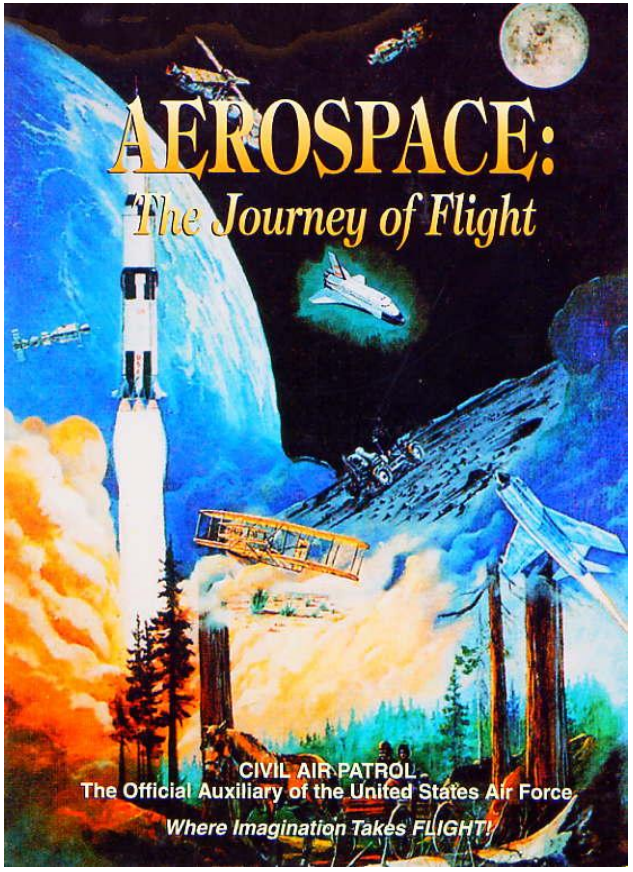
Aerospace Education Program

MOD 4



Weather Elements

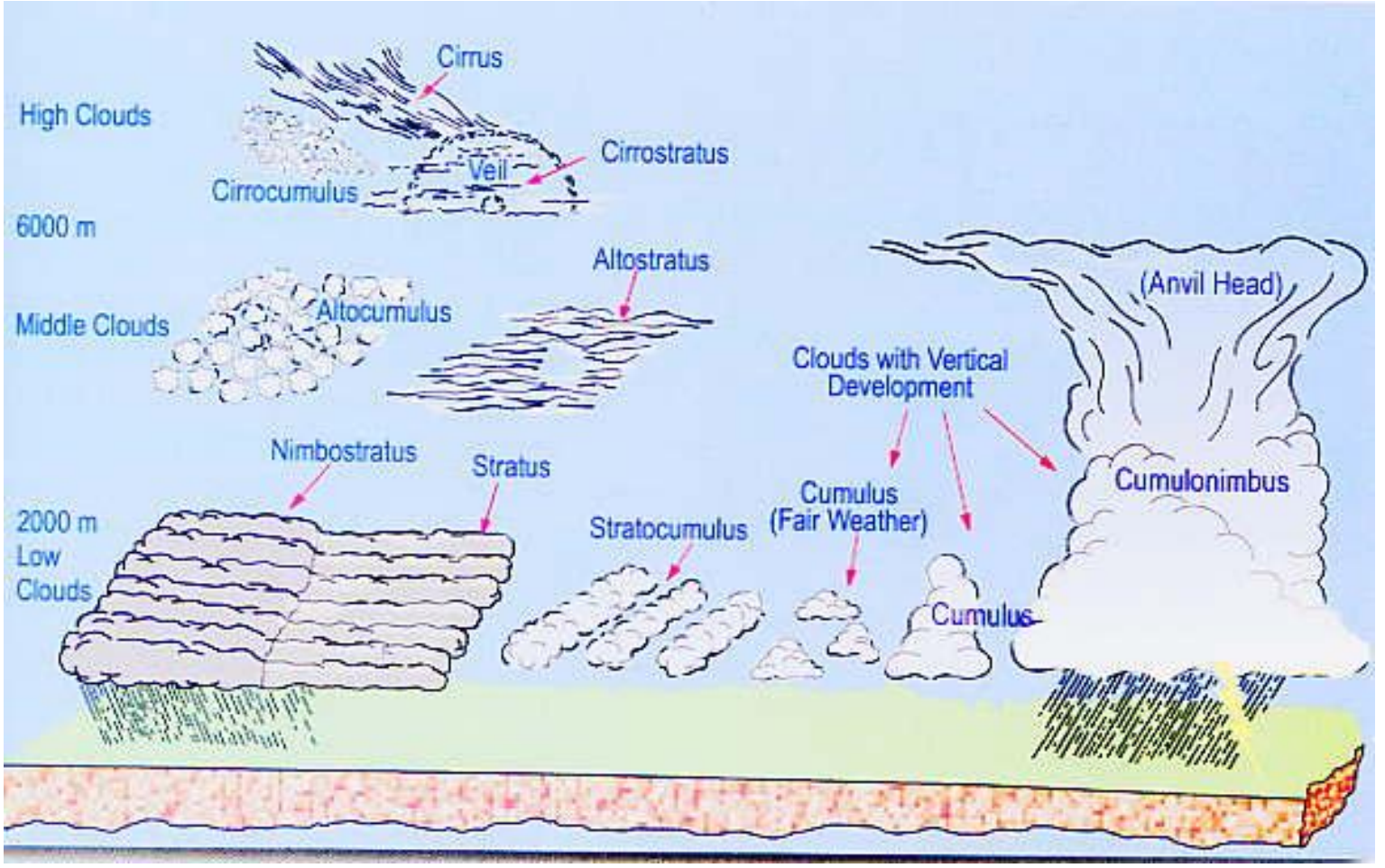
Air Masses & Fronts

- Cold Front - Pushes warm air upward and can create thunderstorms
- Warm Front - Warm air covers cold air, usually high, thin wispy clouds develop
- Stationary Front - When air masses lose their “punch” and do not replace each other
- Occluded Front - Warm air mass, lying between two cold masses is lifted by cold mass behind

- Polar - Cold
- Tropical - Hot
- Maritime - Humid
- Continental - Dry

Clouds

- Cumulus - Piled up
- Stratus - Layered
