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“Impact of the Deepwater Horizon Spill” Science Lesson Plan

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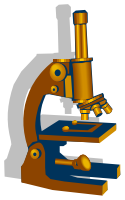

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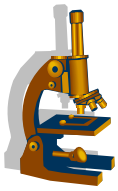
Segment 2:
"Impact of the Deepwater Horizon Spill"
Science Curriculum

Table of Contents



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Fall, 2010

Dear Educator,

the.News online video reports for *the.Sci* and *the.Gov* provide middle and high school students with a valuable exercise in science, social studies and language arts with this **9:08** segment on " The Aftermath of the Gulf Coast Oil Spill" at www.pbs.org/newshour/thenews/thegov and also at www.pbs.org/newshour/thenews/thesci . Correspondent, Antonio Neves investigates the economic, biological, and social implications of this major crisis that occurred on Earth Day – April 20, 2010. Lessons for social studies, language arts and also science are available to support this video in the "For Educators" section of the website. All videos and curricula have been informed by *the.News* instructional design that can be found on the website www.pbs.org/newshour/thenews. The curriculum includes content-based standards, discussion questions, student activities, vocabulary and primary reference sources. A complete transcript of each video report includes time codes to assist in isolating specific segments of the video and to augment the instruction of media literacy and multimedia production. Also, we have added a journalism blog about his report, by Antonio, which can be found within the SS/LA lesson plan as well as on the district website. All of this material is presented as options to fit teachers' instructional needs.

References to Larry Bell's "The 12 Powerful Words" are highlighted in **bold** in the lesson plans and in the "thought starter" questions on the home page and educator's page, and in the transcript (to denote where they are used in the video segment).

We have also added general topics to correlate to the lessons and video as well as concept based standards with conceptual lens and enduring understanding.

We welcome our partners at the Omaha Public Schools who have joined *the.News* in the second year of a special pilot project. We have also developed a new authoring tool for students called *YOU.edit* which gives students an online tool to remix the content of *the.News* reports, so they can create their own multimedia presentations. This editing tool can be found by clicking on the *YOU.edit* button on the home page of the website. Currently used with our OPS teacher consultants it is password protected so that it can serve as a viable educational asset that allows classroom teachers to assign multimedia projects within the security and content safety of *the.News* website.

Answers to **student "thought starter"** questions listed below the video**.**
#1 Nebraska.
#2. .civil penalty or fine
#3. oysters and people

Sincerely,

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The Aftermath of the Gulf Coast Oil Spill

This lesson was designed to support *the.News* video "Impact of the Deepwater Horizon Spill"
The video can be found online at www.pbs.org/newshour/thenews/thesci

Omaha Public Schools Standards
http://www.ops.org/District/LinkClick.aspx?fileticket=Hbqyrrg2ydM%3d&tabid=912&mid=2006
Grade 7
Science
Standard 1. Examine problems using scientific inquiry.

1. Design, conduct, and communicate the results of a scientific investigation to determine the identity of an unknown substance using its physical properties

Standard 2. Integrate unifying concepts and processes in science experiences.

1. Select and use instruments correctly to determine physical properties of a substance.

Standard 3. Investigate and examine properties and changes of properties in matter.

1. Identify physical properties of matter.

Standard 4. Relate how changes in matter can affect the health and safety of our environment.

Conceptual Lens: Human/Environmental Interaction
Enduring Understanding: Human and environmental factors influence on organisms' biology and behavior patterns

Grade Level: Grades 7–12

Content Areas:
Science, Chemistry
Key Concept(s)
Density, Data Analysis, Viscosity, Physical Properties, Polarity

Objectives:
Students will

- **Compare** densities of oil and water.
- **Analyze** class data to **predict** ways in which oil and water interact.
- Use data **analysis** to **formulate** methods of removing oil from water.

