

Day 16: 50 Multiple choice questions
 50 points **Section I Part A and B Practice**

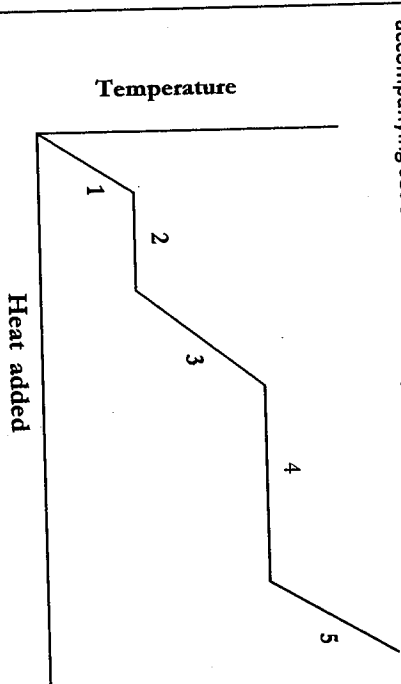
Start: Answer all questions on this day before stopping.

Note: No calculators may be used for questions on this day.

You may use **ONLY** the **Periodic Table provided on pg 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 diagram and the accompanying set of choices with regard to the heat being transferred:



- (A) Liquid phase
- (B) Increase in average kinetic energy of particles
- (C) Decrease in average kinetic energy of particles
- (D) Heat of fusion
- (E) Heat of vaporization

1. Moving left to right on segment 1 represents this.
2. Segment 2 corresponds to this phase or phase change.
3. Segment 3 corresponds to this phase or phase change.
4. Segment 4 corresponds to this phase or phase change.
5. Moving right to left on segment 5 represents this.

Day 16: Continue

Questions 6 through 9 refer to atoms for which the occupied atomic orbitals are shown below.

- (A) $1s \uparrow \quad 2s \uparrow\downarrow$
 (B) $1s \uparrow\downarrow \quad 2s \uparrow\downarrow$
 (C) $1s \uparrow\downarrow \quad 2s \uparrow\downarrow \quad 2p \uparrow \quad \uparrow \quad _$
 (C) $1s \uparrow\downarrow \quad 2s \uparrow\downarrow \quad 2p \uparrow\downarrow \quad \uparrow\downarrow \quad \uparrow\downarrow$
 (E) $[Ar] 4s \uparrow\downarrow \quad 3d \uparrow\downarrow \quad \uparrow \quad \uparrow \quad \uparrow \quad \uparrow$

6. Represents an atom that forms a basic solution when reacted with water.
 7. Represents an atom that forms colored aqueous solutions.
 8. Represents an atom that readily forms four sp^3 hybrid orbitals.
 9. Represents an atom that is not in its ground state.

Questions 10 through 14 refer to the following elements:

- (A) Na
 (B) Mg
 (C) Al
 (D) S
 (E) Cl

10. Is the heaviest metal
 11. Is the most electronegative
 12. Has the largest first ionization energy
 13. Has the largest jump between second and third ionization energies

14. Has the largest atomic radius

Day 16: Continue

15. Which of the following represents the energy of the single electron in a hydrogen atom when it is in the $n = 4$ state?

- (A) $\frac{-2.178 \times 10^{-18}}{2}$ joules
 (B) $\frac{-2.178 \times 10^{-18}}{4}$ joules
 (C) $\frac{-2.178 \times 10^{-18}}{8}$ joules
 (D) $\frac{-2.178 \times 10^{-18}}{16}$ joules
 (E) $\frac{-2.178 \times 10^{-18}}{64}$ joules

