The Big Picture: A Classroom Activity for Organic Chemistry W

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The organic chemistry course represents a variety of unique challenges for both the teacher and student. It is notorious for being a gatekeeper course and has the reputation for taxing the limits of student memory *(1)*. At most colleges, it bears the stigma of being one of the most difficult courses a nonchemistry major will encounter *(2)*. The teaching community has attempted to address these areas of disrepute by introducing new pedagogies into the organic curriculum. Many of these approaches center on small group activities *(3)*. Engaging in such activities is often a foreign experience for undergraduates in science classes. In many instances, there is an easing-in period in which student shyness, lack of confidence, and fear of embarrassment hinder the participatory process. Activities that address these obstacles are often effective in facilitating group work.

Through a grant from the Andrew W. Mellon Foundation, the Claremont Colleges[1] have formed a consortium that supports pedagogical innovation. The approach uses workshops, seminars, individual training, and technological support to explore new ways of enhancing experiences for students and instructors. In one of these workshops *(4)*, participants were introduced to a group activity in which the goal was to discover the common thread between a series of illustrations. Each participant was given a different illustration and only allowed to describe the illustration verbally to members of the group. The activity presented an opportunity to observe how group dynamics evolve and how the participatory process is enhanced by a common goal and a nonthreatening environment of collaboration. This provided the impetus for the activity described herein.

Figure 1. Thumbnail images of 15 illustrations. In reverse order from image 15, each is a more detailed image of one portion from the last, until carbon, the fundamental element of organic chemistry, is obtained in image 1.

The Activity

In the style of books by Banyai *(5)* and Morrison et al. *(6),* a series of 8.5 in. × 11 in. illustrations (Figure 1), in which each successive picture focuses on one detail from the previous picture, have been created from a commercially available clip art library *(7)*. Along with scenes from everyday life, each illustration contains some snippet of organic chemistry such as a molecule from an object in the scene, a reaction from the course, or a key concept. The class is divided into equal groups of 10–15 students and each student is given a page from the set of illustrations. The students are told that, aside from organic chemistry, the series of illustrations have another thing in common and that the contest is to see which group can discover this common thread first. The one stipulation is that students cannot visually reveal their assigned illustration to a fellow group member. Rather, they are only allowed to describe the illustration verbally to one another. Care is taken to randomize the illustrations prior to distribution. In groups smaller than 15, the higher numbered images are omitted.

Discussion

The activity takes approximately 15 minutes after each student has been assigned an illustration. In general the group dynamics develop slowly, with each student turning to his or her neighbor and inquiring about the contents of the other's illustration. In some groups this process, in which one student queries another and then moves on to the next student, continues for several minutes. Eventually, small subgroups of 3–4 students form. Within these subgroups of the main group, one student describes his or her illustration to the entire group. Eventually one student will recognize that an item from the orator's description also appears in his or her illustration. As students in the group begin to realize that each illustration contains an object from another illustration, the subgroups become larger until the common thread is solved. The ultimate "winner"[2] is the group that correctly arranges itself in the order of the illustrations as shown in Figure 1.

It is interesting to note the variations among the groups. In some, leaders become apparent as they try to corral other members of the group to become more organized. In other groups, a sole leader will emerge that directs the actions of the whole. Still other groups never reveal true leaders, as members go about the activity in a seemingly random fashion. Instructors (and TAs) will want to take note of any leaders that emerge, as this can aid in the assigning of small groups for future collaborative classroom activities.

This technique can be used at the beginning or at the end of a semester. Because of the chemical content of each illustration, one might expect the nature of the activity to vary depending on the level of organic chemistry knowledge of the group. To solve the puzzle, it is almost better to *not* know any organic chemistry (i.e., to do the activity at the beginning of the semester), so that students do not dwell too much on the organic structures and concepts of each illustration. In any event, the activity creates a situation in which every group member is required to contribute to the conversation.

Summary

This activity can serve many purposes. It can serve as an icebreaker at the beginning of a course. It can be used to reveal the prominence of organic chemistry in everyday life. It can be used as a jumping point for group work or other collaborative activities in a class. Finally, as this author has done in his organic chemistry course, it can be used as a fun activity in celebration of a year of organic chemistry.

Acknowledgments

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[w]Supplemental Material

The full-sized, full color illustrations used in this activity are available in this issue of *JCE Online*.

Notes

1. The Claremont Colleges consist of the primarily undergraduate institutions Claremont McKenna, Scripps, Pitzer, Pomona, and Harvey Mudd Colleges and two graduate institutions, the Keck Graduate Institute of Applied Life Sciences and Claremont Graduate University.

2. In this implementation, the activity was structured as a contest, although this need not be the case. Advantages of doing so include enhancing the excitement level for the activity and quickening the pace so that the activity is completed within the allotted time.

Literature Cited

1. (a) Margulies, J. Bad Chemistry. *Chron. Higher Educ.* **2002,** *48* (Nov 22), A8. (b) Altschuler, G. C. College Prep Premeditations. *New York Times*, Aug 4, 2002, Section 4A, p 13. (c) Cox, A. M. Precipitating Classroom Change. A Professor at Notre Dame Sparks a Quiet Revolution in How Chemistry Is Taught. *Chron. Higher Educ.* **2001,** *47* (May 25), A12.
2. Collaborative Approach Raises Pass Rate in Organic Chemistry Course at Rochester. *Chron. Higher Educ.* **2001,** *47* (Apr 27), A16.
3. For examples, see: (a) Clouston, L. L.; Kleinman, M. H. *J. Chem. Educ*. **1999,** *76,* 60. (b) Kovac, J. *J. Chem. Educ.* **1999,** *76,* 120. (c) Glaser, R. E.; Poole, M. J. *J. Chem. Educ.* **1999,** *76,* 699. (d) Paulson, D. R. *J. Chem. Educ.* **1999,** *76,* 1136. (e) Anthony, S.; Mernitz, H.; Spencer, B.; Gutwill, J.; Kegley, S. E.; Molinaro, M. *J. Chem. Educ.* **1998,** *75,* 322. (f) Dinan, F. J.; Frydrychowski, V A. *J. Chem. Educ.* **1995,** *72,* 429.
4. Doolittle, P. E. "Active Teaching, Active Learning" presented at Claremont McKenna College, Claremont, CA, April 4, 2003.
5. (a) Banyai, I. *Re-Zoom;* Puffin Books: New York, 1998. (b) Banyai, I. *Zoom;* Puffin Books: New York, 1995.
6. Morrison, P.; Morrison, P.; Office of Charles and Ray Eames. *Powers of Ten;* W. H. Freeman & Co.: New York, 1994.
7. *Art Explosion*, Nova Development Corporation: Calabasas, CA, 1997–1998.

