

Name \_\_\_\_\_

Honors Chemistry

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**Final Exam -2013 Version A****Bubble the correct answer for each of the following on your scantron.**

1. A solution is prepared by mixing 23.0 g ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ) with 100.0 g water to give a final volume of 119 mL. Calculate the molarity of ethanol in this solution.

- (A) 2.03 M      (B) 4.20 M      (C) 4.06 M      (D) 1.93 M      (E) 8.90 M

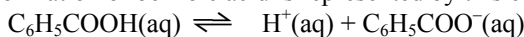
2. When hafnium metal is heated in an atmosphere of chlorine gas, the product of the reaction is found to contain 62.6 percent Hf by mass and 37.4 percent Cl by mass. What is the empirical formula for this compound?

- (A)  $\text{HfCl}$       (B)  $\text{HfCl}_2$       (C)  $\text{HfCl}_3$       (D)  $\text{HfCl}_4$       (E)  $\text{Hf}_2\text{Cl}_3$

3. Which of the following reactions has the largest positive value of  $\Delta S$  per mole of  $\text{Cl}_2$

- (A)  $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2 \text{HCl}(\text{g})$       (B)  $\text{Cl}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{Cl}_2\text{O}(\text{g})$   
(C)  $\text{Mg}(\text{s}) + \text{Cl}_2(\text{g}) \rightarrow \text{MgCl}_2(\text{s})$       (D)  $2 \text{NH}_4\text{Cl}(\text{s}) \rightarrow \text{N}_2(\text{g}) + 4 \text{H}_2(\text{g}) + \text{Cl}_2(\text{g})$   
(E)  $\text{Cl}_2(\text{g}) \rightarrow 2 \text{Cl}(\text{g})$

4. The ionization of benzoic acid is represented by this equation.



If a 0.045 M solution of benzoic acid has an  $[\text{H}^+] = 1.7 \times 10^{-3}$ , what is the  $K_a$  of benzoic acid?

- (A)  $7.7 \times 10^{-5}$       (B)  $2.9 \times 10^{-6}$       (C)  $3.8 \times 10^{-2}$   
(D)  $8.4 \times 10^{-1}$       (E)  $6.7 \times 10^{-5}$

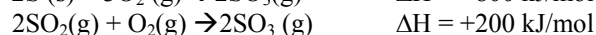
5. A compound contains 1.10 mol of K, 0.55 mol of Te, and 1.65 mol of O. What is the simplest formula of this compound?

- (A)  $\text{KTeO}$       (B)  $\text{KTe}_2\text{O}$       (C)  $\text{K}_2\text{TeO}_3$       (D)  $\text{K}_2\text{TeO}_6$       (E)  $\text{K}_4\text{TeO}_6$

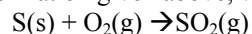
6. Which type of radiation continues in a straight line when passed through an electric field?

- (A) alpha      (B) positron      (C) beta      (D) proton      (E) gamma

7.  $2\text{S}(\text{s}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$        $\Delta H = +800 \text{ kJ/mol}$



Based on the information given above, what is the  $\Delta H$  for the following reaction?



- (A) 300 kJ      (B) 500 kJ      (C) 600 kJ      (D) 1000 kJ      (E) 1200 kJ

8.  $2\text{Al} + 3\text{FeO} \rightarrow \text{Al}_2\text{O}_3 + 3\text{Fe}$  – A student uses 32.0 grams of aluminum and produces 80.4 grams of iron. What is his percent yield?

- (A) 81.0%      (B) 40.5%      (C) 99.2%      (D) 39.8%      (E) none of the above

9. A gas has a volume of 4.0 L at a pressure of 0.80 atm. What is the volume if the pressure is changed to 0.20 atm at constant temperature?

- (A) 1.0 L      (B) 2.0 L      (C) 8.0 L      (D) 6 L      (E) 16 L

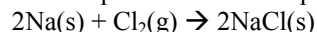
10. Pi bonding occurs in each of the following species EXCEPT

- (A)  $\text{CO}_2$       (B)  $\text{CO}_3^{2-}$       (C)  $\text{CCl}_2\text{F}_2$       (D)  $\text{SeO}_2$       (E)  $\text{HCN}$

11.  $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$  – How many grams of NaCl can be produced from 4.00 mole of sodium?

