Anglophone School District - North

Grade 7 Science - Unit Lesson Guide

Fluids

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The Aim of Science Education - Scientific Literacy

The aim of science education in the Atlantic Provinces is to develop scientific literacy.

Scientific Literacy is an evolving combination of the science-related attitudes, skills, and knowledge students need to develop inquiry, problem-solving, and decision-making abilities; to become lifelong learners; and to maintain a sense of wonder about the world around them. To develop scientific literacy, students require diverse learning experiences that provide opportunities to explore, analyze, evaluate, synthesize, appreciate, and understand the interrelationships among science, technology, society, and the environment.

The Three Processes of Scientific Literacy

An individual can be considered Scientifically Literate when he/she is familiar with, and able to engage in, three processes: Inquiry, problem solving, and decision making.

Inquiry

Scientific inquiry involves posing questions and developing explanation for phenomena. While there is a general agreement that there is no such sing as the scientific method, students require certain skills to participate in the activities of science. Skills such as questioning, observing, inferring, predicting, measuring, hypothesizing, classifying, designing experiments, collecting data, analysing data, and interpreting data are fundamental to engaging science. These activities provide students with opportunities to understand and practise the process of theory development in science and the nature of science.

Problem Solving

The process of problem solving involves seeking solutions to human problems. It consists of proposing, creating, and testing prototypes, products, and techniques to determine the best solution to a given problem.

Decision Making

The process of decision making involves determining what we, as citizens, should do in a particular context or in response to a given situation. Decision-making situations are important to their own right, and they also provide a relevant context for engaging in scientific inquiry and/or problem solving.

Science Assessment Overview

Science is a hybrid term that houses different disciplines such as: Physics, Chemistry, Biology, Environmental Studies, Engineering, Math, etc. Given this broad spectrum, it is not realistic that we can paint science assessment with a single brush in terms of probes that work for every science activity. However, regardless of school subject, let alone science, the frequency of assessment should be unbalanced with formative assessment occupying 80% of practise and summative with the remaining 20%.

80% Formative - 20% Summative

Formative Assessment
Formative assessment is a range of formal and informal assessment procedures employed by teachers during their learning process in order to modify teaching and learning activities to improve student attainment. It typically involves qualitative feedback (rather than scores) for both students and teacher that focuses on the detail of content and performance. Feedback is the central function of formative assessment. It typically involves a focus on the detailed content of what is being learnt.

Science Formative Assessment falls into 2 distinct categories, and they are divided about how feedback is given. Please be aware that an activity could be informal or formal, it is the purpose of the task that determines purpose.

Informal Formative
Informal Formative Science Assessment acts as a monitoring probe and is distinct because it is not graded.

Formal Formative
Formal Formative Science Assessment provides specific feedback to students, the teachers corresponds via anecdotal feedback, rubrics, and written responses to offer progress to student attainment.

Summative Assessment
Summative assessment seeks to monitor educational outcomes, often for the purposes of external accountability. Usually occurring at the end of a learning unit and determines if the content being taught was retained.

Fluids

Focus and Context

The focus of this unit is on the inquiry process. Students will also have the opportunity to design and carry out activities based on fluids. The context is the students' knowledge and use of fluids and buoyancy. Ocean-going vessels and oil rigs provide a context to investigate why some things sink and some things float.

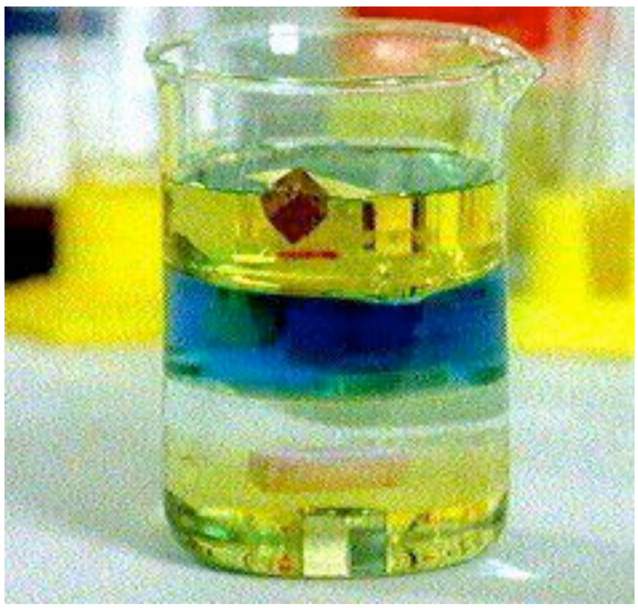


Image source: www.wsd1.org/pc_science/

Unit Instructional Overview

Floating and Sinking-Density	Forces in Fluids*	Viscosity of Liquids
Activity -Access to Prior Knowledge	2nd Cycle -Make a Cartesian Diver Activity	Comparing Viscosity Investigation
1st Cycle - Sinking and Floating Objects	3rd Cycle -Quantify the Forces Activity	Modifying Viscosity Investigation
Layered Liquids		
Archimedes Principle Activity	Build Your Own Dynamometer	Relating Fluid Dynamics to Everyday Life
Temperatures affect on Density Activity	Understanding Pascal's Principle and Hydraulics	
Density Changes in Nature	Investigating Pressure Changes	
Design Your Own Density Investigation		

* - EECD Grade 8 Inquiry package - available at https://portal.nbed.nb.ca/tr/lr/k-8Science/Pages/default.aspx

Fluids - Curriculum Outcomes

Floating and Sinking- Density	Forces in Fluids	Viscosity of Liquids
307-8 describe the relationship among mass, volume, and density of solids, liquids and gases using the particle theory of matter	309-2 describe the movement of objects in terms of balanced or unbalanced forces	307-6 compare the viscosity of various liquids
210-7, 307-11 analyse quantitatively the density of various substances and suggest explanations for discrepancies in data, such as the measurements of the volume of irregular object by water displacement	210-13 test and compare a student-constructed dynamometer with a commercial dynamometer	208-6 design an experiment to test the viscosity of various common fluids and identify the major variables
	210-14 calibrate a student-constructed dynamometer with known masses	
307-9 explain the effects of changes in temperature on the density of solids, liquids and gases and relate the results to the particle model of matter	309-1 describe qualitatively the difference between mass and weight	307-7 describe factors that can modify the viscosity of a liquid: temperature concentration
307-10 describe situations in life where the density of substances naturally changes or is intentionally changed	111-1 provide examples of technologies that have been developed because of our understanding of density and buoyancy	209-3 use a temperature-measuring technology effectively and accurately for collecting data in temperature-viscosity investigations
208-2 identify questions to investigate arising from practical problems involving floating, sinking, and density	309-3 explain quantitatively the relationship between force, area, and pressure: pressure(Pascal)=force(N)/ area(m2) investigate and solve problems involving Pascal's principle	209-7 demonstrate a knowledge of WHMIS standards by demonstrating the correct methods of disposal of various oils, for example
208-6, 211-3 Work cooperatively with team members to design an experiment and identify major variables in order to investigate floating, sinking, and density	111-5 describe the science underlying hydraulic technologies	109-10, 112-7, 210-12 identify and relate personal activities and potential applications to fluid dynamics
	309-4 explain qualitatively the relationship among pressure, volume, and temperature when liquid and gaseous fluids are compressed or heated	

