

Day 10: 50 Multiple Choice questions
50 points *Section I Part A and B Practice*

Start: Answer all questions on this day before stopping.

Note: NO CALCULATORS may be used for questions on this day.

You may use ONLY the Periodic Table provided on page 337

Note: For all questions, assume that the temperature is 298 K, the pressure is 1.00 atmosphere and solutions are aqueous unless otherwise noted.

For Questions 1 through 5, consider the following system at equilibrium:



and select from the following choices:

- (A) to the right
 - (B) to the left
 - (C) neither
 - (D) in both directions
 - (E) cannot be determined from information provided
1. In which direction will the system move in order to reestablish equilibrium if N_2O is added?
 2. In which direction will the system move in order to reestablish equilibrium if O_2 is removed?
 3. In which direction will the system move in order to reestablish equilibrium if the volume is decreased?
 4. In which direction will the system move in order to reestablish equilibrium if the temperature is raised?
 5. In which direction will the system move in order to reestablish equilibrium if a catalyst is added?

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For questions 6 through 8 refer to the following configurations.

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

6. The configuration of an atom of a paramagnetic element.
7. The ground state configuration for both a potassium ion and a chloride ion.
8. An atom that has this ground state electron configuration will have the smallest radius of those listed.

Questions 9 through 12 refer to the following solutions.

- (A) 250 mL of 0.50 M KNO_3 (molar mass = 101)
- (B) 400 mL of 0.10 M $Al(NO_3)_3$ (molar mass = 213)
- (C) 500 mL of 0.20 M NH_4NO_3 (molar mass = 80)
- (D) 300 mL of 0.30 M $Pb(NO_3)_2$ (molar mass = 170)
- (E) 200 mL of 0.10 M $Ni(NO_3)_2$ (molar mass = 183)

9. Is an appropriate reagent for a Beer's Law experiment.
10. Forms a precipitate when 0.50 moles of solid NaCl is added.
11. Has the highest boiling point.
12. Has the highest $[NO_3^-]$.

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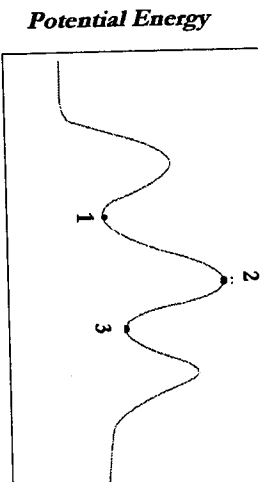
13. Given a molecule with the general formula AB_2 , which one of the following would be the most useful in determining whether the molecule was bent or linear?

- (A) ionization energies
- (B) electron affinities
- (C) bond energies
- (D) electronegativities
- (E) dipole moments

14. The radioactive decay of $^{19}_8O$ to $^{19}_9F$ occurs by the process of

- (A) beta emission
- (B) alpha emission
- (C) positron emission
- (D) electron capture
- (E) neutron capture

15. Which of the following statements about the energy diagram below is incorrect?



- (A) The overall reaction is endothermic.
- (B) The reaction has two intermediates.
- (C) Point 2 represents a transition state.
- (D) Raising the energy of point 3 decreases the equilibrium concentration of product.
- (E) Raising the energy of point 2 decreases the rate of product formation.

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16. In expanding from 5.00 to 6.00 liters at a constant pressure of 2.00 atmospheres, a gas absorbs 505.64 joules of energy (101.32 joules = 1 liter · atm). The change in energy, ΔE , for the gas is
- (A) 50.66 J
 (B) 101.32 J
 (C) 303.00 J
 (D) 505.64 J
 (E) 606.00 J
17. $2 \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{NH}_2^-$
 In the reaction NH_4^+ acts as
- (A) a catalyst
 (B) both an acid and a base
 (C) the conjugate acid of NH_3
 (D) the reducing agent
 (E) the oxidizing agent
18. A molecule in which the central atom exhibits sp^2 hybrid orbitals has which of the following molecular shapes?
- (A) linear
 (B) trigonal planar
 (C) trigonal bipyramidal
 (D) square planar
 (E) tetrahedral
19. If ΔH is positive and ΔS is negative, then ΔG is always
- (A) positive
 (B) negative
 (C) negative at low temperatures; positive at high temperatures
 (D) positive at low temperatures; negative at high temperatures
 (E) cannot be determined from the information provided

