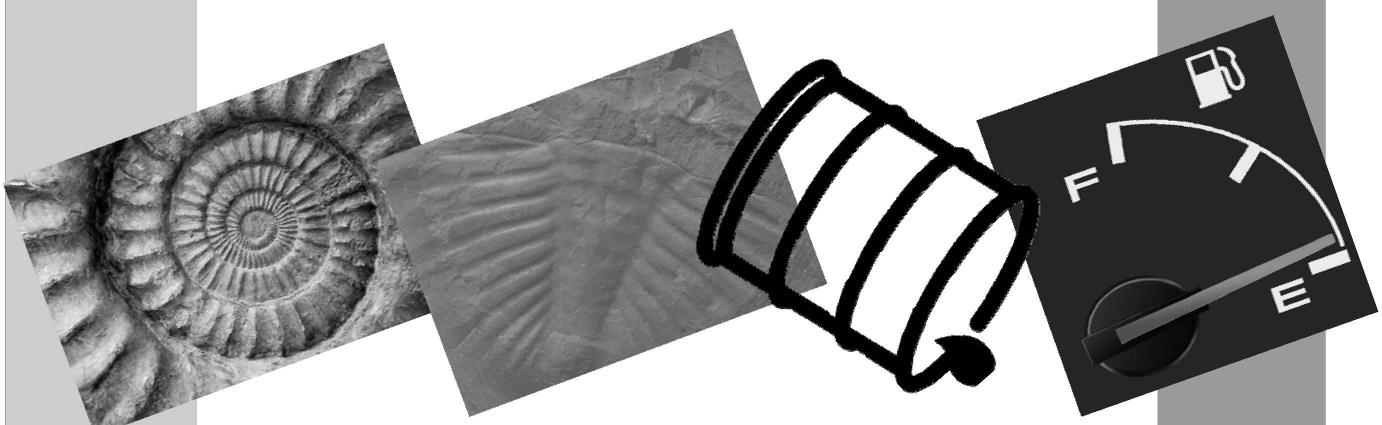
An Elementary School PETRO SCIENCE CURRICULUM

Elementary Petro Science

Illinois Petroleum Resources Board



POWERING EDUCATION

Original curriculum courtesy of

Oklahoma Energy Resources Board

Aligned to Illinois Learning Standards

Last Updated: 1/1/2020

What is the IPRB?

The **Illinois Petroleum Resources Board** formed to provide public awareness and education programs and to clean up abandoned well sites throughout the state. Funding for IPRB programs comes from voluntary contributions of oil and natural gas producers and royalty owners in Illinois.

IPRB provides funding and expertise in the reclamation and restoration of abandoned oilfield sites in the State of Illinois. These restoration projects fulfill another goal of IPRB which is to restore abandoned sites previously used for oil and gas production back to commercial or agricultural use for current land owners.

For more information about the IPRB and free education programs, please visit the IPRB website at iprb.org, contact us at office@iprb.org or call the Illinois Petroleum Resources Board at 618-242-2861.

One of our most important missions is Energy Education! Our program serves two primary goals:

1. To develop and design oil and natural gas education activities for K-12 teachers and students in Illinois.

2. To provide teachers with:

- Workshops statewide that provide free training and resources in energy education
- Educational field trips for students and teachers
- Professional development hours
- Other education resources that help interest students in science and math, energy, and their understanding of how Illinois crude oil and natural gas are an important part of the energy picture and the Illinois economy. Utilize the videos provided at iprb.org to help students understand.

Professional development

The IPRB will provide professional development for use of this curriculum. To receive information on professional development sessions, please contact the IPRB at iprb@yahoo.com or 618-242-2861.

FREQUENTLY ASKED QUESTIONS

The activities in this book are designed to teach students through discovery hands-on investigative experiences and open-ended inquiry questions.

WHAT IS ENERGY?

The world is full of movement. Birds fly in the air, trees move in the wind, and ships sail on the sea. People, animals, and machinery move around, but not without a source of energy.

Living things and machines need energy to work. For example, the energy that turns the blade of a windmill comes from the wind. The sun provides the energy needed to produce the food you eat. Food provides the energy your muscles need to ride your bike. The energy to make a car, plane or motorboat move comes from the gasoline inside the engine.

FROM WHERE DOES ENERGY COME?

All energy originates from the sun. Without the sun, there would be no life on earth. The energy from the sun is transformed into many other types of energy that we use every day. Important forms of energy are oil, natural gas and coal, also known as fossil fuels.

HOW ARE OIL, NATURAL GAS AND COAL FORMED?

Millions of years ago, the seas were filled with billions of tiny plants and animals. As these plants and animals died, their remains sank to the ocean floor and were buried in layers of sand and sediment. As more and more time passed, heat and pressure worked on the buried remains until they became fossil fuels. These fossil fuels were then trapped in underground rock formations. If rock is porous (containing holes or void spaces), it can accumulate oil, natural gas and coal.

For more than 150 years, man has been exploring and extracting fossil fuels. Today, when we use the estimated 6,000 products made from fossil fuels, we are releasing the energy that first came to earth from the sun millions of years ago.

HOW DO WE FIND OIL AND NATURAL GAS?

Edwin L. Drake was the first person to drill specifically for oil. In 1859, near Titusville, Pennsylvania, Drake struck oil. Drake's discovery helped make the finding of oil a big business. By 1900, prospectors had found oil fields all over the country, especially in Oklahoma and Texas.

Today, prospecting for oil and natural gas is highly skilled detective work as scientists use computers, satellites, sound waves and high-tech equipment to search both underground and under the ocean floor. Long before drilling can begin, geologists and geophysicists (scientists who explore for oil and gas) gather clues to locate possible sites for drilling. These clues come in many forms . . . from maps to locating fossils to studying sound waves from deep beneath the surface. The scientists make their best predictions, locate the spot and then the exploration begins. However, this process does not proceed without concern for the environment.

For many years, oil and gas companies have devoted considerable time and resources to finding ways of reducing their impact on the environment. In fact, U.S. companies are spending more dollars protecting the environment than drilling new wells. The effects that drilling, as well as any eventual production operations, will have on an offshore environment or a sensitive onshore tract must be anticipated and thoroughly spelled out. Blowout preventers used during the drilling process insure against the potential release of oil or natural gas into the atmosphere making oil "gushers" a relic of the distant past. Steel casing is set and cemented to protect the water table from contamination. Oil companies routinely take all necessary steps to prevent harmful interaction with wildlife and crop production.

In the final analysis, it is a question of balance between the need for energy and the desire to have an undisturbed environment. Oil companies and the government must cooperate to ensure this balance is achieved.

HOW IS OIL AND NATURAL GAS TRANSPORTED AND USED?

Once oil and natural gas are produced and collected, they must be safely transported for their many uses. Oil can be transported by truck, pipeline or ships to factories called refineries. Natural gas can only be transported in large quantities through high pressure pipelines. Consequently, natural gas produced in the U.S. can only be used on this continent. Crude oil can be shipped all over the world where it is made into the thousands of products that we use every day. You don't need to leave home to find oil in some of its many forms.

By processing fossil fuels at power stations, stored energy can be converted to electricity. The carpet on your floor and the paint on your walls probably have oil in them. You brush your teeth with a plastic tooth brush which is made from petroleum (oil is the key ingredient of plastic). It is estimated that we have found more than 500,000 uses for oil.

Learning Cycle

Elementary Petro Science activities follow the learning cycle format:

1. Wonder Why

The Wonder Why question focuses on the topic of the activity and engages student interest.

2. WOW!

The WOW is a discrepant event activity used to set the stage for the hands-on-exploration of the concept.

3. Discovery Procedure

This stage of the learning cycle provides information and procedures for inquiry based, hands-on investigations.

4. Concept Formation

Based on the discovery activity, this stage of the learning cycle develops the main idea through questioning and additional resources.

5. Extensions

Extensions allow for further development of the concept through the use of subject integration, resources, community outreach, experimentation, creativity and decision-making.

Treasure Hunt

Next Generation Science Standards

Grade 4

Earth's Place in the Universe

4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

Earth's Systems

4-ESS2-1 Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

Grade 6

Earth's Systems

MS-ESS2-2 Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

Common Core Standards

Literacy in Science and Technical subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Integration of Knowledge and Ideas

3.8 Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).

Writing

Text Types and Purposes

3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Production and Distribution of Writing

3.4 With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.

Research to Build and Present Knowledge

3.7 Conduct short research projects that build knowledge about a topic

3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Grade 4

Reading Informational Text

Integration of Knowledge and Ideas

4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.

Writing

Research to Build and Present Knowledge

4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Grade 5

Writing

Text Types and Purposes

5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Production and Distribution of Writing

5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge

5.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Grade 6

Reading

Integration of Knowledge and Ideas

6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Writing

Research to Build and Present Knowledge

6.7 Conduct short research projects to answer a question, drawing on several sources andrefocusing the inquiry when appropriate.

Science and Technical Subjects-Writing

Production and distribution of Writing

6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge

6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow formultiple avenues of exploration.

Common Core Mathematics

Grade 5
Mathematics
Geometry

Graph points on the coordinate plane to solve real-world and mathematical problems.
5.1 Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond.

Treasure Hunt

Time: approximately 50 minutes

WONDER WHY...

Have you ever wondered where crude oil is found in Illinois?

CONCEPT

A location can be found on a coordinate grid by using an ordered pair.

TEACHER INFORMATION:

Ordered Pairs

A coordinate grid is a special type of graph that is used to locate points. On the coordinate grid the horizontal axis is the x-axis and the vertical axis is the y-axis. Each axis is divided into units. The units are numbered along each axis. Ordered pairs are always in the order of (x,y). In an ordered pair, the first number tells how many units to go to the right, and the second number tells how many units to go up. Students can use the saying "Step Right Up!" to learn about the coordinate grid.

When reading the ordered pair, (9,3), the 9 is the x-coordinate and the 3 is the y-coordinate. To find (9,3) on the coordinate grid, start at (0,0), step right 9 units on the x-axis and from there go up 3 units. The point will be above the 9 on the x-axis and to the right of the 3 on the y-axis.

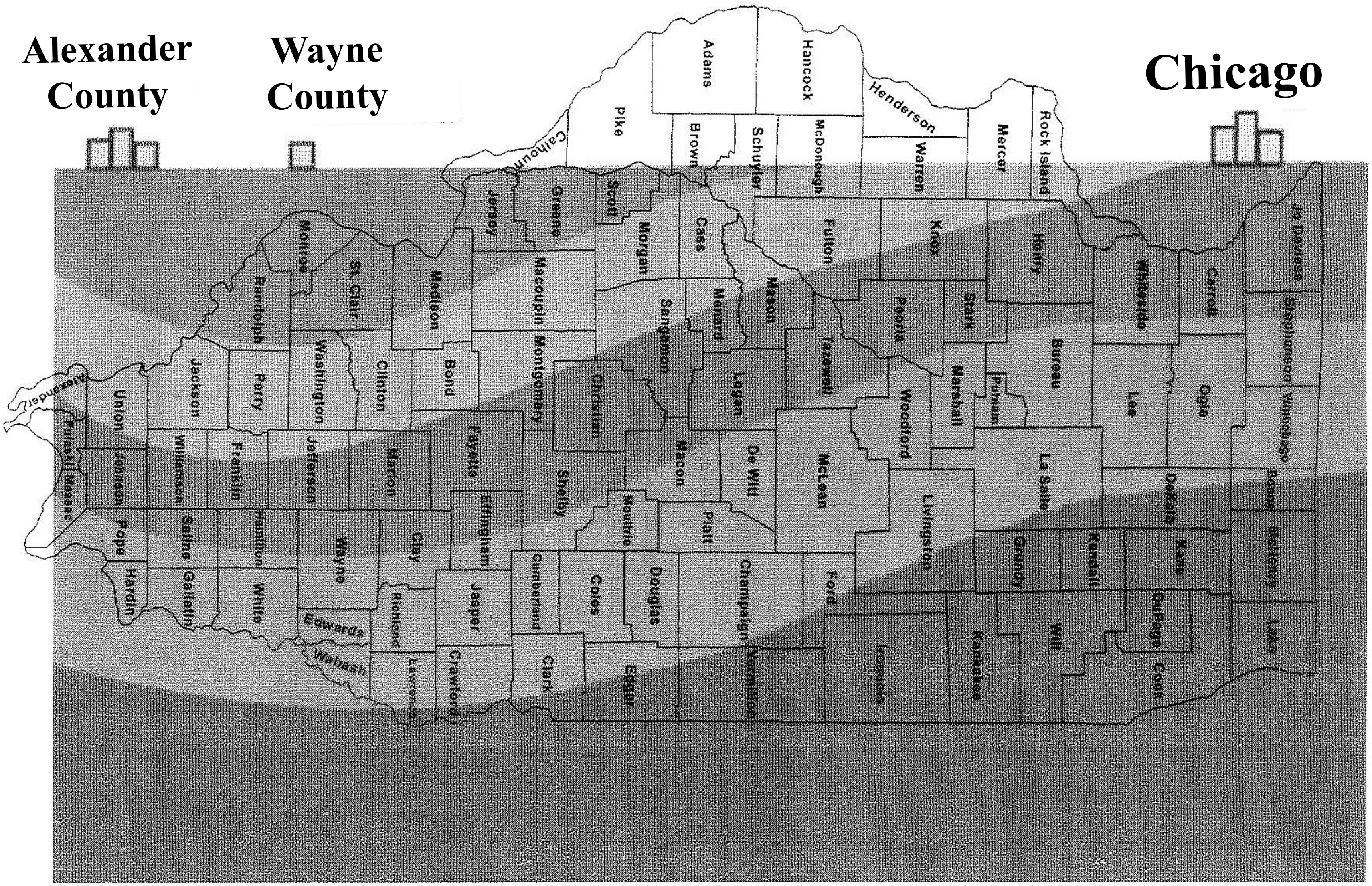
Illinois Basin

Millions of years ago much of the state of Illinois was covered by an ocean. When tiny plants and animals found in the ocean died, they sank to the bottom of the ocean and accumulated in large geologic basins. A basin is a large bowl-shaped depression in a rock formation. With increasing temperature and pressure and over a great period to time, the dead plants and animals were changed into crude oil and natural gas.

The majority of the Illinois Basin is located in Illinois, however portions of the basin are located in Indiana and Kentucky. The crude oil and natural gas formed in the basin was less dense than the water originally trapped when the sediments were deposited. Where the rock was permeable, the crude oil and natural gas migrated upward until it was blocked by an impermeable rock. Today, geologist search for that trapped oil in the basin.

The Illinois Basin

(See “Exploring the Illinois Basin” video)
at iprb.org/education/classroom-curriculum/references



1. WOW!

Help find where crude oil is located by plotting positions named by an ordered pair on Coordinate Grid 1. Give each student a copy of Coordinate Grid 1 and have them complete the Treasure Hunt and discuss the results.

MATERIALS FOR WOW:

- Coordinate Grid 1 – 1 per student

2. STUDENT ACTIVITY: TREASURE HUNT! (See student sheets)

MATERIALS FOR ACTIVITY: (per student)

- colored pencils
- Coordinate Grid 2
- Coordinate Grid 3

3. EXTENSION

- Use the Internet to research the amount of crude oil and natural gas produced in your county.
- Ask students to draw a picture on graph paper and make a list of the ordered pairs that were used to create the picture. Students can exchange lists of ordered pairs to recreate the designs.
- Look at a map of Illinois and locate where you live (county and town).
- Use the internet to learn more information about the top 5 oil producing counties in Illinois.

Treasure Hunt

Vocabulary

1. **basin** – a large bowl-shaped depression in the basement rock

2. **coordinate grid** - a network of evenly spaced horizontal and vertical lines

3. **coordinates** - a set of numbers, like an ordered pair, used in finding a location on a grid

4. **county** - land divisions of a state. Illinois has 102 counties; 44 are producing oil.

5. **crude oil** – oil in its natural liquid state (a mixture of gases, oil, and water) as it comes out of the ground

6. **map** - a drawing representing an area

7. **natural gas** – a gas which comes from the earth's crust

8. **oil well** - a hole drilled in the earth from which crude oil and natural gas are pumped

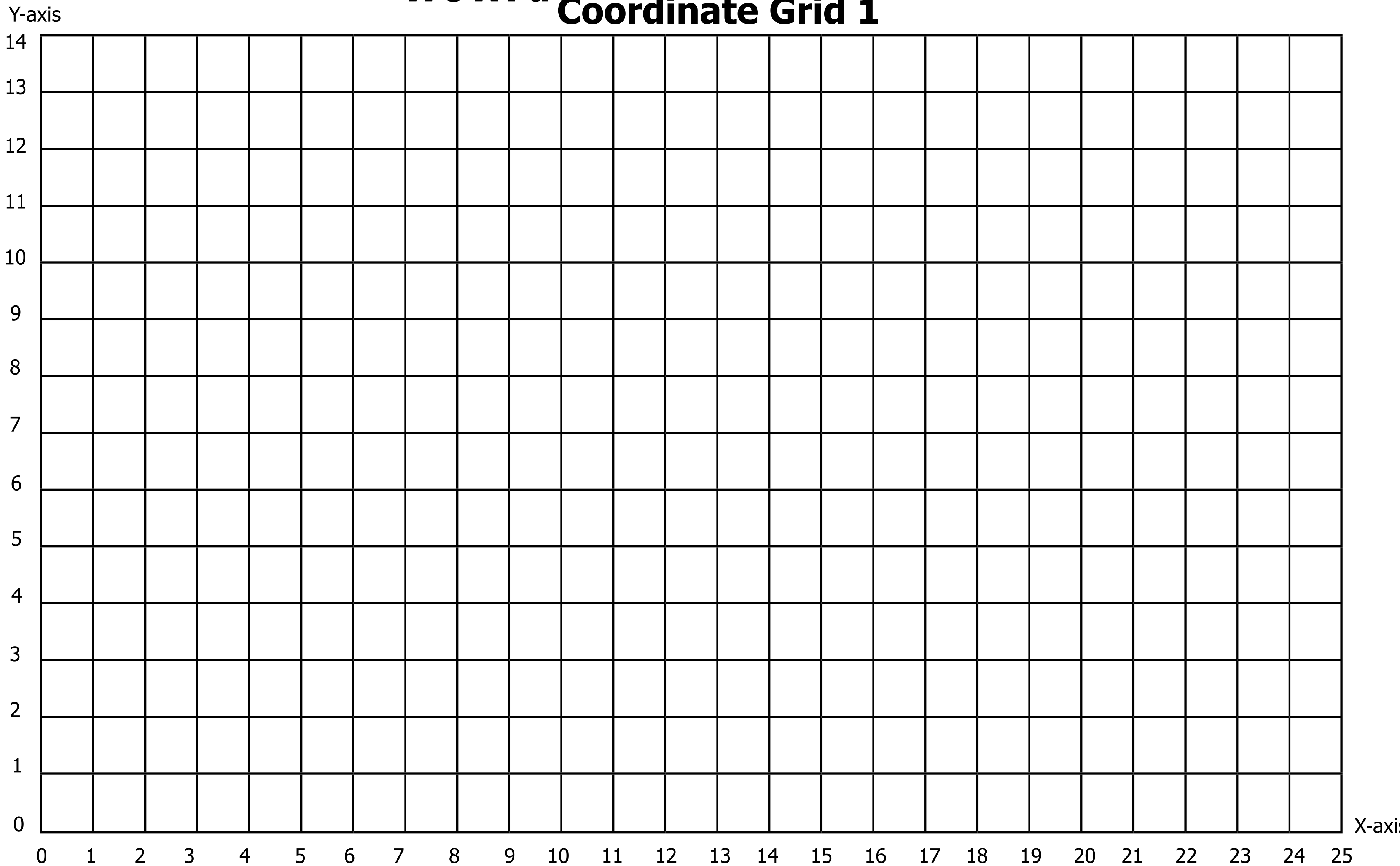
9. **ordered pair** - a pair of numbers used to find a location

10. **X-axis** - the horizontal line (left to right) on a grid

11. **Y-axis** - the vertical line (up and down) on a grid

Name ____________________

WOW! a Treasure Hunt Coordinate Grid 1

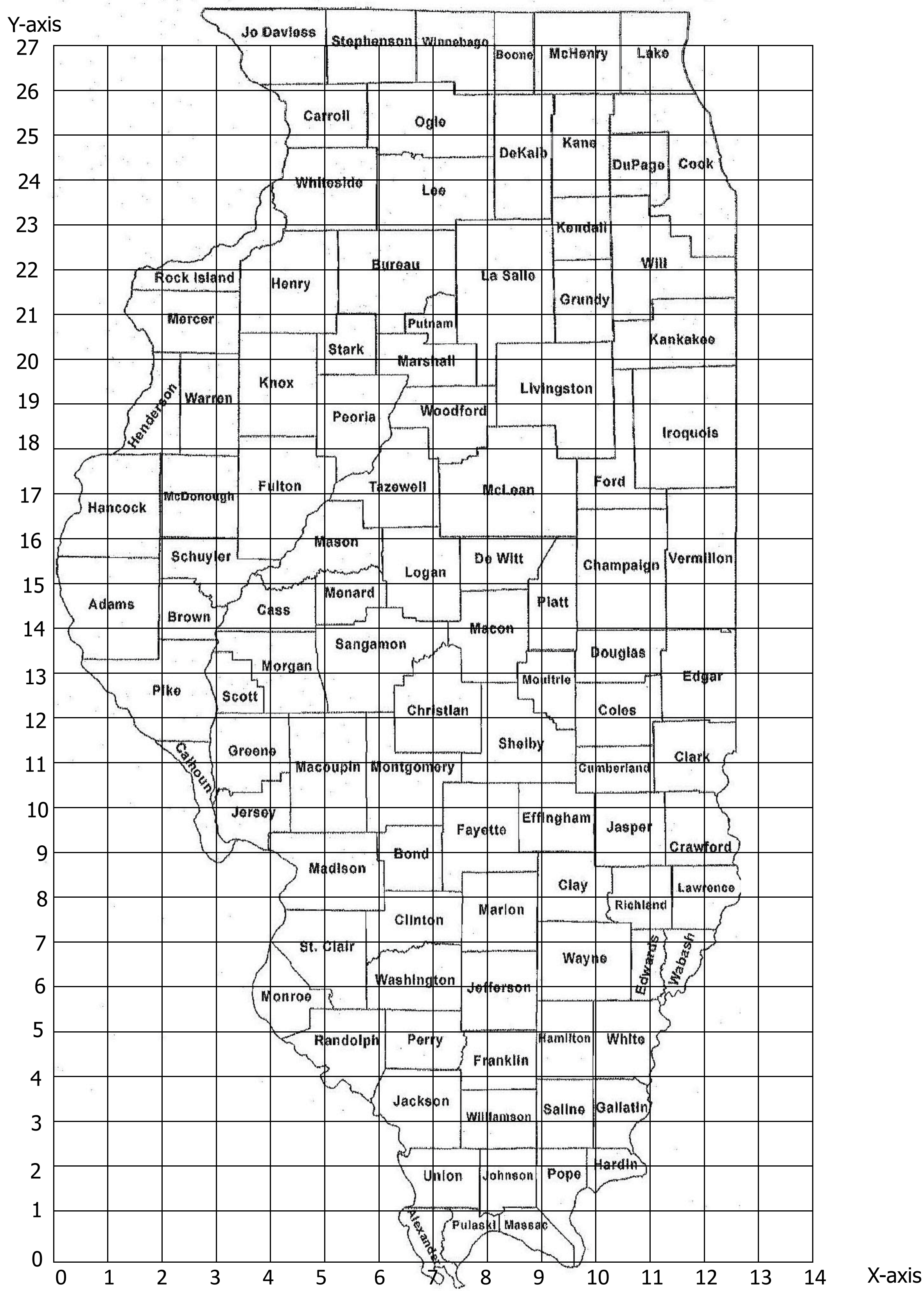


1. Find where oil and natural gas are located by graphing the following ordered pairs in the order given. Label each one with the corresponding letter on your graph and connect the points in order alphabetically. A(8,0) B(15,0) C(22,0) D(24,1) E(25,1) F(25,11) G(23,9) H(21,10) I(20,13) J(18,12) K(15,14) L(13,14) M(12,13) N(10,11) O(9,11) P(9,9) Q(7,10) R(6,10) S(5,9) T(4,7) U(3,7) V(1,6) W(2,5) X(1,3) Y(3,3) Z(3,2) AA(4,2) BB(6,1)
2. Look at the shape of your drawing. In which state are you looking for energy? ____________________

Coordinate Grid 2

Name ____________

Help locate the counties with the greatest production of crude oil.



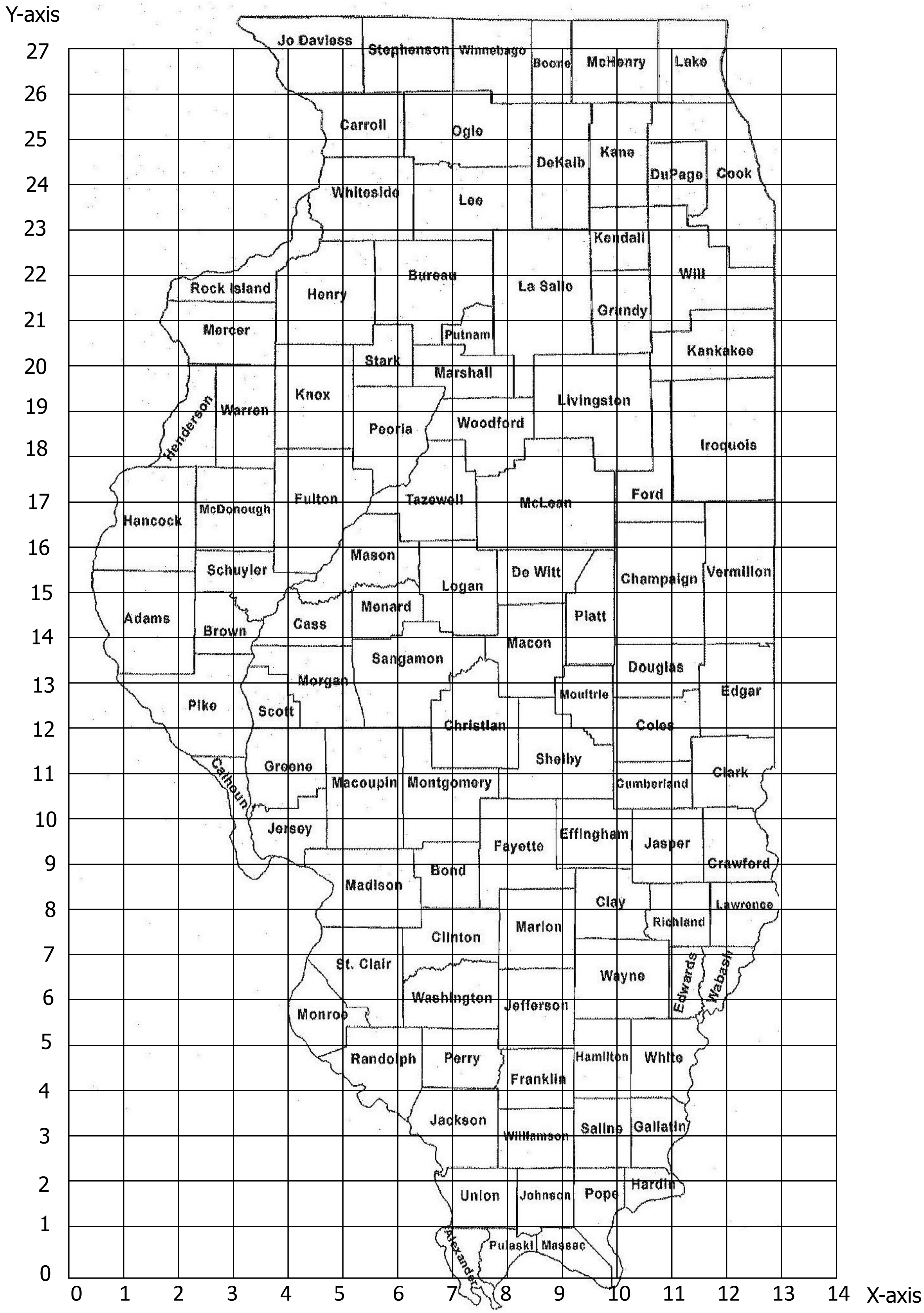
Plot each of the top 10 crude oil-producing counties with a green dot:

1(10,5) **2**(8,8) **3**(12,10) **4** (12,8) **5**(8,10) **6**(9,8) **7**(9,7) **8**(12,7) **9**(10,3) **10**(8,4)

Coordinate Grid 3

Name ____________________

Find the counties that make-up the two productive areas of the basin in Illinois by plotting the following ordered pairs in the order given. Connect the points around the perimeter of Area 1. Connect the points around Area 2.



Illinois Basin Area 1: (7,3) (11,3) (12,6) (13,9) (13,12) (9,12) (9,16) (8,16) (6,14) (5,11) (5,6) ____________________

Illinois Basin Area 2: (3,14) (4,15) (3,17) (2,14) ____________________

Name ____________________________Date ______________

TREASURE HUNT!
STUDENT SHEET

WONDER WHY...

Have you ever wondered where crude oil is found in Illinois?

CONCEPT

A location can be found on a coordinate grid by using an ordered pair.

MATERIALS FOR ACTIVITY: (per student)

- colored pencils
- Coordinate Grid 2
- Coordinate Grid 3

PROCEDURE

1. Use the information in Table 1 and Coordinate Grid 2, to locate the top 10 crude oil-producing counties in Illinois in 2010. Plot each of the top 10 crude oil-producing counties with a green dot.
2. Write the name of each county in Table 1.

TABLE 1: Top 10 Oil-Producing Counties in Illinois in 2010

Rank in Oil Production	Ordered Pair	County
1	(10, 5)	
2	(8, 8)	
3	(12, 10)	
4	(12, 8)	
5	(8, 10)	
6	(9, 8)	
7	(9, 7)	
8	(12, 7)	
9	(10, 3)	
10	(8, 4)	

5. Using Coordinate Grid 3, plot the ordered pairs and connect the points to locate the counties that makeup the perimeter of two productive areas of the basin in Illinois.

Name ____________________________**Date** ______________

CONCLUSION

1. Some Illinois counties produce more crude oil than others. How would you describe the location of these counties in Illinois?

____

____

2. How would you describe the area 1 portion of the basin?

____

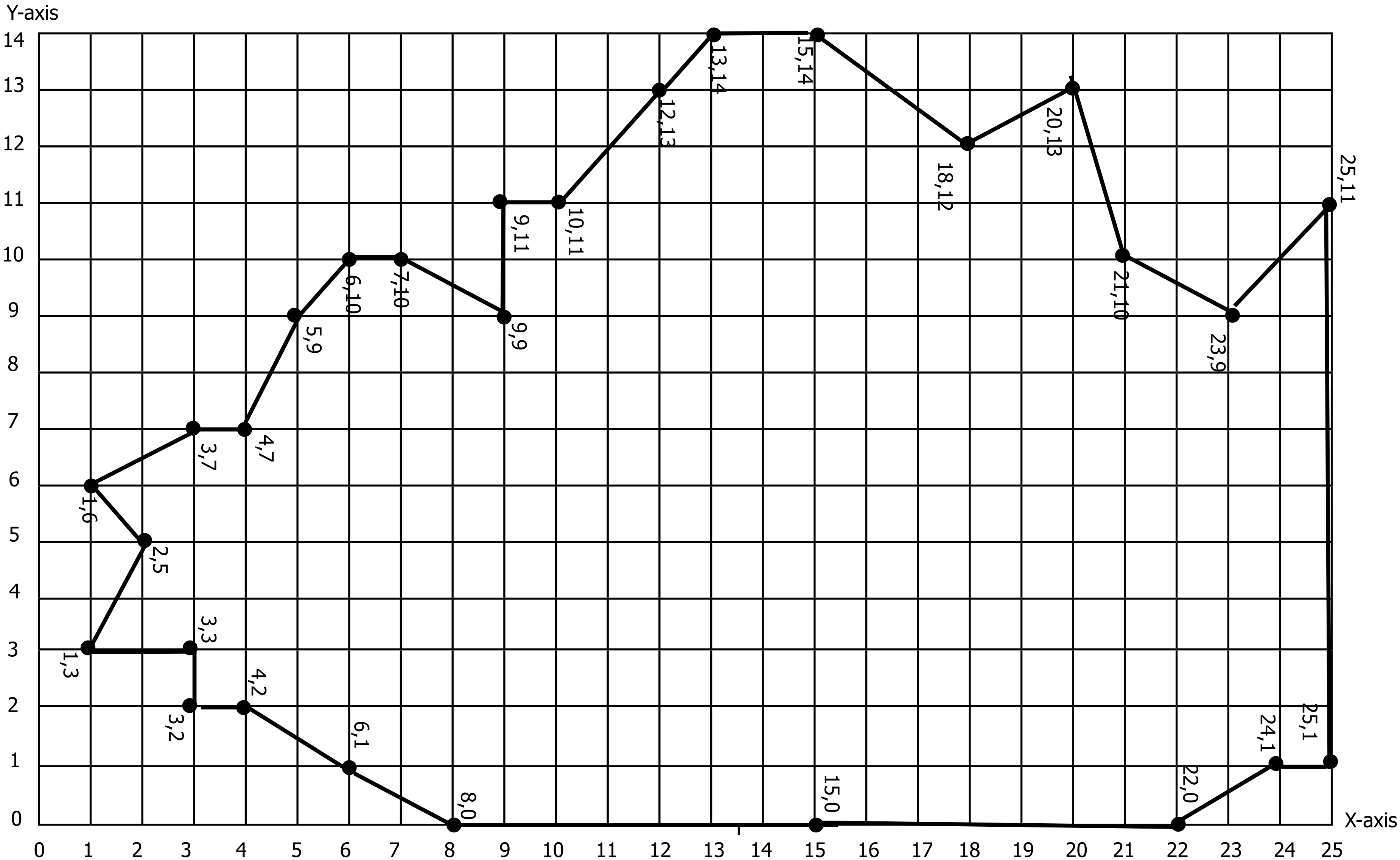
____

Extended Response

- Use the internet to research one of the jobs involved in oil or natural gas exploration. For example, geologist, petroleum engineer, land surveyor, wild catter, etc. Write a narrative explaining which job you find most interesting and why. Career information can be found on www.iprb.org.

- Create a Venn Diagram and research the Illinois Basin verses the Williston Basin in North Dakota. Use the information to write an essay comparing and contrasting the two basins.

Coordinate Grid 1
Treasure Hunt!



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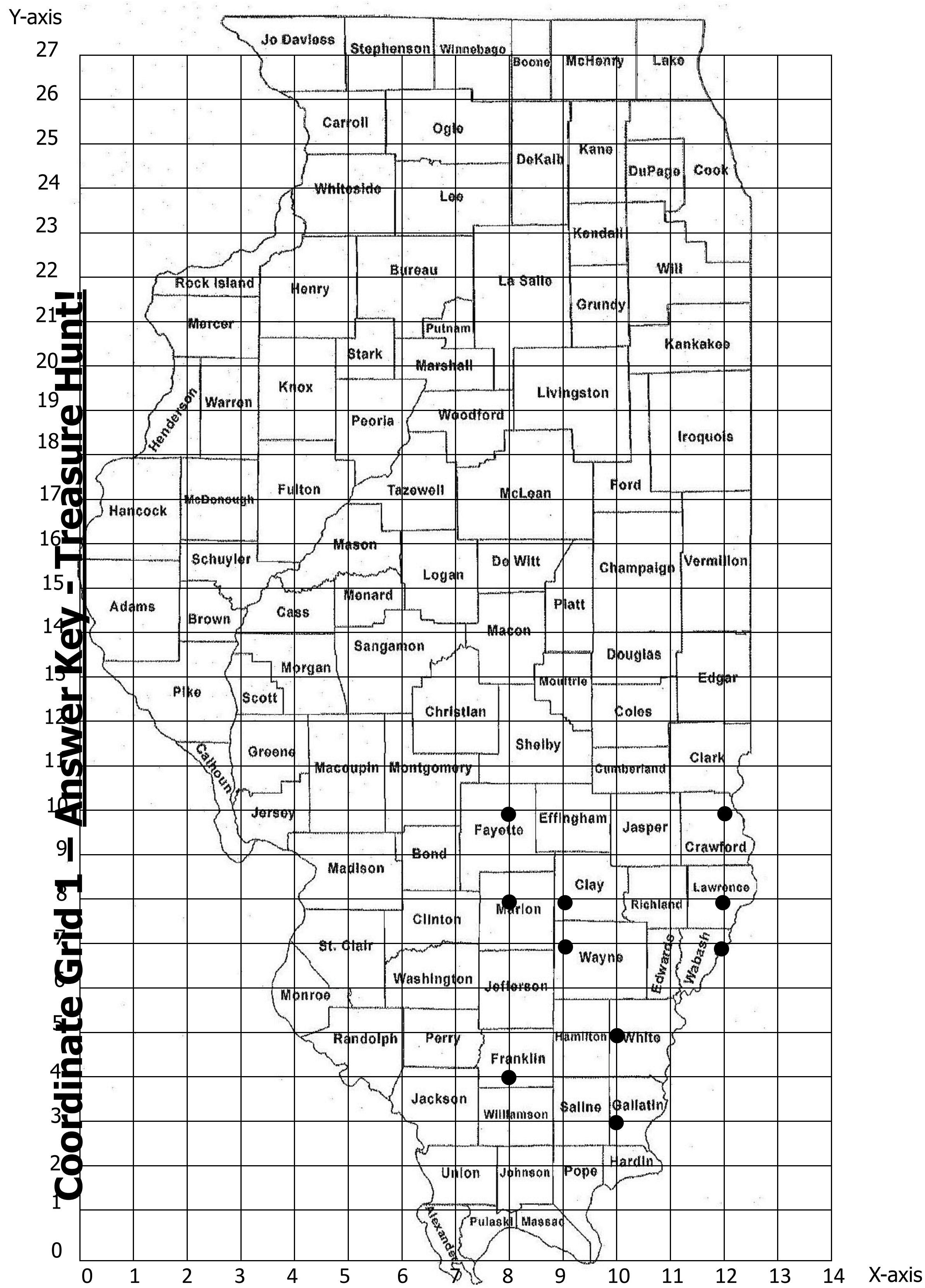
2. Look at the shape of your drawing. In which state are you looking for energy? **Illinois**

Coordinate Grid 2 – Answer Key

Help locate the counties with the greatest production of crude oil.

Coordinate Grid 1 – Answer Key - Treasure Hunt!



Plot each of the top 10 crude oil-producing counties with a green dot:

1(10,5) **2**(8,8) **3**(12,10) **4** (12,8) **5**(8,10) **6**(9,8) **7**(9,7) **8**(12,7) **9**(10,3) **10**(8,4)

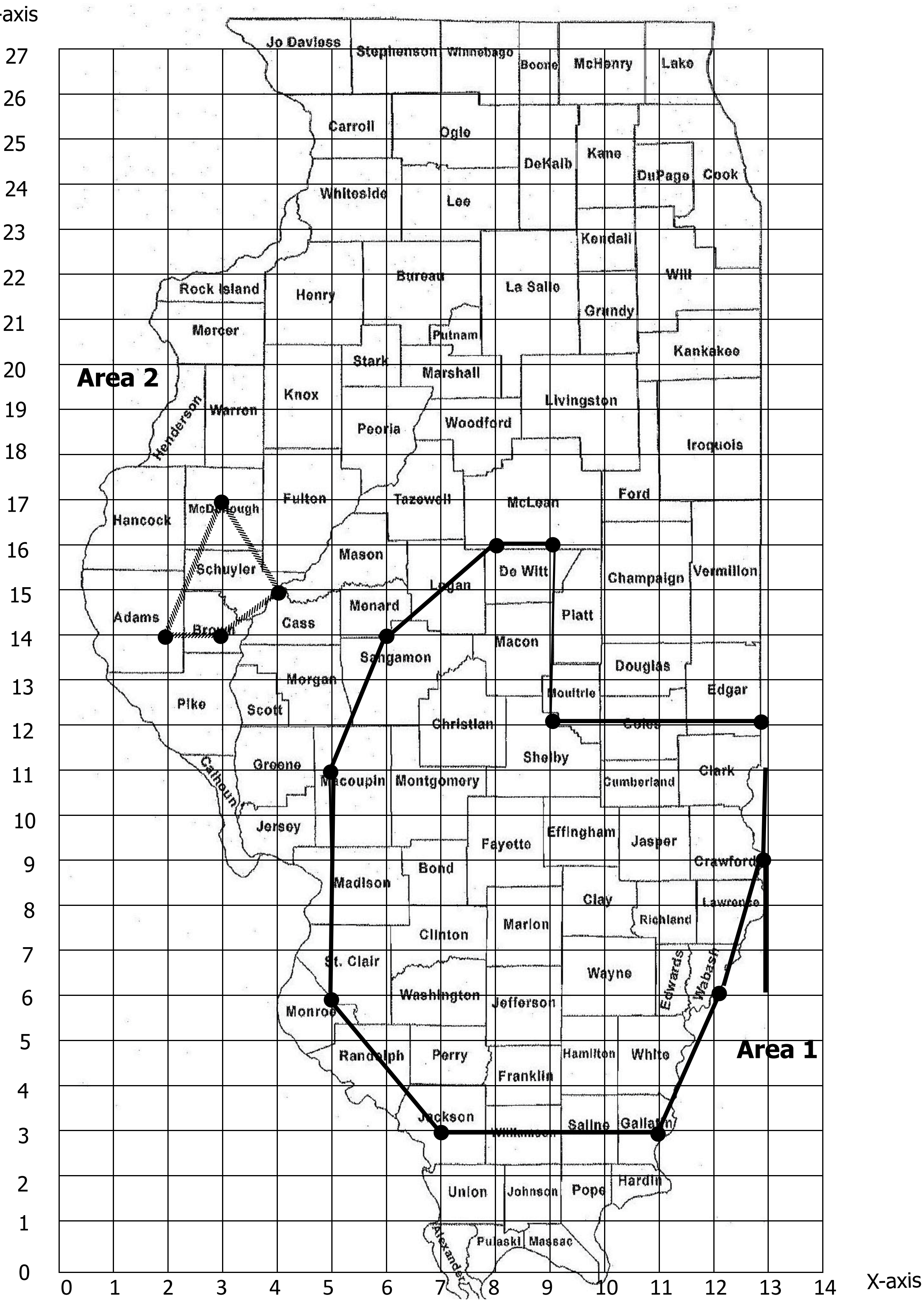
ANSWER KEY

TABLE 1: Top 10 Oil-Producing Counties in Illinois in 2010.

Rank in Oil Production	Ordered Pair	County
1	(10, 5)	White
2	(8, 8)	Marion
3	(12, 10)	Crawford
4	(12, 8)	Lawrence
5	(8, 10)	Fayette
6	(9, 8)	Clay
7	(9, 7)	Wayne
8	(12, 7)	Wabash
9	(10, 3)	Gallatin
10	(8, 4)	Franklin

Coordinate Grid 3 – Answer Key

Find the counties that make-up the two productive areas of the basin in Illinois by plotting the following ordered pairs in the order given. Connect the points around the perimeter of Area 1. Connect the points around Area 2.



Illinois Basin Area 1: (7,3) (11,3) (12,6) (13,9) (13,12) (9,12) (9,16) (8,16) (6,14) (5,11) (5,6) ————————
Illinois Basin Area 2: (3,14) (4,15) (3,17) (2,14) ————————

CONCLUSION

Answer Key

1. Some Illinois counties produce more crude oil than others. How would you describe the location of these counties in Illinois?

They are located primarily in the south eastern part of the state.

2. How would you describe the area 1 portion of the basin?

Most of the southern part of Illinois from Springfield south to near the Shawnee Forest, and from Springfield easterly to the Indiana border.

Rubric for Venn Diagram & Extended Response

4 Advanced	Compares and contrasts items clearly. The writer points to specific examples to illustrate the comparison. The writer includes only the information relevant to the comparison.
3 Proficient	Compares and contrasts items clearly, but supporting information is incomplete. Essay may include information that is not relevant to the comparison.
2 Basic	Compares and contrasts items clearly but the supporting information is incomplete. Essay may include information that is not relevant to the comparison.
1 Below Basic	Compares or contrasts but not both. There is no supporting information or the support is incomplete.
0	Does not show comparing or contrasting. Student only presents a minimal amount of information.

