

Career Connection

At play in streams of molecules...

On the outside, the refinery looks like a maze of steel and steam, but inside it's a different story. The cracker unit uses various chemicals to produce a million gallons of gasoline each day. As a **chemical engineer**, you will study the composition, structure, and properties of substances to help the refinery produce safely and efficiently.

Facts True or False?

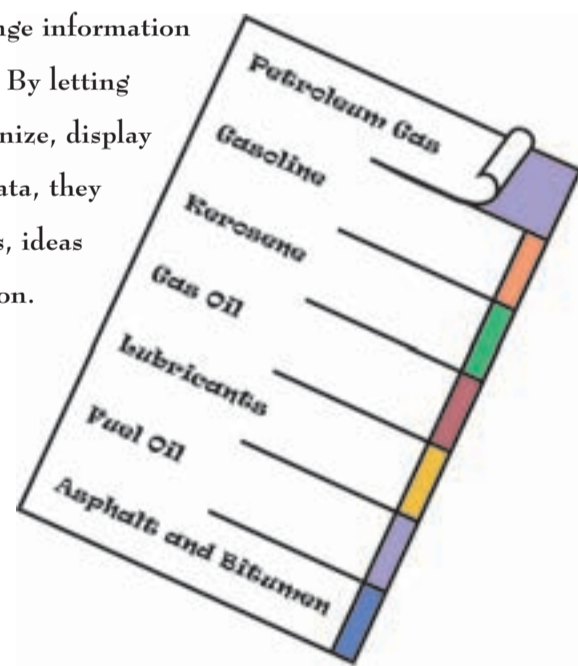
The average American consumes **3 gallons of refined petroleum products each day.**

TRUE.

Graphic Organizers

Using a Diagram and Tab Book to Understand the Refining Process

Charts can be used as study guides when students rearrange information and diagrams. By letting students organize, display and arrange data, they study concepts, ideas and information.



