Day 13: 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.

Questions 1 through 5 refer to the following set of choices:

(A) Particles vibrate about average positions.
(B) Particles are ordered and occur within a sea of mobile electrons.
(C) Particles are ionized, disordered and highly energetic.
(D) Particles diffuse rapidly and can dissolve many solutes.
(E) Particles do not translate but lack long-range order.

1. Supercritical fluid

2. Metallic solid

3. Amorphous solid

4. Plasma

5. Crystalline solid

Questions 6 through 7 refer to the following substances

        (A) Nitric acid
        (B) Sulfur dioxide
        (C) Hydrochloric acid
        (D) Zinc
        (E) Potassium permanganate

6. A strong oxidizing agent that changes color upon reduction.

7. Is known as the oxidizing acid.

8. Is used to galvanize building materials.

9. Is known to cause to acid rain.

Questions 10 through 13 refer to types of reactions below.

(A) Oxidation-reduction
(B) Neutralization
(C) Fusion
(D) Combination
(E) Combustion

Which of the reaction types listed above best describes each of these processes?

10. CO_2 (g)   +   CaO (s)   -----> $CaCO_3$ (s)

11. $2Fe^{3+}$ (aq) + $2I^-$ (aq) -----> $2Fe^{2+}$ (aq) + I_2 (aq)

12. CH_3COOH (aq)   +   NaOH (aq)   -----> CH_3COONa (aq)   + H_2O (l)

13. C_3H_8 (g)   + $5O_2$ (g)   ----> $3CO_2$ (g)   + $4H_2O$ (g)

Questions 14 through 16 refer to the following.

(A) Arrhenius acid
(B) Bronsted-Lowry acid
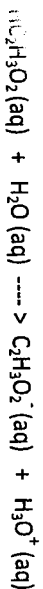(C) Bronsted-Lowry base
(D) Lewis acid
(E) Lewis base

14. BF_3 in the reaction:

$$BF_3 + F^- \longrightarrow BF_4$$

... the reaction:

... (aq)   + $4CN^-$ (aq)   -----> $Cu(CN)_4^{2-}$ (aq)

...$_2H_3O_2$ (aq) + H_2O (aq) --> $C_2H_3O_2^-$ (aq) + H_3O^+ (aq)

17. $AgNO_3$ (aq)   +   KCl (aq)   ----->   _____   +   _____

What are the missing products?

(A) $AgNO_3$ (aq)   +   KCl (aq)
(B) $AgCl_2$ (s)   + K_2NO_3 (aq)
(C) AgCl (s)   + KNO_3 (aq)
(D) Ag^{2+} (aq)   +   Cl- (aq)   + KNO_3 (aq)
(E) $AgCl_2$ (s)   + K^+ (aq)   +   Cl- (aq)

18. The Lewis dot structure of which of the following molecules shows only one unshared pair of valence electrons around the central atom?

(A) Br_2
(B) O_2
(C) NH_3
(D) CH_4
(E) SO_3

19. The half-life of ^3H is about 12 years. How much of a 4mg sample will remain after 36 years?

(A) 0.25mg
(B) 0.5mg
(C) 1mg
(D) 2mg
(E) 4mg

20. Arrange the following ionic compounds in order of decreasing lattice energy: KBr, LiF, MgO

(A) KBr   >   LiF   >   MgO
(B) MgO   >   LiF   >   KBr
(C) KBr   >   MgO   >   LiF
(D) MgO   >   KBr   >   LiF
(E) LiF   >   KBr   >   MgO

21. A 40-gram sample of helium and a 40-gram sample of neon are placed in a sealed container. What is the partial pressure of the neon if the total pressure in the sealed container is 6 atm?

(A) 1 atm
(B) 2 atm
(C) 3 atm
(D) 4 atm
(E) 5 atm

22. Which of the following must be true for a reaction that proceeds spontaneously from initial standard state conditions?

(A) $\Delta G°$ is positive and K_{eq} is greater than 1
(B) $\Delta G°$ is positive and K_{eq} is less than 1
(C) $\Delta G°$ is negative and K_{eq} is greater than 1
(D) $\Delta G°$ is positive and K_{eq} is greater than 1
(E) $\Delta G°$ is equal to zero and K_{eq} is equal to 1

23. Hydrogen gas and iodine gas are introduced into a cylinder with a movable piston as shown in the following diagram:
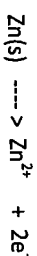

Which of the following would cause a decrease in the reaction rate?

