

Name: _____

Partner(s): _____

1118 section: _____

Desk # _____

Date: _____

Rates of Change

This lab is due at the end of the laboratory period.

Purpose

To understand graphs by recording and graphing several rates of change by filling up glasses with graduate portions of volume of water and a steady flow of water from a Mariotte's bottle.

Part 1: Height versus Volume

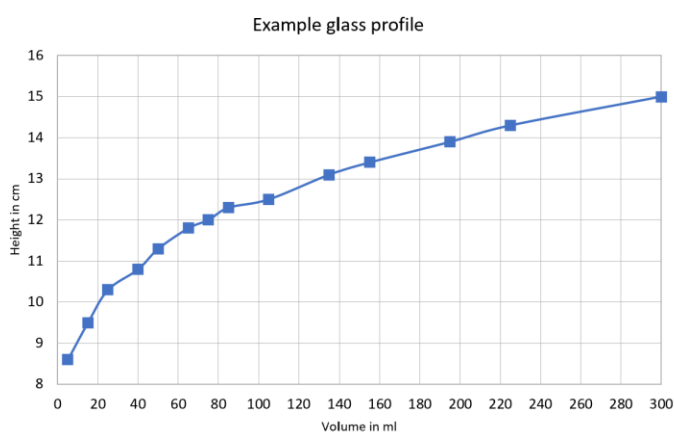
Apparatus

An interestingly-shaped drinking glass, a graduated cylinder, water with food coloring, a ruler.

Activity 1: Sketching your best guess of a graph of height vs volume.

Look at your interestingly-shaped drinking glass. You are going to fill it with water and measure the height of the water level (from the desk surface) and the volume of water. Then you are going to plot a graph to show the relationship between height and volume.

Here is an example graph for the glass shown below.



Look at your glass and sketch your best guess for the graph of height as a function of volume on Page 3. Image how the height changes when you put in a fixed volume (for example, 10ml) of water into the glass. Mark some points on the graph to represent the height with different volume of water and connect the dots to finish your guess graph. It should be a qualitative graph without numbers.

Activity 2: Plotting a graph of height vs volume using Excel.

Step 1: Pick a measuring cylinder.

Choose a small graduated cylinder. Fill the measuring cylinder on your desk with water (with food coloring).

Step 2: Collecting data.

Draw a data table on a separate sheet of paper to record the height of the water level from the desk surface and the volume of water in the glass.

Check the bottom of the ruler. If the “0 cm” mark is not at the edge of the ruler, then you need to record the zero reading of the ruler. Measure the height of the water surface from the top surface of the desk. Make sure your eyes are at the same level with the water surface. Make many measurements (at least 20 data points) of the height and volume of water in the glass.

Step 3: Plotting the graph.