16. A molecule whose central atom has d^2sp^3 hybridization can have which of the following shapes?

- (I) Tetrahedral
 (II) Square pyramidal
 (III) Square planar

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

17. What is the molality of a 10. % (by weight) $C_6H_{12}O_6$ (MW = 90.) solution?

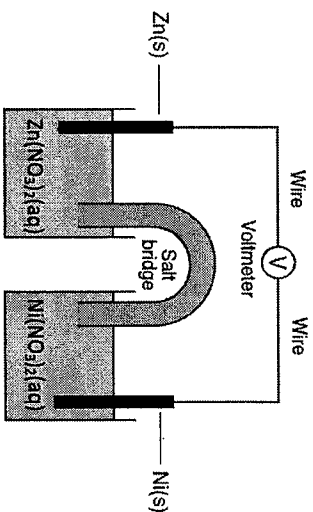
- (A) 0.012 *m*
 (B) 0.12 *m*
 (C) 1.2 *m*
 (D) 2 *m*
 (E) Not enough information is provided.

Day 16: Continue

18. Which of the following polyatomic ions has the greatest amount of negative charge?
- (A) Nitrate
 - (B) Sulfate
 - (C) Phosphate
 - (D) Permanganate
 - (E) Ammonium
19. Which of the following is the safest and most effective procedure to treat a base spill onto skin?
- (A) Dry the affected area with paper towel
 - (B) Flush the area with a dilute solution of HCl
 - (C) Flush the affected area with water and then with a dilute NaOH solution
 - (D) Flush the affected area with water and then with a dilute NaHCO_3 solution
 - (E) Flush the affected area with water and then with a dilute vinegar solution.
20. In solid carbon tetrachloride, the force holding the molecules together is best characterized as
- (A) covalent bond
 - (B) London (dispersion) forces
 - (C) hydrogen bonds
 - (D) ionic bonds
 - (E) molecule-ion attraction

Day 16: Continue

Questions 21 and 22 refer to the galvanic cell diagram below



21. Which statement identifies the part of the cell that conduct electrons and describes the direction of electron flow as the cell operates?
- (A) Electrons flow through the salt bridge from $\text{Ni}(s)$ to the $\text{Zn}(s)$
 - (B) Electrons flow through the salt bridge from $\text{Zn}(s)$ to the $\text{Ni}(s)$
 - (C) Electrons flow through the wire from $\text{Ni}(s)$ to the $\text{Zn}(s)$
 - (D) Electrons flow through the wire from $\text{Zn}(s)$ to the $\text{Ni}(s)$
 - (E) Electrons flow through both the wire and the salt bridge
22. Which equation correctly shows the overall redox reaction that occurs in this cell?
- (A) $\text{Zn}(s) + \text{Zn}^{2+}(\text{aq}) \rightarrow \text{Ni}(s) + \text{Ni}^{2+}(\text{aq})$
 - (B) $\text{Zn}^{2+}(\text{aq}) + \text{Ni}(s) \rightarrow \text{Zn}(s) + \text{Ni}^{2+}(\text{aq})$
 - (C) $\text{Zn}(s) + \text{Ni}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Ni}(s)$
 - (D) $\text{Zn}(s) + \text{ZnNO}_3^-(\text{aq}) \rightarrow \text{Zn}(\text{NO}_3)_2(\text{aq})$
 - (E) $\text{Ni}(s) + \text{ZnNO}_3^-(\text{aq}) \rightarrow \text{Ni}(\text{NO}_3)_2(\text{aq})$

Day 16: Continue

23. Which of the following pairs of compounds are not a conjugate acid/base pair?

- (A) H_3O^+ and H_2O
- (B) H_2O and OH^-
- (C) NH_3 and NH_2^-
- (D) CH_3COOH and CH_3COO^-
- (E) H_3PO_4 and PO_4^{3-}

24. In which of the following compounds is the mass ratio of element X to oxygen closest to 2.5 to 1.0? (Molar mass of element X = 40.0 grams per mole)

- (A) XO
- (B) XO_2
- (C) XO_3
- (D) X_2O
- (E) X_2O_3

25. Which of the following operations should have a final answer containing four significant figures?

- (A) 12.2×13.51
- (B) $(62.315)^2$
- (C) $0.023 + 1.311$
- (D) $1.010 - 11.623$
- (E) $64.5 \div 3.2$

