

CHEMISTRY 204  
Hour Exam III  
April 25, 2019  
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Name \_\_\_\_\_

Signature \_\_\_\_\_

T.A. \_\_\_\_\_

Section \_\_\_\_\_

This exam contains 23 questions on 11 numbered pages. Check now to make sure you have a complete exam. You have two hours to complete the exam. Determine the **best** answer to the first 20 questions and enter these on the special answer sheet. Also, circle your responses in this exam booklet. **Show all of your work and provide complete answers to questions 21, 22 and 23.**

|       |           |       |
|-------|-----------|-------|
| 1-20  | (60 pts.) | _____ |
| 21    | (20 pts.) | _____ |
| 22    | (30 pts)  | _____ |
| 23    | (10 pts.) | _____ |
| Total | (120 pts) | _____ |

Useful Information:

- Unless otherwise noted, all solutions referred to on this exam are aqueous solutions at 25°C.
- 760 torr = 1.00 atm
- $R = 0.08206 \text{ Latm/molK} = 8.314 \text{ J/Kmol}$
- $K = ^\circ\text{C} + 273$
- $N_A = 6.022 \times 10^{23}$

$$P_{\text{soln}} = \chi_{\text{solvent}} P^\circ_{\text{solvent}}$$

$$P_{\text{total}} = P_A + P_B = \chi_A P^\circ_A + \chi_B P^\circ_B$$

$$\pi = iMRT$$

$$\Delta T = iK_f m_{\text{solute}}$$

$$\Delta T = iK_b m_{\text{solute}}$$

$$K_f = 1.86 \text{ K/m for water}$$

$$K_b = 0.51 \text{ K/m for water}$$

$$\mathcal{E} = \mathcal{E}^\circ - \frac{0.0591}{n} \log(Q)$$

$$F = 96,485 \text{ coulombs}$$

$$1 \text{ Ampere} = 1\text{C/s}$$

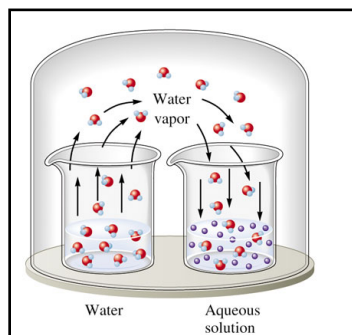
$$\Delta G^\circ = -nF\mathcal{E}^\circ$$

1. You have a solution of liquid A (pure vapor pressure = 150.0 torr) and liquid B (pure vapor pressure = 450.0 torr). The solution is placed in a closed container and allowed to come to equilibrium with its vapor. The vapor pressure above the solution is measured at 25°C and found to be 185.0 torr. Determine the composition of the **vapor** (by moles).
- a) 11.67% A  
b) 28.38% A  
c) 62.83% A  
d) 71.62% A  
e) 88.33% A
2. You know the freezing point of an aqueous solution. In order to use this number to calculate the osmotic pressure of the solution, how many of the following must be true?
- The solution is relatively dilute.
  - The solute is ionic.
  - The solute has a van't Hoff factor (i) equal to 1.
  - $\Delta H_{\text{solution}}$  is negative.
  - $\Delta H_{\text{solution}}$  is positive.
- a) 0                      b) 1                      c) 2                      d) 3                      e) 4
3. Consider the following data at the same temperature for a mixtures of liquids A and B (note: the vapor pressures are in an undefined unit and given for their relative values):

| Mole fraction of A | Vapor Pressure |
|--------------------|----------------|
| 0                  | 10.0           |
| 0.400              | 31.4           |
| 1.00               | 70.0           |

- |    | Liquid A | Liquid B |
|----|----------|----------|
| a) | Acetone  | Water    |
| b) | Water    | Acetone  |
| c) | Water    | Heptane  |
| d) | Hexane   | Heptane  |
| e) | Heptane  | Water    |
4. You dissolve 1.00 g  $\text{MgCl}_2$  in enough water to make 100.0 mL of solution at 25°C. Assuming that 15.0% of the  $\text{MgCl}_2$  exists as ion pairs, determine the osmotic pressure ( $\pi$ ) of the solution.
- a) 2.56 atm  
b) 4.75 atm  
c) 6.53 atm  
d) 6.93 atm  
e) 7.71 atm

5. Recall the following system discussed in your text (and lecture!):



First, 1.00 kg of water was added to each beaker. Then, 360.0 g of NaCl was added to the beaker on the right to make a saturated solution. The beakers were covered as shown above.

Given that the system is at a constant temperature of 25°C and that the vapor pressure of pure water is 23.8 torr at 25°C, determine the vapor pressure of the system at equilibrium. Assume ideal conditions.