Rock Detective

<u>Next Generation Science Standards</u>

Grade 4

Earth's Place in the Universe

4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

Earth and Human Activity

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Grade 5

Matter and Its Interactions

5-PS1-3 Make observations and measurements to identify materials based on their properties.

Common Core Standards

<u>Literacy in Science and Technical subjects</u>

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Integration of Knowledge and Ideas

3.8 Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).

Writing
Text Types and Purposes

3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

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3.4 With guidance and support from adults, produce writing in which the development and organization are appropriate to task and purpose.

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3.7 Conduct short research projects that build knowledge about a topic

3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

Grade 4

Reading Informational Text

Integration of Knowledge and Ideas

4.7 Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears

Writing

Research to Build and Present Knowledge

4.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Grade 5

Writing

Text Types and Purposes

5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Production and Distribution of Writing

5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge

5.7 Conduct short research projects that build knowledge through investigation of different aspects of a topic.

Grade 6

Reading

Integration of Knowledge and Ideas

6.7 Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Writing

Research to Build and Present Knowledge

6.7 Conduct short research projects to answer a question, drawing on several sources andrefocusing the inquiry when appropriate.

Science and Technical Subjects-Writing

Production and distribution of Writing

6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Research to Build and Present Knowledge

6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Rock Detective

Time: approximately 60 minutes

WONDER WHY...

Why do rocks look different from each other?

CONCEPT

Rocks are a natural, solid, nonliving material made of two or more minerals. Using a dichotomous key, rocks can be identified by physical properties such as color, luster, texture, feel or grain size.

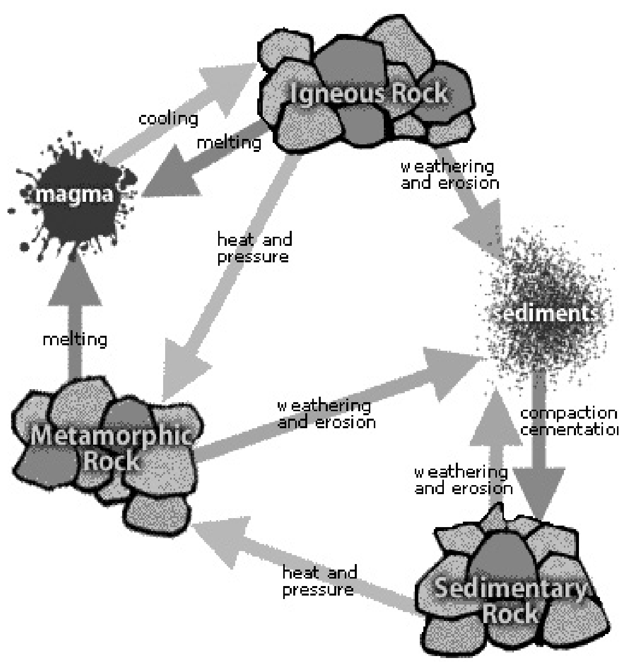
TEACHER INFORMATION:

Earth's outer layer, or crust, is made mostly of rock. Rocks are naturally occurring solid material consisting of two or more minerals. Rocks are identified based on observable physical properties such as: luster, color, feel/texture, shape, and grain size.

Rocks occur in three major groups based on how they are formed.

- **Igneous rocks** are formed underground as magma (melted rock) which cools, and turns into a solid called igneous rock. Igneous rocks can also be formed on the surface of the earth when molten magma from volcanoes cools.
- **Metamorphic rocks** form when existing sedimentary or igneous rocks are subjected to increased heat and pressure inside the Earth's crust.
- **Sedimentary rocks** form from sediments. Sediment is created by the erosion, or breaking up of, igneous, metamorphic or sedimentary rocks. As these sediments and other materials, such as plants and animals, are buried deep below ground they are subjected to increased heat and pressure. This increased heat and pressure changes the sediment to sedimentary rock.

Figure 1
Rock Cycle



Over many years igneous, metamorphic and sedimentary rocks are formed and then worn away by erosion again and again. This continuous process that rocks go through is called the **rock cycle**. As seen in Figure 1, the three types of rocks can change from one type to another at different points within the rock cycle. Geologist refer to the oldest rocks in Illinois as "basement" rocks.

Geologists often classify areas as either uplifts (high areas) or basins (low areas). As the uplifted areas are subjected to erosion, the material that is eroded (sediment) is washed off the uplifts and collects in the adjacent low areas or basins, forming thick layers of sediment over time that later may be transformed by heat and pressure into sedimentary rocks.

Sedimentary rocks, like sandstone and limestone, are the most likely rocks to contain crude oil and natural gas trapped in the rock pores.

In this activity, students will become rock detectives and use physical properties to classify rocks.

1. WOW! Have students watch Exploring the Illinois Basin video at: https://iprb.org/education/classroom-curriculum/references/ and discuss the statements from the video. Divide students into groups. Give each group a container of 10 rocks. Have students come up with ways to sort the rocks using physical properties. Have groups share and discuss results.

MATERIALS FOR WOW:
- Exploring the Illinois Basin at https://iprb.org/education/classroom-curriculum/references/
- 1 collection of 10 rocks per group
- 2 magnifying lens per group

2. STUDENT ACTIVITY: ROCK DETECTIVE! (See students sheets)

MATERIALS FOR ACTIVITY:
- 1 collection of 10 rocks per group
- 2 magnifying lens per group
- 1 Rock Identification Sheet per student
- 1 Rock Identification Dichotomous Key per student

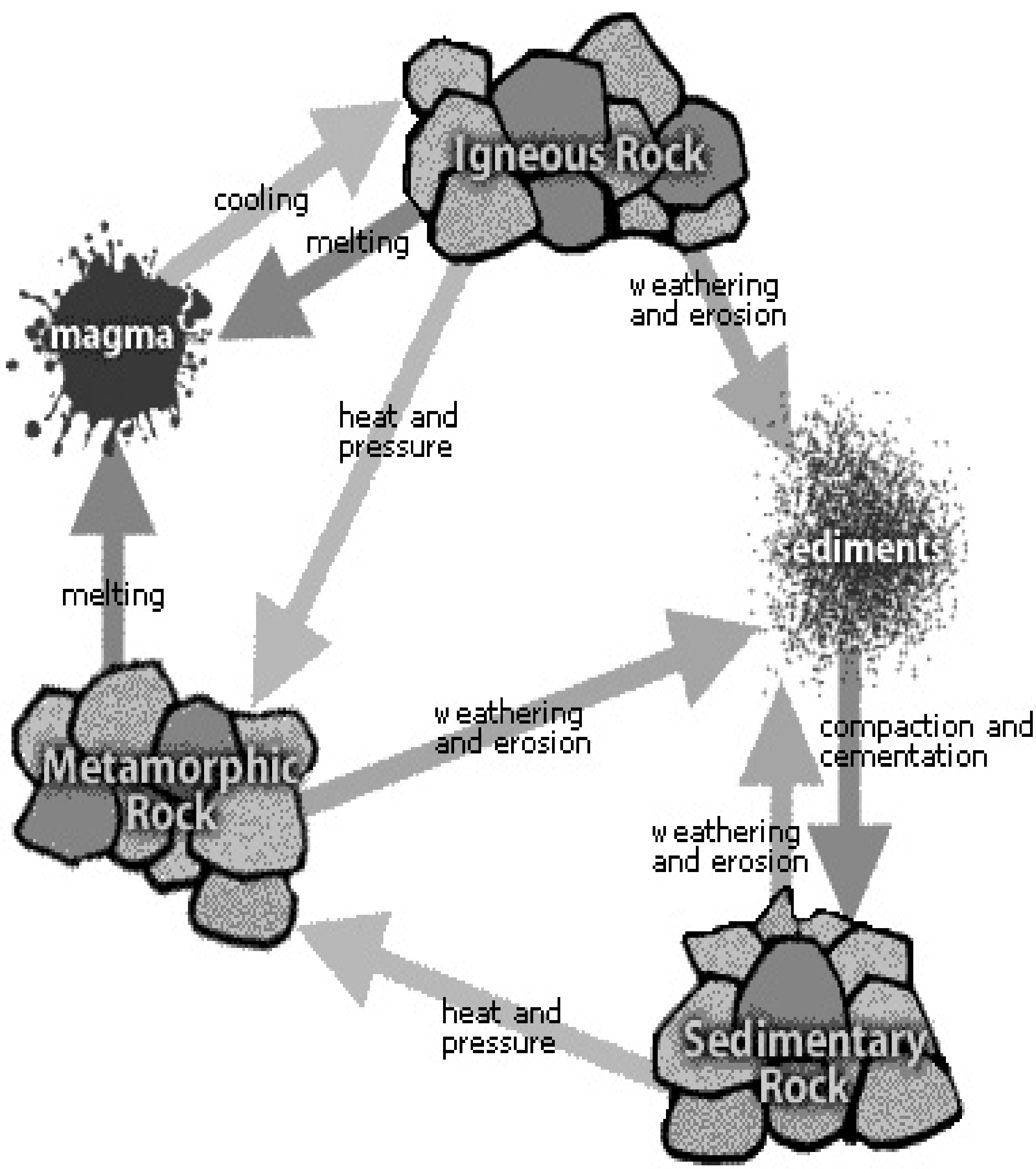
Let's Go Rock Collecting, By: Roma Gans, Illustrated by: Holly Keller, ISBN-13: 978-0-06-445170-3 (included in lab/kit

3. EXTENSION:

- Develop a poster about the rock cycle and determine how igneous, sedimentary and metamorphic rocks are formed.

Extended Response:
- Write a short story from the viewpoint of a particular sedimentary, igneous or metamorphic rock as you travel through the rock cycle moving from one type of rock to another.

Figure 1
Rock Cycle



Rock Detective

Vocabulary

1. **crude oil** – oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

2. **dichotomous key** – a key used for the identification of objects based on a series of choices

3. **granular** – containing small, hard particles or grains

4. **igneous rocks** - form when the magma (melted rock) cools and turns solid

5. **layering** – horizontal layers or lines

6. **luster** - the way light reflects from a surface

7. **metamorphic rocks** - form when existing rocks are exposed to increased heat and pressure inside the Earth's crust.

8. **mineral** - a solid inorganic material found in the Earth's crust; the building blocks of rocks

9. **natural gas** - colorless, odorless gas found in the Earth

10. **physical property** – what can be seen or measured

11. **pore** – openings or spaces within a rock

12. **rock** - the solid part of earth made of two or more minerals

13. **rock cycle** - the series of events that rocks, over time, go through that changes them from one type of rock to another.

14. **sedimentary rocks** - form when sediments and other materials press together and harden

15. **texture** – characteristic of a rock that you can see and feel

Name________________________ Date ______________

ROCK DETECTIVE!
STUDENT SHEET

WONDER WHY...

Why do rocks look different from each other?

CONCEPT

Rocks are a natural, solid, nonliving material made of one or more minerals. Using a dichotomous key, rocks can be identified by physical properties such as color, luster, texture, feel or grain size.

MATERIALS FOR ACTIVITY:

- 1 collection of 10 rocks per group
- 2 magnifying lens per group
- 1 Rock Identification Sheet per student
- 1 Rock Identification Dichotomous Key per student

SAFETY:

- Keep rocks on the table or desktop.
- Do not put rocks in mouth.
- Wash hands after handling rocks.

PROCEDURE:

1. Place the rock samples out on the table.
2. Select one rock from the rock samples.
3. Read carefully through the Rock Identification Dichotomous Key to classify and name the rock.
4. Record the rock number on the Rock Identification Sheet in the

   blank next to the correct name of the rock.
5. Record the physical properties of the rock.
6. Repeat steps 3-6 until all rock samples have been classified.
7. Share your results with the class.

Rock Identification

Dichotomous Key

1. What is the overall color of the rock?
   a. Rock is black in color ....Go to step 2
   b. Rock is not black ....Go to step 3

2. Is the rock glassy or not?
   a. Rock is smooth and glassy ....Obsidian (Igneous)
   b. Rock is not glassy ....Go to step 4

3. Inspect the rock carefully **without** the hand lens. Are there large holes or pores?
   a. Rock has visible holes or pores .... Go to step 5
   b. Rock has small or unseen pores ....Go to step 6

4. Does the rock show layering or is it more blocky?
   a. Rock is layered ....Shale (Sedimentary)
   b. Rock is not layered it is more blocky ....Coal (Sedimentary)

5. What is the overall color of the rock?
   a. Rock is grey or light grey ....Pumice (Igneous)
   b. Rock is reddish-brown or dark brown .... Scoria (Igneous)

6. Look closely at the rock **with** a hand lens. Does the surface sparkle or have crystals?
   a. Rock sparkles or appears crystalline ....Go to step 7
   b. Rock is dull and doesn't sparkle ....Go to step 8

7. Look carefully at the rock. Is the rock multicolored or not?
   a. Rock color is multicolored or speckled .... Go to step 9
   b. Rocks color is the same throughout ....Marble (Metamorphic)

8. Look closely at the rock **with** a hand lens. Are the grains large or small?
   a. Rock grains are pebble size and/or mixed sizes ....Conglomerate (Sedimentary)
   b. Rock grains are mostly sand size ....Sandstone (Sedimentary)

9. Does the rock show layering of grains?
   a. Rock grains are in layers ....Gneiss (Metamorphic)
   b. Rock grains are scattered with crystals ....Granite (Igneous)

Luster

What is Luster?
Luster refers to how light is reflected from the surface of a mineral. The two main types of luster are metallic and nonmetallic.

What is Metallic Luster?
Minerals exhibiting metallic luster look like metal, such as a silvery appearance or that of a flat piece of steel.

How many types of nonmetallic luster are there?

- Vitreous: The luster of glass
- Resinous: The luster of resin.
- Pearly: The luster of pearls.
- Greasy: Looks like it is covered in a thin layer of oil.
- Silky: The luster of silk.
- Adamantine: A hard, brilliant luster.

Another common nonmetallic luster is called **translucent** luster, where you can see into the mineral, but not completely through it. A mineral that displays a **transparent** luster transmits light completely through it, resembling glass.

From: http://www.mineralogy4kids.org/mineral-properties/luster

Color

Color can always be due to an impurity or surface stain.

- Bright blue to green: suspect a copper mineral. Dull greens are usually not copper greens, nor are blues that have a violet cast.
- Earth tones are almost always due to iron, either as a principal ingredient or as an impurity or surface coating.
- *Bright* yellow, orange or red: suspect one of the non-metallic sulfides, then one of the transition metal radicals (chromate, vanadate, etc.). A few oxides are also brightly colored. Some uranium minerals are bright yellow or yellow-green.
- Pink: if hard, suspect potassium feldspar. The common manganese minerals rhodonite (silicate) and rhodochrosite (carbonate) are also pink, and manganese can stain other minerals pink as well. Some lithium silicates are also pink or lavender.
- Black or dark green: if hard, suspect a ferromagnesian silicate
- Pea green, especially in granite or a metamorphic rock: epidote. Almost always.
- Dark green mineral in sandstone: glauconite

- Light blue mineral in carbonate rocks: celestite
- Light blue mineral with long crystals in metamorphic rocks: kyanite

From: https://www.uwgb.edu/dutchs/Petrology/IdentifyRxMin.htm

Texture

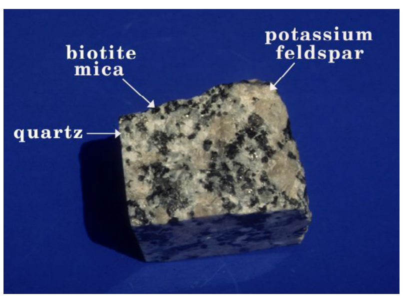
Texture for Metamorphic Rocks

Texture is divided into two groups. Foliated textures show a distinct planar character. This means that the minerals in the rock are all aligned with each other. This planar character can be flat like a piece of slate or folded. Non-foliated textures have minerals that are not aligned. Essentially, the minerals are randomly oriented

From: http://facweb.bhc.edu/academics/science/Harwoodr/Geol101/labs/metamorf/index.htm

Texture for Igneous Rocks

A) COARSE GRAINED TEXTURE (PHANERITIC), mineral grains easily visible (grains several mm in size or larger)

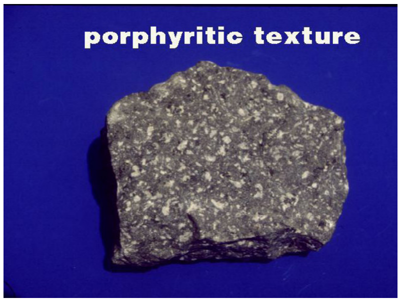


A hand specimen of granite with phaneritic (course grained texture. Principal minerals are Potassium Feldspar, Biotite Mica, and Quartz.

B) FINE GRAINED TEXTURE (A PHANITIC), mineral grains smaller than 1mm (need hand lens or microscope to see minerals)

A hand specimen of basalt with aphanitic (fine grained) texture. The dark color is due to abundant dark colored minerals (pyroxene, hornblende).

C) PORPHYRITIC TEXTURE (MIXED FINE AN COARSE)

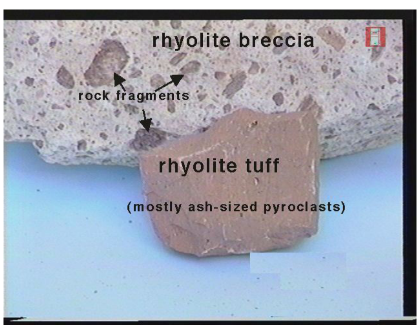


A hand specimen of a volcanic rock with porphyritic texture. Larger crystals of plagioclase feldspar (white), are suspended in a groundmass/matrix of fine grained dark and light minerals (thus the gray color). The plagioclase had already crystallized at depth in the underlying magma chamber, and was suspended in a magma. When the lava erupted it cooled down rapidly, and formed the fine grained matrix around the already existing plagioclase crystals.

D) GLASSY TEXTURE (NO CRYSTALS VISIBLE)

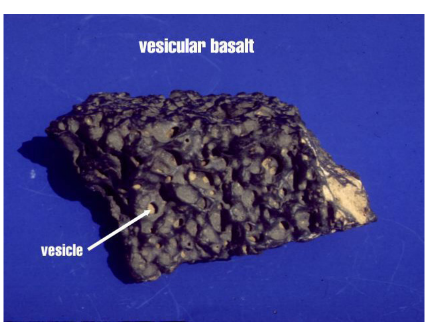
A handspecimen of obsidian (volcanic glass). The cooling occurs so rapidly that no crystals have time to form. Thus, we have a glass (no ordering like in minerals) and the rock breaks like glass does, with a conchoidal fracture.

E) PYROCLASTIC TEXTURE (VOLCANIC ASH AND TUFF DEPOSITS)



Handspecimens of a rhyolite breccia and a rhyolite tuff. Both are volcanic rocks of granitic composition, that formed due to explosive volcanism. Bits of preexisting volcanic rocks are reduced to rubble, mixed with newly erupted material, and blown up in the air. As the material settles down we get rocks with an obvious fragmental component (rhyolite breccia), and if it is very fine we may only see those fragments with a microscope (rhyolite tuff).

F) VESICULAR TEXTURE (Open spaces, bubbles)

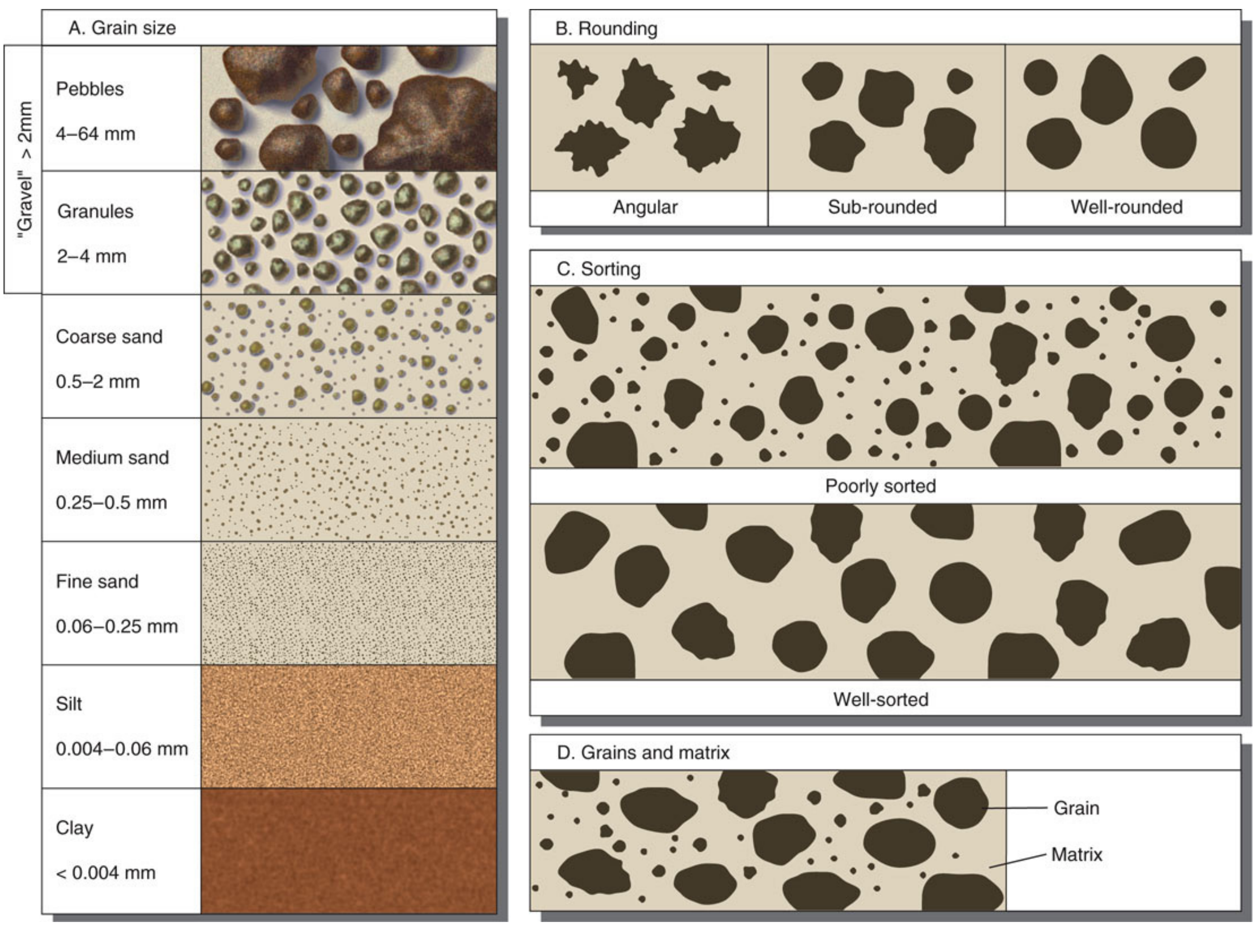


If magma contains dissolved gases, these will tend to bubble out when the magma comes to the surface (just like CO_2 bubbles out of a bottle of Seltzer). Because cooling is rapid, not all the gas may escape from the lava flow and bubbles (vesicles) are preserved.

G) FROTHY TEXTURE (abundant small bubbles, more bubbles than rock)

Handspecimen of pumice with frothy texture. Pumice is volcanic glass with abundant bubbles, so many in fact that pumice often floats in the water. The sharp edges of open bubbles on broken surfaces make this rock useful as an abrasive. Pumicestones that are sold in drugstores for skincare, work on that principle.

From: http://www.indiana.edu/~geol105/images/gaia_chapter_5/igneous_rock_textures.htm



From: http://www.earth.lsa.umich.edu/earth118/Sedimentary.htm

Name_____________________________ Date ________________

TABLE 1: ROCK IDENTIFICATION

<table>
<tr><td rowspan="2">Igneous</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

OBSIDIAN # _____</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

PUMICE # _____</td></tr>
<tr><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

SCORIA # _____</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

GRANITE # _____</td></tr>
<tr><td rowspan="2">Sedimentary</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

SHALE # _____</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

SANDSTONE # _____</td></tr>
<tr><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

COAL # _____</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

CONGLOMERATE # _____</td></tr>
<tr><td>Metamorphic</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

MARBLE # _____</td><td>Color: ________________
Luster: ________________
Feel/Texture:______________
Grain Size:______________

GNEISS # _____</td></tr>
</table>

Name______________________________ Date _______________

CONCLUSION

1. What properties did you use to classify your rocks?__________________________

____

2. Choose two or more of the sedimentary rock specimens to compare and contrast.

____

____

3. In what type of rock do you think crude oil and natural gas are most likely to be found? Why?

____

____

Name______________________________ Date _______________

Extended Response:

- Write a short story from the viewpoint of a particular sedimentary, igneous or metamorphic rock as you travel through the rock cycle moving from one type of rock to another.

Rubric for Venn Diagram & Extended Response

4 **Advanced**	In addition to score 3 performance, in depth inference and what was taught. In addition to score 3, was able to show creativity and originality above and beyond the information that was explicitly taught.
3 **Proficient**	No major errors or omissions regarding any of the information and/or processes, simple or complex, that was explicitly taught. Shows understanding of the rock cycle and can connect the fact that rocks change form over long periods of time by being exposed to heat, pressure, weathering, and erosion, etc.
2 **Basic**	No major errors or omissions regarding the simpler details and processes but major errors or omissions regarding more complex ideas and processes. Shows understanding of rock cycle and can connect the simpler details.
1 **Below Basic**	With help, a partial understanding of some of the simpler details and processes, and some of the more complex ideas and processes.

TABLE 1: ROCK IDENTIFICATION - Answer Key

Igneous	Color: **Black** Luster: **Glassy** Feel/Texture: **Glassy, smooth** Grain Size: **Cannot see grains** OBSIDIAN #**6**	Color: **Light colored** Luster: **Dull** Feel/Texture: **Many holes or pores** Grain Size: **Fined grained** PUMICE #**7**
	Color: **Reddish Brown – Dark brown** Luster: **Dull** Feel/Texture: **Many holes or pores** Grain Size: **Fine grained** SCORIA #**9**	Color: **Variable** Luster: **Crystalline** Feel/Texture: **Crystals visible** Grain Size: **Coarse** GRANITE # **4**
Sedimentary	Color: **Grey – Dark grey – black** Luster: **Dull** Feel/Texture: **Thin layers visible** Grain Size: **Fine to very fine grained** SHALE #**10**	Color: **Variable** Luster: **Dull** Feel/Texture: **Grainy - rough** Grain Size: **Sand size grains** SANDSTONE #**8**
	Color: **Black – Dark grey** Luster: **Dull - Shiny** Feel/Texture: **Blocky** Grain Size: **Fine grained** COAL #**1**	Color: **Variable** Luster: **Dull** Feel/Texture: **Grainy - rough** Grain Size: **Larger than sand size grains** CONGLOMERATE #**2**
Metamorphic	Color: **Variable** Luster: **Crystalline - sparkles** Feel/Texture: **Rough** Grain Size: **Fine grained** MARBLE #**5**	Color: **Variable** Luster: **Crystalline - sparkles** Feel/Texture: **Layers of crystals or color** Grain Size: **Fine to coarse** GNEISS #**3**

CONCLUSION

Answer Key

1. What properties did you use to classify your rocks? Physical properties such as luster, color, grain size, and composition.

2. Choose two or more of the sedimentary rock specimens to compare and contrast. Possible Answer: Shale and coal are both grey and black in color. They both have a dull luster. The shale has visible thin layers while the coal is blocky. Both are very fine-grained.

3. In what type of rock do you think crude oil and natural gas are most likely to be found? Why? Sedimentary rocks because of the three rock types they are the most likely to contain pores and connected pores where oil and natural gas can be trapped and stored.

Thirsty Rocks

Next Generation Science Standards

Grade 4

Earth's Place in the Universe

4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

Earth's Systems

4-ESS2-1 Plan and conduct investigations on the effects of water, ice, wind, and vegetation on the relative rate of weathering and erosion.

Earth and Human Activity

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Grade 5

Matter and Its Interactions

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3 Make observations and measurements to identify materials based on their properties.

Common Core Standards

Literacy in Science and Technical subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Craft and Structure

3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Range of Reading and Level of Text Complexity

3.10 By the end of the year, read and comprehend informational texts, including history/ social studies, science, and technical texts, at the high end of the grades 2–3 text complexity bandindependently and proficiently.

Writing

Text Types and Purposes

3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly. b. Develop the topic with facts, definitions, and details.

Grade 4

Reading Informational Text

Key Ideas and Details

4.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure

4.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 4 topic or subject area.

4.5 Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/ solution) of events, ideas, concepts, or information in a text or part of a text.

Range of Reading and Level of Text Complexity

4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Writing

Range of Writing

4.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grade 5

Reading Informational Text

Key Ideas and Details

5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Craft and Structure

5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Range of Reading and Level of Text Complexity

5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

Writing

Range of Writing

5.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grade 6

Reading Informational Text

Key Ideas and Details

6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Craft and Structure

6.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings

Range of Reading and Level of Text Complexity

6.10 By the end of the year, read and comprehend literary nonfiction in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range

Writing

Range of Writing

6.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Science and Technical Subject-Writing

Production and Distribution of Writing

6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Grade 3

Measurement and Data

Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.

3.MD.1 Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).6 Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units. e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Thirsty Rocks

time: approximately 2:30-minute periods

WONDER WHY...

Have you ever wondered where crude oil can be trapped underground?

CONCEPT

A rock is composed of small grains of minerals and crystals packed together. Between the rock grains are spaces called pores where crude oil and natural gas may be found.

TEACHER INFORMATION:

Crude oil was formed from tiny plants and animals that lived in ancient seas and oceans a very long time ago. As these plants and animals died, they sank to the bottom of the water where they mixed with mud, sand, and clay. Over millions of years this layer of organic-rich mud became buried thousands of feet deep. The combination of increased temperature and pressure caused the organic material to change into crude oil.

Crude oil is retained in porous rock. A **pore** is an open space in a rock. Porosity refers to the amount of pores or open spaces in a rock. The grain size and shape, and how closely the grains are packed affect the porosity. Grain size is classified as **clay** (extremely small particles), **silt** (medium-size particles), or as **sand** (large-size particles). Shale is a sedimentary rock made from compacted clay and other minerals. Sandstone is a porous sedimentary rock made of sand size sediment.

1. WOW! Shake the sedimentation tube. The sedimentation tube is filled with rocks of various size, plant remains, and water. Have students predict the order in which different sediments settle. Observe and discuss.

Show the students the sample of shale. The fine clay near the top of the sedimentary tube compacts to form the sedimentary rock, shale, which contains very small pores. Show students the sample of sandstone and explain that the large gravel and sand near the bottom of the sedimentary tube compacts to form the sedimentary rock, sandstone. Large gravel will not pack together as well as small grains, leaving more spaces, or pores, where crude oil and natural gas may be found.

Figure 1
Sedimentation Tube

MATERIALS FOR WOW:(included in lab/kit)
- sedimentation tube
- 1 sample of sandstone rock
- 1 sample of shale rock

2. STUDENT ACTIVITY: THIRSTY ROCKS! (See student sheets)

NOTE: Data may vary when rocks are reused because the pores in the rocks absorb water.

MATERIALS FOR ACTIVITY: (per group)

- 2 - 9 oz plastic cups
- 1 – 250mL graduated cylinder (included in lab/kit)
- small and large rocks which represent rock grains
- water

SAFETY:

- Do not put samples in mouth.
- Wash hands after handling samples.

3. EXTENSION

- Calculate the porosity of each sample by dividing the volume of water that you were able to pour into the cup by the total volume of the cup (250mL) and multiplying by 100. Record your calculations in Data Table 1.

$$\text{Porosity} = \frac{\text{volume of water in mL}}{250 \text{ mL}} \times 100$$

- Repeat the activity, measuring the mass of water using a kitchen scale rather than the volume of water in the graduated cylinder.

- Repeat the activity using a variety of rock grain sizes.

- Use Excel to make the graph.

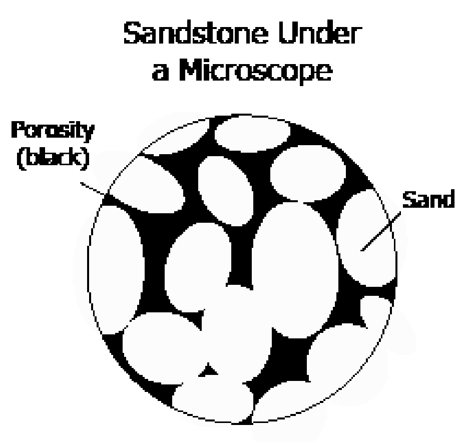
Extended Response

- Read the article below and apply the information.

Sedimentary rocks are made up of tiny particles, other rocks and minerals. These particles are packed together. In between the particles are spaces that are filled with air, gas, or liquid. These spaces are called porosity (from the word "porous"). The porosity of a rock is a measure of its ability to hold a fluid or gas. Mathematically, porosity is the open space in a rock divided by the total rock volume (solid + space or holes). The shape and size of the particles affect the way they pack together in a certain amount of space, which affects a rock's porosity. In general, larger particles cannot pack together as well as smaller particles can, which means that packing larger particles together leaves more room for air, water and gas to fill in between the particles, making the rock more porous. The porosity of a rock can be used to characterize the rock. Even though sandstone is hard, and appears very solid, it can really be very much like a sponge (a very hard, incompressible sponge.) Between the grains of sand, enough space can exist to trap fluids like water, oil or natural gas! If you take a piece of sandstone with sufficient porosity and pour water on it, you will see the water is absorbed right into the rock. The water is soaked into the pores.

A geologist has been hired by a local oil company to find a new site to drill for oil. One site has granite outcroppings and the other site has sandstone outcroppings. Write a letter to the oil company stating your opinion on which site would be the best area to consider to drill. In your letter, include information from all sources to write about the subject knowledgably. Use details from the Thirsty Rocks activities and the provided article to support your opinion. Also remember to use correct grammar usage, capitalization, punctuation and spelling when writing your essay.

In the picture below the porosity is shown as black. Oil or gas will fill these holes in the rock. The more spherical (rounded) the grains are, the more space or porosity is left between them. Therefore, well-rounded sandstone will have more porosity than a poorly-rounded one! A geologist loves to encounter well-rounded sandstone, because it can hold the most oil and gas of any of the rock type.



Thirsty Rocks

Vocabulary

1. **crude oil** - oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

2. **gram** - the metric unit of mass: one gram of water occupies one cubic centimeter of pore space

3. **grain** - a small, hard particle of a rock

4. **mass** - amount of matter in an object

5. **matter** - anything that takes up space and has mass

6. **oil reservoir** - an underground rock formation where oil collects and is stored or trapped

7. **porosity** - refers to the size and amount of pores or open spaces in a rock, indicating how much fluid a rock can hold

8. **sedimentary rock** - rock formed by sediments, examples include sandstone and shale

9. **volume** - the amount of space that an object takes up or occupies

Name________________________________ Date ________

THIRSTY ROCKS!
STUDENT SHEET

WONDER WHY...

Have you ever wondered where crude oil can be trapped underground?

CONCEPT

A sedimentary rock is composed of small, medium, or large grains of minerals and crystals packed together. Between these grains there can be spaces called pores where crude oil and natural gas may be found.

MATERIALS FOR ACTIVITY: (per group)
- 2 - 9 oz plastic cups
- 1 – 250mL graduated cylinder
- water
- small and large rocks

SAFETY:
- Do not put samples in mouth.
- Wash hands after handling samples.

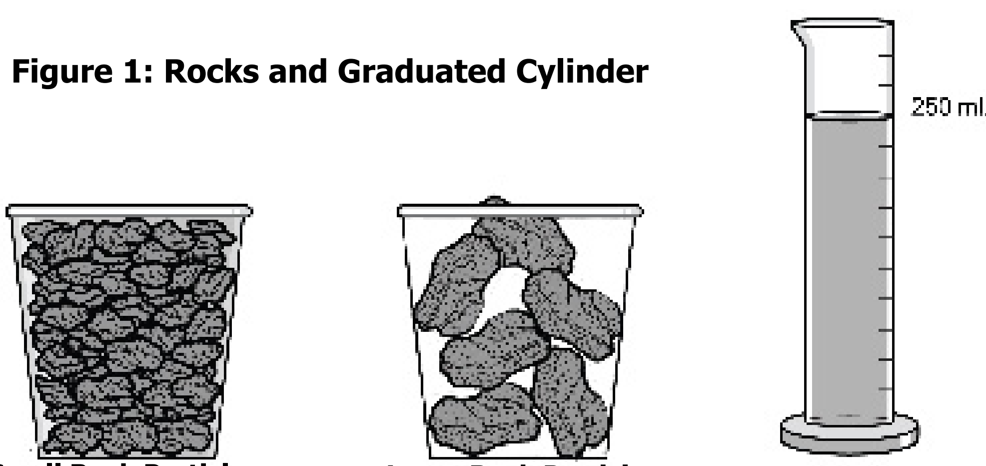
PROCEDURE

Note: The cup is a model of a rock. The small and large rocks inside the cups represent the small or large grains.

1. Fill one clear plastic cup with small rock grains. Fill a second clear plastic cup to the same level as the first cup with large rock grains. Pretend the cup filled with small rock grains is a piece of shale rock and the cup filled with large rock grains is a piece of sandstone rock. Both rocks, shale and sandstone, are examples of sedimentary rock.

2. **Predict** which cup you think will hold the most water. Answer: ____________________

Figure 1: Rocks and Graduated Cylinder



Small Rock Particles **(Represents shale rock)** | **Large Rock Particles** **(Represents sandstone rock)** | **Graduated Cylinder**

3. Fill your graduated cylinder to the 250mL mark with water.

4. Pour water from the graduated cylinder into the cup which represents shale rock until it is full to the **lower line** on the rim of the cup. Pour slowly and gently so you do not spill water out of the graduated cylinders.

5. In Data Table 1, record the amount of water left in the graduated cylinder.

6. Repeat steps 2-4 using the second cup which represents sandstone rock.

7. Calculate the amount of water that you poured into each cup by subtracting the amount of water you measured from 250mL. For example, if after pouring water into your cup you were left with 110mL of water, then you would subtract 110mL from 250mL to get 140mL. This means that there is 140mL of pore space between the grains in your cup.

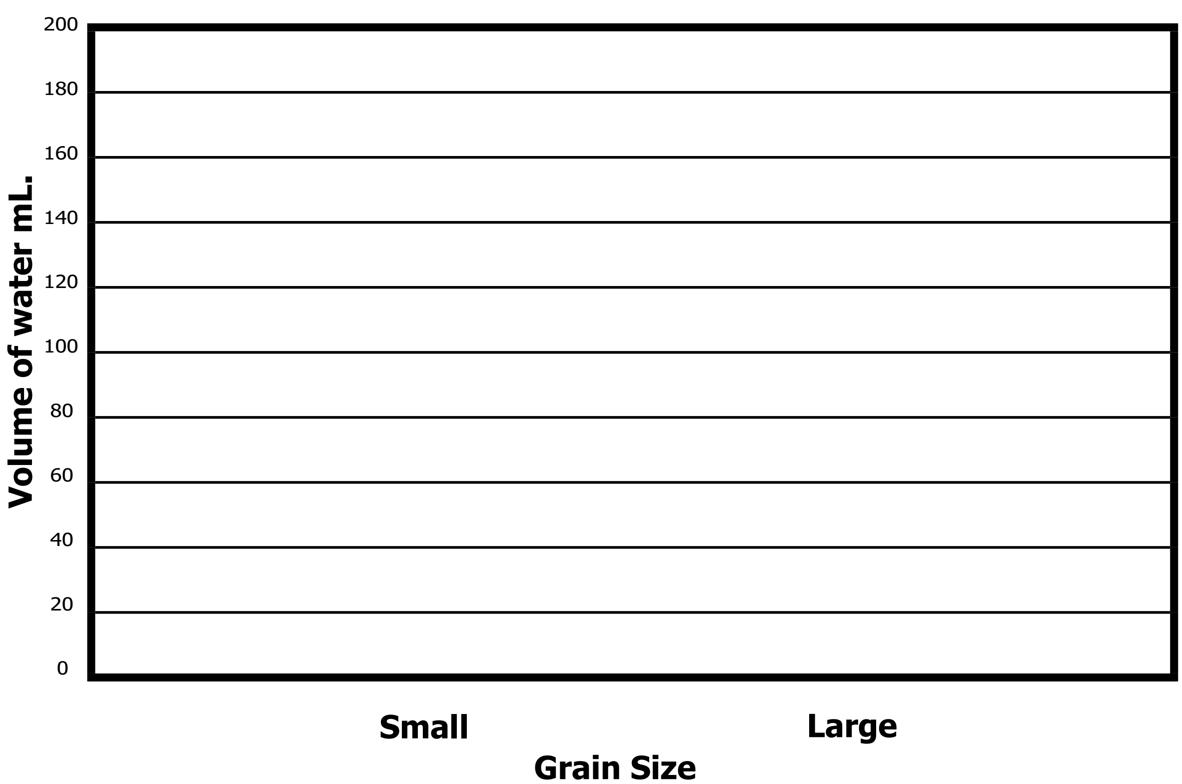
8. Compare your results, by graphing your results on Bar Graph 1.

Name________________________________ Date __________

Table 1: Volume of Water vs. Grain Size

Grain Size	Amount of Water Before (mL)	Amount of Water After (mL)	Volume of Water Used (mL)	*Optional % Pore Space (porosity)
Small Rock Grains	250mL			
Large Rock Grains	250mL			

Bar Graph 1: Volume of Water (mL) vs. Grain Size



Name________________________________ Date ________

CONCLUSION

1. Which cup held the most water: the cup containing the small rock grains or the cup containing the large rock grains? ____

____

2. Which cup had the most pore space between the grains: the cup containing the small rock grains or the cup containing the large rock grains?____

____

3. The cup filled with small rock grains represented shale rock and the cup filled with large rock grains represented sandstone rock. Which type of rock, sandstone or shale, is the most porous?

____

____

4. Good oil reservoirs have a high porosity. Which type of rock, sandstone or shale, is more likely to be a good oil reservoir? ____

____

5. In the sedimentary tube, why are the larger sediments found near the bottom of the tube?

____

____

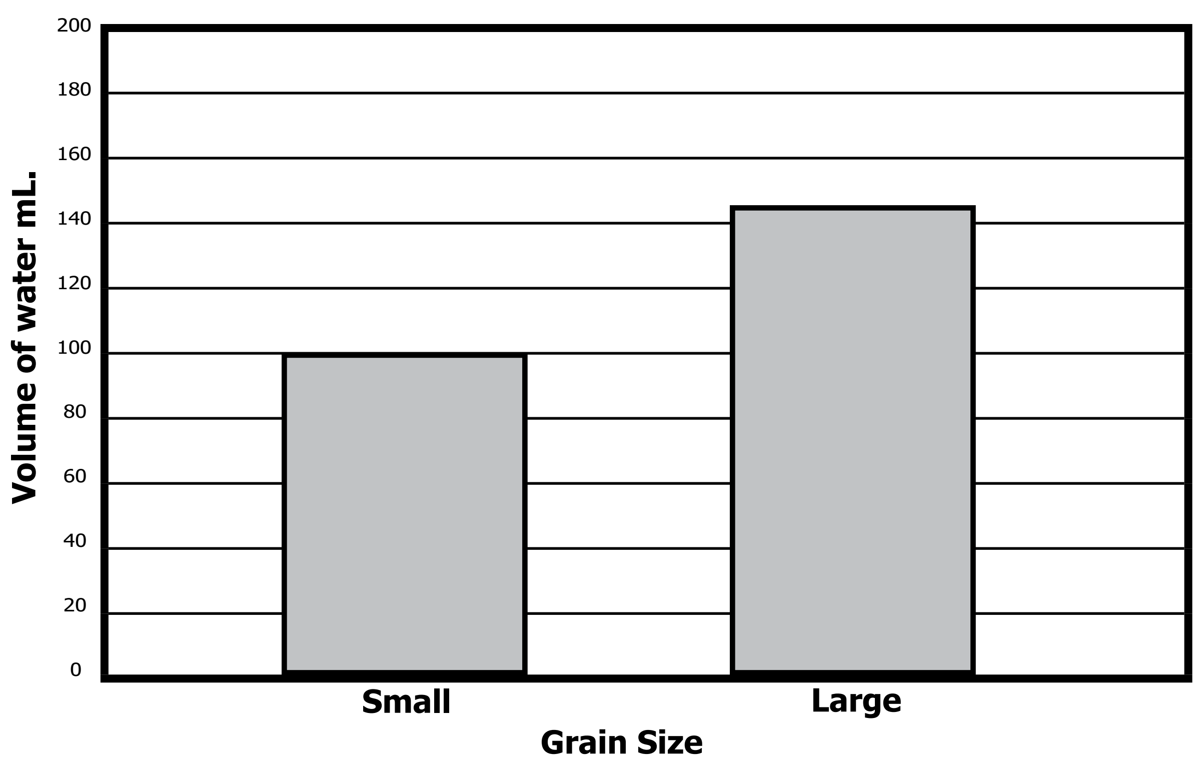
Table 1: Volume of Water vs. Grain Size

(Sample Data)

Grain Size	Amount of Water Before (mL)	Amount of Water After (mL)	Volume of Water Used (mL)	*Optional % Pore Space (porosity)
Small Rock Grains	250mL	150mL	100mL	40%
Large Rock Grains	250mL	103mL	147mL	59%

Bar Graph 1: Volume of Water vs. Grain Size

(Sample Data)



CONCLUSION

Answer Key

1. Which cup held the most water: the cup containing the small rock grains or the cup containing the large rock grains? The cup containing the large rock grains.