Key Vocabulary:

- **Density**: How much things are packed together. Imagine a cube, one inch tall, one inch wide, and one inch long. If that cube is filled with Styrofoam it is light. If it is filled with lead (Pb) it is heavy. The lead (Pb) is heavier because it has a higher density than Styrofoam. (www.chem4kids.com) Mass per unit volume (www.dictionary.com)
- **Dissolve**: to cause to pass into solution (http://www.merriam-webster.com)
- **Electron**: a negatively charged subatomic particle
- **Heavy Crude Oil:** Any type of crude oil which does not flow easily (http://oilgasglossary.com/)
- **Light Crude Oil:** Liquid petroleum that has a low density and flows freely at room temperature. (http://oilgasglossary.com/)
- **Mass**: the amount of something there is, and is measured in grams (or kilograms). (http://www.physics4kids.com)
- **Molecule**: This is a group of atoms bonded together. A molecule is the smallest piece of a compound that can exist. You can hold a compound such water in a glass. One water molecule

would be one piece of the H_2O. The atoms could be all the same type (like ozone) or they could be different (like carbon dioxide). (http://www.chem4kids.com)

- **Physical Property**: properties which can be observed or measured without changing the composition of matter. Physical properties are used to observe and describe matter. (http://www.elmhurst.edu)
- **Polar bond**: A type of covalent bond between two atoms in which electrons are shared unequally. Because of this, one end of the molecule has a slightly negative charge and the other a slightly positive charge. (http://dictionary.reference.com)
- **Salinity**: a measure of dissolved salts in sea water (www.bigelow.org)
- **Viscosity**: A measure of the resistance of a fluid to flow. (http://oilgasglossary.com/)
- **Volume**: the amount of space something takes up

Omaha Public Schools Standards
Grades 9-12
Chemistry 1-2 & AP Chemistry

Standard 5. Investigate properties and states of matter.

3. The behavior of matter is dependent on its structure and energy: Speed of molecules and molecular shapes.

Lesson Topics:

- Oil Spill
- Density
- Physical Properties
- Viscosity
- Molecular Polarity
- Gulf of Mexico
- Dissolving

Materials:

- Video Link: http://www.pbs.org/newshour/thenews/thesci/
- Densities: Oil and Water lab sheet (Handout #1)
  - Calculators
  - Water
  - Cooking oil
  - Graduated cylinders
  - Spoons
  - 250 ml beakers
  - Scales
  - cups
- Oil Spill Spreads Across the Gulf Coast article (Handout #2)
- Density Column lab sheet (Handout #3)
  - Graduated cylinders
  - Test tubes

- Rubbing alcohol
- Vegetable oil
- Water
- Dish soap
- Maple syrup

- Density Disaster worksheet (Handout #4)
- Why Doesn't Oil Dissolve in Water worksheet (Handout #5)
- Viscosity Lab worksheet (Handout #6)
  - Stopwatches
  - Cups
  - Funnels
  - Graduated cylinders

- Test tube cleaning brush
- Water
- Honey
- Canola Oil
- Syrup

McRel
Science (www.mcrel.org)
Standard 8. Understands the structure and properties of matter.

Level III (Grades 6–8)

7. Knows methods used to separate mixtures into their component parts (boiling, filtering, chromatography, screening)

Level IV (Grades 9-12)

17. Understands the properties of solutions and mixtures (e.g., saturation, concentration, solubility)

Time Frame:
2 class periods (approximately 50 minutes each)
(Does not include extension assignments)

Background:
Gulf Spill Timeline
April 20, 2010: Explosion on BP's Deepwater Horizon drilling rig tragically kills 11 workers.
April 29, 2010: Homeland Security Secretary Napolitano announces a "Spill of National Significance" and President Obama makes first public remarks on the disaster.
April 30, 2010: President deploys senior Administration officials to Gulf region. Louisiana National Guard activated.
May 4, 2010: Cabinet officials brief Members of Congress for the first time.
May 11, 2010: Louisiana requests emergency permission from the federal government to dredge barriers and construct berms.
May 27, 2010: Federal government grants Louisiana partial permission to dredge.
May 29, 2010: BP announces that its "top kill" plan to fill the well had failed.
June 2, 2010: Administration approves Louisiana's plan to dredge and tells BP to pay $360 million for five new berms.
July 15, 2010: Oil well is capped, stopping the flow of oil into the Gulf of Mexico.
January 12, 2011: Final report from the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling due to the President (Potential findings for public release can be found here: http://www.oilspillcommission.gov/library). Some potential findings are critical of the administration's response.
(Sources: http://www.gop.gov/policy-news/10/06/16/gulf-of-mexico-oil-spill, http://www.oilspillcommission.gov/page/about-commission)

EPA Response to BP Spill in the Gulf of Mexico

In response to the BP oil spill, EPA has been monitoring air quality, surface water quality, sediment, and waste management along the Gulf of Mexico. Overall, data (described in more detail below) shows some specific concerns, but an overall healthy Gulf of Mexico.