Fluids

Strand - Floating and Sinking - Density

General Curriculum Outcomes	Specific Curriculum Outcomes
307-8 describe the relationship between the mass, volume, and density of solids, liquids, and gases using the particle model of matter	307-8 describe the relationship among, mass, volume, and density of solids, liquids and gases using the particle model of matter
210-7 identify, and suggest explanations for, any discrepancies in data	210-7, 307-11 analyse quantitatively the density of various substances and suggest explanations for discrepancies in data, such as the measurements of the volume of irregular objects by water displacement.
307-11 analyse quantitatively the density of various substances	
307-9 explain the effects of changes in temperature on the density of solids, liquids, and gases and relate the results to the particle model of matter	307-9 explain the effects of changes in temperature on the density of solids, liquids, and gases and relate the results to the particle model of matter
307-10 describe situations in daily life where the density of substances naturally changes or is intentionally altered	307-10 describe situations in life where the density of substances naturally changes or is intentionally changed
208-2 identify questions to investigate arising from practical problems and issues	208-2 identify questions to investigate arising from practical problems involving floating, sinking, and density
208-6 design an experiment and identify major variables	208-6, 211-3 work cooperatively with team members to design an experiment and identify major variables in order to investigate floating, sinking and density
211-3 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise	

Science Resource Package: Grade 8

Fluids: Forces in Fluids

New Brunswick Department of Education

September 2009

Prior Knowledge:

In grade 6, students learn about Bernoulli's principle as applied to air.

Students were exposed to the particle model of matter in grade 7 and have continued to expand on this in grade 8. Students should understand that all matter is made up of particles and that particles are continuously in motion.

Grade 8 students have learned about density of fluids in the current unit.

Common Misconceptions:

MISCONCEPTION	FACT
"Gases are not fluids because they are not liquids"	Gases are fluids. A fluid is any substance that is able to flow.
"Heavy things sink and light things float"	Things that appear heavy may, in fact, have a low average density. (For example, a ship which contains a large volume of air.)

Did You Know?

Density is the "crowdedness" of particles, or more properly, the amount of a substance that occupies a particular space.

Average density: the total mass of all substances in a given volume divided by the total volume. For example, when the weight of the ship and cargo is spread out over a large enough volume, the ship's average density is less than the density of the water.

Archimedes' principle: the **buoyant force** acting on an object equals the **weight** (force of gravity) of the fluid displaced by the object. The **volume** of an object is equal to the **volume** of fluid displaced by the object.

Buoyancy: the tendency of an object to rise or float in fluids, the ability of a fluid to support an object floating in or on the fluid. The particles in a fluid exert a force in a direction opposite to the force of gravity.

Floating: when an object does not fall in air or sink in water, but remains suspended in the fluid

Instructional Plan

Access Prior Knowledge

- In small groups, have students brainstorm and record a list of things that float and another list of things that sink
- Have students discuss this in pairs or small groups before sharing ideas with the whole class.
- Then as a whole class, share one item from each group and record on the board or on chart paper. Continue until all ideas are shared.
- Accept all ideas and record them in a way so these ideas can be revisited in later lessons. If students disagree with each other, allow them to express their thinking and reasons to each other. See supporting discussion tips on pages 14-15.
- Ask students if the items can be clustered as to why they sink or float. Cluster items with a card indicating why they have been placed together.

You could have students print ideas on index cards or on pieces of paper with markers. These can be tacked to a bulletin board as they are shared and are easy to move around for the clustering part of the activity.

✓ **Assessment:**
Note the concepts and misconceptions students are expressing. You will need to know these to plan effective questions for subsequent activities and discussions so that students will examine and adjust their alternate conceptions.
Notice what sorts of examples students came up with. What reasons are being given for why specific items sink or float?

Post student versions of curricular outcomes on chart paper (see page 17). Inform students that these outcomes will be addressed over the next portion of the unit. Point out to students which outcomes are being addressed in each activity.

🚲 1st Cycle

✪ Curriculum Outcomes

208-6 Design an experiment and identify major variables.
210-13 Test the design of a constructed device or system.
210-14 Identify and correct practical problems in the way a prototype or constructed device functions.
211-3 Work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise.

Sinking and Floating Objects

Materials:
Tin foil
Modelling clay
Wax paper
Water
Container to test shapes – one large container to share or smaller containers for each group
Paper towels

Provide students with a variety of substances (tin foil, modelling clay, wax paper) and ask them to create shapes from each and explore if the shapes will sink or float. They can draw pictures that show the shapes they made and whether the shape sank or floated. A possible recording sheet is given on page 20.

✓ Assessment:

During student activity, make notes on outcomes (or parts of outcomes) you observe being addressed. Process skill outcomes are part of the curriculum and should be assessed. Using the observation chart or the checklist (on pages 23-25) on a clipboard may be helpful to you. Develop your own code for quick notes.

A suggested code:
√ observed and appropriate,
WD with difficulty,
RTT refused to try,
A absent.

This chart may be used on multiple days, using a different coloured pen or pencil each day and putting the date in the corner. You may not have a symbol or note for every child every day. Some teachers like to focus on a group or two each time. However you choose to make note of your observations, you will always have a sense of who you need to take more notice of and who might need extra support. The information will also help you when it is reporting time.

Reflection: Class Discussion

- First ask students to discuss and record in their small groups:

What characteristics are necessary to have a sinking object?
What characteristics are necessary to have a floating object?

