CAP Model Rocketry
Titan Phase

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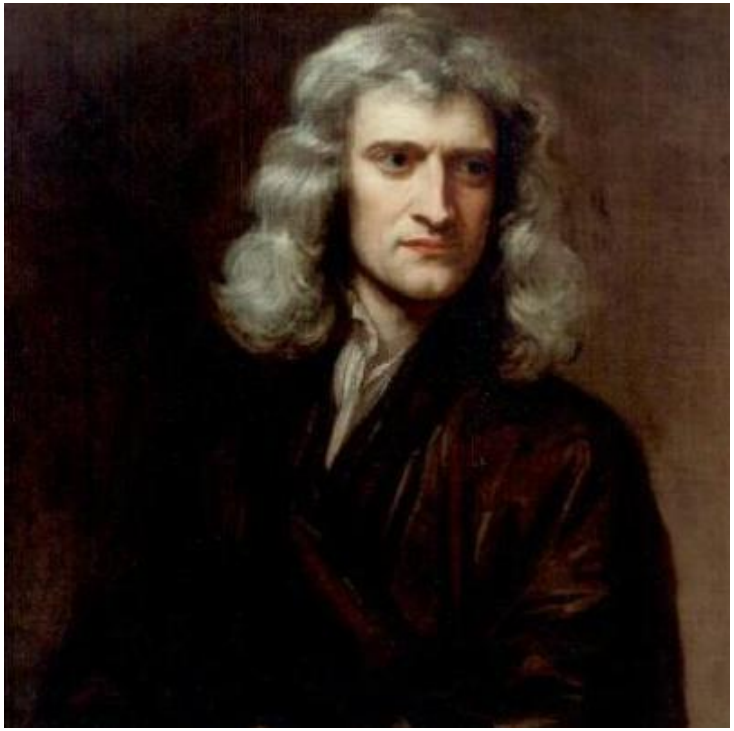
Laws That Govern Rocket Science

Sir Isaac Newton (1643-1727), an English scientist, discovered and recorded the three laws of motion:

1) A body in a state of rest and a body in motion tend to remain at rest or in uniform motion unless acted upon by some outside force.

2) The rate of change in the momentum of a body is proportional to the force acting upon the body and is in the directon of that force.

3) For every action there is an equal and opposite reaction.



Laws That Govern Rocket Science

Newton's First Law

A body in a state of rest and a body in motion tend to remain at rest or in uniform motion unless acted upon by some outside force.

- **Rest**: the state of an object when its not changing position in relation to its surroundings.
- **Motion**: the state of an object when it is changing position in relation to its surroundings.

An object will change from one state to another when acted upon by one or more unbalanced outside forces.

If there are no forces present, or all forces present are in balance, then the state of the object will not change.

Laws That Govern Rocket Science

Newton's Second Law

The rate of change in the momentum of a body is proportional to the force acting upon the body and is in the directon of that force.

This statement can be expressed mathematically as F=M*A, where

- F = Force exerted on an object
- M = Mass of the object
- A = Acceleration (the rate of change in velocity with respect to time)

Laws That Govern Rocket Science

Newton's Third Law

For every action, there is an equal and opposite reaction.

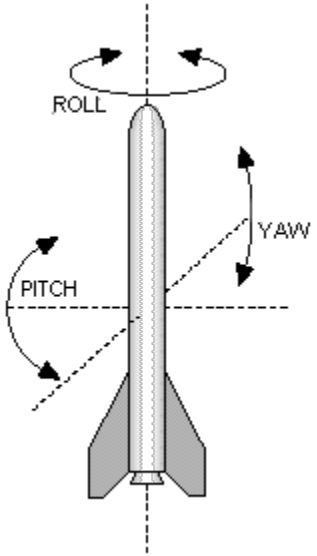
In a rocket launch, the rule works like this:

- Fuel is ignited in the rocket motor
- The rocket exerts a force on the gas, pushing it out the exhaust nozzle (action)
- The resulting burning gas expands and exerts a force on the rocket, pushing it upward (reaction)

Rocket Aerodynamics

- Like an airplane, all of a rocket's mass is balanced at a point called the center of gravity.