2. Which cup had the most pore space between the grains: the cup containing the small rock grains or the cup containing the large rock grains? The cup containing the large rock grains.

3. The cup filled with small rock grains represented shale rock and the cup filled with large rock grains represented sandstone rock. Which type of rock (sandstone or shale) is the most porous? Sandstone is the most porous.

4. Good oil reservoirs require a high porosity. Which type of rock (sandstone or shale) is more likely to be a good oil reservoir? Sandstone is a good oil reservoir.

5. In the sedimentary tube, why are the larger sediments found near the bottom of the tube? Larger rocks settle to the bottom faster than smaller rocks because the larger rocks have greater weight.

Visiting Viscosity

Next Generation Science Standards

Grade 3

Motion and Stability: Forces and Interactions

3-PS2-2 Make observations and/or measurements of an object's motion to provide evidence that that a pattern can be used to predict future motion.

Grade 4

Energy

4-PS3-1 Use evidence to construct an explanation relating the speed of an object to the energy of that object.

Grade 5

Matter and Its Interactions

5-PS1-3 Make observations and measurements to identify materials based on their properties.

Grade 6

Energy

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Common Core Mathematics

Grade 3

Measurement and Data

Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.

3.MD.1 Tell and write time to the nearest minute and measure time intervals in minutes.
Solve word problems involving addition and subtraction of time intervals in minutes,
e.g., by representing the problem on a number line diagram.

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).6 Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Common Core State Standards

Literacy in Science and Technical subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Craft and Structure

3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Range of Reading and Level of Text Complexity

3.10 By the end of the year, read and comprehend informational texts, including history/ social studies, science, and technical texts, at the high end of the grades 2–3 text complexity bandindependently and proficiently.

Grade 4

Reading Informational Text

Key Ideas and Details

4.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure

4.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 4 topic or subject area.

4.5 Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

Range of Reading and Level of Text Complexity

4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Grade 5

Reading Informational Text

Key Ideas and Details

5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Craft and Structure

5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Range of Reading and Level of Text Complexity

5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

Grade 6

Reading Informational Text

Key Ideas and Details

6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Craft and Structure

6.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

Range of Reading and Level of Text Complexity

6.10 By the end of the year, read and comprehend literary nonfiction in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Visiting Viscosity!

Time: approximately 50 minutes

WONDER WHY...

Have you ever wondered why some liquids are thick and pour slowly?

CONCEPT

Liquids flow at different rates because of their **viscosity** (resistance to flow). In this activity, students will use viscosity tubes to explore the rate of flow of liquids.

TEACHER INFORMATION:

Viscosity can tell the petroleum engineer about the grade or quality of the crude oil. If the oil is too thick, it has a high viscosity and may contain impurities that must be removed before it can be used. Viscous or "thick" oil is also hard to pump from the oil reservoir.

Viscosity of drilling mud, a fluid used to lift rock cuttings from the bottom of the well and to cool the drill bit during the drilling of a well, is also important to the oil and gas industry. Today, drilling fluids are still called mud, but engineers carefully design the fluid to meet specific needs. Deep wells could not exist without using drilling fluids which have specific viscosities to lift rock cuttings from the well, lubricate the pipe, and cool the drillbit as well as prevent well-blowouts.

1. WOW! Turn the viscosity tube over and watch as the liquid flows through the hole. Pour water into an empty cup. Ask students to compare the flow of the two liquids. Which liquid seemed to pour the slowest? The slower a liquid pours the greater its **viscosity**. The term viscosity can be used to describe the flow of a liquid. A viscous liquid is said to have a **resistance to flow**. The liquid in the ooze tube flows slower than the water and is more viscous.

MATERIALS FOR WOW:
- ooze tube included in lab/kit
- water
- plastic cup
- Data Table 1

2. STUDENT ACTIVITY: VISITING VISCOSITY! (See student sheets)

MATERIALS FOR ACTIVITY: (per group)
- 1 viscosity tube (included in lab/kit)
- 1 stopwatch
- 1 metric ruler
- calculator

SAFETY:

Some simple precautions will help ensure that the viscosity tubes provide years of use.

- Although plastic, the viscosity tubes may crack or break as a result of rough treatment. **Caution students not to place tubes where they may fall by rolling off a table.**
- Do not expose the tubes to temperature below 0°C (32°F), or above 45°C (113°F).
- The tubes contain mineral oils with small amounts of additives. If a tube should crack or break, absorb the spilled fluid with a cloth, and then clean the cloth with soapy water.
- **Caution students not to taste any of the liquids.**
- Store the tubes in the original cardboard container, out of direct sunlight.

3. EXTENSION:

- Allow students to investigate the changes in viscosity with temperature changes by placing the viscosity tubes in a refrigerator or wrapping the tubes in a heating pad using the lowest temperature setting. Do not expose the tubes to temperature below 0°C or above 45°C. Repeat the procedure to determine the time required for the white sphere to travel 10 cm. Have groups share and discuss results.

Visiting Viscosity

Vocabulary

1. **bar graph** - a graph using parallel bars of varying lengths to make comparisons

2. **crude oil** - oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

3. **drilling mud** - fluid pumped into an oil well during drilling to seal off porous rock layers, cool the drill bit, and bring rock cuttings to the surface

4. **drilling mud engineer** - a person trained to design and manage drilling mud

5. **impurity** - polluted or contaminated, not pure

6. **oil reservoir** - an underground place where oil collects and is stored

7. **petroleum engineer –** a person trained in the methods used to get crude oil and natural gas from the earth

8. **rock cuttings** - small pieces of rock that are formed during the drilling process

9. **viscosity** - the resistance of a liquid to flow

10. **viscosity tube** - a transparent plastic tube containing a viscous oil

Name_________________________ **Date** ___________

VISITING VISCOSITY!
STUDENT SHEET

WONDER WHY...

Have you ever wondered why some liquids are thick and pour slowly?

CONCEPT

Liquids flow at different rates because of their viscosity (resistance to flow).

MATERIALS FOR ACTIVITY: (per group)
- 1 viscosity tube
- 1 stopwatch
- 1 metric ruler
- calculator

SAFETY
- Do not place tubes where they may roll off a table or desk.
- Do not taste any of the liquids.

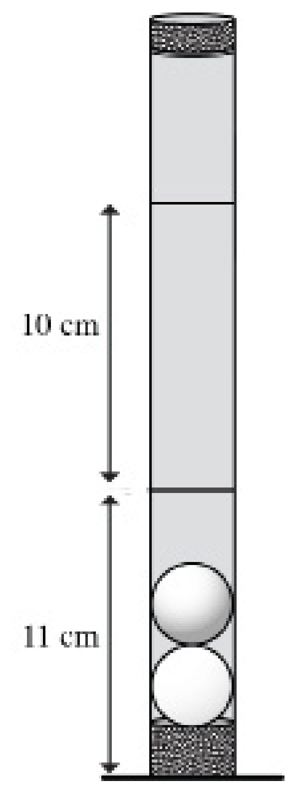
PROCEDURE:

1. Obtain one viscosity tube.

2. **Hold the tube upright with the white sphere below the silver metal sphere.** Give the spheres time to sink all the way to the bottom of the tube.

3. Using the metric ruler, measure and move the bottom o-ring to 11 cm. Move the top o-ring to 21 cm. The distance between the o-rings is 10 cm. See Figure 1.

Figure 1: Viscosity Tube



4. Using the stopwatch, one student should be ready to time the fall of the white sphere.

5. Turn the tube over. Start timing when the white sphere comes even with the first o-ring.

6. Stop timing when the white sphere comes even with the second o-ring.

7. Record the time below. Using the same viscosity tube, repeat the activity twice and record your time in seconds. Find the average (or mean) time by adding the time of the three trials and dividing the sum by 3.

Trial 1 -- time in seconds ________________

Trial 2 -- time in seconds ________________

Trial 3 -- time in seconds ________________

Average time = ________________

8. Calculate the speed of the white sphere in the viscosity tube using the formula.

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Average Time}} = \frac{\textbf{10 cm}}{\textbf{time in seconds}}$$

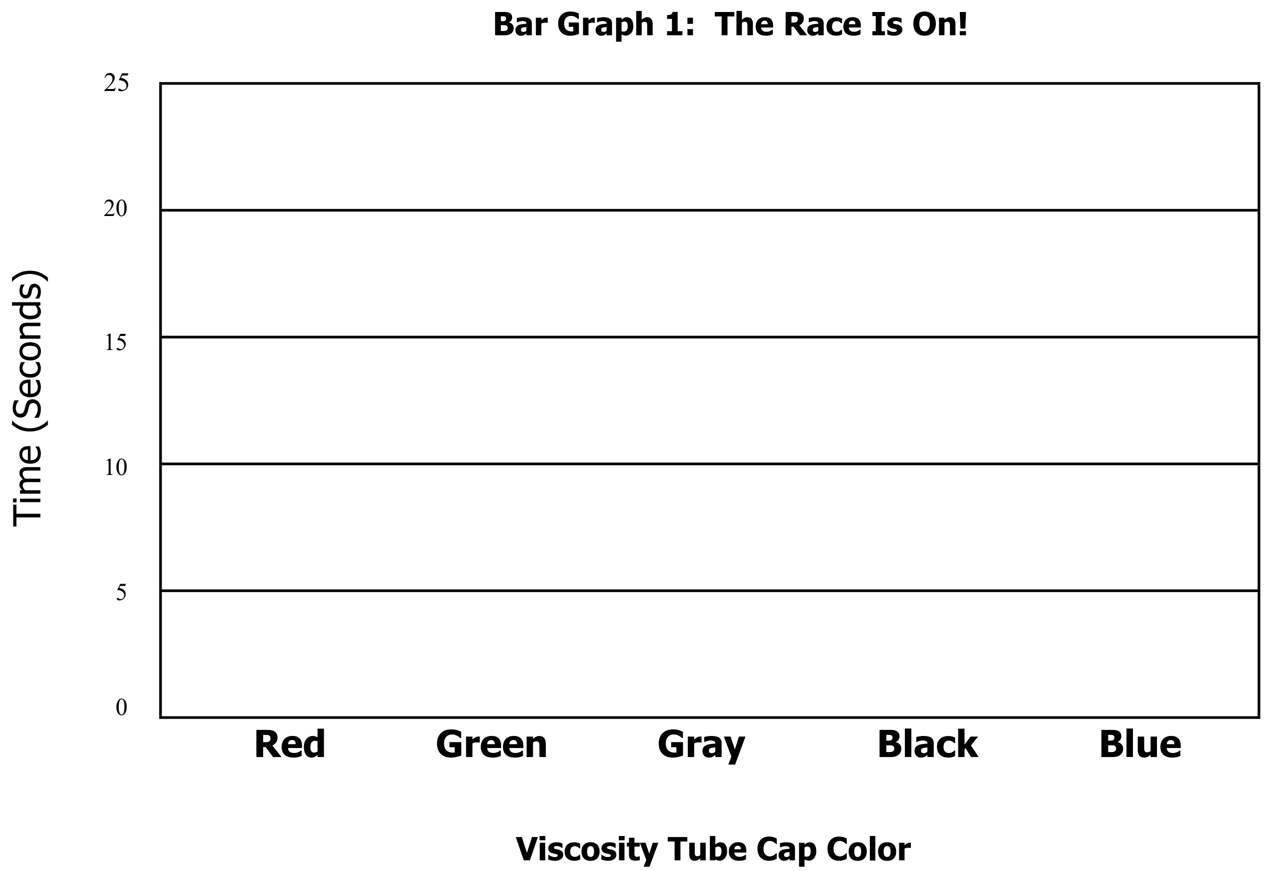
9. Share your results by writing your average time and speed on the transparency of Data Table 1.

10. Record the class data in Table 1.

TABLE 1: The Race Is On!

Viscosity Tube Cap Color	Time in Seconds	Speed (cm/s)
RED		
GREEN		
GRAY		
BLACK		
BLUE		

11. Use the class data from Table 1 to make Bar Graph 1.



Name ______________________________ **Date** ____________

VISITING VISCOSITY!

ASSESSMENT

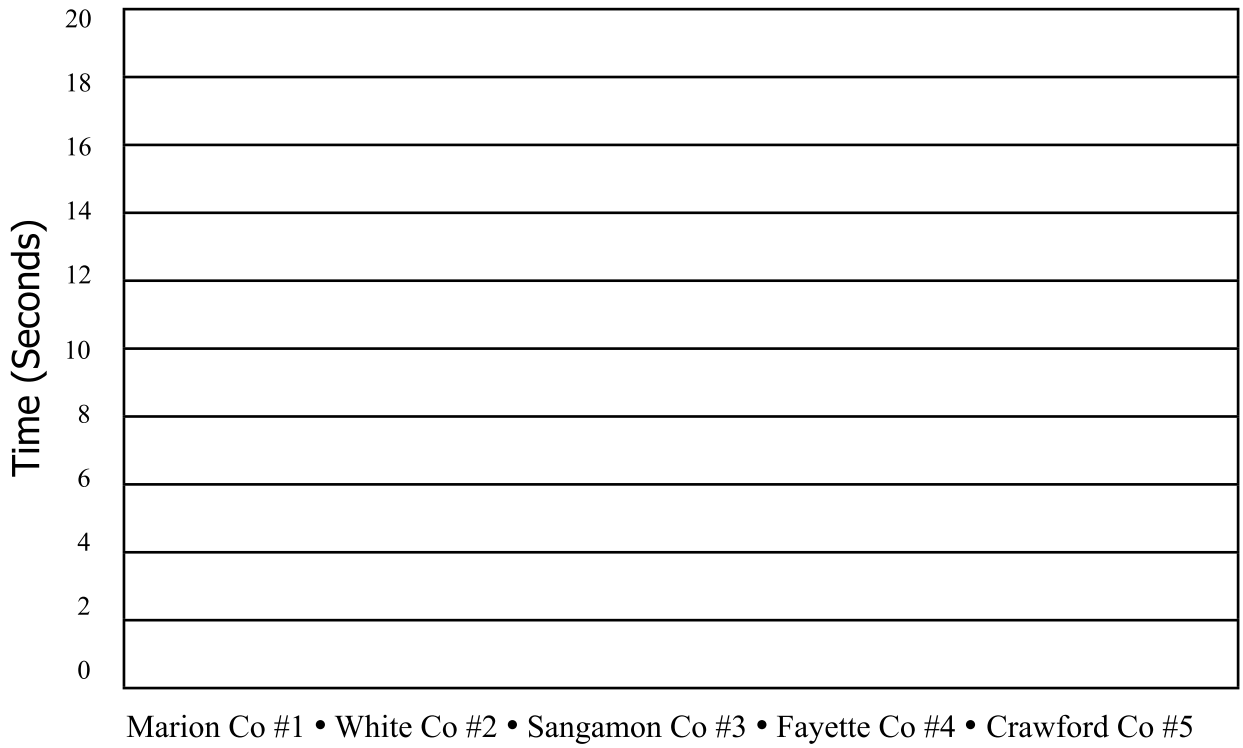
You are given five samples of oil from different oil wells in Illinois. Each sample of oil is placed in viscosity tubes and the time required for the white sphere to fall 10 centimeters was found. Use the data from Table 2 to make Bar Graph 2.

Table 2
Viscosity of Illinois Crude Oil

Viscosity Tube Cap Color	Time in Seconds	Name and Location of Oil Reservoir
RED	10	Marion County #1
GREEN	12	White County #2
GRAY	6	Sangamon County #3
BLACK	8	Fayette County #4
BLUE	10	Crawford County #5

Name______________________ **Date**__________

Bar Graph 2
The Viscosity of Illinois Crude Oil



Oil Wells of Illinois

1. Which oil well has the most viscous crude il? ______________________

____

2. You have been given samples of oil from each of the oil wells in Table 2. Which sample of oil would pour the fastest from a jar?

____

____

Name____________________________ Date ____________

CONCLUSION

1. In which viscosity tube did the white sphere take the shortest time to travel the 10cm between the o-rings?____

____

2. In which viscosity tube did the white sphere take the longest time to travel the 10cm between the o-rings?____

____

3. Why is the time required for each sphere to fall different?____________________

____

4. Which tube contains the most viscous liquid? ____________________________

____

5. List the liquids from least viscous to most viscous using the color of the tube caps.

Least viscous   Most viscous

__________, __________, __________, __________, __________

6. If an object falls in liquid **A** faster than in liquid **B**, what does that say about liquid **A**?

____

____

____

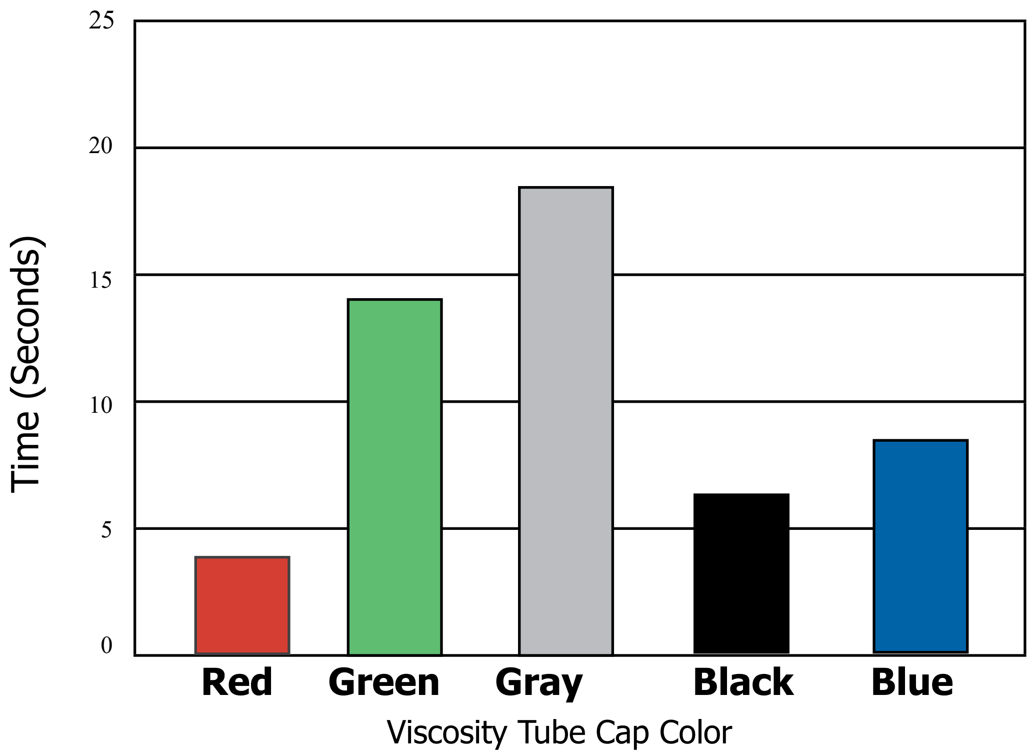
TRANSPARENCY FOR CLASS OBSERVATIONS
Data Table 1
The Race Is On!

Viscosity Tube Cap Color	Time in Seconds	Speed(cm/s)
RED		
GREEN		
GRAY		
BLACK		
BLUE		

Table 1: The Race Is On!
(Sample Data)

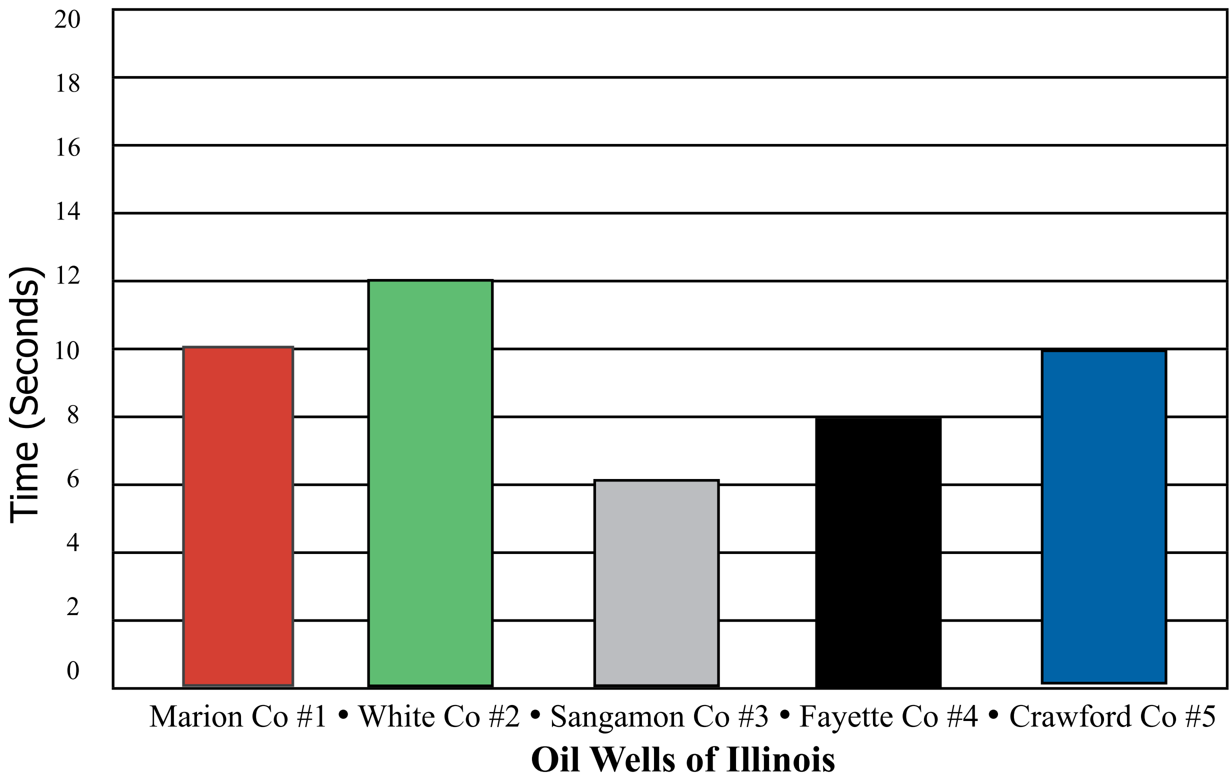
Viscosity Tube Cap Color	Time in Seconds	Speed(cm/s)
RED	3.8	2.6
GREEN	13.1	0.8
GRAY	18.6	0.5
BLACK	6.4	1.6
BLUE	8.5	1.2

Bar Graph 1: The Race Is On!
(Sample Data)



Assessment — Answer Key

Bar Graph 2
The Viscosity of Illinois Crude Oil



1. Which oil well has the most viscous crude oil?
<u>White County #2</u>

2. You have been given samples of oil from each of the oil wells in Table 2. Which sample of oil would pour the fastest from a jar? <u>Sangamon County #3</u>

CONCLUSION

Answer Key

1. In which viscosity tube did the white sphere take the shortest time to travel the 10cm between the o-rings? Red

2. In which viscosity tube did the white sphere take the longest time to travel the 10cm between the o-rings? Gray

3. Why is the time required for each sphere to fall different? The liquids have different viscosities (resistance to flow) or thickness.

4. Which tube contains the most viscous liquid? Gray

5. List the liquids from least viscous to most viscous using the cap color.

Least viscous Most viscous

___red_____, ___black_____, ____blue____, ___green____, ___gray_____

6. If an object falls in one liquid faster than in another liquid, what does that say about the liquids? The liquids have different viscosities (resistance to flow) or thickness. The object will fall faster in the least viscous liquid.

Pulley's: A Weighty Problem

Next Generation Science Standards

Grade 3

Motion and Stability: Forces and Interactions

3-PS2-1 Plan and conduct investigations on the effects of balanced and unbalanced forces on the motion of an object.
3-PS2-2 Make observations and/or measurements of the object's motion to provide evidence that a pattern can be used to predict future motion.

Grade 4

Energy

4-PS3-4 Apply scientific ideas to design, test, and refine a device that converts energy from one form to another.

Grades 3-5

Engineering Design

3-5-ETS1-1 Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2 Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.

3-5-ETS1-3 Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

Grade 6

Engineering Design

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2 Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Energy

MS-PS3-1 Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

Common Core Standards

Literacy in Science and Technical subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Craft and Structure

3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Range of Reading and Level of Text Complexity

3.10 By the end of the year, read and comprehend informational texts, including history/ social studies, science, and technical texts, at the high end of the grades 2–3 text complexity bandindependently and proficiently.

Grade 4

Reading Informational Text

Key Ideas and Details

4.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure

4.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 4 topic or subject area.

4.5 Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

Range of Reading and Level of Text Complexity

4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Grade 5

Reading Informational Text

Key Ideas and Details

5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Craft and Structure

5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Range of Reading and Level of Text Complexity

5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

Grade 6

Reading Informational Text

Key Ideas and Details

6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Craft and Structure

6.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.

Range of Reading and Level of Text Complexity

6.10 By the end of the year, read and comprehend literary nonfiction in the grades 6–8 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Common Core Mathematics

Grade 3
Measurement and Data

Solve problems involving measurement and estimation of intervals of time, liquid volumes, and masses of objects.

3.MD.1 Tell and write time to the nearest minute and measure time intervals in minutes. Solve word problems involving addition and subtraction of time intervals in minutes, e.g., by representing the problem on a number line diagram.

3.MD.2 Measure and estimate liquid volumes and masses of objects using standard units of grams (g), kilograms (kg), and liters (l).6 Add, subtract, multiply, or divide to solve one-step word problems involving masses or volumes that are given in the same units, e.g., by using drawings (such as a beaker with a measurement scale) to represent the problem.

Pulleys - A Weighty Problem

Time: approximately 75 minutes

WONDER WHY...

Have you ever wondered how oil field workers lift heavy objects?

CONCEPT

Pulleys are simple machines that make the job of lifting easier. Pulleys are made of a wheel with a rope, wire, or chain around it.

TEACHER INFORMATION:

An oil derrick is a supporting framework over an oil well that is designed to lift drilling equipment. Pulleys are simple machines that make lifting pipe and drill bits easier. There are two types of pulleys. One type is called a **fixed pulley** because it is fastened and does not move. The advantage of a fixed pulley is that you don't have to pull or push the pulley up and down. The other type is called a **movable pulley**. A movable pulley is a pulley that moves with the load. It allows the effort to be less than the weight of the load. The advantage is that you use less effort to pull the load.

A block is one or more pulleys in a frame. In Figure 1, the **crown block** is a set of fixed pulleys and the **traveling block** is a set of movable pulleys. Such a combination of fixed and movable pulleys with a rope is called a **block and tackle**. Pulleys help raise and lower the drill pipe into the well. Each steel drill pipe is approximately 30 feet long (about 9 meters) and weighs about 500 pounds (2250 Newtons). These drill pipes are screwed together to form a continuous pipe extending from the drilling rig to the drill bit at the bottom of the well. Some drilling rigs drill more than 7 miles through the earth to explore for oil.

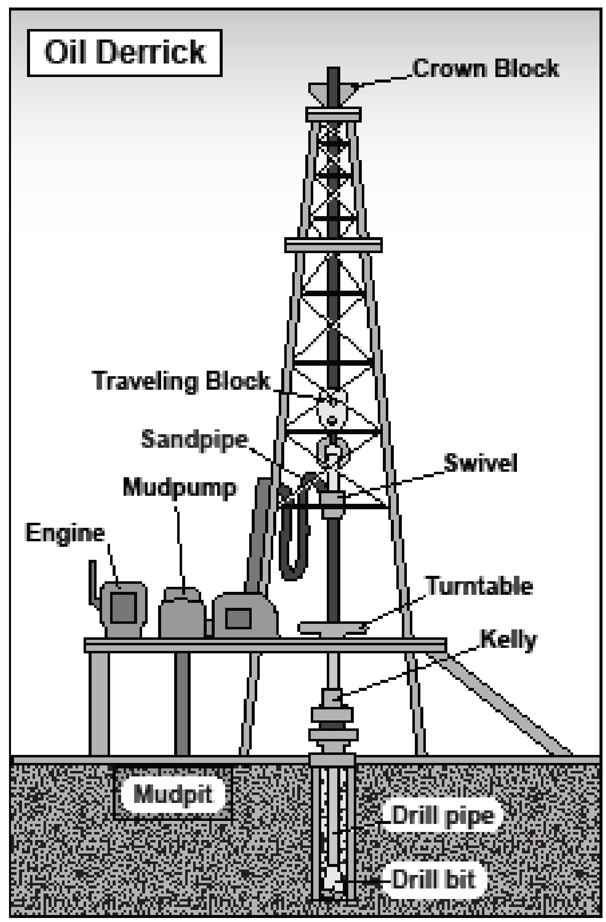


Figure 1

1. WOW! Three students are needed for the WOW activity. Tie one end of the rope to the middle of one of the dowel rods. Loop the rope around the dowel rods as shown in Figure 2. Have two students face each other, each holding a dowel rod with their hands positioned 10-12 centimeters on either side of the rope. The dowel rods should be one half meter apart. The two students holding the dowel rods should pull against each other. Watch what happens when another student pulls on the loose end of the rope! The two dowel rods should come together easily no matter how much the dowel rods are pulled apart. **Be careful of pinching fingers between the dowel rods.**

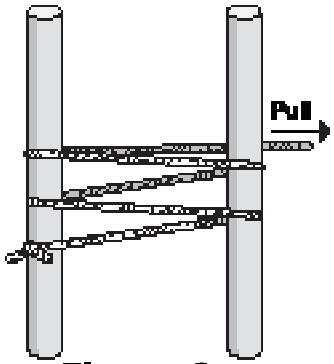


Figure 2
"Pulley"

***How it works**: The ropes wrapped around the dowel rods act as a pulley and distribute the weight so that less force is needed to pull the dowel rods together.

MATERIALS FOR WOW:
- 2 dowel rods 3/4" x 22" L
- 1 rope, 3 meters in length (#15 nylon rope)

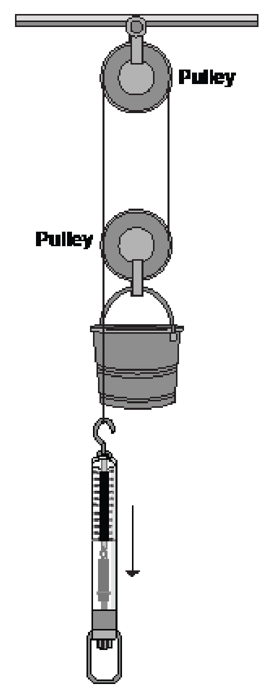
2. STUDENT ACTIVITY: PULLEYS - A WEIGHTY PROBLEM (See student sheets)

MATERIALS FOR ACTIVITY: (per group)
- 1 dowel rod (3/4" x 22" L (drill hole for eye bolt)
- 1 eyebolt 3/16" x 2"
- 1 pulley
- 1 bucket with 10 rocks
- 1 pulley cord (1 meter in length) (#18 nylon rope)
- 1 spring scale (included in lab/kit)
- 1 metric ruler

Pull, Lift, and Lower-**(included in lab/kit)**: A Book About Pulleys,
By: Michael Dahl, Illustrated by: Denise Shea, ISBN-13: 978-1-4048-1908-5

SAFETY:
- Be careful of pinching fingers between the dowel rods.
- Hold dowel rod securely between the two desks.
- Never let go of the pulley cord until the bucket is setting on the floor.

Figure 3
Combination Pulley



3. EXTENSION:

- Design and draw a pulley system that will lift an object that weighs 100 Newtons using only 50 Newtons of force.
- Repeat the activity and use a ruler to measure the distance you pull on the pulley cord compared with the distance that the bucket of rocks moves.
- Locate pulleys around your school and home.
- Explore by inquiry a combination of fixed and movable pulleys

Pulleys-A Weighty Problem

Vocabulary

1. **block** - one or more pulleys in a frame

2. **block and tackle** - a combination of fixed and movable pulleys with a rope

3. **crown block** – a set of fixed pulleys at the top of the oil derrick

4. **derrick** - steel tower that rises above the oil well

5. **effort** - force used to move an object

6. **fixed pulley** - a pulley that stays in place when the pulley cord and load moves

7. **force** - a push or a pull

8. **load** - the mass or object that is being moved

9. **movable pulley** - a pulley that is attached to the load and moves with the load

10. **newton** - the metric unit used to measure force or weight (1 pound is about 4 Newtons; 1 pound = 454 grams)

11. **pulley** - a simple machine that is a wheel with a groove to hold a rope

12. **spring scale** - measuring device used to determine the amount of force used to lift an object

13. **traveling block** – a set of movable pulleys

14. **weight** - measure of the heaviness of an object

Name ____________________________ Date ___________

PULLEYS: A WEIGHTY PROBLEM!

STUDENT SHEET

WONDER WHY...

Have you ever wondered how oil field workers lift heavy objects?

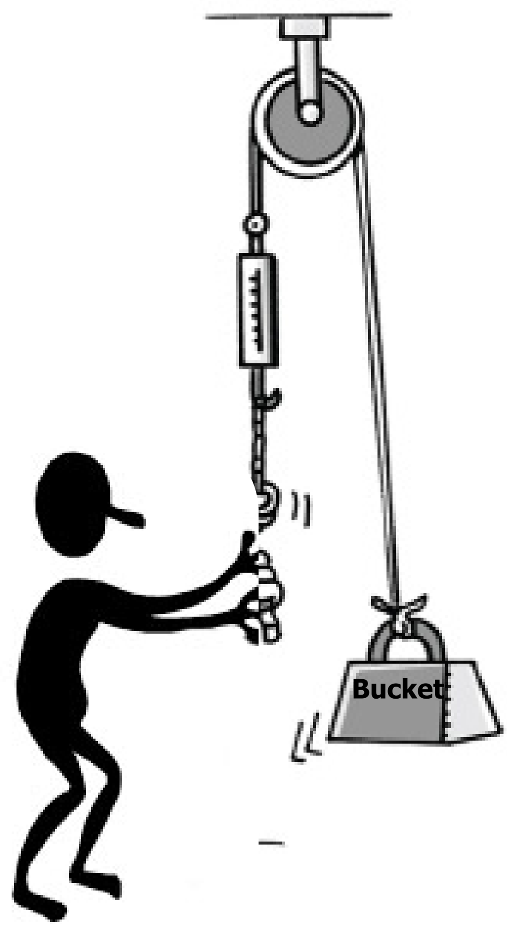
CONCEPT

Pulleys are simple machines that make the job of lifting easier. Pulleys are made of a wheel with a rope, wire, or chain around it.

MATERIALS FOR ACTIVITY: (per group)
- 1 dowel rod with eye bolt
- 1 pulley
- 1 pulley cord (1 meter in length)
- 1 spring scale
- 1 bucket with 10 rocks
- 1 ruler

SAFETY:
- Hold dowel rod securely between the two desks.
- Never let go of the pulley cord until the bucket is setting on the floor.

PROCEDURE:
1. Hold the spring scale upright and check to see that the spring scale reads zero when no weight is attached.
2. Attach the bucket of rocks to the spring scale and record the weight in Table 1.
3. Place the dowel rod between two flat tables or desktops. Two students should hold dowel rod securely.
4. Hook a pulley to the screw-eye.
5. Tie the bucket of rocks to the pulley cord. Place the pulley cord in the groove of the pulley and tie the pulley cord securely to the hook of the spring scale as shown in Figure 1 Fixed Pulley.



*A fixed pulley does not move with the load.

Figure 1
Fixed Pulley

6. Pull the spring scale straight down to raise the bucket of rocks until the bottom of the bucket is 10 centimeters off the floor. Using the spring scale, measure the force (or pull) needed to hold the bucket of rocks in place.

7. Record the force (in Newtons) in Table 1.

8. Lower the bucket of rocks to the floor and take apart the pulley system.

9. Tie the pulley cord to the screw-eye. Place the pulley cord in the groove of the pulley and tie the pulley cord to the hook at the bottom of the spring scale. Attach the bucket of rocks to the hook on the bottom of the pulley as shown in Figure 2.

10. Raise the bucket of rocks 10 centimeters off the floor and record in Table 1 the force needed to hold the bucket of rocks in place.

11. Lower the bucket of rocks to the floor and disassemble the equipment.

*A moveable pulley moves with the load.

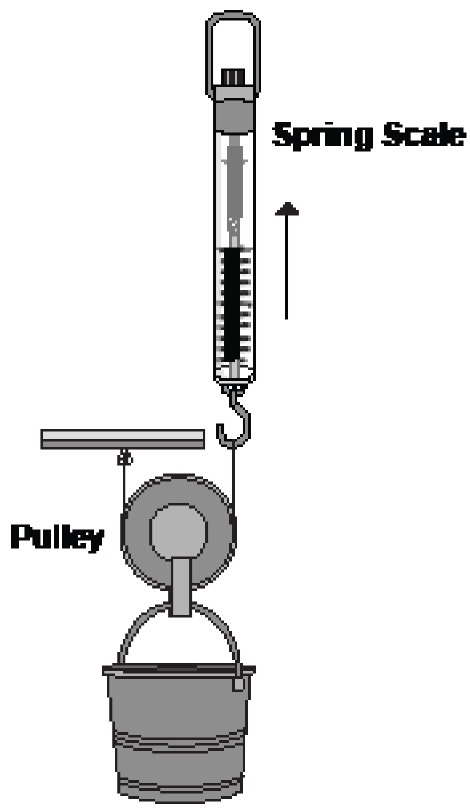


Figure 2
Moveable Pulley

HOW THE SPRING SCALE WORKS

An instrument called a **spring scale** is used to measure force or weight. There is a hook on the bottom of a spring scale. When an object hangs from the hook, the spring on the inside of the spring scale is stretched. The heavier the object, the more the spring will stretch. On the spring scale the numbers show the size of the force in Newtons that has stretched the spring. Be sure to make all readings on your spring scale with your eye at the level of the disk inside the spring scale tube.

Your spring scales measures a force between
0-20 Newtons.

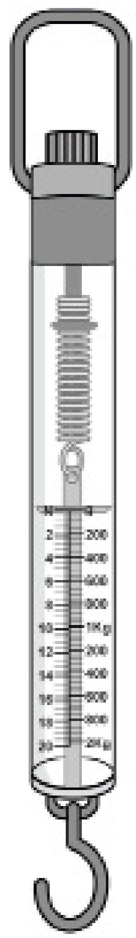


Figure 4
Spring Scale

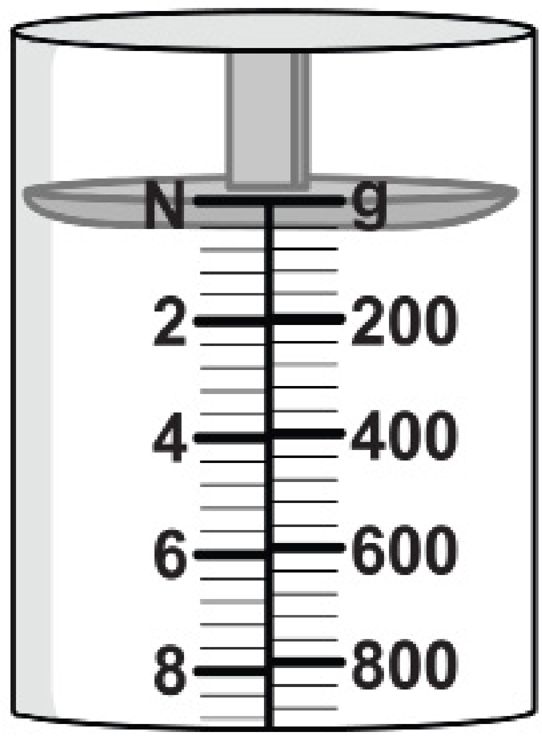


Figure 5
Section of a Spring Scale

Name ______________________________ Date ________

TABLE 1: Force Needed to Hold the Bucket of Rocks

Force Needed to Hold the Bucket of Rocks	
Without a Pulley (This is the weight of the bucket of rocks.)	______ Newtons
Fixed pulley with a bucket of rocks	______ Newtons
Movable pulley with a bucket of rocks	______ Newtons

CONCLUSION:

1. Answer the question by placing an X in the correct box.

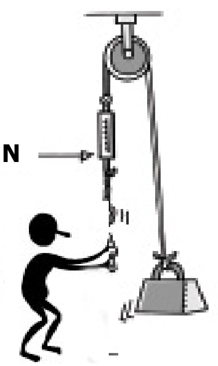
Question	Fixed Pulley	Movable Pulley
Which type of pulley lets you hold the bucket of rocks with less force?		
Which type of pulley is used to lift the bucket of rocks when you pull **down** on the cord?		

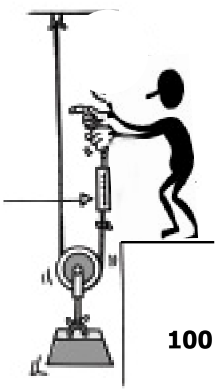
Name ______________________________ Date ___________

2. Why is changing the direction of the force helpful? ________

3. Oil Dude supports a 100 Newton load with the pulley systems shown below. What type of pulley is Oil Dude using in each of the diagrams? Fill in the spring-scale readings that show how much force he must exert.

Type of pulley: ________________ Type of pulley: _________________





4. An oil derrick is a supporting framework over an oil well that is designed to lift drilling equipment. In the diagram, the crown block is a set of fixed pulleys and the traveling block is a set of movable pulleys. Explain how pulleys (crown block and traveling block) are a helpful on the oil derrick.

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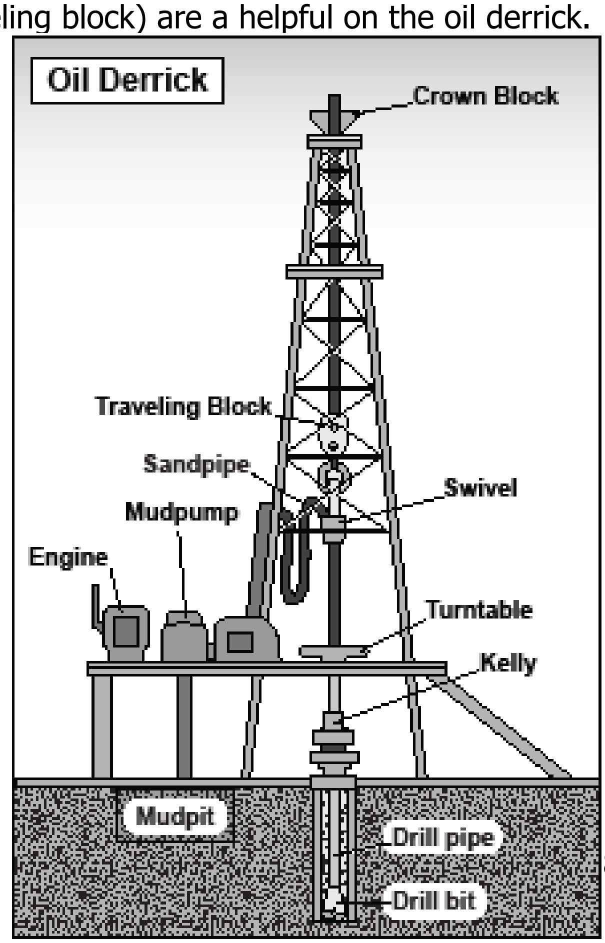


Extended Response- Student Read

Read the following article and answer the questions.