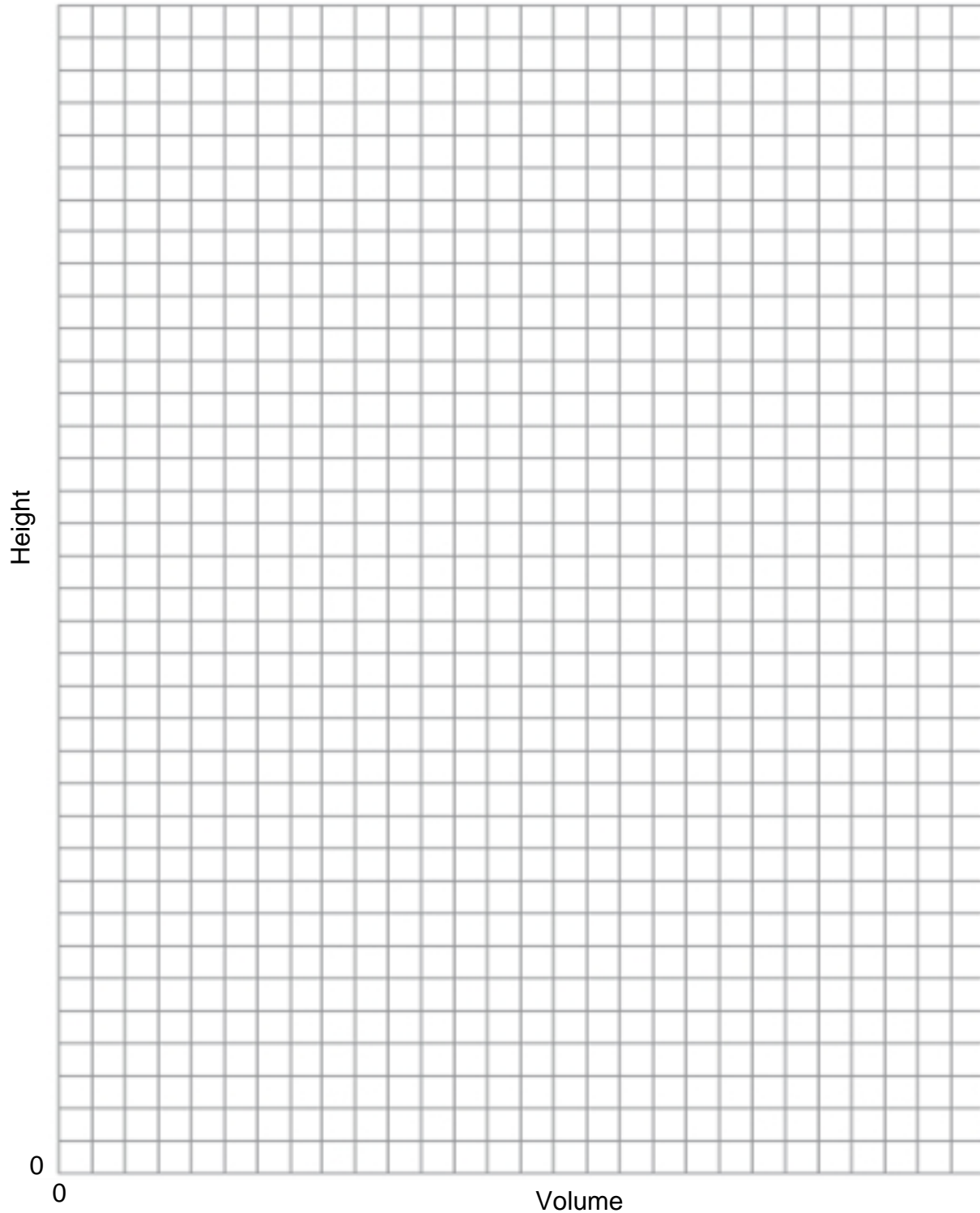
Open an Excel spreadsheet, record your data in an Excel worksheet and plot a graph of height vs volume with your data. Don't forget the height should be corrected with the zero reading.

Check your graph and see if you need more data points. Finish your graph by adding proper labels (name and units) for both x and y axes. Type in “Activity 2” as the title for the graph. Once you are happy with your graph, get the approval of your lab instructor.

Open “Snipping Tool” app and click “New”. Use the cross cursor to select the graph and save it as a .jpg image with name as “Activity2_[your name]”. Upload your image of the graph and submit it through Brightspace. Each student should submit one graph.