The air monitoring conducted to date has found levels of ozone and particulates ranging from "good" to "unhealthy for sensitive groups" on EPA's Air Quality Index, these are at levels well below those that would cause short-term health problems. The air monitoring conducted to date has not found any pollutants at levels expected to cause long-term harm. With the well capped and no new oil coming into the Gulf, we expect air monitors to continue to show pollution levels that are well below levels of concern.

EPA's surface water samples collected September 10, 2010 along the Gulf coast found two samples exceeded chronic aquatic benchmarks for nickel. Analysis of water samples collected along the Gulf Coast August 28, and September 9-10, 2010 did not detect levels of dispersant chemicals above the reporting limit.

EPA's sediment samples collected September 18-20, 2010 along the Gulf coast found one sample with vanadium in exceedance of chronic aquatic benchmarks. Analysis of sediment samples collected along the Gulf Coast September 20-26, 2010 did not detect levels of dispersant chemicals above the reporting limit.

To date, waste sampling results are within regulatory limits for the disposal of oil waste in state permitted landfills. These landfills have already been identified for disposal of BP's collected oil waste and material in the Waste Management Plans approved by the U.S. Coast Guard in consultation with EPA and the States involved in this response
(Source: US Environmental Protection Agency, http://www.epa.gov/bpspill/)

Partnership for 21st Century Skills (http://www.21stcenturyskills.org/)
Critical Thinking and Problem Solving
Make Judgments and Decisions

- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Interpret information and draw conclusions based on the best analysis

Reason Effectively

- Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation

Make Judgments and Decisions

- Effectively analyze and evaluate evidence, arguments, claims and beliefs
- Interpret information and draw conclusions based on the best analysis

Lesson Plan:

DAY 1

1. Densities: Oil and Water Lab (Handout #1)
    a. Have students perform the lab. As they complete their experiments, have them record their data on the board (or another place where it will be visible to all).
    Be sure that students make a **prediction** prior to starting.
    b. Have students answer the questions by **analyzing** class data.

DAY 2

1. NASA Article – Oil Slick Spreads Across Gulf Coast (Handout #2)
    a. As a class, read the article and discuss ways in which the oil spill could/does affect the region.
    b. Have students get out the Densities: Oil and Water lab and ask students to share answers to question number three. Be sure that students **predict** what they think would happen when oil and water are mixed and use class data to **support** their **predictions**.
    (Source: *NASA.gov*,
    http://www.nasa.gov/multimedia/imagegallery/image_feature_1649.html)
2. Density Column Lab (Handout #3)
    a. Pass out and preview the Density Column Lab with students.
    b. Have students make **predictions** and complete the lab and answer questions. Review with the class.
    (Data Source: http://www.stevespanglerscience.com/experiment/seven-layer-density-column)
3. Density Disaster Question Sheet (Handout #4)
    a. In groups or alone, have students work through the questions, using their data and understanding of density to **explain** answers to each question.

Extension:

1. Why Doesn't Oil Dissolve in Water (Handout #5)
    a. Alone or in pairs, have students read the article and answer the questions that follow.
    (Source: Modified from Saundra Sample's post on Office of DOE Science Education's Ask a Scientist, (http*://www.newton.dep.anl.gov/askasci/chem00/chem00278.htm*).
2. Viscosity Lab (Handout #6)
    a. Have students perform the lab. As they complete their experiments, have them record their data on the board (or another place where it will be visible to all).
    Be sure that students make a **prediction** prior to starting.
    b. Have students answer the questions by **analyzing** class data.
    c. Actual viscosity data:
    Water: ~1.79 mPa (millipascal seconds)
    Canola Oil: ~57 mPa s
    Honey: ~10,000 mPa s
    Syrup: ~2000-3000 mPa s
    (Source: *The Physics Hypertextbook*, http://physics.info/viscosity/)

Assessment:

Densities: Oil and Water

(2pts) Gives an accurate **summary** of class data
(3 pts) Considering class data, makes an accurately **compares** water and oil densities
(3pts) Makes a well-reasoned **prediction** of what would happen when oil and water are mixed

Density Column

(2 pts) Uses density to **explain** the data collected
(3 pts) Effectively **summarizes** the role density plays in a material's ability to float.