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20. Silver hydroxide will be LEAST soluble in a solution with a pH of
- (A) 3
 (B) 5
 (C) 7
 (D) 9
 (E) 11
21. Which of the following is an impossible set of quantum numbers?
- (A) 4, 0, 0, $\frac{1}{2}$
 (B) 4, 0, 1, $\frac{1}{2}$
 (C) 4, 1, 0, $\frac{1}{2}$
 (D) 4, 1, 1, $\frac{1}{2}$
 (E) 4, 2, 1, $\frac{1}{2}$
22. A 96-g sample of methane reacts with fluorine gas to produce 96 g of 1-fluoroethane and hydrogen gas. What is the percent yield?
- (A) 33%
 (B) 66%
 (C) 50%
 (D) 100%
 (E) 300%
23. Liquid A and liquid B form a solution that behaves ideally according to Raoult's law. The vapor pressures of the pure substances A and B are 75 mmHg and 25 mmHg, respectively. What is the vapor pressure over the solution if 1.50 moles of liquid A is added to 5.50 moles of liquid B?
- (A) 30.0 mmHg
 (B) 35.7 mmHg
 (C) 71.4 mmHg
 (D) 125 mmHg
 (E) 250 mmHg

24. When an aqueous solution of potassium chloride is compared with water, the salt solution will have

- (A) a higher boiling point, a lower freezing point, and a lower vapor pressure
- (B) a higher boiling point, a higher freezing point, and a lower vapor pressure
- (C) a higher boiling point, a higher freezing point, and a higher vapor pressure
- (D) a lower boiling point, a lower freezing point, and a lower vapor pressure
- (E) a lower boiling point, a higher freezing point, and a higher vapor pressure

25. What is the mass of oxygen in 148 grams of a calcium hydroxide?

- (A) 16 g
- (B) 24 g
- (C) 32 g
- (D) 48 g
- (E) 64 g

26. $\text{SnO}_2(s) + 2\text{CO}(g) \rightleftharpoons \text{Sn}(s) + 2\text{CO}_2(g)$

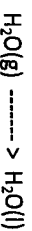
Which of the following is a correct equilibrium constant expression for the above reaction?

- (A) $K_{\text{eq}} = \frac{[\text{CO}_2]^2}{[\text{CO}]^2}$
- (B) $K_{\text{eq}} = \frac{[\text{Sn}]}{[\text{SnO}_2]}$
- (C) $K_{\text{eq}} = \frac{[\text{SnO}_2][\text{CO}]^2}{[\text{Sn}][\text{CO}_2]^2}$
- (D) $K_{\text{eq}} = \frac{[\text{Sn}][\text{CO}_2]}{[\text{SnO}_2][\text{CO}]}$
- (E) $K_{\text{eq}} = \frac{[\text{Sn}][\text{CO}_2]^2}{[\text{SnO}_2][\text{CO}]^2}$

27. In the titration of a weak acid of unknown concentration with a standard solution of a strong base, the pH of the resulting solution was monitored as the titration progresses. Which of the following is true for this experiment?

- (A) The pH is 7 at the equivalence point.
- (B) The pH at the equivalence point depends on the indicator used.
- (C) The graph of pH versus volume of base added rises gradually at first and then much more rapidly.
- (D) The graph of pH versus volume of base added shows no sharp rise.
- (E) The $[\text{H}^+]$ at the equivalence point equals the ionization constant of the acid.

28. Consider the reaction below.



Which of the following is true of the values of ΔH , ΔS , and ΔG for the reaction shown above at 25°C?

- | | ΔH | ΔS | ΔG |
|-----|------------|------------|------------|
| (A) | Positive | Positive | Positive |
| (B) | Positive | Negative | Negative |
| (C) | Negative | Positive | Negative |
| (D) | Negative | Negative | Positive |
| (E) | Negative | Negative | Negative |

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Questions 29 through 30 refer to an electrolytic cell that involves the following half-reaction.



29. Which of the following occurs in the reaction?

- (A) Au is oxidized at the anode.
- (B) AuCl_4^- is reduced at the cathode.
- (C) Gold is converted from the -3 oxidation state to the 0 oxidation state.
- (D) Cl^- acts as a reducing agent.
- (E) Cl^- is oxidized at the anode.

30. A steady current of 4.0 amperes is passed through a gold-production cell for 30 minutes. Which of the following is the correct expression for calculating the number of grams of gold produced? (1 faraday = 96,500 coulombs)

- (A) $\frac{(4) (30) (60)}{(197) (96,500) (3)}$
- (B) $\frac{(4) (30) (96,500)}{(197) (60)}$
- (C) $\frac{(4) (30) (60) (197)}{(3) (96,500)}$
- (D) $\frac{(96,500) (197)}{(3) (4) (60) (30)}$
- (E) $\frac{(4) (60) (30) (96,500)}{(3) (197)}$

Day 10: Continue

31. Arrange the following ions in order of increasing ionic radius: Mg^{2+} , F^- , and O^{2-}

- (A) O^{2-} , F^- , Mg^{2+}
- (B) Mg^{2+} , O^{2-} , F^-
- (C) Mg^{2+} , F^- , O^{2-}
- (D) O^{2-} , Mg^{2+} , F^-
- (E) F^- , O^{2-} , Mg^{2+}

32. Which of the following pairs of solutions produce a precipitate if mixed?

- (i) $\text{HBr}(aq)$ and $\text{Ca}(\text{OH})_2(aq)$
- (ii) $\text{Pb}(\text{NO}_3)_2(aq)$ and $\text{LiI}(aq)$
- (iii) $(\text{NH}_4)_3\text{PO}_4(aq)$ and $\text{MgCl}_2(aq)$

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

33. Which of the following systems would NOT experience a change in the concentration of the substances present at equilibrium when the volume of the system is changed at constant temperature?