**Height as a function of volume
Qualitative graph sheet**

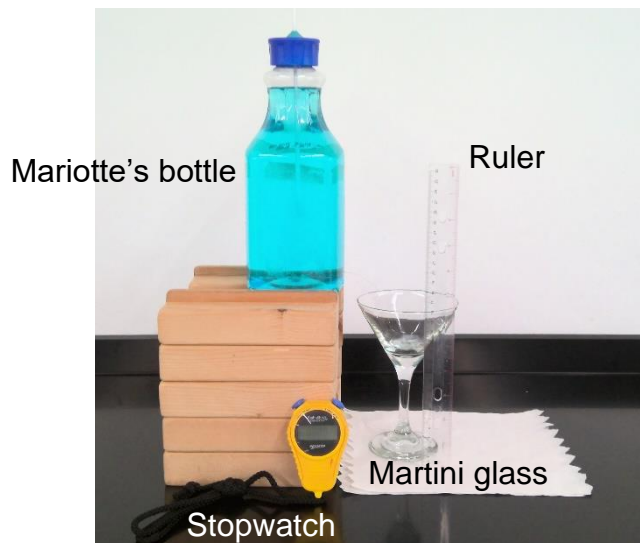
Glass Number: _____



Part 2: Height versus constant flow of water

Apparatus

A Martini glass, a cylindrical glass (cylinder), a Mariotte's bottle, a stopwatch, a ruler, wooden blocks, an electronic device to record video.



Problem 1 Filling up a cylindrical glass with constant flow of water.

Activity 4: Sketching your best guess for the graph of height vs time for cylinder.

The Mariotte's bottle will deliver an approximately constant stream of water to the glass. In order to maintain a constant flow of water, make sure that the water level is above the opening of the straw inside the Mariotte's bottle. In the video, we are going to use the Mariotte's bottle to fill the cylinder.

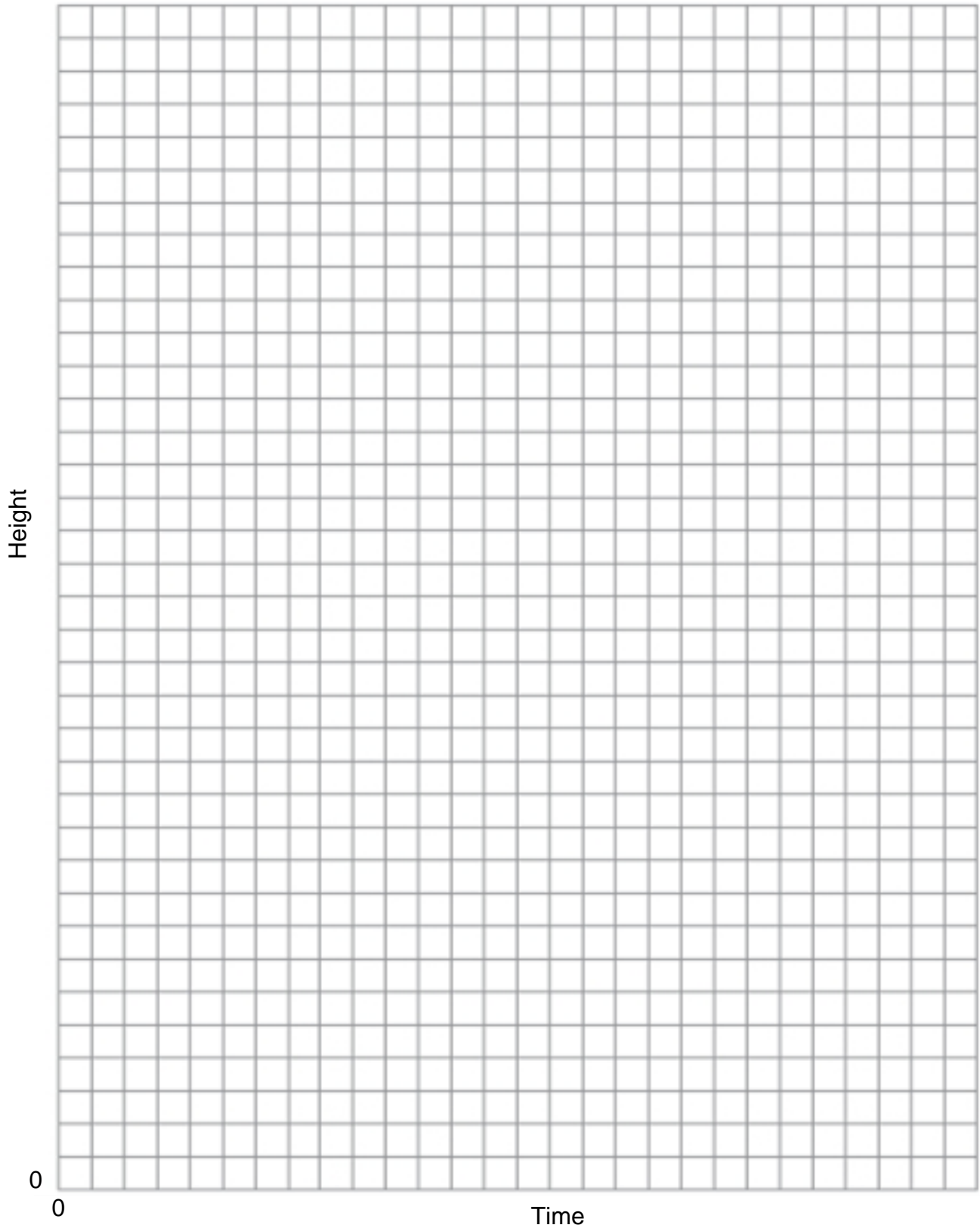
Try to imagine how the cylinder will fill up over time. Sketch a graph of height as a function of time for the cylinder on Page 6. It should be a qualitative graph without numbers.

