LIVELY CHEMISTRY UGANDA

ITEM 1

A group of learners in a laboratory were assigned to plan preparations of useful organic compounds from readily available starting materials.
One group was provided with ethanol and asked to obtain propanone in the laboratory.
They discussed the need to first convert the alcohol into a more reactive intermediate before forming the desired ketone.
Another group was given methylbenzene and instructed to prepare 1-phenylethanol.
They recalled that reactions on the benzene ring differ from those occurring on the side chain.
The teacher reminded them that careful selection of reagents and reaction conditions is essential to obtain the correct product.
The class further noted that oxidation, substitution, and reduction processes may be involved in such transformations.
At the end of the discussion, each group was asked to clearly describe how the conversions could be achieved, without writing chemical equations.

Tasks

A. Describe how ethanol can be converted into propanone, stating the key stages involved and the type of reactions taking place.
B. Identify the important reagents and conditions required at each stage of converting ethanol to propanone.
C. Describe how methylbenzene can be converted into 1-phenylethanol, outlining the main steps involved.
D. State the reagents and conditions necessary for the conversion of methylbenzene to 1-phenylethanol.
E. Explain the role of oxidation and reduction processes in the preparation of propanone and 1-phenylethanol.

Item 2

In an advanced organic chemistry practical, ethanal and propanone were reacted separately with hydroxylamine and with phenylhydrazine under suitable conditions.
In each case, solid derivatives were formed after warming in the presence of a weak acid catalyst.
The products obtained from hydroxylamine were identified as ethanal oxime and propanone oxime.
Those formed from phenylhydrazine were identified as ethanal phenylhydrazone and propanone phenylhydrazone.
The teacher reminded the class that these reactions proceed through nucleophilic addition to the carbonyl group followed by elimination of water, and should be explained using full mechanisms.

Tasks

A. Describe the formation of ethanal oxime from ethanal and hydroxylamine, stating the conditions required.

B. Using a stepwise mechanism, show how ethanal reacts with hydroxylamine to form ethanal oxime.
C. Describe the formation of propanone phenylhydrazone from propanone and phenylhydrazine.
D. Using a stepwise mechanism, show how propanone reacts with phenylhydrazine to form propanone phenylhydrazone.
E. Explain the role of the acid catalyst in the mechanisms for the formation of oximes and hydrazones.

Item 3

Laboratory Preparation of Carbonyl Compounds

In a school laboratory, a group of students were assigned to prepare different carbonyl compounds using various organic starting materials.
One group gently oxidized ethanol under controlled conditions and obtained ethanal, which gave a silver mirror with Tollens' reagent.
Another group oxidized propan-2-ol and obtained propanone, which did not react with Tollens' reagent.
A third group carried out the oxidation of but-2-ene to form butan-2-one.
Other learners prepared benzaldehyde by the oxidation of benzyl alcohol and acetophenone from the oxidation of 1-phenylethanol.
Each group was required to identify the product formed and explain the type of reaction involved in its preparation.

Tasks

A. Describe the laboratory preparation of ethanal from ethanol, stating the reagents and conditions.
B. Describe the preparation of propanone from propan-2-ol, including the reagents and conditions.
C. Outline the oxidation of but-2-ene to butan-2-one, stating the reagents required.
D. Describe the preparation of benzaldehyde from benzyl alcohol and acetophenone from 1-phenylethanol.
E. Explain why ethanal reacts faster than propanone in nucleophilic addition reactions at the carbonyl group.

Item 4

During a practical lesson, students studied the reactions of several carbonyl compounds.
Ethanal was reacted with hydrogen cyanide to form 2-hydroxypropanenitrile, and the mechanism involved nucleophilic attack on the carbonyl carbon.
Propanone was reduced using sodium borohydride to form propan-2-ol, with the hydride ion attacking the carbonyl carbon.
Benzaldehyde was treated with hydroxylamine, giving benzaldehyde oxime through nucleophilic addition followed by elimination of water.
Similarly, propanone reacted with phenylhydrazine to form propanone phenylhydrazone, again through nucleophilic addition and water elimination.

The teacher emphasized that these reactions illustrate key mechanisms of carbonyl chemistry and should be understood step by step.

Tasks

A. Using a stepwise mechanism, show how ethanal reacts with hydrogen cyanide to form 2-hydroxypropanenitrile.
B. Using a stepwise mechanism, show the reduction of propanone to propan-2-ol by sodium borohydride.
C. Describe the formation of benzaldehyde oxime from benzaldehyde and hydroxylamine, including the mechanism.
D. Show, using a mechanism, how propanone reacts with phenylhydrazine to form propanone phenylhydrazone.
E. Explain why aldehydes, such as ethanal and benzaldehyde, are generally more reactive than ketones in nucleophilic addition reactions.

“Success is the sum of small efforts, repeated day in and day out.” – Robert Collier
(Reminds students that consistent effort matters more than last-minute cramming.)

