Alcohols and their reactions

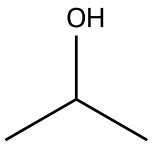
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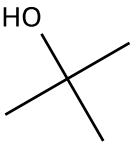
Show your working where needed. Check the worked answers when you finish.

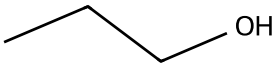
Name _____ Date _____

1. Classify three structures

Classify structures A, B and C as primary, secondary or tertiary alcohols. Explain your rule.

A 

B 

C 

2. Explain the boiling point

Propan-1-ol boils at 97 °C. Butane has a similar molar mass but boils at about −1 °C. Explain the large difference.

3. Collect the distillate

A student adds acidified potassium dichromate(VI) to butan-1-ol and distils the organic product as it forms. Identify the intended product, write an equation using [O] and explain the choice of distillation.

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4. Predict the reflux product

A second student heats 2-methylpropan-1-ol under reflux with excess acidified potassium dichromate(VI). Identify the organic product. Write the equation using [O] and explain how the conditions favour that product.

5. Compare two test results

Butan-2-ol and 2-methylpropan-2-ol are warmed separately with acidified potassium dichromate(VI). Give the usual colour change or lack of change and name any organic product.

6. Predict two structures

Butan-2-ol is heated in the presence of concentrated phosphoric acid. Write condensed formulae for the two structural alkene products and name the reaction type.

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7. Build a two-stage route

Suggest a two-stage route from ethene to ethanal. Identify the intermediate, the reagent or reagents for each step, and how you collect the ethanal.

8. Prepare a haloalkane from an alcohol

A student heats propan-1-ol with sodium bromide and sulfuric acid. Give the name of the organic product and an equation using HBr to represent the reacting species. Name the reaction type.

9. Extra challenge · Identify the alcohol and plan two routes

An alcohol has formula $C_4H_{10}O$. Heating it with acidified dichromate turns the mixture green and gives a ketone. Identify the alcohol and write the oxidation equation using [O].

Use the same starting alcohol to make a haloalkane and, in a separate reaction, two structural alkene products. Give the reagents or conditions, name the types of reaction and draw the organic products.

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Worked answers

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1. Classify three structures

A is secondary, B is tertiary and C is primary. Count the carbon atoms directly bonded to the carbon that carries OH. The counts are two, three and one, respectively.

2. Explain the boiling point

Both have London forces. Propan-1-ol molecules also form hydrogen bonds between the H of one OH group and a lone pair on an O of another molecule. More energy is needed to separate the alcohol molecules.

3. Collect the distillate

The intended product is butanal. $CH_3CH_2CH_2CH_2OH + [O] \rightarrow CH_3CH_2CH_2CHO + H_2O$.

Distilling the butanal out as it forms limits its contact with the oxidising mixture and reduces further oxidation.

4. Predict the reflux product

$(CH_3)_2CHCH_2OH + 2[O] \rightarrow (CH_3)_2CHCOOH + H_2O$. The product is 2-methylpropanoic acid.

The alcohol first forms an aldehyde. Reflux returns volatile material to the hot mixture, and excess oxidant allows the aldehyde to oxidise further to the carboxylic acid.

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Worked answers

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5. Compare two test results

Butan-2-ol gives butan-2-one and the solution changes from orange to green. The tertiary alcohol 2-methylpropan-2-ol resists oxidation under these conditions, so the solution stays orange.

6. Predict two structures

CH_2=$CHCH_2CH_3$ and CH_3CH=$CHCH_3$. Elimination forms water and a C=C bond between the carbon that carried OH and one of its two neighbouring carbons.

7. Build a two-stage route

Add steam with an acid catalyst such as phosphoric acid to make ethanol. Oxidise the ethanol using acidified potassium dichromate(VI).

Distil off ethanal as it forms to limit further oxidation.

8. Prepare a haloalkane from an alcohol

The product is 1-bromopropane. $CH_3CH_2CH_2OH + HBr \rightarrow CH_3CH_2CH_2Br + H_2O$. This is substitution.

9. Extra challenge · Identify the alcohol and plan two routes

It is butan-2-ol, the only secondary alcohol with formula $C_4H_{10}O$. $CH_3CH(OH)CH_2CH_3 + [O] \rightarrow CH_3C(=O)CH_2CH_3 + H_2O$.

Heat with NaBr and sulfuric acid for substitution to $CH_3CH(Br)CH_2CH_3$. In a separate reaction, heat with an acid catalyst such as concentrated phosphoric acid for elimination. This gives CH_2=$CHCH_2CH_3$ and CH_3CH=$CHCH_3$.

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