University of Al-Ameed
College of Pharmacy

Organic Chemistry II Lab

IDENTIFICATION OF ALCOHOLS

From structure to evidence: solubility, color, precipitate, and reaction time.

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Clear Samples — Different Identities



Can we identify an unknown alcohol without reading the label?

General Objective and Learning Map

General objective

By the end of this lab session, students will identify and classify alcohols using solubility behavior, ceric ammonium nitrate, iodoform, and Lucas tests, while interpreting observations safely and scientifically.

1. **Hook + pre-test**
2. **Concept bridge**
3. **Solubility + general test**
4. **Iodoform + Lucas tests**
5. **Unknown evidence table**
6. **Post-test + homework**

Engage → Explore → Explain → Practice → Evaluate.

Behavioral Learning Objectives

At the end of the session, each student should be able to:

1. Distinguish alcohols from phenols based on the position and behavior of the –OH group.
2. Classify an alcohol as primary, secondary, tertiary, cyclic, or aromatic side-chain alcohol from structure.
3. Apply solubility, ceric ammonium nitrate, iodoform, and Lucas tests using correct safety practice.
4. Explain observations: red complex, yellow precipitate, cloudiness, or two-liquid phases.
5. Use evidence to propose the identity/class of an unknown alcohol and state limitations.

Now, Let’s Move to Kahoot!

Pre-test activity — answer individually

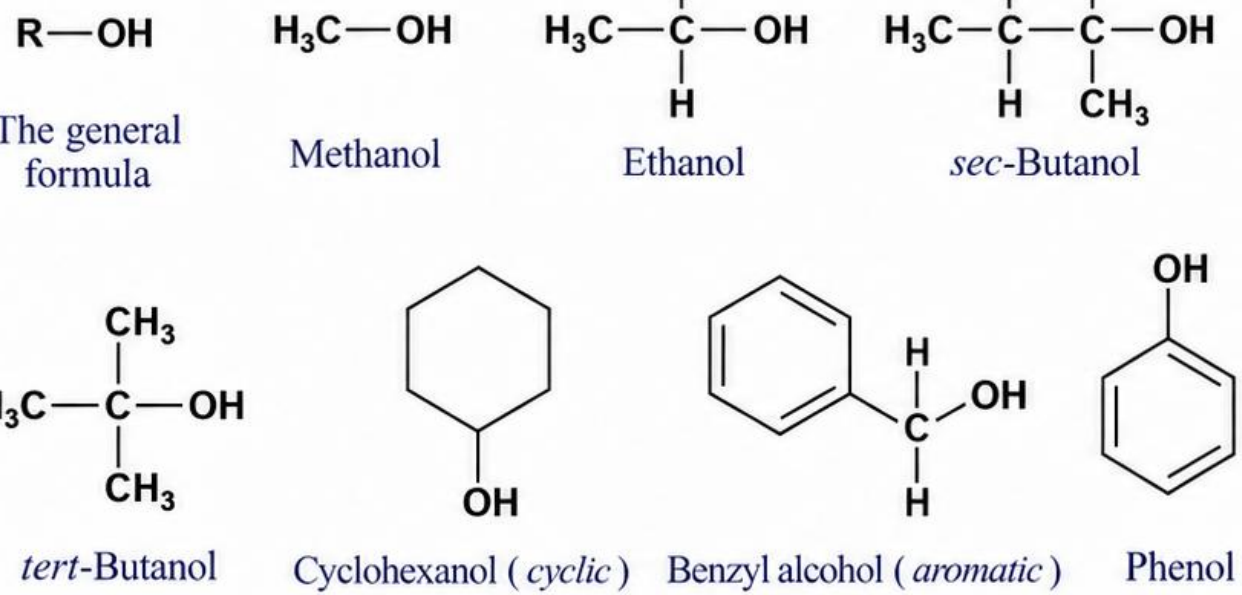
1. Take out your phone or laptop
2. Scan the QR code or enter the game PIN
3. Answer all questions within the time limit



Ready? Let’s begin.

Concept Bridge: Alcohol or Phenol?

Examples of alcohols



Key idea

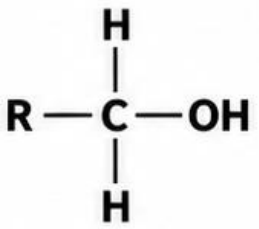
- Alcohol: –OH attached to an sp^3 carbon.
- Phenol: –OH attached directly to an aromatic ring.
- This structural difference changes acidity and chemical behavior.

