chocolate, citrus (lemon or orange), and perfume.

5. Make two odor boxes for the vinegar by placing a cotton ball in one marked odor box and a cotton ball in one unmarked odor box, then dropping five drops of vinegar on the cotton balls using a dropper. Repeat for the other four liquid scents, using a different dropper for each scent.

6. Make two odor boxes, a marked odor box and an unmarked odor box, for each of the other three scents. Place either 0.5 teaspoon of instant coffee, 0.5 teaspoon of powdered chocolate, or a chunk of lemon or orange in each of the odor boxes.

7. Have students help you cut the aluminum foil into pieces to make model antennae. You will need one 60-cm × 5-cm (24-in. × 2-in.) piece and two 25-cm × 5-cm (10-in. × 2-in.) pieces for each student.

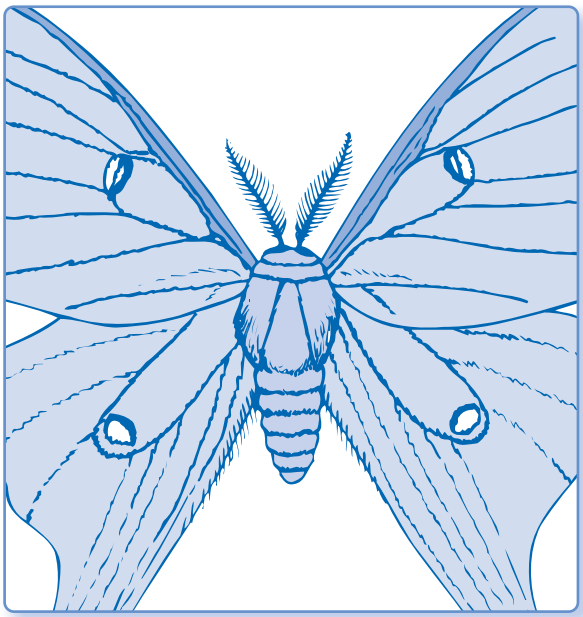
BACKGROUND INFORMATION

Butterflies and moths use their sense of smell to find food and to find their mates. Some follow the sweet ***scent*** of flowers to find their meals of nectar. Most of them follow the scents given off by others of their species to find potential mates.

In butterflies it is mostly the males that give off scents to attract the females that they approach in their courtship dances. In moths, the females give off most of the ***odors*** and the males are known to travel great distances, as far as 8 km (5 mi) for some species, in search of the source of such compelling smells.

Both butterflies and moths have ***antennae*** attached to their heads. Depending upon the species of insect, antennae may be sensitive to smell, touch, taste, sound, and even dark and light. The antennae of the butterflies and moths are often called "feelers," but would be better known as "smellers."

The antennae of both moths and butterflies are covered with thousands of tiny sensory organs capable of detecting odors at very small concentrations. The male moths that travel the farthest distances in response to scents are the ones with the most complex, feathery antennae (see Figure 7-1).



▲ ***Figure 7-1.*** *The antennae of a male Luna moth.*

While most butterflies and moths are able to detect odors too faint for humans to notice, it is male moths that win the prize for being able to detect scents from the farthest away. With this in mind, students will role-play moths in search of scents.

In this activity, students will be trying to identify and match a variety of scents. The particular scents used were chosen because they are both relatively strong and should be familiar to most students. If some students do not recognize the identity of a scent, it is appropriate to name it for them, since the point of the activity is not to have the students name unknown smells, but to have them test their ability to detect smells at a distance and to discern between smells to match them, just as male moths must detect the scent of their females at a

distance and respond only to the scent of their own kind of female.

▼ **Activity Sheet 7**

Making Scents

1. What scent was in your first odor box?
   Answers will vary.
2. From how far away could you smell the other team's odor box? Distances will vary.
   6 feet 3 feet 1 foot 6 inches
3. What was its scent?
   Answers will vary.
4. Was it easy or hard to find a box with the same odor as yours? Why?
   Answers will vary.
5. Why do moths have antennae that are very sensitive to odors?
   to find their mates from far away in the dark

Guiding the Activity

Additional Information

1 Ask, **What are some ways that our sense of smell is important to humans?**

Answers will vary. Students may say we use it to locate food, to tell if food is rotten, to get pleasure from flowers or perfumes, or to smell smoke and detect possible danger.

