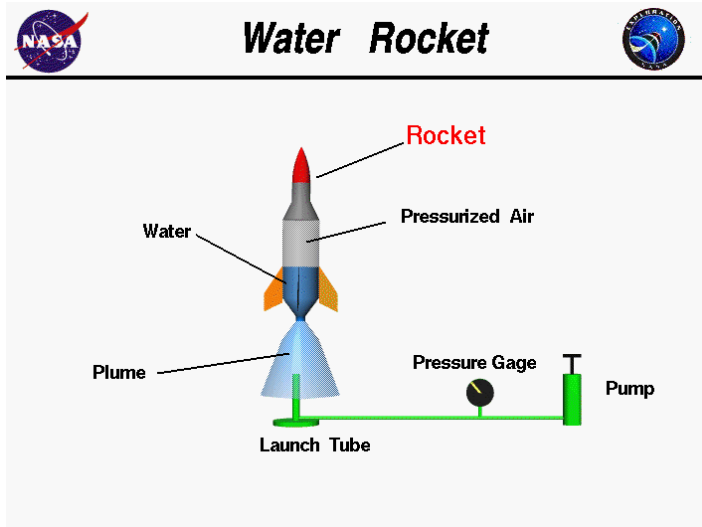


Water Rocket—Design, Construct, and Test


Project 2 (Rev 0)




Project Steps:

1. Review Newton's Laws of Motion
2. Become familiar with the physics that affect water rocket flight/stability/launch
3. Determine an experimental strategy to efficiently design the rocket
4. Conduct computer simulations to optimize design
5. Construct a water rocket based on these results.
6. Field test the rocket
7. Analyze results and compare with the simulations
8. Document

Newton's Laws of Motion according to NASA



Newton's First Law



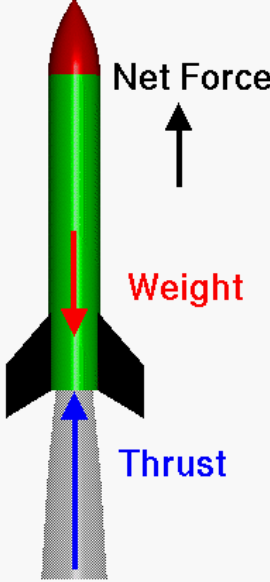
Applied to Rocket Liftoff


"Every object persists in its state of rest or uniform motion in a straight line unless it is compelled to change that state by forces impressed on it."

Before firing:
Object in state of rest, airspeed zero.


Engine fired:
Thrust increases from zero.
Weight decreases slightly as fuel burns.

When Thrust is greater than Weight:
Net force (Thrust - Weight) is positive upward.
Rocket accelerates upward
Velocity increases

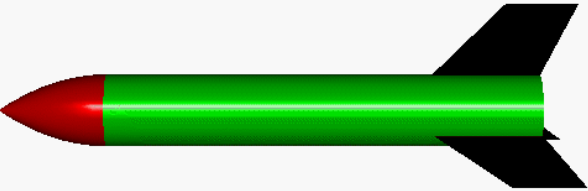




Newton's Second Law



Definitions



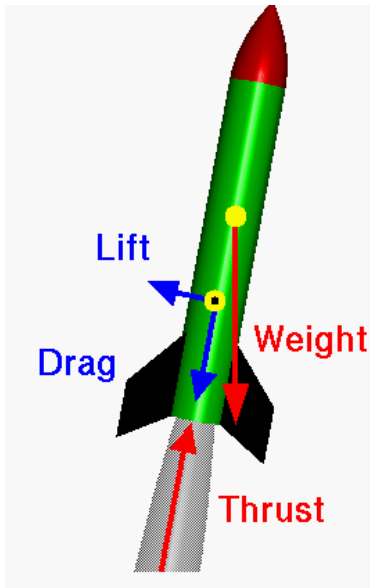
Differential Form: Force = change of momentum with change of time $F = \frac{d(mv)}{dt}$

or:
Force = change in mass X velocity with time $F = \frac{(m_1 V_1 - m_0 V_0)}{(t_1 - t_0)}$

With mass constant: Force = mass X acceleration $F = m a$

*Force, acceleration, momentum and velocity are all vector quantities.
Each has both a magnitude and a direction.*

Four Forces



Lift is the component of aerodynamic force perpendicular to the relative wind.

Drag is the component of aerodynamic force parallel to the relative wind.

Weight is the force directed downward from the center of mass of the airplane towards the center of the earth. It is proportional to the mass of the airplane times the strength of the gravitational field.

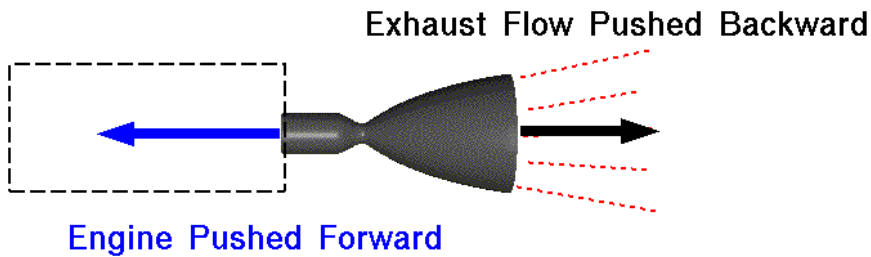
Thrust is the force produced by the engine. It is directed forward along the axis of the engine.



Newton's Third Law



Rocket Engine Thrust



For every action, there is an equal and opposite re-action.