26. Which conclusion is based on Rutherford's "gold foil" experiment?

- (A) Electrons orbit the nucleus in concentric rings
- (B) All neutrons are located in a central nucleus
- (C) Most of the mass of an atom is located in a central, dense core
- (D) Atoms are composed of positively and negatively charged particles
- (E) Alpha particles are attracted to a negative charged plate

Day 16: Continue

27. Excess silver carbonate is added to 500 mL of water and the mixture stirred. Which of the following will cause the equilibrium to shift in the direction that would favor ionization?

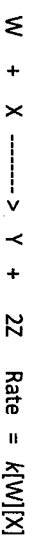
- (1) add some AgNO_3
- (2) add some NH_3
- (3) add some Na_2CO_3
- (4) add some HNO_3

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

28. The pH of 0.1-molar acetic acid is approximately

- (A) 1
- (B) 4
- (C) 7
- (D) 11
- (E) 14

29. Given the reaction and rate expression below:



What is the relationship between the rates of change in $[W]$, $[X]$, $[Y]$, and $[Z]$?

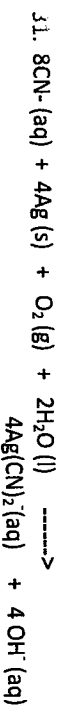
- (A) $\text{Rate} = d[W]/dt = d[X]/dt = -d[Y]/dt = -2d[Z]/dt$
- (B) $\text{Rate} = d[W]/dt = d[X]/dt = -d[Y]/dt = 2d[Z]/dt$
- (C) $\text{Rate} = d[W]/dt = d[X]/dt = -d[Y]/dt = -0.5d[Z]/dt$
- (D) $\text{Rate} = d[W]/dt = d[X]/dt = -d[Y]/dt = 0.5d[Z]/dt$
- (E) $\text{Rate} = 2d[W]/dt = 2d[X]/dt = -d[Y]/dt = -0.5d[Z]/dt$

30.

Time (hours)	% radioisotope remaining
0	100
2	82
4	67
6	50
8	41
10	32
12	25
14	20
...	...
20	10
...	...
40	1

The data table above shows the percentage of a radioisotope remaining every two hours as it decays for a period of 40 hours. Which of the following best describes the order and the half-life of the reaction?

- Order of reaction Half-life of reaction (in hours)
- (A) Second 6
 (B) Second 20
 (C) First 6
 (D) First 12
 (E) First 20



Which of the following is true regarding the reaction represented above?

- (A) The oxidation number of O does not change.
 (B) The oxidation number of H changes from -1 to +1.
 (C) The oxidation number of Ag changes from zero to -1.
 (D) The oxidation number of C is +4 in the cyanide ion.
 (E) This oxidation number of N is -3 in the cyanide ion.

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32. A radioactive isotope has a half-life of 6.93 years and decays by beta emission. Determine the approximate fraction of the sample that is left undecayed at the end of 11.5 years.

- (A) 1%
 (B) 5%
 (C) 30%
 (D) 75%
 (E) 99%

33. Which of the following would be spontaneous?

- (A) the decomposition of iron(II) oxide to iron metal and oxygen gas
 (B) heat transfer from an ice cube to a room maintained at a temperature of 27°C
 (C) expansion of a gas to fill the available volume
 (D) the decomposition of sodium chloride
 (E) freezing of water at 2°C

34. In the reaction



if 500. g of Fe_2O_3 reacts with 75.0 g of C, how many grams of Fe will be produced?