- (A) $\text{SO}_2(g) + \text{NO}(g) \rightleftharpoons \text{SO}_2(g) + \frac{1}{2} \text{N}_2(g)$
- (B) $\text{O}_2(g) + 2 \text{H}_2(g) \rightleftharpoons 2 \text{H}_2\text{O}(g)$
- (C) $\text{N}_2(g) + 2 \text{O}_2(g) \rightleftharpoons 2 \text{NO}_2(g)$
- (D) $\text{N}_2\text{O}_4(g) \rightleftharpoons 2 \text{NO}_2(g)$
- (E) $\text{CH}_4(g) + 2 \text{O}_2(g) \rightleftharpoons \text{CO}_2(g) + 2 \text{H}_2\text{O}(g)$

34. What number of moles of O_2 is needed to produce 25.5 grams of Al_2O_3 from solid Al? (Molecular weight $\text{Al}_2\text{O}_3 = 102 \text{ g/mole}$)

- (A) 0.125 mole
- (B) 0.250 mole
- (C) 0.375 mole
- (D) 0.500 mole
- (E) 1.00 mole

Day 10: Continue

35. Which of the following acids can be oxidized to form a stronger acid?

- (A) $\text{H}_2\text{C}_2\text{O}_4$
- (B) HNO_2
- (C) H_2SO_4
- (D) H_3PO_4
- (E) $\text{HC}_2\text{H}_3\text{O}_2$

36. In which equation would you expect ΔE and ΔH to be nearly equal?

- (A) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$
- (B) $\text{C}_2\text{H}_4(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{C}_2\text{H}_6(\text{g})$
- (C) $\text{BrO}_3^-(\text{aq}) + 5\text{Br}^-(\text{aq}) + 6\text{H}^+(\text{aq}) \rightarrow 3\text{Br}_2(\text{aq}) + 3\text{H}_2\text{O}(\text{l})$
- (D) $\text{HCOOH}(\text{aq}) + \text{Br}_2(\text{aq}) \rightarrow 2\text{H}^+(\text{aq}) + 2\text{Br}^-(\text{aq}) + \text{CO}_2(\text{g})$
- (E) $\text{N}_2(\text{g}) + \text{N}_2(\text{g}) \rightarrow \text{N}_4(\text{g})$

- (A) Diethyl ether will have the higher boiling point.
- (B) 1-butanol will have the higher boiling point.
- (C) Because they contain the same number and types of atoms, they will boil at the same temperature.
- (D) Because they contain the same number of atoms, but different types of atoms, more information is needed in order to determine which one will boil at a higher temperature.
- (E) Because they contain different numbers of atoms, but the same type of atoms, more information is needed in order to determine which one will boil at a higher temperature.

38. Which of the following gases would be expected to have a rate of effusion that is one-third as great as that of hydrogen gas?

- (A) Oxygen
- (B) Nitrogen
- (C) Helium
- (D) Water
- (E) Carbon dioxide

Day 10: Continue

39. The O—N—O bond angle in the NO_3^- ion is

- (A) 90°
- (B) 105°
- (C) 109°
- (D) 120°
- (E) 180°

40. A student pipetted five 25.00-milliliter samples of acetic acid and transferred each sample to a beaker, diluted it with distilled water, and added a few drops of phenolphthalein to each. Each sample was then titrated with a sodium hydroxide solution to the appearance of the first permanent faint pink color. The following results were obtained.

Solution	Volume of NaOH
First Sample.....	15.33 mL
Second Sample.....	16.35 mL
Third Sample.....	16.37 mL
Fourth Sample.....	16.40 mL
Fifth Sample.....	16.38 mL

Which of the following is the most probable explanation for the variation in the student's results?

- (A) More water was added to the first sample.
- (B) More phenolphthalein was added to the first sample.
- (C) The first sample was titrated beyond the end point.
- (D) The pipette was not rinsed with the acetic acid solution.
- (E) The buret was not rinsed with the NaOH solution.

