

SI GOB - Full Discipline Demo

GOB-Properties of Alcohols

Final Report - Answer Guide

Institution	Science Interactive University
Session	SI GOB - Full Discipline Demo
Course	SI GOB - Full Discipline Demo
Instructor	Sales SI Demo

Test Your Knowledge

Identify each bond as either ionic or covalent.

⚡ Na-Cl	⚡ H-O-H	⚡ Li-Br	⚡ H-CH ₃	⚡ O=O	⚡ K-OH
Ionic Bond			Covalent Bond		
1			2		

Correct answers:

1 K-OH Na-Cl Li-Br 2 H-O-H H-CH₃ O=O

Identify each compound as either polar or nonpolar.

⚡ NH ₃	⚡ CH ₃ -CH ₃	⚡ N ₂	⚡ HF	⚡ H ₂	⚡ HOCH ₃
Polar			Nonpolar		
1			2		

Correct answers:

1 NH₃ HF HOCH₃ 2 CH₃-CH₃ N₂ H₂

Identify the physical state of each compound at room temperature (25°C) based on its provided boiling point.

⚡ Water (100°C)	⚡ Ammonia (-33°C)	⚡ Ethanol (78°C)	⚡ Butane (-1°C)
⚡ Diethyl ether (34°C)			
Gas		Liquid	
1		2	

Correct answers:

1 Ammonia (-33°C) Butane (-1°C)
2 Water (100°C) Ethanol (78°C) Diethyl ether (34°C)

Exploration

Ionic bonds occur when atoms ____.

- ☐ gain or lose electrons
- ☐ have complete charge separation
- ☐ are bonded by opposite charges
- ☒ All of the above

✓

Covalent bonds are formed when atoms share electrons.

- ☒ True
- ☐ False

✓

1-Butanol has a higher boiling point than tert-butyl alcohol.

- ☒ True
- ☐ False

✓

As the number of hydrogen bond donors in a molecule increase, the boiling point decreases.

- ☐ True
- ☒ False

✓

An alcohol with three carbon groups is classified as a ____.

- ☐ primary alcohol
- ☐ secondary alcohol
- ☒ tertiary alcohol
- ☐ All of the above

✓

Oxygen is more electronegative than hydrogen.

- ☒ True
- ☐ False

✓

When two alcohols hydrogen bond, the hydrogen is the hydrogen bond _____ and the lone pair on oxygen is the hydrogen bond _____.

- ☐ acceptor; donor
- ☒ donor; acceptor
- ☐ transporter; donor
- ☐ acceptor; facilitator

✓

The intermolecular interaction between the C-H of an alcohol and the lone pair of oxygen on water is a repulsive interaction.

- ☒ True
- ☐ False

✓

Increasing the carbon chain length of an alcohol makes an alcohol more soluble in water.

- ☐ True
- ☒ False

✓

Exercise 1

Sulfur is the atom below oxygen on the periodic table. Do you hypothesize that a S-H bond or O-H bond is a better hydrogen bond donor? Why?

An O-H bond is a better hydrogen bond donor than S-H because oxygen is more electronegative than sulfur. This means the O-H bond is weaker and places a larger partial positive charge on the hydrogen. This makes the hydrogen better at accepting a partial negative charge.

Image 1: Label methanol's hydrogen bond donors and acceptors
(SAMPLE ANSWER BELOW)

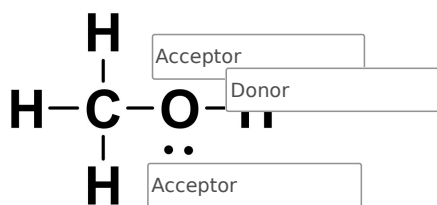


Image 2: Methanol's intermolecular hydrogen bonding
(SAMPLE ANSWER BELOW)