- a) 19.6 torr      b) 21.4 torr      c) 22.5 torr      d) 23.8 torr      e) 25.0 torr
6. Which of the following is expected to have the lowest vapor pressure at 25°C?
- propane
  - dimethyl ether
  - ethanal (also known as acetaldehyde)
  - ethene (also known as ethylene)
  - ethyl alcohol
7. Which of the following statements is/are correct?
- The value of  $\mathcal{E}$  is equal to zero in a galvanic cell at equilibrium.
  - The value  $\mathcal{E}$  is equal to zero in any concentration cell.
  - The value of  $\mathcal{E}^\circ$  is equal to zero in any galvanic cell at equilibrium.
  - The value of  $\mathcal{E}^\circ$  can never be equal to zero in a galvanic cell with a potential.
  - At least two of the above choice (a-d) are correct.
8. For how many of the following solutions would bubbling  $\text{Cl}_2(\text{g})$  through the molten ionic compound cause a reaction?
- $\text{KI}(\text{l})$
  - $\text{KBr}(\text{l})$
  - $\text{NaF}(\text{l})$
  - $\text{NaCl}(\text{l})$

- a) 0      b) 1      c) 2      d) 3      e) 4

9, 10. Given the following two standard reduction potentials,



9. Solve for the absolute value (magnitude) of the standard reduction potential of half-reaction  $\text{M}^{3+} + \text{e}^{-} \rightarrow \text{M}^{2+}$ .

- a) 0.45 V      b) 0.70 V      c) 0.85 V      d) 1.90 V      e) 2.35 V

10. Is the sign of the standard reaction potential in Problem #9 positive or negative?

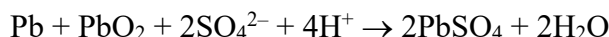
- a) Positive  
b) Negative

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11. Consider an electrochemical cell with a zinc electrode immersed in  $1.0 \text{ M Zn}^{2+}$  and an unknown metal "M" electrode immersed in  $1.0 \times 10^{-3} \text{ M "M}^{2+}"$ . The cell potential at  $25^{\circ}\text{C}$  is 0.53 V. Determine the identity of "M".

- a) Fe  
b) Zn  
c) Sn  
d) Cu  
e) We cannot determine the identity of the metal with this information.

12. The reaction that occurs in a lead storage battery for a car can be represented as follows:



Suppose you are starting a car on a cold morning and a current of 250.0 amperes is drawn for 31.4 seconds from the battery. How many grams of lead would be consumed?

- a)  $8.55 \times 10^{-3} \text{ g}$   
b) 0.0171 g  
c) 4.21 g  
d) 8.43 g  
e) 16.9 g

13. A fuel cell is designed to react rubbing alcohol (isopropyl alcohol) with oxygen to produce carbon dioxide and water. If you knew the maximum work that one mole of rubbing alcohol would yield, you could determine the theoretical maximum voltage of this cell. In making this calculation, what is the value of  $n$ ?

- a) 2      b) 6      c) 9      d) 12      e) 18

14. How many of the following alcohols are tertiary ( $3^\circ$ ) alcohols?

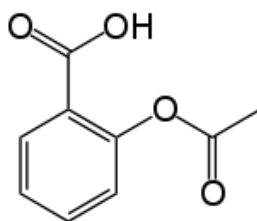
- I. 2-methyl-1-propanol
- II. 2-methyl-2-propanol
- III. 2-butanol
- IV. 3,3-dimethyl-1-butanol

a) 0                      b) 1                      c) 2                      d) 3                      e) 4

15. Complete the following sentence (hint: draw out the functional groups to answer this question). An ester is similar to a carboxylic acid as

- a) a primary alcohol is similar to a secondary alcohol.
- b) an amine is similar to a ketone.
- c) an alcohol is similar to an ether.
- d) an aromatic ring is similar to a polymer.
- e) a ketone is similar to an aldehyde.

16. Which functional groups are present in aspirin (shown below)?



- a) alcohol, ether, ketone
- b) secondary alcohol, ketone, ester
- c) carboxylic acid, ether
- d) aldehyde, ester
- e) carboxylic acid, ester

17. Which of the following names is a **correct** one?

- a) 3,4-dichloropentane
- b) 1,1-dimethyl-2,2-diethylbutane
- c) *cis*-1,3-dimethylpropane
- d) 2-bromo-1-chloro-4,4-diethylheptane
- e) At least two of the above are correct.

18. How many of the following groups of two compounds have the same molecular formulas?

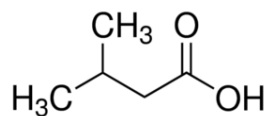
- dimethyl ether and ethanol
- propanol and propanal
- propanone and propanol
- dimethyl ether and methanol

a) 0                      b) 1                      c) 2                      d) 3                      e) 4

19. As a question on an organic chemistry exam, you are given the name of an alcohol, an ester, a carboxylic acid, a ketone, an amine, and an aldehyde, and asked to draw their structures. In drawing the structures for all of these, what is the **minimum** number of oxygen atoms you must include?

- a) 5                      b) 6                      c) 7                      d) 8                      e) 9

20. Provide the best name for the following compound.



- a) 3-methylbutanoic acid  
b) 2-isopropylethanoic acid  
c) 3-methylpropanoic acid  
d) 2-methylpropanoic acid  
e) 2-methylbutanoic acid