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## Lab 4: Identification of Aldehydes, Ketones, and Alcohols

**Objective:** The objectives of this experiment are to identify an unknown of an aldehyde, ketone, or alcohol using tests that can separate the functional groups.

### **Background Information:**

The functional groups that will be used in this experiment are alcohols, aldehydes, and ketones. Alcohols have the hydroxide (-OH) functional group, and aldehydes and ketones have carbonyl (C=O) functional groups. The difference between an aldehyde and a ketone is where on the alkyl  $(-(\text{CH}_2)_n\text{CH}_3$  or -R) chain or ring the carbonyl group is located. For an aldehyde, the carbonyl group is at end or on the terminal carbon and is bonded to a hydrogen atom. For a ketone, the carbonyl group is located between two carbons of the chain or ring. An example alcohol, aldehyde, and ketone are shown in Figure 1.

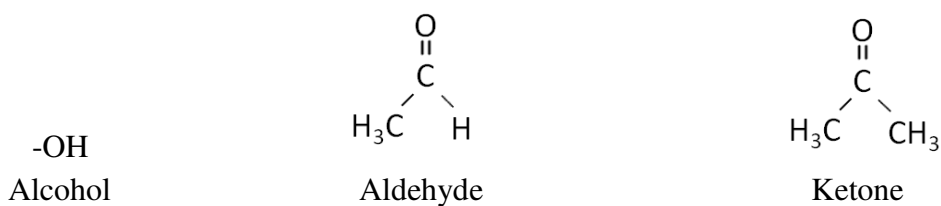


Figure 1.

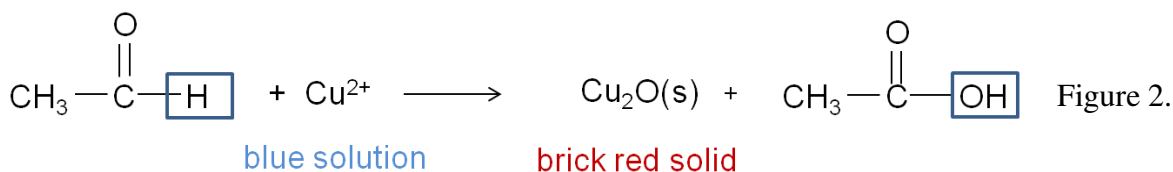
The focus of the experiment is to determine an unknown sample by using tests that are known to react with a specific functional group to produce a change in color or formation of a solid, but not react with other functional groups.

### 2,4-DNP Test for Aldehydes and Ketones

2,4-DNP will react with the double bonded O in the carbonyl group of an aldehyde or ketone and form a solid. If the solution goes from clear to cloudy a solid has formed. If you do not see a solid during this test, an alcohol is present.

### Benedict's Test for Aldehydes

In a Benedict's test,  $\text{Cu}^{2+}$  reacts with an aldehyde in an oxidation reaction that changes the aldehyde into a carboxylic acid. The reaction for the Benedict's test is shown in Figure 2.



A positive Benedict's test will form a  $\text{Cu}_2\text{O}(s)$  which will be seen in the test tube as a brick red solid. If the solution remains blue, no aldehyde is present.

### Iodoform Test for methyl alcohols, methyl aldehydes, and methyl ketones

An iodine solution will react with the methyl group in any of the three functional groups with a methyl group in its structure and form a yellow solid. A methyl alcohol, methyl aldehyde, and methyl ketone are shown in Figure 3.

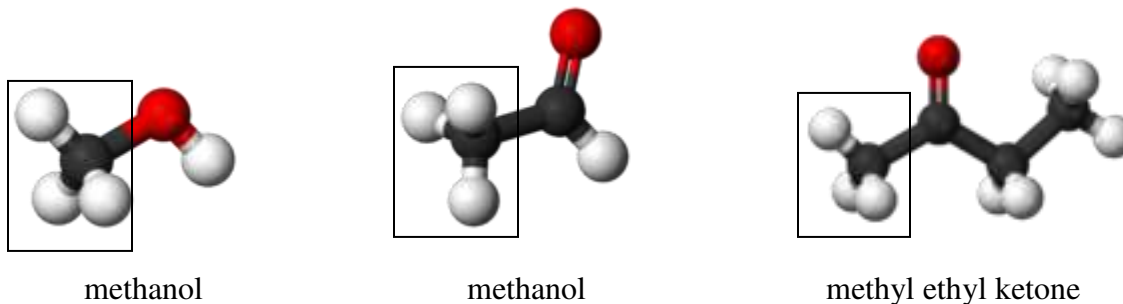


Figure 3.

Any structure with a methyl group will react with the iodine reagent to produce a yellow solid. The cyclic alcohol in Figure 4 has a methyl group attached to the ring so it would also produce a yellow solid or positive test for iodoform.

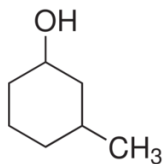


Figure 4.