- Have groups share these ideas with the whole class to come up with an overall list of requirements for each. Record student ideas on chart paper.

The Explore Learning site has simulations called Gizmos. The simulations may be useful to test student generalizations arising during the discussion.

The link below is to a "Gizmo" on Archimedes Principle. The Gizmo allows the width, height and length of a "boat" to be adjusted, weights to be added and the density of the fluid to be changed.
http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=603
This is an excellent resource for showing students how these factors affect whether something floats or sinks. This also provides a visual way to explain "average density".
The "Gizmo" site allows unregistered users to run each Gizmo for 5 minutes a day. It is also possible to sign up for a free trial. Membership is not free.

- Revisit the sinking and floating ideas created in the Accessing Prior Knowledge activity (page 4). Ask: *Are there any items that should be added to or revised. Is there other information we could add?* Remind your class about respectful discussion. The discussion tips on pages 14-15 may be helpful.

Reflection: Journaling

Have students explain floating and sinking with these sentence starters.

Objects will float when . . .

Objects will sink when . . .

> ✓ **Assessment:**
> Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective.
>
> When reading the journal entries, note which students are using appropriate characteristics to explain sinking and floating.

Sinking and Floating Objects

Material	Draw shape	Sink or Float?

Layered Liquids

Outcomes:
307-11 Analyze quantitatively the density of various substances
211-3 work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise
209-3 use instruments effectively and accurately for collecting data
208-5 state a prediction and hypothesis based on an observed pattern of events

Objectives:
- Layer the four liquid samples and explain their results
- Determine the layered position of the fifth, unknown, liquid based on its density, which they will calculate

Materials:
- Water
- Food Coloring (one color)
- Corn Syrup
- Tall, Clear, plastic containers (Empty water bottles, approximately 500 ml capacity)
- Beakers or graduated cylinders
- Paper cups
- Balances
- Calculators
- Maple syrup
- Vegetable oil
- Dishwashing detergent
- Mineral oil

Inquiry Lesson:
1. Begin the preliminary demonstration by showing the class a two layered liquid “parfait”: water floating on corn syrup. (The effect is more dramatic if you first mix a little food coloring into the water and if you let students see you pour the two liquids carefully together.) Ask,
    - Why do you suppose these liquids form into two layers?

   Accept divergent answers, but help students see that density is the reason.

2. Working together in small, cooperative groups, students begin by measuring out 100 ml each of four different liquids: water, maple syrup, vegetable oil, and dishwashing detergent. Samples must be poured into identical containers (because their masses will be compared); paper cups work well. Students should list the substances by sample number on Activity Sheet 1, Table 1.

3. Next, students predict the order of the layers that the four samples will form when poured carefully into the same jar. Which will be on top, and so on? They should record their predictions in Activity Sheet 1, Table 2.

4. Using a balance, students measure the mass of each of the samples. (This is why they need to be in identical containers; subtract the mass of the cup, weighed when empty, from the mass of each cup when filled with the liquid sample.) Students should record all data on Activity Sheet 1, Table 3.

5. Students should calculate the density of each liquid (mass divided by volume: 100 ml each). Then they should record the densities and again predict the order of the layers that will form when the four samples are poured into the same container (using Activity Sheet 1, Table 4). Ask students,
   - Did your predictions change? Why or why not?

6. Students should carefully pour the liquids into a single, tall, clear container, one at a time over a spoon so that they don't mix. Then they record the results of the layering effect in Activity Sheet 1, Table 5.
   - Explain your results, particularly in relation to your predictions.

7. Before having students pour out their samples, try this method of performance assessment and/or application of concepts. Each group receives a fifth liquid sample (for instance, mineral oil; again 100 ml in an identical paper cup). Students must determine where in the layered column the liquid will come to rest by measuring its mass, calculating its density, and using the density to predict correctly (in Activity Sheet 1, Table 6). Then students can pour the fifth liquid into the column to check their calculations, analysis, and prediction. They can write science journal entries about how density affects floating and sinking.

Extension:
1. Groups can place some small objects (pieces of wood, cork, rock, eraser, wax, fruit, plastic, metal, etc.) into the layered column (from Procedure 6), predicting where each will come to rest. Students will see that density applies to solid as well as liquid matter.

Discussion Questions:
1. What does density have to do with Sinking and Floating?

2. If you tried the layering activity aboard the space shuttle in outer space, would the results differ, and if so, how? (The liquids are weightless, so no layers form.) What if you tried the activity on the surface of the Moon? (The liquids would have the same layers as on Earth, despite lower gravitational pull.)

3. Can you think of any jobs that might involve the concept of density, sinking, and/or floating? Explain your answer for each job that you can name.

Assessment:

1. Were students able to successfully layer the liquid samples? (Use observations made during Procedures 2-6 as performance assessments.)

2. Were students predictions correct? If so, could students explain why? if not, could they explain why not? (Use Activity Sheet 1 as a performance assessment, and use responses to Discussion Questions 1-3 as embedded evidence or as writing prompts for science journal entries.)

3. Could students successfully determine the layered position of the fifth liquid, and did they explain how they arrived at their answer? (Use observations made during Procedure 7 as a performance assessment, and use students analysis of that procedure as a prompt for a science journal entry.)

Rubric:

	Developing 1	**Proficient 2**	**Exemplary 3**
Were students able to successfully layer the liquid samples?	Attempted to layer but were unsuccessful	Successfully measured and layered their liquid samples	Successfully measured and layered their liquid samples and took a leadership role in data collection and analysis
Were student predictions correct? If so, could students explain why? If not, could they explain why not?	Attempted to explain their predictions and results but were not able to do so to any significant extent	Effectively explained their predictions, whether accurate or not, in terms of their data and results	Effectively explained their predictions, whether accurate or not, in terms of their data and results, and used math concepts as part of their explanation
could students successfully determine the layered position of the fifth liquid, and did they explain how they arrived at their answers?	Attempted to predict the position of the unknown liquid but were not successful	Successfully predicted the position of the unknown liquid	Successfully predicted the position of the unknown liquid and were able to explain their rationales using math concepts and data examples

Activity Sheet 1

Layered Liquids

Table 1

Samples	Which Substances?
1	
2	
3	
4	

Prediction 1: In what order will the sample layers end up?