Misconception alert

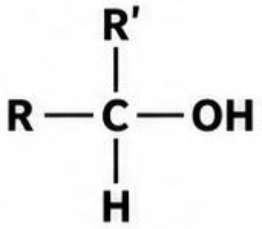
"Contains –OH does not automatically mean alcohol."

Ask: Which –OH is responsible for alcohol tests?

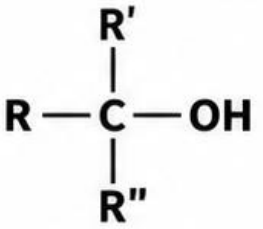
Classifying Alcohols: Primary, Secondary, Tertiary



Primary (1°)



Secondary (2°)



Tertiary (3°)

1° Primary (1°)

–OH carbon attached to one carbon usually slower in Lucas test

2° Secondary (2°)

–OH carbon attached to two carbons intermediate Lucas reaction time

3° Tertiary (3°)

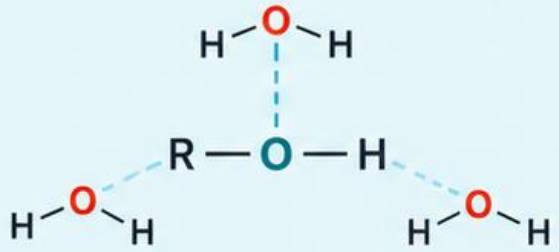
–OH carbon attached to three carbons rapid Lucas reaction

Structure predicts the most useful confirmatory tests.

Solubility in Alcohols: Simple Idea

1) The –OH part likes water

- The –OH group can interact with water.
- This helps the alcohol dissolve.
- Small alcohols mix better with water.



↑ More soluble in water

2) The carbon chain does not like water

- The hydrocarbon part is nonpolar.
- When the carbon chain gets longer, it resists water.
- So solubility becomes lower.



↓ Less soluble in water

3) What this means in the lab

- More –OH effect → better water solubility
- Longer chain → poorer water solubility
- Use solubility first before specific tests.

S1 = soluble in water

N = insoluble in water

Easy example: Ethanol is more soluble in water than sec-butanol.

Safety First: Alcohol Tests Are Chemical Evidence



PPE

Wear a lab coat, gloves, and safety goggles before handling reagents.

Ventilation

Avoid inhaling alcohol, iodine, HCl, and other reagent vapors.

No open flames

Alcohols are flammable: keep away from heat sources and flames.

Observation discipline

Do not smell directly; record color, precipitate, layers, and time.

Safety behavior is assessed during the practical work.

Testing Strategy: From Unknown to Evidence-Based Identification

Unknown alcohol sample

1 Solubility
Water miscible or not?

→

2 CAN test
Red complex?

→

3 Iodoform
Yellow precipitate?

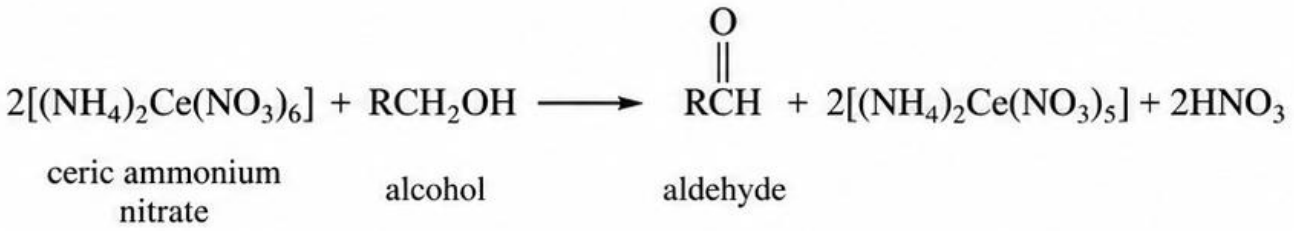
→

4 Lucas
Cloudiness / two phases over time?

Conclusion must be based on the full pattern, not one isolated observation.

General Test: Ceric Ammonium Nitrate

Reaction



Ceric ammonium nitrate (CAN) oxidizes primary alcohols to aldehydes.

What students should look for

1. **Alcohols:** red complex
2. **Phenols:** brown to greenish-brown precipitate
3. **Interpretation:** the reagent detects hydroxyl-containing compounds, so context matters.

Ask before adding reagent: What result would support "alcohol present"?

Procedure: Ceric Ammonium Nitrate Test

Water-soluble alcohols

1. Add 2 drops of alcohol.
2. Add 1 drop of CAN solution.
3. Mix gently.
4. Positive result: red complex.

Water-insoluble alcohols

1. Add 2 drops of alcohol.
2. Add 0.5 mL dioxane and shake.
3. Add 1 drop of CAN solution.
4. Positive result: red complex.