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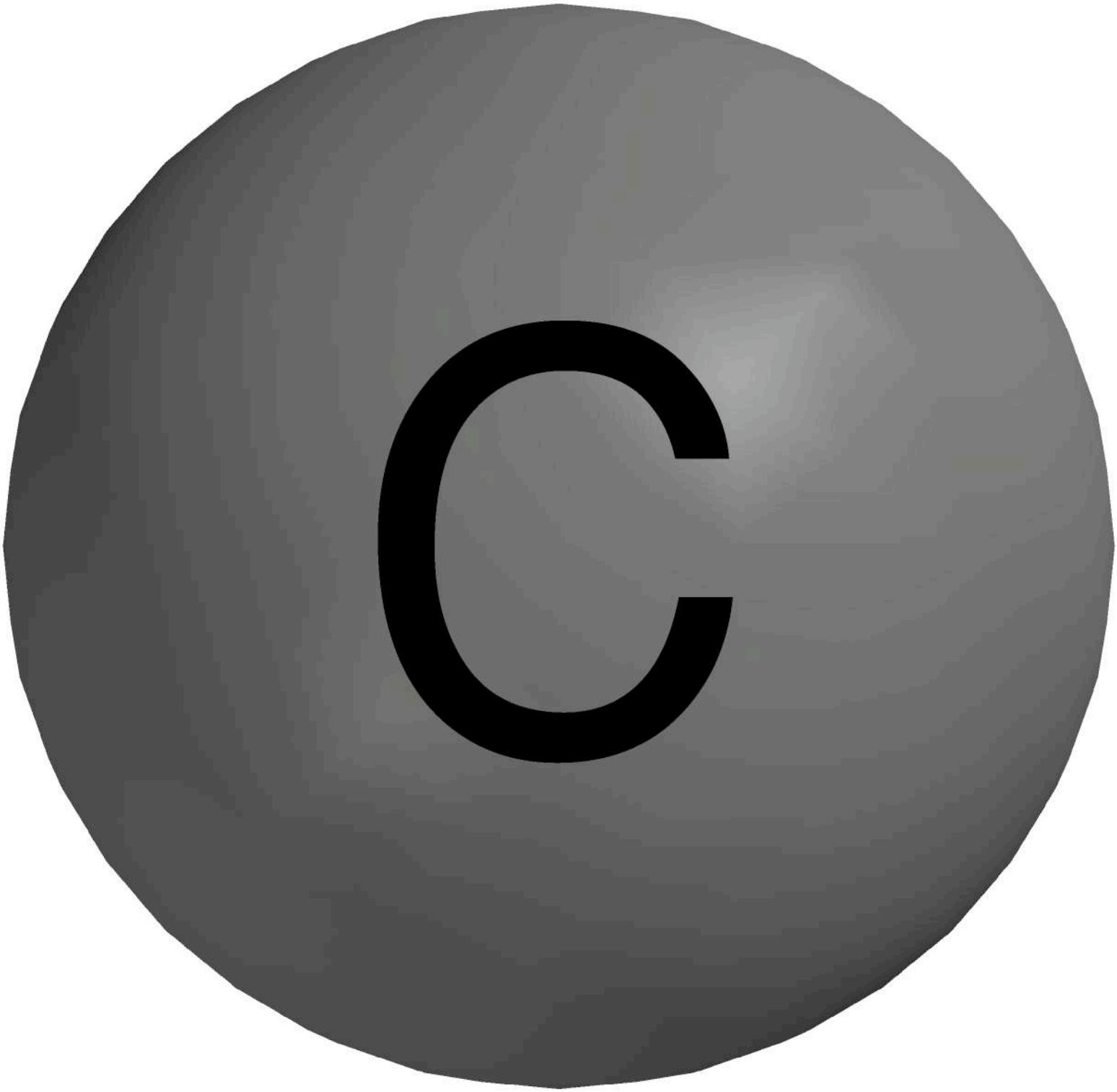
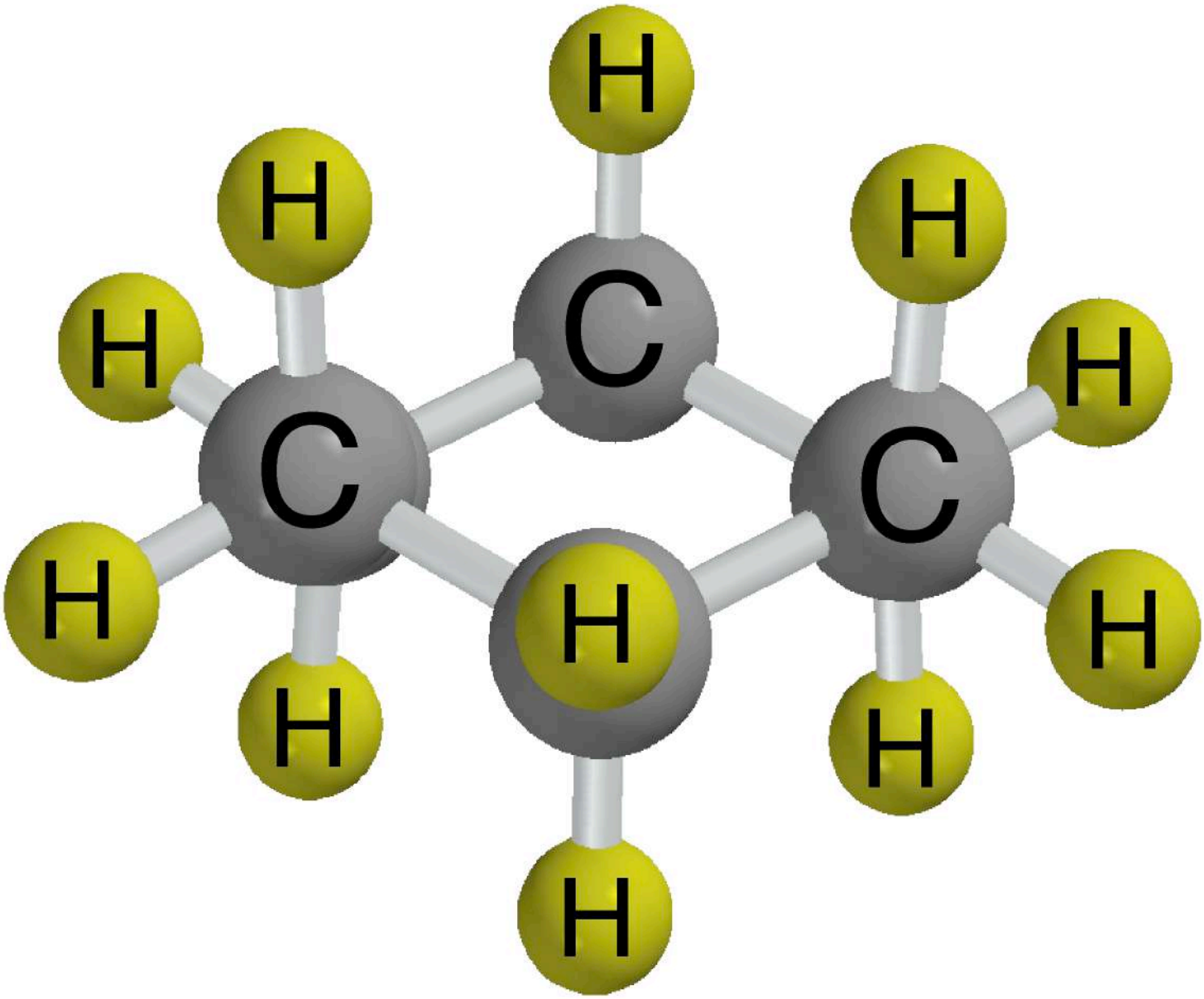
Supplemental Material - Graphics

Following are the 15 full-color graphics for the classroom activity.

