**CH 338M - Final Exam** **Name**_____
**Lab day:**

(141 points)

1. (20) You have just accepted a job in an industrial laboratory where the director of the lab asks you to solve certain problems, indicated below. Describe briefly, but specifically, how you would set out to solve these problems, using only methods you encountered in the organic labs. (For each problem include all relevant methods.)

Problem A. A competitor has just come out with a new, highly effective paint remover, which is suspected to be a mixture of common laboratory solvents. Do a preliminary screening of the competitor's product to find out which solvents might be present, and approximately how much of each one is in the mixture.

Problem B. The men in the plant say that the most recently purchased tank car of cyclohexanone is not behaving right in a reaction. Check out the purity of this tank car of cyclohexanone.

Problem C. The plant foreman brought in a sample of unwanted solid which was crystallizing in a reaction vessel. The lab director suspected it was probably adipic acid, a pure sample of which (mp 153ºC) was available in the lab. The foreman's sample had mp 147-151˚C. Verify its identity.

Problem D. The vice president of the company has a harebrained idea about trying to commercialize "natural" food coloring by purifying and selling the solid colored organic compounds of various fruits and vegetables. He wants to start with beets. Take a dried, powdered beet; first find out roughly how many colored components are present, then try to get a reasonably pure sample of each one.

2. In the organic labs, you encountered three experimental methods that were classified as chromatography.

a) (6) List the three methods.

b) (3) Describe the features that are common to all forms of chromatography.

c) (4) Indicate why a separation takes place.

3. You are planning to oxidize benzyl alcohol to benzoic acid with chromic anhydride, according to the following balanced equation. (Molecular weights are given in parentheses.)

$$\underset{(108)}{3\text{Ph-CH}_2\text{OH}} + \underset{(100)}{4\text{CrO}_3} + \underset{(98)}{6\text{H}_2\text{SO}_4} \longrightarrow \underset{(122)}{3\text{Ph-COOH}} + \underset{(392)}{2\text{Cr}_2(\text{SO}_4)_3} + \underset{(18)}{9\text{H}_2\text{O}}$$

a) (6) Calculate the oxidation number of the alcohol carbon in benzyl alcohol as well as the carbonyl carbon in benzoic acid, and indicate why the alcohol is said to be oxidized.

b) (5) How many grams of benzyl alcohol should you start with if you want to prepare 50 g of benzoic acid and you expect a yield of 70%? Show your work.

c) (4) What is the minimum weight of $CrO_3$ you would need to oxidize all of the benzyl alcohol you start with? Show your work.

4. (5) Explain why a few percent impurity can usually be effectively removed in a recrystallization, even though the solubility of the impurity is similar to that of the main component. Why doesn't the impurity crystallize with the main component? Where does it end up?

5. Activate charcoal and activated alumina are commonly used in chemical laboratories.

   a) (2) How is activation accomplished?

   b) (3) What changes have taken place that make the activated solid behave differently from the unactivated?

6. (5) You plan to carry out an oxidation using nitric acid, and have decided that you need 4.7 g of $HNO_3$. Your source of nitric acid is the concentrated solution available in the lab. This reagent has a density of 1.41 g / mL and contains 71% $HNO_3$ by weight. How many milliliters of the concentrated acid should you measure out to get 4.7 g of $HNO_3$? Show your work.