- Cirrus - High, thin appearance
- Low - 300-6500 ft, stratus, cumulus, stratocumulus, cumulonimbus, nimbostratus
- Medium - “Alto” high but not highest, 6500 - 20000 ft
- High - Cirrus - wispy



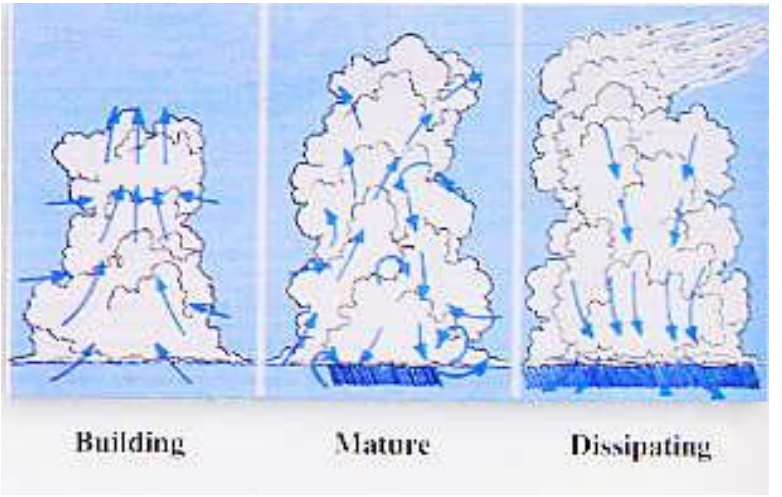
Aviation Weather

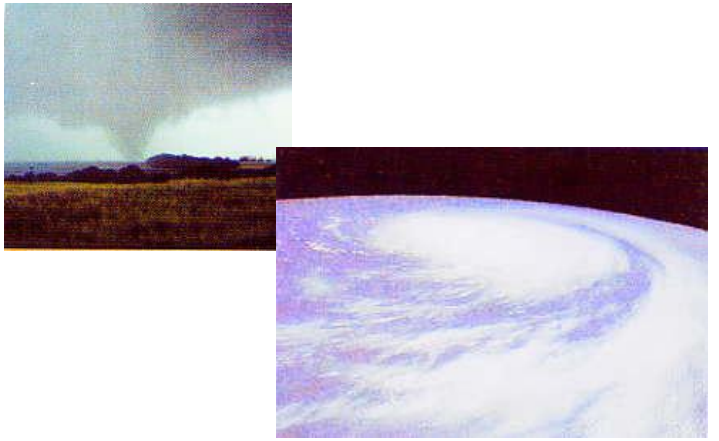
Weather Hazards

- Visual Flt Rules (VFR) - Cloud ceiling > 3000 ft and visibility > 3 miles
- Instrument Flt Rules (IFR) - Cloud ceiling >500 and <1000 ft and visibility >1 mile and <3miles
- Clouds, rain, snow, fog, haze, smoke, blowing dust, sand, snow
- Icing - Carburetor, glaze, rime, frost