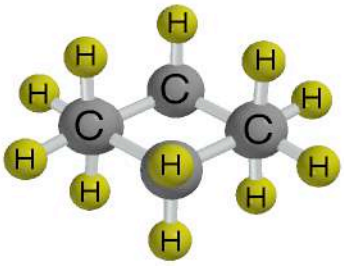
Organic Chemistry

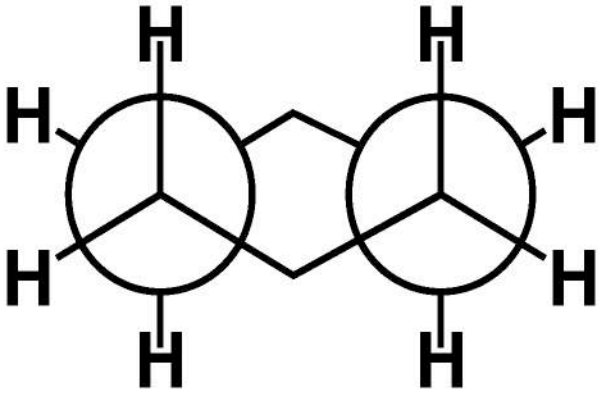


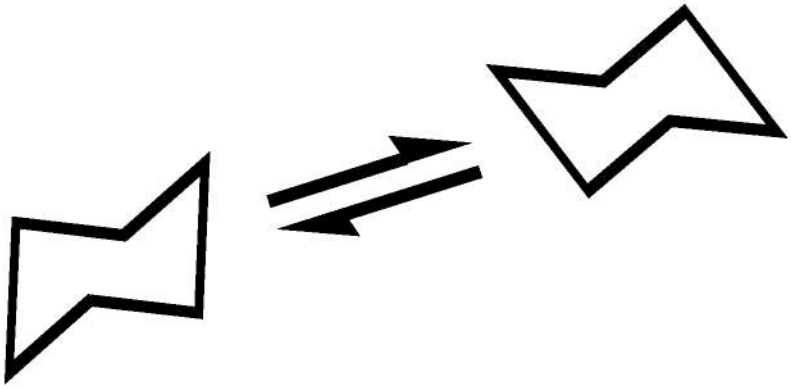
Structure

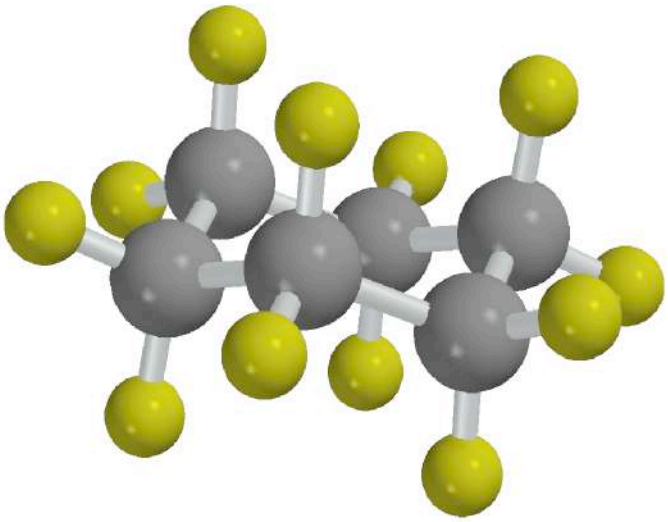


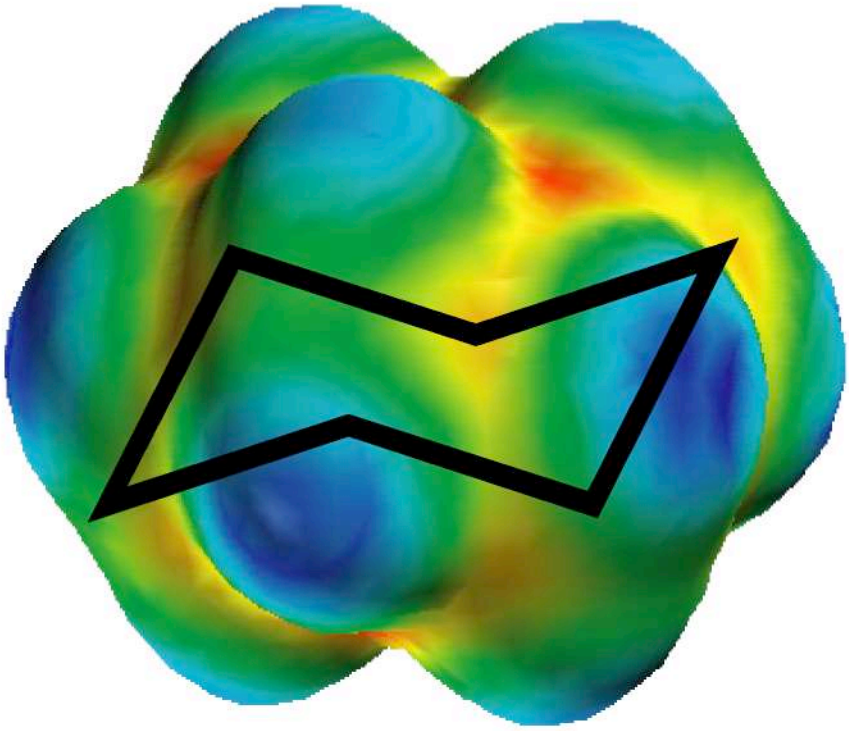
Conformational Analysis