Table 2

Layer Order	Sample	Substance
Top Layer		
Second Layer		
Third Layer		
Bottom Layer		

Table 3

Sample	Substance	Mass (g)	Volume	Mass/Volume	Density
1			100 ml	/100 ml	
2			100 ml	/100 ml	
3			100 ml	/100 ml	
4			100 ml	/100 ml	

Table 4

Layer Order	Sample	Substance
Top Layer		
Second Layer		
Third Layer		
Bottom Layer		

Results:

Table 5

Layer Order	Sample	Substance
Top Layer		
Second Layer		
Third Layer		
Bottom Layer		

Explain your results:

Data for Sample 5:

Table 6

Sample	Substance	Mass (g)	Volume	Mass/Volume	Density
5			100 ml	/100 ml	

Prediction: Where will the Sample 5 layer be in relation to the other four samples, and how do you know?

Results, using Sample 5:

Archimedes Principle Activity

Outcomes:
307-11 analyse quantitatively the density of various substances
210-7 and suggest explanation for, any discrepancies in data, such as the measurement of the volume of irregular objects by water displacement
309-1 describe qualitatively the difference between mass and weight

Lesson Activity Overview
The focus of this lesson is on calculating density of irregular objects. The generation of number data is the quantitative piece that the outcome refers to. Students should have knowledge from Math of how to calculate volume of regular shaped objects, so given the mass they should be able to calculate volume. D=M/V

There should be a conversation related to the difference between mass and weight. Student often confuse the two terms and they should be able to distinguish between them. For the purpose of this lesson, students should understand that mass is measure in g or kg. Later, working with dynamometers students will investigate weight in Newtons.

Next students can determine the volume of regular or irregular shaped objects that sink and float, using a graduated cylinder. The reference to Archimedes is not a major focus of the lesson, although it can be mentioned. Students should spend a significant part of the lesson measuring volume, determining mass and calculating density from their measurements.

Activity
1. Use a beaker of water and a balance to determine the density of a irregular shaped object. (307-11)

2. Determine the volume of water displaced by irregular-shaped objects and compare results with other groups. Suggest why some measurements vary. (210-7, 307-11)

Discussion
Students can discuss possible reasons for discrepancies in volume reading when using the water displacement method for determining the volume of an irregular solid. So emphasis should be placed on reporting honestly.

Journal
How could you explain the difference between mass and weight to an elementary student? (309-1)

Assessment:Informal Formative
Ensure that students have correctly calculated density of regular shaped objects 307-11

Ensure that students have been involved in conversations that distinguish mass and weight 309-1

Ensure that students have participated in discussion related to reasons for discrepancies in volume when using water displacement 210-7

Assessment:Formal Formative
Ensure that students have correctly determined the density of irregular shaped objects via displacement of water 307-11

Ensure that students have correctly determined the mass of objects using a balance 307-11

Ensure that students have correctly calculated Density 307-11

1. Using the formula for calculating density, solve the following.
Density=Mass/Volume

A. Mass = 5kg
Volume = 20L

B. Mass = 45g
Volume = 90ml

C. A cube that has a mass of 150g has a side that measures 5cm. Determine the density of the cube.

D. A regular shaped object has sides of 10 cm, 14 cm and 7cm. This object has a mass of 210g. Determine the density of this object.

Calculations of Irregular Shaped Objects

Object 1	Object 2	Object 3
Name of Object	Name of Object	Name of Object
Measurement of Water Displacement (ml)	Measurement of Water Displacement (ml)	Measurement of Water Displacement (ml)
Balance Reading of Mass (g)	Balance Reading of Mass (g)	Balance Reading of Mass (g)
Calculation of Density (g/ml)	Calculation of Density (g/ml)	Calculation of Density (g/ml)

Temperatures affect on Density Activity

Outcomes:
307-9 explain the effects of changes in temperature on the density of solids, liquids, and gases and relate the results to the particle model of matter

Lesson Activity Overview
The intent of this outcome is for students to understand how the density will change based on temperature change

Similar to the work done in Learning Cycle 1 activity sinking and floating objects, students should have the option to explore how density will change given temperature change.

Purpose: In each of the following activities, students will drop an object into the cylinder filled with liquid. Students will predict what they thing will happen in each activity, they will record their observations as it is taking place, and they will explain what actually happened.

Instructional Options:
Activity 1 - POE objects in water (Use the same object, vary temperature of water by + and - 10 degrees)

Activity 2 - POE Hydrometer (Use the same liquids, vary the temperature of ONE liquid by + and - 10 degrees)

After students have worked with materials and have predicted what they thought would happen and have thus explain what they have learned from what was observed, some focus should be placed on the Particle Theory of Matter. Students should explain in terms of how particles are behaving.

Activity
Using a sketch/cartoon, have students illustrate the volume of a gas at different temperatures using the particle model of mater. (307-9)

Use sketches or models to illustrate what happens to the densities of solids, liquids and gases when they are subjected to temperature changes (particle model of matter). (307-9)

Assessment:Informal Formative
Ensure that students have participated in activities related to temperatures affect on density 307-9

Assessment:Formal Formative
Ensure that students have completed activity 1 related to varying the temperature of the liquid and that answers are acceptable 307-9

Ensure that students have completed activity 2 related to varying the temperature of the various liquids and that answers are acceptable 307-9

Ensure that students have created some sort of sketch that explains the how particles are behaving under various conditions. 307-9

Activity 1 - Same Object, Same Liquid, Different Temperatures

Control	**-10ºc**	**+10ºc**
Drop an object into a cylinder of water at room temperature	Drop the same object into the same cylinder but lower the temperature by **10ºc** from the starting temperature	Drop the same object into the same cylinder but raise the temperature by **10ºc** from the starting temperature
Predict	Predict	Predict
Observe	Observe	Observe
Explain	Explain	Explain

Activity 2 - Same Object, Various Liquids, Different Temperatures

Control	**-10^{o}c**	**+10^{o}c**
Drop an object into a Hydrometer of various liquids at room temperature	Drop the same object into the same hydrometer but lower the temperature by **10^{o}c** from the starting temperature	Drop the same object into the same hydrometer but raise the temperature by **10^{o}c** from the starting temperature
Predict	Predict	Predict
Observe	Observe	Observe
Explain	Explain	Explain

Density Changes in Nature

Outcomes:
307-10 describe situations in life where the density of substances naturally changes or is intentionally changed

Lesson Activity Overview
This should be a brief exploration about Hot air balloons, submarines, and scuba gear are a few examples of situations that may be used to study and eventually describe how the density of some substances changes or is changed. Students can investigate situations in nature where the density of substances change naturally such as in fish (air bladders) and ice.