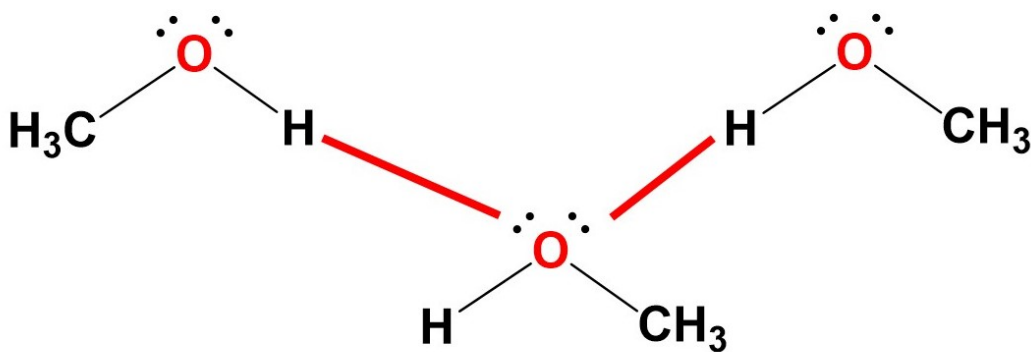


Image 3: Label Glycerol for hydrogen bond donors and acceptors
Circle all hydrogen bond donors in blue and all hydrogen bond acceptors in red (SAMPLE ANSWER BELOW)

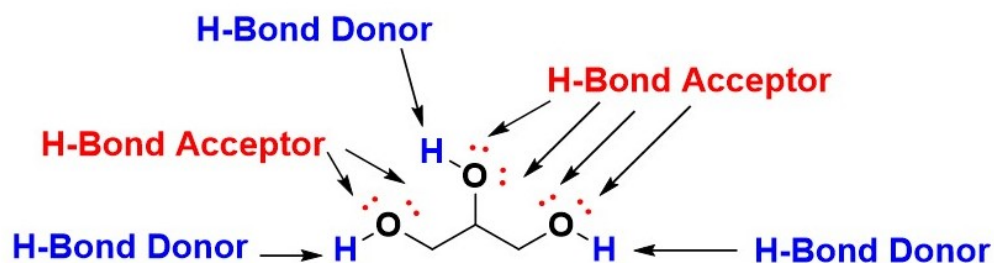
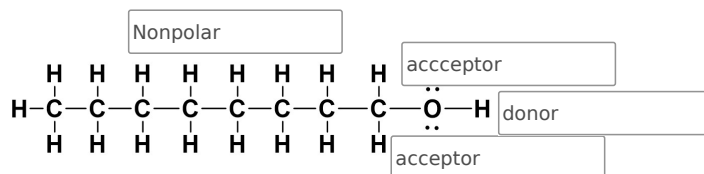


Image 4: Label octanol
(SAMPLE ANSWER BELOW)



Exercise 2

Based on the results in Data Table 1, what property of the alcohols made them insoluble in water?

As the carbon chain length increases, so does the nonpolar characteristic. This leads to more repulsive interactions between the hydrocarbon tail and the polar water molecules. This makes the alcohol insoluble in water.

Without changing the number of carbon atoms in an alcohol, how could you make an alcohol more soluble in water?

To make an alcohol more soluble you will want to make it more polar. If you decrease the size of the molecule such as switching from 1-butanol to tert-butyl alcohol, the tertiary alcohol will be more soluble in water. Additionally, if you add more alcohol groups to the carbon chain, it will also be more soluble.

Based on the results in Data Table 2, what happens when you add salt to the water? What property of the solution does it increase? How does this affect the solubility of isopropanol and propanol in water?

When you add salt (NaCl) to water, the ions Na^+ and Cl^- are formed in the solution, making it more polar. The increase in polarity reduces the solubility of isopropanol leading to it floating above the water in the test tube.

Describe the interface between two insoluble liquids.

Between two insoluble liquids there is a section called the meniscus where the two layers touch. It has a shape of a U.

Based on the results in Data Table 1, why were there differences in solubility of the alcohols in oil and water? Where was the change in solubility of the alcohols in water and in oil?

