# ROCKET BASICS

TEAM 1

# ROCKET PRINCIPLES

- A rocket in its simplest form is a chamber enclosing a gas under pressure.
- A small opening at one end of the chamber allows the gas to escape, and in doing so provides a thrust that propels the rocket in the opposite direction.
- A good example of this is a balloon. Air inside a balloon is compressed by the balloon's rubber walls. The air pushes back so that the inward and outward pressing forces balance. When the nozzle is released, air escapes through it and the balloon is propelled in the opposite direction.
- The only significant difference is the way the pressurized gas is produced. With space rockets, the gas is produced by burning propellants that can be solid or liquid in form or a combination of the two.

# NEWTON’S LAW OF MOTION

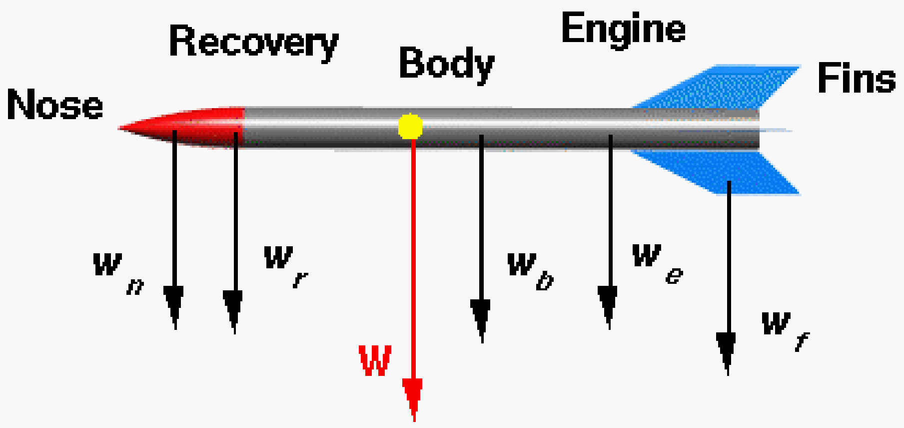
- Objects at rest will stay at rest and objects in motion will stay in motion in a straight line unless acted upon by an unbalanced force.
- Force is the derivative of momentum
- For every action there is always an opposite and equal reaction.

Newton’s laws are really simple statements of how things move. But with them, precise determinations of rocket performance can be made.

# ROCKET ENGINES

- Most rockets today operate with either solid or liquid propellants.
- The word propellant does not mean simply fuel, as you might think; it means both fuel and oxidizer.
- The fuel is the chemical the rocket burns but, for burning to take place, an oxidizer (oxygen) must be present.
- Jet engines draw oxygen into their engines from the surrounding air. Rockets do not have the luxury that jet planes have; they must carry oxygen with them into space, where there is no air

# Model Rocket Weight




Each component has some weight $w_i = m_i g$

where $m_i$ is the component mass and

where $g$ is the gravitational acceleration.

Total rocket weight W is the sum of the component weights.