Formative prompt: Why does dioxane help in water-insoluble samples?

Checkpoint 1: Predict → Observe → Explain

Predict

If the sample is an alcohol, what color change should appear after adding CAN?

Observe

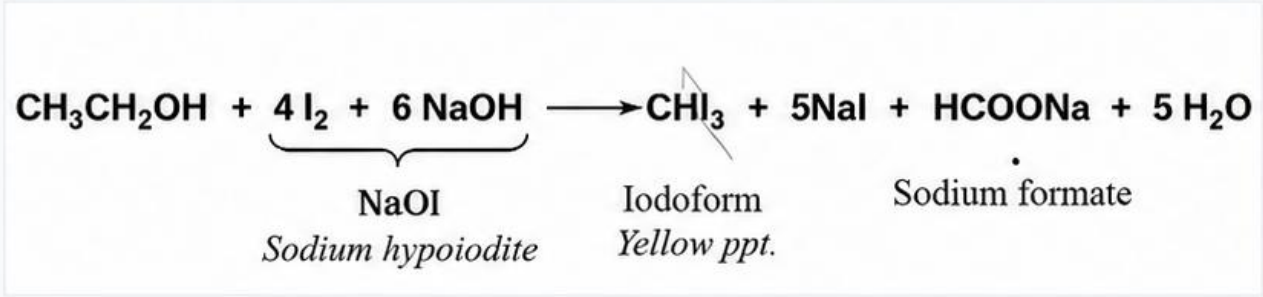
Record exactly: color, precipitate, and whether the mixture is homogeneous.

Explain

Does the observation support “alcohol present”? What alternative hydroxyl compounds may interfere?

Expected reasoning: alcohol + CAN → red complex; phenols can produce a brown/green precipitate.

Specific Test: Iodoform (Haloform) Test



Visible evidence: yellow precipitate

Positive indication

Yellow precipitate of iodoform.

Specific for alcohols that contain:

- CH_3–CH(OH)– group
- ethanol is also positive

Tertiary alcohols are negative.

Link observation to structure, not only to color.

Iodoform Test (Haloform Test)

Procedure • Observations • Interpretation • Key Points

What does a positive test mean?

Formation of yellow iodoform (CHI_3) indicates the presence of a $CH_3–CH(OH)–$ group (or a methyl ketone, $R–CO–CH_3$).



CHI_3 (iodoform)

1 Prepare the sample

- Add 3 drops of the alcohol to a clean test tube.
- Add 1 mL solvent:

Use water if the alcohol is water-soluble.
Use dioxane (or ethanol) if the alcohol is poorly water-soluble.



2 Make alkaline

- Add 1 mL of 10% NaOH solution.
- Mix well (shake).



3 Add iodine

- Add iodine solution (I_2 in KI) dropwise with continuous shaking.
- Continue until a faint brown/yellow color persists for a few seconds (slight excess I_2).



4 Warm if needed

- If no yellow precipitate appears, warm the tube in a water bath at 50–60 °C for 3–5 minutes.
- Then allow to stand and observe.



5 Adjust if necessary

- If the solution remains strongly brown (excess I_2) and the precipitate is difficult to see, add 10% NaOH dropwise until the iodine color is reduced to pale yellow.
- Mix and allow to stand.



6 Final observation

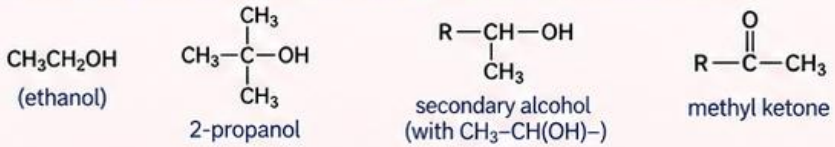
- **Positive:** yellow crystalline precipitate of iodoform (CHI_3).
- **Negative:** no yellow precipitate (solution remains clear or brown without ppt).



Positive (yellow precipitate) | **Negative** (no precipitate)

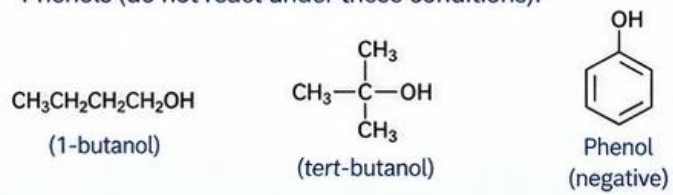
Which compounds give a positive test?