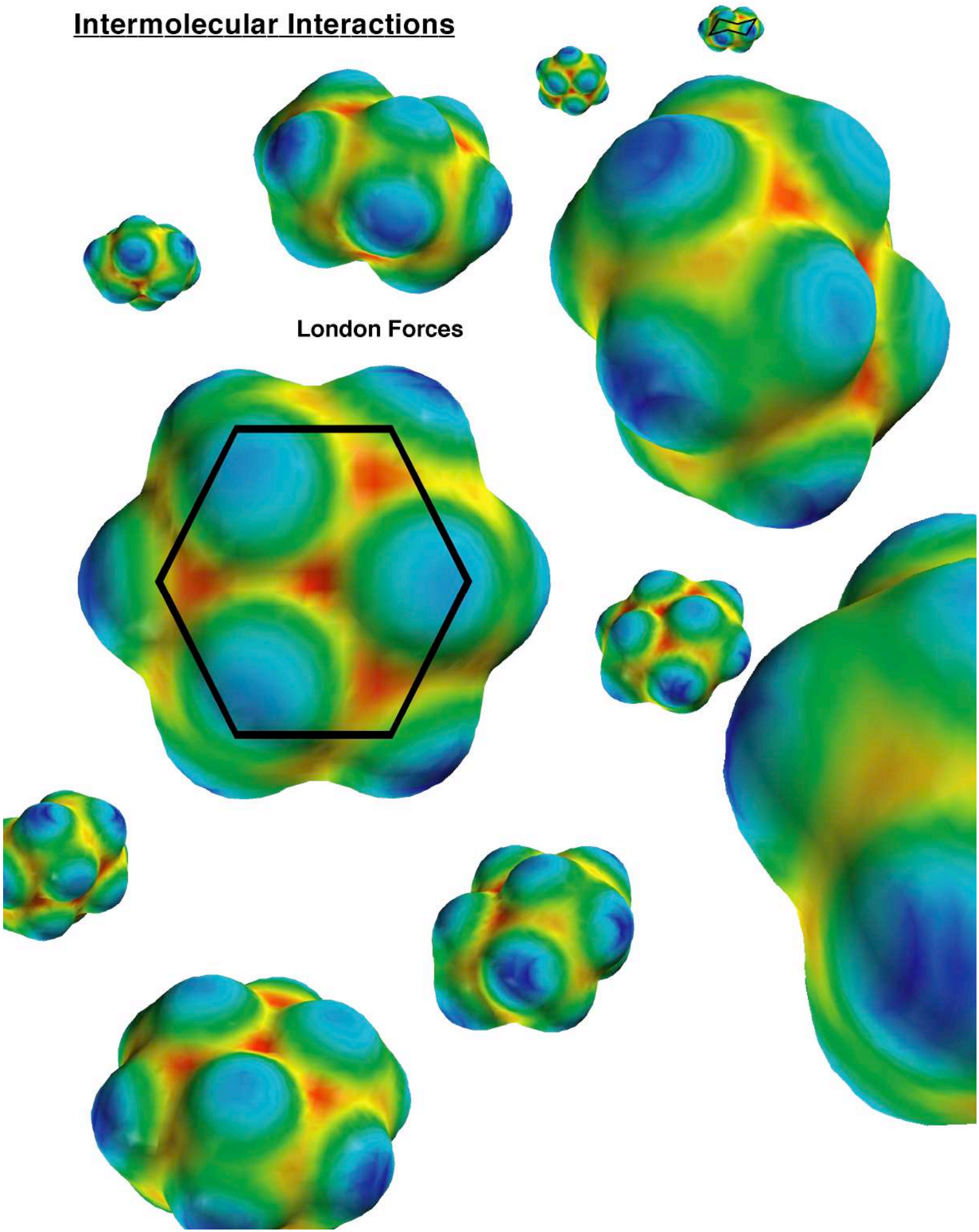


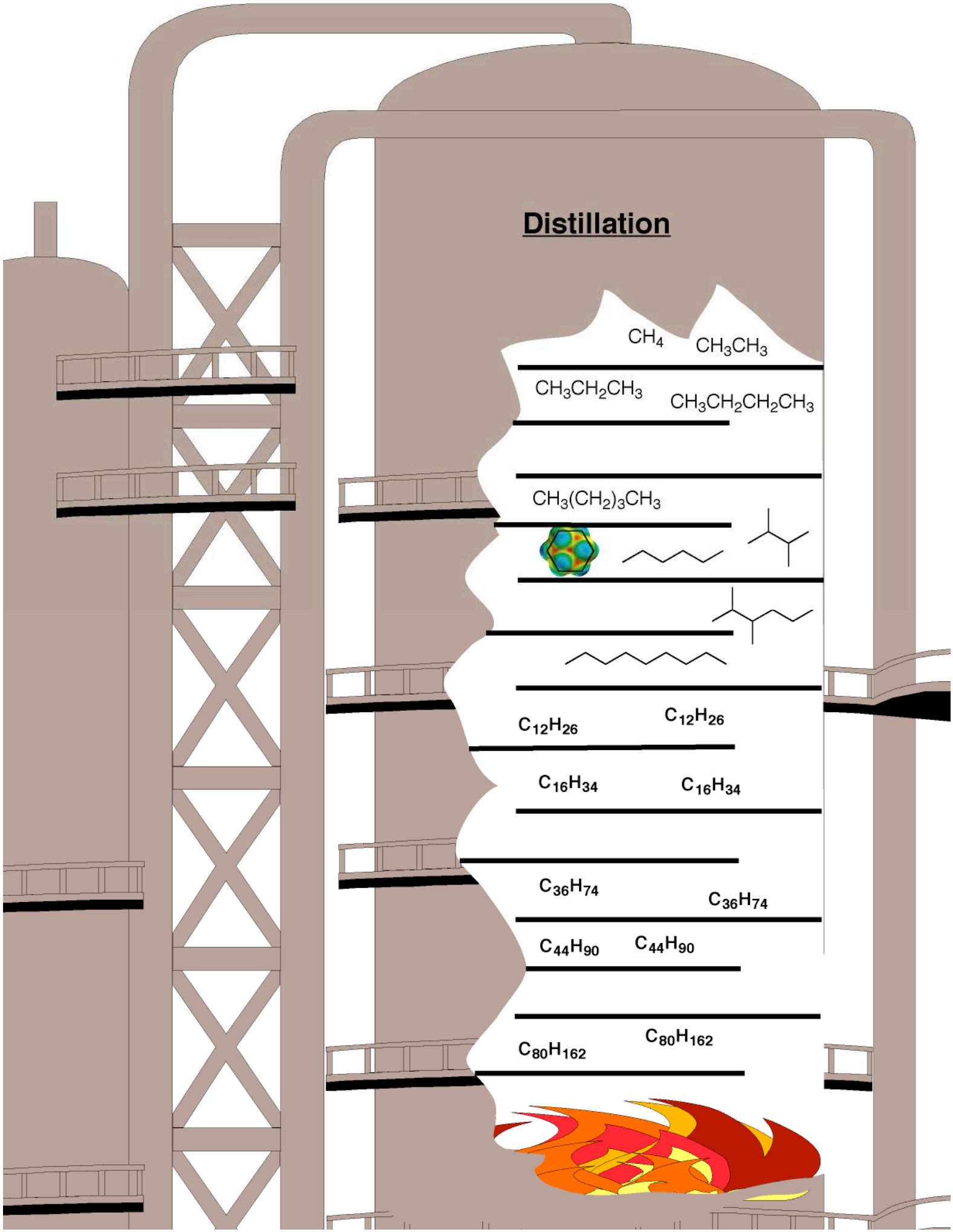






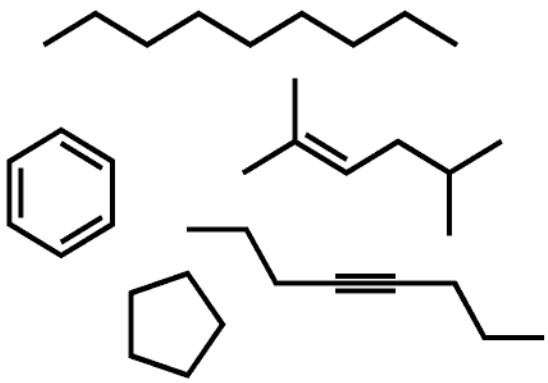
Intermolecular Interactions

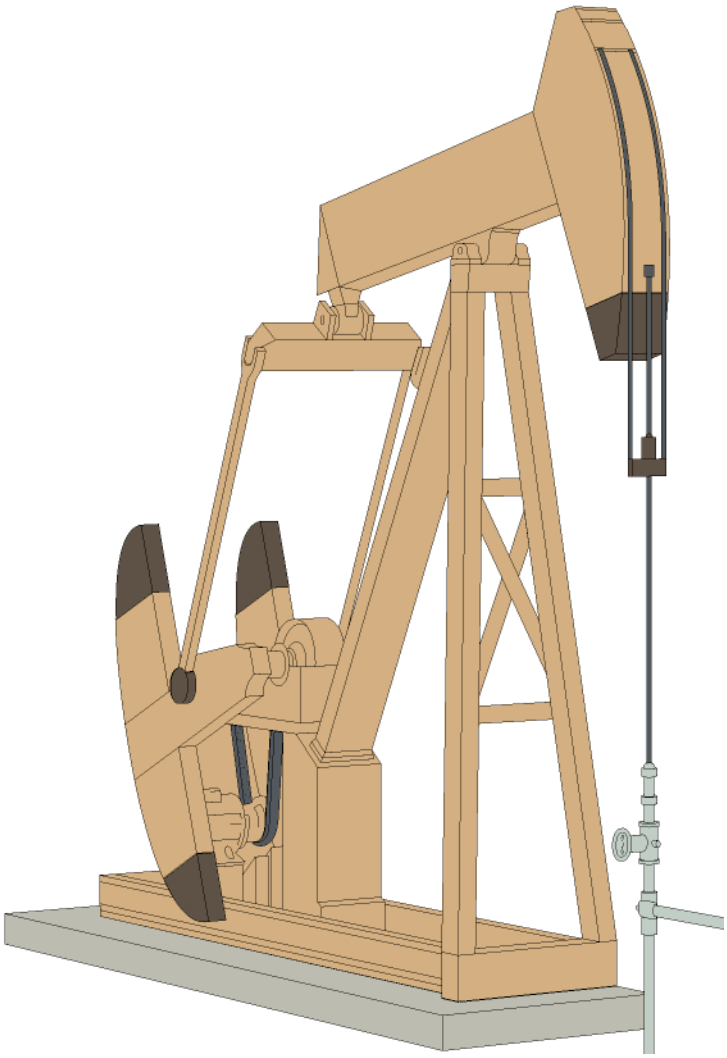


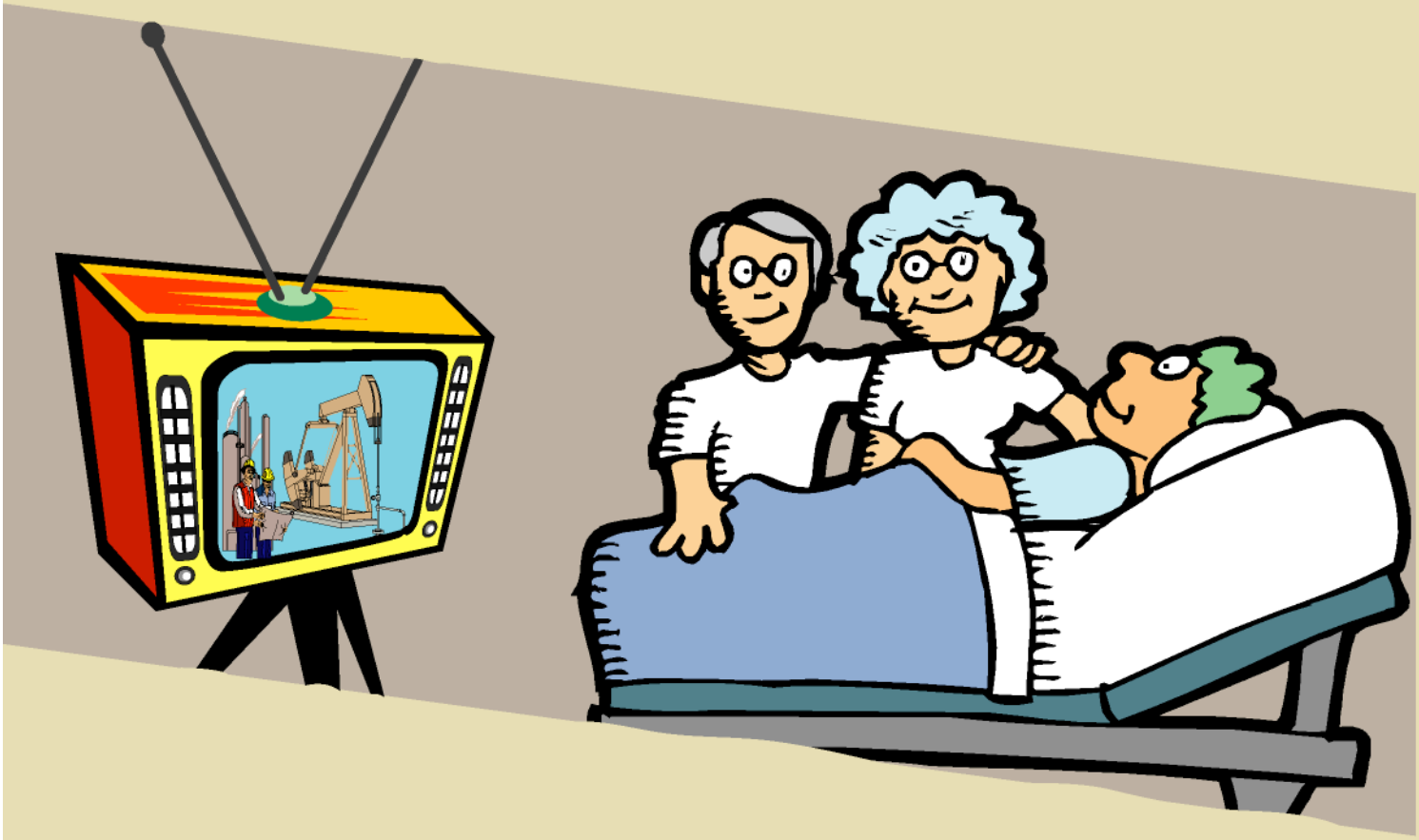

Distillation
CH_4
CH_3CH_3
$CH_3CH_2CH_3$
$CH_3CH_2CH_2CH_3$
$CH_3(CH_2)_3CH_3$
$C_{12}H_{26}$
$C_{12}H_{26}$
$C_{16}H_{34}$
$C_{16}H_{34}$
$C_{36}H_{74}$
$C_{36}H_{74}$
$C_{44}H_{90}$
$C_{44}H_{90}$
$C_{80}H_{162}$
$C_{80}H_{162}$

Crude Oil

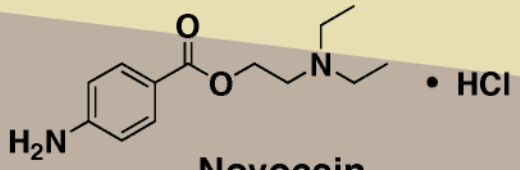
Parraffins
Aromatics
Cycloalkanes
Alkenes
Alkynes



