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Social Security # | | | | | | | | | |

School: | Barnard | College | Engineering | General Studies | Other

Chemistry 1404y Section 1

Exam 1 abcde

March 1, 2000

- 1. Please make sure you have your CUID to present to the TAs.**
- 2. Please fill in your name and CUID number as indicated above.**
- 3. Read and acknowledge your understanding of the statement in the box below:**

ACADEMIC PRINCIPLES: GUIDELINES FOR STUDENTS

Columbia University is dedicated to the highest ideals of integrity in academia. Thus any instance of academic dishonesty, attempted or actual, will not be tolerated. Academic dishonesty includes but is not limited to:

1. Plagiarism: Failure to acknowledge ideas or phrases used in any paper, exercise, or project submitted in a course but gained from another person.
2. Self-plagiarism: The submission of one piece of work in more than one course without the explicit permission of the instructors involved.
3. The submission of work as one's own which has been prepared by or purchased from another.
4. **Cheating on examinations or tests:** To give or receive assistance from written material, another person, his or her paper, or any other source during an examination or test.
5. Falsification or misrepresentation of data in any course work.
6. Violating the limits of acceptable collaboration in course work set forth by a faculty member or department.
7. Removing, hiding, or altering library materials so as to hinder the research of others.
8. Facilitating academic dishonesty by enabling another to engage in such behavior.

Ignorance of College policy shall not be a defense in any disciplinary proceedings. The University holds each member of the community responsible for understanding these principles and for abiding by them. By signing my name below, I affirm that I have read and understood this document.

Name (Signature)

March 1, 2000

Date _____

- 5. Now turn to page 2 and read the instructions. Do not turn to page 3 until you are instructed to do so.**

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INSTRUCTIONS:

FREE RESPONSE QUESTIONS MUST BE DONE IN PEN ON THE EXAM. MULTIPLE CHOICE RESPONSES MUST BE DONE ON BUBBLE SHEET IN PENCIL.

DO NOT TURN TO PAGE 3 UNTIL INSTRUCTED TO DO SO.

Fill in your name and CUID number as indicated above.

On the exam sheets:

- 1) Write on the exam sheets for the purpose of doing calculations and **answers to the free response questions**.
- 2) Answers to free response should contain one sentence maximum or simple numerical answer. **Please circle the answer clearly.**

On the bubble sheet:

- 1) On **Side 2 of the Bubble Sheet** print your first and last name in the box provided.
- 2) Then fill in the **IDENTIFICATION NO.** in the space provided and as indicated.
Your Identification No. is your SOCIAL SECURITY NUMBER.
- 3) Using a soft lead pencil, blacken the one response that best answers the question or completes the statement. There is only one correct answer to each question. Any question with more than one answer will not be counted. Your score will be the total number of correct answers; therefore, it is to your advantage to answer every question.
- 4) There are **31 QUESTIONS - 17 MULTIPLE CHOICE AND 10 FREE RESPONSE**. They are equally weighted unless otherwise indicated.

UNDER NO CIRCUMSTANCES are you to make any other marks... anywhere on the bubble sheet... except in the appropriate *bubbles* for marking an answer you believe to be correct.

CONSTANTS, CONVERSION FACTORS, AND FORMULAS are provided with each question where needed or appear on the scratch sheet, which is **PAGE 12** of this exam.

A **PERIODIC TABLE OF THE ELEMENTS** can be found on **PAGE 13** of this exam.

Check the front blackboard for **TIME REMAINING**, **LAST-MINUTE CORRECTIONS** and **ADDITIONAL INFORMATION**.

You will have 60 MINUTES to complete the exam.

IF YOU HAVE FINISHED THE EXAM and wish to turn it in and leave, you may do so up to ten minutes before the end of the allotted time. Come to the front of the room! There, the proctors will check your CUID. Then, place the exam and your bubble sheet in the correct boxes. The ten-minute mark will be announced to the entire class.