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41. Given the following standard molar entropies measured at 25°C and 1 atm pressure, calculate ΔS° in $(\text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1})$ for the reaction



Substances	S° ($\text{J} \cdot \text{mol}^{-1} \cdot \text{K}^{-1}$)
Al(s)	28.0
$\text{Al}_2\text{O}_3(s)$	51.0
Mg(s)	33.0
MgO(s)	27.0

- (A) $-29.0 \text{ J}/(\text{mol} \cdot \text{K})$
 (B) $-13.0 \text{ J}/(\text{mol} \cdot \text{K})$
 (C) $13.0 \text{ J}/(\text{mol} \cdot \text{K})$
 (D) $69.0 \text{ J}/(\text{mol} \cdot \text{K})$
 (E) $139 \text{ J}/(\text{mol} \cdot \text{K})$

42. An unknown substance is placed into a hot flame. The color of the flame is bright red. Which of the following substances is most likely to be the unknown?

- (A) $\text{Cu}(\text{NO}_3)_2$
 (B) NaCl
 (C) KCl
 (D) LiCl
 (E) $\text{Na}(\text{NO}_3)_2$

The atomic mass of copper is 63.55. Given that there are only two naturally occurring isotopes of copper, ^{63}Cu and ^{65}Cu , the natural abundance of ^{63}Cu is approximately

- (A) 90%
 (B) 72%
 (C) 62%

Day 10: Continue

For Questions 44 and 45, use the following information:

A student prepared a 1.00 M acetic acid solution ($\text{HC}_2\text{H}_3\text{O}_2$). The student found the pH of the solution to be 2.00.

44. What is the K_a value for the solution?

- (A) 3.00×10^{-7}
 (B) 2.00×10^{-6}
 (C) 2.00×10^{-5}
 (D) 1.00×10^{-4}
 (E) 1.00×10^{-3}

45. What is the approximate % dissociation of the acetic acid? (Use the 5% rule.)

- (A) 0.050%
 (B) 1.0%
 (C) 1.5%
 (D) 2.0%
 (E) 2.5%

Day 11: 2 Free Response Questions
20 points **Section II Part A Practice**

START: Answer all questions on this day before stopping.

Note: You may use a calculator for questions on this day.

You may use any of the reference material provided on pg 337-340

CLEARLY SHOW THE METHOD USED AND THE STEPS INVOLVED IN ARRIVING AT YOUR ANSWERS. It is to your advantage to do this, since you may obtain partial credit if you do and you will receive little or no credit if you do not. Attention should be paid to significant figures.

1. (10 points)

Hypochlorous acid, HOCl, is a weak acid that ionizes in water, as represented by the equation below:



$$K_a = 2.9 \times 10^{-8}$$

- (a) Calculate the $[\text{H}^+]$ in a HOCl solution that has a pH of 5.24.
- (b) Using information provided above:
- (i) Write the equilibrium expression (K_a) for the ionization of HOCl in water.
- (ii) Calculate the concentration of HOCl(aq) in a HOCl solution that has $[\text{H}^+]$ equal to 2.4×10^{-5} M.
- (c) A solution of $\text{Ba}(\text{OH})_2$ is titrated into a solution of HOCl.
- (i) Calculate the volume of 0.200 M $\text{Ba}(\text{OH})_2(aq)$ needed to reach the equivalence point when titrated into a 75.0 mL sample of 0.150 M HOCl(aq).
- (ii) Write the equilibrium expression, K_b , for the titration reaction that occurs.
- (iii) Calculate K_b of OCl⁻.
- (iv) Calculate the pH at the equivalence point.
- (d) HClO₃ is a stronger acid than HOCl. Account for this fact in terms of molecular structure.

Day 12: 2 Free Response Questions
23 points **Section II Part B practice**

START: Answer all questions on this day before stopping.

Note: NO CALCULATORS should be used for questions on this day.

You may use any of the Reference Materials provided on pg 337-340

1. For each of the following three reactions, write a balanced equation for the reaction in part (i) and answer the question about the reaction in part (ii). In part (i), coefficients should be in terms of lowest whole numbers. Assume that solutions are aqueous unless otherwise indicated. Represent substances in solutions as ions if the substances are extensively ionized. Omit formulas for any ions or molecules that are unchanged by the reaction. (15 points)

(a) Dinitrogen oxide is mixed with water?

(i) Balanced equation:

(ii) Would the pH of the solution that is produced less than 7, equal to 7, or greater than 7. Explain your answer.

(b) Carbon dioxide gas is heated in the presence of solid magnesium oxide.

(i) Balanced equation:

(ii) How many grams of magnesium oxide must completely react with 11 grams of the carbon dioxide?

(c) Small pieces of aluminum are added to a solution of copper(II) sulfate.

(i) Balanced equation:

(ii) Write the correct oxidation and reduction-half equations for the reaction that occurs.