Activity
Create a mural that illustrates everyday uses of technologies and living things in which the density of substances are changed naturally or intentionally. (307-10)

Assessment:Informal Formative
Ensure that students have participated in conversations and activities related to density naturally changing 307-10

Assessment:Formal Formative
Ensure that students have created an illustration depicting density of substances changed naturally or intentionally. 307-10

Design Your Own Density Investigation

Outcomes:
208-2 Identify questions to investigate arising from practical problems involving floating, sinking, and density
211-3 work cooperatively with team members
208-6 to design an experiment and identify major variables in order to investigate floating, sinking and density

Lesson Activity Overview
Based on the work that students have done in previous explorations in this section, students should be challenged to design an investigation. Be careful that students do not just recreate an investigation from one of the 4 previous lessons. Variables such as the shape and mass distribution of the object can be explored and tested. Students should work co-operatively with team members to design and test questions.

*Hint - a way to get a round the "group mark" is to have each student create a different question (208-2) and then have the group design and text the experiment (208-6, 211-3) .

Assessment Possibilities
Checklist/Rubric on the planning and design of an experiment. (208-6, 211-3)

Do group and self-assessment of the work to design an experiment based on floating and sinking. (206-6, 211-3)

Assessment:Informal Formative
Ensure that students participate in a group experiment related to density 211-3

Assessment:Formal Formative
Ensure that students have identified a questions to investigate related to density 208-2

Ensure that students have designed an experiment and have identified and controlled major variables 208-6

Design Your Own Density Investigation

208-2	Identify questions to investigate arising from practical problems involving floating, sinking, and density

Hypothesis	Predict what you think will happen based on your prior knowledge
I expect....because....	

208-6 Identify Variables	
Variables to Control	Variable to Test

208-6	Design an experiment related to Density

Record Observations

Conclusions

Fluids

Strand - Forces in Fluids

General Curriculum Outcomes	Specific Curriculum Outcomes
309-2 describe the movement of objects in terms of balanced and unbalanced forces	309-2 describe the movement of objects in terms of balanced and unbalanced forces
210-13 test the design of a constructed device or system	210-13 test and compare a student-constructed dynamometer with a commercial dynamometer
210-14 identify and correct practical problems in the way a prototype or constructed device functions	210-14 calibrate a student-constructed dynamometer with known masses
309-1 describe quantitatively the relationship between mass and weight	309-1 describe qualitatively the difference between mass and weight
111-1 provide examples of scientific knowledge that have resulted in the development of technologies	111-1 provide examples of technologies that have been developed because of our understanding of density and buoyancy
309-3 describe quantitatively the relationship among force, area, and pressure	309-3 explain quantitatively the relationship between force, area, and pressure - pressure (Pascal) = force (N)/area(m2) - investigate and solve problems involving Pascal's principle
111-5 describe the science underlying particular technologies designed to explore natural phenomena, extend human capabilities, or solve practical problems	111-5 describe the science underlying hydraulic technologies
309-4 explain qualitatively the relationship among pressure, volume, and temperature when liquid and gaseous fluids are compressed or heated	309-4 explain qualitatively the relationship among pressure, volume, and temperature when liquid and gaseous fluids are compressed or heated

🚲 2nd Cycle

✪ Curriculum Outcomes

210-13 Test the design of a constructed device or system.
211-3 Work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise.
309-2 Describe the movement of objects in terms of balanced and unbalanced. forces.

Make a Cartesian Diver Activity

Although this activity can be found on page 149 of the *SCIENCEPOWER 8* resource, an alternate method is detailed below.

Materials:
2 litre pop bottle
Plastic pipette or ballpoint pen coverMetal nuts or modelling clay

Method:
Using a pipette:

- Cut off the stem of the pipette, about 2 cm under the bulb.
- Slip at least one nut onto the end of the pipette – depending on the size of the nuts, it might be necessary to use a glue gun to keep the nut in place.
- Place the pipette into a glass of water, and squeeze some of the air out so that it just barely floats. Ideally, this should happen when the water level inside the bulb is approximately ¼ to ½ of the bulb – the diver is now ready to be used. If it takes too much water to make it sink, or it will not sink at all, add an additional nut to the end of the pipette.

Alternative to pipette:

- Place some modeling clay on the ballpoint pen cover (see photo). The cover must not have holes in it.

Then:

- Completely fill the pop bottle with water, and then add the diver to the bottle.
- Screw on the lid of the bottle, and squeeze the sides of the bottle.
- Record observations

✓ Assessment:

On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection: Discussion

- Have students discuss first in small groups. *Why did the diver float at the beginning? What changed?*

(The pressure was increased by pressing on the bottle forcing more water into the diver. The diver becomes heavier, and overcoming the buoyant forces, sinks. When the pressure is released, the extra water in the diver comes out, the diver is lighter, and it rises).

- Have students draw a diagram showing the forces acting on the diver (gravity - down, buoyancy- up)
- Share diagrams and discuss as a class.

Students should be getting the idea that when something sinks, the force of gravity is greater than the buoyancy force. When something floats, the buoyancy force is greater than the force of gravity. When something neither sinks nor floats, the forces are balanced.

- Revisit the sinking and floating ideas created in the Accessing Prior Knowledge activity (page 4). Ask: *Are there any items that should be added to or revised. Is there other information we could add?* Remind your class about respectful discussion. The discussion tips on pages 14-15 may be helpful.

✓ **Assessment:**

Students can draw diagrams of real situations that use arrows to show the magnitude and direction of forces when:

a) an object sinks
b) an object floats
c) an object is suspended in a liquid

(See diagrams on page 151 of *SCIENCEPOWER 8* resource) Note if students have the idea of two forces in opposition (gravity and buoyancy) and their relationship to floating and sinking.

- The story of Archimedes

Use the story of Archimedes (beginning at page 27) to introduce Archimedes' principle and give some perspective on the history of the development of scientific thought.

The following site has simulations. The link is to a "Gizmo" on *Determining Density via Water Displacement*. Use this simulation to measure volume in much the same way as Archimedes. http://www.explorelearning.com/index.cfm?method=cResource.dspView&ResourceID=400 The "Gizmo" site allows unregistered users to run each Gizmo for 5 minutes a day. It is also possible to sign up for a free trial. Membership is not free.

