Chemistry 210 Name_____
Final Exam, June 15, 1996
Prof. D. L. Naud ID No._____Section_____
Note: Some students have yet to check out. Please check out on Monday, June 17, 1 to 2 PM. Students who fail to check out by that time will have 1 point deducted from their Final score for every day after June 17.

1. (6 points, no partial credit) Successful crystallization depends upon proper solvent choice. Order the following solvents in decreasing polarity.

A. acetone B. p-dimethylbenzene C. ethanol D. water
E. isoamyl acetate F. cyclopentane G. diethyl ether

_____ _____ _____ _____ _____ _____ _____
Polar ⟶ Non-Polar

2. (8 points) A mixture of water (density = 1.00 g/ml) and an organic liquid (call it liquid A, density = 0.80 g/ml, MW = 56 g/mole, normal boiling point= 92°C) was codistilled. The vapor pressures of water and liquid A at 79°C are 340 and 420 torr respectively. The initial composition of the mixture was 700 ml of water and 700 ml of liquid A. One hour into the distillation, the total volume of the distillate was measured to be 900 ml. What is the boiling point temperature of the remaining residue in the distilling flask? Show work to support your answer. No guesses allowed. Assume that the atmospheric pressure was 1 atm during distillation.

3. (8 points) Calculate the mole fraction of compound A in the vapor phase (at 80°C) for the following solution:
$X_A = 0.35$ (mol fraction in liquid phase), $P_A^\circ = 760$ torr at 80°C (vapor pressure of pure A)
$X_B = 0.65$, $P_B^\circ = 180$ torr at 80°C
Assume the solution behaves ideally.

4. (6 points) Can N-methylaniline be converted to the diazonium salt with nitrous acid? If so, explain how.

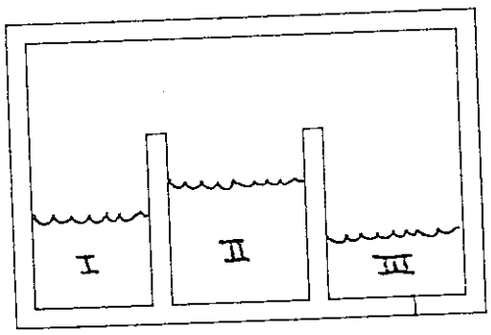
5. (8 points) You are a world renown expert on the Sandmeyer reaction. You have been invited to attend a conference on diazonium chemistry in San Francisco and listen to two speakers give their individual theories on the Sandmeyer reaction mechanism. Speaker A proposes a mechanism with a first order rate law; Speaker B introduces a different mechanism that follows a second order rate law. After the seminars, the audience and speakers gather over cocktails and casually discuss chemistry. You meet up with speakers A and B and chat about their work and proposed mechanisms. What do you say to them? Be brief with your remarks because lunch will be served in five minutes and you are hungry.

6. (8 points) A student mixes 20 ml of cyclohexanol and 40 ml of 50% sulfuric acid in a distilling flask and codistills out two immiscible liquids. One is water and the other is an organic liquid. He takes a test-tube filled with 2 ml of 5% bromine (dissolved in CCl_4) and adds a couple of drops of the organic liquid. The 5% bromine solution does not change color; it is dark red. What is the structure of the organic liquid? Give any remarks or opinions relevant to student's work.

7. (6 points) It was recently reported on BBC that an unusually tough strain of bacteria was discovered in very deep ocean waters near *sea-floor vents*. (Hot gases heated by molten rock escape through *sea-floor vents*, which are openings in the earth's crust.) The bacteria feed and grow comfortably in ocean waters with temperatures ranging from 90 to 130°C. How could this be possible if water boils at 100°C?

8. (6 points) Could recrystallization be used to isolate o-aminophenol from a 55/45 mixture of o-aminophenol and p-aminophenol with ease and efficiency? Give a brief opinion and/or procedure.

9. (8 points) A sealed box contains three liquids in separate compartments. They are:
Compartment I: 3.0 liters of 0.40 M NaCl (aqueous solution),
Compartment II: 4.0 liters of pure water, and
Compartment III: 2.0 liters of 0.80 M NaCl (aqueous solution). After infinite time what will be the final concentrations and volumes in each compartment? If the sealed box is heated to 200°C (after it had been resting at infinite time at room temperature), will the concentration of the aqueous solution in compartment I *increase, decrease* or *remain exactly the same*? Support your answer with a correct and brief explanation.



10. (8 points) Gases A and B undergo reaction at 20°C to give gas C. Given that the rate constant, k, (pseudo-first order with respect to reactant A) for the reaction is 0.00050 1/(torr·min), calculate how long it will take for 60% of A to undergo reaction. The initial partial pressures of A and B are 10 and 760 torr respectively. Give the answer in minutes.

11. (9 points) Compound **X** decomposes to compound **Z** via **Y** according to the following scheme:

$$\mathbf{X} \xrightarrow{k_1} \mathbf{Y} \xrightarrow{k_2} \mathbf{Z}$$

All reactions are first order in substrates. A solution of compound **X** was made (initial concentration is unknown) and the progress of reaction was followed. Four measurements were made 25.0 minutes into the reaction. These **instantaneous** measurements are: (1) the concentration of **X** is 0.1396 M; (2) the concentration of **Y** is 0.2651 M; (3) the rate of formation of **Y** is 1.554 mM per second; and (4) the rate of formation of **Z** is 5.569 mM per second. Calculate the rate constants, k_1 and k_2 and the initial concentration **X** at time equal to zero.

12. (9 points) A good protecting group should meet three basic requirements? What are they?

13. (8 points) A student needs to purify 6-chloro-4-hepten-2-one by distillation, however, the compound decomposes at its normal boiling point. He believes that he has two options to succeed in purifying the compound. In the first, he could codistill the compound with water (the compound is barely soluble in water at room temperature) or distill the compound under reduced pressure (i.e. vacuum distillation). Analyze both methods and determine which is the better procedure. You must have correct reasoning to obtain full credit.

14. (9 points) Briefly give an efficient method for separating a 50/50 mixture of:

a) benzene and cyclohexene

b) p-diaminobenzene and cyclohexene

c) 1-chloromethylcyclohexane and diethyl ether