National Standards

Physical Science

- EXPLORE INTERACTIONS OF ENERGY AND MATTER
- EXPLORE CHEMICAL REACTIONS

Science as Inquiry

- CONDUCT SCIENTIFIC INVESTIGATIONS
- USE PROPER EQUIPMENT AND SAFETY PRECAUTIONS

Science and Technology

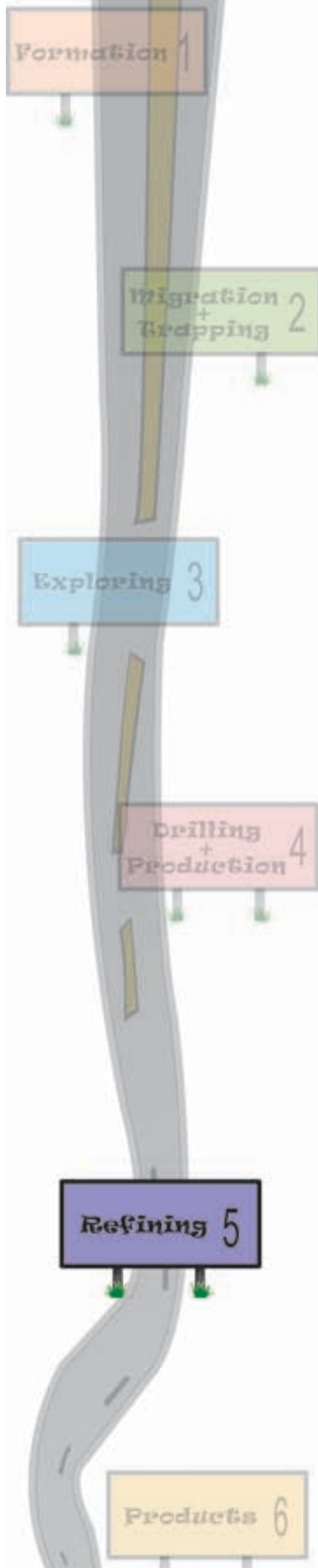
- UNDERSTAND THAT TECHNOLOGY HELPS SOLVE HUMAN PROBLEMS

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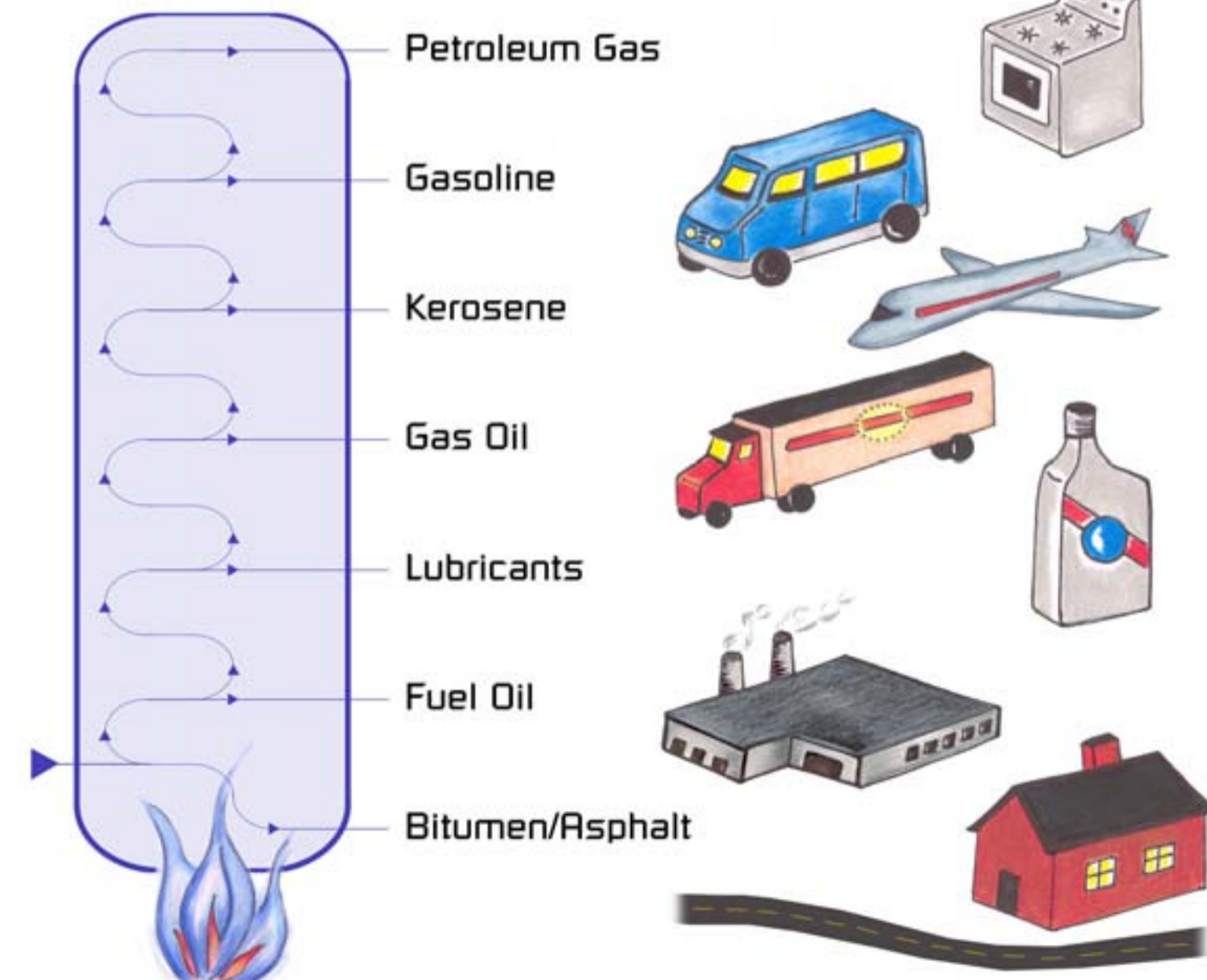
Refining

of Natural Gas and Oil

The crude oil produced from a well cannot be used in its raw form. To make it into products we can use, it is sent by truck or pipeline to a processing plant called a refinery. The refinery uses a process called cracking to heat the crude oil and distill it into useful petroleum products. The lightest products such as jet airplane fuel and gasoline break out of the crude oil first. Then, as the temperature of the oil is increased, the heavier products such as motor oil, lubricating greases, and asphalt are distilled from the oil.



