THE THREE ISOMERS OF BUTANOL

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COMPARING THE ISOMERS OF BUTANOL

I have been working on involving more open ended questioning in my classes - how can I better incorportate the ideas of inquiry and sustained inquiry in my teaching? The following is the re-working of a lab on the isomers of Butanol. By making this lab into more of a thought experiement students are more engaged in communicating their ideas and predictions - and we have less chemical waste too. I am playing with the ideas of argumentation and exploration. I use whiteboarding quite a bit for this process as students seems much more willing to write something down if they feel they can easily change it or erase it.

I opened with a "ladder" activity about boiling points - one of the physcial properties we study with relation to organic compounds. I asked students to organize the comounds based on their prior knowledge from lowest to highest and to rationalize their choices. We then had a great discussion about the effects of branching, and chain length on boiling points. We also looked at the location of functional groups on chains and what effects this may have. We then applied these principles to examining how chain length and functional group location may affect chemical properties also. Using a similar approach and data we looked at the isomers of butanol.

Groups presented their findings via their "speakers" and at the end of the group sharing were permitted to change any answers before I took up the work on our document camera. Managers evaluated their groups written performance and critical thinking skills. I then posted my "solution" on Remind as a pdf. for all students to see.

Background:

The reactivity of alcohols can be accounted for by their molecular structure – particularly by the attachment of their hydroxyl functional group.

Using the isomers of butanol we will examine how the molecular structure of an organic molecule affects its properties.

Recorder: _____

Manager: _____

Speaker: _____

TASK #1 – Guided Practice

[C][K/U][T/I][A]: 0 1 2 3 4 5

Determine the three isomers of butanol. Draw condensed and line diagrams of each and name them according to IUPAC rules.

Prediction: Rank the isomers from least to most reactive (1 is least and 3 is most). Include your reasoning.
_____ < _____ < _____

Prediction: Rank the isomers in terms of boiling point from lowest to highest (1 is lowest and 3 is highest). Include your reasoning.

_____ < _____ < _____

TASK #2 – Analysis Questions – see Table 1: Observations

Each of the three isomers of butanol was mixed with concentrated hydrochloric acid. The presence of an alkyl halide product is indicated by cloudiness of the mixture, as the halides are only slightly soluble in water. This test indicates that a halogenation reaction has taken place. P

Each alcohol was also separately mixed with dilute potassium permanganate solution, which provides conditions for controlled oxidation. Any colour change of the permanganate solution indicates that an oxidation reaction has taken place.

Table 1: Observations:

Alcohol	HCl added	$KMnO_4$ added
Butan-1-ol	Cloudy layer formed after more than 1 minute	Colour change
Butan-2-ol	Cloudy layer formed at the 1 minute mark	Colour change
2-methylpropan-2-ol	Cloudy layer former immediately	No colour change – no evidence of a chemical reaction.

Analysis Questions:

1. Does each type of alcohol undergo halogenation and/or controlled oxidation?

2. Write a structural diagram equation to represent the reaction between each alcohol and $HCl_{(aq)}$. Where no reaction occurred, simply write “NR”. Discuss any differences in rates of reaction.

3. Write a structural diagram equation to represent the reaction between each alcohol in $KMnO_{4\,(aq)}$ solution. Where no reaction occurred, simply write “NR”. Explain why certain alcohols reacted in $KMnO_{4\,(aq)}$ and others did not.

4. Re-evaluate your predictions for reactivity and boiling points. Were they correct? How do intermolecular forces play a role in these properties?

Conclusion:

Create a one-sentence summary statement about halogenation and oxidation reactions of primary, secondary and tertiary alcohols.

WATCH THE VIDEO
01:30 min

(//www.youtube.com/embed/kRD_fRadU3o?width=800&height=450&iframe=true)

RESOURCES

- Isomers of butanol dry lab group activity handout (https://connex.stao.ca/sites/default/files/isomers_of_butanol_dry_lab.docx)
- Boiling points - ranking and reasoning activity (https://connex.stao.ca/sites/default/files/boiling_points_sorting_activity_spring_2016.docx)

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