The difference in solubility of the alcohols in water vs oil is because of the carbon chain.

As the chain increased the alcohols became insoluble in water. This is because the alcohol became more non polar due to the high number C-H bonds.

Conversely, for the alcohols solubility in oil the longer the chain length the more soluble it became. This is because the oil is a non polar liquid.

In water 1-butanol was soluble and 1-pentanol was insoluble. In oil it was insoluble in ethanol and soluble in 1-propanol.

Panel 1: Solubility of oil and water
(SAMPLE ANSWER BELOW)

The oil and water do not mix and are insoluble. The oil is yellow and water is clear. The oil is less dense and will be the top layer and water will be the bottom layer.

Data Table 1: Solubility of Alcohols in Water and Oil
(SAMPLE ANSWER BELOW)

Alcohol	Solubility in Water	Solubility in Oil
Methanol	Soluble	Insoluble
denatured Ethanol	Soluble	Insoluble
1-Propanol	Soluble	Soluble
Isopropanol	Soluble	Soluble
1-Butanol	Soluble	Soluble
1-Pentanol	Insoluble	Soluble
1-Hexanol	Insoluble	Soluble
1-Octanol	Insoluble	Soluble

Panel 2: Salt effects of propanol and isopropanol solubility in water
(SAMPLE ANSWER BELOW)

Both propanol and isopropanol are water soluble. Upon addition of salt to these test tubes, the salt will precipitate out at the bottom. The isopropanol will become insoluble and form 2 layers and the propanol remain soluble.

Exercise 3

Describe one trend that increases the boiling point of an alcohol (Note: there are several trends that increase boiling point).

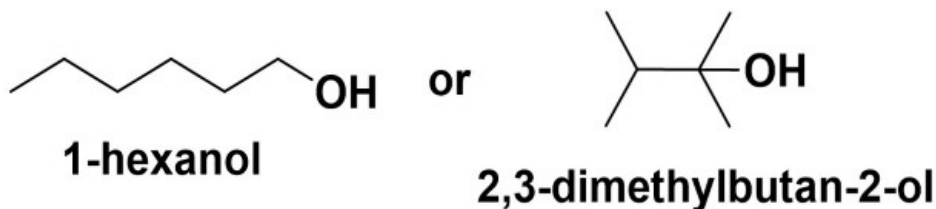
There are several changes that increase boiling points of alcohols.

- 1) Increasing the carbon chain length
- 2) Making the carbon chain more linear, 1° is higher than 2° which is higher than 3° alcohol.
- 3) Adding more alcohol groups to the compound.

An ether is formed by the reaction of two alcohols and the loss of water. Why do ethers with the same molecular formulas as an alcohol have lower boiling points?

An ether with the same molecular formula as an alcohol will have a lower boiling point, because it does not have a hydrogen bond donor to intermolecularly bond with another molecule in solution.

Based on your observations, which of the compounds below do you think would have a higher boiling point? Why?



These two alcohols have the same molecular formula, which means that 1-hexanol will have a higher boiling point, because it is both more linear and a primary alcohol.

Based on the results obtained in Data Table 3, which alcohol had a higher boiling point? Would 1-propanol have a higher or lower boiling point compared to isopropanol?

Isopropanol had a higher boiling point than ethanol by 5°C. Isopropanol's boiling point is 82°C and 1-propanol's boiling point is 97°C, therefore 1-propanol will have a higher boiling point.

Data Table 3: Boiling points of alcohols
(SAMPLE ANSWER BELOW)

Alcohol	Boiling Point (°C)
Ethanol	78
Isopropanol	82

Competency Review

For three alcohols with identical formulas, the ____ alcohol will have the highest boiling point.

- ☐ primary
- ☐ secondary
- ☐ tertiary
- ☐ None of the above

✓

An increase in hydrogen bond donors results in a(n) ____ in water solubility and a(n) ____ in boiling point.

