Alcohols and their reactions

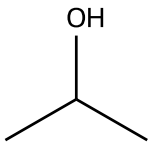
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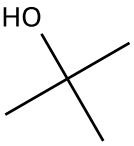
Show your working where needed. Check the worked answers when you finish.

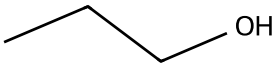
Name _____ Date _____

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. Assess a biofuel claim

Write the equation for fermentation of glucose to ethanol. Explain why making ethanol from a crop does not guarantee zero net carbon dioxide emissions.

9. Extra challenge · Use oxidation evidence to recover structures

Three isomeric alcohols A, B and C have the 2-methylbutane carbon skeleton. Warm each with excess acidified potassium dichromate(VI). A stays orange. B gives a ketone. C gives a carboxylic acid with a methyl branch next to COOH.

Give condensed structural formulae for A, B and C. Name the type of alcohol in each case and write an equation for C using [O].

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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.

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.

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Worked answers

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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. Assess a biofuel claim

$C_6H_{12}O_6 \rightarrow 2C_2H_5OH + 2CO_2$. The crop absorbs carbon dioxide while growing, but cultivation, fertiliser production, distillation and transport can all add to emissions.

9. Extra challenge · Use oxidation evidence to recover structures

A is $CH_3C(OH)(CH_3)CH_2CH_3$, a tertiary alcohol. The carbon bearing OH has no H attached.

B is $CH_3CH(OH)CH(CH_3)CH_3$, a secondary alcohol. C is $HOCH_2CH(CH_3)CH_2CH_3$, a primary alcohol.

$HOCH_2CH(CH_3)CH_2CH_3 + 2[O] \rightarrow HOOCCH(CH_3)CH_2CH_3 + H_2O$. This product has the required methyl branch on carbon 2, next to the acid group.

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