Year 13 Science: Oxidation, reduction and elimination

Name: _____ Date: _____

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

Practice

1. Name the organic product when propan-1-ol is heated under reflux with excess acidified permanganate.

2. Which gives a silver mirror with Tollens' reagent: propanal or propanone?

3. Name the product when butanone is reduced with $NaBH_4$.

4. Name the major product when 2-bromobutane is heated with KOH in ethanol.

5. What colour change is seen when 2-methylpropan-2-ol is warmed with acidified dichromate?

Exam-style question: identifying compound P

Compound P, $C_4H_{10}O$, is an alcohol that exists as enantiomers. P is warmed with acidified dichromate to give compound Q, which gives no silver mirror with Tollens' reagent. P is also heated with concentrated H_2SO_4, giving compounds R (major) and S (minor), both of which decolourise bromine water.

6. Name compound P.

7. Name Q and give the colour change seen as it forms.

8. Explain why Q gives no silver mirror.

9. Name R and S, and explain why R is the major product.

10. Q is reduced with $NaBH_4$. Explain why the product does not rotate plane-polarised light, although P from the bottle did.

Fix the mistake

11. Correct this statement: "Heating propan-1-ol under reflux with dichromate is the way to make propanal."

12. Correct this statement: "With dichromate, the alcohol turns green."

13. Correct this statement: "Butan-2–ol gives but-2–ene only when it is dehydrated."

14. Correct this statement: "$NaBH_4$ oxidises the ketone to an alcohol."

Answer key (for parents and tutors)

1. Name the organic product when propan-1-ol is heated under reflux with excess acidified permanganate.
   Propanoic acid: under reflux the propanal formed is oxidised further.
2. Which gives a silver mirror with Tollens' reagent: propanal or propanone?
   Propanal, the aldehyde.
3. Name the product when butanone is reduced with $NaBH_4$.
   Butan-2-ol, a secondary alcohol (as a racemic mixture).
4. Name the major product when 2-bromobutane is heated with KOH in ethanol.
   But-2-ene (cis and trans); but-1-ene is the minor product.
5. What colour change is seen when 2-methylpropan-2-ol is warmed with acidified dichromate?
   None: it stays orange, because a tertiary alcohol has no H on the C carrying the OH and is not oxidised.
6. Name compound P.
   Butan-2-ol: the only $C_4H_{10}O$ alcohol with a carbon bonded to four different groups (Achieved).
7. Name Q and give the colour change seen as it forms.
   Q is butanone; orange to green as $Cr_2O_7^{2-}$ is reduced to Cr^{3+} (Achieved; Merit for linking the colour to the oxidation of a secondary alcohol).
8. Explain why Q gives no silver mirror.
   Butanone is a ketone: its C=O carbon carries no H, so the mild oxidant in Tollens' cannot oxidise it and Ag^+ is not reduced (Merit).
9. Name R and S, and explain why R is the major product.
   R is but-2-ene, formed as cis and trans isomers; S is but-1-ene. Removing an H from C3, which has fewer H atoms than C1, gives the major product (Merit; Excellence for drawing both but-2-ene isomers and explaining why there are three products).
10. Q is reduced with $NaBH_4$. Explain why the product does not rotate plane-polarised light, although P from the bottle did.
    $NaBH_4$ adds hydrogen to the flat C=O from either side equally, so both enantiomers of butan-2-ol form in equal amounts. Their rotations cancel in this racemic mixture, whereas P from the bottle was a single enantiomer (Excellence).
11. Correct this statement: "Heating propan-1-ol under reflux with dichromate is the way to make propanal."
    Reflux returns the propanal to be oxidised again, giving propanoic acid; distil it off as it forms to keep the aldehyde.
12. Correct this statement: "With dichromate, the alcohol turns green."
    The alcohol is colourless; it is the orange $Cr_2O_7^{2-}$ that is reduced to green Cr^{3+}.
13. Correct this statement: "Butan-2-ol gives but-2-ene only when it is dehydrated."
    It gives cis- and trans-but-2-ene as major products and but-1-ene as the minor product.
14. Correct this statement: "$NaBH_4$ oxidises the ketone to an alcohol."
    $NaBH_4$ is a reductant: it adds hydrogen to the C=O, so the ketone is reduced to a secondary alcohol.