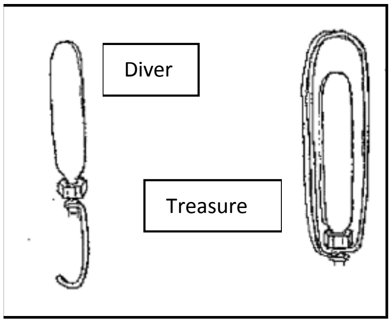
- Video

The Bill Nye video "Buoyancy" is a good summary video at this point. It can be found at http://learning.aliant.net/school/index.asp Type buoyancy into the search box. When you click on the picture, the video will start with a table of contents to the right of it. Note that you can click on any part of the contents list to go to that portion. There is no need to view the entire video. (You need to register to use the videos on the Aliant site. Registration is free. If you try to watch the video without logging in, you are prompted to do so.)

Extension idea:

Make your Cartesian diver pick up sunken treasure. This slight variation provides students with the challenge of picking up a sunken diver.

- Students will need to add a short piece of wire to their Divers. The wire should be twisted around the stem of the pipette while the rest of the wire is bent into a hook. This may require some Crazy Glue.
- The Treasure is similar to the diver, where a pipette is cut about 1cm above the bulb and a nut is added. Using a longer piece of wire than that used for the diver, twist it around the stem, make a loop over the top of the bulb, and then twist the other end of the wire around the stem. It can be glued in place.
- Place the treasure on the bottom of the pop bottle. The diver still barely floats. *Can you make your diver descend and pick up the treasure?*



Cartesian Diver

Materials:

2 litre pop bottle
Plastic pipette or ballpoint pen cover (without holes)
Metal nuts or modeling clay

Method:

- Cut off the stem of the pipette, about 2 cm under the bulb. Slip at least one nut onto the end of the pipette – depending on the size of the nuts, it might be necessary to use a glue gun to keep the nut in place.
- Place the pipette into a glass of water, and squeeze some of the air out so that it just barely floats. Ideally, this should happen when the water level inside the bulb is approximately ¼ to ½ of the bulb – the diver is now ready to be used. If it takes too much water to make it sink, or it will not sink at all, add an additional nut to the end of the pipette.
- **Alternative to pipette**: place some modeling clay on the stem of the ballpoint pen cover. The cover must not have holes in it.
- Completely fill the pop bottle with water, and then add the diver to the bottle. Screw on the lid of the bottle, and squeeze the sides of the bottle.

Record observations:

Why did the diver float at the beginning?

What changed?

🚲 3rd Cycle

✪ Curriculum Outcomes

209-3 Use instruments effectively and accurately for collecting data.
211-3 Work co-operatively with team members to develop and carry out a plan, and troubleshoot problems as they arise.
307-10 Describe situations in daily life where the density of substances naturally changes or is intentionally altered.
309-2 Describe the movement of objects in terms of balanced and unbalanced forces.

Quantify the Forces Activity

Students will explore the forces acting on a weight and other objects in a variety of liquids.

This activity can be set up in stations to limit the amount of materials required and can be done in 2 parts or as one activity. Each station can have a different type of liquid to test. Students can move from station to station floating/sinking objects and measuring the buoyant force with the spring scales.

Materials:

4 or 5 different fluids of varying densities - pop, molasses (or corn syrup), water, salt water
Plastic cups or other containers for liquids
Spring balances
Objects to test – corks, sections of candles, large metal nuts or washers
Weights (the kind used with pan balances)

Method:

Part 1 – to determine the change in force on a weight in different liquids

- Have students predict and record the liquids from most dense to least dense.
- Have students put a weight/mass on a spring balance, suspend it in air and record the force.
- Have students submerge the weight into each test liquid (e.g. salt water) and make a note of the reading on the spring balance. (a possible recording sheet is given on page 20.

Part 2 – to test the floating and sinking of different items in those fluids (differences in density)

- Based on the results in part 1, have students predict whether different items such as a cork, a piece of candle and a metal nut or washer will sink or float in each liquid.

- Have students test their prediction and record their observations (suggested recording sheet on page 21).

> ✓ **Assessment:**
> On observation chart (or other record), note how students are performing on the skill outcomes.

Reflection

Alternate between small group and whole class discussions as these items are discussed:

- Have students share diagrams of the forces acting on the mass in each liquid. Ask: *How do we know the forces are different in different liquids? What are these forces acting on – the spring balance or the objects?*

- Have students rank the liquids from the liquid with the most buoyant force to the least buoyant force. Can they justify the rankings?

- Have students rank the liquids from the liquid that is most dense to the liquid that is least dense. Can they justify these rankings?

- What do they notice about the two lists (buoyant rankings and density rankings)? Ask: *What is the relationship between density and buoyancy?*

- Have students rank the items tested for sinking and floating from most dense to least dense.

- Have students write one sentence that explains how to predict if something will sink or float based on density of the object and density of the fluid.

There are several simulations at http://www.explorelearning.com/index.cfm?method=cResource.dspResourcesForCourse&CourseID=308
which will allow students to explore ranking objects by density by testing whether they sink or float in various liquids. Try "Density via Comparison", "Density", and "Density Laboratory".
The "Gizmo" site allows unregistered users to run each Gizmo for 5 minutes a day. It is also possible to sign up for a free trial. Membership is not free.

- Revisit the sinking and floating ideas created in the Accessing Prior Knowledge activity (page 4). Ask: *Are there any items that should be added to or revised. Is there other information we could add?* Remind your class about respectful discussion.

Reflection: Journaling

Thinking about the cork, metal washer and piece of candle - why did some objects always float, some objects always sink and some do both depending on the liquid they were added to?

or

How would the results of the above experiment change if the same mass used to measure buoyancy was in the shape of a small 1cm cube square?

✓ **Assessment:** Journal entries should not receive a score or mark. A positive comment followed by a question to refocus attention or suggest the next step in learning is very effective. When reading the journal entries, note which students are discussing densities or forces to explain floating and sinking. Students should come away with: if an object is less dense than the fluid in which it is immersed, it will float; if an object is more dense than the fluid in which it is immersed, it will sink.

Where in real life are there situations where density of an object is naturally or intentionally changed?

- Research activity:

Explain _____ using the ideas of density and buoyancy.