Severe Weather

- Thunderstorms
  - Cumulus stage - updraft of warm moist air
  - Mature stage - Rain, strong downdrafts
  - Dissipating stage - Downdrafts produce heating, drying, ceasing rain
- Tornadoes
  - Funnel cloud that touches ground - violent energy in small area
  - Occur most often in N. America & Australia
- Hurricane
  - Strong tropical cyclone that occur around world
  - Eye of hurricane is calm low pressure core
- Hail
  - Frozen rain pellets that circulate in thunderstorm





MOD 4- Rockets

Chap. 21- Rocket Fundamentals

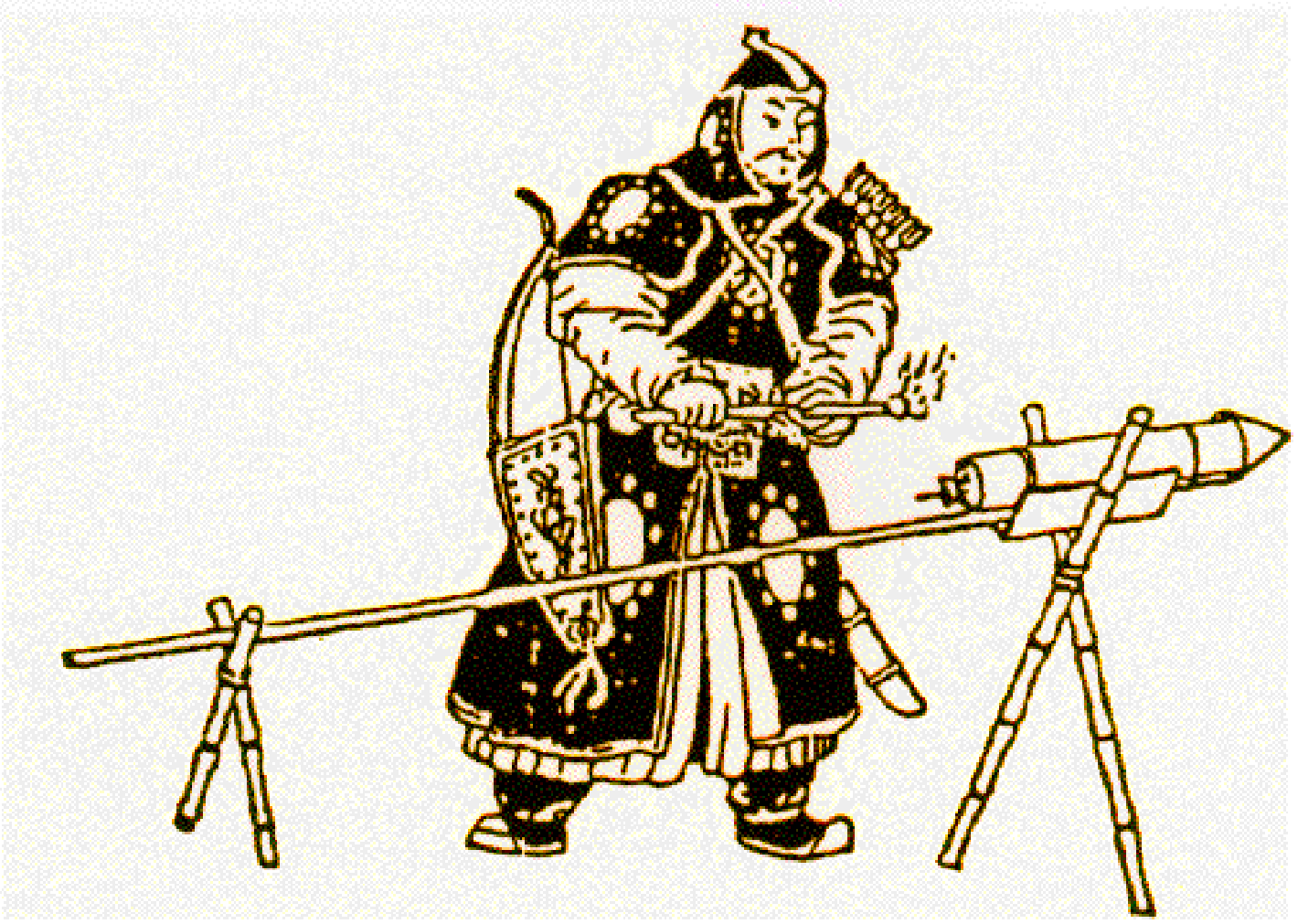
Chap. 22- Chemical Propulsion

Chap. 23- Orbits & Trajectories

Rocket Fundamentals

History of Rocketry

- Rocketry is based on the propelling of a vehicle by a reactive force.
- Chinese developed rockets in 1220 and were first to use in war.
- 1405 - German engineer Konrad Kyeser von Eichstadt devised rocket propelled by gunpowder
- 1800 - Britain's William Congreve developed flight-stabilizing guide sticks and built first viable launching pad.
- William Hale (English) developed spin stabilization with angled exhaust tubes.
- WW I - rockets used as signal flares and to carry messages, not used as primary weapon.
- Dr. Robert H. Goddard - Developed and launched first liquid propelled rocket. Recognized as the "Father of Modern Rocketry".
- Germany developed liquid rocket as weapon in WW II know as the V-2.



