

## ACTIVITY 7

## TEACHER GUIDE

# REFINERY MAZE



### BACKGROUND

After crude oil (petroleum) is brought to the surface from a well, it is transported in order to be separated into its many products. The first step to separating the crude oil into its many hydrocarbon components is distillation. This takes place in a refinery where a fractional distillation tower, or fractionating tower, is used to separate the products by applying heat. The crude oil is pumped into the tower and heated. Parts of the crude oil mixture turn into gases as the crude boils. The bottom of the tower is very hot, while the top of the tower is allowed to be much cooler. The gaseous molecules of move up the tower based on their boiling points. Larger molecules with higher boiling points and higher densities will collect at the bottom, while smaller molecules with lower boiling points and lower densities will try to push their way to the top. As gas molecules meet an area of the tower that is cooler than their boiling temperature, these gases will condense. There are plates staged throughout the tower that the gases condense onto and then are pumped out of the tower with the materials of similar molecular makeup. Each material can then be further processed into other products if needed – anything from aviation fuel, to gasoline, surf boards, plastic bags, cosmetics and shampoos, motor oil, and even the plastic cases for your phones. This game enables students to visualize how the molecules of hydrocarbons can be separated into their smaller components in the refining process, and one day, become a product that consumers will use.

### OBJECTIVEVS

- Students will be able to define the term hydrocarbon as chains of hydrogen and carbon molecules used to create chemicals and synthetic materials in everyday products.
- Students will be able to explain that hydrocarbons make up petroleum and natural gas, and these products are common sources for many of our chemical and synthetic products.
- Students will be able to describe the general process followed to separate petroleum into its many products in a refinery.

### MATERIALS

- Pennies
- Nickels
- Quarters
- Dimes
- Scissors
- Tape
- Pipe cleaners, straws, or similar items
- Refinery Maze worksheet
- Fractional Distillation Tower master

### PREPARATION AND PROCEDURE

**TIME:** 30 - 40 MINUTES

- Copy or make copies of the worksheet and master for student work and/or projection.
- Gather enough coins for each student or group to have one of each coin.
- Ask students to observe the coins and explain or identify the physical characteristics that are different for each coin. Students will likely point out their diameters being different, and also their materials.
- Ask the class how they think refineries might create hundreds of products from petroleum. What kinds of processes might they use to create so many things?
- Ask students to tape straws or pipe cleaners on all borders of the maze worksheet. These rigid borders will help them from "cheating" a coin further in the maze.
- Tell students that they will pretend each coin is a hydrocarbon molecule found in a mixture of crude oil. Each coin will enter at the fractioning tower for processing at the bottom. The coin will then move through the tower maze, attempting to move as high as it can, before becoming stuck. Move the coin out of the tower at the spot where it has collected.
- Ask students to compare their maze to the master. Review the process of fractional distillation and ask students to identify which coins might represent certain petroleum products based on the master and products listed there. Explain to the class that feedstocks are materials that are further processed into many more materials through chemical manufacturing. These hydrocarbons can be turned into items like plastics, fiberglass, Teflon, and PVC through various chemical processes that break up the hydrocarbon chains (cracking), combine hydrocarbon chains (unification), or rearrange the hydrocarbons in a chain (alteration). Ask the class to list hydrocarbon-based items from Hydrocarbon Hunt and point out where they might come out of the fractional distillation process.
- Ask students to explain how this game board might differ from an actual tower. How could students re-design the game board to be a better model for the process and technology?