

Organic Chemistry

Name

Professor

Course

Date

Organic Chemistry

1. Select the best technique for the removal of a drying agent from an organic solvent. (2 points)

- (a) simple distillation (b) gravity filtration
(c) fractional distillation (d) vacuum filtration

2. List the three processes required for any distillation technique. (3 points)

- (i) Basic Distillation Process
(ii) Fractional Distillation Process
(iii) Destructive Distillation Process

3. What precaution must be observed when extracting an acidic solution with sodium bicarbonate? (3 points)

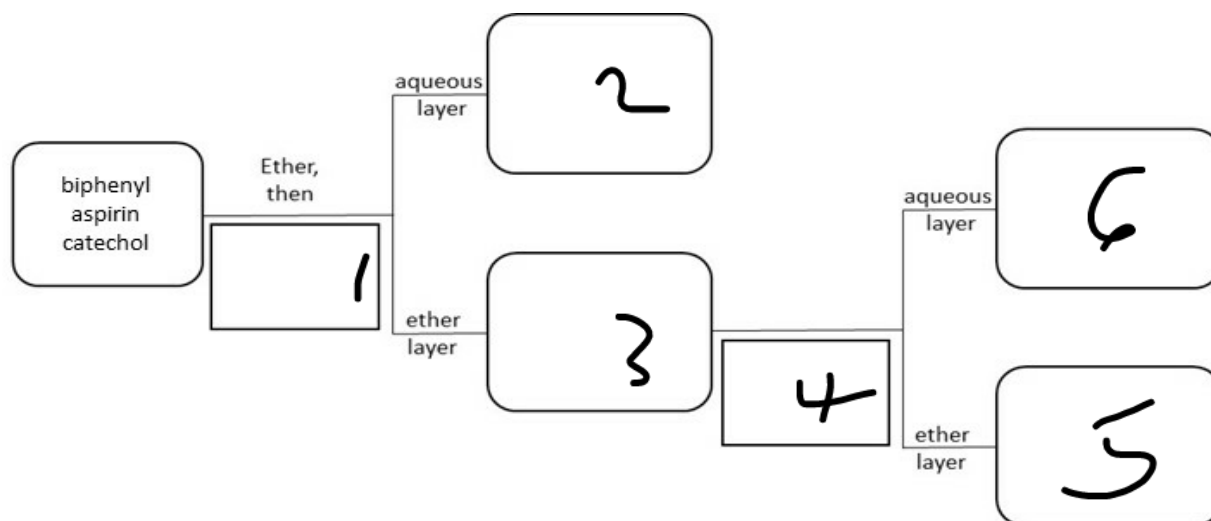
One should ensure that the lab should be well ventilated, there should be no flames, and gloves should be worn.

4. Name three routes by which chemical substances may enter the body and, for each, a laboratory practice to minimize exposure. (6 points)

- i. Inhalation: aerosol release
ii. Skin (eyes) absorption: Washing with a lot of water
iii. Ingestion: Vomiting

5. Complete the flow chart below for the separation of the mixture of biphenyl, aspirin and catechol. Draw the structure of the organic compounds in the

appropriate box at the end of each step and the required reagent below each line. The acidic compounds will be in their conjugate base form. (6 points)



