Molecules in two dimensions DRAFT#1 June 19, 2002
Richard

Content: Students learn to identify four common functional groups in small organic molecules.

Time Required: 45 minutes

Target student audience: Year 1

College prep chemistry

ChemSense User Level: Beginning

ChemSense Tools used: Drawing tools

Text notes - summarize

Context: At this point, students have learned that molecular formula corresponds with smell of small organic molecules. In this lesson, students examine the structural formulas of 24 small organic molecules to identify four different functional groups related to smell: ketone, carboxylic acid, ester and amine.

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

Structural formula: part of NSES Content Standard A/Structure and Properties of Matter
Functional group: part of NSES Content Standard A/Structure and Properties of Matter

Pre-requisite Chemistry Concepts: Molecular formula, common smell categories (putrid, sweet, minty, fishy, leafy/grassy)

Inquiry Skills

Identify questions and concepts that guide scientific investigations (NSES)

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

Communicate and defend a scientific argument (NSES)

ACTIVITY [UHS1]Summary:

1. ChemCatalyst: compare two structural formulas
2. Concept introduction: structural formula
3. Activity: identify common structural features in molecules

4. Discussion: define functional group, summarize functional group names, structures, and corresponding smells
5. Check-in: describe features of a molecule with a specific smell

ACTIVITY

1. ChemCatalyst

   Here are drawings of two molecules that you've already smelled. List at least three differences and three similarities between the two molecules.

   Use the discussion to begin to get a sense of students' initial ideas.

2. Concept introduction: structural formulas

   Begin to draw the connection between different molecular structures and different smells.

   Explore structural formulas and what they represent.

   Define structural formula: a drawing or diagram that a chemist uses to show how the atoms in a molecule are connected.

3. Activity: identify common structural features in molecules

   Work in groups of four.
   Sort 24 cards in any way that reveals patterns/relationships between structural formula and smell.
   Use the ChemSense text tool to write a note that summarizes what you've learned.

4. Discussion

   Discuss the common structural features discovered in the structural formulas of molecules in the different smell categories.

   Define functional group: structural features that show up repeatedly in molecules and seem to account for some of their chemical properties.

   Introduce the names of the different functional groups found so far in these smell molecules[UHS2].
   - Ketone
   - Carboxylic acid
   - Ester
   - Amine

   In ChemSense, draw structures for these functional groups (on their own) and label with name and smell caused.

5. Check-in

   If a molecule is sweet, what other things can you say about it? List at least four things that are probably true.

Rubric/s for scoring:

Common structural features (ChemSense text item):

- Insufficient mastery: Students identify fewer than four unique structural features or misplace molecules with different smells in the same group.
- Basic mastery: Students identify four unique structural features, all molecules in each group have the same structural feature and the same smell.
- Exceptional mastery: Students identify four unique structural features, all molecules in each group have the same structural feature and the same smell, students identify just the functional group as the key common feature, not including additional unnecessary carbon atoms around the functional group.

Functional group structures (ChemSense drawing item)

- Insufficient mastery: Students draw fewer than four unique functional groups (such as confusing carboxylic acid and ester). The order of the atoms in each functional group is not always correct.
- Basic mastery: Students draw four unique functional groups correctly representing ketone, ester, carboxylic acid, and amine. Smell is also correctly labeled. Some additional carbon atoms may be included.
- Exceptional mastery: Students draw four unique functional groups correctly representing ketone, ester, carboxylic acid, and amine. Smell is also correctly labeled. Each functional group shows only the minimum number of atoms needed to identify it, with free lines representing bonds to other atoms beyond the functional group.

Check-in

- Insufficient mastery: Students are only able to identify one or two features of a molecule that smell sweet. Students are not able to focus their answer on structural features, such as functional group or arrangement of atoms.
- Basic mastery: Students are able to identify four features of molecules that smell sweet, including having the functional group ester.
- Exceptional mastery: Students are able to identify more than four features of molecules that smell sweet, emphasizing the functional group ester but also including the presence of the suffix “-ate” in the name, the presence of 2 oxygen atoms in the molecular formula, and the existence of a long chain of carbon atoms in the middle of the molecule.

Links: Living by Chemistry, Lawrence Hall of Science, Unit 2, Investigation II, Lesson 1

Integrated Uses: May support an introduction to biological macromolecules.