Write *scent* and *odor* on the board. Say that when something has a smell, we can refer to that smell as a **scent** or an **odor.**

Ask, **What are some scents that you can notice from far away?**

Answers will vary depending upon your community. Possibilities include the smell of popcorn popping, brownies baking, restaurant food (such as french fries or Chinese food), orchards in bloom, factory waste, and fish smells near fish stores or wharves.

Ask, **How far away do you think you can detect scents?**

Answers will vary. Of course, the distance will vary with the strength of the scent, also.

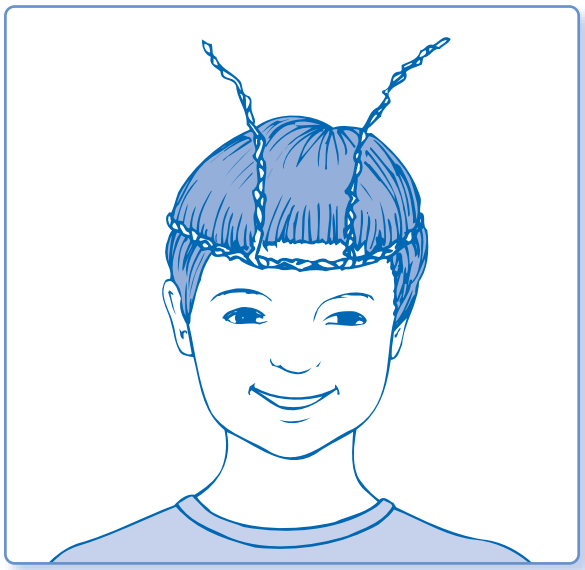
Guiding the Activity

	Additional Information
Tell students that the sense of smell is very important to many moths and butterflies. Explain that many moths have an outstanding sense of smell and use it to find their mates. Explain that just after emerging from their cocoons, many female moths give off a chemical with a smell that attracts the males of that kind of moth. Certain male moths have the very best sense of smell of all the butterflies and moths. These male moths can detect the scent of a female of their kind from very long distances.	*Some male moths can smell their females' scents from as far away as 8 km (5 mi)!*
2 Ask, **What part of our bodies do humans use to smell scents?**	*Humans use their noses to detect scents.*
Ask, **What part of their bodies do you think butterflies and moths use to smell scents?** Write *antenna* and *antennae* on the board. Explain that an **antenna** is the real name for an insect's "feeler," and that **antennae** is the plural of antenna. Tell students that butterflies and moths use their antennae to smell scents.	*Students may not know, and may guess that butterflies and moths must have noses too.* *Depending upon the species of insect, antennae may also be sensitive to touch, taste, sound, and even dark and light.*
3 Tell students that since butterflies and moths use their antennae to detect scents, the students will be making imitation antennae for this activity on smelling. Distribute one 60-cm × 5-cm (24-in. × 2-in.) piece of aluminum foil and two 25-cm × 5-cm (10-in. × 2-in.) pieces of aluminum foil to each student. Have them crumple or roll the longer piece into a thin band, and fit it around their heads like a headband. Next have them roll or crumple the two shorter pieces of aluminum foil into "antennae." These can then be attached to the headband as shown in Figure 7-2.	

Guiding the Activity

Tell students that although they use their noses to smell, they will wear these "antennae" to dramatize the idea that it is the moth's antennae, not its nose, that allow it to smell.

Additional Information



▲ ***Figure 7-2.*** *The aluminum foil antennae.*

4 Tell students that they will be doing some experiments to test their own sense of smell.

Divide the class into teams of two. Distribute a copy of **Activity Sheet 7** to each student and an odor box to each team.

It does not matter which teams get the marked odor boxes and which get the unmarked ones.

Tell teams to smell their odor box and try to decide what the scent is, but not to say it out loud.

Dramatizing the idea of "keeping it secret" can help them control any inclination to blurt it out. If some teams seem unsure of the identity of their odor box's scent, quietly tell them what it is. Have students record the identities on their activity sheets.

Have each team pair up with another team for the experiment. Then have one team set aside their odor boxes for a short while.

5 Have the team still holding their odor box challenge the other team to try to smell their odor box scent from different distances.