$$W = w_n + w_r + w_b + w_e + w_f$$

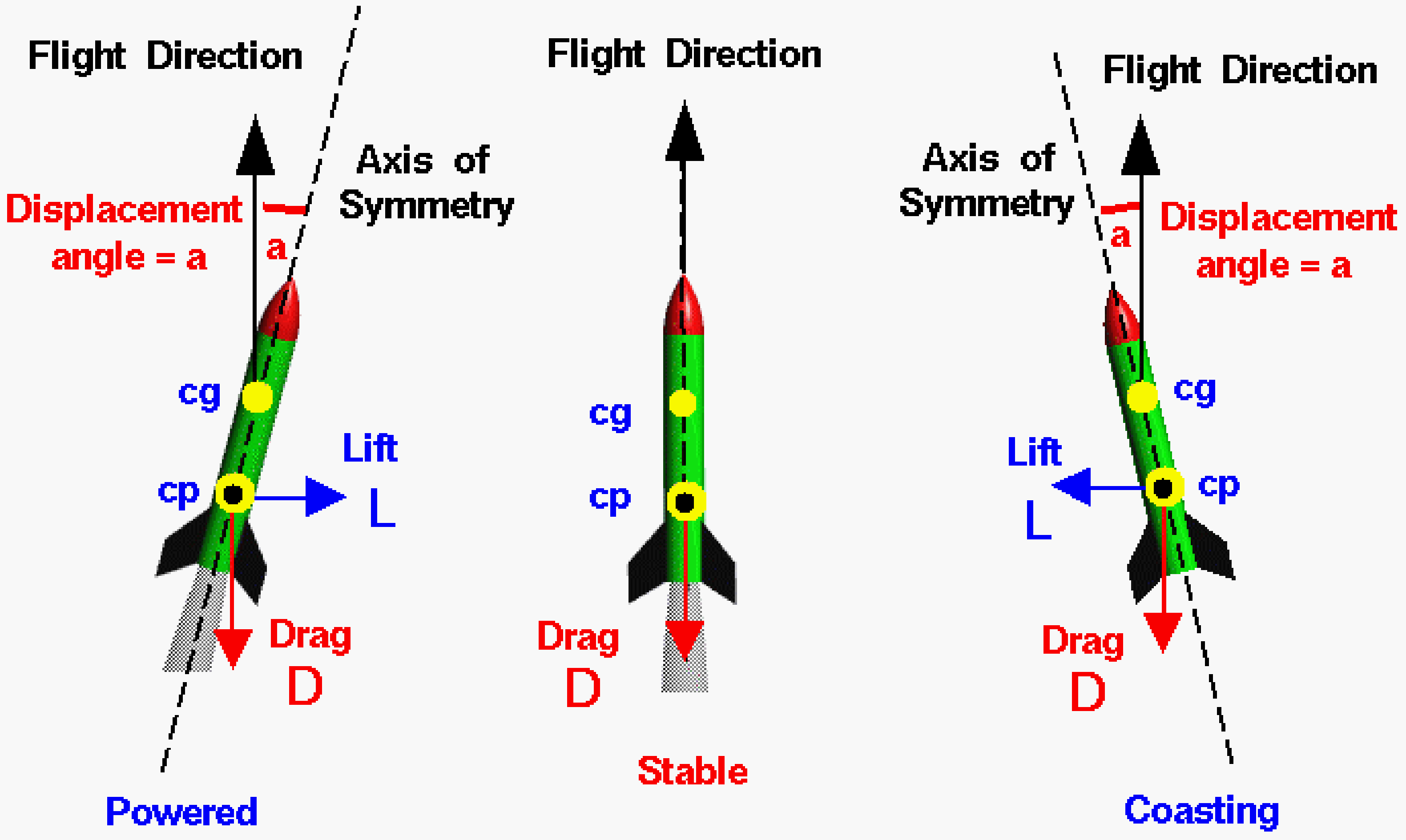
$$W = \sum_i^n w_i \qquad W = \int w(x)\, dx$$

# ENGINE THRUST CONTROL

- Engine Thrust Control Controlling the thrust of an engine is very important to launching payloads (cargoes) into orbit.
- Thrusting for too short or too long of a period of time will cause a satellite to be placed in the wrong orbit. This could cause it to go too far into space to be useful or make the satellite fall back to Earth. Thrusting in the wrong direction or at the wrong time will also result in a similar situation.
- A computer in the rocket’s guidance system determines when that thrust is needed and turns the engine on or off appropriately.
- Liquid engines do this by simply starting or stopping the flow of propellants into the combustion chamber. On more complicated flights, such as going to the Moon, the engines must be started and stopped several times. Some liquid-propellant engines control the amount of engine thrust by varying the amount of propellant that enters the combustion chamber. Typically the engine thrust varies for controlling the acceleration experienced by astronauts or to limit the aerodynamic forces on a vehicle.

- Solid-propellant rockets are not as easy to control as liquid rockets.
- Once started, the propellants burn until they are gone. They are very difficult to stop or slow down part way into the burn.
- Sometimes fire extinguishers are built into the engine to stop the rocket in flight. But using them is a tricky procedure and does not always work.
- Some solid-fuel engines have hatches on their sides that can be cut loose by remote control to release the chamber pressure and terminate thrust.
- The burn rate of solid propellants is carefully planned in advance. The hollow core running the length of the propellants can be made into a star shape. At first, there is a very large surface available for burning, but as the points of the star burn away, the surface area is reduced. For a time, less of the propellant burns, and this reduces thrust. The Space Shuttle uses this technique to reduce vibrations early in its flight into orbit.