- Also like an airplane, a rocket moves about three axes that are centered at the center of gravity. These axes are called longitudinal, lateral and vertical.

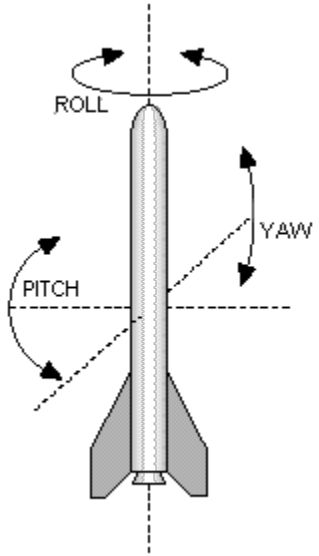


Rocket Aerodynamics

- **Longitudinal axis**: runs from nose to tail. Movement about this axis is called roll.

- **Lateral axis**: runs from side to side. Movement about this axis is called pitch.

- **Vertical axis**: runs from top to bottom. Movement about this axis is called yaw.

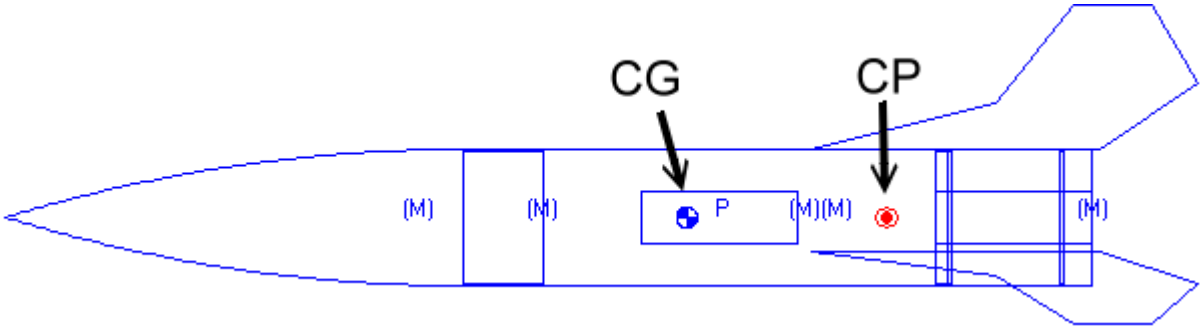


Rocket Aerodynamics

- There also exists another center, the center of pressure. This is the point at which all aerodynamic forces are concentrated.

- The center of pressure must always be between the center of gravity and the rocket's tail.

- If the center of pressure is too close to the center of gravity, the rocket will not be stable and will not fly correctly.



Rocket Aerodynamics

- To ensure a rocket is stable for flight, the rocket is loaded with it's engine, wadding and payload (if it will be carrying one).

- A string is tied to the rocket at the center of gravity and taped into place. It is then swung around a person's head in a circular pattern.

- If the rocket is very stable, the nose will point forward into the wind created by its forward motion.

Rocket Aerodynamics

If the rocket does not pass the swing test, it can be made stable using either of two methods:

- The balance point can be moved forward by adding weight to the nose.

- The fin area can be enlarged by either replacing the existing fins with larger ones, or by adding extra fins behind the center of gravity.

Sources

http://capmembers.com/media/cms/Stage_2_Titan_8A2C82380E695.pdf

http://ts4.mm.bing.net/th?id=H.4712422125535343&pid=1.7

http://www.biography.com/imported/images/Biography/Images/Profiles/N/Sir-Isaac-Newton-9422656-1-402.jpg

http://www.angelfire.com/sc/highschoolphysics/images/STAB.GIF

http://www.rocketreviews.com/images/cp_cg_image.gif

http://library.thinkquest.org/10568/media/stable1.gif