- (A) 56.4g
 (B) 75.0g
 (C) 316.g
 (D) 350.g
 (E) 465.g

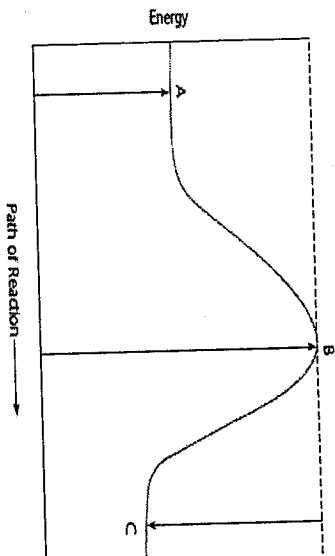
35. $\text{H}_2\text{O}(l) \text{ -----} \rightarrow \text{H}_2\text{O}(s)$

When water freezes at its normal freezing point, 0°C and 1 atm, which of the followings is true for the process shown above?

- (A) $\Delta H < 0$, $\Delta S > 0$, $\Delta V > 0$
 (B) $\Delta H < 0$, $\Delta S < 0$, $\Delta V > 0$
 (C) $\Delta H > 0$, $\Delta S < 0$, $\Delta V < 0$
 (D) $\Delta H > 0$, $\Delta S > 0$, $\Delta V > 0$
 (E) $\Delta H > 0$, $\Delta S > 0$, $\Delta V < 0$

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Day 16: Continue



36. Which correctly represents the enthalpy for the reaction?
- (A) B – (C – A)
 (B) B
 (C) C – A
 (D) B – C
 (E) A – (B – C)
37. 10.0 mL of 1.00 M NaOH will create a solution of pH = 7 when mixed with which of the following (assume the solution is 0.500 M)?
- (A) 10.0 mL HNO₃
 (B) 10.0 mL CH₃COOH
 (C) 5.00 mL HCl
 (D) 5.00 mL H₂SO₄
 (E) 10.0 mL H₂SO₄
38. When benzene and toluene are mixed together, they form an ideal solution. If benzene has a higher vapor pressure than toluene, the vapor pressure of a solution that contains an equal number of moles of benzene and toluene will be
- (A) higher than the vapor pressure of benzene
 (B) equal to the vapor pressure of benzene
 (C) lower than the vapor pressure of benzene and higher than the vapor pressure of toluene
 (D) equal to the vapor pressure of toluene
 (E) lower than the vapor pressure of benzene and higher than the vapor pressure of toluene

Day 16: Continue

39. Which of the following is not a likely product for the decay of iodine-131?
- (A) Antimony-127
 (B) Tellurium-131
 (C) Iodine-131
 (D) Xenon-131
 (E) Cesium-135
40. Which of the following substances will exhibit hydrogen bonding?
- (A) Butane
 (B) Butanone
 (C) Butanol
 (D) Butanoic acid
 (E) Methyl butanoate

Questions 41 through 42



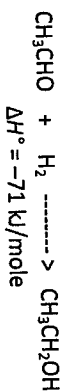
The oxidation of bromide ions by bromate ions in acidic aqueous solution occurs according to the stoichiometry shown above. The experimental rate law of the reaction is:

$$\text{Rate} = k [\text{BrO}_3^-] [\text{Br}^-] [\text{H}^+]$$

41. What is the order of the reaction with respect to Br⁻?
- (A) 1
 (B) 2
 (C) 3
 (D) 5
 (E) 6
42. According to the rate law for the reaction, an increase in the concentration of hydrogen ion has what effect on this reaction?
- (A) The rate of reaction increases.
 (B) The rate of reaction decreases.
 (C) The value of the equilibrium constant increases.
 (D) The value of the equilibrium constant decreases.
 (E) Neither the rate nor the value of the equilibrium constant is changed.

Day 16: Continue

43. Given the following heat of reaction and the bond energies listed in the accompanying table (measured under standard conditions), calculate the energy of the C=O bond. All numerical values are in kilojoules per mole, and all substances are in the gas phase.



