Organic Compounds: Functional Group Identification

1. How does an alcohol differ from a hydrocarbon?

2. Why do alcohols have properties intermediate between hydrocarbons and water?

3. How are esters prepared in the laboratory?

4. How are organic acids prepared in the laboratory?

5. Write the formula for the aldehyde formed from the oxidation of ethanol.

6. How can you distinguish an organic acid from an organic base?

7. Write the formula for the acid formed from ethanol' s oxidation.

8. How is an organic base similar to ammonia?

9. Write the structural formula of the functional group for each class of organic compounds studied in this experiment.

Perform ALL parts with an unknown sample (if provided) and record with the known samples simultaneously.

A. Alcohols

Iodoform

1. Obtain a small sample of the alcohols listed on the Report Sheet. Dissolve 0.5 mL of each alcohol in 5 mL of H_2O in separate 150-mL test tubes. Add 5 mL of 10% NaOH. While shaking, add drops of 10% KI/I_2 until the definite dark yellow of iodine persists (that is, when you observe colour in the solution mixture). Warm gently in a hot water bath; ***do not exceed 60°C***. Add more KI/I_2 at the elevated temperature until the dark yellow remains for 2 minutes. Allow the test tube and contents to cool. While shaking, add drops of 10% NaOH to expel excess I_2. Half-fill the test tube with de-ionized water and allow it to stand for 10 minutes. Look for CHI_3, a yellow crystalline precipitate. Note any characteristic odour. *Show your products to the instructor*. Whenever the amount of alcohol is small, iodoform may not separate; however, the characteristic odour establishes its formation. **Summarize** the comparative results on the Report Sheet.

Alcohol oxidation

2. Place 2 mL of 0.1 M $K_2Cr_2O_7$ in a 150-mm test tube and slowly add 1-mL conc. H_2SO_4. Swirl to dissolve the $K_2Cr_2O_7$ and cool. Prepare all testing alcohols *each* in a 150-mm test tube. Simultaneously add ***slowly*** 2 mL each test alcohol to the $K_2Cr_2O_7$ solution. Note any colour change, odour and the rate of reaction. Compare its odour with the test alcohol. Write your conclusions.

B. Aldehydes and Ketones

Tollens Test

1. To a ***clean*** 150-mm test tube, add about 1 mL of 10% NaOH solution and wash the test tube. Then add about 1 mL of 0.1M $AgNO_{3(aq)}$. Next add drop by drop of $NH_4OH_{(aq)}$ with constant shaking until the silver oxide just dissolves. Then add 1 mL of aldehyde. Repeat the same proportion with 1 mL of ketone. Warm both test tubes in a water-bath (about 70°C). Record and account the observation, and write balance equations.

Fehling Test

2. (optional) In a 150-mm test tube, mix about 2 mL of Potassium Sodium tartrate ($KNaC_4H_6O_6$) and 1 mL of Sodium hydroxide (NaOH) with 1 mL of Copper(II) sulphate ($CuSO_4$). Warm the test tubes in a water bath. Then add 1 mL of aldehyde. Repeat the same proportion with 1 mL of ketone. Record and account the observation, and write balance equations.

C. Acids and Bases

1. Obtain a sample of an organic acid and base. Add 0.1 g of solid (0.2 mL, that is about 4 **or** 5 drops of liquid if available) to 1 mL of water in a 150-mm test tube. Test the pH with litmus paper. If the sample is insoluble in water, add drops of ethanol or acetone or ether until it dissolves.

2. To approximately 0.1 g of solid acid (0.2 mL, that is about 4 **or** 5 drops of liquid) in a 150-mm test tube, add 2 mL of 10% $NaHCO_3$. A distinct "fizzing" sound is detectable even if the visual evolution of CO_2 is questionable. Record.

3. Place 2 mL of 0.1 M $KMnO_4$ in a 150-mm test tube and 1 mL of conc. H_2SO_4. ***Slowly*** add 1 mL of ethanol. Watch for any colour change. Compare its odour with that of acetic acid. What is your conclusion?

D. Esters

Banana Oil

1. Place 2 mL of glacial CH_3COOH and 3 mL of iso-amyl alcohol, [iso-$C_5H_{11}OH$], in a 150-mm test tube. Slowly and cautiously add 1 mL of conc. H_2SO_4. Heat the mixture gently and carefully over a very low flame [or in a hot water bath]. If the odour changes the product is an ester. Name it. Request the instructor to assist you in writing the reaction's chemical equation.

Oil of Wintergreen

2. In a 150-mm test tube, place a small amount of salicylic acid, HO-C_6H_4-COOH, about half the size of a pea. Add 1 drop of 3 M H_2SO_4 and 3 drops of water. After one-half minute add 3 or 4 drops of methanol, CH_3OH. Place a ***loose*** plug on the test tube and allow it to warm in a water bath at about 60°C for 20 to 30 minutes. Note the odour. Request the instructor to assist you in writing the reaction's chemical equation.

Data

A. Alcohols

1. Iodoform Test

Alcohol	Subclass 1°,2°,3°	Observation	Oxidation Product	Tick if observed for unknown
Methanol				
Ethanol				
i-Propanol				
t-Butanol				

Conclusion of observations on alcohols.

2. Oxidation of Alcohols

Alcohol	Subclass 1°,2°,3°	Observation	Conclusion	Tick if observed for unknown
Methanol				
Ethanol				
i-Propanol				
t-Butanol				

Conclusion of observations on alcohols.

B. Aldehydes and Ketones

1. Silver Mirror Reaction

Name of Compound	Results of Test	Tick if observed for unknown

2. Fehling Reaction

Name of Compound	Results of Test	Tick if observed for unknown

C. Acids and Bases

1. pH Test

Name of Compound	Results of Test	Tick if observed for unknown

2. Sodium Bicarbonate Test

Name of Compound	Results of Test	Tick if observed for unknown

3. (a) Oxidation of Alcohol

Observation: _____

Conclusion: _____

(b) Preparation of Acid

Observation: _____

Conclusion: _____

D. Esters

1. Banana Oil
   Odour of solution _____
   Write an equation for the product' s formation.
   _____
2. Oil of Wintergreen
   Odour of solution _____
   Write the formula for the compound.

Post-Laboratory Assignment

1. Write the structural formulas for propanol and isopropanol.

2. What reactants make the flavour characteristic of the following (refer to instruction during the lab):
   a. Pineapple

   b. Orange

   c. grape

3. How can you distinguish between:
   a. CH_3NH_2 and CH_3OH

   b. C_2H_5OH and t-C_4H_9OH

   c. CH_3CHO and CH_3CH_2OH

   d. CH_3COOH and CH_3CHO

   e. CH_3CH_2CHO and $CH_3CH_2CH_2Cl$

4. Acetic acid is prepared by the oxidation of ethanol with permanganate ion in an acidic solution. Write a balanced (redox) equation for this reaction. The reduction product of permanganate ion is Mn^{2+}.