{-1}
calculate a value for the free energy change, ΔG_T° for the reaction,
$CdSO_4(s) \rightarrow CdO(s) + SO_3(g)$ at 750 K
A. +223.3 kJ
*B. +138.5 kJ
C. +296.0 kJ
D. +420.5 kJ
E. +335.3 kJ

4. Using the standard free energies of formation:
$NO_2(g)$, ΔG_f°; = +51.84 kJ mol^{-1}
$NO(g)$, ΔG_f°; = +86.69 kJ mol^{-1}
$SO_2(g)$, ΔG_f°; = -300.0 kJ mol^{-1}
$SO_3(g)$, ΔG_f°; = -370.0 kJ mol^{-1}
calculate the standard free energy change, $\Delta G°$; for the reaction:
$NO_2(g) + SO_2(g) \rightarrow NO(g) + SO_3(g)$
*A. -35.15 kJ
B. -104.9 kJ
C. -429.2 kJ
D. -619.6 kJ
E. -808.5 kJ

5. Using the standard entropy values:
$H_2(g)$, S° = +130.6 J mol^{-1} K^{-1}
$I_2(s)$, S° = +116.12 J mol^{-1} K^{-1}
HI(g), S° = +206.0 J mol^{-1} K^{-1}
calculate the standard entropy change, ΔS°, for the reaction:
$H_2(g) + I_2(s), \rightarrow 2\ HI(g)$
A. -40.8 kJ
B. +40.8 kJ
C. -165.3 kJ
*D. +165.3 kJ
E. +206.0 kJ

6. The reaction, M_2O_3,(s), + C(s) → M(s), + CO_2(g), is spontaneous at low temperatures but non-spontaneous at high temperatures. If we assume that, since the physical states do not change, the values of ΔH_T° and ΔS_T° are constant over a wide temperature range, including 25.0°C, we can deduce that, over this range
A. ΔH < 0 and ΔS > 0
*B. ΔH < 0 and ΔS < 0
C. ΔH > 0 and ΔS < 0
D. ΔH > 0 and ΔS > 0
E. the information is insufficient to make an judgment as to the signs of ΔH and ΔS

7. Which one of the sets below has the species listed in order of increasing standard entropy, S°?
A. $NaHCO_3$(s), < C_2H_5OH(I) < Cr(s), < N_2(g)
B. Cr(s), < N_2(g) < $NaHCO_3$(s) < C_2H_5OH(l)
C. Cr(s) < C_2H_5OH(I) < $NaHCO_3$,(s), < N_2(g)
*D. Cr(s), < $NaHCO_3$,(s), < C_2H_5OH(I) < N_2(g)
E. N_2(g) < $NaHCO_3$(s) < Cr (s) < C_2H_5OH(l)

8. Which statement below is always true for a spontaneous chemical reaction
A) $\Delta S_{sys} + \Delta S_{surr} = 0$
B) $\Delta S_{sys} + \Delta S_{surr} < 0$
*C) $\Delta S_{sys} + \Delta S_{surr} > 0$
D $\Delta S_{sys} - \Delta S_{surr} = 0$
E) $\Delta S_{sys} - \Delta S_{surr} < 0$

9. Given the data:
$NH_3(g)$, ΔH_f° = -46.0 kJ mol^{-1}, S° = +192.5 J mol^{-1} K^{-1}
NO(g), ΔH_f° = +90.4 kJ mol^{-1}, S° = +210.6 J mol^{-1} K^{-1}
$H_2O(l)$, ΔH_f° = -286 kJ mol^{-1}, S° = +69.96 J mol^{-1} K^{-1}
$O_2(g)$, ΔH_f° = -0.00 kJ mol^{-1}, S° = +205 J mol^{-1} K^{-1}
calculate the standard free energy change, ΔG° for the reaction:
$2\ NH_3(g) + 5/2\ O_2(g) \rightarrow 2\ NO(g) + 3\ H_20(l)$
A. -100.8 kJ
B. -206.7 kJ
C. -276.5 kJ
*D. -505.8 kJ
E. -664.3 kJ

