Answer all the questions below and then check your answers

1. Draw the displayed formula for the following alcohols and label each alcohol as primary, secondary or tertiary.

i. propan-2-ol ii. 2-methylpropan-2-ol iii. Ethanol

iv. butan-2-ol. v. $(CH_3)_2CHCH(OH)CH_3$

2. Complete the equations below to show the oxidation products of primary, secondary and tertiary alcohols using acidified potassium dichromate:

i. primary alcohol + [O] ⟶

ii. secondary alcohol + [O] ⟶

iii. tertiary alcohol + [O] ⟶

a. What colour change is observed when acidified potassium dichromate oxidises a primary alcohol?

b. Write an ion electron half-equation to show the reduction reaction responsible for this colour change.

3. Propanone can be obtained by the oxidation of an alcohol.

a. To what homologous series does the compound propanone belong to?

b. What alcohol is oxidised to propanone?

c. Write an equation to show how propanone is obtained from this alcohol, use [O] to represent the oxidising agent.

d. Name the oxidising agent commonly used in the lab to carry out this reaction.

4. Outline briefly the method used to oxidise ethanol to ethanol. Include in your description the apparatus and all chemicals needed and how you would obtain the ethanol from the ethanol mixture.

i. Explain why a water bath is preferable to a Bunsen burner when heating this oxidation reaction.

5. Draw the structure of an alcohol that is not oxidised by acidified potassium dichromate solution.

6. Draw the displayed formula for each of the following pairs of compounds:

a. ethanal and ethanone

b. propanal and propanone

c. butanal and butanone.

7. Name a 2 reagents that can differentiate between an aldehyde and a ketone.

i. State the observations you would expect to see when using these two reagents.

8. Ethanol is the alcohol found in alcoholic drinks. If wine is stored incorrectly, it can taste sour due to the presence of ethanoic acid. Ethanol can be oxidised in the lab in a two step process.

a. This two step oxidation process is partly outlined below. Complete the equation below.

Ethanol + [O] ⟶ ⟶

b. Why is ethanal more volatile than ethanol?

c. Ethanal is obtained by the mild oxidation of ethanol using distillation. However to obtain ethanoic acid the ethanol/oxidising agent are heated under reflux. Why is it necessary to heat the mixture under reflux conditions?

d. What chemical test could be used to confirm that the ethanal obtained by mild oxidation of ethanol did not contain any ethanoic acid?

e. When ethanal is warmed in a test-tube with Tollens reagent a silver mirror is observed.

i. Write an equation to show how this silver mirror is formed.

ii. What does Tollens reagent convert ethanal into?

iii. What type of reagent is Tollens acting as in this reaction?

9. Draw the displayed formula of butane-1,4-diol.

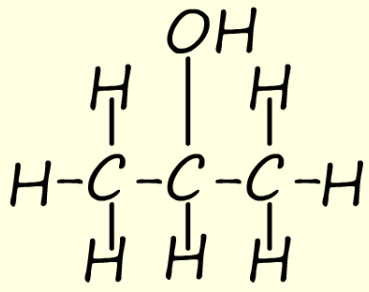
a. Draw the displayed formula of the compound obtained when butane-1,4-diol is heated under reflux conditions with an acidified sodium dichromate solution.

Answers

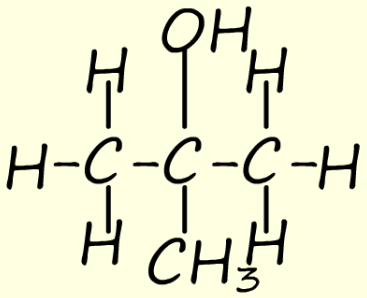
1. Draw the displayed formula for the following alcohols and label each alcohol as primary, secondary or tertiary.

i. propan-2-ol ii. 2-methylpropan-2-ol iii. Ethanol

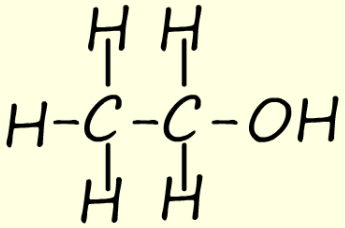
iv. butan-2-ol. v. $(CH_3)_2CHCH(OH)CH_3$



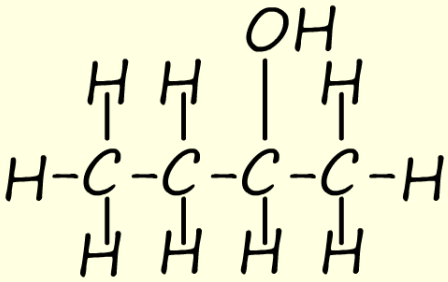
propan-2-ol
secondary alcohol



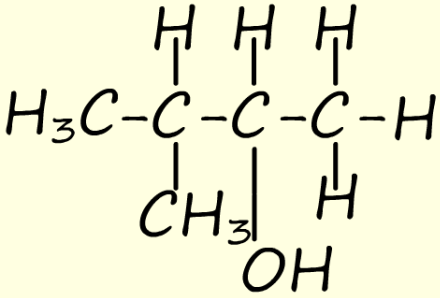
2-methylpropan-2-ol
tertiary alcohol



ethanol
primary alcohol



butan-2-ol
secondary alcohol



2-methylbutan-2-ol
secondary alcohol

2. Complete the equations below to show the oxidation products of primary, secondary and tertiary alcohols using acidified potassium dichromate:

i. primary alcohol + [O] ⟶ aldehyde + water

ii. secondary alcohol + [O] ⟶ ketone + water

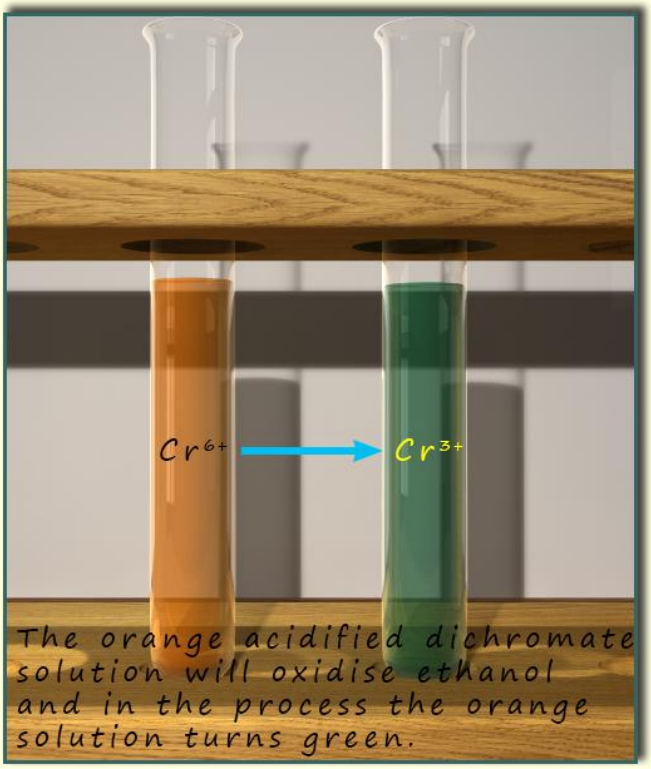
iii. tertiary alcohol + [O] ⟶
no oxidation using acidified dichromate

a. What colour change is observed when acidified potassium dichromate oxidises a primary alcohol?

Orange to green

b. Write an ion electron half-equation to show the reduction reaction responsible for this colour change.

Cr^{6+} +3e ⟶ Cr^{3+}



3. Propanone can be obtained by the oxidation of an alcohol.

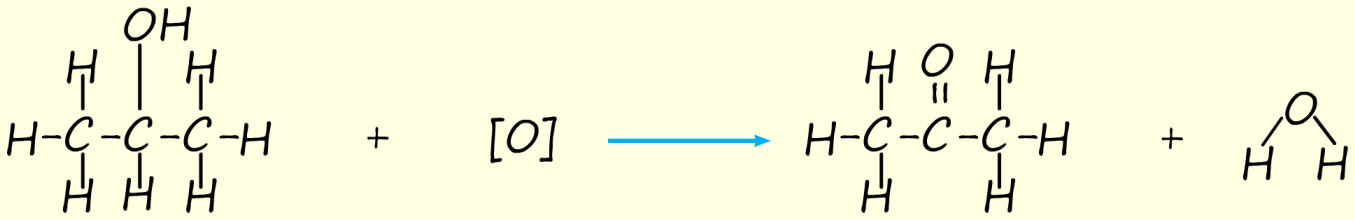
a. To what homologous series does the compound propanone belong to?

ketones

b. What alcohol is oxidised to propanone?

Propan-2-ol

c. Write an equation to show how propanone is obtained from this alcohol, use [O] to represent the oxidising agent.



$$CH_3CH(OH)CH_3 + [O] \longrightarrow CH_3COCH_3 + H_2O$$

d. Name the oxidising agent commonly used in the lab to carry out this reaction.

Acidified potassium or sodium dichromate

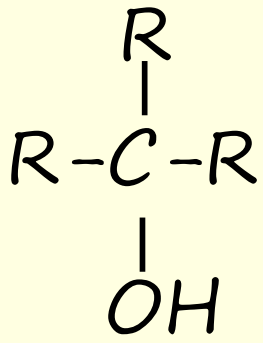
4. Outline briefly the method used to oxidise ethanol to ethanol. Include in your description the apparatus and all chemicals needed and how you would obtain the ethanol from the ethanol mixture.

The method outlined on the page alcohols classification and oxidation describes the method used to obtain an aldehyde. The method is also suitable for the production of ketones.

i. Explain why a water bath is preferable to a Bunsen burner when heating this oxidation reaction.

Ketones are highly flammable. A naked flame is a fire risk.

5. Draw the structure of an alcohol that is not oxidised by acidified potassium dichromate solution. Any tertiary alcohol will do, R is an alkyl group.