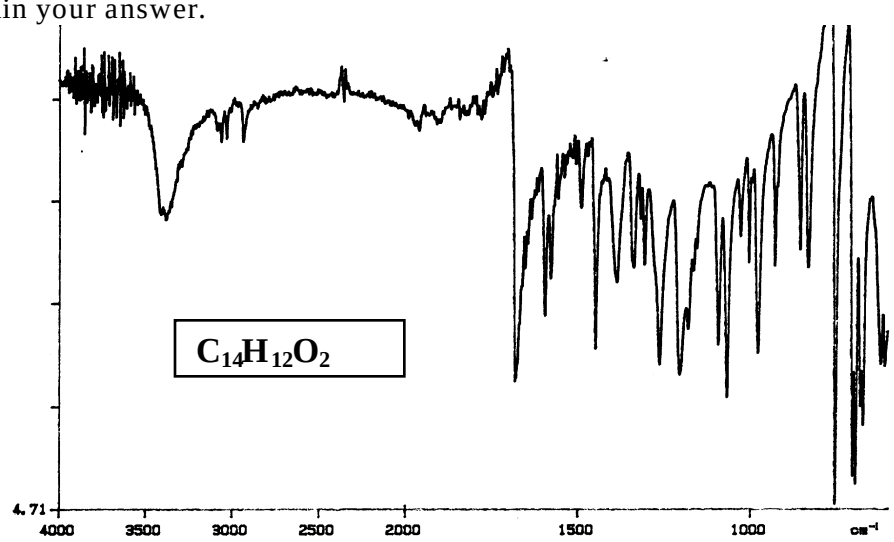
7. a) (3) What is the chemical composition of petroleum ether?

   b) (2) What is meant by petroleum ether (30-60º)?

8. You used a mixture of pet. ether / acetone to effectively analyze the ferrocene / acetylferrocene mixture using thin-layer chromatography. a) (3) What would have been the <u>specific</u> outcome if you had used pure pet. ether? Explain your answer. (Include a sketch of the developed TLC plate.)

   b) (3) What would have been the <u>specific</u> outcome if you had used pure acetone? Explain your answer. (Include a sketch of the developed TLC plate.

9. (10) The compound whose infrared spectrum and molecular formula are given below was encountered in the lab this term. Assign obvious IR peaks to the appropriate functional groups. Give the structure of this compound, and explain your answer.




10. (6) Circle the compound below that would have the strongest C=C stretching absorption in the infrared spectrum (assuming equal molar concentrations). Underline the compound that would have the weakest C=C stretching absorption. Explain your answer.

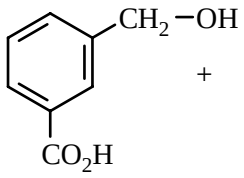
a) $CH_3$-CH=CH-$CH_2$-$CH_3$ b) $CH_2$=CH-$CH_2$-$CH_3$ c) $CH_2$ =$CCl_2$

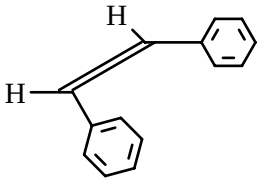
11. (10) Suggest a method for preparing the benzyltriphenylphosphonium bromide used in the Wittig reaction. Also give the mechanism for its formation.

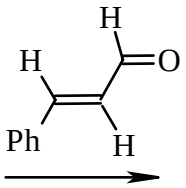
12. a) (6) Give the chemical formulas of two of the solid drying agents that you used in the lab, and indicate briefly how they work. (Include any reactions.)

b) (2) What liquid 'drying agent' did you encounter in the lab?

13. (30) Complete the following, showing stereochemistry clearly for those marked with an asterisk (∗).

a)  + $KHCO_3$ (excess) ⟶

★ b)  $\xrightarrow{Br_2}$ _____ $\xrightarrow[\text{(1 equiv.)}]{KOH}$ _____

★ c) $Ph-\overset{Ph}{\underset{Ph}{\overset{|}{\underset{|}{P^{+}}}}}-CH_2-Ph\ Br^{-}$ $\xrightarrow{NaNH_2}$ _____ $\xrightarrow{}$  _____

★ d)  $\xrightarrow[\triangle]{}$

e) $Ph-\overset{O}{\overset{||}{C}}-\overset{O}{\overset{||}{C}}-Ph$ + $Ph-\overset{O}{\overset{||}{C}}-CH_2-Ph$ (1 equiv.) $\xrightarrow[\triangle]{OH^{-}}$