Suggestions include: scuba divers, submarines, submersibles, floating docks, hot air balloons

Extension:

Students can make their own dynamometer (similar to the spring scale) to test. (see page 22)

This can be done by using a ruler, a rubber band or spring and a weight (for example, a small bag of nuts, wet sand or anything else heavy).

Attach the rubber band or spring to the top of the ruler either by making a hole in the ruler or by taping it in place. The elastic or spring should stretch at least ¾ down the ruler. A paperclip or paper arrow pointer can be used to mark the changes in the force in different liquids.

Quantify the Forces Activity

Part 1

1) Rank the liquids from what you predict to be the most dense to the least dense before starting the experiments.

2) Put a weight/mass on a spring balance, suspend it in air and record the force.
3) Submerge the weight into each test liquid ensuring the weight does not touch the bottom of the container.
4) Record the reading on the spring balance.

Liquid	Reading on Spring Scale in Air	Reading on Spring Scale in Liquid
Water		
Pop		
Molasses		
Corn Syrup		
Salt Water		

Draw a diagram of the forces acting on the mass in each liquid. Why are the forces different in the different liquids?

Quantify the Forces Activity

Part 2

1) Based on the reading, predict whether different items such as a cork, a piece of candle and a metal nut or washer will sink or float

2) Test your prediction and record your observations.

Liquid	Sink or Float? **Prediction**	Sink or float? **Actual**	Sink or Float **Prediction**	Sink or float? **Actual**	Sink or Float **Prediction**	Sink or float? **Actual**
	Candle	Candle	Cork	Cork	Metal Nut	Metal Nut
Water						
Pop						
Molasses						
Corn syrup						
Salt water						

Build Your Own Dynamometer

Outcomes:
309-2 describe the movement of objects in terms of balanced and unbalanced forces
210-13 test and compare a student-constructed dynamometer with a commercial dynamometer
210-14 calibrate a student-constructed dynamometer with known masses
111-1 provide examples of technologies that have been developed because of our understanding of density and buoyancy
309-1 describe qualitatively the difference between mass and weight

Lesson Activity Overview
This lesson is intended for students to create their own dynamometer and to test their design against a commercial dynamometer. This leads students to understanding the difference between mass and weight, since the measurements will now be in Newtons due to buoyant force.
Use the attached Make a Dynamometer instructions for a student-constructed dynamometer. Students should compare the readings from their dynamometer to a commercial one.

Activity
List and explain the steps taken to calibrate a student-constructed dynamometer to standard masses. (210-14)

Journal
Why does a rock feel lighter in the water? Draw a force diagram to illustrate your answer. (111-1)

Investigate the term "displacement" as it refers to ships and report on your findings. (309-2)

Assessment:Informal Formative
Ensure that students have constructed their own dynamometer

Ensure that students have compared their dynamometer to a commercial one

Assessment:Formal Formative
Ensure that students have explained the steps to calibrate their dynamometer

Ensure that students have journaled about why rocks feel lighter in water

Ensure that students can explain why a ship can float using the term displacement and look for reference to buoyant force.

Make a Dynamometer

Materials:

Ruler
Rubber band or spring
Weight (for example, a small bag of nuts, wet sand or anything else heavy).

Method:

- Attach the rubber band or spring to the top of the ruler either by making a hole in the ruler or by taping it in place. The elastic or spring should stretch at least ¾ down the ruler.
- Attach a paperclip or paper arrow pointer midway down the elastic or spring. This pointer will be used to mark the changes in length of the elastic/spring in different liquids.
- Try it out and make adjustments if necessary.

Understanding Pascal's Principle and Hydraulics

Outcomes:
309-3 explain quantitatively the relationship between force, area, and pressure:
-pressure(Pascal) = force (N)/area (m^2)
-investigate and solve problems involving Pascal's principle
111-5 describe the science underlying hydraulic technologies

Lesson Activity Overview
The connection between the outcome is Pascal's principle. Students should begin by calculating simple question using Pascal's Principle. Then students can begin to solve real world examples once the math is proficient. Of those real work examples, students should be introduced to hydraulics and how it relates to Pascal's Principle.

Students should begin by quantitatively solving problems related to Pascal's Principle on the worksheet. 309-3 Once students are competent in solving using this equation, then the concept of hydraulics should be introduced. Especially how hydraulics work with Pascal's Principle. The concept of the area changing to create a pressure change should be the focus 111-5.

Journal
The technology I have seen that works on Pascal's Principle is a ... It functions in this way (sketch). (111-5)

Why does a barber have to step on or pump the barber's chair in order to make it raise? (111-5)

Explain how a water-spraying toy functions (Pascal's Principle). (111-5)

Sketch
Sketch a simplified hydraulic system and briefly explain its benefits. (309-3)

Assessment:Informal Formative
Ensure that students have participated in discussion related to Pascal's Principle and its relations to pressure and hydraulics 309-3

Assessment:Formal Formative
Ensure that students have adequately completed the worksheet on solving problems related to pressure 309-3

Ensure that students have journaled about ideas related to hydraulics connection to pressure and Pascal's Principle 111-5

1. Using the formula for calculating Pascal's Principle, solve the following.
Pressure(Pascal)=force(Newton)/area(meter^2)

A. Force = 5N
Area = 30m^2

B. Force = 25N
Area = 120m^2

C. How much pressure would be exerted on the floor beneath an object that weighs 800 N and has a base area of 2m^2?

D. A fish tank's bottom has a side that is 1m and the other is 3m. The tank is partially filled with water that is exerting a force of 30N on the bottom surface. What is the pressure exerted?

E. Jim is pushing against a filing cabinet. The side he is pushing against has one side of 2m and the other is 4m. The filing cabinet exerts a force of 245N on the floor. How much pressure will Jim have to exert on the filing cabinet to get it to move?

F. What would happen to the pressure if the weight of the object remained the same but the area of its base were cut in half.

G. How many newtons of force on a stick with a base area of $0.01m^2$ would be required to produce a pressure of 1000 Pascals.

Investigating Pressure Changes

Outcomes:
309-4 explain qualitatively the relationship among pressure, volume, and temperature when liquid and gaseous fluids are compressed or heated

Lesson Activity Overview
The focus of this lesson is to describe how changes occur. Specifically, it is trying to show students the extra things like friction that occur when items interact. There are a variety of items that could be explored or discussed.
"Students should investigate and explore what happens to fluids when the temperature of the fluid is altered. Air-filled balloons and balls may be cooled or placed in warm settings to observe changes in their volume. Students can use tire pressure gauges to measure pressure changes at various temperatures. Students can place their thumbs on the nozzle of a bicycle pump to experience pressure."