Pulley's: Fixed and Moveable

Archimedes was a great mathematician and engineer who was born in 287 BC in Syracuse, Sicily. He is credited with the development of many of our modern day mathematical and mechanical principles (such as Archimedes' principle, the concept of pi, and geometric proofs) and machines like the lever, a pump, and pulleys. According to Plutarch, Archimedes had stated in a letter to King Hieron that he could move any weight with pulleys; he boasted that given enough pulleys he could move the world! The king challenged him to move a large ship in his arsenal, a ship that would take many men and great labor to move to the sea. On the appointed day, the ship was loaded with many passengers and a full cargo, and all watched to see if Archimedes could do what he said. He sat a distance away from the ship, pulled on the cord in his hand by degrees, and drew the ship along "as smoothly and evenly as if she had been in the sea."

Archimedes understood the concept of mechanical advantage and how to use it to move or lift heavy objects with less force. The mechanical advantage of a machine is the ratio of the output and input forces that are used within the machine. A good mechanical advantage is a number that is greater than 1. The output force generated should be larger than the input force used to start the machine. For a simple machine like a pulley or a lever, these forces are easy to determine. For a pulley, the output force is the weight of the object and the input force is the force applied on the end of the rope.

A force is a push or a pull on an object or machine that may cause an action. Forces are measured in units of pounds-force (lbf) or newtons (N). A newton is a kilogram times a meter divided by seconds squared (N = kg m/s2). A force is a vector; it has both a magnitude (numerical value) and a direction. If an object is held up by a rope, for example, it has a force called the weight (the mass times the gravitational acceleration) acting downward, and it causes a tension in the rope, which acts upward. If the object is in equilibrium, the downwards weight of the object will be equal to the upwards tension. When something is in equilibrium, it means that it is not moving; all the forces are balanced. A book sitting on a table is in equilibrium. The weight of the book is balanced by the reaction force of the table on the book. The study of objects with forces in equilibrium is called Statics.

Archimedes knew that he could improve his mechanical advantage for lifting or moving an object by using pulleys. A pulley is an object that is usually round with a smooth groove around its outside edge. A pulley transfers a force along a rope without changing its magnitude. When engineers work with pulleys, they often assume that the rope through the groove of a pulley moves smoothly and evenly, without catching. They say it moves without friction. When two rough surfaces are rubbed together (like two wooden blocks), they become warm; the heat is caused by friction. If the two surfaces were slicked with oil and then rubbed together, they would move much more smoothly and very little heat would be generated. There is much less friction. Engineers also assume that the pulley and rope weigh very little compared to the weight on the end of the rope, so they can ignore these two weights and make their calculations with only the heavy weight on the end of the rope.

The first figure shows a single pulley with a weight on one end of the rope. The other end is held by a person who must apply a force to keep the weight hanging in the air (in equilibrium). There is a force (tension) on the rope that is equal to the weight of the object. This force or tension is the same all along the rope. In order for the weight and pulley (the system) to remain in equilibrium, the person holding the end of the rope must pull down with a force that is equal in magnitude to the tension in the rope. For this simple pulley system, the force is equal to the weight, as shown in the picture. The mechanical advantage of this system is 1! The output force is the weight to be held in equilibrium and the input force is the applied force.

The pulley in the first figure is a fixed pulley; it doesn't move when the rope is pulled. It is fixed to the upper bar. In the second figure, the pulley is moveable. As the rope is pulled up, it can also move up. The weight is attached to this moveable pulley. Now the weight is supported by both the rope end attached to the upper bar and the end held by the person! Each side of the rope is supporting the weight, so each side carries only half the weight (2 upward tensions are equal and opposite to the downward weight, so each tension is equal to 1/2 the weight). So the force needed to hold up the pulley in this example is 1/2 the weight! Now the mechanical advantage of this system is 2; it is the weight (output force) divided by 1/2 the weight (input force).

Each additional figure shows different possible pulley combinations with both fixed and moveable pulleys. The mechanical advantage of each system is easy to determine. Count the number of rope segments on each side of the pulleys, including the free end. If the free end is to be pulled down, subtract 1 from this number. This number is the mechanical advantage of the system! To compute the amount of force necessary to hold the weight in equilibrium, divide the weight by the mechanical advantage! In the third figure, for example, there are 3 sections of rope. Since the applied force is downward, we subtract 1 for a mechanical advantage of 2. It will take a force equal to 1/2 the weight to hold the weight steady. The fourth figure has the same two pulleys, but the rope is applied differently and it is pulled upwards. The mechanical advantage is 3, and the force to hold the weight in equilibrium is 1/3 the weight. Each additional figure shows another possible pulley configuration and lists the force necessary to lift and hold the weight still. The mechanical advantage for the system will be the number in the denominator of the force. Check out the pulley problems in the interactive section to test your knowledge of the mechanical advantage of pulleys!

These systems are known as simple pulley systems because they use the same rope throughout the system. If the pulleys were attached with several different ropes (not one continuous rope), the system would be a complex pulley system. The force necessary to hold a complex pulley system in equilibrium would have to be computed using other Statics methods. Once it was known, however, the mechanical advantage of the system would still be computed by dividing the weight to be held by the force applied to hold it.

Name ______________________ Date __________

Extended Response

1. Who was Archimedes and how did he prove to King Heiron that a pulley would work?

____

____

2. Define the term force based upon the given text. Give the unit of measure for force.

____

____

3. If an object is held up by a rope it has a force called the ______________, which is measured in ______________. ______________________________

4. If an object is in a state of equilibrium is it in motion? Explain your answer making sure that you define the meaning of equilibrium. ______________________________

____

5. Describe the relationship between the forces being applied to the weight of an object if the object is in equilibrium. ______________________________

____

TABLE 1: Force Needed to Hold the Bucket of Rocks
(Sample Data)

Force Needed to Hold the Bucket of Rocks	
Without a Pulley	__4__Newtons
Fixed pulley with a bucket of rocks	Weight of the bucket of rocks __4__Newtons
Movable pulley with a bucket of rocks	One half the weight of the bucket of rocks __2__Newtons

CONCLUSION

Answer Key

1. Answer the question by placing an X in the correct box.

Question	Fixed Pulley	Movable Pulley
Which type of pulley lets you hold the bucket of rocks with less force?		X
Which type of pulley is used to lift the bucket of rocks when you pull **down** on the cord?	X	

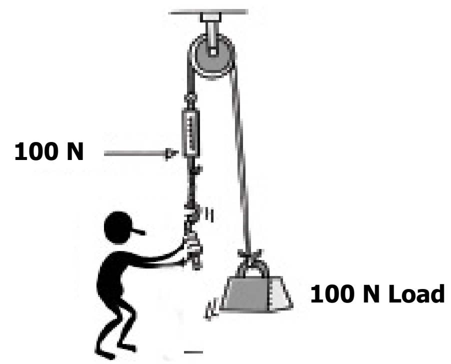
2. Why is changing the direction of the force helpful? Sometimes it is easier to raise an object by pulling down on it. ______________________________

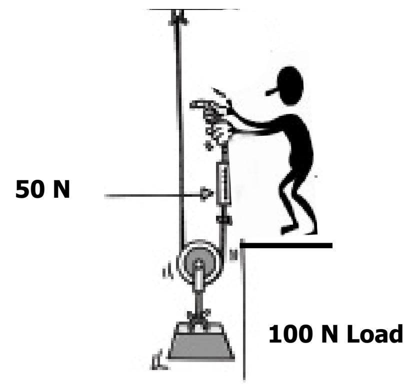
____

3. Oil Dude holds a 100 Newton load with the pulley systems shown below. What type of pulley is Oil Dude using in each of the diagrams? Fill in the spring-scale readings that show how much force he must exert.

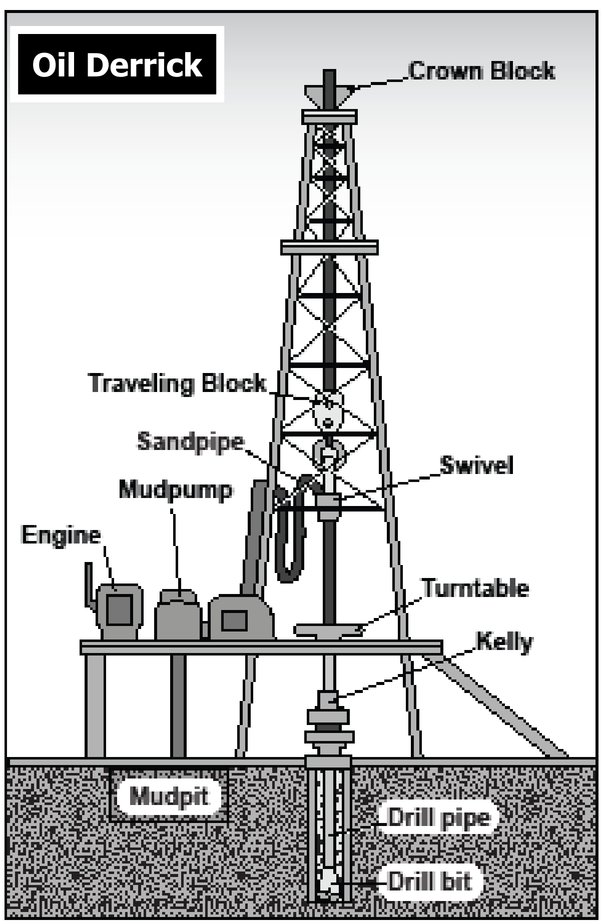
Type of Pulley: fixed pulley

Type of Pulley: movable pulley





4. An oil derrick is a supporting framework over an oil well that is designed to lift drilling equipment. In the diagram, the crown block is a set of fixed pulleys and the traveling block is a set of movable pulleys. Explain how pulleys (crown block and traveling block) are helpful on the oil derrick. Pulleys make it easier to lift heavy pipe and drill bits into and out of the well.



Extended Response

- Have students read the article, Pulleys: Fixed and Moveable and then answer the following questions about the article.

1. Who was Archimedes and how did he prove to King Heiron that a pulley would work?

Answer: Archimedes was a mathematician and engineer in ancient Sicily. He told the King that he could move the world with a pulley. King Hieron challenged Archimedes to move one of his heavy ships. Archimedes pulled the ship through the water by hooking a pulley to it.

2. Define the term force based upon the given text. Give the unit of measurement for force.

Answer: A force is a push or a pull on an object or machine that may cause an action. Forces are measured in units of pounds-force (ibF) or newtons (N).

3. If an object is held up by a rope it has a force called the _______________, which is measured in ______________.

Answers: Weight, pounds (lb)

4. If an object is in a state of equilibrium is it in motion? Explain your answer making sure that you define the meaning of equilibrium.

Answer: No, the object is not in motion because equilibrium means that two objects balance each other.

5. Describe the relationship between the forces being applied to the weight of an object if the object is in equilibrium.

Answer: They are exerting an equal amount of force on them. Equilibrium means equal and balanced forces.

Rises to the Top

Next Generation Science Standards

Grade 5

Matter and Its Interactions

5-PS1-1 Develop a model to describe that matter is made of particles too small to be seen.

5-PS1-3 Make observations and measurements to identify materials based on their properties.

5-PS1-4 Conduct an investigation to determine whether the mixing of two or more substances results in new substances.

Common Core Standards

Literacy in Science and Technical subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

3.3 Describe the relationship between a series of historical events, scientific ideas or concepts, or steps in technical procedures in a text, using language that pertains to time, sequence, and cause/effect.

Craft and Structure

3.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 3 topic or subject area.

Range of Reading and Level of Text Complexity

3.10 By the end of the year, read and comprehend informational texts, including history/ social studies, science, and technical texts, at the high end of the grades 2–3 text complexity bandindependently and proficiently.

Writing

Text Types and Purposes

3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly a. Introduce a topic and group related information together; include illustrations when useful to aiding comprehension.

Range of Writing

3.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grade 4

Reading Informational Text

Key Ideas and Details

4.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

4.3 Explain events, procedures, ideas, or concepts in a historical, scientific, or technical text, including what happened and why, based on specific information in the text.

Craft and Structure

4.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 4 topic or subject area.

4.5 Describe the overall structure (e.g., chronology, comparison, cause/effect, problem/solution) of events, ideas, concepts, or information in a text or part of a text.

Range of Reading and Level of Text Complexity

4.10 By the end of year, read and comprehend informational texts, including history/social studies, science, and technical texts, in the grades 4–5 text complexity band proficiently, with scaffolding as needed at the high end of the range.

Writing

Text Types and Purposes

4.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly
a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.

Production and Distribution of Writing

4.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

Range of Writing

4.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grade 5

Reading Informational Text

Key Ideas and Details

5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Craft and Structure

5.4 Determine the meaning of general academic and domain-specific words and phrases in a text relevant to a grade 5 topic or subject area.

Range of Reading and Level of Text Complexity

5.10 By the end of the year, read and comprehend informational texts, including history/social studies, science, and technical texts, at the high end of the grades 4–5 text complexity band independently and proficiently.

Writing

Text Types and Purposes

5.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly

a. Introduce a topic clearly and group related information in paragraphs and sections; include formatting (e.g., headings), illustrations, and multimedia when useful to aiding comprehension.
d. Use precise language and domain-specific vocabulary to inform about or explain the topic.

Production and Distribution of Writing

5.4 Produce clear and coherent writing in which the development and organization are appropriate to task, purpose, and audience. (Grade-specific expectations for writing types are defined in standards 1–3 above.)

Range of Writing

5.10 Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences.

Grade 6

Reading Informational Text

Key Ideas and Details

6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgments.

Craft and Structure

6.4 Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

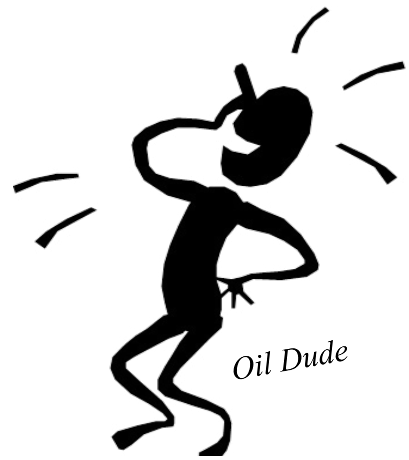
Integration of Knowledge and Ideas

6-8.7 Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Rising To The Top

Time: approximately 45 minutes



WONDER WHY...

Have you ever wondered why oil and water don't mix?

CONCEPT

Attraction between molecules that are alike is called cohesion. Cohesion is a physical property of liquids. In this activity, students will explore the physical property of cohesion in oil and water.

TEACHER INFORMATION:

Crude oil comes out of the ground as a mixture containing gases, oil and water. Once the fluid mixture is pumped from the well, it goes to a separator. Petroleum engineers use the physical properties of oil and water to separate the liquids. Two physical properties used to separate oil and water are density and cohesion. Density is the mass of a substance divided by its volume.

$$\text{DENSITY} = \frac{\text{MASS}}{\text{VOLUME}}$$

Oil is less dense than water which causes the oil to move to the top of the water. Because water "sticks" to other water molecules and not to the oil molecules, the liquids stay separated. Cohesion is the term used for the attraction between molecules that are alike.

1. WOW! Show students a bottle from the kit containing a mixture of oil and water. Observe the mixture and share the observations with the class.
(Oil floats on top of the water.)

MATERIALS FOR WOW:

- 1 small clear plastic bottle containing a mixture of oil and water

2. STUDENT ACTIVITY: RISES TO THE TOP! (See student sheets)

MATERIALS FOR ACTIVITY:

- 2 pennies per student
- mineral or vegetable oil
- water
- 2 plastic cups (9oz, clear)per group
- aluminum foil
- 4 pipettes per group(included in lab/kit)
- molecular model for water(included in lab/kit)
- paper towels
- color map pencils

SAFETY:

- Do not put samples in mouth.
- Wash hands after handling samples.

3. EXTENSION:

- Research physical properties of both oil and water.

- Repeat the activity using different liquids: i.e., salt water, clear carbonated beverage.

Rising To The Top
Vocabulary

1. **cohesion** - attraction between like molecules

2. **density** - the mass of a substance divided by its volume

3. **liquid** - a substance that flows and has no shape

4. **mass** - the amount of matter in an object

5. **mixture** - two or more materials not bound to each other

6. **molecule** - the smallest particle of a substance that has the properties of that substance

7. **physical property** - what can be seen or measured

8. **volume** – the amount of space something takes up

Name ____________________________ Date ___________

RISING TO THE TOP!

STUDENT SHEET

WONDER WHY...

Have you ever wondered why oil and water don't mix?

CONCEPT

Attraction between molecules that are alike is called cohesion. Cohesion is a physical property of liquids.

MATERIALS FOR ACTIVITY:

- 2 pennies per student
- mineral or vegetable oil
- water
- aluminum foil
- molecular model for water
- 4 pipettes per group
- 2 plastic cups per group
- map pencils
- paper towel

SAFETY:

- Do not put samples in mouth.
- Wash hands after handling samples.

PROCEDURE PART A: *Be sure to return the droppers to the correct cup.

1. Place a square of aluminum foil on the desktop. Put 1 dry penny on top of the foil.
2. Using the pipette place 5 drops of water, one drop at a time, onto the center of the head side of the penny.
3. Observe the water on the penny from a side view. Use Figure 1 to draw how the 5 drops of water look on the penny.
4. Remove the penny from the foil. Wipe **DRY** the penny and the foil with a paper towel. Repeat the experiment using oil instead of water.
5. Observe the oil on the penny from a side view. Use Figure 2 to draw how the 5 drops of oil look on the penny.

PROCEDURE PART B:

1. Using the clean, second penny, **predict** how many drops of water you can place on the surface of a penny before the water overflows. Record your prediction in Table 1.

2. Add the number of drops predicted by each student in your group and divide by the number of students in your group to find the **average** number of drops of water that your group predicted would fit on the penny. Record in Table 1.

3. Place a clean square of aluminum foil on the desktop. Put 1 dry penny on top of the foil.

4. Carefully drop water from the pipette, one drop at a time, onto the center of the head side of the penny. Keep careful count of each drop. Record in Table 1 the number of drops of water that were on the penny just before the water flowed off the penny.

5. Find the group average and record in Table 1.

6. Remove the penny from the foil. Wipe the penny and the foil dry with a paper towel.

Name ______________________________ Date ____________

Figure 1: Five drops of water on a penny

____
top of penny

Figure 2: Five drops of oil on a penny

____
top of penny

Table1: How Many Drops of Water Will Fit on a Penny?

	Predicted Number of Water Drops	Number of Water Drops That Fit on the Penny
Student 1		
Student 2		
Student 3		
Student 4		
Group Average		

Conclusion

1. What do you think caused the drops of water to look different than the drops of oil on the penny? ____

____

2. Why do you think so many drops of water fit on a penny?______________________

____

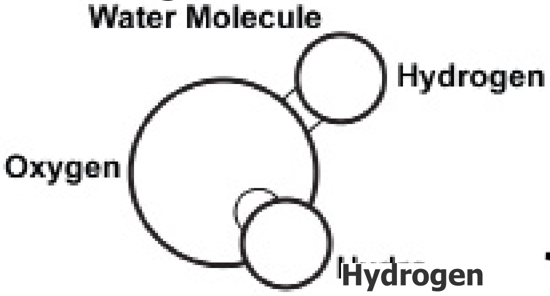
Name ______________________ Date __________

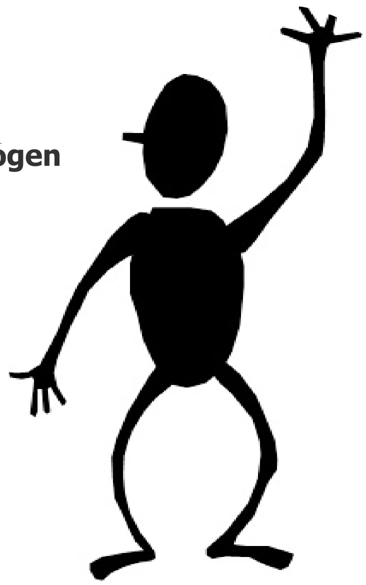
"STICKY" MOLECULES

***Color the oxygen atoms red and leave the hydrogen atoms white.**

Figure 3

Water Molecule

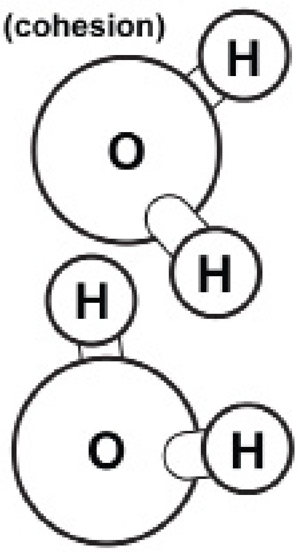




This is a water molecule. It is made up of 1 oxygen atom and 2 hydrogen atoms. (Figure 3)

Figure 4

Two water molecules "attracted" to each other (cohesion)



Using the 2 water molecule models, bring the hydrogen atom of one model towards the oxygen atom of the other model. (Figure 4)

WHAT HAPPENS?

Answer: ______________________________

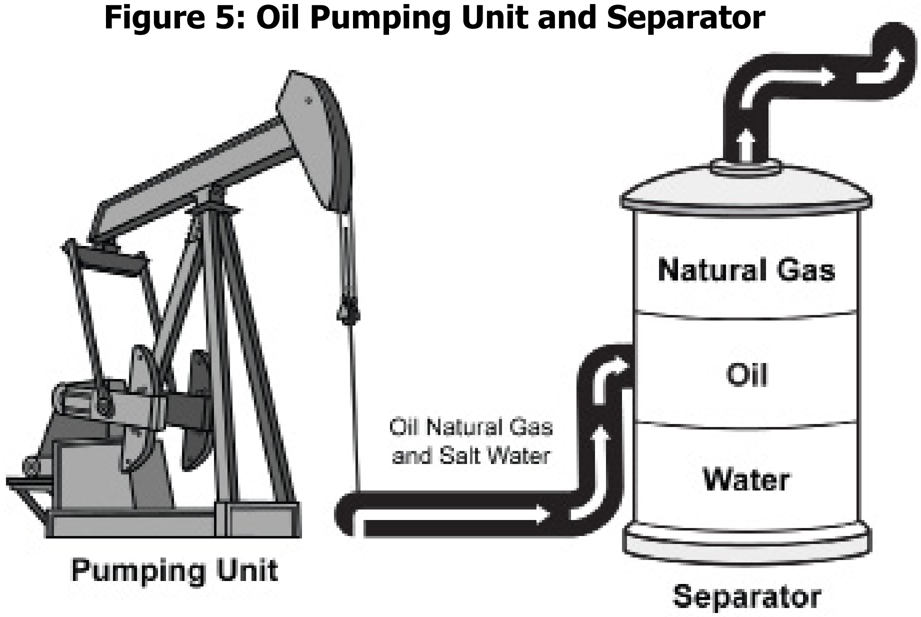
____

Name ________________________ Date __________

RISES TO THE TOP!
ASSESSMENT

Color the layer of oil in the separator black.
Color the layer of water in the separator blue.

Figure 5: Oil Pumping Unit and Separator



See an animation of this process at http://iprb.org/drlngforoilinil.html

1. Fill in the blanks.

Word List: densities, separator, cohesion, oil, natural gas

As crude oil is pumped from the ground it flows into a tank called a _______________________. Crude oil is a mixture containing ______________, natural gas, and water. At the top of the separator, ____________ _______ is collected. Oil and water separate because they have different _________. ____________ is the attraction between molecules that are alike.

2. Use the term cohesion to explain what happened when the water and the oil were placed on the pennies.

____

____

Figure 1: Five drops of water on a penny

Answer Key

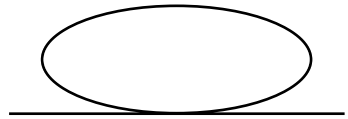


Figure 2: Five drops of oil on a penny

Answer Key

Table1: How Many Drops of Water Will Fit on a Penny?

	Predicted Number of Water Drops	Number of Water Drops That Fit on the Penny
Student 1	Answers will vary	31
Student 2	Answers will vary	27
Student 3	Answers will vary	28
Student 4	Answers will vary	30
Group Average	Answers will vary	29

CONCLUSION

Answer Key

1. Describe what the five drops of water on the penny look like. Possible answer: The drops of water looked like one large drop on the penny

2. Use the term cohesion to explain what happened when the five drops of water were added to the penny. Possible answer: The cohesive force between water molecules is very strong and keeps the water together in one large drop.

"STICKY" MOLECULES

Answer Key

***Color the oxygen atoms red and leave the hydrogen atoms white.**

Figure 3

Water Molecule

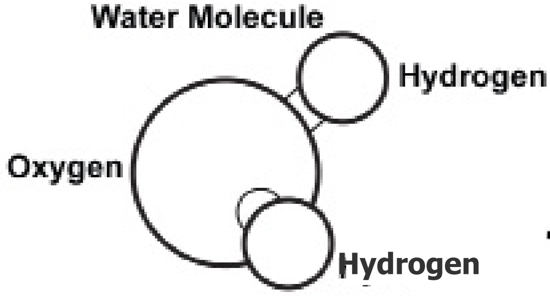
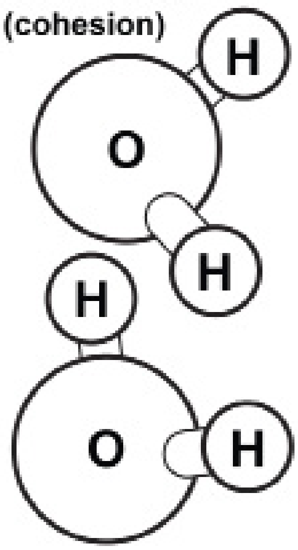
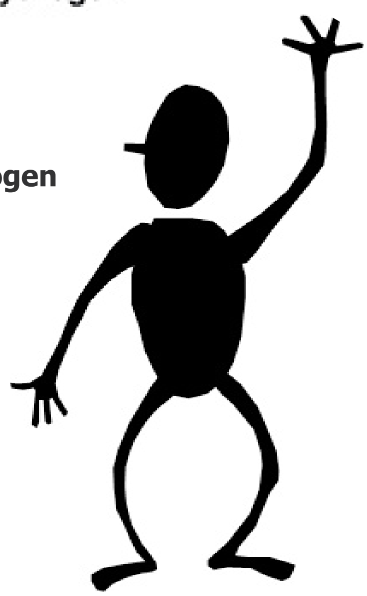


Figure 4

Two water molecules "attracted" to each other (cohesion)





This is a water molecule. It is made up of 1 oxygen atom and 2 hydrogen atoms. (Figure 3)

Using the 2 water molecule models, bring the hydrogen atom of one model towards the oxygen atom of the other model. (Figure 4)

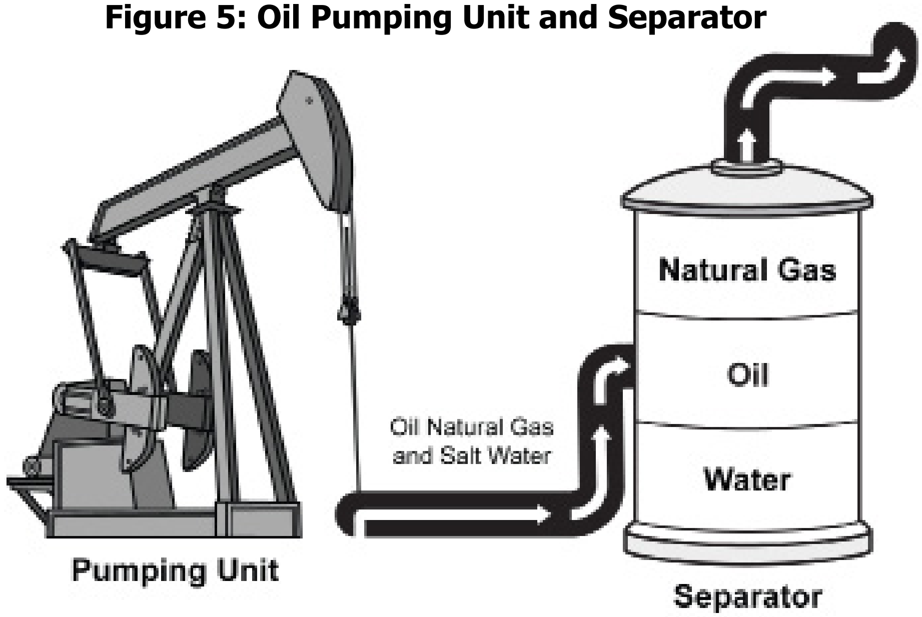
WHAT HAPPENS?

Answer: The H atom of one water molecule is attacted to the O atom of the other water molecule.

ASSESSMENT

Answer Key

Figure 5: Oil Pumping Unit and Separator



See an animation of this process at http://iprb.org/drlngforoilinil.html

1. Fill in the blanks.

Word List: densitites, separator, cohesion, oil, natural gas

As crude oil is pumped from the ground, it flows into a tank called a separator. Crude oil is a mixture containing oil, natural gas and water. At the top of the separator, natural gas is collected. Oil and water separate because they have different densities. Cohesion is the attraction between molecules that are alike.

2. Use the term cohesion to explain what happened when the water and the oil were placed on the pennies. Water molecules show more cohesion than oil. The water molecules are more attracted to each other and seem to "stick" together more than the molecules of oil.

Realistic Recycling

Next Generation Science Standards

Grade 4

Earth and Human Activity

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

4-ESS3-2 Generate and compare multiple solutions to reduce the impacts of natural Earth processes on humans.

Grade 5

Matter and Its Interactions

5-PS1-3 Make observations and measurements to identify materials based on their properties.

Earth and Human Activity

5-ESS3-1 Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment.

Grade 6

Matter and Its Interactions

MS-PS1-3 Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

Common Core State Standards

Literacy in Science and Technical Subjects

Grade 3

Reading Informational Text

Key Ideas and Details

3.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

3.2 Determine the main idea of a text; recount the key details and explain how they support the main idea.

Integration of Knowledge and Ideas

3.8 Describe the logical connection between particular sentences and paragraphs in a text (e.g., comparison, cause/effect, first/second/third in a sequence).

Writing

Text Types and Purposes

3.2 Write informative/explanatory texts to examine a topic and convey ideas and information clearly.

Grade 4

Reading Informational Text

Key Ideas and Details

4.1 Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.

4.2 Determine the main idea of a text and explain how it is supported by key details; summarize the text.

Grade 5

Reading Informational Text

Key Ideas and Details

5.1 Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

5.2 Determine two or more main ideas of a text and explain how they are supported by key details; summarize the text.

Grade 6

Reading Informational Text

Key Ideas and Details

6.2 Determine a central idea of a text and how it is conveyed through particular details; provide a summary of the text distinct from personal opinions or judgements.

Science and Technical Subjects-Reading

Key Ideas and Details

6-8.1 Cite specific textual evidence to support analysis of science and technical texts.

Integration of Knowledge and Ideas

6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Science and Technical Subject-Writing

Production and Distribution of Writing

6-8.4 Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

Realistic Recycling

Time: approximately 30 minutes

WONDER WHY...

Have you ever wondered what can be made from recycled plastic?

CONCEPT

One way our natural resources can be conserved is by recycling plastics which are made from crude oil. In this activity, students will classify plastic objects according to their recycling symbols.

TEACHER INFORMATION:

The basic raw material for plastic is petroleum. This fossil fuel is sometimes combined with other elements, such as oxygen or chlorine, to make different types of plastic such as soft drink bottles, bread bags, and food containers.

Over 22 million tons of plastics are discarded each year in the trash. Because plastics are made from fossil fuels, you can think of them as another form of stored energy. Pound for pound, plastics contain as much energy as petroleum or natural gas, and much more energy than other types of garbage. Waste plastic products can be recycled into useful products. The use of recycled plastics has grown in the past several years.

A Plastic Identification Code (PIC) is used to identify 7 groups of plastics. The PIC is usually a number which is found inside a recycle symbol that looks like three-chasing arrows arranged in a triangle. The symbol is used to help recycling companies separate different plastics. Refer to Table 1 for recycling symbols, product examples, and recycled products. The most often recycled plastic is the PIC number 2, which is recycled into benches, trash receptacles, rulers, plastic lumber, and other plastic products.

1. WOW! Display the plastic bottle and the carpet made from recycled plastic bottles. Ask the students to try to guess the connection between the two items. Discuss what recycle means. (Recycling is the process of turning waste plastic materials into useful products.)

MATERIALS FOR WOW:

- a plastic bottle
- a carpet sample made from recycled plastic bottles

2. STUDENT ACTIVITY: Realistic Recycling! (See student sheets)

MATERIALS FOR ACTIVITY: (each group will have 7 plastic objects)
• 7 plastic objects - each with a different recycling symbol

Where Does the Garbage Go?-**(included in lab/kit)**, By: Paula Showers, Illustrated by: Randy Chewing, ISBN-13: 978-0-06-445114-7

3. EXTENSION:

• Start a plastic recycling project.

• Find examples of recyclable plastic products at home. List the plastic products and PIC numbers.

• Use the internet to research plastic recycling.

Realistic Recyclig

Vocabulary

1. **fossil fuel-** natural fuel formed over millions of years from plant and animal remains

2. **natural resource -** a material that is found in nature

3. **petroleum-** a thick, dark liquid that occurs naturally below the surface of the earth

4. **plastic -** a type of material that is made from crude oil

5. **plastic Identification Code (PIC) -** a numbering system used to identify each of the seven groups of plastics

6. **trash -** material that is no longer used

7. **recycle -** to use again; the process of turning waste plastic materials into useful products

8. **recycling symbol -** a three-chasing arrow symbol containing a number

Name ______________________ **Date** __________

REALISTIC RECYCLING!
STUDENT SHEET

WONDER WHY

Have you ever wondered what can be made from recycled plastic?

CONCEPT

One way our natural resources can be conserved is by recycling plastics which are made from crude oil.

MATERIALS FOR ACTIVITY: (per group)

- 1 group of 7 plastic objects

PROCEDURE

1. Place the plastic objects on the desk.
2. Decide how to group the objects.
3. Discuss how the objects were grouped.
4. Using Table 1, regroup your plastic objects.
5. Write a name or description of each plastic object in Table 1.

Name ______________________________ **Date** _________

TABLE 1: Plastic Identification Coding System

Recycling Symbol	Plastic Objects	Recycled Products
1		Fiberfill in coats Carpet
2		Trash cans Garden furniture
3		Flexible hoses, Playground equip- ment
4		Floor tile Garbage can liners
5		Lawn mower wheels, Battery cables
6		Flower pots, rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

Name ______________________________ Date _________

TABLE 2: Assessment Information

Recycling Symbol	Plastic Objects	Recycled Products
1	Soft drink bottles and food containers	Fiberfill in coats Carpet
2	Milk jugs, grocery bags, toys, juice containers	Trash cans Garden furniture
3	Clear food packaging, shampoo bottles, credit cards	Flexible hoses, Playground equip-ment
4	Bread bags, frozen food bags	Floor tile Garbage can liners
5	Food containers and medicine bottles	Lawn mower wheels, Battery cables
6	CD jackets, disposable utensils and cups	Flower pots, rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

CONCLUSION

1. Use Table 1 to decide what products a drink bottle with a number 1 can be recycled to make.

____

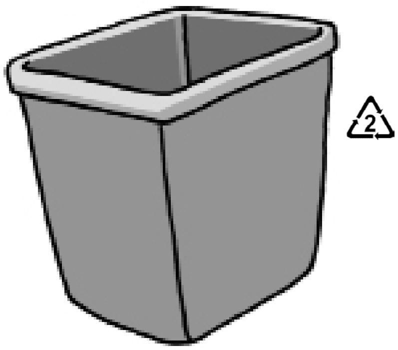
2. Why do you think using and recycling plastics is important?

____

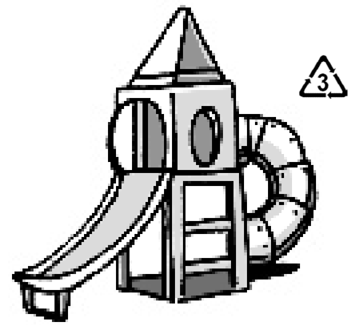
____

Name ______________________________ Date ________

You need to know what products can be recycled to make the following objects: Use Table 2 to find your answers.

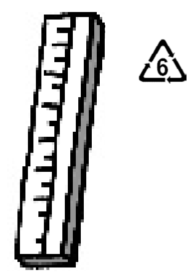


Trash can

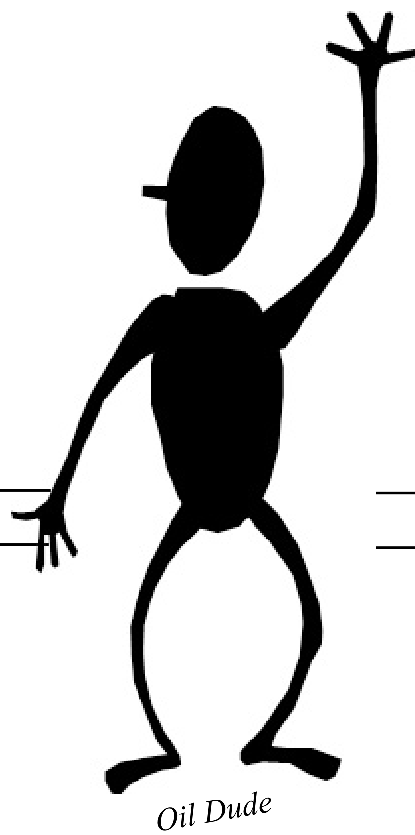


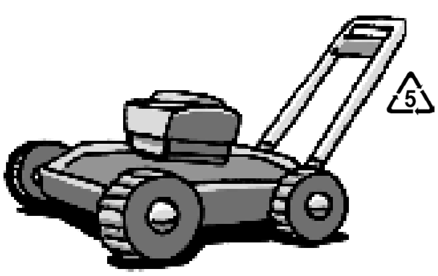
Playground equipment

Fiberfill in coats

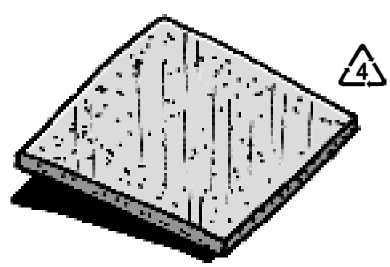


Ruler





Lawn mower wheels



Floor tile

Name ______________________________ Date ______________

Extended Response

- After reading “Drinking Water: Bottled or from the Tap?” and “Art for Ocean Animals,” write an essay in which you compare and contrast the authors’ views on littering and pollution. Include information from both texts to write about the subject knowledgeably. Use details from both passages to help you write your essay. Also, remember to use correct grammar, usage, capitalization, punctuation, and spelling when writing your essay.

Name ________________________________ Date ________________

Scoring Rubric-Extended Response

4 Advanced	In addition to score 3 performance, in-depth inferences and applications that go beyond what was taught will be included. Student was able to apply information about littering and pollution to a related topic or event with supporting evidence from text. Student can apply the efforts the oil and natural gas industry have in place to support recycling, reducing, and reusing.
3 Proficient	No major errors or omissions regarding any of the information and/or processes, simple or complex, that were explicitly taught. Student shows understanding of littering and pollution and can connect the fact that littering and pollution directly affect our environment with support from text.
2 Basic	No major errors or omissions regarding the simpler details and processes, but major errors or omissions regarding more complex ideas and processes. Student shows understanding of littering and pollution and can connect the fact that some efforts are needed to bring about awareness of littering and pollution.
1 Below Basic	With help, partial understanding of some of the simpler details and processes, and some of the more complex ideas and processes. Student understands what littering and pollution is but is unclear as to why it affects the environment.
0	Even with help, no understanding or skill is demonstrated. Student does not have a basic understanding of littering and pollution .

Drinking Water: Bottled or From the Tap?

by Catherine Clarke Fox

If your family is like many in the United States, unloading the week's groceries includes hauling a case or two of bottled water into your home. On your way to a soccer game or activity, it's easy to grab a cold one right out of the fridge, right?

But all those plastic bottles use a lot of fossil fuels and pollute the environment. In fact, Americans buy more bottled water than any other nation in the world, adding 29 billion water bottles a year to the problem. In order to make all these bottles, manufactures use 17 million barrels of crude oil. That's enough oil to keep a million cars going for twelve months.

Imagine a water bottle filled a quarter of the way up with oil. That's about how much oil was needed to produce the bottle.

So why don't more people drink water straight from the kitchen faucet? Some people drink bottled water because they think it is better for them than water out of the tap, but that's not true. In the United States, local governments make sure water from the faucet is safe. There is also growing concern that chemicals in the bottles themselves may leach into the water.

People love the convenience of bottled water. But maybe if they realized the problems it causes, they would try drinking from a glass at home or carrying water in a refillable steel container instead of plastic.

Plastic bottle recycling can help—instead of going out with the trash, plastic bottles can be turned into items like carpeting or cozy fleece clothing.

Unfortunately, for every six water bottles we use, only one makes it to the recycling bin. The rest are sent to landfills. Or, even worse, they end up as trash on the land and in rivers, lakes, and the ocean. Plastic bottles take many hundreds of years to disintegrate.

Water is good for you, so keep drinking it. But think about how often you use water bottles, and see if you can make a change.

Betty McLaughlin, who runs an organization called the Container Recycling Institute, says try using fewer bottles: "If you take one to school in your lunch, don't throw it away—bring it home and refill it from the tap for the next day. Keep track of how many times you refill a bottle before you recycle it."

And yes, you can make a difference. Remember this: Recycling one plastic bottle can save enough energy to power a 60-watt light bulb for six hours.

Art for Ocean Animals
by Elise Jonas-Delson

What do you do when you see litter on the beach? You pick it up, of course. But artist Angela Haseltine Pozzi doesn't throw it away. She uses the trash to create giant sculptures of marine animals. The project is called Washed Ashore and its goal is to raise awareness about the effects of littering on ocean animals.

"The first thing you need to do is get people's attention," Pozzi told TFK [TIME For Kids]. "Giant animals tend to do this very well."

Pozzi started Washed Ashore when she noticed plastics on the beaches in Oregon, where she lives. Plastic doesn't break down and become absorbed by the environment. Instead, sunlight breaks it down into pieces about the size of plankton, which are tiny organisms that float in the sea. These tiny pieces of plastic enter the food chain. Sea animals eat them and end up dying. Pozzi always loved the ocean and the animals in it, and she wanted to do something to help both.

Sea Change
One of Angela's sculptures is a turtle. The turtle's head is an old garbage can lid. There is netting around it to show that turtles are getting caught in these nets.

Another sculpture, called Fish Bite Fish, is shaped like a fish and made out of little bits of plastic that contain tooth and claw marks from the fish and crabs that tried to devour the plastic. "We get so many pieces of plastic like this, I'm on my third Fish Bite Fish [sculpture]," says Pozzi.

The Sea Star figure is made of glass and plastic bottles, some of which are from the Beijing Olympics of 2008. The bottles started landing on the beaches in Oregon in 2010, and they still are arriving. The Sea Star acts as a musical instrument. You put water in the bottles and hit them to make music.

A Helping Hand
Pozzi doesn't collect all the trash by herself. When people spot litter on beaches, they drop it off at Artula Institute for Arts and Environmental Education, in Bandon, Oregon. Then Angela and her volunteers begin the process of turning the waste into art. Everything used for the sculptures is found on the beach, except for the framework and the materials used to connect the litter together.

Who does Pozzi believe can save marine animals? "Kids have a lot of power," she told TFK. "They are the ones that can make things happen. I really believe it."
TIME For Kids caught up with the Washed Ashore tour in Sausalito, California. The exhibit is currently in Chula Vista, California, from December 8 until July of next year.

TABLE 1: Plastic Identification Coding System - Answer Key

Recycling Symbol	Plastic Objects	Recycled Products
1	clear flexible cup, clear oval bottle	Fiberfill in coats Carpet
2	round bottle	Trash cans Garden furniture
3	15cm clear container	Flexible hoses, Playground equip-ment
4	lid	Floor tile Garbage can liners
5	large white jar, small jar	Lawn mower wheels, Battery cables
6	clear rigid cup	Flower pots, Rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

TABLE 2: Assessment Information

Recycling Symbol	Plastic Objects	Recycled Products
1	Soft drink bottles and food containers	Fiberfill in coats Carpet
2	Milk jugs, grocery bags, toys, juice containers	Trash cans Garden furniture
3	Clear food packaging, shampoo bottles, credit cards	Flexible hoses, Playground equipment
4	Bread bags, frozen food bags	Floor tile Garbage can liners
5	Food containers and medicine bottles	Lawn mower wheels, Battery cables
6	CD jackets, disposable utensils and cups	Flower pots, Rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

CONCLUSION

Answer Key

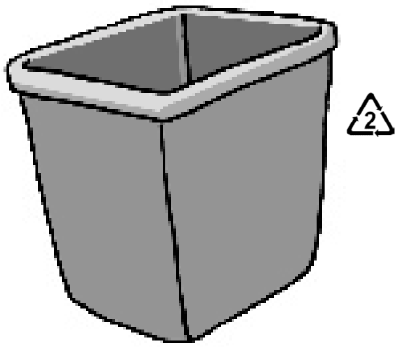
1. Use Table 1: Plastic Identification Coding System to decide what products a drink bottle with a number 1 can be recycled to make. fiberfill in coats, carpet

2. Why do you think using and recycling plastics is important?
Recycling plastics is really very energy efficient. By recycling, you reduce the demand for natural resources and limit waste and pollution.