10. Given the data:
$Ag_2O(s)$, ΔH_f° = -31.1 kJ mol^{-1}, S° = +121.3 J mol^{-1} K^{-1}
$O_2(g)$, ΔH_f° = 0.00 kJ mol^{-1}, S° = +205 J mol^{-1} K^{-1}
Ag(s), ΔH_f° = 0.00 kJ mol^{-1}, S° = +42.55 J mol^{-1} K^{-1}
calculate the standard free energy change ΔG°for the reaction:
$Ag_2O(s) \rightarrow 2\ Ag(s) + 1/2\ O_2(g)$
*A. +11.3 kJ
B. -24.0 kJ
C. -38.2 kJ
D. -50.4 kJ
E. -50.9 kJ

11. The expression for the solubility product of silver oxalate ($Ag_2C_2O_4$) is
A. $[Ag_2^{2+}][C_2O_4^{2-}]$
B. $[Ag^+][C_2O_4^{2-}]^2$
C. $2[Ag^+][C_2O_4^{2-}]$
*D. $[Ag^+]^2[C_2O_4^{2-}]$
E. $2[Ag^+]^2[C_2O_4^{2-}]$

12. The solubility product for $PbCl_2$ is 1.7×10^{-5}. What is the solubility of $PbCl_2$ in pure water, in moles per liter?
A. 2.4×10^{-4} mol L^{-1}
B. 6.2×10^{-2} mol L^{-1}
C. 7.7×10^{-3} mol L^{-1}
*D. 1.6×10^{-2} mol L^{-1}
E. 6.0×10^{-5} mol L^{-1}

13. The solubility product of lead fluoride, (PbF_2) is 3.6×10^{-8}. What is its solubility in 0.10 M NaF solution, in grams per liter?
*A. 8.8×10^{-4} g L^{-1}
B. 3.9×10^{-4} g L^{-1}
C. 13 g L^{-1}
D. 3.9×10^{-3} g L^{-1}
E. 8.8×10^{-5} g L^{-1}

14. Will a precipitate form (yes or no) when 20.0 mL of 1.8×10^{-3} M $Pb(NO_3,)_2$ is added to 30.0 mL of 5.0×10^{-4} M Na_2SO_4? The k_{sp} of ($PbSO_4$) is 6.3 x 10-^{7}.
*A. no, because the ion product < K_{sp}
B. no, because the ion product > K_{sp}
C. yes, because the ion product < K_{sp}
D. yes, because the ion product > K_{sp}
E. no, because the ion product > K_{sp}

15. Which one of the following salts has the highest solubility in water, expressed in moles per liter?
A. PbF_2, $K_{sp} = 3.6 \times 10^{-8}$
B. Ag_2CrO_4, $K_{sp} = 1.2 \times 10^{-12}$
C. CaF_2, $K_{sp} = 3.9 \times 10^{-11}$
*D. BaF_2, $K_{sp} = 1.7 \text{ X } 10^{-6}$
E. PbI_2, $K_{sp} = 7.9 \times 10^{-9}$

16. Calculate the concentration of iodate ions in a saturated solution of barium iodate. The $K_{sp} = 1.5 \times 10^{-9}$.
*A. 1.4×10^{-3} M
B. 2.3×10^{-3} M
C. 7.2×10^{-4} M
D. 3.9×10^{-5} M
E. $7.7 \text{ X } 10^{-5}$ M

17. The solubility of barium carbonate is 14.8 mg L^{-1}at 30 °C. calculate the K_{sp} value for $BaCO_3$.
A. 7.5×10^{-5}
B. 1.5×10^{-4}
*C. 5.6×10^{-9}
D. 7.5×10^{-6}
E. 1.5 x 10-3