# Rocket Stability

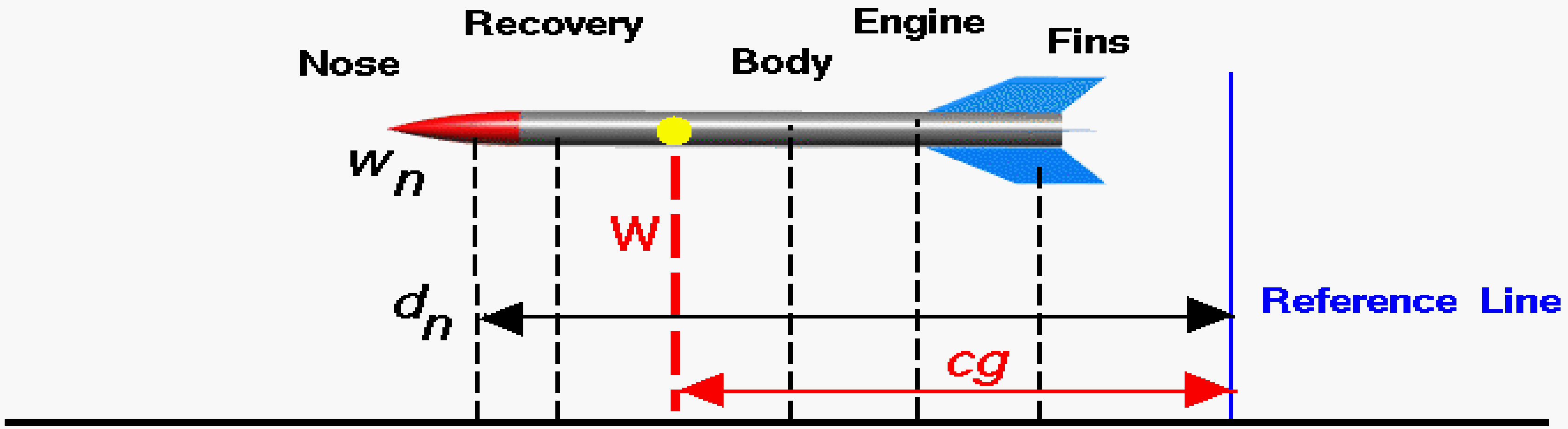


# STABILITY AND CONTROL SYSTEMS

- Stability and Control Systems Building an efficient rocket engine is only part of the problem in producing a successful rocket.
- The rocket must also be stable in flight. A stable rocket is one that flies in a smooth, uniform direction.
- An unstable rocket flies along an erratic path, sometimes tumbling or changing direction. Unstable rockets are dangerous because it is not possible to predict where they will go. They may even turn upside down and suddenly head back directly to the launch pad.
- Making a rocket stable requires some form of control system. Controls can be either active or passive.

# DETERMINING CENTRE OF GRAVITY

## *Determining Center of Gravity – cg*



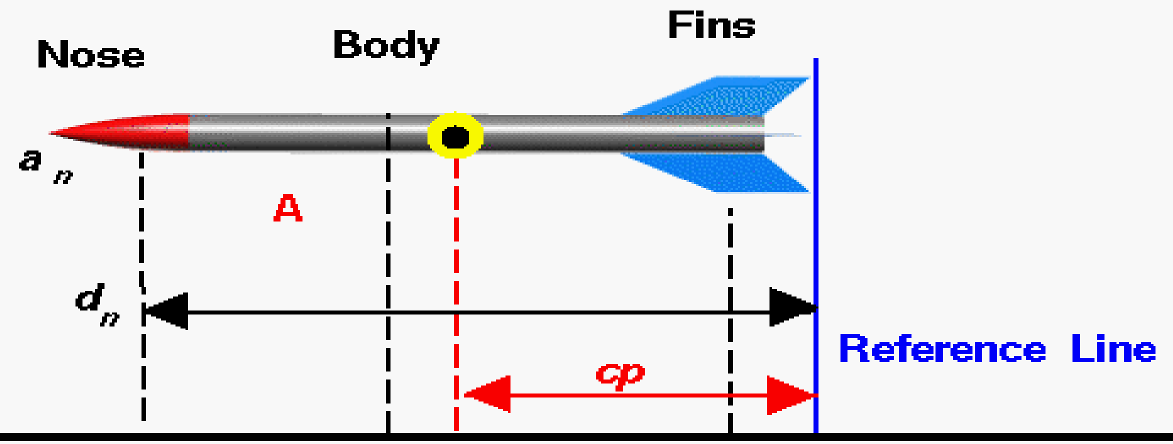

Each component has some weight $w_i$
located some distance $d_i$ from the reference line.