ASSESSMENT

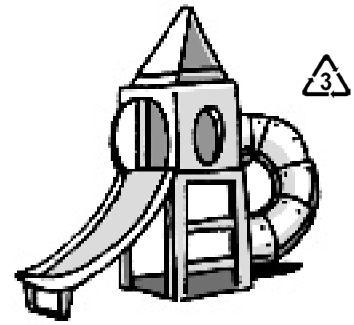
Answer Key

You need to know what products can be recycled to make the following objects: Use Table 1 to find your answers.



Trash can

Possible Ans: Milk jugs, grocery bags, toys, juice containers

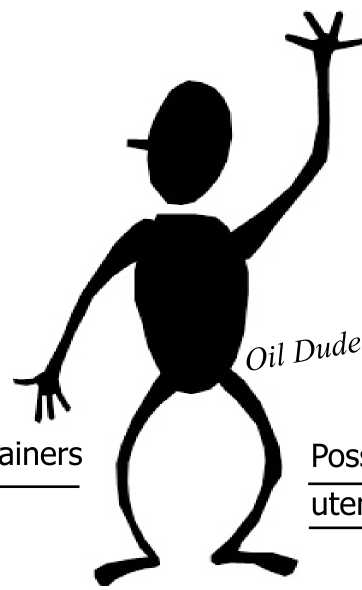


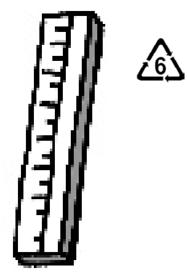
Playground equipment

Possible Ans: Clear food packaging, shampoo bottles, credit cards

Fiberfill in coats

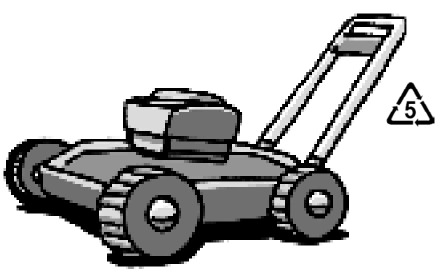
Possible Ans: Soft drink bottles, food containers





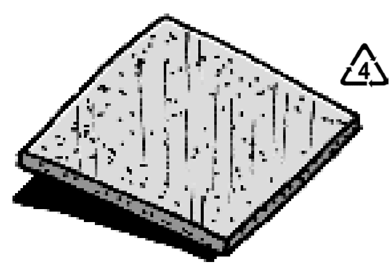
Ruler

Possible Ans: CD jackets, disposable utensils, cups



Lawn mower wheels

Possible Ans: Food containers, medicine bottles



Floor tile

Possible Ans: Bread bags, frozen food bags

Cooking Up Crude

Next Generation Science Standards

Grade 3
Biological Evolution: Unity and Diversity

3-LS4-1 Analyze and interpret data from fossils to provide evidence of organisms and environments in which they lived long ago.

Grade 4

Earth's Place in the Universe

4-ESS1-1 Identify evidence from patterns in rock formations and fossils in rock layers for changes in a landscape over time to support an explanation for changes in a landscape over time.

Earth's Systems

4-ESS2-2 Analyze and interpret data from maps to describe patterns of Earth's features.

Earth and Human Activity

4-ESS3-1 Obtain and combine information to describe that energy and fuels are derived from natural resources and their uses affect the environment.

Cooking Up Crude

Formation of Oil and Natural Gas

Wonder Why . . .

Have you ever wondered how crude oil and natural gas form?

Concept

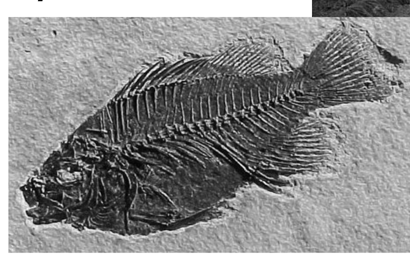
The oil and natural gas taken from the earth's crust today originated as microscopic plants and animals that lived in the ocean millions of years ago.

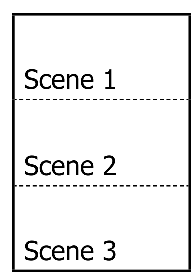
Activity – How do <u>you</u> see it?

Students illustrate the sequence of oil formation.

Materials

- "Cooking Up Crude" video at **iprb.org/education/classroom-curriculum/references**
- Paper (8½" x 14")
- Color map pencils
- Fossils (if available)





Cooking Up Crude Activity Outline (Power Point Presentation Preferred)

1. Have students discuss their ideas of the formation of oil & natural gas, and sketch it on one side of the paper.
2. Instruct students to draw 2 lines on the other side, dividing the paper into 3 sections. Label each section, scene 1, scene 2, & scene 3 in preparation for the story they will hear about oil & gas formation.
3. Start the video. After each chapter instruct students to sketch the scene.

Narrator:

I am going to tell you a story about the history of the formation of oil and natural gas in the state of Illinois. This story will be told in three short chapters. When I finish each chapter, I would like for you to draw a picture representing what you have just heard. Please begin drawing when I say, "Can you picture this scene?" Let's begin.Chapter One

Chapter One

544 million years ago — a geologic period known as the "Paleozoic Era" began—a large sea covered much of the United States, including what is now Illinois. In this sea lived a vast number of microscopic plants and animals called plankton. This microscopic plankton drifted on or near the surface of the water and became so numerous that it could actually be seen with the naked eye.

Throughout the "Paleozoic Era" the sea was also alive with trilobites, corals, crinoids, brachiopods and a host of other marine plants and animals that were evolving over many millions of years. A trilobite was a strange-looking little creature. Small grooves divided its body and hard segmented shell into three vertical parts. Its head was covered by a semicircular shield. Many kinds of trilobites lived in the seas that covered Illinois.

Coral, which still exists today, came in many different sizes, shapes and colors. The coral polyps were simple animals that were able to take calcium out of saltwater and convert it into a rocklike shelter, in which they lived.

Crinoids anchored themselves to the sea floor with a root-like structure that supported a long stalk or column. On top of this stalk was a cup-like cavity, which formed a protective case for a flower-like structure that was used to catch tiny particles of food as they drifted by.

Brachiopods were clam-like animals that lived on the sea floor. Their two-piece dorsal and ventral shells enclosed and protected their soft body parts just like clams and oysters today.

Although during this time Illinois was covered by the sea, other parts of the world were exposed as land. As rivers, wind, rain, avalanches, and ice movements eroded the surrounding landscape, tiny particles—called clastic sediments—were carried into the sea where the billions of tiny sea creatures lived.

All organisms on Earth contain carbon. Billions of tiny plankton can contain quite a large amount of carbon. As these numerous lifeforms in the sea of the Paleozoic era died, their remains settled to the deep sea floor and became covered with the mud, sand and sediment from the eroding mountains and surrounding areas.

If these dead plankton and other sea creatures were buried quickly on the deep sea floor, the sediment would protect them from being exposed to oxygen, which is necessary for decay (or decomposition). If the dead organisms don't decay, the carbon in their remains can be preserved. If a layer has a particularly large amount of carbon, we tend to call it "organic rich".

In Illinois several thin organic-rich layers were deposited, but the thickest, and by far the most important one, was deposited in the middle of the Paleozoic Era, about 360 – 350 million years ago.

Can you picture this scene?

Chapter Two

For perhaps another 100 million years, sediments continued to bury our organic-rich layer. By now it was the last of the Paleozoic Era and the layers of sediments on the sea floor have become thousands upon thousands of feet thick.

The weight and depth of all this rock created immense pressure and heat that began to affect the buried organic rich layers.

About this time the seas were leaving Illinois and no more sediments were being deposited. Even so, the heat and pressure continued to work on these buried sediments and were responsible for slowly changing the inorganic layers into sedimentary rock.

The rare, organic-rich layers were changed into what geologists call source rock – and it is only in these source rocks where the dead organic material can slowly change into hydrocarbons – which are compounds containing only hydrogen and carbon.

Can you picture this scene?

Chapter Three

A few million years later, or around 248 million years ago, the Mesozoic Era began. It was the "Age of Reptiles". Illinois was now dry land and would never again be covered by the sea. From that time through the entire Mesozoic Era - - and through the entire Cenozoic Era - - all the way until today, the animals that plodded, walked, and flew across Illinois had no idea that pressure and heat were continuing to act on the layers of sedimentary rock deep beneath their feet.

The effects of the heat and pressure over all this time formed many layers of sedimentary rock under the Illinois area, including the organic-rich source rock. Much of the water that was in the ancient sea is now in the pore spaces of the sedimentary rocks. The remaining water evaporated or was pushed into areas where seas or oceans now exist.

For over 250 million years, temperatures ranging from 150-300 degrees Fahrenheit have "cooked" the organic materials in the buried sediments causing a complex chemical change creating oil and natural gas.

Molecule by molecule the oil and gas was pushed out of the source rock and migrated into porous reservoir rocks in other layers. It's in these reservoir rocks that we find oil today.

Can you picture this scene?

As you finish drawing the last scene, keep in mind that there are several theories concerning the formation of oil and natural gas. What you have just heard is the most widely accepted scientific theory.

Concept Formation

1. Using the picture you have drawn, tell how oil and natural gas are formed. (Possible answer(s): See teacher information.)

2. Why does Illinois have so much petroleum? (Possible answer(s): Because millions of years ago Illinois was covered by an ocean.)

Teacher Information

Much of what is Illinois today was under an ancient ocean millions of years ago. Geologists believe this because many rock layers containing fossil remains of marine life have been found throughout the state. Millions of microscopic marine plants and animals which lived in the waters eventually died and settled on the ocean floor. The dead plants and animals were often buried by sand and other sediment. Heat from beneath the earth's crust "cooked" the plant and animal remains forming oil and natural gas deposits within the rock layers. This is why oil and natural gas, or petroleum, are called fossil fuels.

Treasure Hunt

Vocabulary

1. **basin** – a large bowl-shaped depression in the basement rock

2. **coordinate grid** - a network of evenly spaced horizontal and vertical lines

3. **coordinates** - a set of numbers, like an ordered pair, used in finding a location on a grid

4. **county** - land divisions of a state. Illinois has 102 counties; 44 are producing oil.

5. **crude oil** – oil in its natural liquid state (a mixture of gases, oil, and water) as it comes out of the ground

6. **map** - a drawing representing an area

7. **natural gas** – a gas which comes from the earth's crust

8. **oil well** - a hole drilled in the earth from which crude oil and natural gas are pumped

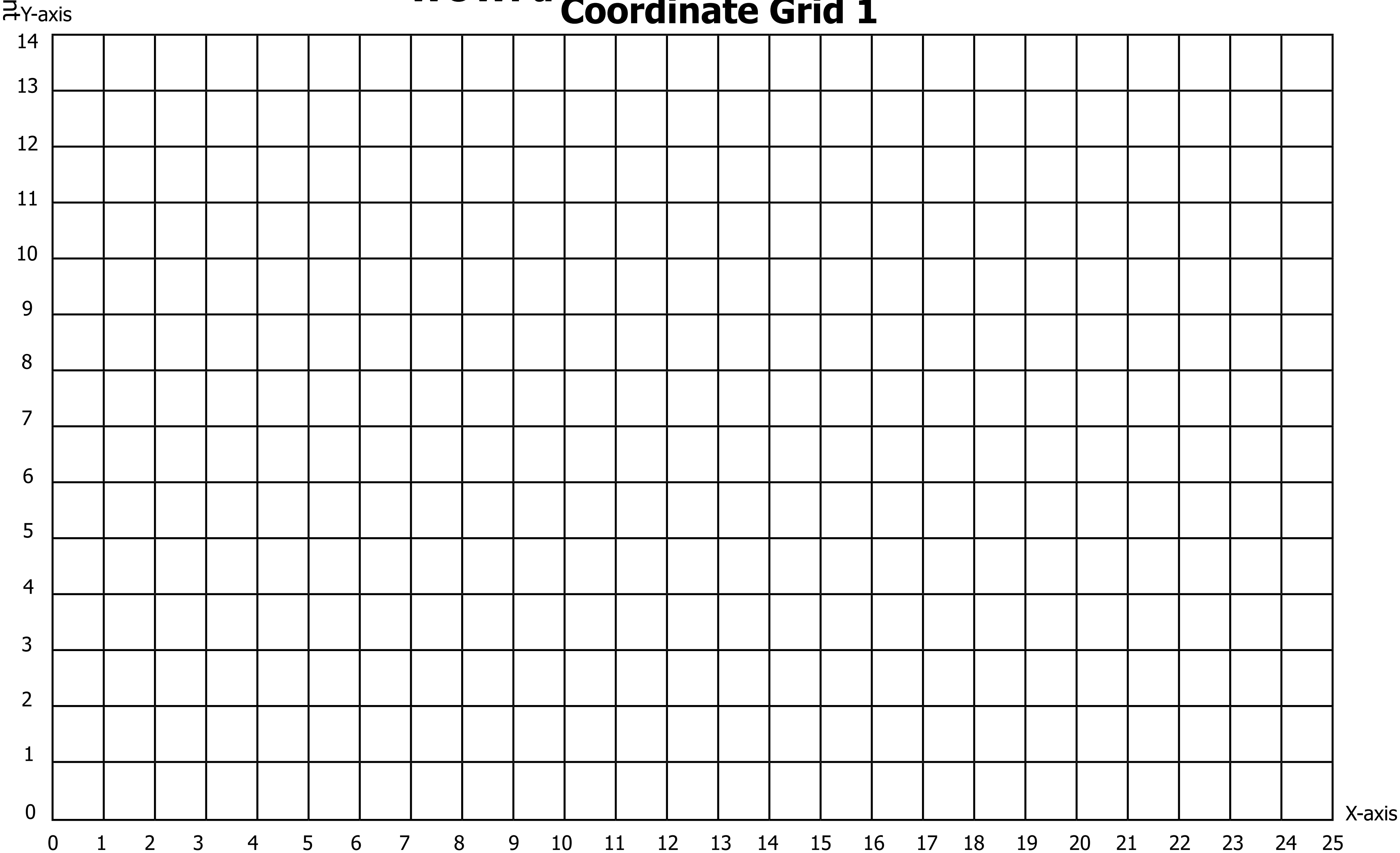
9. **ordered pair** - a pair of numbers used to find a location

10. **X-axis** - the horizontal line (left to right) on a grid

11. **Y-axis** - the vertical line (up and down) on a grid

Name ____________________

WOW! a Treasure Hunt Coordinate Grid 1

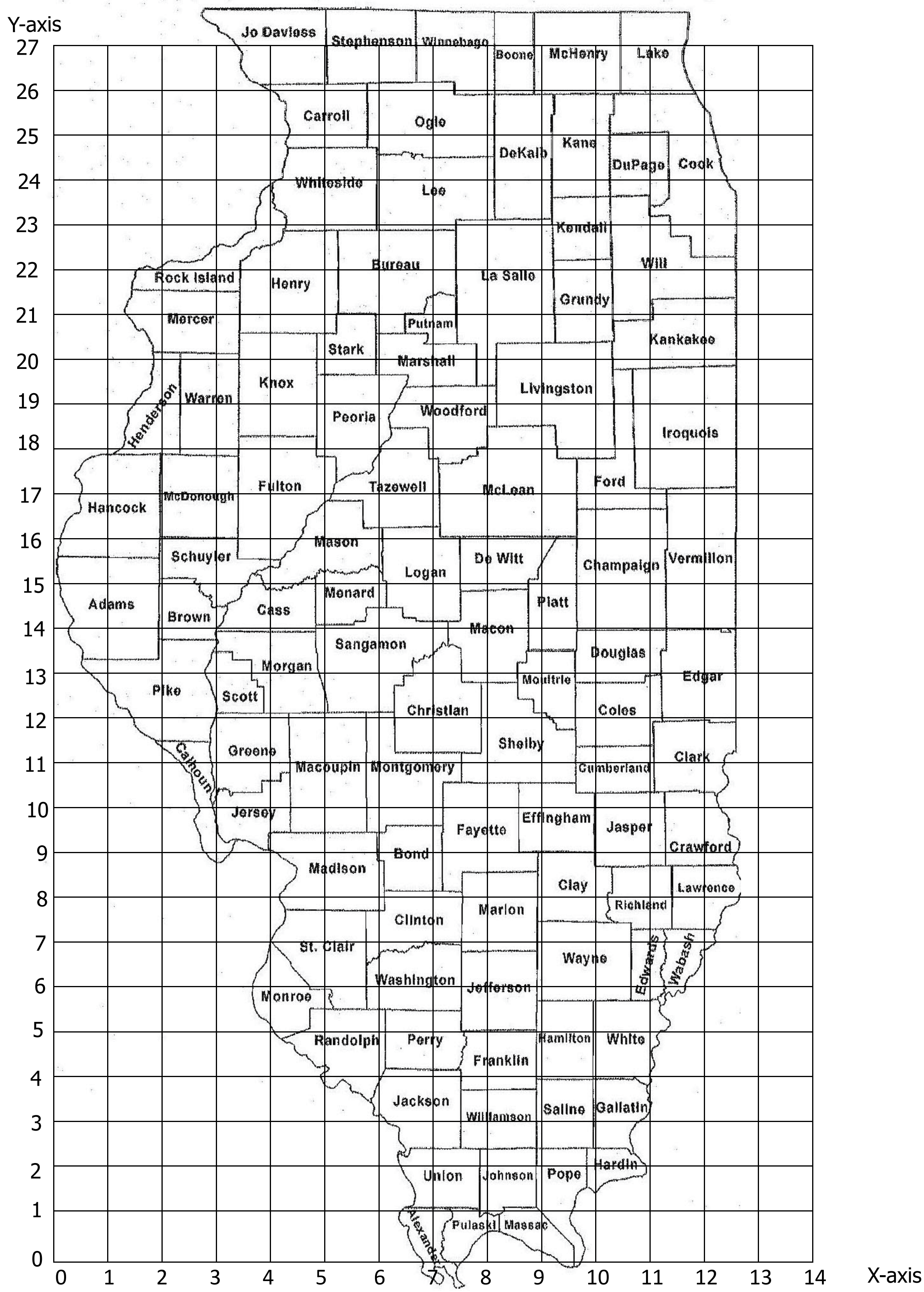


1. Find where oil and natural gas are located by graphing the following ordered pairs in the order given. Label each one with the corresponding letter on your graph and connect the points in order alphabetically. A(8,0) B(15,0) C(22,0) D(24,1) E(25,1) F(25,11) G(23,9) H(21,10) I(20,13) J(18,12) K(15,14) L(13,14) M(12,13) N(10,11) O(9,11) P(9,9) Q(7,10) R(6,10) S(5,9) T(4,7) U(3,7) V(1,6) W(2,5) X(1,3) Y(3,3) Z(3,2) AA(4,2) BB(6,1)
2. Look at the shape of your drawing. In which state are you looking for energy? ____________

Coordinate Grid 2

Name ______________

Help locate the counties with the greatest production of crude oil.

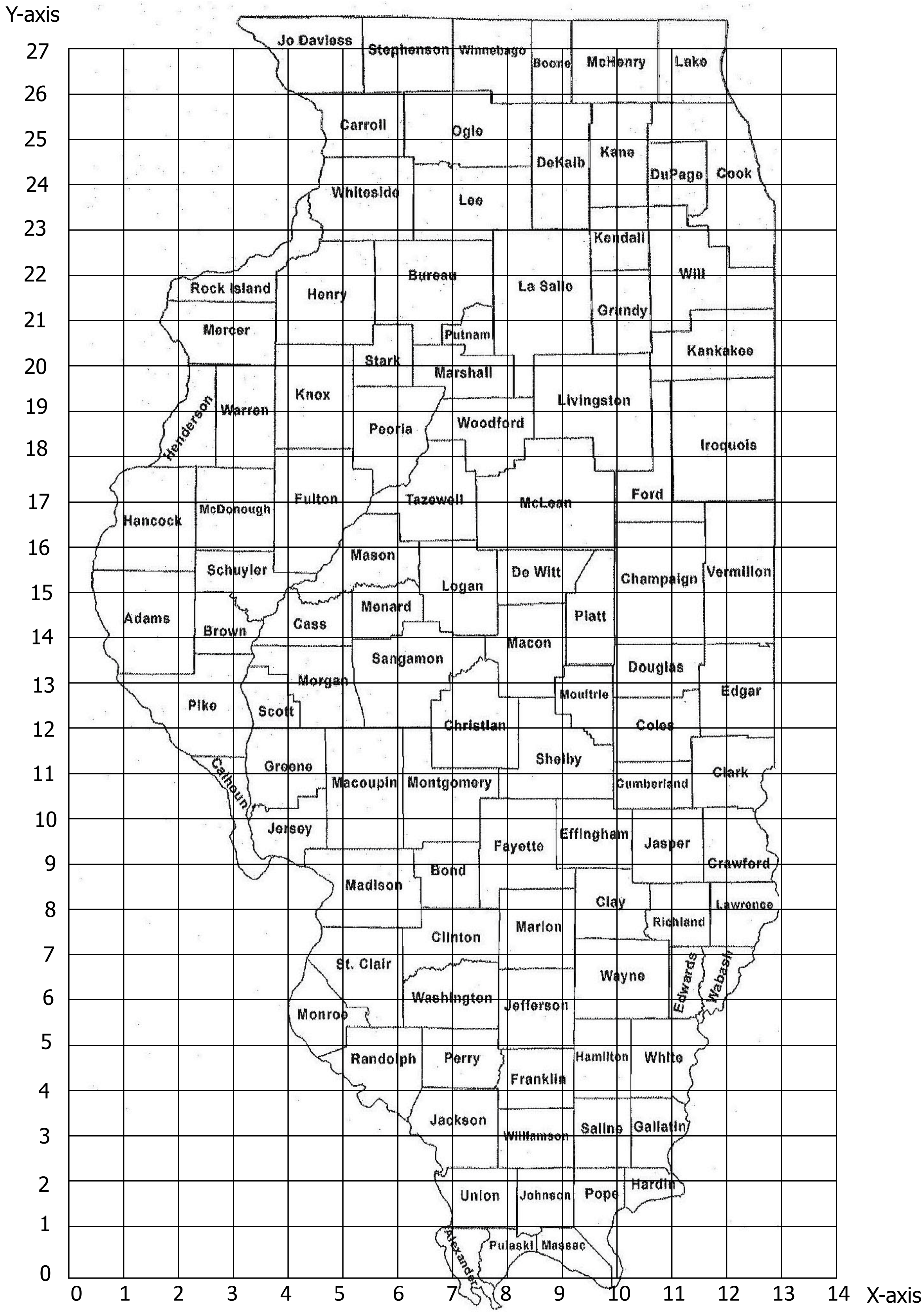


Plot each of the top 10 crude oil-producing counties with a green dot:
1(10,5) **2**(8,8) **3**(12,10) **4** (12,8) **5**(8,10) **6**(9,8) **7**(9,7) **8**(12,7) **9**(10,3)
10(8,4)

Coordinate Grid 3

Name ____________________

Find the counties that make-up the two productive areas of the basin in Illinois by plotting the following ordered pairs in the order given. Connect the points around the perimeter of Area 1. Connect the points around Area 2.



Illinois Basin Area 1: (7,3) (11,3) (12,6) (13,9) (13,12) (9,12) (9,16) (8,16) (6,14) (5,11) (5,6) ____________________

Illinois Basin Area 2: (3,14) (4,15) (3,17) (2,14) ____________________

Name ______________________________**Date** ________________

TREASURE HUNT!
STUDENT SHEET

WONDER WHY...

Have you ever wondered where crude oil is found in Illinois?

CONCEPT

A location can be found on a coordinate grid by using an ordered pair.

MATERIALS FOR ACTIVITY: (per student)

- colored pencils
- Coordinate Grid 2
- Coordinate Grid 3

PROCEDURE

1. Use the information in Table 1 and Coordinate Grid 2, to locate the top 10 crude oil-producing counties in Illinois in 2010. Plot each of the top 10 crude oil-producing counties with a green dot.
2. Write the name of each county in Table 1.

TABLE 1: Top 10 Oil-Producing Counties in Illinois in 2010

Rank in Oil Production	Ordered Pair	County
1	(10, 5)	
2	(8, 8)	
3	(12, 10)	
4	(12, 8)	
5	(8, 10)	
6	(9, 8)	
7	(9, 7)	
8	(12, 7)	
9	(10, 3)	
10	(8, 4)	

5. Using Coordinate Grid 3, plot the ordered pairs and connect the points to locate the counties that makeup the perimeter of two productive areas of the basin in Illinois.

Name ______________________________ **Date** _______________

CONCLUSION

1. Some Illinois counties produce more crude oil than other counties. How would you describe where these counties are located in Illinois?

____

____

2. How would you describe the Area 1 portion of the basin?

____

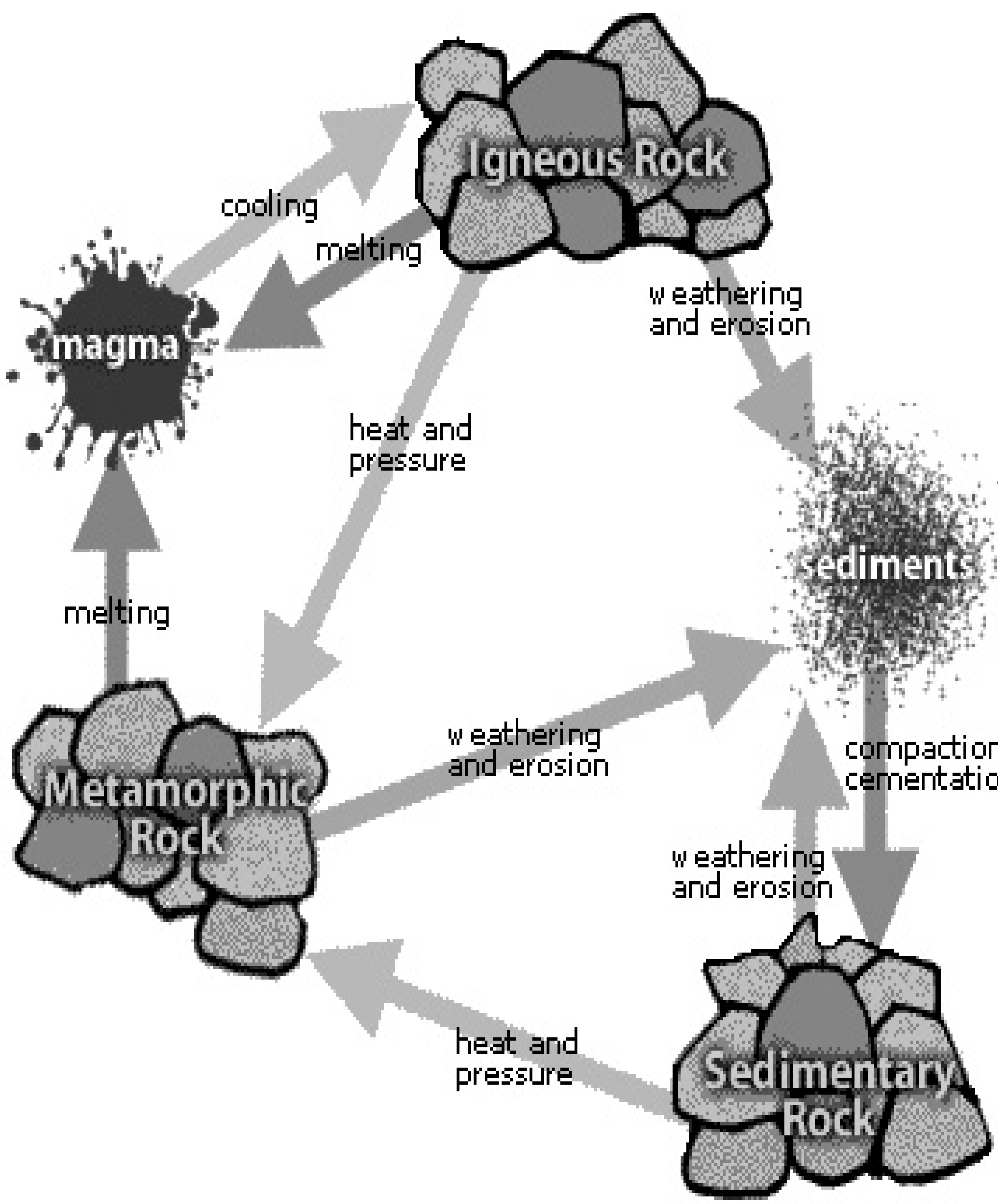
____

Extended Response

• Use the internet to research one of the jobs involved in oil or natural gas exploration. For example, geologist, petroleum engineer, land surveyor, wild catter, etc. Write a narrative explaining which job you find most interesting and why. Career information can be found on www.iprb.org.

• Create a Venn Diagram and research the Illinois Basin verses the Williston Basin in North Dakota. Use the information to write an essay comparing and contrasting the two basins.

Figure 1
Rock Cycle



Rock Detective

Vocabulary

1. **crude oil** – oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

2. **dichotomous key** – a key used for the identification of objects based on a series of choices

3. **granular** – containing small, hard particles or grains

4. **igneous rocks** - form when the magma (melted rock) cools and turns solid

5. **layering** – horizontal layers or lines

6. **luster** - the way light reflects from a surface

7. **metamorphic rocks** - form when existing rocks are exposed to increased heat and pressure inside the Earth's crust.

8. **mineral** - a solid inorganic material found in the Earth's crust; the building blocks of rocks

9. **natural gas** - colorless, odorless gas found in the Earth

10. **physical property** – what can be seen or measured

11. **pore** – openings or spaces within a rock

12. **rock** - the solid part of earth made of two or more minerals

13. **rock cycle** - the series of events that rocks, over time, go through that changes them from one type of rock to another.

14. **sedimentary rocks** - form when sediments and other materials press together and harden

15. **texture** – characteristic of a rock that you can see and feel

Name________________________ Date ______________

ROCK DETECTIVE!
STUDENT SHEET

WONDER WHY…

Why do rocks look different from each other?

CONCEPT

Rocks are a natural, solid, nonliving material made of one or more minerals. Using a dichotomous key, rocks can be identified by physical properties such as color, luster, texture, feel or grain size.

MATERIALS FOR ACTIVITY:

- 1 collection of 10 rocks per group
- 2 magnifying lens per group
- 1 Rock Identification Sheet per student
- 1 Rock Identification Dichotomous Key per student

SAFETY:

- Keep rocks on the table or desktop.
- Do not put rocks in mouth.
- Wash hands after handling rocks.

PROCEDURE:

1. Place the rock samples out on the table.
2. Select one rock from the rock samples.
3. Read carefully through the Rock Identification Dichotomous Key to classify and name the rock.
4. Record the rock number on the Rock Identification Sheet in the

   blank next to the correct name of the rock.
5. Record the physical properties of the rock.
6. Repeat steps 3-6 until all rock samples have been classified.
7. Share your results with the class.

Rock Identification

Dichotomous Key

1. What is the overall color of the rock?
   a. Rock is black in color ....Go to step 2
   b. Rock is not black ....Go to step 3

2. Is the rock glassy or not?
   a. Rock is smooth and glassy ....Obsidian (Igneous)
   b. Rock is not glassy ....Go to step 4

3. Inspect the rock carefully **without** the hand lens. Are there large holes or pores?
   a. Rock has visible holes or pores .... Go to step 5
   b. Rock has small or unseen pores ....Go to step 6

4. Does the rock show layering or is it more blocky?
   a. Rock is layered ....Shale (Sedimentary)
   b. Rock is not layered it is more blocky ....Coal (Sedimentary)

5. What is the overall color of the rock?
   a. Rock is grey or light grey ....Pumice (Igneous)
   b. Rock is reddish-brown or dark brown .... Scoria (Igneous)

6. Look closely at the rock **with** a hand lens. Does the surface sparkle or have crystals?
   a. Rock sparkles or appears crystalline ....Go to step 7
   b. Rock is dull and doesn't sparkle ....Go to step 8

7. Look carefully at the rock. Is the rock multicolored or not?
   a. Rock color is multicolored or speckled .... Go to step 9
   b. Rocks color is the same throughout ....Marble (Metamorphic)

8. Look closely at the rock **with** a hand lens. Are the grains large or small?
   a. Rock grains are pebble size and/or mixed sizes ....Conglomerate (Sedimentary)
   b. Rock grains are mostly sand size ....Sandstone (Sedimentary)

9. Does the rock show layering of grains?
   a. Rock grains are in layers ....Gneiss (Metamorphic)
   b. Rock grains are scattered with crystals ....Granite (Igneous)

Name_____________________________ Date ________________

TABLE 1: ROCK IDENTIFICATION

Igneous	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ OBSIDIAN # _____	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ PUMICE # _____
	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ SCORIA # _____	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ GRANITE # _____
Sedimentary	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ SHALE # _____	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ SANDSTONE # _____
	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ COAL # _____	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ CONGLOMERATE # _____
Metamorphic	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ MARBLE # _____	Color: ____________ Luster: ____________ Feel/Texture:____________ Grain Size:____________ GNEISS # _____

Name______________________________ Date ________________

CONCLUSION

1. What properties did you use to classify your rocks?______________________________

____

2. Choose two or more of the sedimentary rock specimens to compare and contrast.

____

____

3. In what type of rock do you think crude oil and natural gas are most likely to be found? Why?

____

____

Name_____________________________ Date _______________

Extended Response:

- Write a short story from the viewpoint of a particular sedimentary, igneous or metamorphic rock as you travel through the rock cycle moving from one type of rock to another.

Rubric for Venn Diagram & Extended Response

4 **Advanced**	In addition to score 3 performance, in depth inference and what was taught. In addition to score 3, was able to show creativity and originality above and beyond the information that was explicitly taught.
3 **Proficient**	No major errors or omissions regarding any of the information and/or processes, simple or complex, that was explicitly taught. Shows understanding of the rock cycle and can connect the fact that rocks change form over long periods of time by being exposed to heat, pressure, weathering, and erosion, etc.
2 **Basic**	No major errors or omissions regarding the simpler details and processes but major errors or omissions regarding more complex ideas and processes. Shows understanding of rock cycle and can connect the simpler details.
1 **Below Basic**	With help, a partial understanding of some of the simpler details and processes, and some of the more complex ideas and processes.

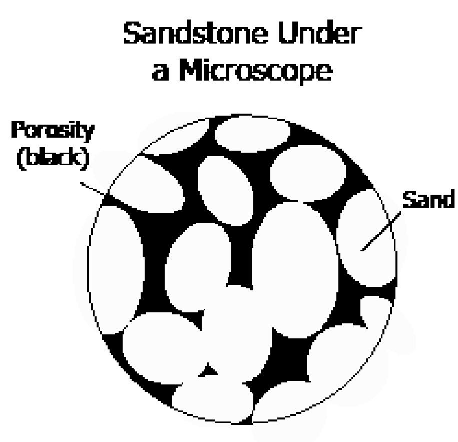
Extended Response

- Read the article below and apply the information.

Sedimentary rocks are made up of tiny particles, other rocks and minerals. These particles are packed together. In between the particles are spaces that are filled with air, gas, or liquid. These spaces are called porosity (from the word "porous"). The porosity of a rock is a measure of its ability to hold a fluid or gas. Mathematically, porosity is the open space in a rock divided by the total rock volume (solid + space or holes). The shape and size of the particles affect the way they pack together in a certain amount of space, which affects a rock's porosity. In general, larger particles cannot pack together as well as smaller particles can, which means that packing larger particles together leaves more room for air, water and gas to fill in between the particles, making the rock more porous. The porosity of a rock can be used to characterize the rock. Even though sandstone is hard, and appears very solid, it can really be very much like a sponge (a very hard, incompressible sponge.) Between the grains of sand, enough space can exist to trap fluids like water, oil or natural gas! If you take a piece of sandstone with sufficient porosity and pour water on it, you will see the water is absorbed right into the rock. The water is soaked into the pores.

A geologist has been hired by a local oil company to find a new site to drill for oil. One site has granite outcroppings and the other site has sandstone outcroppings. Write a letter to the oil company stating your opinion on which site would be the best area to consider to drill. In your letter, include information from all sources to write about the subject knowledgably. Use details from the Thirsty Rocks activities and the provided article to support your opinion. Also remember to use correct grammar usage, capitalization, punctuation and spelling when writing your essay.

In the picture below the porosity is shown as black. Oil or gas will fill these holes in the rock. The more spherical (rounded) the grains are, the more space or porosity is left between them. Therefore, well-rounded sandstone will have more porosity than a poorly-rounded one! A geologist loves to encounter well-rounded sandstone, because it can hold the most oil and gas of any of the rock type.



Thirsty Rocks

Vocabulary

1. **crude oil** - oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

2. **gram** - the metric unit of mass: one gram of water occupies one cubic centimeter of pore space

3. **grain** - a small, hard particle of a rock

4. **mass** - amount of matter in an object

5. **matter** - anything that takes up space and has mass

6. **oil reservoir** - an underground rock formation where oil collects and is stored or trapped

7. **porosity** - refers to the size and amount of pores or open spaces in a rock, indicating how much fluid a rock can hold

8. **sedimentary rock** - rock formed by sediments, examples include sandstone and shale

9. **volume** - the amount of space that an object takes up or occupies

Name________________________________ Date ________

THIRSTY ROCKS!

STUDENT SHEET

WONDER WHY...

Have you ever wondered where crude oil can be trapped underground?

CONCEPT

A sedimentary rock is composed of small, medium, or large grains of minerals and crystals packed together. Between these grains there can be spaces called pores where crude oil and natural gas may be found.

MATERIALS FOR ACTIVITY: (per group)

- 2 - 9 oz plastic cups
- 1 – 250mL graduated cylinder
- water
- small and large rocks

SAFETY:

- Do not put samples in mouth.
- Wash hands after handling samples.

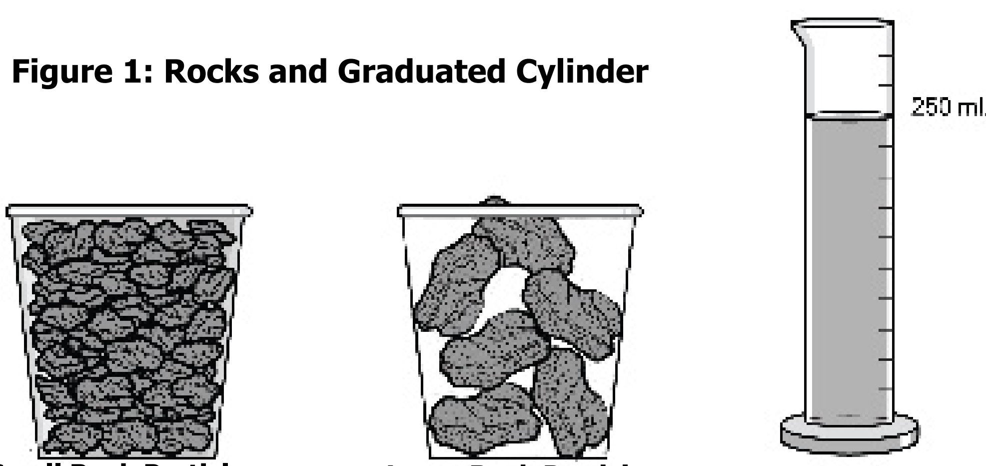
PROCEDURE

Note: The cup is a model of a rock. The small and large rocks inside the cups represent the small or large grains.

1. Fill one clear plastic cup with small rock grains. Fill a second clear plastic cup to the same level as the first cup with large rock grains. Pretend the cup filled with small rock grains is a piece of shale rock and the cup filled with large rock grains is a piece of sandstone rock. Both rocks, shale and sandstone, are examples of sedimentary rock.

2. **Predict** which cup you think will hold the most water. Answer: ____________________

Figure 1: Rocks and Graduated Cylinder



Small Rock Particles
(Represents shale rock)

Large Rock Particles
(Represents sandstone rock)

Graduated Cylinder

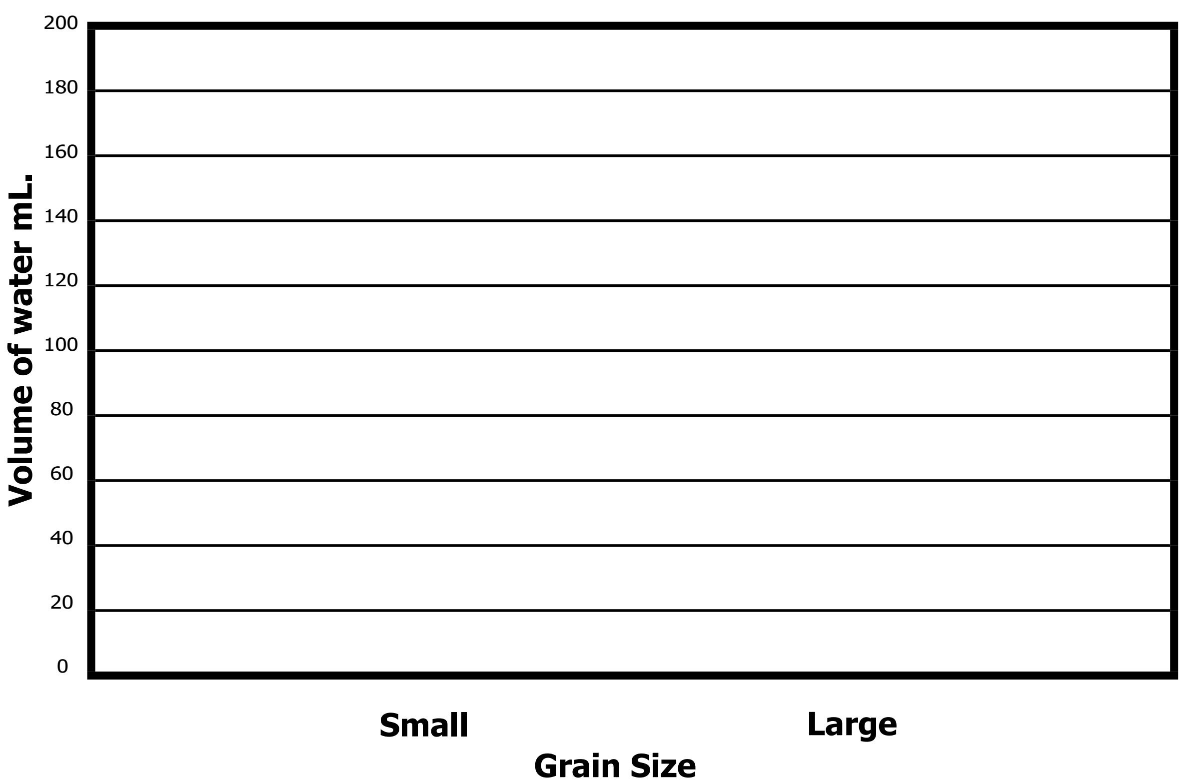
3. Fill your graduated cylinder to the 250mL mark with water.
4. Pour water from the graduated cylinder into the cup which represents shale rock until it is full to the **lower line** on the rim of the cup. Pour slowly and gently so you do not spill water out of the graduated cylinders.
5. In Data Table 1, record the amount of water left in the graduated cylinder.
6. Repeat steps 2-4 using the second cup which represents sandstone rock.
7. Calculate the amount of water that you poured into each cup by subtracting the amount of water you measured from 250mL. For example, if after pouring water into your cup you were left with 110mL of water, then you would subtract 110mL from 250mL to get 140mL. This means that there is 140mL of pore space between the grains in your cup.
8. Compare your results, by graphing your results on Bar Graph 1.