- ☐ increase; increase
- ☐ decrease; decrease
- ☐ increase; decrease
- ☐ decrease; increase

✓

Increasing the chain length of an alcohol will make it more soluble in water.

- ☐ True
- ☐ False

✓

When a hydrogen from an alcohol interacts with a lone pair on water, this is a repulsive force.

- ☐ True
- ☐ False

✓

The ____ is temperature at which a chemical changes from a liquid to a gas.

- ☐ freezing point
- ☐ boiling point
- ☐ melting point
- ☐ sublimation

✓

Methanol is soluble in water.

- ☒ True
- ☐ False

✓

Which is the correct order of the following alcohols from most to least soluble in water.

- ☐ ethanol, methanol, propanol, butanol
- ☐ propanol, ethanol, butanol, methanol
- ☒ methanol, ethanol, propanol, butanol
- ☐ butanol, ethanol, methanol, propanol

✓

The bond between K^+ and ^-OH is an example of a covalent bond.

- ☐ True
- ☒ False

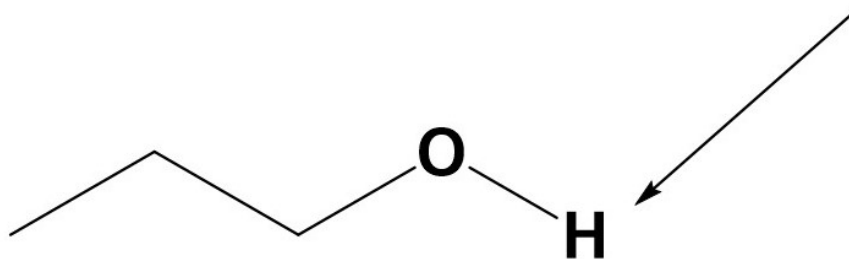
✓

The bond between the O and H of ethanol ($\text{CH}_3\text{CH}_2\text{O}-\text{H}$) is an example of a(n) ____.

- ☒ covalent bond
- ☐ ionic bond

✓

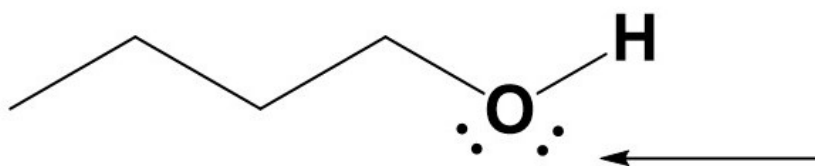
The object indicated by the arrow in the image of 1-propanol below is an example of a(n) ____.



- ☐ hydrogen bond acceptor
- ☒ hydrogen bond donor
- ☐ ionic bond
- ☐ an alkane

✓

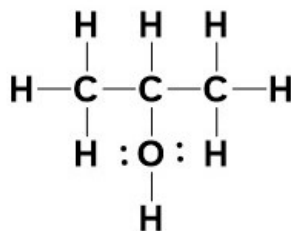
The object indicated by the arrow in the image of 1-butanol below is an example of a(n) ____.



- ☐ hydrogen bond donor
- ☒ hydrogen bond acceptor
- ☐ ionic bond
- ☐ alkene

✓

Based on the alcohol structure below, how would the alcohol be classified?



- ☐ primary alcohol
- ☒ secondary alcohol
- ☐ tertiary alcohol



Extension Questions

Windshield washer fluid is often composed of a mixture of water and various low-molecular weight alcohols (like ethanol and methanol). Imagine you have been asked to prepare two formulations of washer fluid: one for use in Florida and one for use in Alaska. Describe the ratios of alcohol to water that you would use for each solution. (SAMPLE ANSWER BELOW)

When making two windshield washer fluids the ratio of water to alcohol will change depending on the temperature of the environment. Pure water will freeze at 0°C, but as more alcohol is added, the freezing point will be depressed. This means the windshield washer fluid in Alaska will have a higher ratio of alcohol to water than one in Florida.