1 Extract with 3N HCL

2 O_2N

3 $CO_2^-Na^+$

4. Neutralize with HCL

5 CO_2H

6 NH_2

6. Ethanol is considered a (2 points)

(a) non-polar solvent

(b) polar aprotic solvent

(c) polar protic solvent

(d) an ionic solvent

7. The purpose of washing an ether solution with a saturated sodium chloride solution is (2 points)

(a) to remove traces of acid

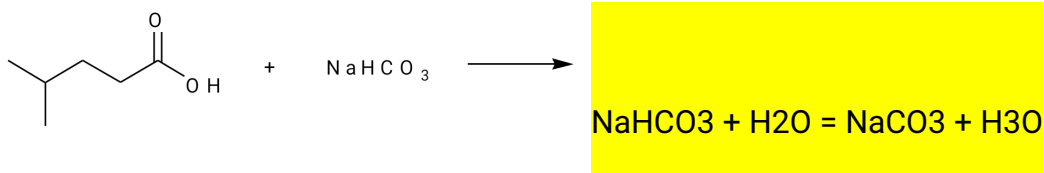
(b) to extract inorganic

compounds

(c) to remove unreacted sodium bicarbonate

(d) to remove excess water

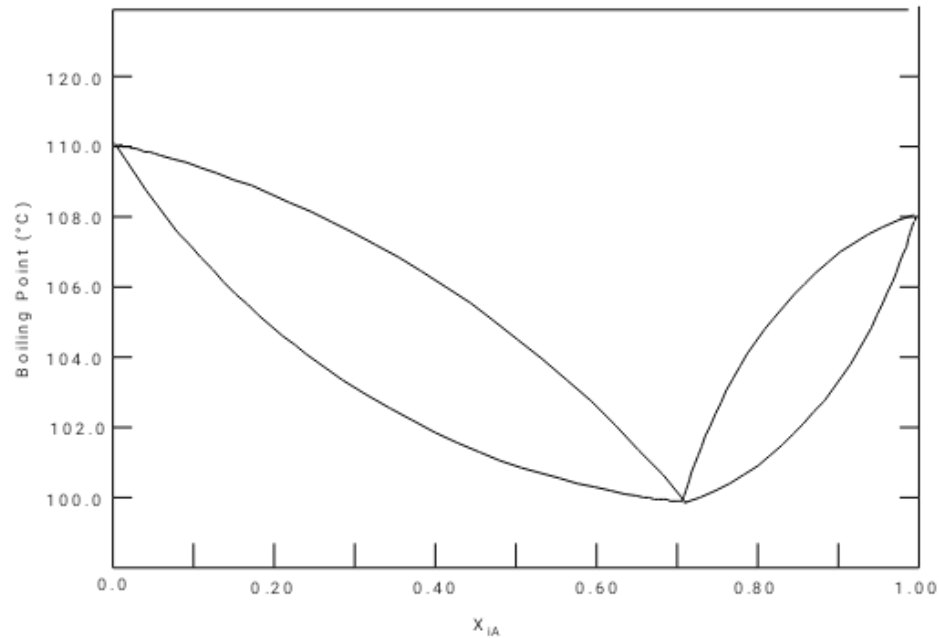
8. Give the product of the following reaction. (3 points)



9. Defend or refute: If both components of a solution are volatile, stable at their boiling points, and have differing boiling points, they can be separated by fractional distillation. Justify your answer. (3 points)

True: fractional distillation involves separation of a liquid mixture into fractions based on their differing in boiling point (and chemical composition) by means of distillation, using a fractionating column. Hence, where components of a solution are volatile, stable at their boiling points, and have differing boiling points, they can be separated by fractional distillation

10. The boiling point composition diagram for a binary mixture of benzene and isopropanol is shown below:



(a) What is the boiling point of pure A? (2 points)

100°C

(b) What is the composition of the azeotrope? (2 points)

- i. benzene and
- ii. isopropanol

(c) What is the boiling point of the pot solution when the solution is 20% A?

(2 points)

100°C

(d) In the simple distillation of the solution that is 20% A, what is the expected temperature of the initial distillate? (2 points)

120°C

(e) In the fractional distillation of the solution that is 20% A, what is the expected temperature of the initial distillate? (2 points)