Name________________________________ Date __________

Table 1: Volume of Water vs. Grain Size

Grain Size	Amount of Water Before (mL)	Amount of Water After (mL)	Volume of Water Used (mL)	*Optional % Pore Space (porosity)
Small Rock Grains	250mL			
Large Rock Grains	250mL			

Bar Graph 1: Volume of Water (mL) vs. Grain Size



Name_______________________________ Date ________

CONCLUSION

1. Which cup held the most water: the cup containing the small rock grains or the cup containing the large rock grains? ____

____

2. Which cup had the most pore space between the grains: the cup containing the small rock grains or the cup containing the large rock grains?______________________________

____

3. The cup filled with small rock grains represented shale rock and the cup filled with large rock grains represented sandstone rock. Which type of rock, sandstone or shale, is the most porous?

____

____

4. Good oil reservoirs have a high porosity. Which type of rock, sandstone or shale, is more likely to be a good oil reservoir? ____

____

5. In the sedimentary tube, why are the larger sediments found near the bottom of the tube?

____

____

Visiting Viscosity

Vocabulary

1. **bar graph** - a graph using parallel bars of varying lengths to make comparisons

2. **crude oil** - oil in its natural liquid state (a mixture of gases, oil, and water) as it comes from the ground

3. **drilling mud** - fluid pumped into an oil well during drilling to seal off porous rock layers, cool the drill bit, and bring rock cuttings to the surface

4. **drilling mud engineer** - a person trained to design and manage drilling mud

5. **impurity** - polluted or contaminated, not pure

6. **oil reservoir** - an underground place where oil collects and is stored

7. **petroleum engineer –** a person trained in the methods used to get crude oil and natural gas from the earth

8. **rock cuttings** - small pieces of rock that are formed during the drilling process

9. **viscosity** - the resistance of a liquid to flow

10. **viscosity tube** - a transparent plastic tube containing a viscous oil

Name___________________________ Date ____________

VISITING VISCOSITY!
STUDENT SHEET

WONDER WHY...
Have you ever wondered why some liquids are thick and pour slowly?

CONCEPT
Liquids flow at different rates because of their viscosity (resistance to flow).

MATERIALS FOR ACTIVITY: (per group)
- 1 viscosity tube
- 1 stopwatch
- 1 metric ruler
- calculator

SAFETY
- Do not place tubes where they may roll off a table or desk.
- Do not taste any of the liquids.

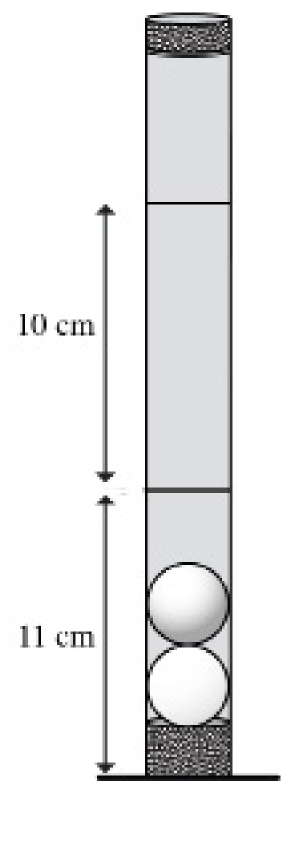
PROCEDURE:

1. Obtain one viscosity tube.

2. **Hold the tube upright with the white sphere below the silver metal sphere.** Give the spheres time to sink all the way to the bottom of the tube.

3. Using the metric ruler, measure and move the bottom o-ring to 11 cm. Move the top o-ring to 21 cm. The distance between the o-rings is 10 cm. See Figure 1.

Figure 1: Viscosity Tube



4. Using the stopwatch, one student should be ready to time the fall of the white sphere.

5. Turn the tube over. Start timing when the white sphere comes even with the first o-ring.

6. Stop timing when the white sphere comes even with the second o-ring.

7. Record the time below. Using the same viscosity tube, repeat the activity twice and record your time in seconds. Find the average (or mean) time by adding the time of the three trials and dividing the sum by 3.

Trial 1 -- time in seconds ________________

Trial 2 -- time in seconds ________________

Trial 3 -- time in seconds ________________

Average time = ________________

8. Calculate the speed of the white sphere in the viscosity tube using the formula.

$$\textbf{Speed} = \frac{\textbf{Distance}}{\textbf{Average Time}} = \frac{\textbf{10 cm}}{\textbf{time in seconds}}$$

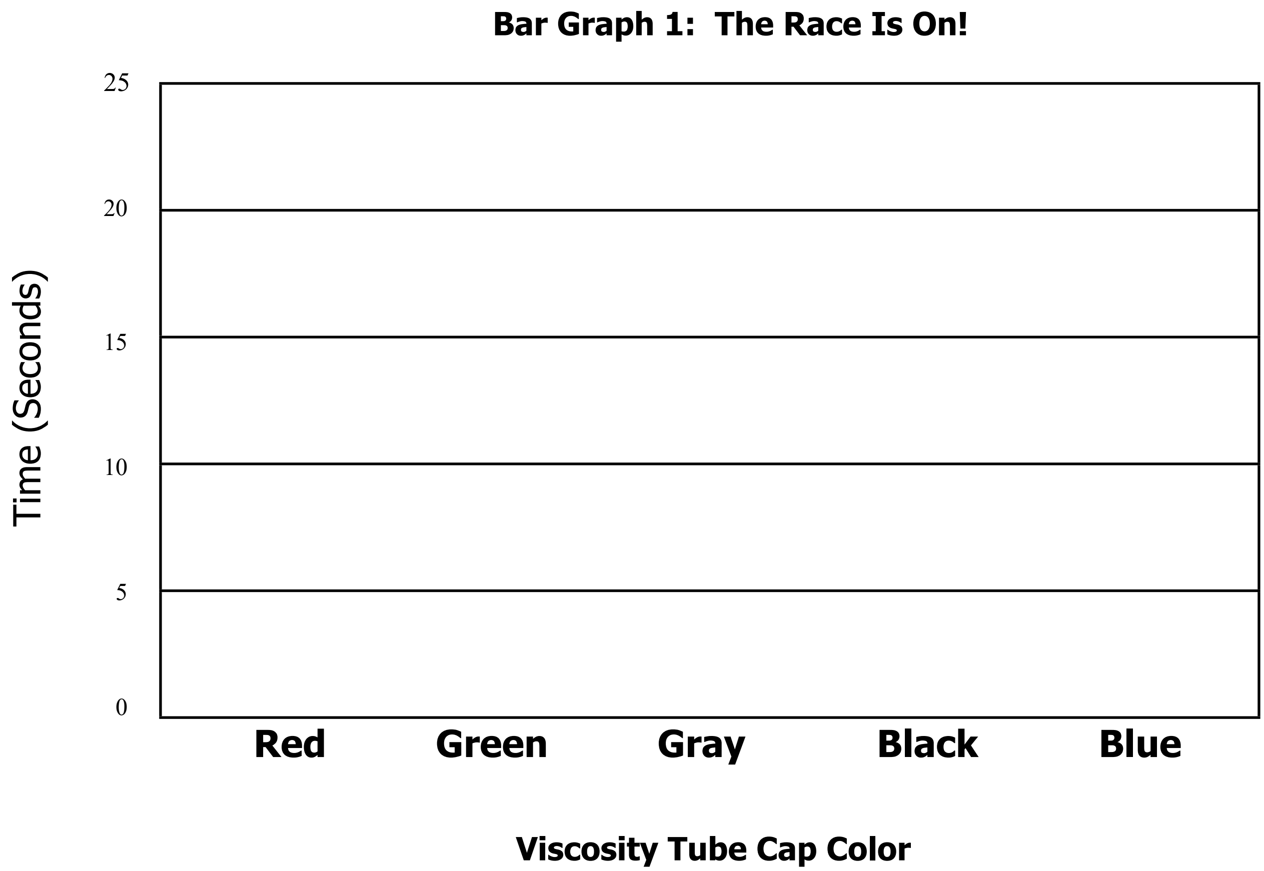
9. Share your results by writing your average time and speed on the transparency of Data Table 1.

10. Record the class data in Table 1.

TABLE 1: The Race Is On!

Viscosity Tube Cap Color	Time in Seconds	Speed (cm/s)
RED		
GREEN		
GRAY		
BLACK		
BLUE		

11. Use the class data from Table 1 to make Bar Graph 1.



Name ____________________________ Date ____________

VISITING VISCOSITY!

ASSESSMENT

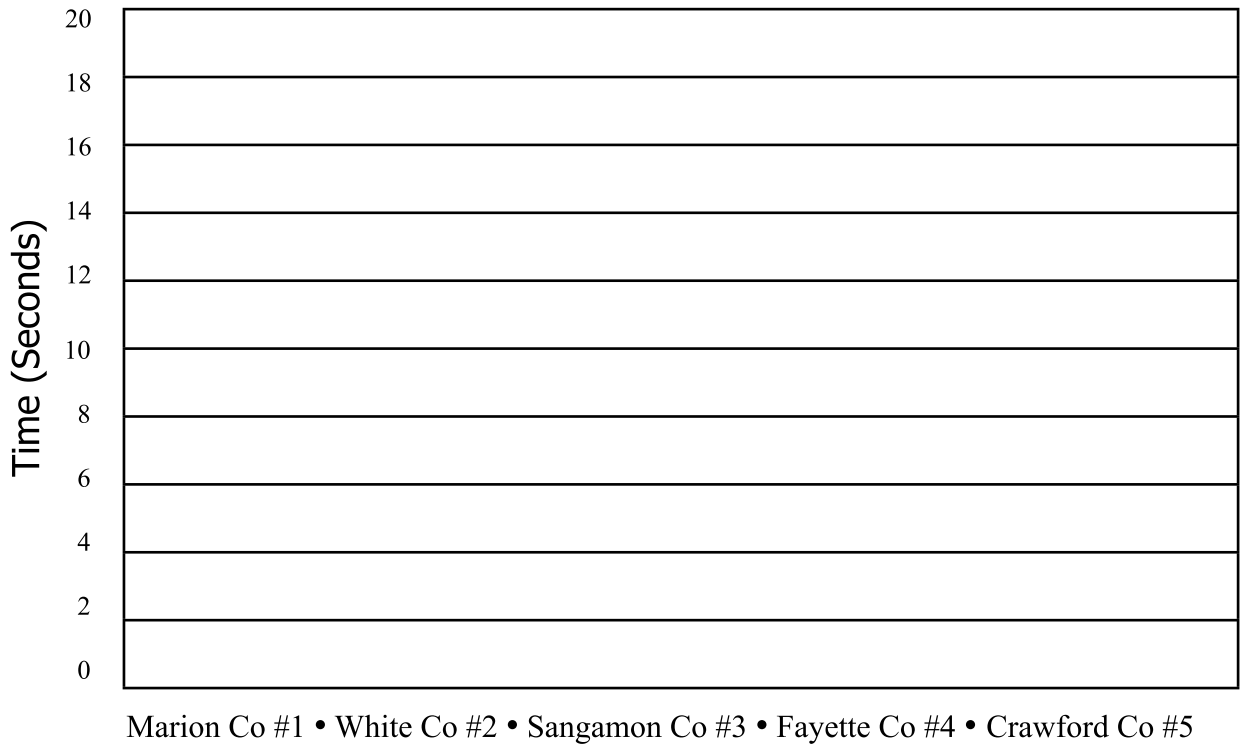
You are given five samples of oil from different oil wells in Illinois. Each sample of oil is placed in viscosity tubes and the time required for the white sphere to fall 10 centimeters was found. Use the data from Table 2 to make Bar Graph 2.

Table 2
Viscosity of Illinois Crude Oil

Viscosity Tube Cap Color	Time in Seconds	Name and Location of Oil Reservoir
RED	10	Marion County #1
GREEN	12	White County #2
GRAY	6	Sangamon County #3
BLACK	8	Fayette County #4
BLUE	10	Crawford County #5

Name____________________________ Date___________

Bar Graph 2
The Viscosity of Illinois Crude Oil



1. Which oil well has the most viscous crude il? ____________________________

____

2. You have been given samples of oil from each of the oil wells in Table 2. Which sample of oil would pour the fastest from a jar?

____

____

Name_________________________ **Date** ___________

CONCLUSION

1. In which viscosity tube did the white sphere take the shortest time to travel the 10cm between the o-rings?____

____

2. In which viscosity tube did the white sphere take the longest time to travel the 10cm between the o-rings?____

____

3. Why is the time required for each sphere to fall different?_____________________

____

4. Which tube contains the most viscous liquid? _____________________

____

5. List the liquids from least viscous to most viscous using the color of the tube caps.

Least viscous Most viscous

__________, __________, __________, __________, __________

6. If an object falls in liquid **A** faster than in liquid **B**, what does that say about liquid **A**?

____

____

____

TRANSPARENCY FOR CLASS OBSERVATIONS

Data Table 1
The Race Is On!

TRANSPARENCY FOR CLASS OBSERVATIONS
Data Table 1

Viscosity Tube Cap Color	Time in Seconds	Speed(cm/s)
RED		
GREEN		
GRAY		
BLACK		
BLUE		

Pulleys-A Weighty Problem

Vocabulary

1. **block** - one or more pulleys in a frame

2. **block and tackle** - a combination of fixed and movable pulleys with a rope

3. **crown block** – a set of fixed pulleys at the top of the oil derrick

4. **derrick** - steel tower that rises above the oil well

5. **effort** - force used to move an object

6. **fixed pulley** - a pulley that stays in place when the pulley cord and load moves

7. **force** - a push or a pull

8. **load** - the mass or object that is being moved

9. **movable pulley** - a pulley that is attached to the load and moves with the load

10. **newton** - the metric unit used to measure force or weight (1 pound is about 4 Newtons; 1 pound = 454 grams)

11. **pulley** - a simple machine that is a wheel with a groove to hold a rope

12. **spring scale** - measuring device used to determine the amount of force used to lift an object

13. **traveling block** – a set of movable pulleys

14. **weight** - measure of the heaviness of an object

Name ____________________________ Date __________

PULLEYS: A WEIGHTY PROBLEM!
STUDENT SHEET

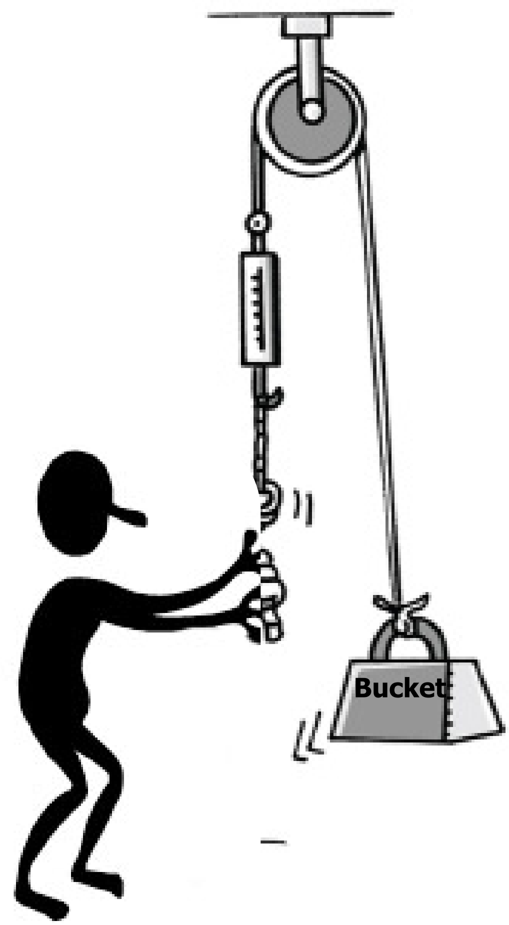
WONDER WHY...
Have you ever wondered how oil field workers lift heavy objects?

CONCEPT
Pulleys are simple machines that make the job of lifting easier. Pulleys are made of a wheel with a rope, wire, or chain around it.

MATERIALS FOR ACTIVITY: (per group)
- 1 dowel rod with eye bolt
- 1 pulley
- 1 pulley cord (1 meter in length)
- 1 spring scale
- 1 bucket with 10 rocks
- 1 ruler

SAFETY:
- Hold dowel rod securely between the two desks.
- Never let go of the pulley cord until the bucket is setting on the floor.

PROCEDURE:
1. Hold the spring scale upright and check to see that the spring scale reads zero when no weight is attached.
2. Attach the bucket of rocks to the spring scale and record the weight in Table 1.
3. Place the dowel rod between two flat tables or desktops. Two students should hold dowel rod securely.
4. Hook a pulley to the screw-eye.
5. Tie the bucket of rocks to the pulley cord. Place the pulley cord in the groove of the pulley and tie the pulley cord securely to the hook of the spring scale as shown in Figure 1 Fixed Pulley.



*A fixed pulley does not move with the load.

Figure 1
Fixed Pulley

6. Pull the spring scale straight down to raise the bucket of rocks until the bottom of the bucket is 10 centimeters off the floor. Using the spring scale, measure the force (or pull) needed to hold the bucket of rocks in place.

7. Record the force (in Newtons) in Table 1.

8. Lower the bucket of rocks to the floor and take apart the pulley system.

9. Tie the pulley cord to the screw-eye. Place the pulley cord in the groove of the pulley and tie the pulley cord to the hook at the bottom of the spring scale. Attach the bucket of rocks to the hook on the bottom of the pulley as shown in Figure 2.

10. Raise the bucket of rocks 10 centimeters off the floor and record in Table 1 the force needed to hold the bucket of rocks in place.

11. Lower the bucket of rocks to the floor and disassemble the equipment.

*A moveable pulley moves with the load.

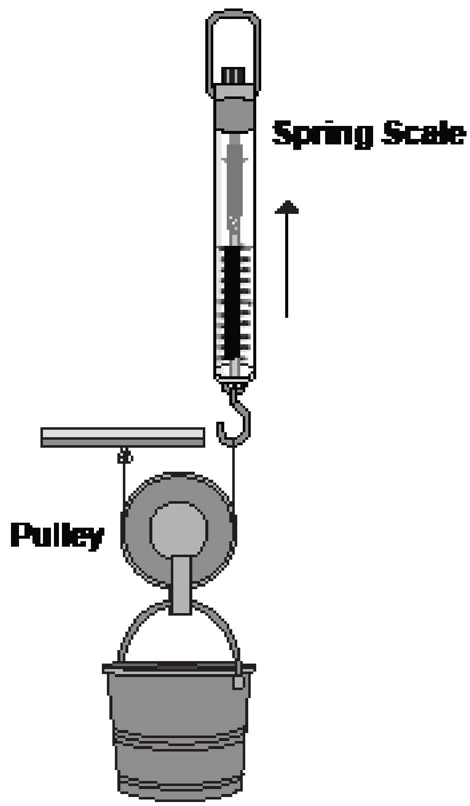


Figure 2
Moveable Pulley

HOW THE SPRING SCALE WORKS

An instrument called a **spring scale** is used to measure force or weight. There is a hook on the bottom of a spring scale. When an object hangs from the hook, the spring on the inside of the spring scale is stretched. The heavier the object, the more the spring will stretch. On the spring scale the numbers show the size of the force in Newtons that has stretched the spring. Be sure to make all readings on your spring scale with your eye at the level of the disk inside the spring scale tube.

Your spring scales measures a force between
0-20 Newtons.

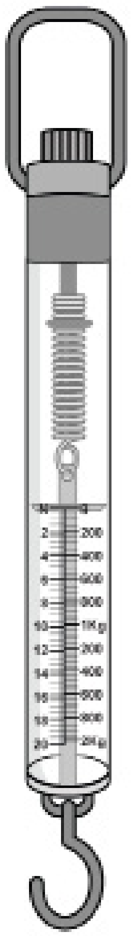


Figure 4
Spring Scale

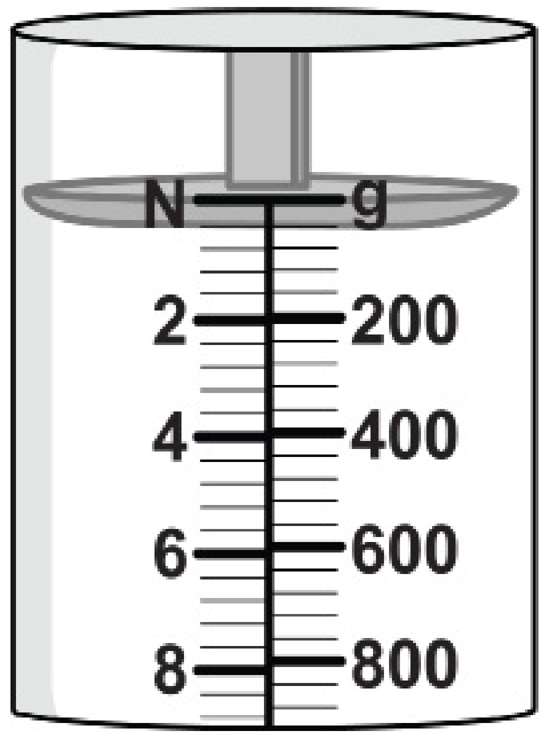


Figure 5
Section of a Spring Scale

Name ______________________________ **Date** ________

TABLE 1: Force Needed to Hold the Bucket of Rocks

Force Needed to Hold the Bucket of Rocks	
Without a Pulley (This is the weight of the bucket of rocks.)	_____ Newtons
Fixed pulley with a bucket of rocks	_____ Newtons
Movable pulley with a bucket of rocks	_____ Newtons

CONCLUSION:

1. Answer the question by placing an X in the correct box.

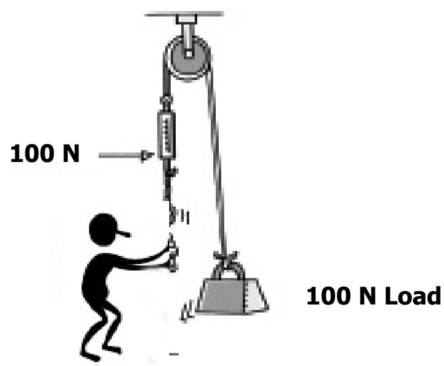
Question	Fixed Pulley	Movable Pulley
Which type of pulley lets you hold the bucket of rocks with less force?		
Which type of pulley is used to lift the bucket of rocks when you pull **down** on the cord?		

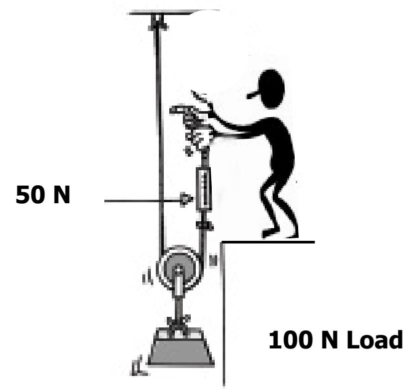
Name ______________________________ **Date** ___________

2. Why is changing the direction of the force helpful? ________

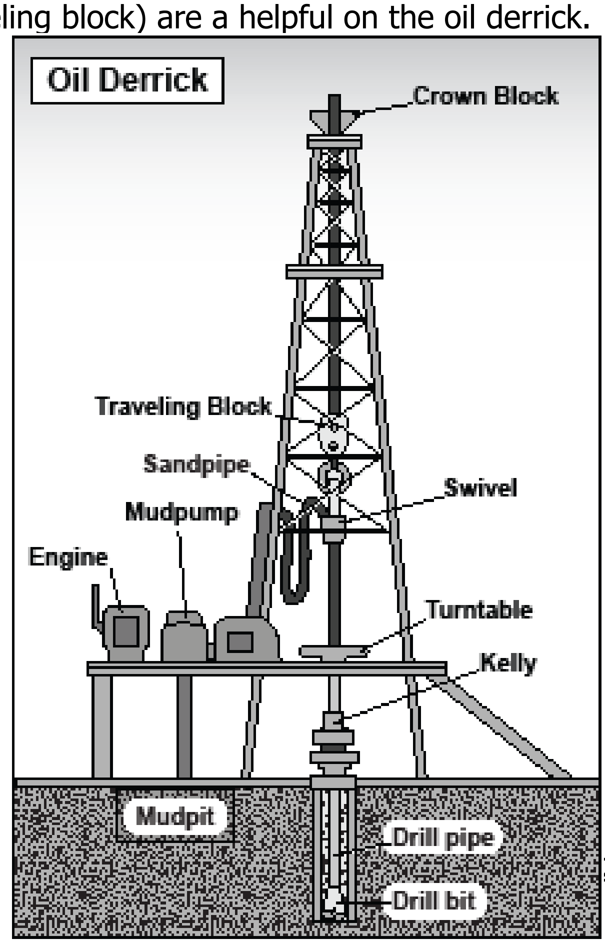
3. Oil Dude supports a 100 Newton load with the pulley systems shown below. What type of pulley is Oil Dude using in each of the diagrams? Fill in the spring-scale readings that show how much force he must exert.

Type of pulley: ________________ Type of pulley: ________________





4. An oil derrick is a supporting framework over an oil well that is designed to lift drilling equipment. In the diagram, the crown block is a set of fixed pulleys and the traveling block is a set of movable pulleys. Explain how pulleys (crown block and traveling block) are a helpful on the oil derrick.



Extended Response- Student Read

Read the following article and answer the questions.

Pulley's: Fixed and Moveable

Archimedes was a great mathematician and engineer who was born in 287 BC in Syracuse, Sicily. He is credited with the development of many of our modern day mathematical and mechanical principles (such as Archimedes' principle, the concept of pi, and geometric proofs) and machines like the lever, a pump, and pulleys. According to Plutarch, Archimedes had stated in a letter to King Hieron that he could move any weight with pulleys; he boasted that given enough pulleys he could move the world! The king challenged him to move a large ship in his arsenal, a ship that would take many men and great labor to move to the sea. On the appointed day, the ship was loaded with many passengers and a full cargo, and all watched to see if Archimedes could do what he said. He sat a distance away from the ship, pulled on the cord in his hand by degrees, and drew the ship along "as smoothly and evenly as if she had been in the sea."

Archimedes understood the concept of mechanical advantage and how to use it to move or lift heavy objects with less force. The mechanical advantage of a machine is the ratio of the output and input forces that are used within the machine. A good mechanical advantage is a number that is greater than 1. The output force generated should be larger than the input force used to start the machine. For a simple machine like a pulley or a lever, these forces are easy to determine. For a pulley, the output force is the weight of the object and the input force is the force applied on the end of the rope.

A force is a push or a pull on an object or machine that may cause an action. Forces are measured in units of pounds-force (lbf) or newtons (N). A newton is a kilogram times a meter divided by seconds squared (N = kg m/s2). A force is a vector; it has both a magnitude (numerical value) and a direction. If an object is held up by a rope, for example, it has a force called the weight (the mass times the gravitational acceleration) acting downward, and it causes a tension in the rope, which acts upward. If the object is in equilibrium, the downwards weight of the object will be equal to the upwards tension. When something is in equilibrium, it means that it is not moving; all the forces are balanced. A book sitting on a table is in equilibrium. The weight of the book is balanced by the reaction force of the table on the book. The study of objects with forces in equilibrium is called Statics.

Archimedes knew that he could improve his mechanical advantage for lifting or moving an object by using pulleys. A pulley is an object that is usually round with a smooth groove around its outside edge. A pulley transfers a force along a rope without changing its magnitude. When engineers work with pulleys, they often assume that the rope through the groove of a pulley moves smoothly and evenly, without catching. They say it moves without friction. When two rough surfaces are rubbed together (like two wooden blocks), they become warm; the heat is caused by friction. If the two surfaces were slicked with oil and then rubbed together, they would move much more smoothly and very little heat would be generated. There is much less friction. Engineers also assume that the pulley and rope weigh very little compared to the weight on the end of the rope, so they can ignore these two weights and make their calculations with only the heavy weight on the end of the rope.

The first figure shows a single pulley with a weight on one end of the rope. The other end is held by a person who must apply a force to keep the weight hanging in the air (in equilibrium). There is a force (tension) on the rope that is equal to the weight of the object. This force or tension is the same all along the rope. In order for the weight and pulley (the system) to remain in equilibrium, the person holding the end of the rope must pull down with a force that is equal in magnitude to the tension in the rope. For this simple pulley system, the force is equal to the weight, as shown in the picture. The mechanical advantage of this system is 1! The output force is the weight to be held in equilibrium and the input force is the applied force.

The pulley in the first figure is a fixed pulley; it doesn't move when the rope is pulled. It is fixed to the upper bar. In the second figure, the pulley is moveable. As the rope is pulled up, it can also move up. The weight is attached to this moveable pulley. Now the weight is supported by both the rope end attached to the upper bar and the end held by the person! Each side of the rope is supporting the weight, so each side carries only half the weight (2 upward tensions are equal and opposite to the downward weight, so each tension is equal to 1/2 the weight). So the force needed to hold up the pulley in this example is 1/2 the weight! Now the mechanical advantage of this system is 2; it is the weight (output force) divided by 1/2 the weight (input force).

Each additional figure shows different possible pulley combinations with both fixed and moveable pulleys. The mechanical advantage of each system is easy to determine. Count the number of rope segments on each side of the pulleys, including the free end. If the free end is to be pulled down, subtract 1 from this number. This number is the mechanical advantage of the system! To compute the amount of force necessary to hold the weight in equilibrium, divide the weight by the mechanical advantage! In the third figure, for example, there are 3 sections of rope. Since the applied force is downward, we subtract 1 for a mechanical advantage of 2. It will take a force equal to 1/2 the weight to hold the weight steady. The fourth figure has the same two pulleys, but the rope is applied differently and it is pulled upwards. The mechanical advantage is 3, and the force to hold the weight in equilibrium is 1/3 the weight. Each additional figure shows another possible pulley configuration and lists the force necessary to lift and hold the weight still. The mechanical advantage for the system will be the number in the denominator of the force. Check out the pulley problems in the interactive section to test your knowledge of the mechanical advantage of pulleys!

These systems are known as simple pulley systems because they use the same rope throughout the system. If the pulleys were attached with several different ropes (not one continuous rope), the system would be a complex pulley system. The force necessary to hold a complex pulley system in equilibrium would have to be computed using other Statics methods. Once it was known, however, the mechanical advantage of the system would still be computed by dividing the weight to be held by the force applied to hold it.

Name ______________________________ Date ______________

Extended Response

1. Who was Archimedes and how did he prove to King Heiron that a pulley would work?

____

____

2. Define the term force based upon the given text. Give the unit of measure for force.

____

____

3. If an object is held up by a rope it has a force called the ______________, which is measured in ____________. ______________________________

4. If an object is in a state of equilibrium is it in motion? Explain your answer making sure that you define the meaning of equilibrium. ______________________________

____

5. Describe the relationship between the forces being applied to the weight of an object if the object is in equilibrium. ______________________________

____

Rising To The Top
Vocabulary

1. **cohesion** - attraction between like molecules

2. **density** - the mass of a substance divided by its volume

3. **liquid** - a substance that flows and has no shape

4. **mass** - the amount of matter in an object

5. **mixture** - two or more materials not bound to each other

6. **molecule** - the smallest particle of a substance that has the properties of that substance

7. **physical property** - what can be seen or measured

8. **volume** – the amount of space something takes up

Name ___________________________ Date ___________

RISING TO THE TOP!

STUDENT SHEET

WONDER WHY...

Have you ever wondered why oil and water don't mix?

CONCEPT

Attraction between molecules that are alike is called cohesion. Cohesion is a physical property of liquids.

MATERIALS FOR ACTIVITY:

- 2 pennies per student
- mineral or vegetable oil
- water
- aluminum foil
- molecular model for water
- 4 pipettes per group
- 2 plastic cups per group
- map pencils
- paper towel

SAFETY:

- Do not put samples in mouth.
- Wash hands after handling samples.

PROCEDURE PART A: *Be sure to return the droppers to the correct cup.

1. Place a square of aluminum foil on the desktop. Put 1 dry penny on top of the foil.
2. Using the pipette place 5 drops of water, one drop at a time, onto the center of the head side of the penny.
3. Observe the water on the penny from a side view. Use Figure 1 to draw how the 5 drops of water look on the penny.
4. Remove the penny from the foil. Wipe **DRY** the penny and the foil with a paper towel. Repeat the experiment using oil instead of water.
5. Observe the oil on the penny from a side view. Use Figure 2 to draw how the 5 drops of oil look on the penny.

PROCEDURE PART B:

1. Using the clean, second penny, **predict** how many drops of water you can place on the surface of a penny before the water overflows. Record your prediction in Table 1.

2. Add the number of drops predicted by each student in your group and divide by the number of students in your group to find the **average** number of drops of water that your group predicted would fit on the penny. Record in Table 1.

3. Place a clean square of aluminum foil on the desktop. Put 1 dry penny on top of the foil.

4. Carefully drop water from the pipette, one drop at a time, onto the center of the head side of the penny. Keep careful count of each drop. Record in Table 1 the number of drops of water that were on the penny just before the water flowed off the penny.

5. Find the group average and record in Table 1.

6. Remove the penny from the foil. Wipe the penny and the foil dry with a paper towel.

Name ______________________________ **Date** ____________

Figure 1: Five drops of water on a penny

____
top of penny

Figure 2: Five drops of oil on a penny

____
top of penny

Table1: How Many Drops of Water Will Fit on a Penny?

	Predicted Number of Water Drops	Number of Water Drops That Fit on the Penny
Student 1		
Student 2		
Student 3		
Student 4		
Group Average		

Conclusion

1. What do you think caused the drops of water to look different than the drops of oil on the penny? ____

____

2. Why do you think so many drops of water fit on a penny?________________________

____

Name ______________________ Date __________

"STICKY" MOLECULES

***Color the oxygen atoms red and leave the hydrogen atoms white.**

Figure 3
Water Molecule

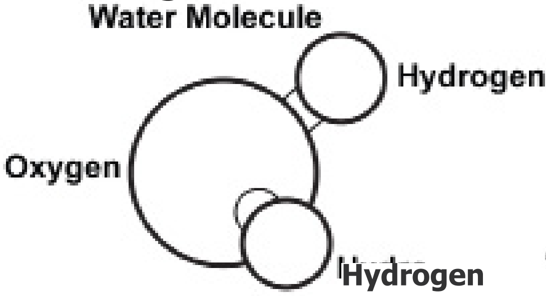
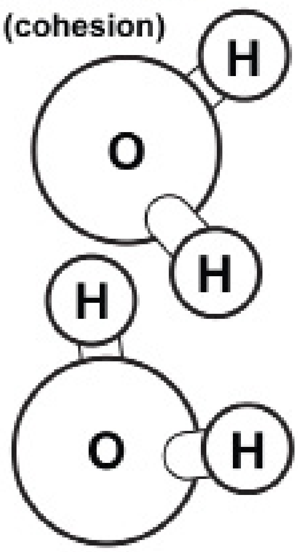
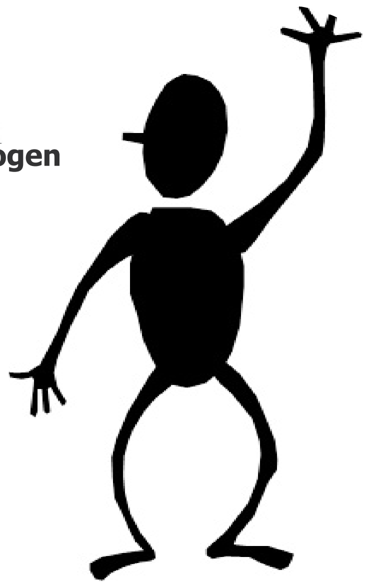


Figure 4
Two water molecules "attracted" to each other (cohesion)





This is a water molecule. It is made up of 1 oxygen atom and 2 hydrogen atoms. (Figure 3)

Using the 2 water molecule models, bring the hydrogen atom of one model towards the oxygen atom of the other model. (Figure 4)

WHAT HAPPENS?

Answer: ______________________________

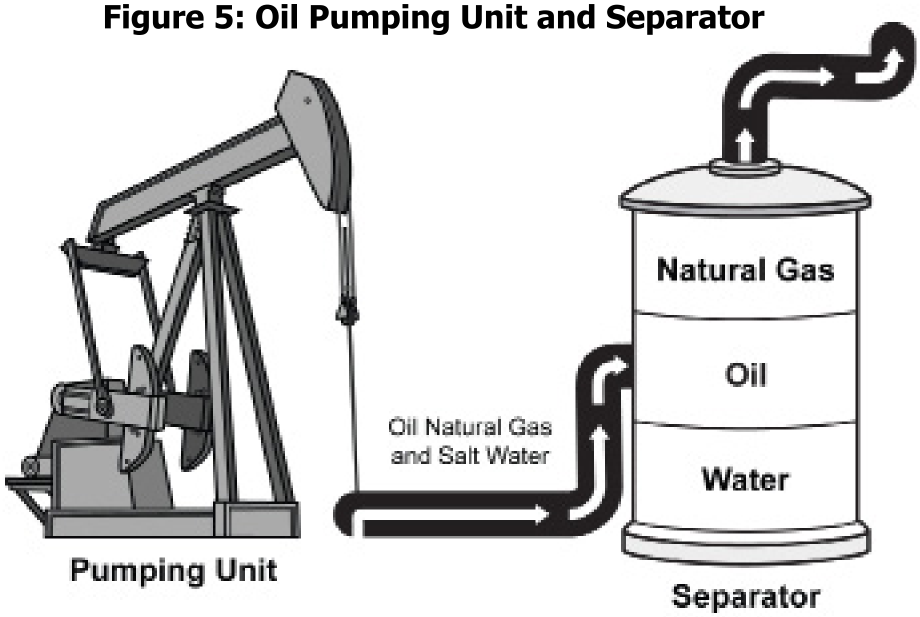
____

Name ________________________ **Date** __________

RISES TO THE TOP!
ASSESSMENT

Color the layer of oil in the separator black.
Color the layer of water in the separator blue.

Figure 5: Oil Pumping Unit and Separator



See an animation of this process at http://iprb.org/drlngforoilinil.html

1. Fill in the blanks.

Word List: densities, separator, cohesion, oil, natural gas

As crude oil is pumped from the ground it flows into a tank called a ______________________. Crude oil is a mixture containing ______________, natural gas, and water. At the top of the separator, ____________ _______ is collected. Oil and water separate because they have different _________. ____________ is the attraction between molecules that are alike.

2. Use the term cohesion to explain what happened when the water and the oil were placed on the pennies.

____

____

Realistic Recyclig

Vocabulary

1. **fossil fuel-** natural fuel formed over millions of years from plant and animal remains

2. **natural resource -** a material that is found in nature

3. **petroleum-** a thick, dark liquid that occurs naturally below the surface of the earth

4. **plastic -** a type of material that is made from crude oil

5. **plastic Identification Code (PIC) -** a numbering system used to identify each of the seven groups of plastics

6. **trash -** material that is no longer used

7. **recycle -** to use again; the process of turning waste plastic materials into useful products

8. **recycling symbol -** a three-chasing arrow symbol containing a number

Name ____________________________ Date ____________

REALISTIC RECYCLING!
STUDENT SHEET

WONDER WHY

Have you ever wondered what can be made from recycled plastic?

CONCEPT

One way our natural resources can be conserved is by recycling plastics which are made from crude oil.

MATERIALS FOR ACTIVITY: (7 items per group)
- plastic objects

PROCEDURE

1. Place the plastic objects on the desk.
2. Decide how to group the objects.
3. Discuss how the objects were grouped.
4. Using Table 1, regroup your plastic objects.
5. Write a name or description of each plastic object in Table 1.

Name ______________________________ **Date** _________

TABLE 1: Plastic Identification Coding System

Recycling Symbol	Plastic Objects	Recycled Products
1		Fiberfill in coats Carpet
2		Trash cans Garden furniture
3		Flexible hoses, Playground equip- ment
4		Floor tile Garbage can liners
5		Lawn mower wheels, Battery cables
6		Flower pots, rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

Name ______________________________ **Date** _________

TABLE 2: Assessment Information

Recycling Symbol	Plastic Objects	Recycled Products
1	Soft drink bottles and food containers	Fiberfill in coats Carpet
2	Milk jugs, grocery bags, toys, juice containers	Trash cans Garden furniture
3	Clear food packaging, shampoo bottles, credit cards	Flexible hoses, Playground equip-ment
4	Bread bags, frozen food bags	Floor tile Garbage can liners
5	Food containers and medicine bottles	Lawn mower wheels, Battery cables
6	CD jackets, disposable utensils and cups	Flower pots, rulers
7	OTHER: All other types of plastics or packaging made from more than one type of plastic.	

CONCLUSION

1. Use Table 1 to decide what products a drink bottle with a number 1 can be recycled to make.

____

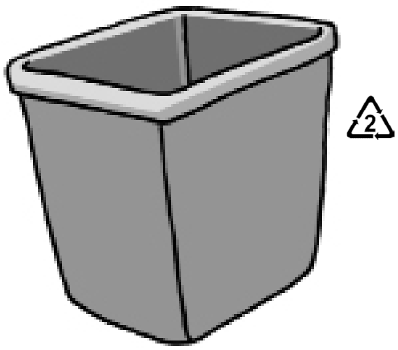
2. Why do you think using and recycling plastics is important?

____

____

Name ______________________________ **Date** ________

You need to know what products can be recycled to make the following objects: Use Table 2 to find your answers.



Trash can

____

____

Playground equipment

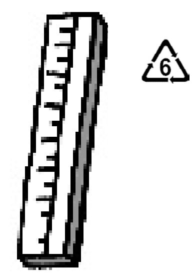
____

____

Fiberfill in coats

____

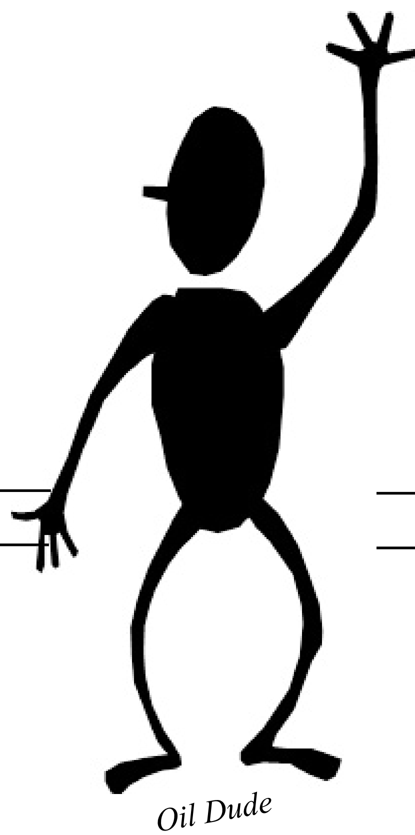
____

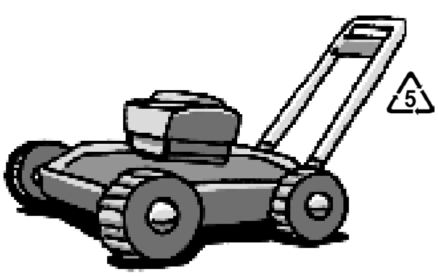


Ruler

____

____

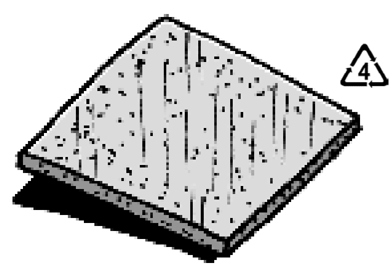




Lawn mower wheels

____

____



Floor tile

____

____

Name ______________________________ Date ______________

Extended Response

- After reading "Drinking Water: Bottled or from the Tap?" and "Art for Ocean Animals," write an essay in which you compare and contrast the authors' views on littering and pollution. Include information from both texts to write about the subject knowledgeably. Use details from both passages to help you write your essay. Also, remember to use correct grammar, usage, capitalization, punctuation, and spelling when writing your essay.

Name ______________________________ Date ______________

Scoring Rubric-Extended Response

4 Advanced	In addition to score 3 performance, in-depth inferences and applications that go beyond what was taught will be included. Student was able to apply information about littering and pollution to a related topic or event with supporting evidence from text. Student can apply the efforts the oil and natural gas industry have in place to support recycling, reducing, and reusing.
3 Proficient	No major errors or omissions regarding any of the information and/or processes, simple or complex, that were explicitly taught. Student shows understanding of littering and pollution and can connect the fact that littering and pollution directly affect our environment with support from text.
2 Basic	No major errors or omissions regarding the simpler details and processes, but major errors or omissions regarding more complex ideas and processes. Student shows understanding of littering and pollution and can connect the fact that some efforts are needed to bring about awareness of littering and pollution.
1 Below Basic	With help, partial understanding of some of the simpler details and processes, and some of the more complex ideas and processes. Student understands what littering and pollution is but is unclear as to why it affects the environment.
0	Even with help, no understanding or skill is demonstrated. Student does not have a basic understanding of littering and pollution .

