Physics 200 Name: _____
Water Rocket Forces Project

What to turn in – 1) Part 1 worksheet, filled-in. 2) This sheet, with part 4 (on the back) filled-in. 3) Graphs and snapshots (parts 2&3, below) – any format you choose (slideshow, doc, etc.).

Part 1: Thrust Phase -- Complete and turn in the analysis part 1 handout (focused on the rocket thrust phase).

Part 2: After-Thrust Motion Graphs

1. Use the provided resources (videos, sensor data, and Clifford Heath's simulator) to create "reasonably accurate" graphs of position, velocity, and acceleration vs time for the flight of your rocket, beginning at the end of the thrust phase, and ending at the moment of touch-down. We have had several launches, and the quality of data varies. If you need to create a *composite flight* based on data from different launches, that is okay. Just make it clear that your project represents a composite based on multiple flights' data. And make sure that your data are reasonable.
2. Graphs should be sized to fill up a full page.
3. On the position graph, provide evidence to support the assertion that your graph is "reasonably accurate." Identify the source(s) of your data and explain how you used those data to create your graph.
4. Each graph should include a correctly labeled and correctly positioned dot for the data points representing force snapshots 3-7, from part 3, below.

Part 3: Force and acceleration "Snapshots" – Create a series of diagrams meeting these requirements:

- Each diagram is centered around a simple drawing (or a screenshot from a video) showing your rocket's appearance at that moment in time.
- To simplify matters, **include only Y dimension forces**; **ignore any motion or forces in the X dimension**.
- Each diagram includes:
  - An appropriate title describing the rocket's stage
  - Labeled arrows showing the magnitudes and directions all of the individual forces acting on the rocket
  - Time elapsed since launch
  - Current Rocket Mass (including the parachute; only include water when it's in the rocket)
  - Net force acting on the rocket
  - Rocket acceleration
  - Rocket Velocity
- For each individual force in your diagram, make sure that the arrow length is reasonable, relative to the other forces (i.e. longer arrows for stronger forces) – but lengths do not have to be in perfect proportion.
- Include the following snapshots
  1. Just before launch (t = -1s)
  2. Middle (in relation to time) of water thrust phase
  3. End of thrust phase / beginning of coasting phase
  4. Approximately half-way (in relation to time) between end of thrust and the moment of reaching apogee.
  5. Apogee (highest point)
  6. 0.5 seconds after reaching apogee
  7. Just before contact with the ground
  8. Landing (after first contact with the ground, but before coming to rest).

Part 4: Drag Coefficients and Cross-sectional Areas

1. C_d and A at the moment of *snapshot* 4 (half-way between the end of thrust and apogee): Find the following values for this moment in time, and enter them here.
    a. _____Approximate cross-sectional area (A) that is exposed to the oncoming air, in m^2.
    b. _____Current mass (kg)
    c. _____Current net force (N)
    d. _____Current speed (m/s)
    e. 1.22___Approximate Air Density (kg/m^3)
    f. _____ Current force of drag (N)
    g. _____ Rocket's drag coefficient, based on the values above
2. C_d and A at the moment of *snapshot* 7 (just before reaching the ground):
    a. _____Approximate cross-sectional area (A) that is exposed to the oncoming air, in m^2.
    b. _____Current mass (kg)
    c. _____Current net force (N)
    d. _____Current speed (m/s)
    e. 1.22___Approximate Air Density (kg/m^3)
    f. _____ Current force of drag (N)
    g. _____ Rocket's drag coefficient, based on the values above