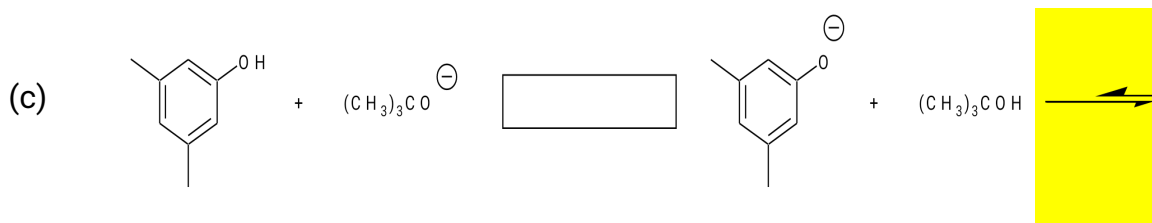
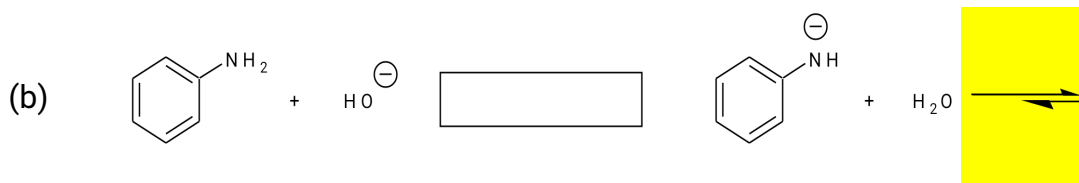
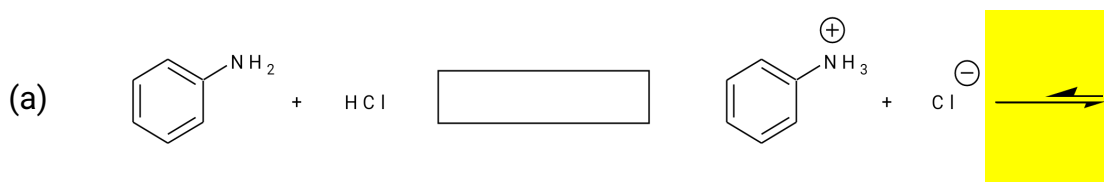
104°C

11. If cooling the solution fails to produce crystals, give two methods for inducing recrystallization and describe how they work. (4 points)

i. Reflux: gently boiling the solvent for about a minute, noting how the vapors condense on the tube walls and run back down into the liquid.

ii. Dissolving: The solute is dissolved to obtain pure crystals.

12. Predict the direction of each of the following equilibria using the appropriate equilibrium arrows: $\rightleftharpoons$ and $\rightleftharpoons$ (6 points)



13. Select the best technique for the separation of methanol from a non-volatile but soluble impurity. (2 points)

- (a) simple distillation (b) gravity filtration
(c) fractional distillation (d) recrystallization

14. What percentage of 2,4-dinitrophenol ($pK_a = 4.1$) is ionized in a 10% aqueous solution of NaHCO_3 ($\text{pH} = 8.2$). Show work. (3 points)

$$\begin{aligned}\text{Percent Ionization} &= \frac{[\text{H}^+]}{[\text{HA}]} \times 100\% \\ &= 0.0018 / 4.1 \times 100\% \\ &= 0.05\%\end{aligned}$$

15. What does each letter of the acronym PASS represent in the use of a fire extinguisher
(2 points)

P: Pull

A: Aim

S: Squeeze

S: Sweep

16. For fractional distillation, HETP may be increased by which of the following? Select all that apply. (2 points)

- (a) changing the column packing
(b) decreasing the distillation rate

- (c) increasing the column length
- (d) decreasing the external pressure

17. Explain why you should not allow a flask to boil to dryness during a distillation although it may allow you to maximize your yield of the product. (3 points)

Lowest temperature at which the liquid has sufficient vapor pressure to ignite when in the presence of an ignition source.

18. Compound B has a melting point range of 128.2 – 131.4°C. To determine if the compound is *trans*-cinnamic acid (m.p. 131 – 133°C), a mixed melting point is done using a 50:50 mixture of the compound and pure *trans*-cinnamic acid. The melting point of the mixture was found to be 129.8 – 132.0°C. What conclusions can be drawn from this experiment? (3 points)

Conclusions drawn in this lab are that melting points were used to determine the purity of organic compounds. It was observed that pure compounds had a narrow melting range, while impurities caused the melting range to become lower and broader. From the mixture melting points one is able to identify the unknown as *trans*-cinnamic acid.