Drinking Water: Bottled or From the Tap?

by Catherine Clarke Fox

If your family is like many in the United States, unloading the week's groceries includes hauling a case or two of bottled water into your home. On your way to a soccer game or activity, it's easy to grab a cold one right out of the fridge, right?

But all those plastic bottles use a lot of fossil fuels and pollute the environment. In fact, Americans buy more bottled water than any other nation in the world, adding 29 billion water bottles a year to the problem. In order to make all these bottles, manufactures use 17 million barrels of crude oil. That's enough oil to keep a million cars going for twelve months.

Imagine a water bottle filled a quarter of the way up with oil. That's about how much oil was needed to produce the bottle.

So why don't more people drink water straight from the kitchen faucet? Some people drink bottled water because they think it is better for them than water out of the tap, but that's not true. In the United States, local governments make sure water from the faucet is safe. There is also growing concern that chemicals in the bottles themselves may leach into the water.

People love the convenience of bottled water. But maybe if they realized the problems it causes, they would try drinking from a glass at home or carrying water in a refillable steel container instead of plastic.

Plastic bottle recycling can help—instead of going out with the trash, plastic bottles can be turned into items like carpeting or cozy fleece clothing.

Unfortunately, for every six water bottles we use, only one makes it to the recycling bin. The rest are sent to landfills. Or, even worse, they end up as trash on the land and in rivers, lakes, and the ocean. Plastic bottles take many hundreds of years to disintegrate.

Water is good for you, so keep drinking it. But think about how often you use water bottles, and see if you can make a change.

Betty McLaughlin, who runs an organization called the Container Recycling Institute, says try using fewer bottles: "If you take one to school in your lunch, don't throw it away—bring it home and refill it from the tap for the next day. Keep track of how many times you refill a bottle before you recycle it."

And yes, you can make a difference. Remember this: Recycling one plastic bottle can save enough energy to power a 60-watt light bulb for six hours.

Art for Ocean Animals

by Elise Jonas-Delson

What do you do when you see litter on the beach? You pick it up, of course. But artist Angela Haseltine Pozzi doesn't throw it away. She uses the trash to create giant sculptures of marine animals. The project is called Washed Ashore and its goal is to raise awareness about the effects of littering on ocean animals.

"The first thing you need to do is get people's attention," Pozzi told TFK [TIME For Kids]. "Giant animals tend to do this very well."

Pozzi started Washed Ashore when she noticed plastics on the beaches in Oregon, where she lives. Plastic doesn't break down and become absorbed by the environment. Instead, sunlight breaks it down into pieces about the size of plankton, which are tiny organisms that float in the sea. These tiny pieces of plastic enter the food chain. Sea animals eat them and end up dying. Pozzi always loved the ocean and the animals in it, and she wanted to do something to help both.

Sea Change

One of Angela's sculptures is a turtle. The turtle's head is an old garbage can lid. There is netting around it to show that turtles are getting caught in these nets.

Another sculpture, called Fish Bite Fish, is shaped like a fish and made out of little bits of plastic that contain tooth and claw marks from the fish and crabs that tried to devour the plastic. "We get so many pieces of plastic like this, I'm on my third Fish Bite Fish [sculpture]," says Pozzi.

The Sea Star figure is made of glass and plastic bottles, some of which are from the Beijing Olympics of 2008. The bottles started landing on the beaches in Oregon in 2010, and they still are arriving. The Sea Star acts as a musical instrument. You put water in the bottles and hit them to make music.

A Helping Hand

Pozzi doesn't collect all the trash by herself. When people spot litter on beaches, they drop it off at Artula Institute for Arts and Environmental Education, in Bandon, Oregon. Then Angela and her volunteers begin the process of turning the waste into art. Everything used for the sculptures is found on the beach, except for the framework and the materials used to connect the litter together.

Who does Pozzi believe can save marine animals? "Kids have a lot of power," she told TFK. "They are the ones that can make things happen. I really believe it."
TIME For Kids caught up with the Washed Ashore tour in Sausalito, California. The exhibit is currently in Chula Vista, California, from December 8 until July of next year.

LINKS

Countrymark - http://www.countrymark.com/countrymark/AboutUs/americanoil.aspx

Illustrative Mathematics - http://www.illustrativemathematics.org/

Common Core - http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

USGS - http://www.usgs.gov/

Energy Math Challenge - http://www.need.org/needpdf/Energy%20Math%20Challenge.pdf

FOURTH GRADE

MATH COMPONENT

Page

Fraction Games – Equivalent and Ordering Fractions in Small Groups

4.NF.1 - Extend understanding of fraction equivalence and ordering

CCSS.Math.Content.4NF.1

4.NF.3.c.d. – Solving addition and subtraction word problems involving fractions and mixed numbers.

CCSS.Math.Content.4.NF.3c

CCSS.Math.Content.4.NF.3d

WONDER WHY…

How do fractions become part of a whole? How to decompose a fraction? How to order fractions with unlike denominators?

CONCEPT:

Students will review core fraction concepts with a mini-lesson and a rotation of fun fraction centers that connect fractions to real world problem solving.

TEACHER INFORMATION:

Write "fraction = a part of a whole" on the board. Have students brainstorm ways that they have experienced fractions in school or at home. Record student ideas. (Suggestions: being, grades, petals of a flower, portions of a chocolate bar, pieces of pizza.) After the brainstorm, ask students if fractions are more or less than a whole. Review the component of fractions. Ensure that students understand that when a fraction denominator is larger than the numerator, the fraction is smaller than one. The denominator tells that number/quantity in the whole that the fraction (numerator) is taken from. So the fraction 1/8 is less than ¼ because, even though the numerator is the same, the parts (the denominator) are smaller in 1/8.

WOW! Fraction Code
Give your kids copies of the word puzzle shown below. They must assemble words from the fraction clues to discover the secret message. Have small cubes available; some children will find it helpful to manipulate the cubes, using one for each letter of each word. These puzzles aren't difficult to write yourself, so try creating your own or encouraging your students to write some.

MATERIALS FOR WOW:

Student sheet (see attached)

Small cubes or some manipulative that will help students with decomposing the fractions

Answer Key for WOW! (The message is, "If you can find out what this message is, then you are a fraction genius.")

Fraction Code   Student Sheet for WOW!

Can you find the secret message?

1. The first 1/5 of *igloo* + the first 1/5 of *frost*.
2. The last 1/3 of *day* + the first 1/2 of *ouch*.
3. The first 2/3 of *cat* + the last 1/7 of *balloon*.
4. The first 3/4 of *fine* + the middle 1/5 of *daddy*.
5. The middle 1/3 of *dog* + the last 1/2 of *shut*.
6. The last 1/6 of *window* + the first 3/5 of *hatch*.
7. The first 3/4 of *thin* + the middle 1/7 of *monster*.
8. The first 4/5 of *messy* + the last 3/5 of *stage*.
9. The middle 1/5 of *thing* + the first 1/3 of *sun*.
10. The first 1/3 of *thumbs* + the last 1/2 of *oven*.
11. The first 1/4 of *Yosemite* + the middle 1/3 of *gum*.
12. The last 2/5 of *sugar* + the second 1/5 of *belly*.
13. The first or the last 1/4 of *area*.
14. The first 1/3 of *friend* + the first 1/2 of *actors* + the last 1/2 of *motion*.
15. The middle 1/5 of *altogether* + the middle 1/3 of *maniac* + the last 2/9 of *esophagus*.

MATERIALS FOR CENTERS:

Center 1:

Attached sheet	**4 Envelopes**
Scissors	**Timer**

Center 2:

Clothespins	**Permanent Marker**
Card Stock for tent	**Number line**

Center 3:

2 decks of playing cards	**Game board (attached)**

Center 4:

Index Cards with fraction word problems written on them – (I keep multiple sets)

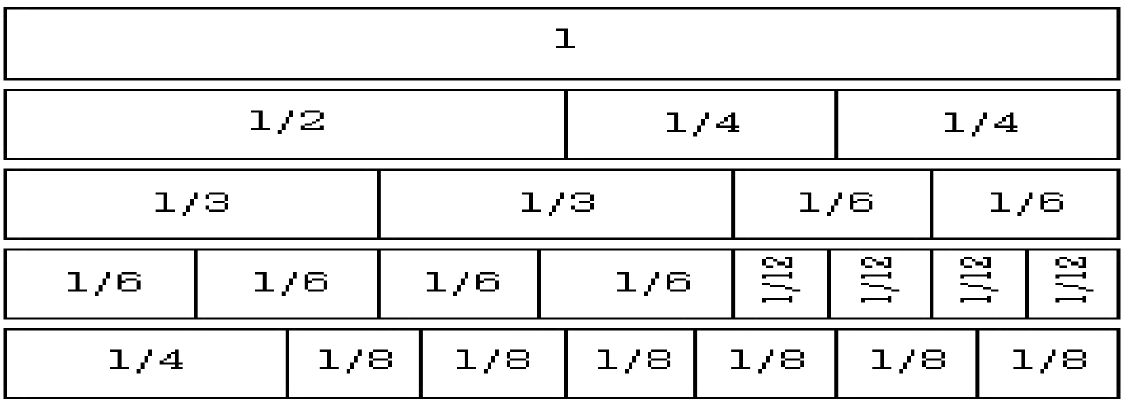
All centers need individual white boards and markers

STUDENT ACTIVITY:

Students that they will be working through four math centers today to practice fraction skills. Model and give directions for each center.

Center 1

Activities/Procedures: Each student makes a set of five fraction strips that look like the following diagrams. Tag board works best for this activity. Each long strip is 12” x 4”



Students are to cut along the lines and write their initials on the back of each piece. Provide envelopes so students can have their own set of fraction pieces.

The fraction pieces are the materials for the following games:

Game 1: Each player empties all the pieces from their kit into a common pile. Each player draws until all pieces have been drawn. Each player begins putting the pieces back together into the same shape as the long strip. The first student who assembles three whole long strips is considered the winner. Each player draws until all pieces have been drawn. The player who has the most equivalent pieces to 1/2 wins. A time limit is helpful in this activity.

Game 2: Each player empties all the pieces from their kit into a common pile. Each player draws two pieces until each student has 10. The remaining pieces are set aside during this game. The first player who first fits all of the parts he or she has drawn into a long strip or strips equivalent to one, wins. If a player needs a piece he or she may ask for one from other players; however, equivalent parts must be exchanged. For example, if player No. 1 needs 1/8 to win and has 1/4, he or she may say, “I need eighths, I will trade one 1/4 for two 1/8’s.” The player must have 1 entire unit in an exact way.

Center 2 - Clothespin Fraction Line

Objective: Students will order fractions with different denominators.

Materials: Clothespins and card tents

Provide students with clothespins with fractions of various denominators and a card tent to sort them on. Have students mix the clothespins, and then put them in order. Students record their ordered fractions on a number line. You can differentiate this center by providing different numbers of clothespins to order or by requiring students to estimate the amount that exists between each clothespin on the number line and space the clothespins accordingly.

Center 3 – Fraction Card Comparison

Objective: Students will compare fractions with unlike denominators.

Materials: Fraction game board, 2 set of playing cards with face cards removed (I prefer two sets of different colors or styles- one set used as numerators (Aces-fives and one set used as denominators (sixes – tens).

Provide students with a fraction game board (a paper with two fractions bars that specify where the numerator and denominator are-attached) and playing number cards. The game is played like war. Students place cards on the numerator and denominator spaces at the same time. The first person to identify the larger fraction by tapping or placing their hand on the fractions that is larger gets all four cards. (I use two different color or design of cards with one set using the Ace – five cards and one set using the six-ten cards).

Numerator **Numerator**

Denominator **Denominator**

Center 3 Game Board

Center 4 – Fraction Word Problems

Objective: Students will solve word problems that require addition and subtraction of fractions.

Materials: Fraction Word Problem Cards

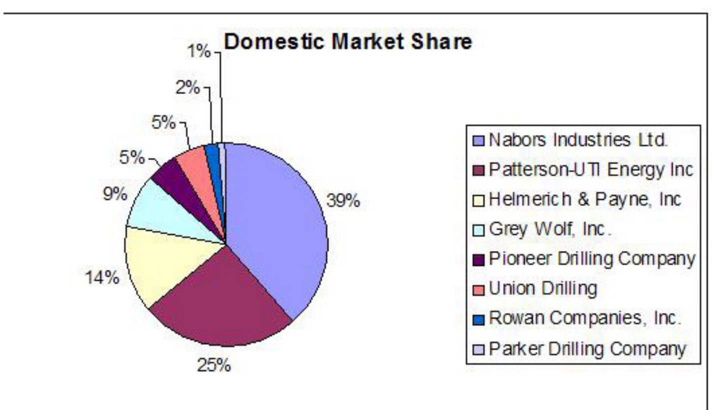
Provide students with note cards with fraction word problems written on them. Have students work in pairs to solve each problem. Make these problems more challenging by requiring students to reduce their answers. The fraction word problems:

Set 1

- Kayla is making cookies. The recipe requires ¾ cup of sugar. She wants to make three batches of cookies. How many cups of sugar does she need?
- Kyle orders a large pizza that has 9 pieces. He eats 2 pieces and gives 3 to Juan. What fraction of the pizza do Kyle and Juan eat? What fraction of the pizza is left?
- Mia counts 20 girls on the beach. 4 have purple flip flops on. 8 have yellow flip flops. 6 have black flip flops and the rest are barefoot. What fraction of the girls is wearing flip flops? What fraction of the girls is barefoot?
- Diego has 18 Skittles. 6 are red, 3 are yellow, 4 are green and 5 are purple. What fraction of the Skittles is primary colors? What fraction is secondary colors? What fraction is NOT purple?
- Shawna has a cheesecake sampler. There are 12 pieces. Of those pieces, 2 are chocolate chip, 4 are blueberry, 5 are regular, and 1 is raspberry. What fraction of the cheesecake slices is fruit flavored? What fraction is NOT regular flavored?

Set 2

- Kevin collected 1 gallon of crude oil. The gallon is ¼ salt water. If he collects 8 gallons of crude oil, if each gallon is ¼ salt water how much salt water will he have? How much crude oil will there be when it is separated?
- Kelly needs to make a mixture of water, alcohol and oil for an experiment to test density. Each cup needs to have 1/5 of alcohol twice as much of water, and the rest of oil. What fraction is water? What fraction is oil?
- Terry counts 28 barrels in the field. 4 have purple labels. 8 have red labels. 10 have black labels and the rest have no label. What fraction does each barrel represent? What fraction of the barrels have no label?
- Denny has 40 gallon of oil. 8 need to be placed in blue containers, 10 need to go in yellow container, 20 need to go in green containers and 2 go in purple containers. List the fraction for each container color.
- Use the picture marked as percents and turn them into fractions. Reduce if possible.



Answers for Center 4-set 1:

Fraction Word Problems:

1. She needs 3 cups.
2. They eat 5/9 of the pizza. There is 4/9 of the pizza left.
3. 18/20 are wearing flip flops. 2/20 are not.
4. 9/18 are primary colors. 13/18 is not purple.
5. 5/12 is fruit flavored. 7/12 is not regular flavored.

Answers for Center 4-set 2:

Fraction Word Problems:

1. He will have 8/4 of a gallon or 2 gallons of salt water. He will have 24/4 or 6 gallons of oil.
2. 2/5 is water and 2/5 is oil
3. Purple is 4/28 = 1/7, Red is 8/28 = 2/7, Black is 10/28 = 5/14, No label is 6/28 = 3/14.
4. Blue = 8/40 or 1/5, Yellow = 10/40 or ¼, Green = 20/40 or ½ and Purple = 2/40 or 1/20.
5. 39/100 – Nabors Industries Ltd

   25/100 = 1/5 – Patterson UTI Energy, INC

   14/100 = 7/50 – Helmerick & Payne, Inc

   9/100 – Pioneer Drilling Company

   5/100 = 1/25 - Grey Wolf, Inc

   5/100 = 1/25 – Union Drilling

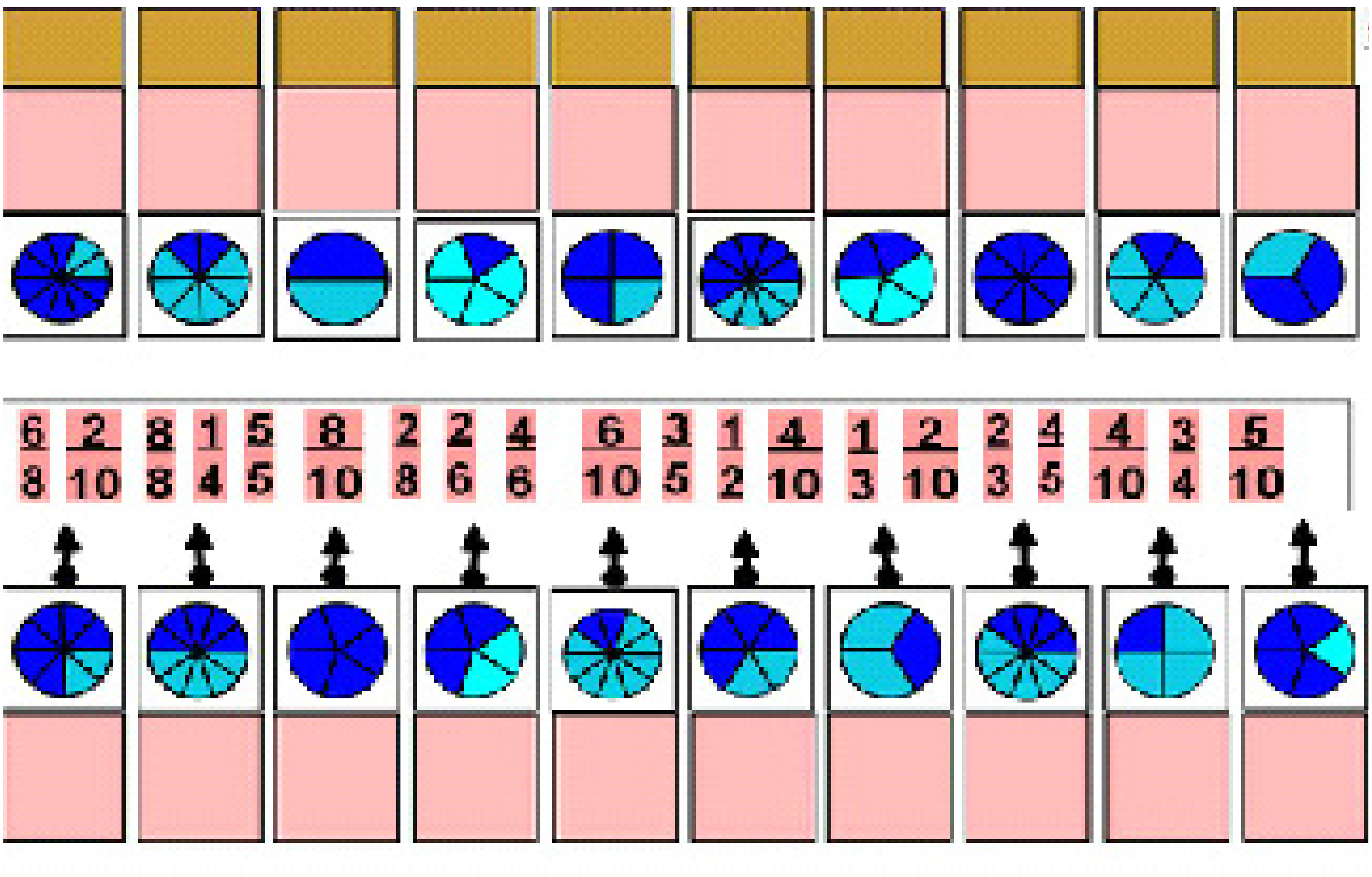
   2/100= 1/50 – Rowan Companies, Inc

   1/100 – Parker Drilling Company

EXTENTION: Use the extension sheet for checking understanding of fraction parts.

EVALUATION: Have the students cut the fraction pictures into labeled rectangled place them in them in order from least to greatest.

Write the correct fraction on the picture



Index Cards for Center 4

- Kayla is making cookies. The recipe requires ¾ cup of sugar. She wants to make three batches of cookies. How many cups of sugar does she need?

- Kyle orders a large pizza that has 9 pieces. He eats 2 pieces and gives 3 to Juan. What fraction of the pizza do Kyle and Juan eat? What fraction of the pizza is left?

- Mia counts 20 girls on the beach. 4 have purple flip flops on. 8 have yellow flip flops. 6 have black flip flops and the rest are barefoot. What fraction of the girls is wearing flip flops? What fraction of the girls is barefoot?

- Diego has 18 Skittles. 6 are red, 3 are yellow, 4 are green and 5 are purple. What fraction of the Skittles are primary colors? What fraction is secondary colors? What is NOT purple?

- Shawna has a cheesecake sampler. There are 12 pieces. Of those pieces, 2 are chocolate chip, 4 are blueberry, 5 are regular, and 1 is raspberry. What fraction of the cheesecake slices is fruit flavored? What fraction is NOT regular flavored?

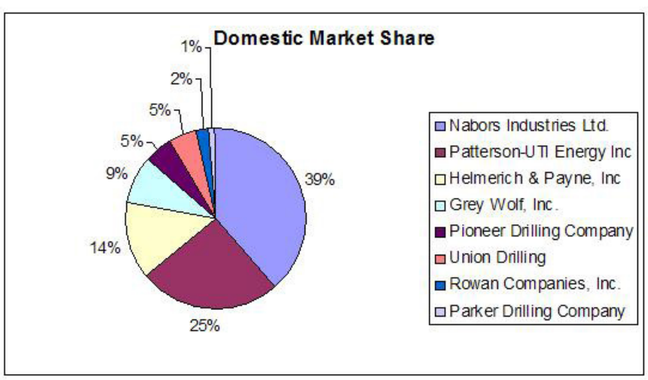
- Kevin collected 1 gallon of crude oil. The gallon is ¼ salt water.
  If he collects 8 gallons of crude oil, if each gallon is ¼ salt water how much salt water will he have? How much crude oil will there be when it is separated?

- Kelly needs to make a mixture of water, alcohol and oil for an experiment to test density. Each cup needs to have 1/5 of alcohol twice as much of water, and the rest of oil. What fraction is water? What fraction is oil?

- Terry counts 28 barrels in the field. 4 have purple labels. 8 have red labels. 10 have black labels and the rest have no label.
  What fraction does each barrel represent?
  What fraction of the barrels have no label?

- Denny has 40 gallon of oil. 8 need to be placed in blue containers, 10 need to go in yellow container, 20 need to go in green containers and 2 go in purple containers. List the fraction for each container color.

- Use the picture marked as percents and turn them into fractions.
- Reduce if possible.



Customary Conversion

4.MD.1

Solve problems involving measurement and conversion of measurements from a larger unit to a smaller unit.

CCSS.Math. Content.4.MD.1

Estimated Duration: *Two hours*

WONDER WHY

Have you ever wondered why different measuring tools can be used to get the same amount of a substance?

CONCEPT

Know relative sizes of measurement units within one system of units including km, m, cm; kg, g; lb, oz, ; L, mL; hr, min, sec. Within a single system of measurement, express measurements in a larger unit in terms of a smaller unit. Record measurement equivalents in a two-column table.

TEACHER INFORMATION:	Making conversions in capacity measurements within the customary system is the focus of this lesson. Students discover in hands-on activities the relationships between the measures. Students work in groups to create conversion tables using familiar measuring tools. They solve problems requiring conversions using their conversion tables.

1. WOW! Ask students how many cups of juice they believe they can pour from a gallon of juice. Have students explain their reasoning. Pour the juice into cups to see how many cups are in one gallon. (let students drink the juice.) (See if any of the

MATERIALS FOR WOW:

2 gallons of juice **8 ounce cups (enough for the entire class)**

Math Journal

Materials and Resources:

For the teacher: Whiteboard, containers to hold water, water, sets of customary measuring tools (cups, pints, quarts and gallons), customary and kitchen teaspoons and tablespoons for each group of students and chart paper

For the students: Sets of customary measuring tools (cups, pints, quarts, gallons, teaspoons and tablespoons), containers of water for each group, journals, chart paper or K-W-L chart (attached).

Lesson Summary:

Making conversions in capacity measurements within the customary system is the focus of this lesson. Students discover in hands-on activities the relationships between the measures. Students work in groups to create conversion tables using familiar measuring tools. They solve problems requiring conversions using their conversion tables.

2. Pre-Assessment Student Activity:

This activity is an informal assessment to determine students' background knowledge about measuring liquids. Students create a K-W-L chart (attached)and answer questions about measuring liquids.

- Have students create a K-W-L chart in the notebooks or journals. In the K-column, have them answer the following questions:

  a. What do you know about measuring liquids?

  b. What are the names of measures for liquids?

  c. When do you measure liquids?

  d. What containers do you use to measure liquids?

- Have students write in the W-column things they would like to know about measuring liquids.

Conduct a class discussion on the questions. Record students' responses on chart paper and post it where all students can view it. Refer to the chart during the lesson, correcting misconceptions.

Scoring Guidelines:

Assess students' knowledge and understanding of capacity conversions in measurement informally by circulating and listening for misconceptions, inaccuracies or lack of information. Record students' responses on chart paper for future reference.

3. Student Activity

Instructional Procedures:

Part One: Liquid Capacity Measurements (Gallons, quarts, pints and cups)

1. Ask students about their experiences with gallon containers.

2. Divide students in to groups of four. Provide each group with measuring tools (one-cup measure, pint, quart and gallon) and a container of water (or rice). Discuss the correct name for each container.

3. Allow students to investigate the relationships using the containers and water. Have them record this information in a table in their notebooks or journals.

4. Ask questions to get at the relationships students discovered, such as:
    a. How many quarts of water did it take to fill the gallon container? (4)
    b. How many pints of water did it take to fill the quart container? (2)
    c. How many pints of water would it take to fill the gallon container? (8)

5. Continue with these types of questions until all of the relationships are given. Have students demonstrate using the appropriate containers to show the relationships.

6. Present the following scenario to students.

    The scientist needs to mix up a solution for cleaning rocks. She has 4 gallons of of cleaner. A mixed solution contains 1 quart of cleaner to 3 quarts of water. How many containers of solution can be made from one gallon of solution? (4 containers of cleaner @ 1 gallon each)

    How many containers of solution can be made from the 4 gallons of cleaners? (16 containers of cleaner @ 1 gallon each)

    a. Have them work the problem first, before discussing it with the group members. Encourage students to use their conversion table to solve the problem.
    b. Observe students as they solve and discuss the problem in the groups.

7. Bring the class together to discuss the solution to the problem. Choose students who have different approaches to solving the problem present it to the class. Allow students to model the problem using the necessary containers. Students should recognize this is not an exact answer. Discuss the interpretation of the remainder for this problem situation.

8. Present the following scenarios to the class. Have students solve the problem in class or as homework. Discuss the solutions before moving to the next part of the lesson. Have students correct any mistakes.

   - *Joe has 1 pint of cleaner. He used ¾ of the pint. How many ounces did he use? How many ounces remain?*

     (3/4 of 16 = 12 ounces) (1/4 of 16 = 4 ounces)

   - *Keri is providing the oil for the class to use in an experiment. She bought 6 bottles and each bottle contains 16 ounces of oil. If each of the 22 students get ½ cup of oil, will there be enough for the class?* (Keri has enough oil since there are 96 ounces of oil in the 6 bottles and **½ cup = 4 ounces times 22** = 88 ounces.)

     How many more students could have ½ of oil for the experiment? (2 students)

9. Assign more examples as and/or instructions if deemed necessary based on individual needs.

10. Have students revisit their conversion tables and make corrections as needed. Have them include comments that will help them is solving problems requiring conversions.

Part Two: Teaspoons and Tablespoons

11. Ask students if they think that the measures of kitchen teaspoons and tablespoons and measures of standard teaspoons and tablespoons hold the same amount (no). Discuss their responses after they discover the relationships between the standard measuring spoons.

12. Provide students with formal teaspoons and tablespoons to discover the relationships between the measures. Have students record their discoveries in their conversion tables.

13. Ask how many teaspoons will be necessary to fill a tablespoon. (3 teaspoons = 1 tablespoon).

14. Revisit step 12 and provide kitchen teaspoons and tablespoons for students to discover the relationship. Ask students to compare the relationships of the kitchen spoons and the standard measuring spoons. Discuss any differences and similarities.

15. Present the following scenarios. Have students solve the problem individually before sharing with the class. Discuss any misconceptions students may have.
    a. *The recipe for making a saline solution calls for 2 tablespoons of salt. Jenna uses a teaspoon instead of a tablespoon. How many teaspoons of salt will she need to put in the make the saline solution? (Jenna will need 6 teaspoons of salt.)*
    b. *Dennis is making a solution with water and oil. The mix he is using needs 1 cup of water and 4 tablespoons of oil. How many teaspoons of oil does he need? (Dennis needs 12 teaspoons of oil.)*
16. Give more examples and/or instruction as deemed necessary based on individual needs.
17. Have students complete the L-column on their K-W-L charts. Have students discuss what they have learned about measurement conversions in capacity.

4. <u>Differentiated Instructional Support</u>:

Instruction is differentiated according to learner needs, to help all learners either meet the intent of the specified indicator(s) or, if the indicator is already met, to advance beyond the specified indicator.

- Provide sand or rice in place of water for capacity measurement findings.
- Color code measurement tools for each capacity.

5. <u>Extensions</u>:

- Do conversions by reducing (i.e., a teaspoon is one-third of a tablespoon, a cup is one-half of a pint, etc.), doubling or tripling the ingredients in recipes.
- Research the origins of gallons, quarts, pints, cups, teaspoons and tablespoon measures.
- Learn appropriate abbreviations for liquid capacity measurements by bring in recipes from home and comparing ingredients.

6. <u>ASSESSMENT</u>

Students will complete the Liquid Measure Table (attached) either individually or with a partner. Attached is a post-assessment with an answer key.

K	W	L

Fill in the missing blanks with the correct measurement.

Name : ____________________ Score : __________

Teacher : ____________________ Date : __________

Liquid Measure Table

___ tsp	___ tbsp	1/2 fl oz				
___ tsp	2 tbsp	___ fl oz	___ cup			
___ tsp	___ tbsp	2 fl oz	___ cup			
___ tsp	___ tbsp	___ fl oz	1/3 cup			
___ tsp	___ tbsp	___ fl oz	1/2 cup			
		8 fl oz	___ cup	___ pt	___ qt	
		16 fl oz	___ cups	___ pt	___ qt	
		___ fl oz	4 cups	___ pt	___ qt	___ gal
		___ fl oz	___ cups	___ pt	2 qt	___ gal
		128 fl oz	___ cups	___ pt	___ qt	___ gal

Fill in the missing blanks with the correct measurement. ANSWER KEY

Name : ____________________ Score : __________

Teacher : ____________________ Date : __________

Liquid Measure Table

3 tsp	1 tbsp	1/2 fl oz				
6 tsp	2 tbsp	1 fl oz	1/8 cup			
12 tsp	4 tbsp	2 fl oz	1/4 cup			
16 tsp	5 1/3 tbsp	2 2/3 fl oz	1/3 cup			
24 tsp	8 tbsp	4 fl oz	1/2 cup			
		8 fl oz	1 cup	1/2 pt	1/4 qt	
		16 fl oz	2 cups	1 pt	1/2 qt	
		32 fl oz	4 cups	2 pt	1 qt	1/4 gal
		64 fl oz	8 cups	4 pt	2 qt	1/2 gal
		128 fl oz	16 cups	8 pt	4 qt	1 gal

Customary Conversion

Vocabulary:

- **Capacity** – the ability to contain or accomodate
- **Cup** – a customary measurement equilant to 8 ounces
- **Customary Measures** – an accepted or conventional unit of measure
- **Gallon** – a customary measurement equilant to 4 quarts; 8 pints; 16 cups; 128 ounces
- **Pint** - a customary measurement equilant to 2 cups; 16 ounces
- **Quart** - a customary measurement equilant to 2 pints; 4 cups; 32 ounces
- **Standard Measures** – accepted or approved instance or example of a quantity or quality against which others are judged or measured or compared
- **Tablespoon** - a measurement in cooking, equivalent to 1/2 fluid ounce, three teaspoons
- **Teaspoon** – a measurement used in cooking, equivalent to $^{1}/_{6}$ fluid ounce, $^{1}/_{3}$ tablespoon

Attachment A

Post-Assessment - Customary Measurement Conversions

Name________________________________ **Date**___________________________

Directions: Read each problem carefully. Use your table of measurements to solve each problem. You may use a calculator. Be sure to label your answers with the correct measurement.

1. The restaurant serves soda in 8-ounce servings. The server brings the soda pop in a 24 ounce container. How many cups of soda are in the container?

2. Gabe is painting his room. He wants to paint all 4 walls. He needs 1 1/2 gallons of paint for each wall. The color Gabe wants only come in quart containers. How many quarts will he need to paint all 4 walls?

3. The State EPA requires the disposal of gallons of oil from oil changes. Joe's Garage removed 5 quarts of oil from 10 cars. How many gallons of oil will Joe's Garage dispose of? How many 5-gallon containers are needed?

4. A dip calls for 2 tablespoons of thinly sliced green onions. How many teaspoons of green onions are in the dip?

5. A double batch of a no-bake cookies recipe uses 6 tablespoons of unsweetened cocoa powder. How many teaspoons of unsweetened cocoa powder are in the recipe?

Attachment B – Answer Key

Post-Assessment - Customary Measurement Conversions Answers

Directions: Read each problem carefully. Use your table of measurements to solve each problem. You may use a calculator. Be sure to label your answers with the correct measurement.

1. The restaurant serves soda pop in 8-ounce servings. The server brings the soda pop in a 24 ounce container. How many cups of soda are in the container? (There are 3 cups of soda pop in the container.)

2. Gabe is painting his room. He wants to paint all 4 walls. He needs $1\frac{1}{2}$ gallons of paint for each wall. The paint store only sells paint by the quarts. How many quarts will he need to paint all 4 walls? (Gabe needs 24 quarts of paint for his room.)

3. The State EPA requires the disposal of gallons of oil from oil changes. Joe's Garage removed 5 quarts of oil from 10 cars. How many gallons of oil will Joe's Garage dispose of? ($12\frac{1}{2}$ gallons) How many 5-gallon containers are needed? (3 5-gallon containers are needed.)

4. A dip calls for 2 tablespoons of thinly sliced green onions. How many teaspoons of green onions are in the dip? (There are 6 teaspoons of green onions in the dip.)

5. A double batch of a no-bake cookies recipe uses 6 tablespoons of unsweetened cocoa powder. How many teaspoons of unsweetened cocoa powder are in the recipe? (There are 18 teaspoons of unsweetened cocoa powder in the recipe.)

4-MD-3 Apply the area and perimeter formulas for rectangles in real world and mathematical problems.

For example, find the width of a rectangular

room given the area of the flooring and the length, by viewing the area

formula as a multiplication equation with an unknown factor.

Example 1

The IPRB is restoring a rectangular tract of land formerly used to produce Illinois oil with an area of 7500 yd^2. If the length of the land is 50 yd. What is the width?

*7500 = 50 * width*

width = 150 yards

Example 2

Pioneer oil wants to fence in a new oil storage facility. The perimeter of their old facility is 100 yd. by 50 yd. They want to fence in at least as much area of land, but use less fence than what was used in the old facility. Is this possible? Draw and illustrate two possible lots supporting your answer.

Current P = 2(100) + 2(50) = 300 yards

Current A = 100(50) = 5000 square yards

Figure needs to become more square like. Check student work. Many possible answers. One example:

75 by 70

Perimeter = 2(75) + 2(70) = 290 yards

Area = 75(70) = 5250 square yards

Measuring Angles

4.MD.6

Measure angles in whole-number degrees using a protractor. Sketch angles of specified measure

CCSS.Math.Content.4.MD.6

WONDER WHY…How to measure angles with the proper measuring tool?

CONCEPT… Angles are a very important concept in geometry though they are not often thought about in our daily lives. However, angles impact our lives in more ways than we think. In this activity students will discover how to label and measure angles of all types.

TEACHER INFORMATION…Students will learn how angle measurement is important in developing different equipment for the oil industry.

1. WOW! Using a large protractor, have students make angles with their arms and measure the degree of the angle they make.

(Materials needed for WOW!-Large Protractor or overhead machine and transparency-attached)

2. STUDENT ACTIVITY

Discuss the following questions:

How do people in various professions use angles to complete their work?

How do all people use angles in their everyday lives?

How do you (as a child/student) use angles?

- A baseball player moves across the field at various angles to catch a ball
- A football player throws a pass at the correct angle for a receiver to catch the ball
- A cook holds a knife at various angles to chop and prepare foods
- A child skis or sleds at various angles to complete a downhill run
- A nurse adjusts a bed to create an angle that is comfortable for a patient
- A student places books on a shelf at a slight angle to prevent them from tipping over
- An oil truck driver needs to calculate the grade(angle) of a hill
- An engineer needs to use angles to build an oil derrick

- Compare how locations on maps and coordinate grids are found?
- A geologist measures angles in geological features

MATERIALS FOR ACTIVITY

Construction Paper	**Pencils**	**Index Cards**
Crayons or Colored Pencils	**Protractor**	**Math Journal**
Glue	**Toothpicks**	

1. Take the students on a walk around the school, both inside and outside. Have students work in pairs to identify and list angles they see in and around their school. The list may include the following: bike wheel spokes, pizza slices, clothing hangers, binders, hands of a clock, a playground slide, an open door, door stopper or wedge, chair, and even a pencil is held at an angle when used for writing.
2. Gather the class and ask each team to share two examples of angles. Create a class list of angles on the board, flipchart, or overhead:
3. Next, provide each student with a copy of the **Angle Facts Sheet (Attached)**. Guide students through each bullet on the worksheet. Draw examples of a straight line, right angle, acute angle and obtuse angle on the board or overhead.
4. Have students create vocabulary index cards with drawings and definitions for each of the bolded words on the worksheet; vertex, degrees, right angle, obtuse angel, and acute angle.
5. Direct student attention back to the class list generated in #2, above. Ask if there are any right angles on the list?

Most likely students did not identify right angles. We tend to forget that a straight corner measuring 90 degrees is actually an angle. Instruct students to look around their classroom and identify at least five right angles. Items might include a television screen, computer monitor, calendar, book, window, and folder. This step can be repeated using acute angles and obtuse angles.

Present students with the following scenario:

An oil truck is climbing a hill with a 15 degree grade. The grade is the pitch or steepness of the road. Draw a picture of the hill using your protractor.

What type of angle is this? (Acute)

1. Demonstrate how a protractor is used. Draw an angle on an overhead transparency or the board. Align the straight edge of the protractor along the bottom of the angle.   Align the center of the protractor at the vertex of the angle.   Use the scale to measure the angle accordingl.

2. Pair students together and provide them with a copy of **Angle Worksheet(attached)**. Instruct students to use a protractor in order to find the angle degree and the type of angle. Students can refer to the **Angle Facts Sheet(attached)** for help in identifying the types of angles.

3. Additional measurement and angle identification can be done by having students create angles out of toothpicks. Angles can be created out of simple toothpicks and glued to construction paper creating a sheet of angles. Students can exchange angle sheets and then measure each angle with a protractor, record the measurement in degrees, and identify the angle.

4. Using the toothpick models, ask students to identify some objects that might resemble or contain each of the angles created. For example, a rectangle end table contains right angles at the corners, a recliner set back might resemble an obtuse angle, and the beak of bird may look acute.

5. Provide students with crayons or colored pencils to turn the toothpick models into images and drawings. Display the creative work of your students.

3. EXTENSION

Discuss another measuring tool called the geometric compass. Have students research who invented the geometric compass and its purpose. They will learn that the geometric compass was invented by Galileo and is a tool used to create a perfect circle.

Visit **Mathisfun.com** for additional information about angles and protractors. This site has an animated tutorial on how to use a protractor for measuring angle. Most angles can be defined as right, obtuse, or acute. Using the Mathisfun website, locate the name of an angle that is exactly 180 degrees (straight angle) and one that is greater than 180 degrees (reflex angle).

Attached there are additional sheets with information about angles and application problems.

4. ASSESSMENT

The lesson objectives can be assessed by evaluating the **Angle Worksheet (Attached)**with the **Angle Worksheet Key (Attached)**. Use the **Assessment of Student Progress (Attached)** to assess students' overall abilities to meet the lessons learning objectives which include identifying, drawing, and building various angles.

5. CLOSURE

Provide each student with an index card and have them answer the following questions on one side of the index card:

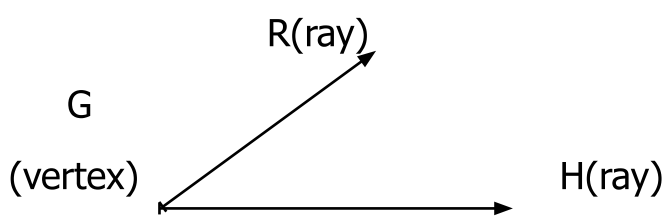
1. **What are two new things that you have learned?**
2. **What else would you like to learn about this topic?**

On the back side of the index card, instruct the students to draw a picture of something they learned about during this lesson. The index cards can be hole punched and held together with a simple shower curtain ring.

Measuring Angles

Angle Facts

- Angles are formed when two lines or rays meet. (A line connects two points and can go on forever in two directions. A ray has one endpoint and can go on forever in one direction.)
- The meeting point of two lines or two rays is called the **vertex**.

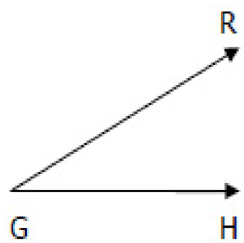


- Angles are measured in units called **degrees**. Angles can range in size between 0 and 180 degrees. (Remind students that a straight line is 180 degrees.)
- There are three major categories of angles: **right angle, obtuse angle, and acute angle.**
- A **right angle** has an exact measurement of 90 degrees.
- An **acute angle** has a measurement between 0 and 90 degrees.
- An **obtuse angle** has a measurement between 90 and 180 degrees.
- Angles are named either by the one letter assigned to the vertex (<G) or by three letters with the vertex as the center letter and the remaining two letters denoting the lines or rays (<RGH) of the angle.

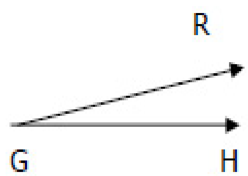
Name______________________________________

Angle Worksheet

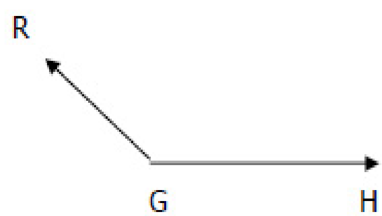
Record each measurement in degrees. Identify each angle as an acute, obtuse, or right angle.



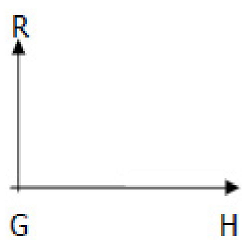
Measurement:____ Type of Angle:_____



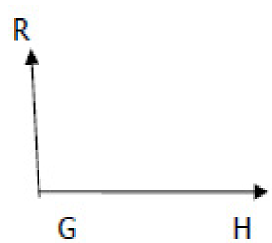
Measurement:____ Type of Angle:_____



Measurement:____ Type of Angle:_____



Measurement:____ Type of Angle:_____



Measurement:____ Type of Angle:_____

Angle Worksheet-Answer Key

Part I

1. Measurement: 30° Type of Angle: acute

2. Measurement: 12°° Type of Angle: acute

3. Measurement: 135° Type of Angle: obtuse

4. Measurement: 90° Type of Angle: right

5. Measurement: 92° Type of Angle: obtuse

Name________________________________

Measuring Angles Assessment

Use the following summary to assess a student's abilities and performance throughout the lesson. Share this assessment with students at the start of the lesson so that students will understand how they will be assessed prior to beginning the Exploring and Learning section. The tool can be used as a basis for providing feedback to students. Use the scale below to score each of the following items:

Making Connections:

____ Student participates in discussion by offering answers to one or more of the questions asked by the teacher.

Exploring and Learning

____ Student works with partner to identify and list examples of angles found inside and outside the school.

____ Student participates in discussion sharing angle examples.

____ Student participates in discussion identifying some major features of a protractor.

_____ Student works with partner using a protractor to measure and identify angles as right, acute, and obtuse angles in problem #1 of the worksheet.

_____ Student solves additional angle problems and understands concepts regarding angle measurements in problems #2-5 of the worksheet.