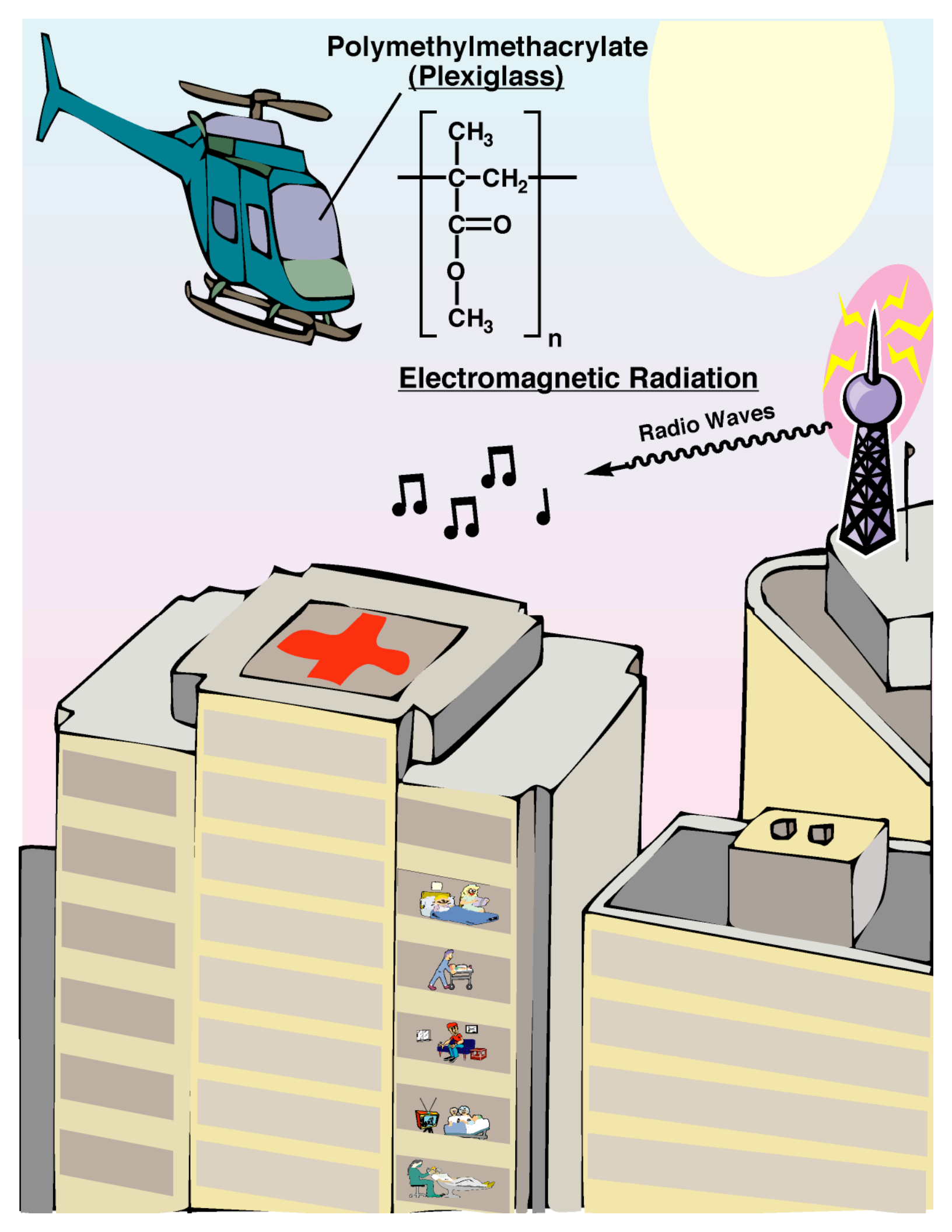




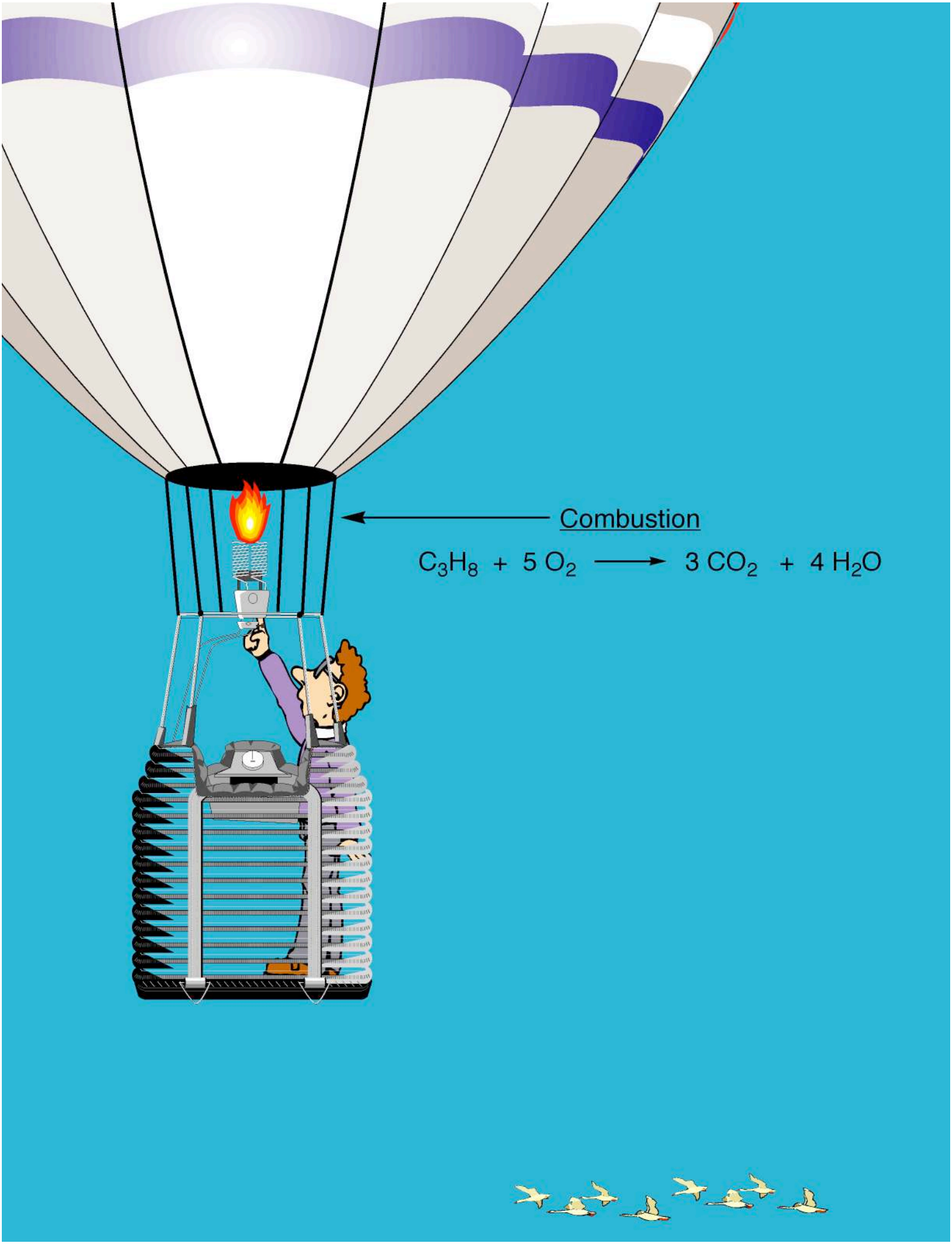
Topical Anesthesia



