Year 13 Science: Functional groups, naming and isomers

Name: _____ Date: _____

Try these without your notes first, then check the answer key.

Practice

1. Name $CH_3CH_2CH_2COCl$.

2. Name $CH_3CH(CH_3)CH_2CHO$.

3. Which of these has optical isomers: propan-2-ol, butan-2-ol, butanone or but-1-ene?

4. Which of these has geometric isomers: pent-1-ene, pent-2-ene, 2-methylbut-2-ene or pentane?

5. How many aldehydes and ketones have the formula C_4H_8O?

Exam-style question: isomers of $C_4H_8O_2$

Butanoic acid, ethyl ethanoate and 3-hydroxybutanal all have the formula $C_4H_8O_2$.

6. Name the ester $CH_3CH_2COOCH_3$, another isomer of $C_4H_8O_2$.

7. Name the branched carboxylic acid with this formula.

8. Which of the three compounds above exists as enantiomers?

9. Explain why butanoic acid boils at 164 °C and ethyl ethanoate at 77 °C.

10. Give a test that tells butanoic acid from ethyl ethanoate, with the observation.

Fix the mistake

11. Correct this statement: "But-1-ene has cis and trans isomers because it has a C=C bond."

12. Correct this statement: "$CH_3COOCH_2CH_3$ is ethanoyl ethyl, or ethyl ester ethanoate."

13. Correct this statement: "Enantiomers have different boiling points because they are different compounds."

14. Correct this statement: "The carbon in a C=O or CH_3 group can be an asymmetric carbon."

Answer key (for parents and tutors)

1. Name $CH_3CH_2CH_2COCl$.
   Butanoyl chloride.
2. Name $CH_3CH(CH_3)CH_2CHO$.
   3-methylbutanal: the CHO carbon is C1 and the branch is on C3.
3. Which of these has optical isomers: propan-2-ol, butan-2-ol, butanone or but-1-ene?
   Butan-2-ol: C2 carries H, OH, CH_3 and CH_2CH_3.
4. Which of these has geometric isomers: pent-1-ene, pent-2-ene, 2-methylbut-2-ene or pentane?
   Pent-2-ene: each C of the C=C has an H and a different alkyl group.
5. How many aldehydes and ketones have the formula C_4H_8O?
   Three: butanal, 2-methylpropanal and butanone.
6. Name the ester $CH_3CH_2COOCH_3$, another isomer of $C_4H_8O_2$.
   Methyl propanoate (Achieved).
7. Name the branched carboxylic acid with this formula.
   2-methylpropanoic acid, $(CH_3)_2CHCOOH$ (Achieved).
8. Which of the three compounds above exists as enantiomers?
   3-hydroxybutanal: C3 carries H, OH, CH_3 and CH_2CHO, four different groups, so it has two non-superimposable mirror images that rotate plane-polarised light in opposite directions (Merit with the reason).
9. Explain why butanoic acid boils at 164 °C and ethyl ethanoate at 77 °C.
   Both are $C_4H_8O_2$, so dispersion forces are similar. Butanoic acid has an O-H group, so its molecules hydrogen bond to each other; ethyl ethanoate has no O-H, so it has only permanent dipole attractions, which are weaker. More energy is needed to separate the acid molecules (Merit; Excellence also notes the acid forms hydrogen-bonded pairs and that size cannot explain the gap).
10. Give a test that tells butanoic acid from ethyl ethanoate, with the observation.
    Add sodium carbonate solution: butanoic acid fizzes, giving CO_2, because it is an acid; ethyl ethanoate does not react (Achieved for the observation, Merit for the reason).
11. Correct this statement: "But-1-ene has cis and trans isomers because it has a C=C bond."
    Each carbon of the C=C needs two different groups; C1 of but-1-ene has two H atoms, so it has no geometric isomers.
12. Correct this statement: "$CH_3COOCH_2CH_3$ is ethanoyl ethyl, or ethyl ester ethanoate."
    Name an ester alkyl first, then the acid part: ethyl ethanoate.
13. Correct this statement: "Enantiomers have different boiling points because they are different compounds."
    Enantiomers have identical physical properties; only the direction they rotate plane-polarised light differs.
14. Correct this statement: "The carbon in a C=O or CH_3 group can be an asymmetric carbon."
    An asymmetric carbon has four single bonds to four different groups, so a C=O carbon or a CH_3 carbon never qualifies.