Title: Oozing Oil

Adapted from *Alaska Resource Kit: Minerals* and *Alaska Tidelines.*

Theme: It is a difficult process to extract fossil fuels from the ground.

Objectives:
- Students will create a working model of an oil well.
- Students will understand why it is challenging to drill for oil.

Duration: 90-120 minutes, can be divided into 2 days

Age Range: 4^{th}-8^{th} Grade

Materials:
- Glass jar
- Dry sand and gravel
- 500 grams of modeling clay
- Short length of rubber tubing attached to a funnel
- 2 metal or rubber tubes (slightly longer than the can)
- Wire screening
- Tape
- Can
- Water
- Vegetable Oil
- Black tempera paint
- Journals or paper
- Pencils
- Worksheets:
    - From Pterodactyls to Petroleum
    - Where Does That Oil Go?

Background:

In addition to all the familiar animals in our oceans and lakes, there are billions of tiny one-celled animals and plants called plankton. In each miniscule body there are minute droplets of fats and oils (hydrocarbons). After dying, these bodies sink down to the bottom of the ocean. Over the centuries they pile up as layers of mud and ooze. During the rock-forming process these layers are squeezed, which forces the drops of oil to move with the water in the sediment. The water and oil move upward to the high points in the layers, where there is a cap rock that halts further passage. It is here that the oil and water separate and the oil nestles in the tiny pores of the rock above the water. Gas usually accompanies the oil and can be found in the spaces in the rock above the oil. An oil field consists of sedimentary rock which is saturated with gas at the top, oil in the middle, and water below. Strike it rich in this activity by actually building your own oil well!

Introduction:

Ask students where oil comes from, and discuss their responses. Share the background information with them.

Activities & Procedures:

Distribute the worksheet "From Pterodactyls to Petroleum" and have students work in pairs to complete it. Discuss the answers. Remind students that oil originates primarily from decayed plants (plankton), as well as from animals such as the pterodactyl. Mention that oil is a non-renewable resource—once used up, it is gone forever, or at least until more plants and animals decay. Each quart of oil took thousands and thousands of years to form. It really is black gold!

Place the tubes in the jar. Add about ½ cup of vegetable oil mixed with tempera paint to the bottom of the jar to represent crude oil. Pack gravel and sand into the bottom half of the jar around the tubes to represent the sedimentary rock. Firmly pack a 3 centimeter layer of modeling clay on top of the gravel and seal tightly around both tubes and the edge of the jar. This is the cap rock. Fill the rest of the jar with sand to represent more sedimentary rock.

Have students look through the glass jar to observe the layers. Where is the oil?

Attach the rubber tubing to one of the tube coming out of the jar. Pour the water slowly into the funnel. Raise the funnel higher above the jar to apply more pressure. What comes out the other tube? What happens as you apply more pressure by raising the funnel?

Have students make a sketch of the model, label each part, and trace the path of the water and oil.

This discovery shows that as external pressure is applied to oil reservoirs, the liquid is forced out. The pressure can come from either expanding gas or from water seeking to move into pore spaces vacated as the oil is removed.

Complete the "Where Does That Oil Go?" Worksheet and discuss the answers.

Wrap-up:

Ask students if they know anyone who works in the oil industry. Is it hard to get the oil out of the ground? What makes it hard? Create a list of things that make it challenging to safely extract oil. Brainstorm and discuss other options for extracting oil. If you have other supplies available, allow students to experiment with different techniques.

Evaluation:

Assess student worksheets and sketches of the model for completeness, neatness, and comprehension. See suggested answers for the worksheet.

From Pterodactyls to Petroleum

How well can you predict the connections between pterodactyls and petroleum? Read the statements and write true or false in this prediction guide, then read the information on the following page and correct your guesses.

Your Prediction	Actual	
___________	___________	1. Some pterodactyls were as big as small planes.
___________	___________	2. At one time all of Alaska was under water.
___________	___________	3. Tremendous pressures changed the silt, sand and clay sediments into oil.
___________	___________	4. Petroleum means "rock oil."
___________	___________	5. Petroleum lies in great underground lakes.
___________	___________	6. To find oil, scientists look for sedimentary rocks.
___________	___________	7. Only one out of 20 wells drilled have produced enough oil to be profitable.
___________	___________	8. Special mud is used in the drilling operation.
___________	___________	9. Once oil is struck, it always has to be pumped out of the ground.