**Procedure:**

**Data:**

**Equipment list:**

- 21 Test Tubes
- Thermometer
- 250 mL Beaker
- Hot Plate

**Choose an unknown and put the unknown number on the line:**

**Unknown#:** \_\_\_\_\_

**A) Set up a Hot Water Bath**

- 1) Fill the 250 mL beaker about  $\frac{3}{4}$  full with water.
- 2) Set the hot plate at medium heat.
- 3) Use the thermometer to heat the water between 50-60°C.

**B) Solubility of Alcohols, Aldehydes, and Ketones**

- 1) Get 7 test tubes and label them with numbers/letter 1-7B.
- 2) Put 5 drops of each solution in the test tubes:  
(1B) 2-methyl-2-propanol, (2B) 2-octanol,  
(3B) 2-methylpropanal, (4B) benzaldehyde, (5B) acetone,  
(6B) cyclohexanone, and (7B) unknown.
- 3) Add 2 mL of water to each test tube.
- 4) Record your observations on the chart below.
- 5) Record your observations on the report sheet also.
- 6) **Save these test tubes for part D.**

#	Compound Name	Soluble or Insoluble?
1B	2-methyl-2-propanol	
2B	2-octanol	
3B	2-methylpropanal	
4B	Benzaldehyde	
5B	Acetone	
6B	Cyclohexanone	
7B	Unknown # _____	

7) a. Do these observations fit the rules for the solubility of alcohols, aldehydes, and ketones?

b. Is your unknown soluble or insoluble in water?

**C) 2,4-DNP Test for Aldehydes and Ketones**

- 1) Get 7 new test tubes and label each with numbers/letter 1-7C.
- 2) Put 5 drops of each solution in the test tubes:  
(1C) 2-methyl-2-propanol, (2C) 2-octanol,  
(3C) 2-methylpropanal, (4C) benzaldehyde, (5C) acetone,  
(6C) cyclohexanone, and (7C) unknown.
- 7) Add 20 drops of the DNP reagent to each test tube.
- 8) If no precipitate forms immediately, heat for 5 minutes in the 60°C bath.
- 9) Record your observations on the chart below.
- 10) Record your observations on the report sheet also.

#	Compound Name	Test Results (+/-)
1C	2-methyl-2-propanol	
2C	2-octanol	
3C	2-methylpropanal	
4C	Benzaldehyde	
5C	Acetone	
6C	Cyclohexanone	
7C	Unknown #_____	

11) a. Which of the compounds above were aldehydes/ketones (which gave a positive test)?

b. Was your unknown an alcohol (negative test) or an aldehyde/ ketone (positive test)?

**D) Iodoform Test for Methyl Alcohol, Aldehydes, and Ketones**

- 1) Using the 7 test tubes from part B, labeled with numbers/letter 1-7B.
- 2) Add 10 drops of 10% NaOH to each test tube.
- 3) Warm the test tubes in a warm water bath to 50-60°C.
- 4) This takes about 5 minutes.
- 5) Remove each test tube one at a time from the bath and add 20 drops of the iodine test reagent. Replace the test tube into the water bath.
- 6) Look for the formation of a yellow solid precipitate.
- 7) Record your observations on the chart below.
- 8) Record your observations on the report sheet also.
- 9) Set the heat on the hot plate to high to get the water to boil for the next part.

#	Compound Name	Test Results (+/-)
1B	2-methyl-2-propanol	
2B	2-octanol	
3B	2-methylpropanal	
4B	Benzaldehyde	
5B	Acetone	
6B	Cyclohexanone	
7B	Unknown # _____	

(+ results = yellow solid)  
(- results = no solid formed)

9) a. Which compounds show an attached methyl group (positive results)?

b. Does your unknown show a methyl group (positive result) or not (negative result)?

**E) Oxidation of Aldehydes and Ketones (Benedict's Test)**

- 1) Get 5 new test tubes and label with numbers/letter 1-5E.
- 2) Put 10 drops of each solution in the test tubes:  
(1E) 2-methylpropanal, (2E) benzaldehyde, (3E) acetone,  
(4E) cyclohexanone, and (5E) unknown.
- 3) Add 2 mL of the Benedict's reagent to each test tube.
- 4) Place the test tubes in a boiling water bath for 5 minutes.
- 5) The appearance of the red-orange color of  $\text{Cu}_2\text{O}$  indicates that oxidation has occurred.
- 6) You can also get a slight mix that will give you a green or rust color.
- 7) Record your observations in the chart below.
- 8) Record your observations on the report sheet also.

#	Compound Name	Test Results (+/-)
1E	2-methylpropanal	
2E	Benzaldehyde	
3E	Acetone	
4E	Cyclohexanone	
5E	Unknown #_____	

- 9) a. Which of the compounds were aldehydes (positive results) and which were ketones (negative results)?

b. Was your unknown an alcohol from part C? If it is, ignore these test results for your unknown and go on to part F. If your unknown was not an alcohol, was it an aldehyde (positive results above) or a ketone (negative results above)?



**F) Identification of Your Unknown**

- 1) Rewrite the test results for your unknown in the chart below.
- 2) Use the flow-chart in Figure 5 to identify your unknown.