____ Student creates angles using toothpicks to build two-dimensional models representing right, acute, and obtuse angles.

SCALE

4 – Excellent

Student completes the activity, task or assignment with no errors and demonstrates mastery of concepts and/or lesson objectives.

3 – Good

Student completes the activity, task, or assignment with few major errors and demonstrates an understanding of the concepts and/or lesson objectives.

2 – Fair

Student completes the activity, task, or assignment with some major errors and demonstrates difficulty with the concepts and lesson objectives.

1 – Poor

Student does not complete the activity, task, or assignment and demonstrates no understanding of the concepts and/or lesson objectives.

Measuring Angles

Vocabulary

1. **Vertex:** The meeting point of two lines or rays

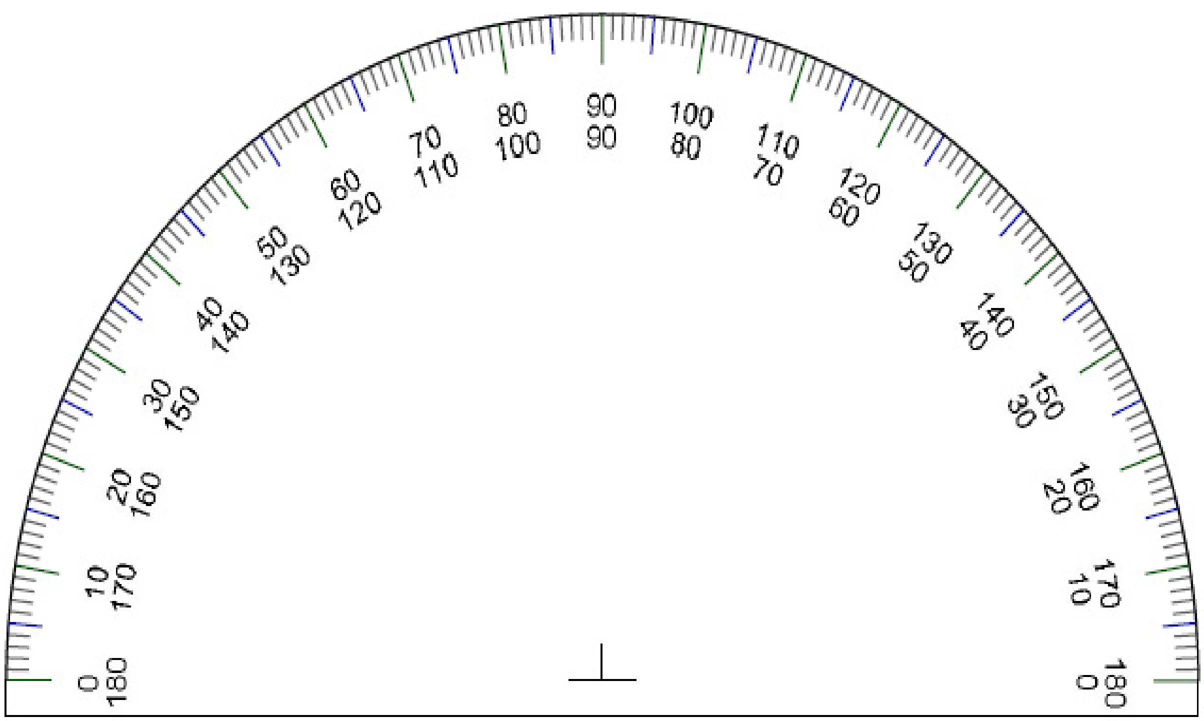
2. **Right angle:** Has an exact measurement of 90 degrees

3. **Acute angle:** Has a measurement between 0 and 90 degrees

4. **Obtuse angle:** Has a measurement between 90 and 180 degrees

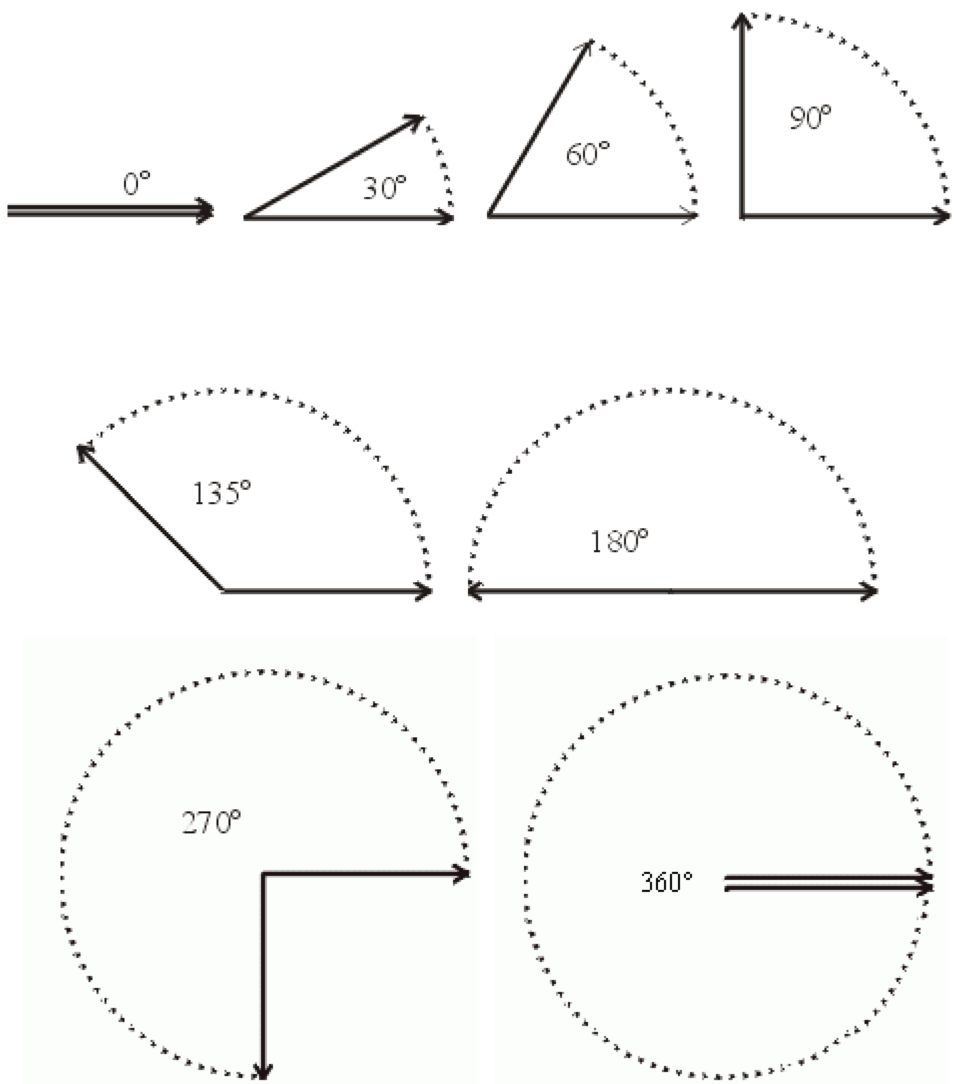
5. **Protractor:** A tool used to measure angles

Transparency for WOW!



Measuring angles – Additional Materials (5 pages)

Angles are measured in *degrees*. Remember how you can picture the one side of the angle as tracing out a circle or an arc of a circle. The FULL CIRCLE forms a **360 degree** angle. Therefore a half circle or a straight angle is 180 degrees, and a fourth of a circle or a right angle is 90 degrees. Look at the pictures. We use the little circle to denote the degree after numbers.

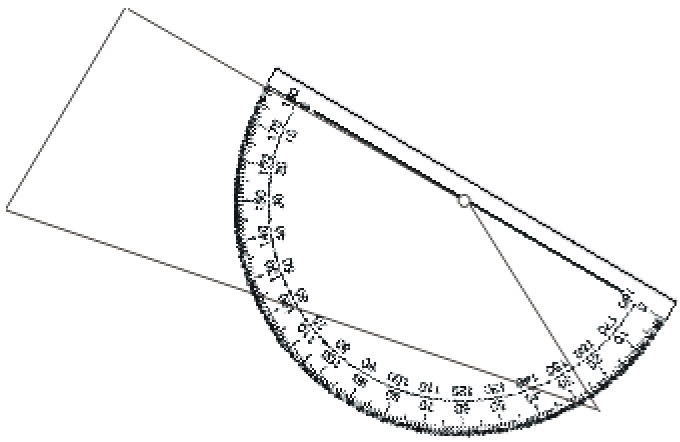


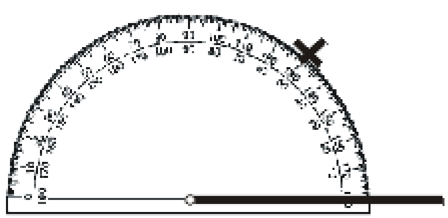
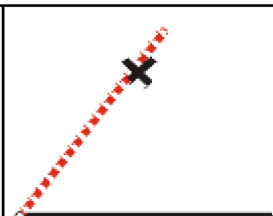
This is a 1 degree angle!

This is a protractor. It is used to measure angles. Note how it has the shape of half a circle; therefore it only measures angles up to 180. It has two sets of numbers: one set goes from 0 to 180 one way, one set from 0 to 180 the other way. Which one you read depends on where you place the one side of the angle you are measuring.

To measure an angle, place the little circle or open hole of the protractor on the VERTEX of the angle. Place the zero line of the protractor on the ONE SIDE of the angle. Then read the measure where the other side hits the protractor scale. This angle is obviously an OBTUSE angle, so we read the scale at 127 degrees.

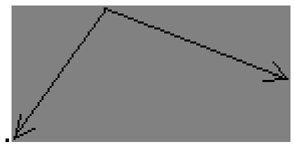
These pictures illustrate how to measure angles from triangles or other figures. The zero line of the protractor needs to be lined up with one side of the angle, and you read the set of numbers from your zero line on.

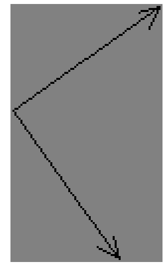


		
To draw an angle of 50°, first draw a line segment that is to be the one side of the angle.	Then put the protractor so that its zero line matches with your line segment and that the vertex is in place. Then put a little mark at the 50°spot.	Take the protractor off and draw a line through your mark.

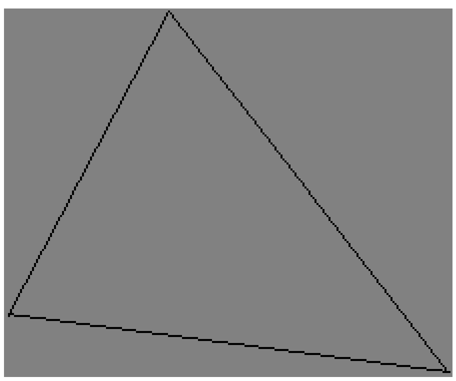
Example problem types

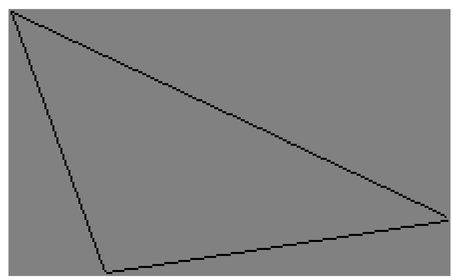
1. Measure the following angles. If necessary, continue the sides of the angle..





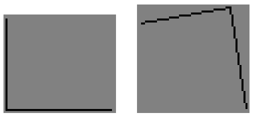
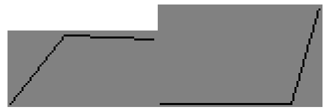
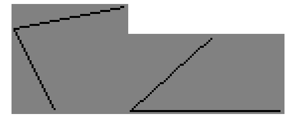
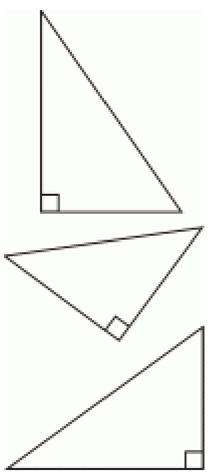
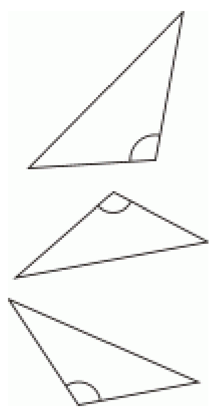
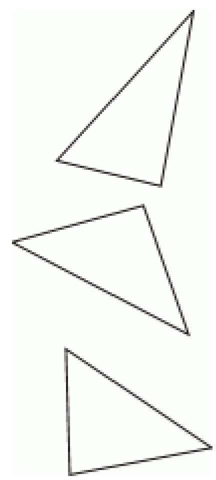
2. Measure and label all the angles in these triangles.





3. Draw an angle of a) 35° b) 76° c) 137° d) 162°

Triangles are closed figures with three sides. They can be classified according to what kind of angle they have.

 right angles (exactly 90°)	 obtuse angles (more than 90°, less than 180°)	 acute angles. (less than 90°)
 **<u>Right triangles</u>** have exactly one right angle.	 **<u>Obtuse triangles</u>** have exactly one obtuse angle.	 **<u>Acute triangles</u>** have three acute angles. In other words, ALL the angles are acute.

Example problem types

1. Draw a right angle. Then make a right triangle out of it by drawing in the third side. Draw two more right triangles with different sizes or positions. Then measure all the angles in all three triangles. Are those angles acute, right, or obtuse? What is the sum of the angles within each triangle?

The other two angles in a right triangle are ____________________.

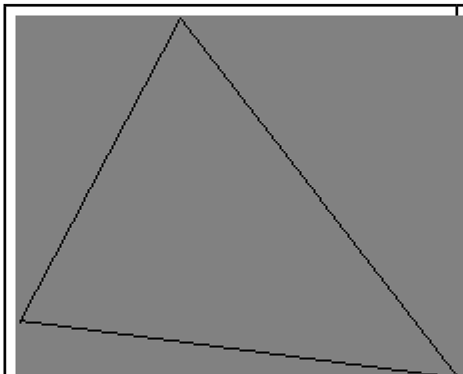
2. Draw an obtuse angle. Then make an obtuse triangle out of it by drawing in the third side. Draw two more obtuse triangles with different sizes or positions. Then measure all the angles in all three triangles. Are those angles acute, right, or obtuse? What is the sum of the angles within each triangle?

The other two angles in an obtuse triangle are ____________________.

3. Based on your calculations in exercises 1 and 2, make a guess for the sum of the angles in a triangle.

5. Draw a triangle whose one angle is 55° and other angle is 35°. Measure the third angle. Its measure is ______ degrees. What kind of triangle did you get (acute, right, obtuse)?

8. Measure some (or all) angles and some (or all) sides of this triangle and then draw it on your own paper. In other words, copy the triangle. Your triangle should match exactly with this triangle if they were placed on top of each other.



Mark the angles and sides first
Then measure, and write down
your
measurements here:

9. These two pictures illustrate how it is ENOUGH to measure just two angles and the side *between* them to copy a triangle. In other words, you don't have to know all the angles and sides to copy the triangle.

Measure the two angles and the one side between the angles from the triangle, and then use that information to copy the triangle to your notebook. When drawing the triangle, start out by drawing the one side you measured.

12. a) Draw a triangle that has a 25° angle, a 115° angle, and a side of 3 inches between those angles.
b) Draw a triangle that has a 67° angle, a 75° angle, and a side of 2 inches between those angles.

13. Draw any parallelogram that is not a rectangle. Then draw another copy of it in your notebook so that you now have two identical parallelograms side by side.

Now draw a diagonal into it, that is a line from one corner to the opposite corner. That forms two triangles. What kind of triangles are they? (acute, right, obtuse) Draw the other diagonal into the second parallelogram. What kind of triangles did you get now? (acute, right, obtuse)

Example problem types

1. Calculate the angle marked with the question mark. Note: do not measure since the pictures are not exact. What principles should you use?

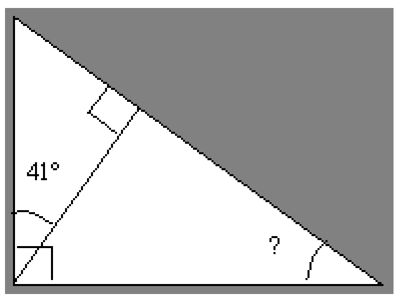
2. Draw a triangle whose all three angles have the same measure. What is that measure?

3. Try to draw a triangle that has two right angles. Can you do it? Why?

6. Draw a triangle whose one angle is 35° and another angle is 85°. Can you draw the triangle without calculating the measure of the third angle?

Puzzle corner

Calculate (do not measure) the angle marked with ?.



Helpful Links

If you have any formatting, ed-tech, or general questions please contact me at

bryanhartman@gmail.com

Links used to create some of these questions. I also used data from the Powerpoint presentations.

LINKS

Countrymark - http://www.countrymark.com/countrymark/AboutUs/americanoil.aspx

Illustrative Mathematics - http://www.illustrativemathematics.org/

Common Core - http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

USGS - http://www.usgs.gov/

Energy Math Challenge - http://www.need.org/needpdf/Energy%20Math%20Challenge.pdf

FIFTH GRADE PROBLEMS

MATH COMPONENT

5-NF-6 Apply and extend previous understanding of multiplication and division to multiply and divide fractions.

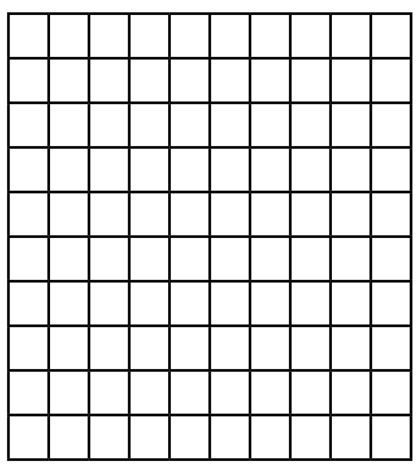
Solve real world problems involving multi-application of fractions and mixed numbers. –e.g., by using visual fraction models or equations to represent the problem.

Example 1

The Countrymark oil refinery just received a shipment of 6,000 gallons of Illinois Oil. ½ of that oil will be used to produce unleaded gasoline. 1/25 of the gasoline produced will be "93 Octane." What fraction of the oil will be used to produce "93 Octane Gasoline?"

Example 2

A simple survey of Tom's land is shown in the diagram below. He has sold mineral rights to ½ of his land. The oil company has promised only $1/10^{th}$ of that land will have wells and storage tanks on it. Use the survey of Tom's land to illustrate a possible scenario for where wells and storage tanks could be located. Model this situation with an expression showing the fraction of Tom's land which will be used for a well and storage tanks.



Example 3

Four brothers, Tom, Jerry, Mickey, and Pluto will split the oil royalties from leasing the mineral rights on their family's land. Tom divides his rights evenly among his two sons and one daughter leaving none to himself. Model this situation with an expression showing the fraction of the original oil rights that Tom's daughter will receive.

Pioneer Example

A landowner typically receives 1/8 of the production from an oil well on his property, which is called a **royalty**. George has a well on his property that produces 60 barrels of oil per day.

- How many barrels of oil are credited to George?
- If oil is currently selling for $90/barrel, how much money is George making each day?

Suppose the oil company drills another well on George's property, and adds 40 barrels/day to his royalty.

- How many barrels/day is now credited to George's royalty?
- With the additional production, how much money is George making per day?

5-NF-7C Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Solve real-world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions. e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share ½ lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins?

Example 1

The land man has signed contracts to lease 70 acres of property near Salem Illinois to drill for oil. This is 2/5 of the total land he needs to lease before his company can start drilling. How much land does he need to lease?

Example 2

One-half of all the oil refined at Countrymark today will turned into unleaded gasoline. If all the un-leaded gasoline is sold evenly to Marathon, Casey's, and Shell. What fraction of the total oil is each company purchasing?

Pioneer Example:

A **<u>Unit</u>** is formed when a group of properties can be more effectively drilled and developed by treating them as one property. Each individual owner within the unit will receive a fractional part of the 1/8 royalty assigned to the unit. How much each individual owner receives depend on what portion of the unit is their acreage. For this problem, Jean owns 60 acres, Hal owns 40 acres, and Logan owns 80 acres.

A. How many total acres are in the unit?

B. What fractional part of the unit belongs to Jean?

C. What fractional part of the unit belongs to Hal?

D. What fractional part of the unit belongs to Logan?

Suppose the unit makes 240 barrels of oil per day. 1/8 of this production will be divided among the three owners.

E. How much is 1/8 of the total production?

F. How much production will be credited to Jean?

G. How much production will be credited to Hal?

H. How much production will be credited to Logan?

Suppose that oil is selling for $90/barrel.

I. How much money will each owner receive on a daily basis?

5-MD-5 Geometric Measurement: understand concepts of volume and relate volume to multiplication and to addition. Relate volume to the operations of multiplication and addition to solve real world and mathematical problems involving volume.

Example 1

An oil barrel is typically defined as 42 US gallons. If an oil pump is producing 1 barrel every 2 days, how many gallons will it produce in 28 days?

Pioneer Example:

A standard "210" oil tank contains 210 barrels of oil.

- Each foot of the tank contains 14 barrels. How high is the tank?
- A barrel of oil contains 42 gallons. How many gallons are there is a "210" tank?
- A lease has three "210" tanks and a "100" (100 barrel) tank. If each tank is half full, how many barrels of oil are currently in the tanks?
- At $80/barrel, how much is the oil currently in the tanks worth?

5-MD-5b Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

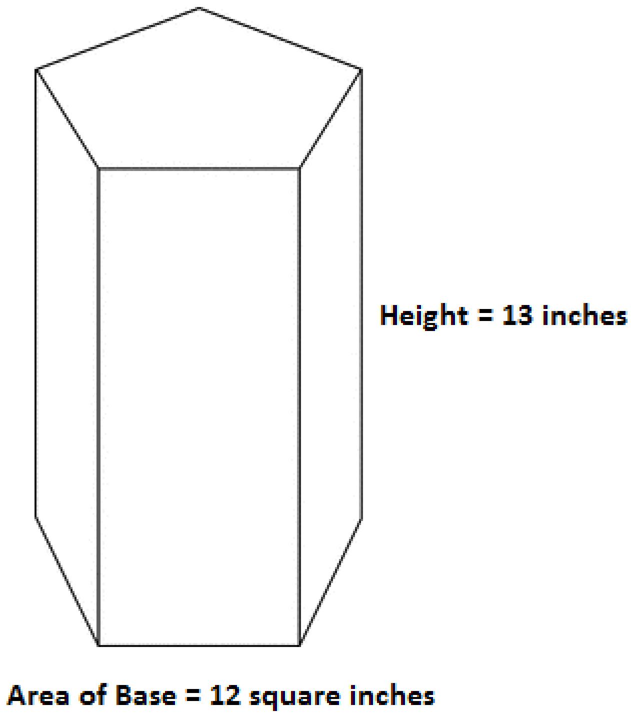
Apply the formulas V = (l)(w)(h) and V = (b)(h) for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

Example 1

Peoples Gas stores natural gas in an underground aquifer. If the aquifer is a rectangular prism and capable of storing 150 billion cubic feet. Give 1 possible set of dimensions for the aquifer using only whole numbers. Sketch and label your aquifer.

Example 2

The following pentagonal prism metal piece is needed to store oil samples. What is its volume?



5-MD-5c

Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Recognize volume as additive. Find volumes of solid figures composed of non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

Example 1

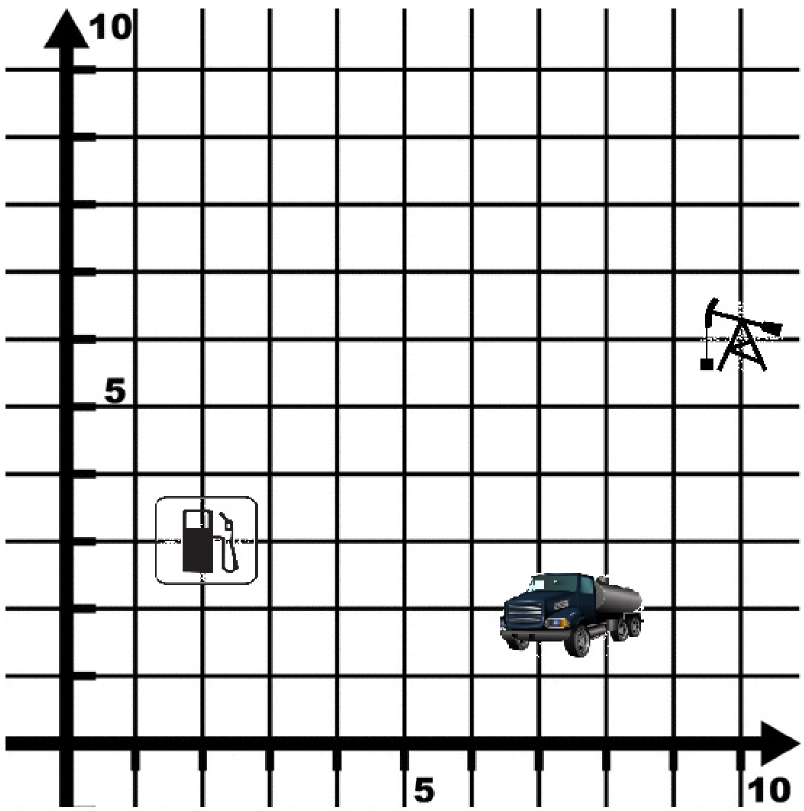
Pioneer Oil is preparing to build a large oil unloading and storage tanks facility. They will be receiving crushed stone via open top box cars on a train. The cubic capacity of a boxcar can be obtained by multiplying the inside dimensions – length, width, and height.

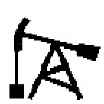
A. If a 60’ standard boxcar measures 60’ long, 9’ wide, and 11’ tall. What is its cubic capacity?
B. If a 50’ High Roof boxcar measures 50’ long, 9’ wide, and 13’ tall. What is its cubic capacity?
C. What is the cubic capacity of 5, 60’ standard box cars combined with 7, 50’ High Roof boxcars?

5-G-1 Graph points on the coordinate plane to solve real-world and mathematical problems. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

Example 1

The first quadrant of the coordinate plane is shown below with a few oil related items. Give the coordinates covered by each item. The oil truck covers two. Also, draw a picture of another oil related item on the coordinate plane and give its coordinates.





Pumpjack

Gas Pump

Oil Truck

5-G-2 Graph points on the coordinate plane to solve real-world and mathematical problems.

Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Example 1

Mr. Roberts is surveying Mrs. Smith's land to show the property boundaries of the land she will be leasing to the oil company. Each segment in the plane below represents 1 mile. Use the coordinate plane to show where Mr. Roberts placed his survey stakes. Mr. Roberts started at her house located at the intersection of the x and y-axis.

1) He traveled north 1 mile, then east 1 mile and placed a stake.
2) From stake one, he traveled 6 miles east, the placed another stake.
3) He traveled 4 miles north, then placed another stake.

A. At what point would Mr. Roberts place his fourth stake to complete the rectangular section of land?

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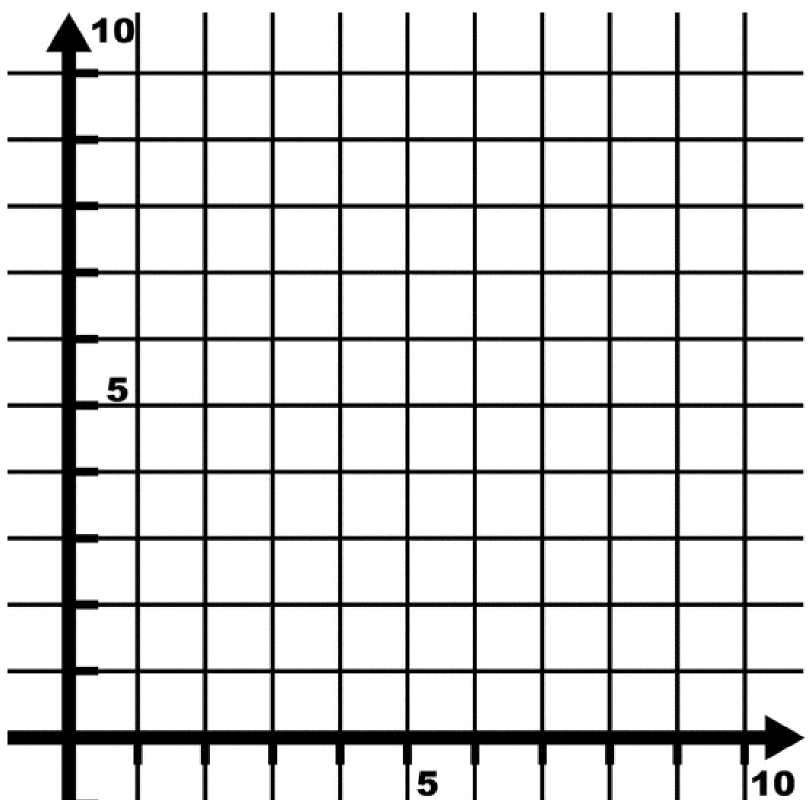


Helpful Links

If you have any formatting, ed-tech, or general questions please contact me at

bryanhartman@gmail.com

Links used to create some of these questions. I also used data from the Powerpoint presentations.

LINKS

Countrymark - http://www.countrymark.com/countrymark/AboutUs/americanoil.aspx

Illustrative Mathematics - http://www.illustrativemathematics.org/

Common Core - http://www.corestandards.org/assets/CCSSI_Math%20Standards.pdf

USGS - http://www.usgs.gov/

Energy Math Challenge - http://www.need.org/needpdf/Energy%20Math%20Challenge.pdf

FIFTH GRADE ANSWER KEY

MATH COMPONENT

5-NF-6 **Apply and extend previous understanding of multiplication and division to multiply and divide fractions.**

Solve real world problems involving multi-application of fractions and mixed numbers. –e.g., by using visual fraction models or equations to represent the problem.

Example 1

The Countrymark oil refinery just received a shipment of 6,000 gallons of Illinois Oil. ½ of that oil will be used to produce unleaded gasoline. 1/25 of the gasoline produced will be "93 Octane." What fraction of the oil will be used to produce "93 Octane Gasoline?"

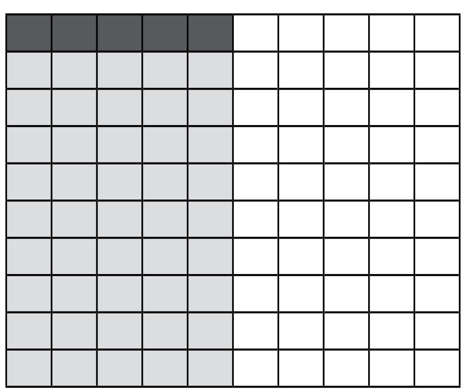
6000 * 1/2 = 3000; 3000 * 1/25 = 120; 120/6000 = 1/50

OR

1/2 * 1/25 = 1/50

Example 2

A simple survey of Tom's land is shown in the diagram below. He has sold mineral rights to ½ of his land. The oil company has promised only 1/10th of that land will have wells and storage tanks on it. Use the survey of Tom's land to illustrate a possible scenario for where wells and storage tanks could be located. Model this situation with an expression showing the fraction of Tom's land which will be used for a well and storage tanks.



Many possible answers. Final answer is 5 boxes shaded. 1/20 of the land.

Example 3

Four brothers, Tom, Jerry, Mickey, and Pluto will split the oil royalties from leasing the mineral rights on their family's land. Tom divides his rights evenly among his two sons and one daughter leaving none to himself. Model this situation with an expression showing the fraction of the original oil rights that Tom's daughter will receive.

*1/4 * 1/3 = 1/12*

OR

1/4 3 = 1/4 1/3 = 1/12*

Pioneer Example

A landowner typically receives 1/8 of the production from an oil well on his property, which is called a **royalty**. George has a well on his property that produces 60 barrels of oil per day.

- How many barrels of oil are credited to George?
- If oil is currently selling for $90/barrel, how much money is George making each day?

Suppose the oil company drills another well on George's property, and adds 40 barrels/day to his royalty.

- How many barrels/day is now credited to George's royalty?
- With the additional production, how much money is George making per day?

*A) 1/8 * 60 = 7.5 barrels/day*

*B) $90 * 7.5 = $675*

*C) 1/8 * 40 = 5; 5 + 7.5 = 12.5 barrels/day*

*D) $90 * 12.5 = $1125*

5-NF-7C Apply and extend previous understandings of multiplication and division to multiply and divide fractions.

Solve real-world problems involving division of unit fractions by non-zero whole numbers and division of whole numbers by unit fractions. e.g., by using visual fraction models and equations to represent the problem. For example, how much chocolate will each person get if 3 people share ½ lb of chocolate equally? How many 1/3-cup servings are in 2 cups of raisins?

Example 1

The land man has signed contracts to lease 70 acres of property near Salem Illinois to drill for oil. This is 2/5 of the total land he needs to lease before his company can start drilling. How much land does he need to lease?

Multiple ways to solve this.

*2 * 35 = 70; 5 * 35 = 175 total acres need to be leased*

Example 2

One-half of all the oil refined at Countrymark today will turned into unleaded gasoline. If all the unleaded gasoline is sold evenly to Marathon, Casey's, and Shell. What fraction of the total oil is each company purchasing?

*1/2 * 1/3 = 1/6*

Pioneer Example:

A **Unit** is formed when a group of properties can be more effectively drilled and developed by treating them as one property. Each individual owner within the unit will receive a fractional part of the 1/8 royalty assigned to the unit. How much each individual owner receives depend on what portion of the unit is their acreage. For this problem, Jean owns 60 acres, Hal owns 40 acres, and Logan owns 80 acres.

J. How many total acres are in the unit?

K. What fractional part of the unit belongs to Jean?

L. What fractional part of the unit belongs to Hal?

M. What fractional part of the unit belongs to Logan?

Suppose the unit makes 240 barrels of oil per day. 1/8 of this production will be divided among the three owners.

N. How much is 1/8 of the total production?

O. How much production will be credited to Jean?

P. How much production will be credited to Hal?

Q. How much production will be credited to Logan?

Suppose that oil is selling for $90/barrel.

R. How much money will each owner receive on a daily basis?

A) 60 + 40 + 80 = 180 total acres

B) 60/180 = 1/3

C) 40/180 = 2/9

D) 80/180 = 4/9

E) 240 / 8 = 30 barrels

*F) 1/3 * 30 = 10 barrels*

*G) 2/9 * 30 = 6 2/3 barrels*

*H) 4/9 * 30 = 13 1/3 barrels*

*I) Owner A = $90 * 10 = $900; Owner B = $90 * 6 2/3 = $600; Owner C = $90 * 13 1/3 = $1200*

5-MD-5 Geometric Measurement: understand concepts of volume and relate volume to multiplication and to addition. Relate volume to the operations of multiplication and addition to solve real world and mathematical problems involving volume.

Example 1

An oil barrel is typically defined as 42 US gallons. If an oil pump is producing 1 barrel every 2 days, how many gallons will it produce in 28 days?

*1 barrel / 2 days = ½ barrel per day; ½ barrel * 42 gallons = 21 gallons per day. 21 * 28 days = 588 g*

.

Pioneer Example:

A standard “210” oil tank contains 210 barrels of oil.

A. Each foot of the tank contains 14 barrels. How high is the tank?

B. A barrel of oil contains 42 gallons. How many gallons are there is a “210” tank?

C. A lease has three “210” tanks and a “100” (100 barrel) tank. If each tank is half full, how many barrels of oil are currently in the tanks?

D. At $80/barrel, how much is the oil currently in the tanks worth?

A) 210 / 14 = 15 feet tall

*B) 210 * 42 = 8820 gallons*

*C) 210 * 3 * 1/2 = 315; 100 * 1/2 = 50; 315 + 50 = 365 barrels.*

*D) 365 * 80 = $29,200*

5-MD-5b Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Apply the formulas V = (l)(w)(h) and V = (b)(h) for rectangular prisms to find volumes of right rectangular prisms with whole-number edge lengths in the context of solving real world and mathematical problems.

Example 1

Peoples Gas stores natural gas in an underground aquifer. If the aquifer is a rectangular prism and capable of storing 150 billion cubic feet. Give 1 possible set of dimensions for the aquifer using only whole numbers. Sketch your aquifer.

Three numbers that multiply to equal 150 billion or 150,000,000,000. If a very small number is used, discuss with the students what that would look like.

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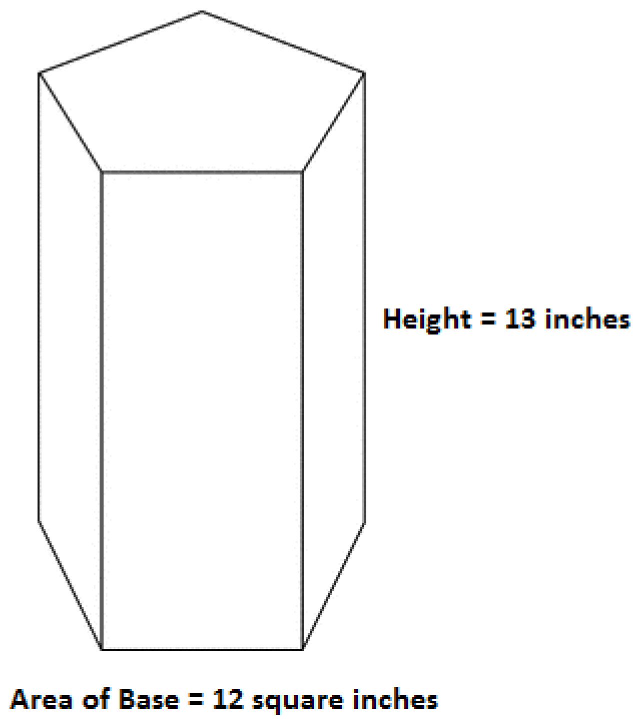


*Area of Base * Height = 12 * 13 = 156 square inches*

5-MD-5c Geometric measurement: understand concepts of volume and relate volume to multiplication and to addition.

Recognize volume as additive. Find volumes of solid figures composed of non-overlapping right rectangular prisms by adding the volumes of the non-overlapping parts, applying this technique to solve real world problems.

Example 1

Pioneer Oil is preparing to build a large oil unloading and storage tanks facility. They will be receiving crushed stone via open top box cars on a train. The cubic capacity of a boxcar can be obtained by multiplying the inside dimensions – length, width, and height.

D. If a 60’ standard boxcar measures 60’ long, 9’ wide, and 11’ tall. What is its cubic capacity?
E. If a 50’ High Roof boxcar measures 50’ long, 9’ wide, and 13’ tall. What is its cubic capacity?
F. What is the cubic capacity of 5, 60’ standard box cars combined with 7, 50’ High Roof boxcars?

*A) 60*9*11 = 5940 cubic feet*

*B) 50*9*13 = 5840 cubic feet*

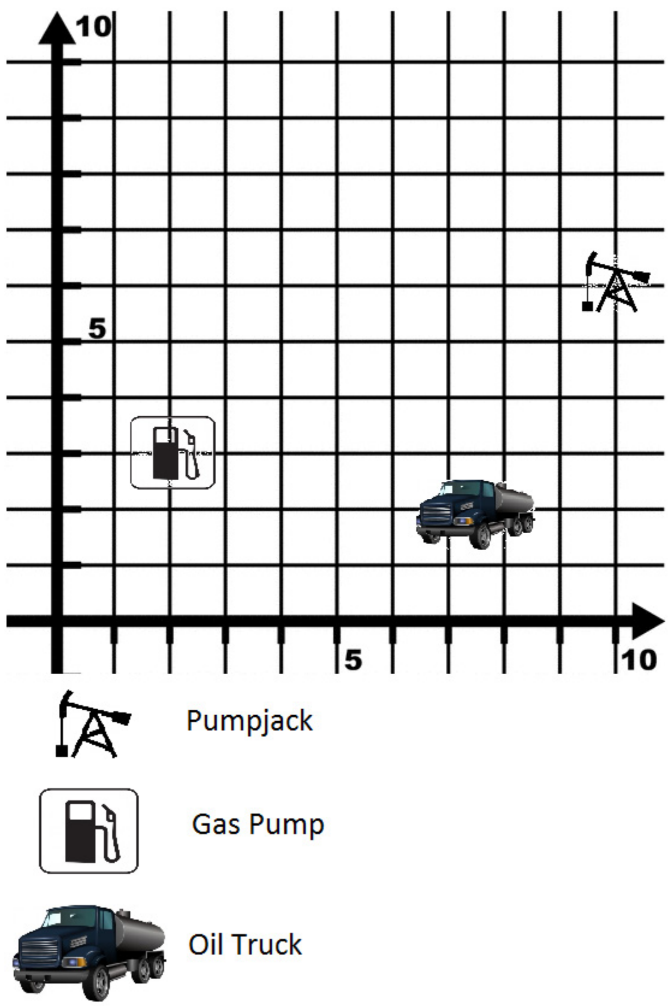
*C) (5 * 5940) + (7 * 5840) = 29700 + 40880 = 70580 cubic feet*

5-G-1 Graph points on the coordinate plane to solve real-world and mathematical problems. Use a pair of perpendicular number lines, called axes, to define a coordinate system, with the intersection of the lines (the origin) arranged to coincide with the 0 on each line and a given point in the plane located by using an ordered pair of numbers, called its coordinates. Understand that the first number indicates how far to travel from the origin in the direction of one axis, and the second number indicates how far to travel in the direction of the second axis, with the convention that the names of the two axes and the

coordinates correspond (e.g., x-axis and x-coordinate, y-axis and y-coordinate).

Example 1

The first quadrant of the coordinate plane is shown below with a few oil related items. Give the coordinates covered by each item. The oil truck covers two. Also, draw a picture of another oil related item on the coordinate plane and give its coordinates.



Pumpjack (10, 6); Gas Pump (2, 3); Oil Truck (7, 2) & (8,2). Check for one other item

5-G-2 Graph points on the coordinate plane to solve real-world and mathematical problems.

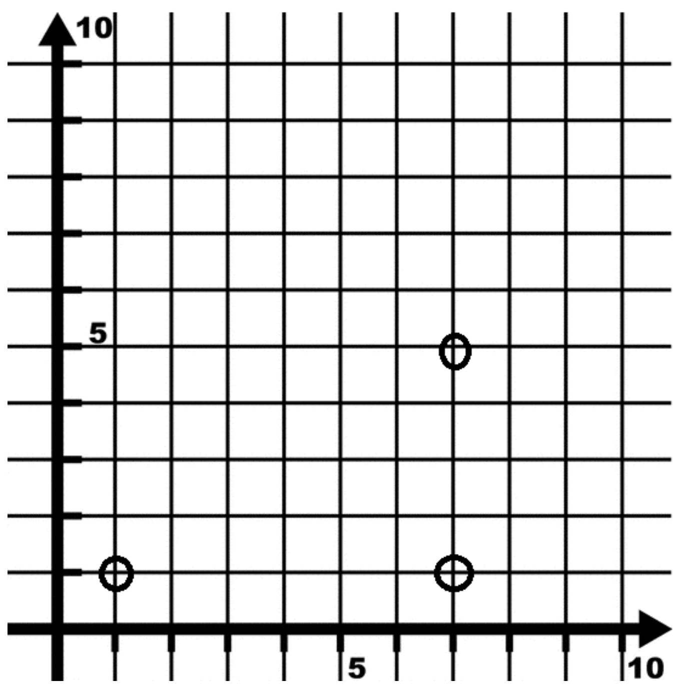
Represent real world and mathematical problems by graphing points in the first quadrant of the coordinate plane, and interpret coordinate values of points in the context of the situation.

Example 1

Mr. Roberts is surveying Mrs. Smith's land to show the property boundaries of the land she will be leasing to the oil company. Each segment in the plane below represents 1 mile. Use the coordinate plane to show where Mr. Roberts placed his survey stakes. Mr. Roberts started at her house located at the intersection of the x and y-axis.

4) He traveled north 1 mile, then east 1 mile and placed a stake.
5) From stake one, he traveled 6 miles east, the placed another stake.
6) He traveled 4 miles north, then placed another stake.

A. At what point would Mr. Roberts place his fourth stake to complete the rectangular section of land?
B. How far would Mr. Roberts travel in total starting from the first stake then going to the second stake, third stake, fourth stake (which you placed for him), and finishing at the first stake?
C. What is the area of Mrs. Smith's land?



A) 4th stake at (1,5) *B) 6 + 4 + 6 + 4 = 20 miles* *C) 6 * 4 = 24 square miles*