What a Drag! Accommodating Assumptions

*Requisite Skills Webquest Worksheet*

**Basics of Water Rocket Design**

Having a stable water rocket requires knowing where the center of pressure and center of gravity are for the rocket. Use the webpage Determining Center of Pressure (<http://microgravity.grc.nasa.gov/education/rocket/rktcp.html>) to answer the next questions.

1. What is the projected area of a rocket?
2. How can the projected area be used to mechanically determine the center of pressure?

Use the Determining Center of Gravity (<http://microgravity.grc.nasa.gov/education/rocket/rktcg.html>) webpage to answer the next question.

1. How can the center of gravity of a model be found mechanically?

The Rocket Stability webpage (<http://microgravity.grc.nasa.gov/education/rocket/rktstab.html>) will help you fill in the blanks below correctly.

1. To make a stable rocket the center of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (pressure/mass) should be above or in front of the center of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ (pressure/mass).
2. Describe how to perform the string test to check a model rocket’s stability.

Use the What is Drag webpage (<http://www.grc.nasa.gov/WWW/k-12/airplane/drag1.html>) to answer these questions.

1. What does drag oppose?
2. What two things must be present for drag to occur?

**Ballistics Equations Simulations**

Complete the following data table to compare two simulations that use traditional ballistics equations.

* PhET: <http://phet.colorado.edu/en/simulation/projectile-motion> (Select “Run Now”)
* HyperPhysics: <http://hyperphysics.phy-astr.gsu.edu/hbase/traj.html> (scroll down to “Where will it land?”)

|  |  |  |
| --- | --- | --- |
|  | PhET | HyperPhysics |
| Angle | 65 | 65 |
| Initial Speed | 50 m/s | 50 m/s |
| Mass | 0.2 kg | N/A |
| Diameter | 0.1 m | N/A |
| Height/y |  | -1.2 m |
| Range/x2 |  |  |
| Time/t2 |  |  |

Give two reasons why most high school math and physics problems involving a falling object or a projectile ignore air resistance.

**Water Rocket Simulations**

Complete the following table with a partner to compare several water rocket simulations involving drag. Convert units as needed – if a value is not given use the simulation default value. Not all values are used in every simulation. Use N/A to indicate a value not used in the simulation.

* Science Bits: <http://www.sciencebits.com/RocketCalculator?fromForm=yes>
* NASA: <http://microgravity.grc.nasa.gov/education/rocket/BottleRocket/sim.htm> (Use both Rocket Modeler II and 3D WaterRocketSim prototype Simulator)
* Brigham Young University: <http://www.et.byu.edu/~wheeler/benchtop/sim.php>
* Water-Rockets.com: <http://www.water-rockets.com/article.pl?4>

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Default Values | Science Bits | NASA II | NASA III | BYU | Water-Rockets |
| Empty Rocket Mass | 0.1 kg |  |  |  |  |  |
| Diameter | 0.1 m |  |  |  |  |  |
| Bottle Volume | 2 L |  |  |  |  |  |
| Initial Pressure | 50 psi |  |  |  |  |  |
| Drag Coefficient | 0.31 |  |  |  |  |  |
| Simulation Time Step | 0.001 s |  |  |  |  |  |
| Bottle Diameter | 11.2 cm |  |  |  |  |  |
| Nozzle Diameter | 2.16 cm |  |  |  |  |  |
| Launch Angle | 65o |  |  |  |  |  |
| Nose Cone Shape | None |  |  |  |  |  |
| Payload | None |  |  |  |  |  |
| Fairing | None |  |  |  |  |  |
| Number of fins | 3 |  |  |  |  |  |
| Shape of fins | Trapezoidal |  |  |  |  |  |
| Fin Length | 10 cm |  |  |  |  |  |
| Fin Width | 10 cm |  |  |  |  |  |
| Water Volume | 300 mL |  |  |  |  |  |
| Altitude | 720 m |  |  |  |  |  |
| Launch Rail Length | 1 m |  |  |  |  |  |
| Temperature | 25 oC |  |  |  |  |  |
| Launch Tube Length | 2 cm |  |  |  |  |  |
| Launch Tube Diameter | 2.15 cm |  |  |  |  |  |
| Maximum Speed |  |  |  |  |  |  |
| Maximum Height |  |  |  |  |  |  |
| Range |  |  |  |  |  |  |
| Time |  |  |  |  |  |  |