Physics 200 Name (s): ____

Bottle Rocket Analysis, Continued

Sensor and Spreadsheet Analysis

Part 3: Sensor Data Analysis – from what I can tell, the only sensor data with the potential to be reliable are the pressure-altitude data. In this process we will see if the max height measured by the sensor seems to correspond well with the max height suggested by your "trajectory with drag" spreadsheet.

Set up an altitude vs elapsed seconds graph…

- Open your sensor data spreadsheet.
- Insert a chart. My method is to click the top of the "elapsed seconds" column, then hold down the control key while clicking the top of the "pressure altitude" column. This selects the entire columns and does not require dragging.
- Set the chart to "scatter."
- Add the x axis by clicking the "add x axis" button and selecting elapsed seconds. Then delete elapsed seconds in the list of series.
- Move the graph to its own sheet
- Adjust the min and max values of the horizontal and vertical axes until you get a good view of the pressure changes during the rocket's flight.

16. Find your rocket's max height. The graph will not be calibrated, so to find the max height you will need to mouse over a point that represents ground level and record that height. Then mouse over a point representing the max height and record that height. Subtract to find the actual max height above ground. [If mousing over has no effect, you either need to close the chart editor or switch your chart to a "scatter" graph (or both).]

    Max height according to the sensor = _________ m

Part 4: "Trajectory With Drag Spreadsheet" Analysis to Find C_d and Max Height. Use recorded data, previous answers, and your "Trajectory With Drag" spreadsheet to find your rocket's C_d and Max Height. [To make your spreadsheet more responsive, you may want to download it onto a laptop or desktop and open it in Excel. This will speed up the calculations and the guess-and-check process.]

17. What was your rocket's mass after all of the water left the rocket (i.e. its dry mass)?
    Dry mass = ________ kg [Make sure that your mass is in kilograms!!]

18. We will assume that your rocket's cross-sectional is slightly larger than a bare 2 liter bottle.
    Use **A = __0.01___m^2**

19. We will assume that the density of the surrounding air was 1.22kg/m^3. In your spreadsheet, use **ρ = 1.22 kg/m^3**.

20. Calculate the amount of time your rocket spend in the coasting phase. In step #12 of the video analysis, you determined the time at which the rocket's thrust phase ended. In step #15, you found the total time aloft. To find the time spent "coasting" subtract the thrust time from the overall time aloft.

Time spent in coasting phase = ___________ s

Part 5: Inferring Cd using time aloft:

Note: your spreadsheet will only work for the "coasting phase." It does not model thrust.

Set up your "Trajectory With Drag" spreadsheet with values, which apply to the rocket at the moment it begins coasting:

- Dry mass, in kilograms
- Cross-sectional area ($0.01m^2$)
- Initial Y position (use your rocket's y position at the beginning of the coasting phase, from #14 of the video analysis)
- Initial Speed (use the y velocity from #13, in m/s)
- Initial Angle (use 90° -- we're just focusing on y axis motion)
- Air density ($1.22kg/m^3$)
- Initial time – It is probably best to just set this to zero.

21. Now it is time to find your rocket's Drag Coefficient using "guess and check." Guess at the drag coefficient and then look at the time aloft that your spreadsheet is calculating. When that time aloft matches your "time spent in coasting phase," from #20, above, you have found your rocket's C_d.

Rocket's C_d = __________

22. Make a copy of your spreadsheet in its current form. Rename it something memorable, and share it with your fellow group members.

23. Once you find your rocket's C_d, record the Max Height that is being calculated by your spreadsheet.

Max Height, according to Spreadsheet = _________ m

24. Transfer the following data from #16…

Max height according to the sensor = _________ m

25. Do you have any reason to suspect that one of these max heights is more reliable than the other? If so, which one do you think is more reliable, and why?

Moment-By-Moment Force Diagrams

For each moment described below, draw a sketch of your rocket, and use labeled arrows to show all of the individual forces – and the net force – acting on your rocket. Each arrow must be labeled with its name, and its arrow must have a reasonable (but not, of course, exactly correct) length and direction. In the box on the right, enter reasonable values for each force. Some forces will be zero in some situations. In some cases you will be able to use your spreadsheet or your knowledge to give a precise answer; in other situations your estimate will be less precise. Follow the convention that upward forces are positive and downward forces are negative.

25. Draw your rocket and its forces at the beginning of the water thrust phase – just after the first bit of water escapes.

Thrust	N
Drag	N
Weight	N
Net Force	N

26. Draw your rocket and its forces at the end of the water thrust phase (beginning of the air thrust phase).

Thrust	N
Drag	N
Weight	N
Net Force	N

27. Draw your rocket and its forces just before it hit the ground.

Thrust	N
Drag	N
Weight	N
Net Force	N