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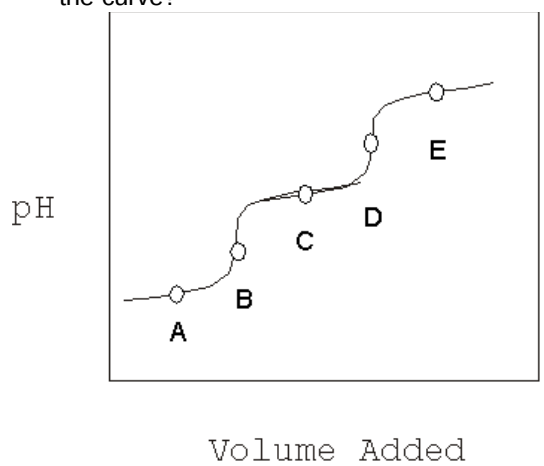
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1. Acid rain exhibits a pH value of 2.6 while normal rain, due to the presence of dissolved carbon dioxide gas, exhibits a pH value of 5.6. What is the ratio of hydronium concentration in acid rain to that in normal rain?

- A) -3.0
- B) 0.001
- C) 3.0
- D) 100
- E) 1000

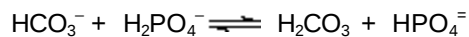
2. The titration of a triprotic acid is shown below. The first two equivalence points are near which points on the curve?



- A) A and C
- B) A, C, and E
- C) B and D
- D) only B, C, and D
- E) none of the above

This problem is double weighted. Enter your answer twice, in the space for 3 and in the space for 4, on the bubble sheet.

3/4. Carbonic acid (H_2CO_3) has a first ionization with a pK_a of 6.37, and phosphoric acid (H_3PO_4) has a second ionization with a pK_a of 7.21. These are the two major buffers in the human body. What is the equilibrium constant for the reaction



- A) $10^{(6.37 - 7.21)} = 6.92$
- B) $e^{(7.21 - 6.37)} = 0.432$

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- C) $10^{(6.37 - 7.21)} = 0.144$
D) $6.37 - 7.21 = -0.840$
E) $6.37 / 7.21 = 0.884$
5. A reaction in the gas phase is exothermic, and can be represented as $A_{(g)} + B_{(g)} \rightleftharpoons 3 C_{(g)}$. Which of the following alterations would increase the percentage yield of the product C.

- A) increase temperature and increase volume
B) increase temperature and decrease volume
C) decrease temperature decrease volume
D) decrease temperature increase volume
E) None of the above

This problem is double weighted. Enter your answer twice, in the space for 6 and in the space for 7, on the bubble sheet.

6/7. The solubility product constant for lead sulfate PbSO_4 is 1.1×10^{-8} at 25°C. Estimate the concentration of lead in mg/liter (ppm or parts per million) for a solution made by dissolving the solid in distilled water, using a molecular weight of 207 for lead. Compare this to the legal limit for agricultural water, namely 50 parts per billion by weight (ppb). If you added sodium sulfate to 10M, would the concentration of lead in the supernatant then be safe to use?

- A) both the solution of lead chloride in pure water, and that in saturated sodium sulfate are safe to use
B) only the solution in saturated sodium sulfate is safe to use
C) only the solution in pure water is safe to use
D) neither solution is safe to use
E) both solutions are safe to drink

8. A complex of Cr III in an octahedral (hexa-coordinate) environment can be prepared with the weak ligand Cl or with the relatively strong ligand ammonia. Which of the following statements is likely to be true.

- A) The amine complex might be more red in color because it absorbs red (lower energy) light
B) The amine complex might be more blue in color because it absorbs red (lower energy) light
C) The chloride complex will be more red in color because it absorbs blue (higher energy) light
D) The chloride complex will be more blue in color because it absorbs red (lower energy) light
E) There is no optical transition because it is a d^{10} ion.

9. Carbonic acid (H_2CO_3) has a first ionization with a pK_a of 6.37. In severe acidosis, the blood pH is less than 7.35. Suppose it is 7.30. What is the ratio of carbonic acid to bicarbonate in this case?