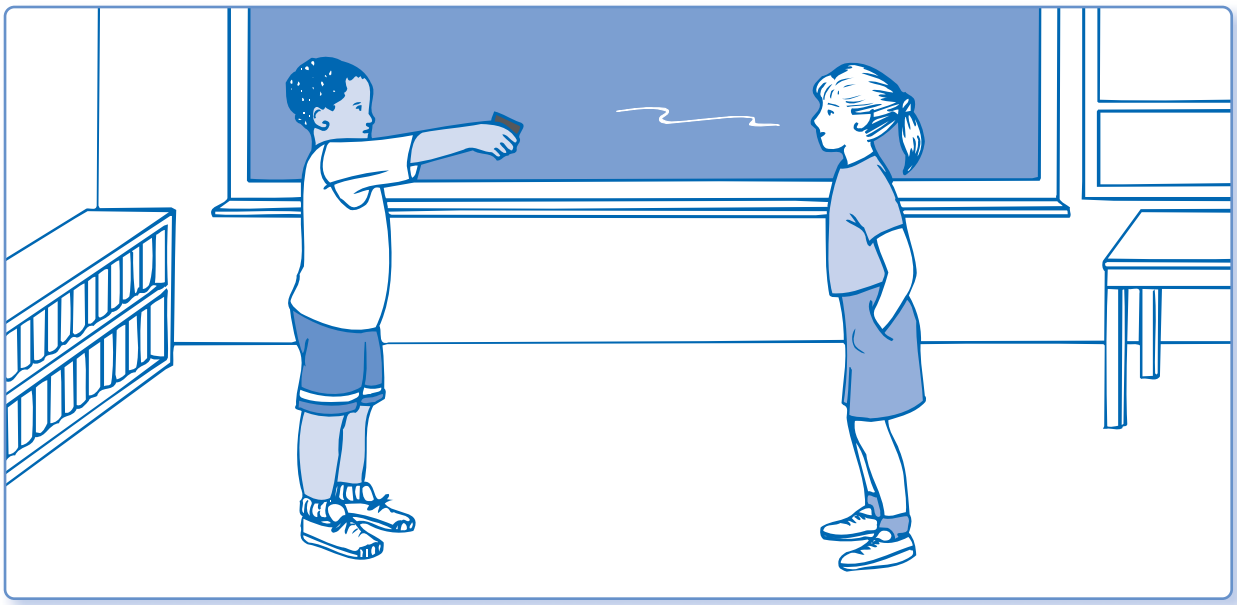
Have one member of one team hold his or her odor box while one member of the other team stands directly across from it. They should first try to detect the scent from about 2 m (6 ft) away (see Figure 7-3), then from about 1 m (3 ft), then from about 0.3 m (1 ft), then from 15 cm (6 in.) or less.

Guiding the Activity

Additional Information

If the student thinks he or she knows what the scent is at any point, he or she should whisper it to the one holding the box, to check.

If any two students seem to disagree over the identity of a scent, whisper the correct answer to them.



▲ ***Figure 7-3.*** *Students try to detect scents.*

When it has been determined what the scent is, have the student holding the odor box give the box to his or her teammate. Let that teammate test the remaining member of the other team.

It is important to keep the identity of the scent a secret until both team members have done the exercise.

Next, have the team who set their odor boxes aside pick them up, while the other teams set theirs aside.

Repeat the exercise until all students have had a chance to try to detect an unknown scent from different distances.

6 When all of the students are finished, have them return to their seats, and allow them time to answer the next two questions on their activity sheets. Then ask, **Who was first able to smell the other team's scent from 5 feet? from 3 feet? from 1 foot? from 6 inches?**

Have students raise their hands when their distance is mentioned.

Guiding the Activity

		Additional Information
	Tell students that some scents were probably easier to smell from far away because they are stronger, but that some students probably just have more sensitive noses. Ask the students who were able to detect their smells from farthest away, **Which scents did you smell?** Have students use this information to decide if certain scents seem to be easier than others to smell from far away.	*Answers will vary.*
7	Tell students that each kind of female moth makes a different scent, and the male moths must not only smell this from far away, but must also be able to tell which scent is the one they want. Explain that in the next experiment the students will be testing their own ability to tell which scent is which.	*Moth antennae are able to detect and differentiate between multitudes of chemicals in the air.*
8	Make sure each team of students has an odor box. Ask, **Who has an odor box marked with masking tape?** Explain that the teams with marked odor boxes are going in search of their mates. They will know they have found the right mate when they find another box with the same smell. Tell one person from each team with a marked odor box to pick up their odor box and get ready to begin. When you say "Begin!" they will walk around the classroom smelling the other odor boxes until they think they have found their match. Remind them to move quietly and carefully, and that it is not a race. You may want to have them hold hands with, or sit or kneel beside, their match when they find it.	*Eight of the teams should raise their hands.*