(1) adding neon, holding the volume constant
(2) increase the volume, holding the temperature constant
(3) increase the temperature, holding the volume constant
(4) adding a catalyst

24. The half-reaction at the anode of a galvanic cells is as follows:

$$Zn(s) \ ---> \ Zn^{2+} \ + \ 2e^-$$

What is the maximum charge, in coulombs, that can be delivered by a cell with an anode composed of 6.54 grams of zinc?

(1 faraday = 96500 coulombs)

(A) 4820 coulombs
(B) 9650 coulombs
(C) 19300 coulombs
(D) 38600 coulombs
(D) 48200 coulombs

25. Which of the following are compounds that might reasonably form from combining iron and oxygen?
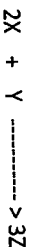
(X) Fe_2O_3
(Y) Fe_3O_2
(Z) FeO

(A) X only
(B) Y only
(C) Z only
(D) X and Y only
(E) X and Z only

26. What is the molar solubility in water of PbI_2?

(The K_{sp} for PbI_2 is 3.2×10^{-8})

A) 3.2×10^{-8} M
B) 8.0×10^{-8} M
C) $\sqrt{1.6 \times 10^{-8}}$ M
D) $\sqrt[3]{1.6 \times 10^{-8}}$ M
E) 2×10^{-3} M

27. The following data was obtained for the reaction

$$2X + Y \longrightarrow 3Z$$

Experiment	$X\left(\dfrac{mole}{liter}\right)$	$Y\left(\dfrac{mole}{liter}\right)$	Rate $\left(\dfrac{mole}{liter.sec}\right)$
1	3.0	1.5	1.8
2	1.5	3.0	0.45
3	1.5	1.5	0.45

What is the proper rate expression?

(A) rate = k[X] [Y]
(B) rate = k[Y]^2
(C) rate = k[X]
(D) rate = k[X]^2 [Y]
(E) rate = k[X]^2

28. Which of the following elements is a diamagnetic?

(A) Hydrogen
(B) Carbon
(C) Magnesium
(D) Fluorine
(E) Sulfur

29. A student wishes to prepare a buffer solution with a pH of 5. Which of the following acids would be the best choice for the buffer?

(A) $H_2C_2O_4$ $K_a = 5.9 \times 10^{-2}$
(B) H_3AsO_4 $K_a = 5.0 \times 10^{-3}$
(C) $H_2C_2H_3O_2$ $K_a = 1.8 \times 10^{-5}$
(D) HOCl $K_a = 3.0 \times 10^{-8}$
(E) HCN $K_a = 4.9 \times 10^{-10}$

30. Which of the following expressions is equal to the density of helium gas at STP?

(A) $\dfrac{1}{22.4}$ g/L

(B) $\dfrac{2}{22.4}$ g/L

(C) $\dfrac{1}{4}$ g/L

(D) $\dfrac{4}{22.4}$ g/L

(E) $\dfrac{4}{4}$ g/L

31. What is the name of the branched alkene $CH_3(CH_2)_2C(CH_3)=CHCH_3$?

(A) 3-methyl-2-hexene
(B) 2-methyl-3-hexene
(C) 1-methyl-2,3 diethyl-3-hexene
(D) 1-methyl-2,2 diethyl-3-hexene
(E) 1,3-dimethyl-3-hexene

32. An unknown quantity of methane gas, CH_4, is held in a 2.0 L container at 77°C. The pressure inside the container is 3.0 atm. How many moles of methane must be in the container?

(A) 0.21 mol
(B) 0.95 mol
(C) 1.05 mol
(D) 4.8 mol
(E) 0.5 mol

33. Antibonding orbitals are found

(A) between the nuclei of atoms
(B) surrounding the nuclei of atoms
(C) nowhere; they only exist theoretically
(D) on the outsides of atoms (the sides opposite the overlapping regions)
(E) above the bonding orbital

34. All of the following can be inferred from the dot diagram below EXCEPT

:: X ::

(A) Element X is a halogen.
(B) Element X forms an anion with a negative one charge.
(C) Element X has a valence electron with a possible set of quantum numbers equaling 3, 1, 1, -½
(D) Element X is highly electronegative when compared to other elements in its period.
(E) Element X forms a strong acid.