19. Given the solubilities below, which of the following solvents is best for the recrystallization of 1.5 grams of compound A? (3 points)

- (a) ethanol
- (b) chloroform
- (c) methanol
- (d) water

Solvent	Solubility of Compound A

	(grams solute/100 mL soln)	
	@ 10°C	@ b.p.
ethanol	2.2	12
methanol	0.4	8.0
chloroform	9.6	24
water	0.15	1.5

20. A solution containing 4.0 g of n-butyric acid in a 100 mL of water was extracted twice with 50-mL portions of benzene. Given the distribution coefficient, K_d (benzene/water), is 5.0, calculate the amount of n-butyric acid extracted from the water. Show all calculations.

(3 points)

$$K_d = (X_o / 100) / (0.12 / 100) \rightarrow 11.25 = (X_o / 0.12)$$

$$X_o = 11.25 \times 0.12 = 1.35 \text{ g, acid extracted in organic phase}$$

$$X_{\text{total}} = X_o + X_{\text{aq}} = 1.35 \text{ g} + 0.12 \text{ g} = 1.47 \text{ g}$$

$$\% \text{ Ex} = (X_o / X_{\text{total}}) \times 100 = (1.35 / 1.47) \times 100 \approx 92 \%$$

21. Discuss two reasons recrystallization typically gives crystals of high purity. (4 points)

i. By removing insoluble impurities from

ii. Isolating purified crystals from remaining isolate

22. Select the true statements about the melting of a solid. (2 points)

- (a) Melting is a phase change.
- (b) The enthalpy of fusion is typically larger than the enthalpy of vaporization.
- (c) Melting occurs with the vapor pressure of the solid equals that of the liquid.
- (d) The melting point is depressed by insoluble impurities,

23. The primary reason for the addition of anhydrous calcium chloride to an organic solvent is (2 points)

- (a) to remove traces of acid
- (b) to remove color impurities
- (c) to remove residual water
- (d) to remove dissolved salts.

24. Select the best approach to separate two immiscible liquid. (2 points)

- (a) separatory funnel
- (b) gravity filtration
- (c) rotary evaporation
- (d) simple distillation

25. Define azeotrope. (3 points)

Refers to a mixture of two liquids which has a constant boiling point and composition throughout distillation.

26. Which pair of solvents can't be used for liquid-liquid extraction? (2 points)

- (a) methylene chloride and water
- (b) diethyl ether & saturated aqueous sodium chloride
- (c) acetone and water
- (d) hexane and methanol

27. For each of the following functional groups, draw the general structure, give the approximate pKa, and draw the conjugate base. The first has been done. (6 points)

Name	General Structure	pKa	Conjugate Base
alcohol	R-OH	~ 15	$\text{R-O}^{\ominus}$
carboxylic acid			
amide			

Name	General Structure	pKa	Conjugate base
Carboxylic Acid	RCOOH	~ 10	$\text{A}^{(-)}$
Amide	-CONH	-0.5	

28. Which of the following melting point capillaries is packed with the appropriate amount of compound? (2 points)

A.



29. Which of the following should be immediately used if you spilled a large amount of chemical on yourself? (2 points)

- | | |
|-----------------------|-------------------|
| (a) fire extinguisher | (b) fire blanket |
| (c) eye-wash fountain | (d) safety shower |

30. During a recrystallization, the desired compound dissolved but an insoluble impurity remained. Describe the procedure for removing the impurity. (4 points)

Recrystallization works just when the best possible solvent is utilized. The solute must be moderately insoluble in the solvent at room temperature but significantly more

solvent in the solvent at higher temperature. Also, impurities that are available should either be soluble in the solvent at room temperature or insoluble in the solvent at a high temperature. In the event, one needed to purify a specimen of Compound A which is contaminated by a little measure of Compound B, a suitable solvent would be one in which all of Compound B dissolved at room temperature on the grounds that the impurities will remain in solution and go through filter paper, abandoning just pure crystals behind. Likewise suitable would be a solvent in which the impurities are insoluble at a high temperature since they will stay strong in the boiling solvent and would then be able to be filtered through.