Distance $cg$ times the weight W equals the sum of the
component distance times component weight.

$$cg\,W = d_n w_n + d_r w_r + d_b w_b + d_e w_e + d_f w_f$$

# DETERMINING CENTRE OF PRESSURE

## *Determining Center of Pressure – cp*
*(simplified)*

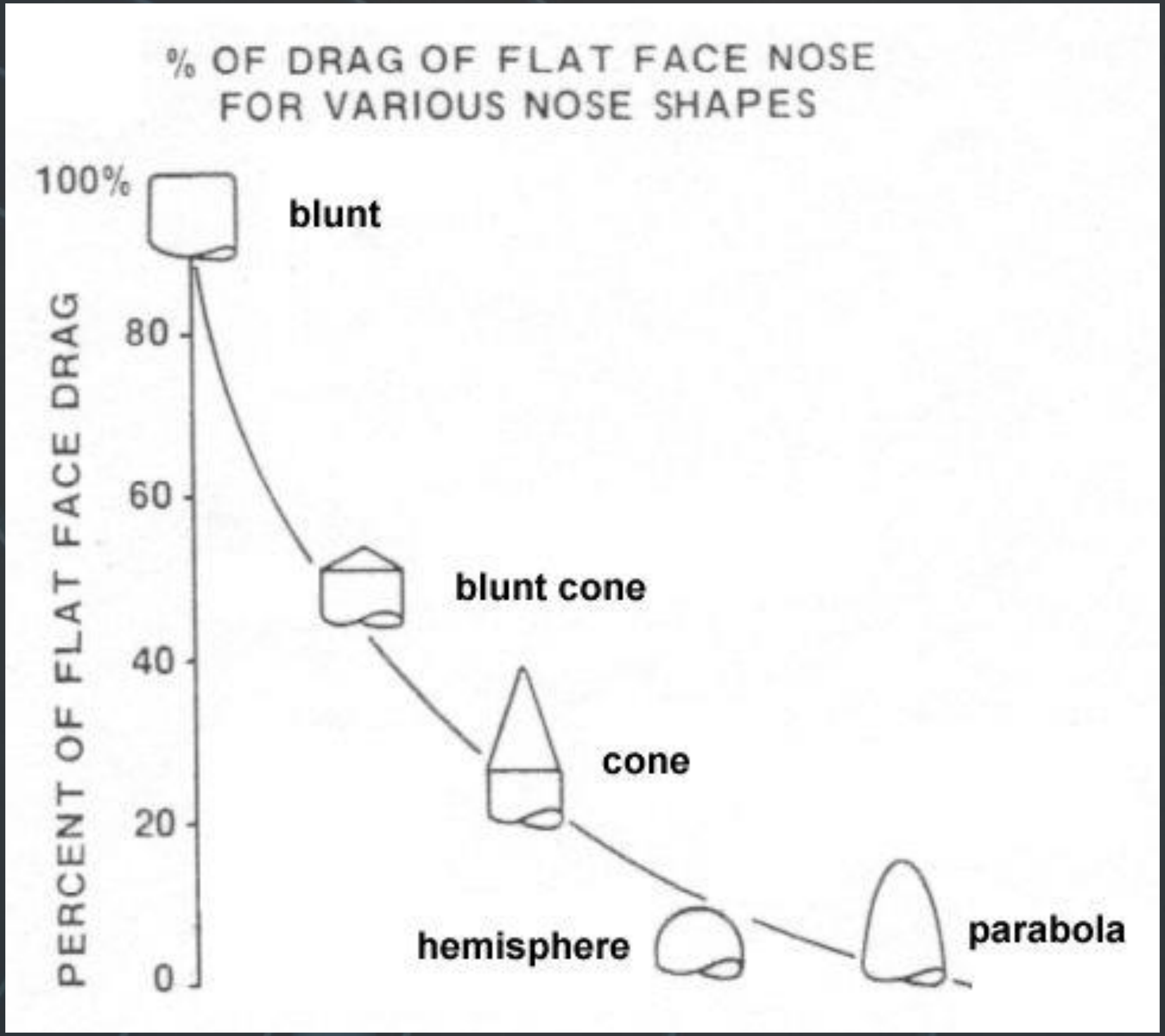



Each component has some area $a_i$ located some distance $d_i$ from reference line.

Distance $cp$ times the area A equals the sum of the component distance times area.

$$cp\ A = d_n a_n + d_b a_b + d_f a_f$$

# DRAG OF NOSE CONES



# THANK YOU