- (A) 4.00 grams      (B) 234 grams      (C) 468 grams      (D) 117 grams      (E) none of the above

12. When pure sodium is placed in an atmosphere of chlorine gas, the following spontaneous reaction occurs.



Which of the following statements is true about the reaction?

- I.  $\Delta S > 0$                       II.  $\Delta H < 0$                       III.  $\Delta G > 0$

- (A) I only              (B) II only              (C) I & II only              (D) II & III only              (E) I, II & III

13. What is the conjugate base of  $\text{H}_2\text{PO}_4^-$ ?

- (A)  $\text{HPO}_4^{2-}(\text{aq})$               (B)  $\text{H}_2\text{O(l)}$               (C)  $\text{HPO}_4^-(\text{aq})$   
(D)  $\text{H}_3\text{PO}_4(\text{aq})$               (E)  $\text{HPO}_4$

14. How many moles of calcium fluoride,  $\text{CaF}_2$ , must be dissolved in 2.0 L of water at  $25^\circ\text{C}$  to form a saturated solution?  $\text{CaF}_2$   $1.6 \times 10^{-10}$   $K_{\text{sp}}$  at  $25^\circ\text{C}$

- (A)  $2.6 \times 10^{-2}$  mol              (B)  $1.3 \times 10^{-3}$  mol              (C)  $6.8 \times 10^{-4}$  mol  
(D)  $3.4 \times 10^{-4}$  mol              (E)  $1.6 \times 10^{-10}$  mol

15. Hydrogen gas is collected over water at  $21^\circ\text{C}$ . At  $21^\circ\text{C}$  the vapor pressure of water is 18.7 torr. If the barometric pressure is 758 what is the pressure of hydrogen gas?

- (A) 758 torr              (B) 739 torr              (C) 777 torr              (D) 48.2 torr              (E) 18.7 torr

16. Which species has the smallest Cl-A-Cl bond angle where A is the central atom?

- (A)  $\text{SCl}_6$               (B)  $\text{CCl}_4$               (C)  $\text{NCl}_3$               (D)  $\text{OCl}_2$               (E)  $\text{BCl}_3$

17. Which of the following is true about ionic compounds?

- I. They are most crystalline solids at room temperature.  
II. They only conduct electricity when dissolved in water.  
III. They have free moving electrons.

- (A) I only                      (B) I and II only                      (C) I and III only  
(D) II and III only                      (E) I, II, and III

18. If 345 grams of  $\text{AlCl}_3$  is dissolved in 890. grams of water, what is the mole fraction of aluminum chloride in water?

- (A) 0.388              (B) 38.8              (C) 0.0522              (D) 0.0496              (E) 2.90

19.  $\text{C}_6\text{H}_5\text{OH(aq)} + \text{CN}^-(\text{aq}) \rightleftharpoons \text{HCN(aq)} + \text{C}_6\text{H}_5\text{O}^-(\text{aq})$

The equilibrium constant for this reaction is less than 1. What is the strongest base in this system?

- (A)  $\text{C}_6\text{H}_5\text{OH(aq)}$               (B)  $\text{CN}^-(\text{aq})$               (C)  $\text{HCN(aq)}$   
(D)  $\text{C}_6\text{H}_5\text{O}^-(\text{aq})$               (E) all bases are equal in strength

20. A sample of 5.16 grams of an ideal gas at  $150.0^\circ\text{C}$  and 1.25 atmospheres pressure has a volume of 2.00 liters. What is the molar mass of the gas?

- (A) 0.0218 gram/mole              (B) 16.2 grams/mole              (C) 37.0 grams/mole  
(D) 71.6 grams/mole              (E) 45.8 grams/mole

21. A 580. mL solution contains 120. mL of ethanol ( $\text{C}_2\text{H}_5\text{OH}$ ). Calculate the volume percent of this solution.

- (A) 4.83%              (B) 20.7%              (C) 7.47%              (D) 4.50%              (E) 0.207%

22. Determine the boiling point if 600. grams of toluene ( $\text{C}_7\text{H}_8$ ) is dissolved in 800. grams of benzene ( $\text{C}_6\text{H}_6$ ).