- Ethanol (CH_3CH_2OH)
- 2-Propanol ($CH_3CH(OH)CH_3$)
- Methyl ketones ($R–CO–CH_3$)
- Other alcohols containing a $CH_3–CH(OH)–$ group (secondary alcohols with a methyl group on the carbinol carbon).



Which compounds give a negative test?

- Most primary alcohols (e.g., 1-butanol).
- Most tertiary alcohols (e.g., *tert*-butanol).
- Alcohols without the $CH_3–CH(OH)–$ group.
- Phenols (do not react under these conditions).



Important notes & tips

1. A yellow precipitate may take time to appear; warming helps.
2. Use dioxane (or ethanol) for water-insoluble samples (immiscible alcohols).
3. Add iodine slowly and stop when a slight excess persists.
4. If the solution is too brown, add NaOH dropwise to reduce iodine color and reveal the precipitate.
5. A small amount of precipitate is still a positive result.
6. Iodoform test is not specific to alcohols (methyl ketones also positive). Use with other tests (e.g., Lucas, oxidation) for identification.

Checkpoint 2: Yellow Precipitate — What Does It Mean?

Question

A sample gives a yellow precipitate in the iodoform test.
Which conclusion is strongest?

A. It is any alcohol
B. It contains a methyl carbinol pattern or is ethanol
C. It is definitely tertiary
D. It is phenol

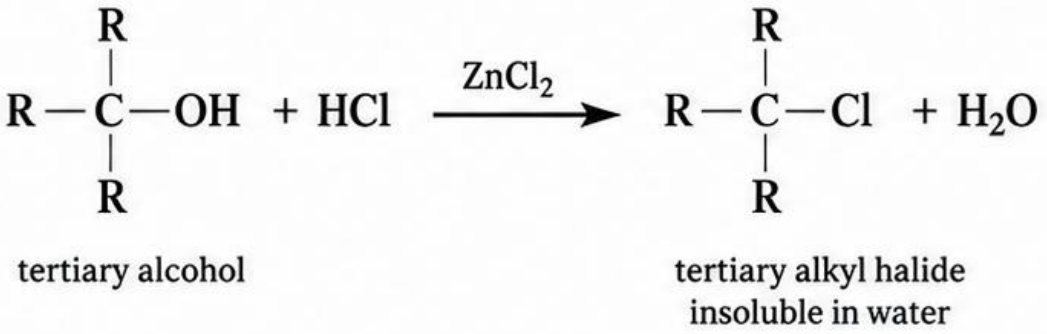
Expected reasoning

The yellow precipitate supports a positive iodoform test, which is not a universal alcohol test. It is structural evidence for alcohols with the required methyl group and hydrogen on the –OH-bearing carbon, such as ethanol and sec-butanol.

Answer: B

Specific Test: Lucas Test

$$ZnCl_2 + HCl \longrightarrow ZnCl_3^- + H^+$$



What Lucas test measures

Lucas reagent: concentrated HCl + anhydrous $ZnCl_2$.

Positive evidence: formation of alkyl chloride as a second liquid phase or cloudiness.

Observation must include time.

Lucas test is a classification test, not just a "positive/negative" test.

Lucas Test Timing: Use the Clock as Evidence

1

Benzyl alcohol

Immediate

very fast result / two phases

2

Tertiary alcohol

2–3 min

rapid two-phase separation

3

Secondary alcohol

15–20 min

cloudy solution / delayed separation

4

Primary alcohol / methanol

No reaction

one layer remains

> Formative prompt: If turbidity appears after 18 minutes, which class is most likely?

Student Practice: Build an Evidence Table

Students test an assigned unknown and complete the table before discussion.

Test	Observation	Chemical meaning	Decision
Solubility			
CAN			
Iodoform			
Lucas			

Rule: no final answer without at least two supporting observations.

Scan the QR Code

POST-TEST

Post-Test: Evidence of Learning

Scan • Answer individually • Submit before leaving the lab

Lecture Summary: Identification of Alcohols

SUMMARY

From unknown sample to justified identification

UNKNOWN ALCOHOL SAMPLE

1 Structure first
Alcohol vs phenol
1st, 2nd, 3rd alcohol

→

2 General evidence
Solubility pattern
CAN red complex

→

3 Specific evidence
Iodoform: yellow ppt
Lucas: time + turbidity

→

4 Final decision
Use full pattern
Avoid one-test identity

Key rule: one observation gives a clue; a pattern of observations gives identification.

By the end, students should be able to justify an unknown alcohol identity using at least two supporting observations.

Structure -> Test result -> Chemical meaning -> Evidence-based conclusion

Thank You

Questions and Discussion

Thank you for your attention.

