

1) The equilibrium constant K_c for forming Nitrogen monoxide gas from its elements is 1.0×10^{-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) 6.32×10^{-4} M
- B) 1.26×10^{-3} M
- C) 3.16×10^{-4} M
- D) 8.94×10^{-4} M
- E) 1.79×10^{-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°C?

I: $3 A(s) + 5 B(g) \rightleftharpoons 3 AB(g) + B_2(g)$, $\Delta H = 30$ J

II: $2 C(g) + 2 D(g) \rightleftharpoons 4 CD(g)$, $\Delta H = -15$ J

III: $2 Y(s) + E_2Y(g) \rightleftharpoons YE(g) + Y_2(g) + E(g)$, $\Delta H = 0$ J

- 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?

96.4%

5) Given the overall reaction $2H_2 + 2NO \rightarrow 2H_2O + N_2$ and the following mechanism:

Step 1: $NO + NO \rightleftharpoons N_2O_2$ (fast)

Step 2: $N_2O_2 + H_2 \rightarrow H_2O + N_2O$ (slow)

Step 3: $N_2O + H_2 \rightarrow N_2 + H_2O$ (fast)

Which of the following is/are true?

I: The rate law for the overall reaction is $\text{Rate} = k[N_2O_2][H_2]$

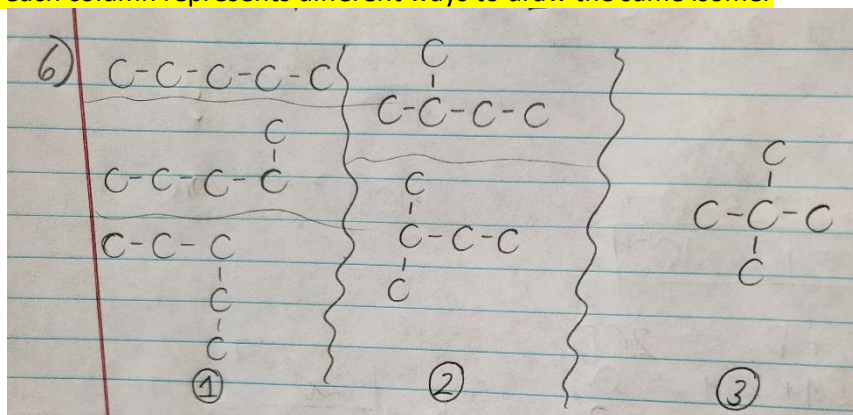
II: The absolute value of the rate of change of H_2 is $\frac{1}{2}$ the rate of change of N_2

III: The rate of the reaction is dependent only on 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} .

There's 3 – each column represents different ways to draw the same isomer



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 4.8×10^{-11}

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

9) A 1.00g piece of chalk containing $CaCO_3$ (and other materials) was placed in 500. mL of hydrochloric acid solution with an initial pH of 1.00. After all of the $CaCO_3$ reacts with the HCl (forming CO_2 gas, H_2O , Ca^{2+} , and Cl^-), the final pH is 1.19. About what mass percent of the chalk was $CaCO_3$?

89%

10) Hypobromous acid is a commonly used disinfectant in swimming pools. At $25^\circ C$ $HBrO$ dissociates in water with a $K_a = 2.3 \times 10^{-9}$. Is this dissociation a spontaneous process when $[H_3O^+] = 6.0 \times 10^{-4} M$, $[BrO^-] = 0.10 M$, and $[HBrO] = 0.20 M$?

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

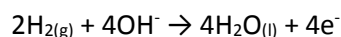
- C) Yes, because $\Delta G < 0$
D) No, because $\Delta G < 0$

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 reaction taking place at the anode:



What volume of H_2 gas at 30°C and 120 atm is required for the fuel cell to run a motor drawing 8.5A for 10.0 hours? 0.33L

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?

1.25x10⁻¹² J/nucleon

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 $\text{H}_2\text{B} = 1 \times 10^{-5}$ and the k_a of $\text{HB}^- = 1 \times 10^{-7}$.

- A) $\text{B}^{2-} / \text{H}_2\text{B}$
B) $\text{B}^{2-} / \text{HB}^-$
C) $\text{HB}^- / \text{H}_2\text{B}$
D) $\text{HB}^- / \text{HB}_2$
E) $\text{B}^{2-} / \text{HB}_2$

17) Calculate the molar solubility of Ag_2CO_3 at 25°C . $K_{sp} = 8.1 \times 10^{-12}$

1.27×10^{-4}

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 MnO_4^- or Br_2 a stronger oxidizing agent? Explain.

MnO_4^- is a stronger oxidizing agent because its oxidation number is a larger difference from its ground state. The oxidation number of Mn is +7 which is the maximum amount of electrons Mn can lose, whereas Br_2 is in its ground state and stable.

20) True or False: CaO is a more basic oxide than Rb_2O .

False – more metallic = more basic, and Rb is more metallic than Ca

21) Consider the complex $\text{trans}[\text{Co}(\text{CH}_3\text{NH}_2)_4\text{Cl}_2]\text{NO}_3$, what is the coordination number and the oxidation state, respectively, of the transition metal ion?

Six, +3