Activity 5: Plotting a graph of height vs time using Excel.

Instead of doing the experiment in the lab, you will take the data from a video of the experiment. In the video, a stopwatch is put beside the cylinder, and the stopwatch starts when the cylinder is being filled with water from Mariotte's bottle. Watch the video and record down the times (converted to seconds) and water heights in a data table on a separate paper.

Enter your data in an Excel spreadsheet and create a graph of water height as a function of time. Finish your graph by adding proper labels (name and units) for both x and y axes. Type in "Activity 5" as the title for the graph. Once you are happy with your graph, get the approval of your lab instructor. Screenshot your graph with the Snipping tool and save your graph (.jpg image) with name as "Activity5_[your name]". Then submit your graph through Brightspace. Each student should submit one graph.

Height as a function of time
Qualitative graph sheet
Cylinder



Activity 6: Questions for understanding the graph of height vs time of a cylinder.

- 1) How does your sketch compare to the real graph? What did you learn from the differences between them?
- 2) How does the shape of the graph relate to the shape of the cylinder?
- 3) What are the units of the slope of your graph?
- 4) What does the slope represent?
- 5) Write down an equation that would give you the height as a function of time.

Problem 2 Filling up a martini glass with constant flow of water.

Activity 7: Sketching your best guess of a graph of height vs time for martini glass.

Try to imagine how the martini glass will fill up over time. Sketch a graph of height as a function of time for the martini glass on Page 9. It should be a qualitative graph without numbers.

Activity 8: Plotting a graph of height vs time for martini glass using Excel.

Instead of doing the experiment in the lab, you will take the data from a video of the experiment. In the video, a stopwatch is put beside the martini glass, and the stopwatch starts when the martini glass is being filled with water from Mariotte's bottle. Watch the video and record down the times (converted to seconds) and water heights in a data table on a separate paper.

Enter your data in an Excel spreadsheet and create a graph of water height as a function of time. Finish your graph by adding proper labels (name and units) for both x and y axes. Type in "Activity 8" as the title for the graph. Once you are happy with your graph, get the approval of your lab instructor. Screenshot your graph with the Snipping Tool and save your graph (.jpg image) with name as "Activity8_[your name]". Then submit your graph through Brightspace. Each student should submit one graph.

Activity 9: Questions for understanding the graph of height vs time of a martini glass.

- 1) How does your sketch compare to the real graph? What did you learn from the differences between them?
- 2) How does the shape of the graph relate to the shape of the martini glass?
- 3) What are the units of the slope of your graph?
- 4) What does the slope represent?
- 5) Write down an equation that would give you the height as a function of time.

**Height as a function of time
Qualitative graph sheet
Martini Glass**