Boiling Point of benzene:  $80.10^\circ\text{C}$ ,  $K_b = 2.53 \text{ kg}\cdot\text{K}\cdot\text{mol}^{-1}$

- (A)  $59.5^\circ\text{C}$               (B)  $100.7^\circ\text{C}$               (C)  $20.6^\circ\text{C}$               (D)  $82.00^\circ\text{C}$               (E)  $1.90^\circ\text{C}$

23. A 0.239 g sample of a gas in a 100-mL flask exerts a pressure of 1520 mmHg at  $14^\circ\text{C}$ . What is the gas?

- (A) chlorine              (B) xenon              (C) krypton              (D) nitrogen              (E) oxygen

24. If a sulfur trioxide molecule is drawn so that the formal charge on each atom is zero, it will have the following types of bonds:

- (A) 3 sigma and 0 pi (B) 3 sigma and 1 pi (C) 3 sigma and 2 pi  
(D) 3 sigma and 3 pi (E) 3 sigma and 6 pi

25. How many mL of stock sodium chloride solution would you need to prepare 700. mL of a 0.60 M solution from a 7.0 M stock solution?

- (A) 8200 mL (B) 640 mL (C) 120 mL (D) 60. mL (E) 30. mL

26. Which of the following atoms is the most paramagnetic?

- (A) sodium (B) chlorine (C) magnesium (D) aluminum (E) sulfur

27. What is the pH of a 0.15 M solution of formic acid, HCOOH?  $K_a = \text{HCOOH } 1.9 \times 10^{-4}$

- (A) 1.49 (B) 2.27 (C) 3.72  
(D) 4.55 (E) 1.94

28. What is the  $[\text{H}^+]$  in a 0.10 M solution of ascorbic acid,  $\text{C}_6\text{H}_8\text{O}_6$ ?  $\text{C}_6\text{H}_8\text{O}_6$ ,  $K_a = 8.0 \times 10^{-5}$

- (A)  $8.0 \times 10^{-6} \text{ M}$  (B)  $6.4 \times 10^{-10}$  (C)  $4.0 \times 10^{-3} \text{ M}$   
(D)  $5.3 \times 10^{-3} \text{ M}$  (E)  $2.8 \times 10^{-3} \text{ M}$

29. When solid ammonium chloride,  $\text{NH}_4\text{Cl}(\text{s})$  is added to water at 25 °C, it dissolves and the temperature of the solution decreases. Which of the following is true for the values of  $\Delta H$  and  $\Delta S$  for the dissolving process?

- $\Delta H$   $\Delta S$   
(A) Positive Positive  
(B) Positive Negative  
(C) Positive Equal to zero  
(D) Negative Positive  
(E) Negative Negative

30. Which of the following measurements shows good precision & bad accuracy, if the actual scientific value is 3.74 cm?

- (A) 2.75 cm, 3.75 cm, 4.05 cm (B) 3.76 cm, 3.76 cm, 3.75 cm  
(C) 4.02 cm, 4.02 cm, 4.01 cm (D) 4.52 cm, 4.78 cm, 3.01 cm

31. Which liquid is most volatile at 25°C?

- (A) butane,  $\text{C}_4\text{H}_{10}$  (B) glycerol,  $\text{C}_3\text{H}_5(\text{OH})_3$  (C) octane,  $\text{C}_8\text{H}_{18}$   
(D) propanol,  $\text{C}_3\text{H}_7\text{OH}$  (E) nonane,  $\text{C}_{10}\text{H}_{22}$

32. Which of the following represents the ground state electron configuration for the  $\text{Mn}^{3+}$  ion?

- (A)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^1$  (B)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$  (C)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$   
(D)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^8 4s^2$  (E)  $1s^2 2s^2 2p^6 3s^2 3p^6 3d^4$

33. How many significant figures are there in 0.0090290 m?

- (A) 5 (B) 3 (C) 7 (D) 8

34.  $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$  – How many moles of water can be produced from 40.0 grams of  $\text{H}_2$  and excess  $\text{O}_2$ ?