“The future depends on what you do today.” – Mahatma Gandhi
(Encourages students to focus on the present and take responsibility for their learning.)

“Don’t watch the clock; do what it does. Keep going.” – Sam Levenson
(Motivates students to stay persistent even when progress feels slow.)

“Believe you can and you’re halfway there.” – Theodore Roosevelt
(Boosts confidence and self-belief, which is crucial for exam success.)

“Education is the most powerful weapon which you can use to change the world.” – Nelson Mandela
(Inspires students to value their studies and see the bigger purpose.)

Item 5.

Percentage by Volume

During a practical chemistry lesson, a student was asked to prepare a solution of ethanol in water.
He measured 40 cm^3 of ethanol and diluted it to make 200 cm^3 of solution.
The teacher asked him to calculate the percentage by volume of ethanol in the solution.
In another example, the student prepared a mixture by mixing 50 cm^3 of methanol with 150 cm^3 of water and was asked to determine the percentage by volume of methanol.
The class discussed the importance of percentage by volume in expressing concentrations of liquids, especially in alcohol-based solutions.

Tasks

A. Calculate the percentage by volume of ethanol in the solution prepared using 40 cm^3 of ethanol diluted to 200 cm^3.
B. Calculate the percentage by volume of methanol in a mixture of 50 cm^3 methanol and 150 cm^3 water.
C. State the formula used to calculate percentage by volume of a component in a solution.
D. Explain why percentage by volume is often used for alcohol solutions.
E. A student wants to prepare 500 cm^3 of a 15% (v/v) ethanol solution. Calculate the volume of ethanol required.

ITEM 6

Percentage by Mass in Mole Concept

A student was given a compound, calcium carbonate ($CaCO_3$), to determine the percentage composition of each element.
He calculated the relative molecular mass and then used it to find the fraction of calcium, carbon, and oxygen in the compound.
In another experiment, the student analyzed sodium sulfate (Na_2SO_4) and calculated the percentage by mass of sodium and sulfur.
The teacher reminded the class that knowing the percentage composition is important for determining empirical formulas and for solving mole-related problems.
The students were asked to show all calculations clearly and explain their reasoning at each step.

Tasks
A. Calculate the percentage by mass of calcium, carbon, and oxygen in $CaCO_3$.
B. Calculate the percentage by mass of sodium and sulfur in Na_2SO_4.
C. Explain the steps involved in finding the percentage composition of an element in a compound.
D. If a student has 5.0 g of $CaCO_3$, calculate the number of moles of calcium present.
E. Explain how knowledge of percentage composition can help in determining the empirical formula of a compound.

ITEM 7

Percentage Yield and Percentage Composition

A student carried out a reaction between calcium carbonate ($CaCO_3$) and hydrochloric acid (HCl) to produce calcium chloride ($CaCl_2$), water, and carbon dioxide.
He started with 5.00 g of $CaCO_3$ and obtained 3.80 g of $CaCl_2$ after the reaction.
In another experiment, the student analyzed magnesium oxide (MgO) to determine the percentage by mass of magnesium and oxygen.
The teacher emphasized that percentage yield measures how much product is actually obtained compared to the theoretical amount, while percentage composition shows the fraction of each element in a compound.
The students were asked to calculate both percentage yield and percentage composition using clear steps.

Tasks

A. Calculate the percentage yield of calcium chloride if 5.00 g of $CaCO_3$ produced 3.80 g of $CaCl_2$.

B. Calculate the percentage by mass of magnesium and oxygen in MgO.

C. Explain the difference between percentage yield and percentage composition.

D. State two reasons why the percentage yield of a reaction is usually less than 100%.

E. A student obtained 12.0 g of water when reacting hydrogen and oxygen. If the theoretical yield was 14.0 g, calculate the percentage yield of water.

ITEM 8

Using Borax in Standard Solutions

In a chemistry laboratory, a student was asked to prepare a standard solution of sodium tetraborate ($Na_2B_4O_7 \cdot 10H_2O$, borax).

He carefully weighed 3.81 g of borax and dissolved it in distilled water in a 250 cm^3 volumetric flask.

After dissolving completely, he made the solution up to the mark and mixed thoroughly.

The teacher reminded the class that borax is used because it is chemically stable, pure, and has a known formula mass, making it ideal for standard solutions.

The students were asked to calculate the concentration of the solution in moles per litre and explain its importance in titration experiments.

Tasks

A. Calculate the molarity of the borax solution prepared by dissolving 3.81 g in 250 cm^3 of water.

B. Explain why borax is suitable as a primary standard for preparing standard solutions.

C. Describe two precautions to take when preparing a standard solution using borax.

D. If 25.0 cm^3 of the borax solution reacts completely with 20.0 cm^3 of hydrochloric acid, explain how this can be used to determine the concentration of HCl.

E. Explain the importance of standard solutions in titration experiments.