

Form Code ☺

NAME _____

CHM 2045 Spring 2020

Final Exam (UF Teaching Center)

(Chapters: all of them)

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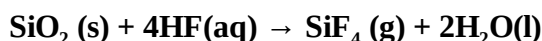
1. What is the molarity (M) of potassium ions in a solution prepared by mixing 150 mL of 0.250 M potassium sulfate with 350 mL of 0.400 M potassium chloride?
(1) 0.430 M (2) 0.355 M (3) 0.215 M (4) 1.43 M (5) 0.614 M
2. Which one of the following aqueous solutions contains the greatest molarity of chloride ions?
(1) 2.00 M potassium chloride
(2) 0.75 M iron(III) chloride
(3) 1.00 M calcium chloride
(4) 1.00 M ammonium chloride
(5) 0.50 M copper(II) chloride
3. Which one of the following statements is true regarding sodium carbonate, Na_2CO_3 ?
(1) Na_2CO_3 is a molecular compound
(2) there are three moles of ions per mole of Na_2CO_3
(3) Na_2CO_3 contains the polyatomic cation Na_2^{2+}
(4) there are three oxide ions in Na_2CO_3
(5) Na_2CO_3 contains no covalent bonds
4. You wish to titrate a 50.0 mL sample of a barium hydroxide solution that is predicted to have a concentration of approximately 0.1 M barium hydroxide. Which of the following acid-containing solutions (volumes and molarities given) should you choose for your titration?
(1) 100. mL of 0.05000 M HCl
(2) 20.0 mL of 0.3000 M HClO_4
(3) 40.0 mL of 0.2000 M HSO_4^-
(4) 40.0 mL of 0.1000 M H_2SO_4
(5) 200. mL of 0.06000 M HNO_3
5. Consider the following reaction between the iodate ion (IO_3^-) and the sulfite ion (SO_3^{2-}) and select the false statement below. $2\text{IO}_3^- (\text{aq}) + 5\text{SO}_3^{2-} (\text{aq}) + 2\text{H}^+ (\text{aq}) \rightarrow \text{I}_2 (\text{s}) + 5\text{SO}_4^{2-} (\text{aq}) + \text{H}_2\text{O} (\text{l})$
(1) this is a redox reaction
(2) the sulfite ion is the oxidizing agent
(3) the oxidation state of the iodine atom in the iodate ion is decreased to 0 in the iodine molecule

- (4) the oxidation state of the sulfur atom is greater in the sulfate ion than in the sulfite ion
 (5) the hydrogen ion is neither reduced nor oxidized in this reaction

6. Which of the following is the net ionic equation for the reaction between formic acid (HCOOH) and sodium hydroxide?

- (1) $\text{HCOOH(aq)} + \text{NaOH(aq)} \rightarrow \text{Na}^+ \text{(aq)} + \text{HCOO}^- \text{(aq)} + \text{H}_2\text{O(l)}$
 (2) $\text{H}^+ \text{(aq)} + \text{OH}^- \text{(aq)} \rightarrow \text{H}_2\text{O(l)}$
 (3) $\text{H}^+ \text{(aq)} + \text{NaOH(aq)} \rightarrow \text{Na}^+ \text{(aq)} + \text{H}_2\text{O(l)}$
 (4) $\text{HCOOH(aq)} + \text{OH}^- \text{(aq)} \rightarrow \text{HCOO}^- \text{(aq)} + \text{H}_2\text{O(l)}$
 (5) $\text{HCOOH(aq)} + \text{OH}^- \text{(aq)} \rightarrow \text{HCOOH}_2 \text{(aq)} + \text{O}^{2-} \text{(aq)}$

7. How much heat is released (rel) or absorbed (abs) by the system in the reaction of 15.0 grams of SiO_2 (60.09 g/mol) with 10.0 g HF (20.01 g/mol)?



ΔH°_f (kJ/mol): -910.9 -320.8 -1615 -285.8

- (1) 3.75 kJ abs (2) 1.87 kJ rel (3) 0.937 kJ abs (4) 0.468 kJ rel (5) 83.6 kJ rel

8. Arrange the following elements in order of increasing first ionization energy:

F, Be, O, N, C

- (1) $\text{F} < \text{O} < \text{N} < \text{C} < \text{Be}$
 (2) $\text{Be} < \text{N} < \text{C} < \text{O} < \text{F}$
 (3) $\text{Be} < \text{C} < \text{O} < \text{N} < \text{F}$
 (4) $\text{O} < \text{F} < \text{N} < \text{Be} < \text{C}$
 (5) $\text{Be} < \text{C} < \text{N} < \text{O} < \text{F}$

9. Which of the following statements is/are true?

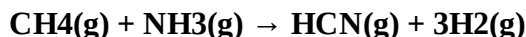
I. Work is done by the system on the surroundings in this equation: $2\text{S(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$

II. No work is done on this system: $2\text{S(s)} + 3\text{O}_2\text{(g)} \rightarrow 2\text{SO}_3\text{(g)}$

III. Work is done by the surroundings on this system: $\text{Fe}_2\text{O}_3\text{(s)} + 3\text{CO(g)} \rightarrow 2\text{Fe(s)} + 3\text{CO}_2\text{(g)}$