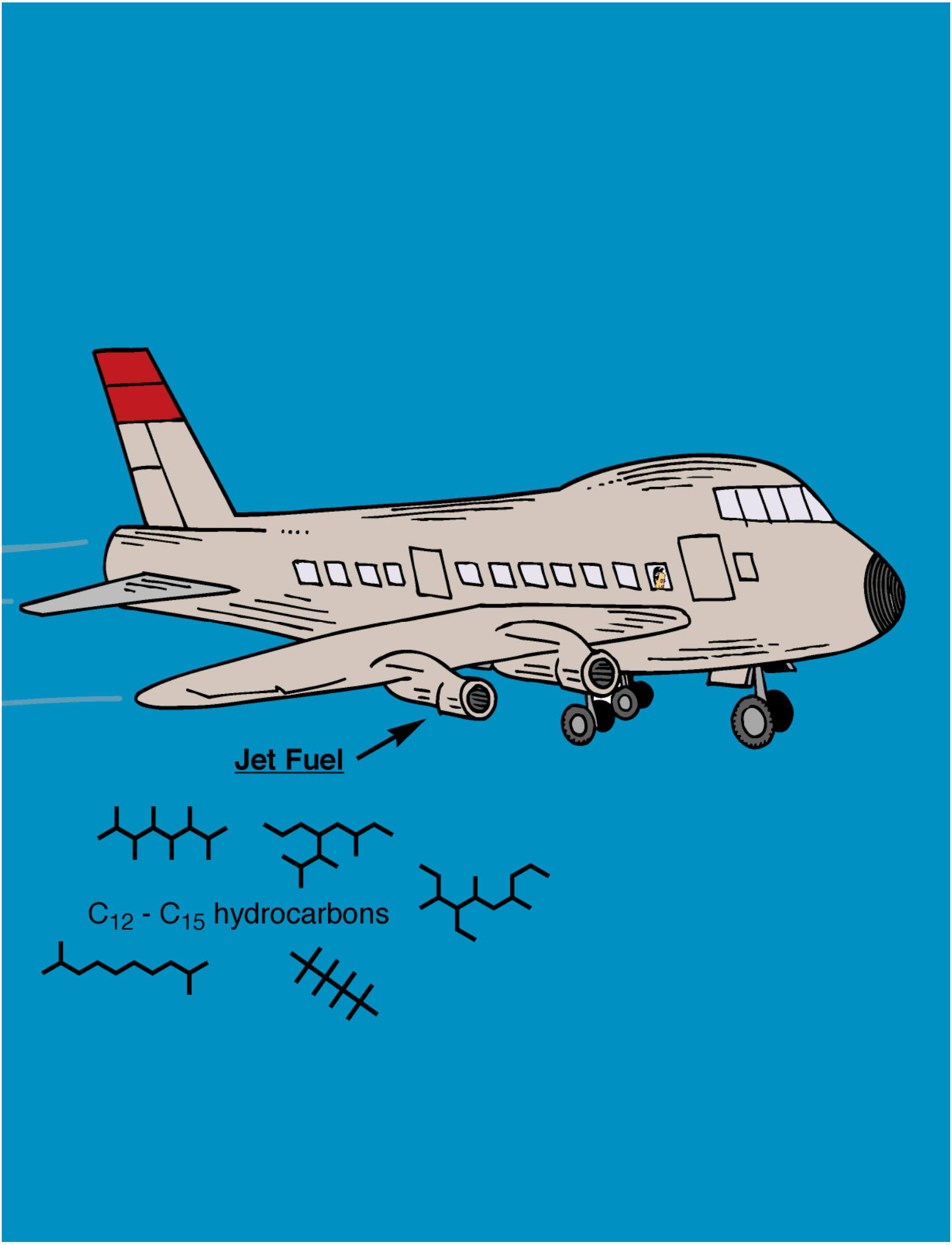
Novocain


Polymethylmethacrylate
(Plexiglass)
CH3
C
CH2
C=O
O
CH3
n
Electromagnetic Radiation
Radio Waves

