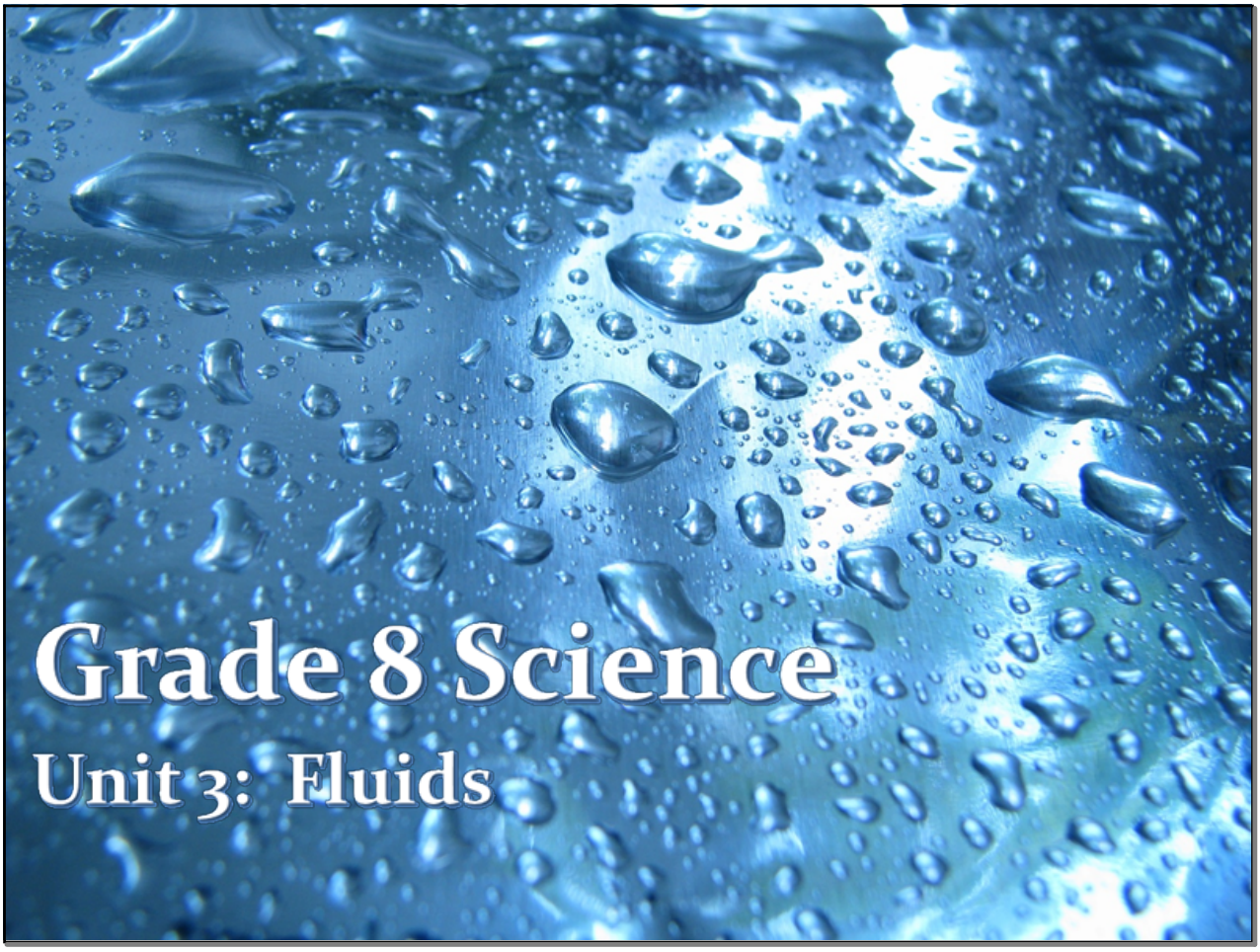
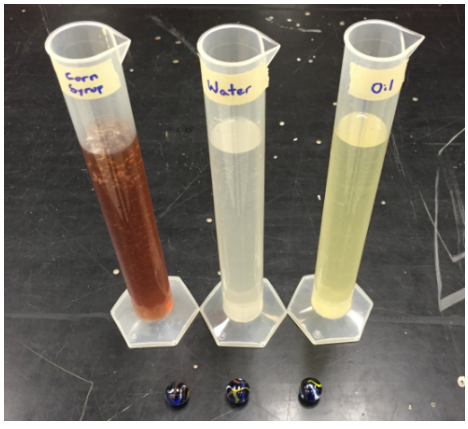


Viscosity

When you look up the definition of viscosity, you will find something along the lines of: *a measure of a fluids resistance to gradual deformation by shear stress or tensile stress*.

This, obviously, will not work for us, so we need to look at what viscosity is. To do that, I would like to start with a demonstration.



Viscosity

In the demonstration we were able to see that the marble sunk at different rates in the different fluids. The property of the fluids that caused this to happen is viscosity. Described in the simplest way, viscosity is the thickness of the fluid. A fluid, like water is very "thin," which meant the marble could easily fall through it. The corn syrup, on the other hand, is very "thick." As a result there was a lot of resistance to the marble dropping.

A "thick" fluid is said to be highly viscous.

A "thin" fluid is said to have low viscosity.