Density Disaster

(3 pts) Demonstrates an understanding of the role density plays in ease of cleaning up an oil spill

Why Doesn't Oil Dissolve in Water worksheet

(1 pt) **Compares** and **contrasts** a molecule of water and a molecule of oil.
(1 pt) **Explains** that an electron has a negative charge
(2 pts) **Explains** that a polar molecule could dissolve in water

Viscosity Lab

(3 pts) Demonstrates an understanding of the role viscosity plays in speed of flow of a fluid.

Resources:

- *Office of DOE Science Education's Ask a Scientist,* (http://www.newton.dep.anl.gov/askasci/chem00/chem00278.htm)
- *Infoplease.com*, http://www.infoplease.com/ipa/A0001451.html
- *National Geographic*, http://www.nationalgeographic.com/
- *National Geographic Kids*, http://kids.nationalgeographic.com/kids/
- *OilGasGlossary.com*, http://oilgasglossary.com/
- *The Physics Hypertextbook*, http://physics.info/viscosity/
- *Rader's Chem4Kids.com*, www.chem4kids.com
- *NASA.gov*, http://www.nasa.gov/multimedia/imagegallery/image_feature_1649.html
- *SteveSpanglerScience.com*, http://www.stevespanglerscience.com/experiment/seven-layer-density-column)
- *The Human Touch of Chemistry*, *http://www.humantouchofchemistry.com/Why-doesn%E2%80%99t-oil-dissolve-in-water*
- *US Environmental Protection Agency*, http://www.epa.gov/)

Activity Designer: Jeff Levine is currently a Science Resource Teacher and 8th grade science teacher in Southern MD. He has been teaching science for ten years.

Handouts:

- Densities: Oil and Water Lab (Handout #1)
- NASA Article – Oil Slick Spreads Across Gulf Coast (Handout #2)
- Density Column Lab (Handout #3)
- Density Disaster Question Sheet (Handout #4)
- Why Doesn't Oil Dissolve in Water (Handout #5)
- Viscosity Lab (Handout #6)

DENSITIES: OIL AND WATER
HOW DO THEY COMPARE?

Handout #1

Name _____

Date _____ Per _____

DIFFERENT SUBSTANCES HAVE DIFFERENT PHYSICAL PROPERTIES. TODAY, YOU'LL **COMPARE** THE DENSITIES OF TWO SUBSTANCES PRESENT IN THE GULF OF MEXICO: OIL AND WATER.

Materials:

calculator	water	oil
graduated cylinder		spoon
2 250ml beakers		scale
cup		

Procedures:

1. With your group, make a **prediction** about the densities of oil and water.
2. Measure 100 ml of water in the graduated cylinder. Pour the water into the beaker.
3. Place the cup on the scale and zero the scale. Measure out 3.5g of salt.
4. Add the salt to the beaker and use the spoon to stir until all of the salt has dissolved. This now simulates water in the Gulf of Mexico (~35% salinity).
5. Place the empty beaker on the scale and zero the scale. Pour the salt water into the beaker. Record the mass below.
6. Use the salt water mass and volume measurements to calculate the density of your salt water. Remember, D = m/v.
7. Repeat steps 4 and 5, using oil in place of the salt water.
8. Repeat steps 2-7 two more times.
9. Record your average densities on the class data sheet and clean up!

Prediction: _____

_____

TRIAL	SALT WATER MASS (g)	SALT WATER VOLUME (ml)	SALT WATER DENSITY (g/ml)	OIL MASS (g)	OIL VOLUME (ml)	OIL DENSITY (g/ml)
1						
2						
3						
AVG.						

QUESTIONS: ANSWER THEM!