Test letter	Test Name	Circle the result
B	Solubility	Soluble / insoluble
C	2,4-DNP	alcohol / aldehyde-ketone
D	Iodoform	methyl group / none
E	Benedict's	aldehyde / ketone

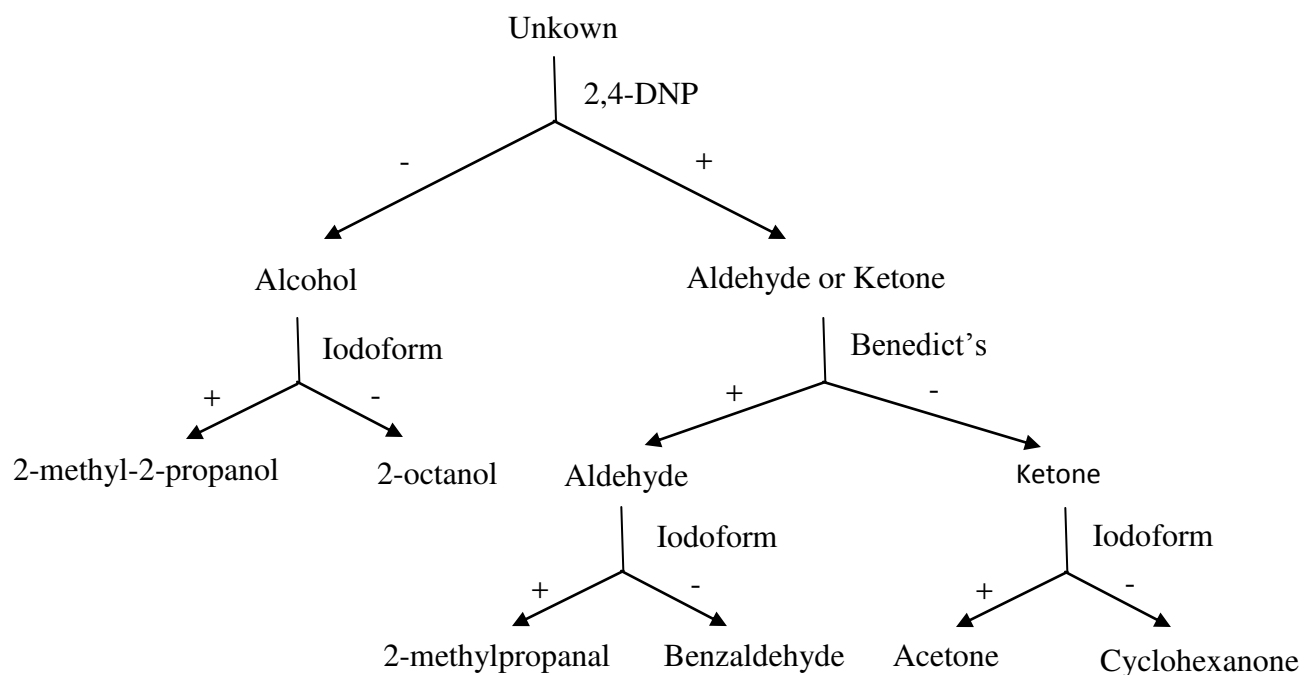


Figure 5.

Unknown #: \_\_\_\_\_

Id for Unknown: \_\_\_\_\_

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# Lab 4: Identification of Aldehydes, Ketones, and Alcohols Report Sheet

Name: \_\_\_\_\_

Partner(s): \_\_\_\_\_

Section: \_\_\_\_\_

## B) Solubility of Alcohols, Aldehydes, and Ketones:

Fill in the tables the same as you did in the procedure/data.

#	Compound Name	Soluble or Insoluble?
1B	2-methyl-2-propanol	
2B	2-octanol	
3B	2-methylpropanal	
4B	Benzaldehyde	
5B	Acetone	
6B	Cyclohexanone	
7B	Unknown # _____	

## C) 2,4-DNP Test for Aldehydes and Ketones:

#	Compound Name	Test Results (+/-)
1C	2-methyl-2-propanol	
2C	2-octanol	
3C	2-methylpropanal	
4C	Benzaldehyde	
5C	Acetone	
6C	Cyclohexanone	
7C	Unknown # _____	

**D) Iodoform Test for Methyl Alcohol, Aldehydes, and Ketones:**

#	Compound Name	Test Results (+/-)
1B	2-methyl-2-propanol	
2B	2-octanol	
3B	2-methylpropanal	
4B	Benzaldehyde	
5B	Acetone	
6B	Cyclohexanone	
7B	Unknown #_____	

**E) Oxidation of Aldehydes and Ketones:**

#	Compound Name	Test Results (+/-)
1E	2-methylpropanal	
2E	Benzaldehyde	
3E	Acetone	
4E	Cyclohexanone	
5E	Unknown #_____	

**F) Identification of Your Unknown**

Unknown #:\_\_\_\_\_

ID of unknown:\_\_\_\_\_