Guiding the Activity

	Additional Information
If there is some confusion, have the students who were not able to find their match double-check all the odor boxes to discover their correct matches. When students find their match, congratulate them and have them return to their seats. Tell them to give their marked boxes to their partners.	
9 For the second round, have the other team members with the marked odor boxes stand up to make the search. Before they begin, have the students with the unmarked boxes trade their boxes around from team to team. Repeat steps 8 and 9, allowing the students with the unmarked odor boxes to take turns doing the searching, until all students have had a chance to search for their "smell mate."	*Because the unmarked teams have switched boxes, the students searching for their mates will not know ahead of time where their matches are.* *Have teams trade the odor boxes around each time so they do not already know the location of their match from the previous round.*
10 When all of the students have finished, have them return to their seats, and allow the students time to complete their activity sheets. Ask, **How did it feel to search for a smell mate?** Tell students that moths are much more sensitive to smells than humans. Their antennae are covered with many more tiny sense organs than humans have in their noses, making it easy for them to detect scents from great distances and to tell many different scents apart. Have students complete their activity sheets.	*Some students may have liked it, while others may have found it difficult and frustrating.*

Reinforcement

Have students try other experiments to discern different things by their smells, such as trying to decide what kind of sandwich someone has by smelling it without looking at it.

Science Journals

Have students place their completed activity sheets in their science journals.

Cleanup

Collect and empty the odor boxes, then wash and dry them before returning to the kit. Rinse and dry the plastic droppers, and return them to the kit, along with the aluminum foil, anise extract, peppermint extract, vanilla extract, vinegar, and masking tape.

Science at Home

Have students keep a smell journal for a week, noting what the strongest smells are that they notice, both outside and inside.

Connections

Science Challenge

After students have learned about pheromones in Science and Language Arts below, and if the season is appropriate, take them outdoors to investigate chemical communication among ants. (*Safety Note:* Warn students not to touch the ants or get any on themselves, since ants can inflict painful bites.) Divide the class into teams, and have each team proceed as follows: Locate an active anthill, and put a spoonful of honey on the ground a meter or so away from it. Arrange four sheets of paper so they surround the honey without overlapping and so that the ants must pass over one of the sheets to reach it. Observe ant scouts finding the honey, establishing a trail back to the anthill, and then more ants following the trail to the honey. When about 25 or 30 ants are traveling back and forth on the trail regularly, quickly turn the paper one quarter turn so that the trail on the paper now crosses the most direct route to and from the honey. Watch the ants carefully to see whether they still follow a direct route. (Most likely, the ants will appear confused as they search for the beginning of the chemical trail at the edge of the paper and when they locate the old trail running crosswise and follow it to a dead end.) How do the ants' movements change over time? (Eventually, some ants will discover what appears to them to be the honey's "new" location and will establish a new direct trail, which other ants will follow.)

Science Extension

Let students experiment to discover how well their sense of smell can identify odors. For each student or team, number six odor boxes from *1–6* and place a different and distinctive odor source in each box. Keep a record of the odor source that is in each box. Direct students as follows: Write the numbers *1–6* on a sheet of paper. Smell each box, one at a time. After you have smelled a box, guess the identity of the odor and write your guess next to the number of the box. When all students have completed the activity, identify the correct odors for them, and have them check their guesses. How many odors did students identify correctly?

Science and Language Arts

- Write the term *pheromone* (pronounced FAIR-uh-mone) on the board, and ask students to consult dictionaries and other sources to find out what a pheromone is. (a chemical substance that is produced instinctively by an animal and that stimulates an instinctive behavioral response in other animals of the same species) Explain that different pheromones can be used to signal danger, to mark territory, to attract a mate, and—in social insects such as bees and ants—to establish different roles for members of the social group. Pheromones are the most important means of communication among insects. (Also see the Science Challenge above for an activity on chemical communication among ants.)

- On the board, write *1 antenna, 2 antennae,* and explain that *antenna* is another word of Latin origin that ends in *a* and forms the plural by adding *e*. Ask a volunteer to write *antenna* and *antennae* in the appropriate columns of the chart students began in the first Science and Language Arts in Activity 1.

Science, Technology, and Society

Some perfume and cologne manufacturers claim to use human pheromones in their products to create scents that are subliminally attractive to others of the opposite gender. Encourage students to find out more about human pheromones and whether such products have any valid scientific basis.