Where Does Oil Come From & How Do We Get It?

Start with this far-out flying reptile, which glided around in prehistoric times on wings made of skin attached to long-fingered arms in the best TV Batman fashion. It had a pointy head and a nose like a beak. And fossils show that it ranged from the size of a small sparrow to that of a giant with a wing-span like a Piper Cub. Its scientific name is pterodactyl (tair-oh DACK-til), from the Greek petron meaning "wing" and dactylos meaning "finger."

In pterodactyl's day—say, 150 million to 65 million years ago—a warm, shallow sea stretched from what is now the Arctic coast of Alaska almost to the Gulf of Mexico (see map #1). As zillions of generations of pterodactyls, along with countless other forms of plant and animal life, lived and died over that enormous time span, their remains settled to the bottom of the ancient sea. There they were broken down by bacteria and covered over by silt, sand and clay.

Over the ages, layer upon layer of decaying material and debris crushed down upon each other, forming what are called sedimentary basins, thousands of feet deep (see Map #2). And in some mysterious way (which we still don't really understand and have never been able to copy), the great pressure, heat and dampness changed the once-living remains of pterodactyl and his like into oil and natural gas, while the silt, sand and clay were molded into rock. So the right name for the kind of oil we're talking about is petroleum (puh-TROH-lee-um), which comes from the Latin petra, meaning "rock," and oleum, meaning "oil."

When you hear about oil "pools" and "reservoirs" (or oil "wells" for that matter), you might get the idea that petroleum lies in great underground lakes. But instead, as its name suggests, it is squeezed into tiny holes in the poris rock with which it was formed, very much like water soaked into a sponge. When this oil-bearing rock—usually sandstone or limestone—is surrounded by layers of hard rock, the oil is trapped and collects in large quantities (see sketch).

So to find the oil, scientists must first find the right kinds of rocks. They start by making surveys of surface formations, giving special attention to sedimentary basins left behind long ago by inland seas. They also look for earthquake faults or fractures that may have sealed in the oil. Complicated instruments give clues as to what kinds of rocks lie below. The seismograph (SIZE-mo-graf), for example, maps underground rock formations by measuring the time it takes for sound waves to bounce back.

But the only way you can tell for sure whether there is oil down there is to drill. And only one out of every fifty wells drilled produces enough oil to make it worth the effort.

Drilling is done from a tall rig or platform with a heavy-duty system of pulleys and blocks to handle long lengths of pipe that must be added as the hole gets deeper. That wicked-looking rotary drill bit (see sketch) works much like a dentist's drill.

A special kind of drilling mud flows down the hollow pipe to flush away rock cuttings as the drill grinds through the earth. This mud then rises through the outer shell casing to carry the rock chips to the surface, where they are screened out and checked for traces of oil. The mud also serves as the first line of defense against possible blowouts.

When oil is struck, the drill pipe and bit are pulled up and holes are punched in the casing for the oil to flow through. And it is pushed up the pipe by the incredible underground pressures that have been building up since the pterodactyl's time.

Suggested Answers

1. true

2. true

3. false

4. true

5. false

6. true

7. false

8. true

9. false

Where Does That Oil Go?

Directions: Read the following story and answer the questions on the next page.

Once the oil comes in, the well is capped and equipment is installed to control the flow, and to separate the crude oil from the natural gas. Prudhoe Bay, on the arctic coast of Alaska, is ice-bound most of the year. So the oil must run a long route to market. From the wells, the crude oil moves through small pipelines to the big trans-Alaska pipeline. There it begins the 800-mile journey to Valdez, where it is loaded on tankers for shipment Outside.

Once the oil reaches the lower 48, modern plants and refineries process the oil and natural gas into gasoline, jet fuel, heating oil, diesel, liquified gas and fertilizer. And those are just a few of the products that can be made from petroleum. Petrochemicals (chemicals made from oil and gas) are used as a base for a wide assortment of things, from plastics to vitamins to records, detergents, movie films, fabrics, and antifreeze.