Bond	O-H	C-H	C-C	C-O	H-H
Bond Energy (kJ. mol ⁻¹)	464	414	347	351	435

- (A) 180 kJ
 (B) 360 kJ
 (C) 723 kJ
 (D) 1446 kJ
 (E) 2892 kJ

44. Which of the following is not capable of reacting with molecular oxygen?

- (A) SO₂
 (B) SO₃
 (C) NO
 (D) N₂O
 (E) P₄O₆

Day 16: Continue

45. What is the [H⁺] of a solution with a pH of 4.50?

- (A) 3.1 × 10⁻⁴
 (B) 5.6 × 10⁻⁵
 (C) 4.2 × 10⁻⁹
 (D) 3.2 × 10⁻¹⁰
 (E) 7.1 × 10⁻¹¹

46. Which of the following compounds is least soluble in water?

- (A) Sodium propanoate
 (B) Propanoic acid
 (C) Propanediol
 (D) Propanone
 (E) Propene

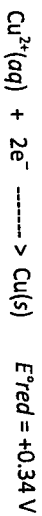
47. Of the following reactions, which involves the largest decrease in entropy?

- (A) MgCO₃(s) → MgO(s) + CO₂(g)
 (B) 2NO(g) + O₂(g) → 2NO₂(g)
 (C) Pb(NO₃)₂(aq) + 2NaCl(aq) → PbCl₂(s) + 2NaNO₃(aq)
 (D) CH₄(g) + 2O₂(g) → CO₂(g) + 2H₂O(l)
 (E) 4Al(s) + 3O₂(g) → 2Al₂O₃(s)

Day 16: Continue

Questions 48 through 50 refer to the following reaction that takes place within an electrochemical cell:

Solid copper reacts with oxygen gas under acidic conditions to produce copper (II) cation and water.



48. What is the balanced reaction equation?

- (A) $2\text{Cu} + \text{O}_2 \longrightarrow 2\text{Cu}^{2+} + \text{H}_2\text{O}$
- (B) $\text{Cu} + \text{O}_2 + \text{H}^{+} \longrightarrow \text{Cu}^{2+} + \text{H}_2\text{O}$
- (C) $2\text{Cu} + \text{O}_2 + 4\text{H}^{+} \longrightarrow 2\text{Cu}^{2+} + 2\text{H}_2\text{O}$
- (D) $2\text{Cu} + \text{O}_2 + 2\text{H}^{+} \longrightarrow 2\text{Cu}^{2+} + \text{H}_2\text{O}$
- (E) $2\text{Cu} + 2\text{O}_2 + 2\text{H}^{+} \longrightarrow \text{Cu}^{2+} + 2\text{H}_2\text{O}$

49. What is the standard cell potential for the reaction?

- (A) -0.89 V
- (B) $+0.89 \text{ V}$
- (C) -1.57 V
- (D) $+1.57 \text{ V}$
- (E) $+1.23 \text{ V}$

50. What is the standard free energy change for the reaction?

(Note: $1 \text{ J} = 1 \text{ C}\cdot\text{V}$, so $1 \text{ F} = \frac{96,500 \text{ J}}{\text{V}\cdot\text{mol}}$)

- (A) $+610 \text{ kJ/mol}$
- (B) -610 kJ/mol
- (C) $+150 \text{ kJ/mol}$
- (D) -340 kJ/mol
- (E) $+340 \text{ kJ/mol}$

Day 16

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

Day 17: 2 Free Response Questions
20 points *Section II Part A Practice*

START: Answer all questions on this day before stopping.

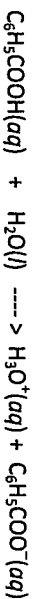
Note: You may use a calculator for questions on this day.