Let's re-arrange these substances to put them in order of increasing viscosity:

Air Water Honey Peanut Butter

Less Viscous → More Viscous

Flow Rate

Another way to understand the idea of viscosity is to look at Flow Rate. To flow means to move in a steady continuous stream, so by measuring the quantity of fluid that moves past a specific area in a specific time, you can determine the Flow Rate.

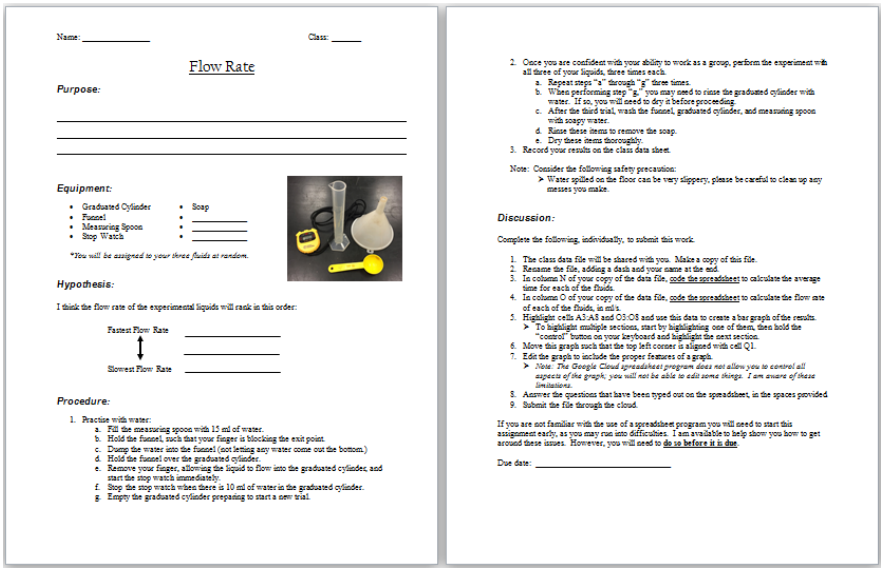
Example: To determine the flow rate of water out of your garden hose simply turn it on and time how long it takes to fill a 2L pop bottle. You can then divide your volume (2L) by the time it took (in seconds) and you have the flow rate in L/s.

When you are comparing different fluids, you will find that a fluid with a high viscosity will have a slower flow rate. The "thickness" of the fluid makes it more difficult to flow.

Can you think about what part of the particle theory might help explain viscosity?

Flow Rate

Next class you will be doing an experiment, measuring the flow rate of a variety of substances. We will use the remaining time today to discuss the experiment, so that when you arrive next class you are ready to start immediately.



Name: _____ Class: _____

Flow Rate

Purpose:

_____
_____
_____

Equipment:

- Graduated Cylinder
- Funnel
- Measuring Spoon
- Stop Watch
- Soap
- _____
- _____
- _____

**You will be assigned to your three fluids at random.*

Hypothesis:

I think the flow rate of the experimental liquids will rank in this order:

Fastest Flow Rate _____
_____
Slowest Flow Rate _____

Procedure:

1. Practise with water:
   a. Fill the measuring spoon with 15 ml of water.
   b. Hold the funnel, such that your finger is blocking the exit point.
   c. Dump the water into the funnel (not letting any water come out the bottom.)
   d. Hold the funnel over the graduated cylinder.
   e. Remove your finger, allowing the liquid to flow into the graduated cylinder, and start the stop watch immediately.
   f. Stop the stop watch when there is 10 ml of water in the graduated cylinder.
   g. Empty the graduated cylinder prepaing to start a new trial.
2. Once you are confident with your ability to work as a group, perform the experiment with all three of your liquids, three times each.
   a. Repeat steps "a" through "g" three times.
   b. When performing step "g," you may need to rinse the graduated cylinder with water. If so, you will need to dry it before proceeding.
   c. After the third trial, wash the funnel, graduated cylinder, and measuring spoon with soapy water.
   d. Rinse these items to remove the soap.
   e. Dry these items thoroughly.
3. Record your results on the class data sheet.

Note: Consider the following safety precaution:
- Water spilled on the floor can be very slippery, please be careful to clean up any messes you make.

Discussion:

Complete the following, individually, to submit this work.

1. The class data file will be shared with you. Make a copy of this file.
2. Rename the file, adding a dash and your name at the end.
3. In column N of your copy of the data file, code the spreadsheet to calculate the average time for each of the fluids.
4. In column O of your copy of the data file, code the spreadsheet to calculate the flow rate of each of the fluids, in ml/s.
5. Highlight cells A5:A8 and O5:O8 and use this data to create a bar graph of the results.
   - To highlight multiple sections, start by highlighting one of them, then hold the "control" button on your keyboard and highlight the next section.
6. Move this graph such that the top left corner is aligned with cell Q1.
7. Edit the graph to include the proper features of a graph.
   - *Note: The Google Cloud spreadsheet program does not allow you to control all aspects of the graph; you will not be able to edit some things. I am aware of these limitations.*
8. Answer the questions that have been typed out on the spreadsheet, in the spaces provided
9. Submit the file through the cloud.

If you are not familiar with the use of a spreadsheet program you will need to start this assignment early, as you may run into difficulties. I am available to help show you how to get around these issues. However, you will need to **do so before it is due**.

Due date: _____

Attachments

3-3 Flow Rate.pdf