CHEMISTRY

2 Days: 45 min. class time daily

Organic Chemistry

Students will be able to: Define key physical science terms; construct and perform an experimental investigation; explain how energy is transferred to extract substances; gather chemicals extracted from organic material; connect physical science concepts with life science concepts.

CONCEPT OVERVIEW

Many plants produce chemical compounds that protect them from insect infestation. Some of these compounds are aromatic, and are used by humans to make essential oils and perfumes. The process of distillation is a relatively safe procedure that allows students to practice chemistry lab skills as they extract natural organic compounds.

Fundamental concepts

- Organic chemistry: key terms, concepts related to matter and energy; connections to living materials
- Scientific methods: general laboratory and observational skills

ACTIVITY OVERVIEW

Introduce the topic by passing around a sprig of an aromatic plant, such as lavender or rosemary. Ask students why the plant might produce compounds that give it a scent. Present a short PowerPoint presentation, showing aromatic plants and the chemicals that they produce (including chemical formulas and molecular models). Include information about why these plants produce these compounds and how humans have used some of them. Allow individual time to define key terms and answer pre-activity questions. Then lead a class discussion on the objectives and procedures of the activity.

Extracting Organic Compounds from Plants: Students set up a distillation system to extract chemical compounds from an aromatic plant. This lesson can be expanded to allow students to perform more research on the compounds they have extracted, including their historical and medicinal uses.

KEY TERMS

- **compound**
- **aromatic**
- **volatility**
- **distillation**
- **distillate**
- **concentration**
- **thermal energy**
- **mechanical energy**

PRE-ACTIVITY QUESTIONS

1. What is an organic compound?
2. How does the process of distillation release chemicals from plant material?
3. How does the process of distillation concentrate chemicals that have been released from plant material?
4. How is energy transferred during the process of distillation?

Common Core Standards:

CCSS.ELA-Literacy.RST.9-10.4, CCSS.ELA-Literacy.RST.11-12.4, CCSS.ELA-Literacy.RST.11-12.9

National Professional Organization Standards (Next Generation Science Standards):

HS-PS1-3, HS-PS1-6, HS-PS3-1

Curriculum Standards Description:

Determine meanings of key terms; analyze relationships between scientific concepts; synthesize information from a variety of sources; plan and conduct an investigation; determine how materials change when they undergo a physical process; examine how energy can be used to extract substances.

MATERIALS / SOURCES

Leaves and stems of lavender (or another plant rich in aromatic compounds, such as geranium, eucalyptus, pine, balsam fir, lemon grass, lemon balm, oregano, or rosemary); aluminum foil; eyedropper; small bottles for the extracted essential oil; computers with printer access; distillation apparatus (500 mL round-bottom boiling flask; still head connection adaptor; 300 mm Graham condenser; ring clamp; two-finger clamp; lab support stand; 500 mL Erlenmeyer collection flask; hot plate or gas burner; two pieces of flexible tubing; cold water source)

EXTRACTING ORGANIC COMPOUNDS FROM PLANTS

1. Practice lab safety by putting on a protective apron and goggles. Tie long hair back and have waterproof and heat-proof gloves available before beginning the lab.
2. Put on the waterproof gloves and tear the plant material into small pieces. Place these pieces into the round-bottom boiling flask. Then fill the flask halfway with water.
3. Set up the distillation apparatus. The flask filled with plant material and water should be set up on a ring clamp above the heat source (that has not been turned on yet). The flask should be connected to the Graham condenser, which is set up on a lab support stand. The open end of the condenser should be set up to empty into the Erlenmeyer flask. One piece of flexible tubing should be connected to both the condenser and a cold water source; the other should be connected to the condenser and should empty into the sink.
4. When your setup is complete, turn on the cold water source and verify that it is running through the condenser and then back out into the sink. Leave the water on throughout the distillation.
5. Turn on the heat source and bring the water in the round-bottom flask to a boil. Keep it on a low boil throughout the distillation. Be careful when working with the apparatus from this point forward, because some glassware will be hot. Avoid putting cold water into hot glassware to prevent shattering.
6. Monitor the apparatus to prevent boiling over. Also be sure that the distillate is running into the Erlenmeyer flask.
7. Continue the process of distillation until the plant material loses its color or water levels get low in the round-bottom flask. Then remove the heat source and turn off the water to the condenser.
8. Allow the apparatus to cool down before you take it apart.
9. Cover the top of the Erlenmeyer flask with aluminum foil. Allow the distillate to sit overnight. There should be a thin layer of oil on top of the distillate the next day. Use an eyedropper to remove the oil and place it in a small container.

Evaluation

Students present a container of essential oil from their plant material as a product of their distillation. They obtain information from the Internet about the chemical composition of the oil and its potential uses. They present this information in the form of an informational pamphlet.

Closure: Students discuss the distillation process and describe what happened to the organic compound at each step in the process. They also explain how energy changed forms to allow the distillation. Students discuss any problems they experienced, and any thoughts they had about making the process easier or more effective at extracting essential oil.

RELATED LITERATURE

Séguin, Margareta. *The Chemistry of Plants: Perfumes, Pigments, and Poisons*. London: Royal Soc. of Chemistry, 2012. Print.
Wormwood, Valerie A. *The Complete Book of Essential Oils and Aromatherapy*. Novato: New World Lib., 1991. Print.

Related Database Search - (("plant extracts" or smell or scent or pheromone or "essential oils") and (extraction or chemical or distillation) and (plant or herb or flower))

Related Image Search - (((condensation or distillation) and (process* or energy or chemistry)) or ((lavender or geranium or eucalyptus or pine or balsam or lemon or oregano or rosemary) and (plant or flower or leaves or leaf) NOT koala))