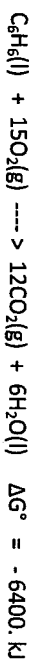35. The best explanation for the fact that diamond is extremely hard is that diamond crystals

(A) are made up of atoms that are intrinsically hard because of their electronic structures
(B) consist of positive and negative ions that are strongly attracted to each other
(C) are giant molecules in which each atom forms strong covalent bonds with all of its neighboring atoms
(D) are formed under extreme conditions of temperature and pressure
(E) contain orbitals or bands of delocalized electrons that belong not to single atoms but to each crystal as a whole

36. Which correctly lists the particles in order of increasing penetrating power?

(A) Gamma rays < alpha particles < beta particles
(B) Beta particles < alpha particles < gamma rays
(C) Beta particles < gamma rays < alpha particles
(D) Alpha particles < beta particles < gamma rays
(E) Alpha particles < gamma rays < beta particles

37. Given standard free energy change for the following reactions:

$C_6H_6(l) + 15O_2(g) \longrightarrow 12CO_2(g) + 6H_2O(l)$ $\Delta G° = -6400. kJ$

$C(s) + O_2(g) \longrightarrow CO_2(g)$ $\Delta G° = -400. kJ$

$H_2(g) + ½ O_2(g) \longrightarrow H_2O(l)$ $\Delta G° = -250. kJ$

What is the standard free energy change for the reaction below, as calculated from the data above?

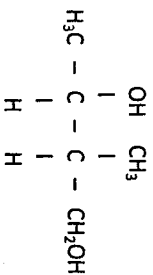$6C(s) + 3H_2(g) \longrightarrow C_6H_6(l)$

(A) -250. kJ
(B) -100. kJ
(C) -50. kJ
(D) 50. kJ
(E) 100. kJ

38. Which of the following molecules has the highest bond energy?
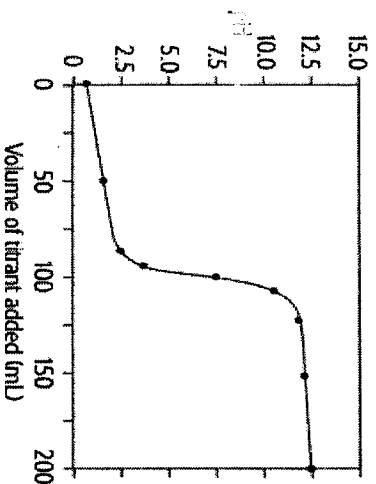
(A) N_2
(B) O_2
(C) Cl_2
(D) Br_2
(E) H_2

39. How many asymmetric carbon atoms are present in the following molecule?

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      OH   CH₃
      |    |
H₃C — C — C — CH₂OH
      |    |
      H    H
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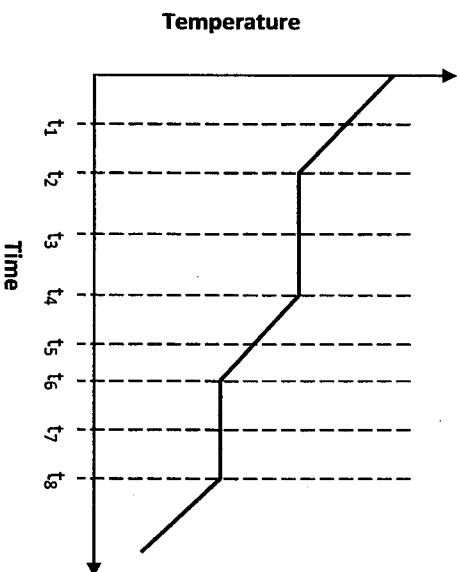
(A) 0
(B) 1
(C) 2
(D) 3
(E) 4

40. Which of the following reactions would most likely produce the titration curve represented below?

(A) H_2SO_4 + NH_3
(B) KOH + $HC_2H_3O_2$
(C) $HC_7H_5O_2$ + CH_3NH_2
(D) HNO_3 + NaOH
(E) HNO_2 + NaOH

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Questions 41 through 42: The phase diagram of an unknown substance is shown below.

41. The phase diagram above shows the temperature change of a substance that starts of as a gas and heat is removed at constant rate. At which time does the sample contain equal amount of gas and liquid?

(A) t_1
(B) t_2
(C) t_3
(D) t_5
(E) t_7

42. Which best describes the potential energy change and the entropy change, ΔS, of the substance from time t_4 to t_5?

(A) Potential energy increases, and ΔS = +
(B) Potential energy decreases and ΔS = -
(C) Potential energy remains the same, and ΔS = +
(D) Potential energy remains the same, and ΔS = -
(E) Potential energy remains the same, and ΔS = 0

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43. What is the osmotic pressure of 0.100 M NaCl that is at 27°C?