- A) 0.93
B) $10^{(-0.93)} = 0.118$
C) -0.93

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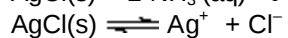
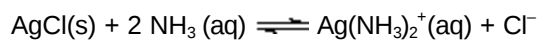
D) $e^{(0.93)} = 2.53$

E) $10^{(0.93)} = 8.51$

10. In a sub-saturated solution, if Q_{sp} and K_{sp} refer to the solubility product constant

- A) $Q_{sp} > K_{sp}$
B) $Q_{sp} < K_{sp}$
C) $Q_{sp} = K_{sp}$
D) None of the above

11. Silver ion concentration and effective solubility can be controlled using the concentration of other species.



$$K_{eq} = 3 \times 10^{-3}$$

$$K_{sp} = 1.6 \times 10^{-10}$$

What is the concentration of silver ion at equilibrium with solid AgCl due to dissolving silver chloride in pure water?

- A) 2.5×10^{-20}
B) 1.6×10^{-10}
C) 1.26×10^{-5}
D) 3.0×10^{-3}
E) none of the above

12. If AgCl is dissolved in a solution containing 0.25 M ammonia, what is the total concentration of all forms of soluble silver?

- A) 1.60×10^{-10} M
B) 1.26×10^{-5} M
C) 0.0137 M
D) 0.125 M
E) none of the above

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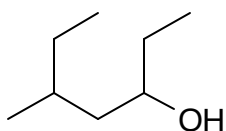
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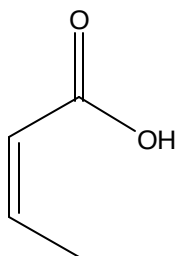
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- A) 2-ethyl, 4-hydroxyhexane
B) 2-ethyl hexane-4-ol
C) 5-methylheptane-3-ol
D) 2,4-diethylbutanol
E) 1,3 diethylbutane-1-ol

19. List the functional groups found in the molecule below



- A) alkyne, alcohol, carbonyl
B) carboxylic acid, alkene
C) ketone, alcohol, alkene
D) ester, alcohol, hydrocarbon
E) none of the above

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Please write your free response answers in pen. Answers to free response should contain one sentence maximum or simple numerical answer. **Please circle the answer clearly.**

20. Write the acid dissociation constants for 2-chloroacetic acid (i.e. the expression for the appropriate the quotient) alongside the balanced reaction for the acid dissociation in water.

21. Write the electron configuration and draw the d orbital energy level and occupancy most likely for $[\text{Mn}(\text{OH}_2)_5\text{Cl}]_2^+$ keeping in mind that the order of the spectrochemical series is: $\text{Cl}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{CO} \sim \text{CN}^-$. Is this species likely to be paramagnetic or diamagnetic? Name the compound.

22. Write the electron configuration and draw the d orbital energy level and occupancy most likely for $[\text{Fe}(\text{CN})_6]\text{K}_4$, keeping in mind that the order of the spectrochemical series is: $\text{Cl}^- < \text{H}_2\text{O} < \text{NH}_3 < \text{CO} \sim \text{CN}^-$. Is this species likely to be paramagnetic or diamagnetic? Name the compound

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25. What solution conditions (e.g., more gold metal, more water, less base, etc.) will favor more gold coming into solution at equilibrium? Keep in mind that HCN is volatile and has a pK_a of 9.21.

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28. To a liter of water is added 0.1 moles sodium hydroxide and 0.2 moles hydrochloric acid. The pK_a of water is 14 and the pK_a of HCl is 4. What is the resulting pH?

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30. Draw 4-chloro-2,3-dimethylpentane-1-oic acid.

31. The catalytic converter in the car causes reduced emission by consuming unspent fuels and oxidized forms of nitrogen and sulfur. Can the converter alter the equilibrium constant or equilibrium composition for these processes? In one sentence, how can the catalyst affect the emissions composition?

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