Driving Question
Why would a bicycle pump get warm in the air compression chamber when the pump is being used? (309-4)

Class Activity
Using a concept map, show the relationships between pressure, volume and temperature when liquids and gases are compressed or heated. (309-4)

Assessment:Informal Formative
Ensure that students have participated in qualitative explorations related to pressure, volume, and temperature 309-4

Ensure that students have participated in creating a concept map 309-4

Assessment:Formal Formative
Ensure that students have appropriately responded to a questions about pressure, volume, and temperature 309-4

Fluids

Strand - Viscosity of Liquids

General Curriculum Outcomes	Specific Curriculum Outcomes
307-6 compare the viscosity of various liquids	307-6 compare the viscosity of various liquids
208-6 design an experiment and identify major variables	208-6 design an experiment to test the viscosity of various common fluids and identify the major variables
307-7 describe factors that can modify the viscosity of a liquid	307-7 describe factors that can modify the viscosity of a liquid: -temperature -concentration
209-3 use instruments effectively and accurately for collecting data	209-3 use a temperature-measuring technology effectively and accurately for collecting data in temperature-viscosity investigations
209-7 demonstrate a knowledge of WHMIS standards by using proper techniques for handling and disposing of lab materials	209-7 demonstrate a knowledge of WHMIS standards by demonstrating the correct methods of disposal of various oils, for example
109-10 relate personal activities in formal and informal settings to specific science disciplines	109-10, 112-7, 210-12 identify and relate personal activities and potential applications to fluid dynamics
112-7 provide examples of how science and technology affect their lives and their community	
210-12 identify and evaluate potential applications of findings	

Comparing Viscosity Investigation

Outcomes:
307-6 compare the viscosity of various liquids
208-6 design an experiment to test the viscosity of various common fluids and identify the major variables

Lesson Activity Overview
Begin with a discussion related to Viscosity. This term may not be understood by students, so prior knowledge should be explored in a brainstorm.

The intent of the lesson is for students to design an investigation to test viscosity of common liquids under the same conditions.

Use the worksheet attached to guide the lab report.

Assessment:Informal Formative
Ensure that students have participated in discussion that relate to understanding the term viscosity 307-6

Ensure that students have designed an experiment 208-6

Assessment:Formal Formative
Prepare a four-point rubric to assess and evaluate the design and carrying out of an experiment to test the viscosity of various common fluids. (208-6)

Design Your Own Viscosity Investigation

Testable Question	Identify questions to investigate arising from practical problems involving Viscosity

Hypothesis	Predict what you think will happen based on your prior knowledge
I expect....because....	

208-6 Identify Variables	
Variables to Control	Variable to Test

208-6	Design an experiment related to Density

Record Observations

Prepare a graph that communicates the varying viscosity of materials tested. (307-6)

Modifying Viscosity Investigation

Outcomes:
307-7 describe factors that can modify the viscosity of a liquid:
-temperature
-concentration
209-3 use a temperature-measuring technology effectively and accurately for collecting data in temperature-viscosity investigations
209-7 demonstrate a knowledge of WHMIS standards by demonstrating the correct methods of disposal of various oils, for example

Lesson Activity Overview
Using water baths, students can heat various cooking oils to see what effect temperature has on the viscosity of liquids. It is important that students do not heat oils or other similar liquids in a single pot on a heating device as it could cause an oil or grease fire. Thermometers or temperature probes can be used to collect data in this activity. Students should be exposed to good safety and disposal practices when dealing with various liquids other than water. Note whether students assume responsibility for waste disposal procedures as an indicator for a safety in science attitudinal outcome.

Assessment:Informal Formative
Ensure that students have used a temperature-measuring technology effectively and accurately for collecting data 209-3

Assessment:Formal Formative
Ensure that students have completed the Predict Observe and Explain activity

Ensure that students explanations for changes in viscosity related to changes in density of the particles

Interview students during an appropriate activity to ascertain if they can read a thermometer properly. (209-3)

How do students clean up and dispose of oils used in their investigations? (209-7)

Predict Observe Explain

1. Choose a liquids that doesn't flow very fast and pour it into a graduated cylinder. At room temperature, drop an object through the liquid to gain a baseline measurement. Repeat this activity 3 times.

Trial 1	Trial 2	Trial 3
Time	Time	Time
Mean Time		

2. Using a water bath, heat the liquid to a higher temperature.

Predict What You Expect to Happen to the Baseline Time

3. Perform the same activity as #1 with the higher temperature

Temperature ___________ ^{o}C		
Trial 1	**Trial 2**	**Trial 3**
Time	Time	Time
Mean Time		

Explain What You Have Learned

Relating Fluid Dynamics to Everyday Life

Outcomes:
109-10, 112-7, 210-12 identify and relate personal activities and potential applications to fluid dynamics

109-10 relate personal activities in formal and informal settings to specific science disciplines
112-7 provide examples of how science and technology affect their lives and their community
210-12 identify and evaluate potential applications of findings

Lesson Activity Overview
"Opportunities should be made available for students to propose and learn about potential, everyday applications related to the viscosity of liquids. Examples related to the world of cooking may include the various viscosities of such foodstuffs as pancake batter and sugared icing (concentrations). The temperature of an engine oil dictates how quickly it will drain from an engine during an oil change, for example. Students can investigate the preparation of various types of maple syrup and honey products that have various viscosities. Some students may investigate the uses of various motor oils for different engines and different seasons."

<u>UDL Design Activities - Have students choose one of the following to demonstrate their understanding.</u>
Interview a mechanic or a person who works with heavy machinery to find out how they deal with the viscosity of the oils they use at different temperatures. Prepare a short written report. (210-12)

Create a poster showing several liquids that can serve different purposes because of their different viscosities (engine oils, maple syrup, ketchup, ...) (210-12)

Research and report on oil viscosity problems that make pipeline transport of oil a challenge. (109-10, 112-7)

Prepare a presentation on "Why liquids of varying viscosity are needed/used in today's society." (210-12)

Assessment:Informal Formative
Ensure that students have participated in activities related to applications of fluid dynamics

Assessment:Formal Formative
Based on the students choice of task, ensure that it is done appropriately to meet the outcome