1. With a partner, review and **summarize** the class data. What is important to consider?

   _____

   _____

2. Make a statement **comparing** the densities of oil and water. Be sure to **support** your statement using the class data. _____

   _____

3. Use the class data and your understanding of density to **predict** what happens when oil and water are mixed. _____

   _____

OIL SLICK SPREADS ACROSS GULF COAST

(Source: http://www.nasa.gov/multimedia/imagegallery/image_feature_1649.html) Handout #2

NASA's Aqua satellite captured this image of the Gulf of Mexico on April 25, 2010 using its Moderate Resolution Imaging Spectroradiometer (MODIS) instrument. With the Mississippi Delta on the left, the silvery swirling oil slick from the April 20 explosion and subsequent sinking of the *Deepwater Horizon* drilling platform is highly visible. The rig was located roughly 50 miles southeast of the coast of Louisiana.

The oil slick may be particularly obvious because it is occurring in the sunglint area, where the mirror-like reflection of the Sun off the water gives the Gulf of Mexico a washed-out look. Oil slicks are notoriously difficult to spot in natural-color (photo-like) satellite imagery because a thin sheen of oil only slightly darkens the already dark blue background of the ocean. Under unique viewing conditions, oil slicks can become visible in photo-like images, but usually, radar imagery is needed to clearly see a spill from space.

Image Credit: NASA/MODIS Rapid Response Team

Handout #3

DENSITY COLUMN!

Name _____

Date _____ Per _____

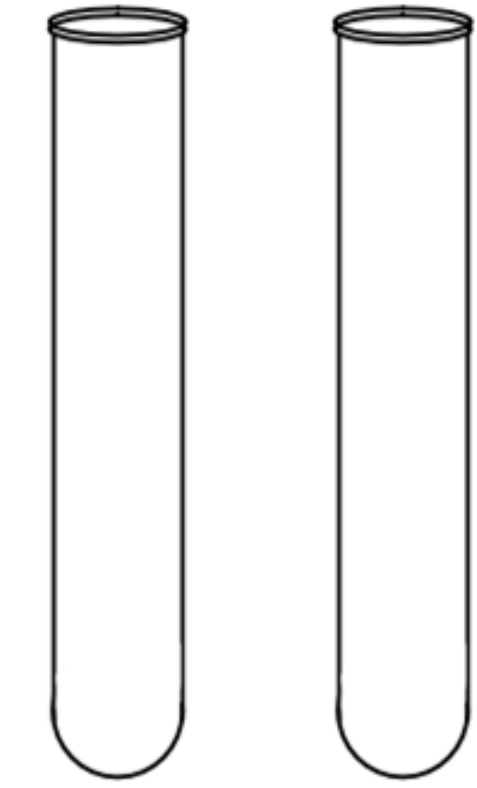
YOU'VE CALCULATED THE DENSITIES OF OIL AND WATER. TODAY, YOU'LL SEE HOW THEY (AND OTHER SUBSTANCES) INTERACT!

Materials:
Graduated cylinder
Liquids (listed below)
Test tube

Procedures:

1. Given the densities of the liquids (right), sketch and label in the "Predicted Data" test tube a **prediction** of what the liquids will look like when mixed.
2. Use your graduated cylinder to add approximately 5ml of each liquid to your test tube.
   Be sure to add each liquid gently.
3. After all of the liquids have been added, sketch and label the outcome in the "Actual Data" test tube below.
4. Clean up!

Material	Density (g/ml)
Rubbing Alcohol	.79
Vegetable Oil	.92
Water	1.00
Dish Soap	1.06
Maple Syrup	1.37



PREDICTED DATA

ACTUAL DATA

ANALYSIS QUESTIONS!

1. How does your **prediction compare** to the actual data?
   _____
   _____
2. Why do you think the liquids ended up like they did?
   Be sure to talk about density in your answer! _____
   _____
   _____
   _____
3. Make a **summary** statement about how density affects something's ability to float. _____
   _____
   _____

Handout #4

DENSITY DISASTER!

Name _____

Date _____ Per _____

In the summer of 2010, the Deepwater Horizon oil rig failed, causing hundreds of millions of barrels of oil to flow into the Gulf of Mexico. This disaster had and continues to have environmental, ecological, and economic effects on the entire Gulf of Mexico region. Today, you'll discuss how the densities of oil and water impact this disaster, and what could have happened if their densities were different.