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)

Benzoic acid dissociates in water according to the reaction below.



$$K_a = 6.17 \times 10^{-5}$$

- (a) Write the equilibrium constant expression for the reaction.
- (b) Calculate the molar concentration of $\text{C}_6\text{H}_5\text{COO}^-$ in a 0.0100M benzoic acid solution.
- (c) What is the pH of the solution in (b) ?
- (d) After adding 10.0mL of $5.00 \times 10^{-6} \text{ M Ca(OH)}_2$ to 90.0mL of an unknown concentration of benzoic acid, the pH of the solution is 5.26. Calculate each of the following:
 - (i) The $[\text{H}^+]$ of the solution after the addition of Ca(OH)_2 .
 - (ii) The $[\text{OH}^-]$ of the solution after the addition of Ca(OH)_2 .
 - (iii) Write a balanced neutralization reaction equation for the reaction of benzoic acid with the calcium hydroxide.
- (e) State whether the solution at the equivalence point of this titration is acidic, basic, or neutral. Explain your reasoning.

Day 17: Continue

2. (10 points)

A student uses spectrophotometer to collect data on the first order decomposition of a colored chemical species, Z, into colorless products.

The molar absorptivity of Z is 5.0×10^3 / (cm.M). The cuvette containing the reaction mixture has a path length of 1.0 cm.

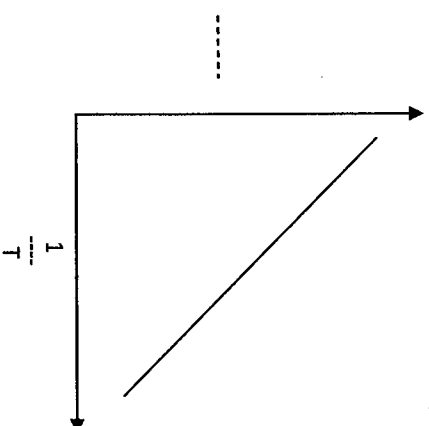
The data table below contains information collected by the student.

[Z] (M)	?	8.00×10^{-5}	6.00×10^{-5}	3.00×10^{-5}
Absorbance	1.20	0.400	0.300	0.150
Time (min.)	0.0	25.0	46.5	?

- (a) What is the initial concentration of the colored species?
- (b) Based on the information provided on the table, determine the rate constant for the first order reaction. Include all units with your answer.
- (c) How many minutes have elapsed from when the absorbance goes from 1.20 to 0.150.
- (d) Determine the half-life of the reaction performed by the student.

Day 17: Continue

- (e) The student performed more experiments to determine the rate constant at various temperature, T. The student plotted the graph below from data she collected from the experiments.



- (i) Label the vertical axis of the graph on the dotted line.
- (ii) Explain how the student can calculate the activation energy, E_a , for the reaction using information provided by the graph.

Day 17

STOP. Correct your answers and note how many correct points

Day 18: 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) A solution of ammonium thiocyanate is added to a solution of iron (III) nitrate.

(i) Balanced equation:

(ii) What is mass of 0.12 mole of ammonium thiocyanate?

(b) Carbon dioxide gas is bubbled through a concentrated solution of sodium hydroxide.

(i) Balanced equation:

(ii) What happens to the pH of the sodium hydroxide as carbon dioxide is added to it.

(c) Calcium chloride dihydrate is gently heated in an open test tube.

(i) Balanced equation:

(ii) If 10 grams of calcium chloride dihydrate is heated for 5 minutes, would the mass of the content of the test tube after heating be greater than 10 gram, equal to 10 grams, or less than 10 grams. Explain.

Day 18: Continue

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. Answer each of the following questions about carbon dioxide and phosphate ion.

(a) Draw a complete Lewis electron-dot diagram for CO_2 and for PO_4^{3-} .

(b) On the basis of your Lewis diagram from part (a), identify the hybridization of the central carbon atom in CO_2 and the central phosphorous atom in PO_4^{3-} .

(c) When carbon dioxide dissolves in water, a small fraction (at equilibrium) of the carbon dioxide reacts with water to form carbonic acid.

(i) Write out a complete, balanced equation for this reaction and

(ii) identify the Lewis acid and the Lewis base in the reaction.

(d) Is CO_2 polar? Explain.

Day 18

STOP. Correct your answers and note how many correct points