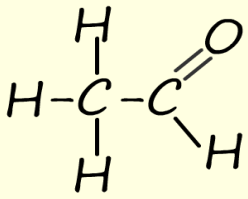


6. Draw the displayed formula for each of the following pairs of compounds:

a. ethanal and ethanone

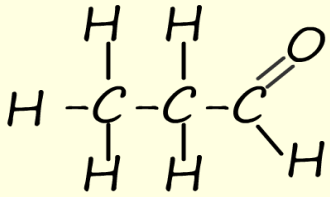
b. propanal and propanone

c. butanal and butanone.

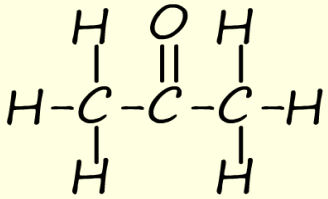


ethanal

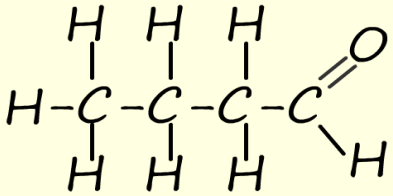
There is no such compound as ethanone. The first ketone is propanone.



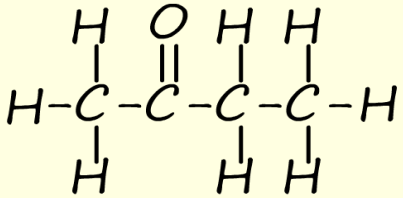
propanal



propanone



butanal



butanone

7. Name a 2 reagents that can differentiate between an aldehyde and a ketone.

   Tollens and Fehling's solutions or Benedicts solution.

i. State the observations you would expect to see when using these two reagents.

   Tollens reagent will produce a silver mirror test with an aldehyde.

   Fehling's solution will produce a orange-brown precipitate of copper(I) oxide when warmed with an aldehyde.

8. Ethanol is the alcohol found in alcoholic drinks. If wine is stored incorrectly, it can taste sour due to the presence of ethanoic acid. Ethanol can be oxidised in the lab in a two step process.

a. This two step oxidation process is partly outlined below. Complete the equation below.

   Ethanol + [O] ⟶ ethanal ⟶ ethanoic acid

b. Why is ethanal more volatile than ethanol?

   Hydrogen bonding present in ethanol will raise the boiling point of the alcohol. Ethanal will have dipole-dipole bonding present, this form of intermolecular bonding is not as strong as H-bonding.

c. Ethanal is obtained by the mild oxidation of ethanol using distillation. However to obtain ethanoic acid the ethanol/oxidising agent are heated under reflux. Why is it necessary to heat the mixture under reflux conditions?

The initial product of the oxidation of ethanol is the aldehyde ethanal. Ethanal is very volatile and would simply evaporate and leave the apparatus. However if the experiment is carried out under reflux conditions the ethanal will condense inside the Liebig condenser and fall back into the oxidising mixture.

d. What chemical test could be used to confirm that the ethanal obtained by mild oxidation of ethanol did not contain any ethanoic acid?

Add a few drops of sodium carbonate solution. If any acid was present then bubbles of carbon dioxide gas would be seen as the carboxylic acid reacted with the carbonate solution.

e. When ethanal is warmed in a test-tube with Tollens reagent a silver mirror is observed.

i. Write an equation to show how this silver mirror is formed.

$Ag^{+}_{(aq)} + e \longrightarrow Ag_{(s)}$

ii. What does Tollens reagent convert ethanal into?

Ethanoic acid

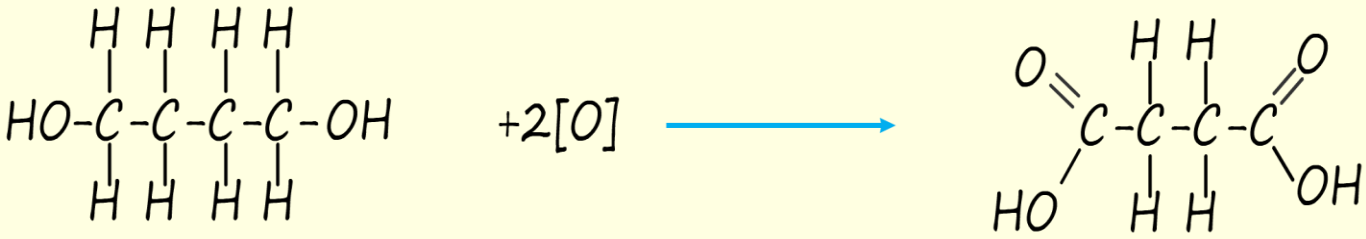
iii. What type of reagent is Tollens acting as in this reaction?

Oxidising agent

9. Draw the displayed formula of butane-1,4-diol.

   See below

a. Draw the displayed formula of the compound obtained when butane-1,4-diol is heated under reflux conditions with an acidified sodium dichromate solution.



butan-1,4-diol

butandioic acid