Process Product By-Products



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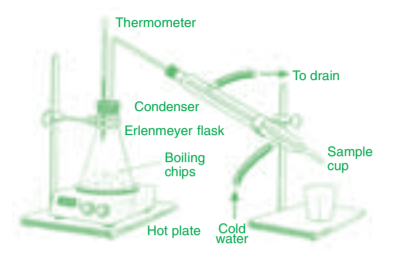
Experiment

The Chemistry of Distillation

Demonstrate the process of separating crude oil.

Materials:

- Safety goggles and aprons (1 per student)
- 1 alcohol thermometer, maximum temp 110° C
- 1 two-hole stopper to fit Erlenmeyer flask
- 1 condenser (design and scale will determine the glass tubing needed to connect to flask)
- 2 lengths flexible tubing for connecting condenser to cold water and to drain
- 1 hot plate
- 25 small containers for collecting condensate (small medicine cups or beakers, each capable of holding about 5 ml of liquid)
- 1 10 ml graduated cylinder
- 1 tube stopcock grease
- 10 boiling chips
- Heavy cloth towel
- 100 ml of sample mixture (mouthwash) plus an additional 5 ml set aside in a sample cup marked "original"
- Waterproof marker



Procedure:

1. Pour 5 ml of water into one small cup, and make the level with a permanent marker.
2. Duplicate this mark at the correct height on the remaining sample cups.
3. Number the cups 1-25
4. Obtain one more cup and mark it "original." Use it to obtain a sample of the mouthwash, and note the substance's physical properties of color and odor.
5. Apply a small amount of stopcock grease to the tip of the thermometer and to any glass tubing to be inserted through the rubber stopper.
6. Assemble apparatus as shown in the Figure by placing 100 ml of mouthwash in the flask.
7. Turn on the water.
8. Turn the hot plate to "medium." Heat the mixture to 80° C. Reduce heat to a medium setting.
9. Begin sample collection and data recording at 80° C.

Data Collection

Set up a table for recording the temperature. Begin taking measurements when the first fraction begins to collect. The last item that you record should be the temperature when approximately 5 ml of sample remains in the flask.

Sample Collection.

1. Place a cap at the end of the condenser before the distillation is started.
2. Record the temperature when the first drop of liquid enters the cup.
3. When 5 ml of liquid has been collected, record the temperature and quickly replace cup 1 with cup 2. When only 5 ml of liquid is remaining in the distilling flask, be certain to turn off the hot plate.
4. Continue recording and replacing cups until only about 5 ml of sample remains in the flask.
5. Observe and record the volume, appearance, and odor of each fraction.

Questions and Explanations:

1. Do these fractions differ by any other properties?
2. How do the fractions differ from the original liquid?
3. Which samples are the most similar in terms of temperature of collection?
4. Are the substances similar or different in physical properties?

Reflection:

1. How does a technician use distillation in analyzing a sample of crude oil?

The Refining Process

Demonstrate the distillation process used in refining oil.

Materials:

- ¼ cup salt
- 2 cups water
- Sauce pan with lid that is too large, flat is better
- Cup or mug
- Hot plate or stove



Caution: Wear safety goggles. Collect used oil in a separate bottle.

Procedure:

1. Stir salt and water together in sauce pan.
2. Boil with lid hanging over the edge.
3. Place cup under the lid to catch the distilled water droplets.
4. Allow boiled water to cool.
5. Compare the taste of salty water in pan with distilled water in the cup.

Questions and Explanations:

1. How does this demonstrate the water cycle: evaporation and condensation?
2. What causes the water to change from a liquid to a gas and back to a liquid?
3. Why is the water in the cup less salty than the water in the pan?

Reflection:

1. How does the oil and gas industry use this science in the refining process?