- (A) 10. moles (B) 640 moles (C) 20. moles (D) 40. moles (E) none of the above

35. When LiF is formed from its elements there are five steps. Which of the following steps is NOT endothermic?

- I. Step 1: Sublimation of solid lithium.  $\text{Li}(\text{s}) \rightarrow \text{Li}(\text{g})$   
II. Step 2: Ionization of lithium atom.  $\text{Li}(\text{g}) \rightarrow \text{Li}^+(\text{g}) + \text{e}^-$   
III. Step 4: Formation of fluoride ions.  $\text{F}(\text{g}) + \text{e}^- \rightarrow \text{F}^-(\text{g})$

- (A) II only (B) II only (C) I and II only (D) II and III only (E) III only

36. If an endothermic reaction is spontaneous at 298 K, which of the following must be true for the reaction?  
 I.  $\Delta G$  is greater than zero      II.  $\Delta H$  is greater than zero.      III.  $\Delta S$  is greater than zero  
 (A) I only      (B) II only      (C) I & II only      (D) II & III only      (E) I, II & III
37. Which of the following has the largest value for the second ionization energy?  
 (A) sodium      (B) chlorine      (C) sulfur      (D) aluminum      (E) magnesium
38. In which of the following are the elements listed in order of increasing Electronegativity?  
 (A) Ba, Zn, C, Cl      (B) N, O, S, Cl      (C) N, P, As, Sb  
 (D) K, Ba, Si, Ga      (E) Li, K, Na, Ca
39.  $2\text{Al} + 3\text{S} \rightarrow \text{Al}_2\text{S}_3$  - Aluminum reacts with sulfur to produce aluminum sulfide. If I have 91 grams of Al and 55 grams of S, what is my limiting reagent?  
 (A)  $\text{Al}_2\text{S}_3$       (B) Al      (C) S      (D) both Al & S      (E) can't be determined
40. A sample of neon gas has a volume of 333 mL at 30.°C and a certain pressure. What volume would it occupy if it were heated to 60.°C at the same pressure?  
 (A) 399 mL      (B) 366 mL      (C) 333 mL      (D) 666 mL      (E) 167 mL
41. An aqueous 1.0 M  $\text{CaCl}_2$  solution has a density of 1.05. Determine the molarity of the solution.  
 (A) 2.84 M      (B) 8.57M      (C) 0.945 M      (D) 10.0 M      (E) 0.857 M
42. For the types of radiation given, which of the following is the correct order of increasing ability to penetrate a piece of lead?  
 (A) Alpha particles < gamma rays < beta particles      (B) Alpha particles < beta particles < gamma rays  
 (C) Beta particles < alpha particles < gamma rays      (D) Beta particles < gamma rays < alpha particles  
 (E) Gamma rays < alpha particles < beta particles
43. Sublimation is an example of an:  
 (A) exothermic chemical change      (B) endothermic physical change  
 (C) endothermic chemical change      (D) exothermic physical change
44. Which set of quantum numbers (n, l, ml, ms) is NOT permitted by the rules of quantum mechanics?  
 (A) 1, 0, 0,  $+\frac{1}{2}$       (B) 2, 1, -1,  $-\frac{1}{2}$       (C) 3, 3, 1,  $-\frac{1}{2}$       (D) 4, 3, 2,  $+\frac{1}{2}$       (E) 4, 1, -1,  $+\frac{1}{2}$
45.  $4\text{HCl} + \text{O}_2 \rightarrow 2\text{H}_2\text{O} + 2\text{Cl}_2$  - How many moles of  $\text{H}_2\text{O}$  can be produced from 30. moles of HCl?  
 (A) 7.5 moles      (B) 15 moles      (C) 30. moles      (D) 60. moles      (E) none of the above
46. Which of the following would likely have the highest melting point?  
 (A) LiCl      (B) LiF      (C) NaCl      (D) NaF      (E) KF
47. As the temperature is raised from 25°C to 75°C, the average kinetic energy of neon atoms changes by a factor of  
 (A)  $\frac{1}{3}$       (B)  $(348/298)^{1/3}$       (C) 348/298      (D) 3      (E) 9
48. How many sulfate ions are there in 111 grams of aluminum sulfate?  
 (A)  $1.95 \times 10^{23}$       (B)  $3.90 \times 10^{23}$       (C)  $5.86 \times 10^{23}$       (D)  $2.98 \times 10^{24}$       (E) none of the above
49. The bonding in carbon monosulfide consists of:  
 (A) 1 sigma bond and 2 pi bonds      (B) 2 sigma bonds and 1 pi bond  
 (C) 3 sigma bonds      (D) 3 pi bonds      (E) 1 sigma and 1 pi bond
50.  $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$  - Using 42.0 grams of methane Lisa was able to produce 56.0 grams of water. Calculate her percent yield?  
 (A) 44.4%      (B) 59.3%      (C) 94.5%      (D) 75.0%      (E) none of the above