- (1) I (2) II (3) III (4) I and II (5) none

10. Calculate (in kJ) the standard enthalpy change $\Delta H^\circ_{\text{rxn}}$ for the following reaction:



(Bond energies (in kJ/mol): C—H, 414; N—H, 393; C—N, 276; C=N, 615; C≡N, 891; H—H, 436)

- (1) +222 kJ (2) +498 kJ (3) +837 kJ (4) -222 kJ (5) -498 kJ

11. Which one of the following is a nonpolar molecule with polar bonds?

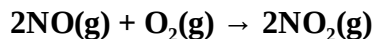
- (1) CH_2O (2) PH_3 (3) SF_4 (4) CCl_4 (5) CH_3OCH_3

12. In which gas phase reaction below will the volume stay the same when the absolute temperature is halved?
- I. $A_2 + B_2 \rightarrow A_2B_2$
 II. $A_2 + B_2 \rightarrow 2AB$ III. $AB \rightarrow A + B$
 IV. $3A + B \rightarrow A_3B$
- (1) I (2) II (3) III (4) IV (5) II and III
13. Calculate the amount of energy (in kJ) required to heat 10.0 g of water from 50.0°C to 150.°C at constant pressure. (specific heat capacity of liquid water is 4.18 J/gK; specific heat capacity of water vapor is 1.84 J/gK; heat of vaporization of water is 2.260 kJ/g).
- (1) 16.2 kJ (2) 25.6 kJ (3) 5.4 kJ (4) 33.2 kJ (5) 1.6 kJ
14. Using the Clausius-Clapeyron equation, determine the vapor pressure of water at 70.0°C. The molar heat of vaporization of water is 40.7 kJ/mol.
- (1) 600 torr (2) 450 torr (3) 241 torr (4) 180 torr (5) 75 torr
15. Which of the following species below will have the weakest nitrogen-oxygen average bond order?
- (1) NO^+ (2) NO_2^+ (3) NO_2^- (4) NO_3^- (5) NO_2
16. What mass of glucose, $C_6H_{12}O_6$, must be added to 125 g of water to raise the boiling point of the water by 1.0°C ? The boiling point elevation constant for water is 0.512 °C/m.
- (1) 10 g (2) 5.0 g (3) 20 g (4) 15 g (5) 2.0 g
17. A 0.00200 m aqueous solution of a dissolved ionic salt M_aX_b freezes at -0.00732°C. Which of the following is most likely the formula unit of the dissolved salt? The freezing point depression constant for water is 1.86 °C/m. (Assume ideal solution behavior)
- (1) MX (2) MX_2 (3) M_2X (4) MX_3 (5) M_2X_3
18. Beta-carotene is the most important of the A vitamins. Calculate the molar mass of beta-carotene if 10.0 mL of a solution containing 7.68 mg of beta-carotene has an osmotic pressure of 26.57 mmHg at 25.0°C.
- (1) 663 g/mol (2) 538 g/mol (3) 862 g/mol (4) 379 g/mol (5) 228 g/mol
19. Rank these aqueous solutions from highest to lowest normal freezing point:
- I. 0.40 m NaCl
 II. 0.20 m $MgCl_2$
 III. 0.50 m $Al(NO_3)_3$
 IV. 1.5 m $C_6H_{12}O_6$
- (1) II > I > IV > III (2) III > IV > I > II (3) II > I > III > IV (4) I > II > III > IV (5) IV > III > I > II

Which of the following is predicted to be the least soluble in water at a given temperature?

- (1) CH_2Cl_2 (2) CS_2 (3) $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ (4) $\text{CH}_3\text{CH}_2\text{OCH}_2\text{CH}_3$ (5) CH_3COOH

20. Use the concentration-rate data table below to determine the rate law for the following reaction at 660K :



Experiment [NO], mol/L [O₂], mol/L Rate, mol/L•s

1	0.010	0.010	2.5×10^{-5}
2	0.020	0.010	1.0×10^{-4}
3	0.010	0.020	5.0×10^{-5}

- (1) $\text{rate} = k[\text{NO}][\text{O}_2]$ (2) $\text{rate} = k[\text{NO}]^2[\text{O}_2]$ (3) $\text{rate} = k[\text{NO}][\text{O}_2]^2$ (4) $\text{rate} = k[\text{NO}]^2[\text{O}_2]^2$ (5) $\text{rate} = k[\text{NO}]$

21. The mechanism for the reaction $2\text{NO} + \text{O}_2 \rightarrow 2\text{NO}_2$ is as follows. What is the rate law?

Step One: $\text{NO} + \text{NO} \leftrightarrow \text{N}_2\text{O}_2$ (fast equilibrium)

Step Two: $\text{N}_2\text{O}_2 + \text{O}_2 \rightarrow 2\text{NO}_2$ (slow)

- (1) $\text{rate} = k[\text{NO}]^2[\text{O}_2]$ (2) $\text{rate} = k[\text{NO}]^2[\text{O}_2]^2$ (3) $\text{rate} = k[\text{NO}][\text{O}_2]^2$ (4) $\text{rate} = k[\text{NO}][\text{O}_2]$ (5) $\text{rate} = k[\text{O}_2]^2$

22. A chloride salt MCl_2 is 55.94% chlorine by mass. What is the identity of the metal M?

- (1) Ca (2) Mg (3) Sr (4) Fe (5) Cu