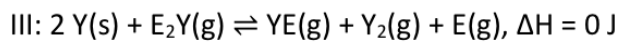
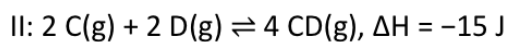


1) The equilibrium constant  $K_c$  for forming Nitrogen monoxide gas from its elements is  $1.0 \times 10^{-5}$  at 1500K. If 0.80 mol of  $N_2$  and 0.20 mol of  $O_2$  were placed in a 1L flask, what is the equilibrium concentration of NO?

- A)  $6.32 \times 10^{-4}$  M
- B)  $1.26 \times 10^{-3}$  M
- C)  $3.16 \times 10^{-4}$  M
- D)  $8.94 \times 10^{-4}$  M
- E)  $1.79 \times 10^{-3}$  M

2)  $K_c$  for the reaction  $C_2 + D_2 \leftrightarrow 2CD$  is 2.0 at 600°C. 0.50 mol of each reactant are put in a 2L flask, predict the percent yield of CD at 600°C.

3) For which of the following reactions does  $K_c = K_p$  at  $25^\circ\text{C}$ ?



A) I only

B) II only

C) III only

D) I and II only

E) II and III only

4) Sodium-24 is a radioactive isotope that decays via first order kinetics and has a half-life of 15 hours. What fraction of an original sample of sodium-24 will decompose in 3 days?

5) Given the overall reaction  $2\text{H}_2 + 2\text{NO} \rightarrow 2\text{H}_2\text{O} + \text{N}_2$  and the following mechanism:

Step 1:  $\text{NO} + \text{NO} \rightleftharpoons \text{N}_2\text{O}_2$  (fast)

Step 2:  $\text{N}_2\text{O}_2 + \text{H}_2 \rightarrow \text{H}_2\text{O} + \text{N}_2\text{O}$  (slow)

Step 3:  $\text{N}_2\text{O} + \text{H}_2 \rightarrow \text{N}_2 + \text{H}_2\text{O}$  (fast)

Which of the following is/are true?

I: The rate law for the overall reaction is  $\text{Rate} = k[\text{N}_2\text{O}_2][\text{H}_2]$

II: The absolute value of the rate of change of  $\text{H}_2$  is  $\frac{1}{2}$  the rate of change of  $\text{N}_2$

III: The rate of the reaction is dependent only on  $\text{H}_2$

A) Only I    B) Only II    C) II and III    D) I and II    E) None

6) Draw all the structural isomers of  $C_5H_{12}$ .

7) Given the reaction for the following hypothetical weak acid:  $HA + H_2O \rightleftharpoons NaA + H_3O^+$ , which would increase the buffer component concentration ratio?

I: Adding 0.1 M NaOH to the buffer    II: Adding 0.1 M HCl to the buffer

A) I only      B) II only      C) both      D) none

8) Calculate the pH of a 0.20 M  $Na_2CO_3$  solution.  $K_a$  of  $HCO_3^-$  is  $4.8 \times 10^{-11}$

- A) 8.49
- B) 2.19
- C) 5.51
- D) 11.81
- E) 9.62

9) A 1.00g piece of chalk containing  $\text{CaCO}_3$  (and other materials) was placed in 500. mL of hydrochloric acid solution with an initial pH of 1.00. After all of the  $\text{CaCO}_3$  reacts with the HCl (forming  $\text{CO}_2$  gas,  $\text{H}_2\text{O}$ ,  $\text{Ca}^{2+}$ , and  $\text{Cl}^-$ ), the final pH is 1.19. About what mass percent of the chalk was  $\text{CaCO}_3$ ?

10) Hypobromous acid is a commonly used disinfectant in swimming pools. At  $25^\circ\text{C}$   $\text{HBrO}$  dissociates in water with a  $K_a = 2.3 \times 10^{-9}$ . Is this dissociation a spontaneous process when  $[\text{H}_3\text{O}^+] = 6.0 \times 10^{-4} \text{ M}$ ,  $[\text{BrO}^-] = 0.10 \text{ M}$ , and  $[\text{HBrO}] = 0.20 \text{ M}$ ?

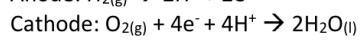
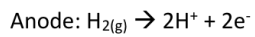
- A) Yes, because  $\Delta G > 0$
- B) No, because  $\Delta G > 0$
- C) Yes, because  $\Delta G < 0$
- D) No, because  $\Delta G < 0$

11) What is the value for the standard free energy of the following reaction:



- A) +432.3 kJ/mol      B) -432.3 kJ/mol      C) +216.1 kJ/mol      D) -216.1 kJ/mol

12) A hydrogen fuel cell operates with the following half reactions:



If the initial  $P_{\text{O}_2}$  is 4 atm, what initial  $P_{\text{H}_2}$  is required for the cell to generate a voltage of 1.25V?

13) The magnetic moment of an inorganic complex represents the number of unpaired electrons present in its d-orbital splitting configuration. A complex  $[\text{MCl}_6]^{4-}$  has a magnetic moment of around 3. Which two elements in the 3d block could be "M"?

- A) V and Ni    B) V and Co    C) Sc and Ni    D) Sc and Co

14) Rank the following in order of increasing magnetism. I:  $[\text{Mn}(\text{NO}_2)_6]^{1-}$  II:  $[\text{Fe}(\text{en})_3]^{2+}$  III:  $[\text{CoCl}_3\text{F}_3]^{3-}$

- A) I < II < III    B) I < III < II    C) II < III < I    D) II < I < III    E) III < I < II

15) What is the binding energy per nucleon of fluorine?

16) Which of the following would buffer systems would you most optimally choose to create a buffer of pH = 6.50? The  $K_a$  of  $H_2B = 1 \times 10^{-5}$  and the  $k_a$  of  $HB^- = 1 \times 10^{-7}$ .

- A)  $B^{2-} / H_2B$
- B)  $B^{2-} / HB^-$
- C)  $HB^- / H_2B$
- D)  $HB^- / HB_2$
- E)  $B^{2-} / HB_2$



17) Calculate the molar solubility of  $\text{Ag}_2\text{CO}_3$  at  $25^\circ\text{C}$ .  $K_{\text{sp}} = 8.1 \times 10^{-12}$

18) Which of the following reactions would you expect to be spontaneous at high temperatures but nonspontaneous at low temperatures?

- A) An exothermic reaction with  $S^\circ_{\text{reaction}} < 0$
- B) An endothermic reaction with  $S^\circ_{\text{reaction}} < 0$
- C) An exothermic reaction with  $S^\circ_{\text{reaction}} > 0$
- D) An endothermic reaction with  $S^\circ_{\text{reaction}} > 0$
- E) Such a reaction does not exist

19) Is  $\text{MnO}_4^-$  or  $\text{Br}_2$  a stronger oxidizing agent? Explain.

20) True or False: CaO is a more basic oxide than Rb<sub>2</sub>O.

21) Consider the complex trans-[Co(CH<sub>3</sub>NH<sub>2</sub>)<sub>4</sub>Cl<sub>2</sub>]NO<sub>3</sub>, what is the coordination number and the oxidation state, respectively, of the transition metal ion?