(A) 0.22 atm
(B) 0.44 atm
(C) 2.5 atm
(D) 4.9 atm
(E) 9.8 atm

44. Electromagnetic radiation with a wavelength of 320 nm

(A) has a higher velocity in a vacuum than does radiation with a wavelength of 400 nm.
(B) has a higher frequency than radiation with a wavelength 200 nm.
(C) is in the visible region of the electromagnetic spectrum.
(D) has a lower energy per photon than does radiation with a wavelength of 100 nm.
(E) has a slower velocity in a vacuum than does radiation with a wavelength of 400 nm.

45. Which of the following unbalanced equation demonstrates aluminum hydroxide's amphoteric properties?

(1) $Al(OH)_3(aq)$ + $H_2O(l)$ ---> $Al(s)$ + $O_2(g)$ + $H_2O(l)$
(2) $Al(OH)_3(s)$ ---> $Al(s)$ + $H_2O(g)$
(3) $Al(OH)_3(s)$ + $O_2(g)$ ---> $Al(s)$ + $H_2O(g)$
(4) $Al(OH)_3(s)$ + $NaOH(aq)$ ---> $NaAl(OH)_4(aq)$
(5) $Al(OH)_3(s)$ + $HCl(aq)$ ---> $AlCl_3(aq)$ + $H_2O(l)$

(A) 1
(B) 2 and 3
(C) 3 and 4
(D) 4 and 5
(E) all

46. ___H_2SO_4 + ___$Ca(OH)_2$ ---> ___$CaSO_4$ + ___H_2O

When the following equation for the acid base reaction above is balanced and all of the coefficients are reduced to lowest whole-number terms, the coefficient of the H_2O is

(A) 1
(B) 2
(C) 3
(D) 4
(E) 5

47. For the reaction

$$2W(g) \ -------> \ 2X(g) \ + \ Y(g),$$

the equilibrium constant, K_p, is 8×10^3 at 298K. A mixture of three gases at 298K is placed in a rigid metal cylinder and the initial pressures are $P_X = 1$ atmosphere, $P_Y = 0.8$ atmosphere, and $P_W = 2$ atmosphere. At the instant of mixing, which of the following is true for the reaction as written?

(A) more product will form
(B) more reactant will form
(C) $\Delta S = 0$
(D) $\Delta G° = 0$
(E) $\Delta G° > 0$

48. As a beaker of water is heated over a flame, the temperature increases steadily until it reaches 373 K. At that point, the beaker is left on the open flame, but the temperature remains at 373 K as long as the water remains in the beaker. This is because at 373 K, the energy supplied by the flame

(A) no longer acts to increase the energy of the water molecules.
(B) is completely absorbed by the glass beaker.
(C) is less than the energy lost by the water through electromagnetic radiation.
(D) is dissipated by the water as visible light
(E) is used to overcome the heat of vaporization of the water

49. Consider the chemical reaction equation below:

$$16HCl + 2K_2CrO_7 + C_2H_5OH \longrightarrow 4CrCl_3 + 4KCl + 11H_2O + 2CO_2$$

According to the balanced equation above, how many moles of HCl would be necessary to produce 4.0 mol of CO_2, starting with 6.0 mol of K_2CrO_7 and 5.0 mol of C_2H_5OH?

(A) 8
(B) 16
(C) 32
(D) 48
(E) 80

50. Solid iron (II) sulfide reacts with atmospheric oxygen to form iron (II) oxide and sulfur dioxide. Which of the following statements are true about the reaction?

I. Sulfur is the reducing agent, oxygen is the oxidizing agent.
II. Sulfur is reduced, oxygen is oxidized.
III. Sulfur transfers electrons to iron and oxygen.

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

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answers and note how many correct **points**

Day 14: 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)

The solubility of $Mg(OH)_2$, magnesium hydroxide, is 6.53×10^{-3} g/L
at 25°C. Assume that this temperature is maintained for all parts of the
question.

(a) Write a balanced equation for the solubility equilibrium.

(b) Based on the equilibrium expression you wrote:

(i) Write expression for the K_{sp}.

(ii) Determine the K_{sp} value from the expression in (b).

(c) Calculate the pH of a saturated solution of $Mg(OH)_2$.

(d) If 100 mL of 2.5×10^{-3} M $Mg(NO_3)_2$ solution is added to 100 mL of
a 3.5×10^{-4} M NaOH solution:

(i) What will be the concentration of the magnesium and hydroxide
ions in the solution?

(ii) Will a precipitate of $Mg(OH)_2$ formed in the solution?
Justify your response by using your calculated data.

