Create a Smell DRAFT#1 June 19, 2002
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Content: Students perform an ester synthesis lab experiment and use ChemSense to predict the structure of the product formed and model the reaction process.

Time Required: 135 minutes

Target student audience: Year 1

College prep chemistry

ChemSense User Level: Intermediate

ChemSense Tools used: Drawing tools

Animation tools

Text notes - summarize

Context: Students' understanding of structural formulas has been informed by the study of the octet rule, Lewis dot structures, and valence electrons. The previous study of functional groups provides students' main clues to the physical property of smell of a substance. These skills are used in this experiment to help the student predict the structure of the ester formed from the reaction of a grassy-smelling alcohol with a putrid-smelling carboxylic acid.

Chemistry Concepts in Activity (linked to CA stds, NSES, Benchmarks, ChemSense 5 themes):

Chemical reactions: part of NSES Content Standard A/Structure and Properties of Matter
Chemical structure determines physical properties of a substance: part of NSES Content Standard A/Chemical Reactions

Pre-requisite Chemistry Concepts:

Functional groups, smell categories, Lewis dot structures

Inquiry Skills:

Identify questions and concepts that guide scientific investigations (NSES)

Design and conduct scientific investigations (NSES)

Formulate and revise scientific explanations and models using logic and evidence (NSES)

Communicate and defend a scientific argument (NSES)

Recognize and analyze alternative explanations and models (NSES)

ACTIVITY Summary:

1. ChemCatalyst: Pre-lab questions
2. Concept introduction: Experimental procedure
3. Activity: Perform experiment with three sets of different reactants
4. Discussion: Preliminary analysis of results
5. Activity: Model products formed from reactions
6. Check-in: Write lab report

ACTIVITY

1. ChemCatalyst

   Students answer pre-lab questions to ensure that they understand the experiment purpose, materials and procedure before beginning.

2. Concept introduction

   Class discusses the experimental procedure

3. Activity

   Students perform experiment with three sets of different alcohols and putrid-smelling carboxylic acids. Special attention is paid to proper experimental precision, accuracy and laboratory safety. Students record qualitative results and observations throughout.

4. Discussion

   Class discusses preliminary results, focusing on the change in physical properties from foul-smelling to sweet-smelling, plus any deviations from the expected results and possible sources of error.

5. Activity

   Students use ChemSense to model the esters and water molecules formed in the three reactions. Students start with pre-made models of the reactants. Rules for this exercise are that students are only allowed to delete and add bonds. They must rearrange the atoms from the reactants and are not allowed to delete or add any atoms at all. This rule emphasizes the nature of a chemical change and reinforces the law of conservation of mass.

6. Check-in

Students write a five-section lab report, including purpose, procedure, results, discussion, and conclusion, or some other formal, structured lab report that the teacher uses in this class. Guiding questions ask the students to identify the structures of the products, propose possible reaction pathways (at a basic level), explain the formation of water in the reaction, and consider the roles of the catalyst and heat in the reaction.

Rubric/s for scoring:

Lab report

Insufficient mastery	Structures of the products are incorrect: an ester is not formed, water is not formed, or the structures do not follow the octet rule or account for all of the atoms in the reactants. No attempt is made to show the reaction pathway. No attempt is made to explain the role of the catalyst or heat in the reaction.
Basic mastery	Structures for the esters and water molecules formed are correct and account for all of the atoms in the reactants. The role of catalyst and heat to speed up the chemical reaction are explained.
Exceptional mastery	Structures for the esters and water molecules formed are correct. Explanation of the reaction pathway is clear and shows how –OH from the carboxylic acid and H from the alcohol combine to form water. The role of the catalyst in reducing the activation energy of the reaction and heat to overcome activation energy and speed up the molecules in the reaction are included in the lab report discussion.

Links: Living By Chemistry, Lawrence Hall of Science, UC Berkeley, Unit 2 Investigation II, Lessons 7-8.

Integrated Uses: Can be adapted for ester synthesis lab in petroleum unit of a chemistry or environmental science class.