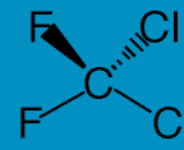

Ambulance
Aspirin
COOH
O
O


Combustion
$C_3H_8 + 5\,O_2 \longrightarrow 3\,CO_2 + 4\,H_2O$


N
N
N
N
N
Cu
N
N
N
N
Pen Inks


Jet Fuel
C_{12} - C_{15} hydrocarbons

The Ozone Layer



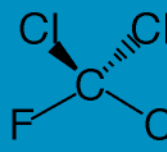
UV

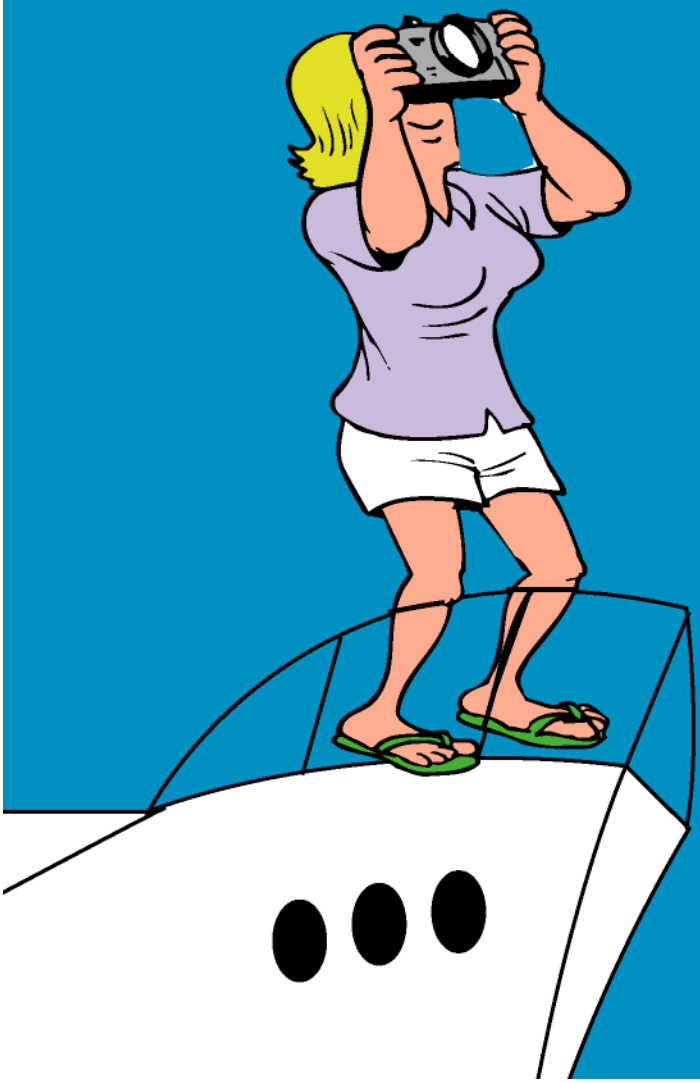
UV

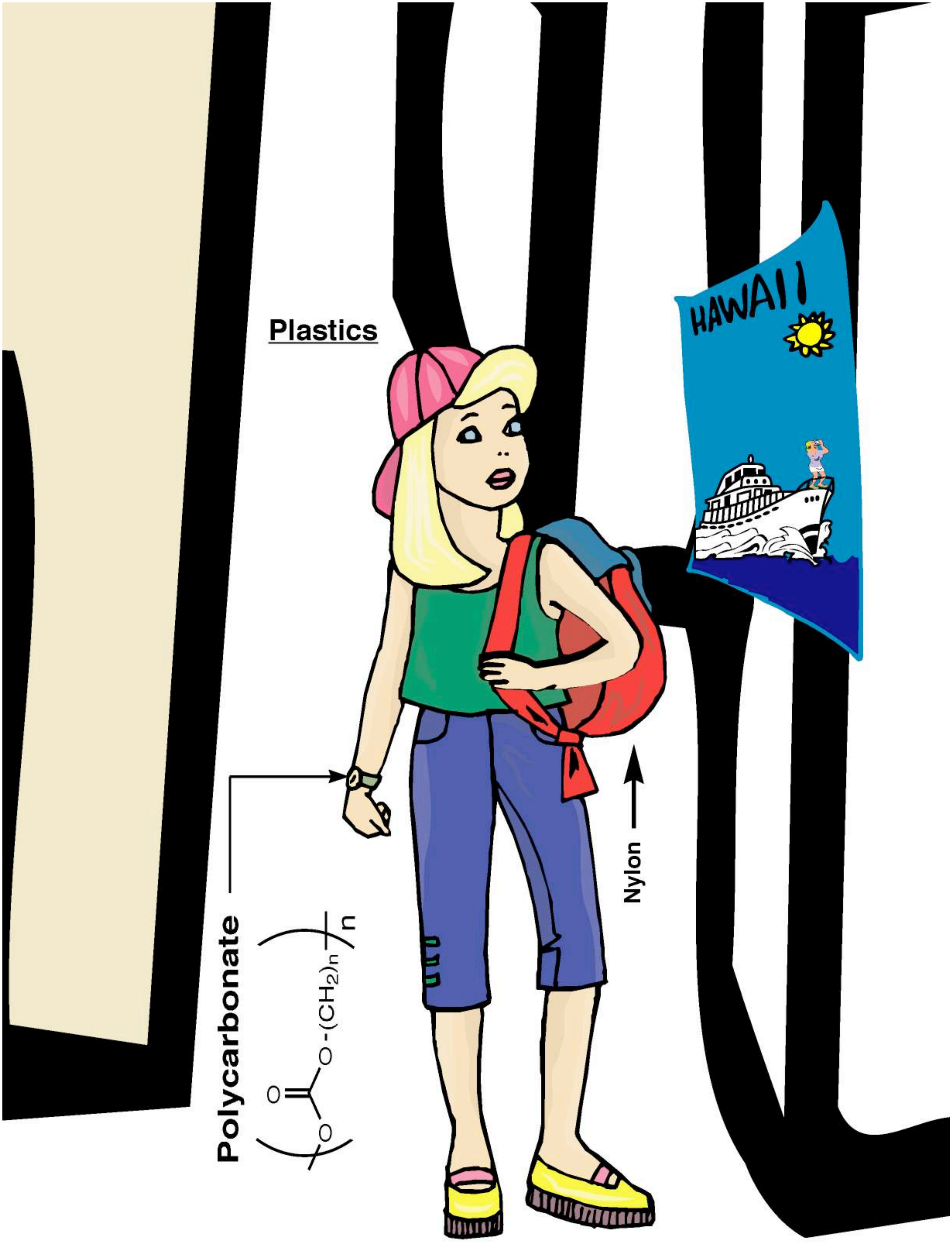
Cl•

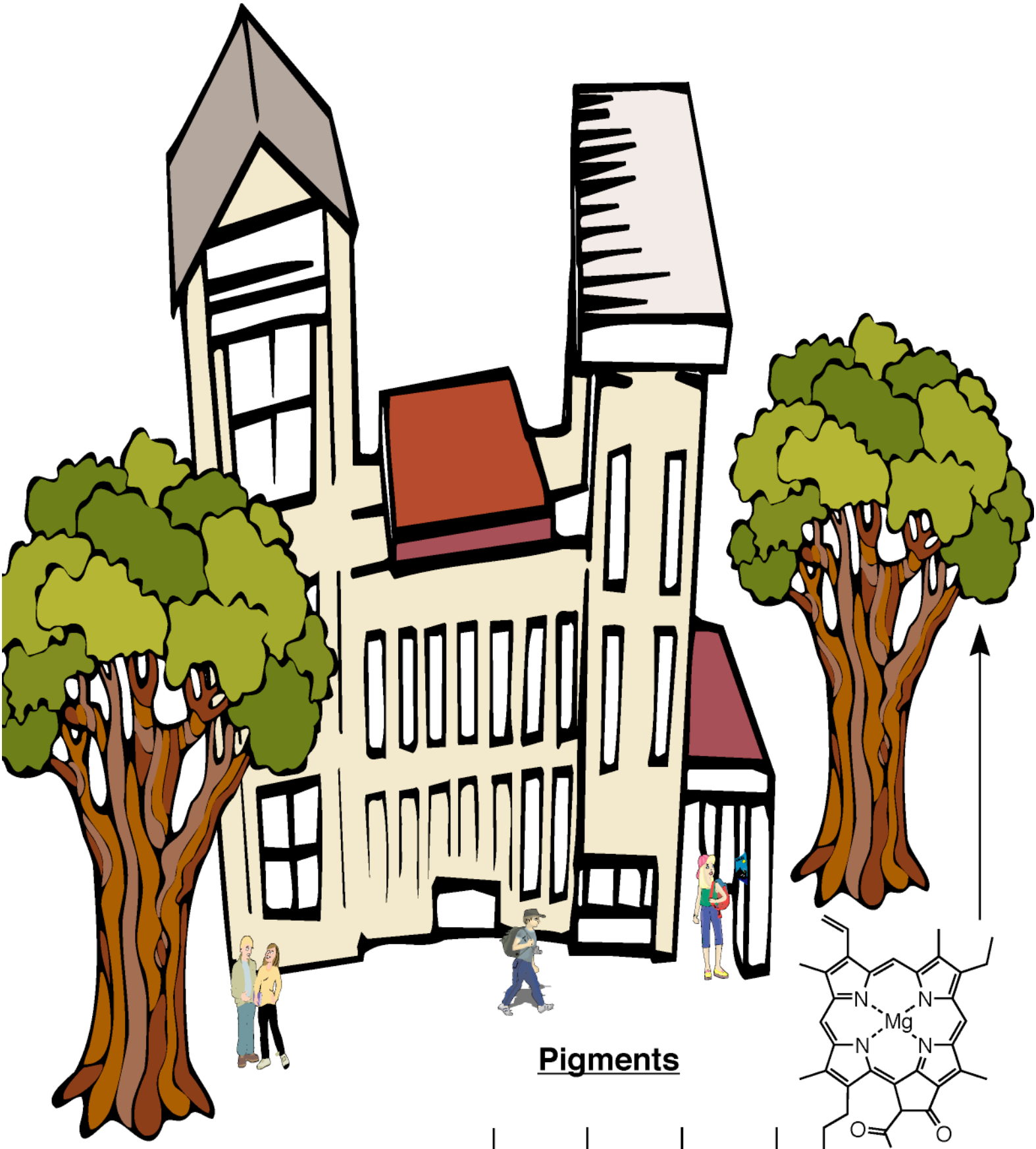
O_3

free radicals






Plastics
HAWAII
Polycarbonate
Nylon



Pigments

Chlorophyll a