This strange stuff we call petroleum is made up almost entirely of only two elements—hydrogen, a gas-like element that will burn; and carbon, a chemical element that is found in all living matter. If you really want to sound like a pro, you can use the scientific word for petroleum, which is "hydrocarbons." These hydrocarbons are present in thousands of different combinations that can be separated and purified in the process called "refining."

The first step in refining is to sort out the major "fractions" or parts of the hydrocarbons that make up crude oil. These fractions boil and vaporize (like steam) at different temperatures. So the simplest form of refining works like this:

a. The crude oil is heated in a furnace and the vapor is piped into a tall refinery tower.
b. Hot steam is pumped in below to speed up the process.
c. The vapors from the different fractions rise, cool off and condense (turn back into liquid) at different levels.
d. There they are drawn off and collected for further processing if necessary—except for the ghost of Pterodactyl, who has finally taken wing again.

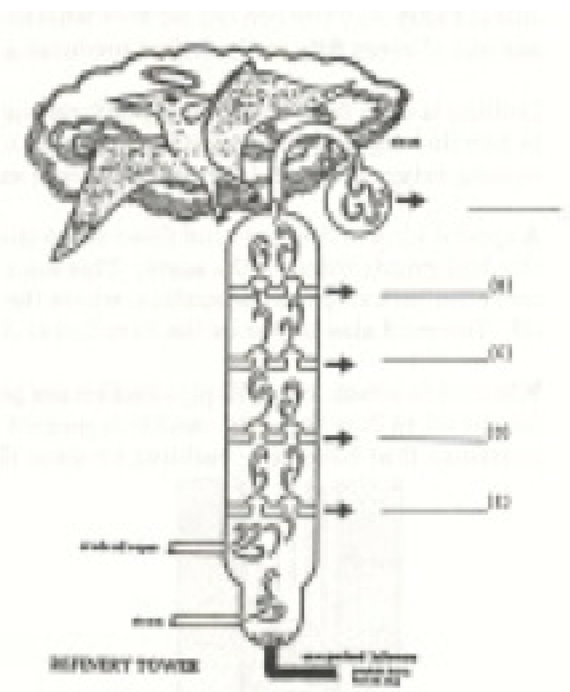
REVIEW:

1. Where does the oil from Prudhoe Bay go?

2. Define petrochemicals.

3. What are the major elements that make up petroleum

4. Here is a drawing of a refinery tower that shows at which points the different products are drawn off and collected. Fill in the blanks. (Hint: Lubricating oil is drawn off first; then heating oil; then jet fuel; then gasoline; then fuel gas.)



5. Circle the most highly refined fuel in each case:
   a. jet fuel or gasoline
   b. lubricating oil or asphalt
   c. heating oil or jet fuel

Suggested Answers:

1. down the pipeline to Valdez and onto tankers for shipment outside

2. chemicals made from oil and gas

3. hydrogen and carbon

4a. fuel gas

4b. gasoline

4c. jet fuel

4d. heating oil

4e. lubricating oil

5a. gasoline

5b. lubricating oil

5c. jet fuel

Oozing Oil

Science As Inquiry and Process: Students develop an understanding of the processes and applications of scientific inquiry.

SA1
Students develop an understanding of the processes of science used to investigate problems, design and conduct repeatable scientific investigations, and defend scientific arguments

The student demonstrates an understanding of the processes of science by:

[3, 4, 5, 6, 7, 8, 9] SA1.1 asking questions, predicting, observing, describing, measuring, classifying, making generalizations, inferring, and communicating

[3] SA1.2 observing and describing the student's own world to answer simple questions

[4] SA1.2 observing, measuring, and collecting data from explorations and using this information to classify, predict, and communicate

Concepts of Physical Science: Students develop an understanding of the concepts, models, theories, universal principles, and facts that explain the physical world.

SB1
Students develop an understanding of the characteristic properties of matter and the relationship of these properties to their structure and behavior.

The student demonstrates an understanding of the structure and properties of matter by:

[3] SB1.1 classifying matter according to physical properties (i.e., color, size, shape, weight, texture, flexibility)

Concepts of Earth Science: Students develop an understanding of the concepts, processes, theories, models, evidence, and systems of earth and space sciences.

SD1
Students develop an understanding of Earth's geochemical cycles.

The student demonstrates an understanding of geochemical cycles by:

[3] SD1.1 recognizing that most rocks are composed of combinations of different substances