2. (10 points)

Substance	Absolute Entropy, S° (J/mol-K)	Molecular Weight (g)
$C_6H_{12}O_6(s)$	212	180
$O_2(g)$	205	32
$CO_2(g)$	213	44
$H_2O(l)$	70.0	18

Energy is released when glucose is oxidized in the following reaction, which is a metabolism reaction that takes place in the body.

$$C_6H_{12}O_6(s) \ + \ 6O_2(g) \ \longrightarrow \ 6CO_2(g) \ + \ 6H_2O(l)$$

The standard enthalpy change, $\Delta H°$, for the reaction is - 2,801 KJ at 298 K.

(a) Calculate the standard entropy change, $\Delta S°$, for the oxidation of glucose.

(b) Calculate the standard free energy change, $\Delta G°$, for the reaction at 298K.

(c) At which temperature, if any, would the spontaneity of this reaction change. Justify your answer with an explanation.

(d) What is the value of K_{eq} for the reaction?

(e) much energy is given off by the oxidation of 1.0 grams of glucose?

(f) A student conducted a laboratory experiment to determine the standard enthalpy change, $\Delta H°$, for oxidation of glucose. From his data, the student calculated a result that was 11.3 % below the accepted value of $\Delta H°$ for glucose. What was the value of the standard enthalpy change from the student's experiment? Assume the experiment was conducted at 298 K.

STOP. Correct your answers and note how many correct **points**

Day 14 Question 2: Space for Work and Answers

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) Solid sodium hydride is added to water

(i) Balanced equation:

(ii) If 10 grams of sodium hydride react with water at STP, how many milliliters of the gaseous product will form?

(b) A solution of hydrogen peroxide is heated.

(i) Balanced equation:

(ii) Indicate the oxidation numbers of oxygen before and after the reaction.

(c) A copper coil is placed in a silver nitrate solution.

(i) Balanced equation:

(ii) Indicate visible changes that would occur in the reaction container as the reaction is proceeding.

Your responses to question 2 will be scored on the basis of the accuracy and relevance of the information cited. Explanations should be clear and well organized. Examples and equations may be included in your responses where appropriate. Specific answers are preferable to broad, diffuse responses.

(8 points)

2. A student performed a titration of a weak monoprotic acid, HA, with a sodium hydroxide, NaOH, solution.

(a) On the graph below, sketch an appropriate representation of the titration curve for the experiment. On the curve, label the half-equivalent point and the equivalent point.

pH

Volume of NaOH (ml)
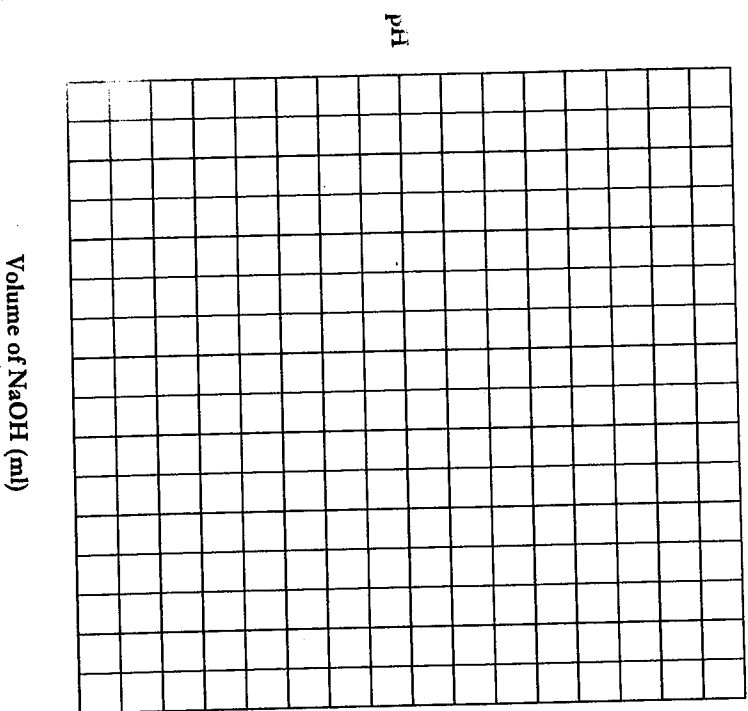
(b) Discuss at least two ways in which a sketch from the titration of a strong, monoprotic, like HCl will differ from the your sketch in (a)

(c) The student has a choice between the two indicators: methyl red (pH range = 4.8 – 6.0) or phenolphthalein (pH range = 8.2 – 10.0). Which should she choose? Justify your response.

(d) Assume that the acid in this titration was acetic acid, what will be the formula and name of the product (other than water) that is formed during the titration process?

Day 15

STOP. Correct your answers and note how many correct **points**