1. Why is the oil in the ocean dangerous? _____

   _____

2. Do you think the danger is greater to birds and other marine animals or to fish and other organisms that live on the ocean bottom? _____

   _____

3. Do the densities of oil and water make the oil easier or more difficult to clean up? ____

   _____

   Why do you think so? _____

   _____

4. How would the cleanup efforts have been different if the density of oil were the same as syrup? _____

   _____

Name _____ Date _____ Per _____ Handout #5

WHY DOESN'T OIL DISSOLVE IN WATER?

Modified from Saundra Sample's post on Office of DOE Science Education's Ask a Scientist, (http://*www.newton.dep.anl.gov/askasci/chem00/chem00278.htm*).

Polar Molecules?

The water molecule is made up of two hydrogen atoms and one oxygen atom. Water, however is known as a polar molecule. This means that certain parts of the water molecule (hydrogen) are slightly positive, and other parts (oxygen) are slightly negative. Here's a little more detail…

What Makes Water a Polar Molecule?

In a water molecule, the oxygen atom attracts electrons from the hydrogen atoms, giving the oxygen a slightly negative charge. As the hydrogen electrons near oxygen, they leave the hydrogen atoms with relatively positive charges.

What Does this Have to Do with Oil?

Unlike the water molecule, oil is made up of long chains of carbon atoms (usually 8 carbon atoms) which do <u>not</u> carry an electric charge. These long, uncharged carbon chains are called *hydrophobic*, or *afraid of water*. Because they carry no charge, there is no attraction between them and the polar, or *charged*, water molecules. That lack of attraction is the reason that oil does not dissolve in water – it two molecules do not bond.

ANALYSIS QUESTIONS

1. **Compare** and **contrast** a molecule of water and a molecule of oil. _____

   _____

2. Based on the reading, what charge can you **infer** an electron to have? _____

3. What property could a molecule have that would help it dissolve in water? _____

   _____

4. You've probably seen salt dissolve in water. Make a **prediction** about the polarity of a salt molecule. _____

Handout #6

VISCOSITY (FLOW RESISTANCE) LAB!

Name _____

Date _____ Per _____

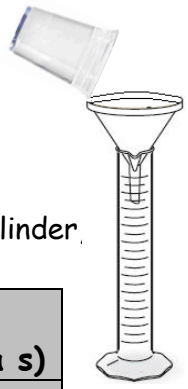
VISCOSITY IS THE RESISTANCE OF A LIQUID TO FLOW. TODAY, YOU'LL SIMULATE MEASUREMENT OF THE VISCOSITIES OF SEVERAL DIFFERENT LIQUIDS.

Materials:

stopwatch cups of liquids funnel
graduated cylinder cleaning brush

Procedures

1. Rest the funnel in the graduated cylinder and pick one liquid to start with (NOT honey).
2. Start pouring the liquid into the funnel. Start the timer as soon as you start pouring. (Be careful not to overflow)!
3. When the graduated cylinder is filled to the 30 mL mark, stop the timer.
4. Record your time in the chart below.
5. Clean out the graduated cylinder with the brush and rinse out the funnel.
6. Repeat steps 1 through 5 for the remaining liquids.
7. CLEAN UP! (Pour out the extra liquids, throw away the cups and wash the graduated cylinder, brush and funnel).



Liquid	Time to Pour	Viscosity Rating (1–Most Viscous, 5-Least Viscous)	ACTUAL VISCOSITY (mPa s)
WATER			
HONEY			
CANOLA OIL			
SYRUP			

QUESTIONS

1. Which liquid had the HIGHEST viscosity (most flow resistance)? The LOWEST viscosity? _____

_____

2. Which liquid do you think would be easiest to clean up in water? _____

Why? _____

For the following questions, use the information below.

Light crude oil is liquid petroleum that has a low density and flows freely at room temperature. Light crude oil receives a higher price than heavy crude oil on commodity markets because it produces a higher percentage of gasoline and diesel fuel when converted into products by an oil refinery.

Heavy crude oil or extra heavy crude oil is any type of crude oil which does not flow easily. It is referred to as "heavy" because its density or specific gravity is higher than that of light crude oil. This mostly results from crude oil getting degraded by being exposed to bacteria, water or air resulting in the loss of its lighter fractions while leaving behind its heavier fractions.

Adapted from http://oilgasglossary.com

1. Which type of oil, light or heavy, do you think has a HIGHER viscosity? _____

Why do you think so? _____