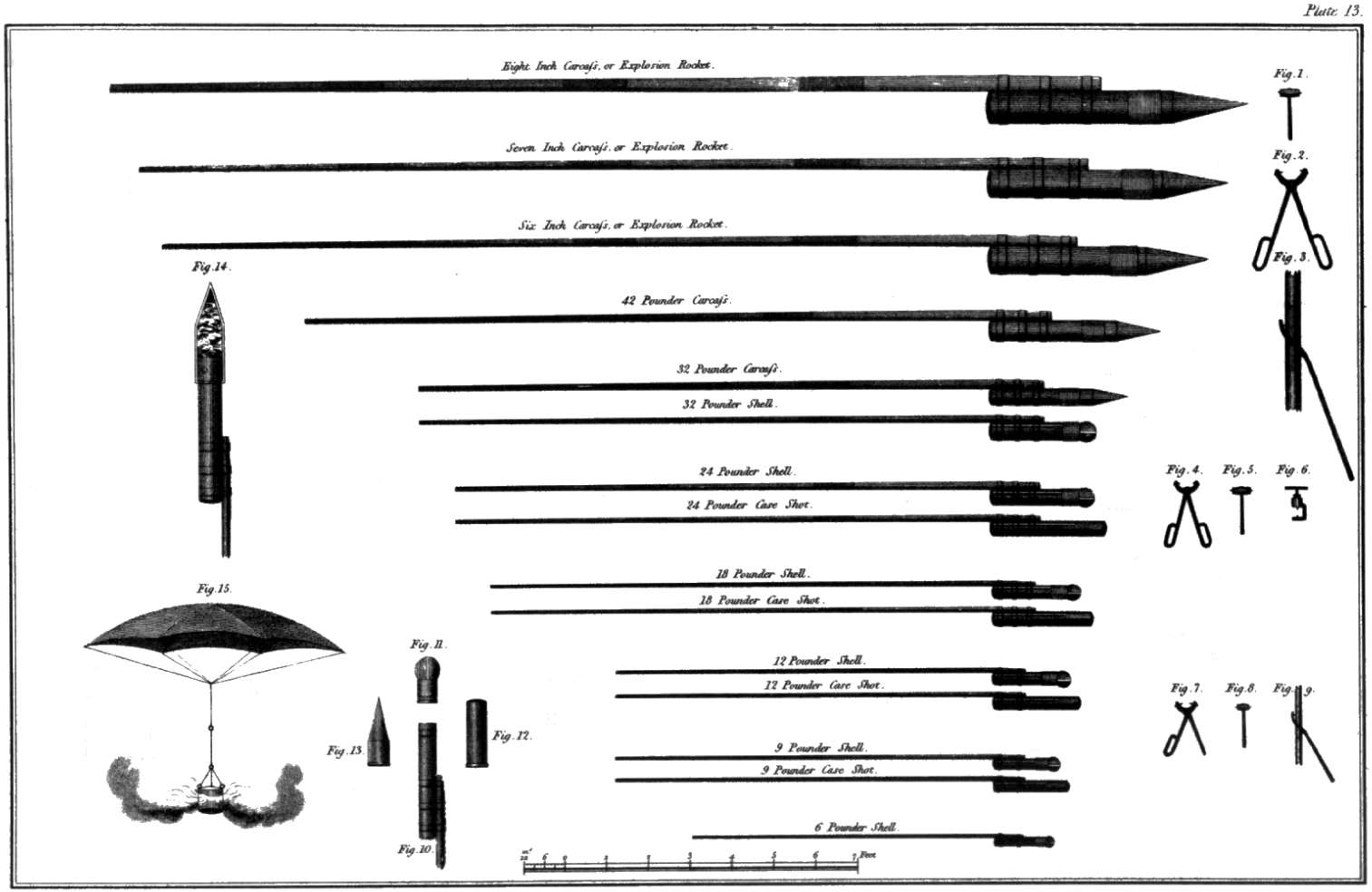


Plate 13.
Eight Inch Carcaſs, or Explosion Rocket.
Fig.1.
Seven Inch Carcaſs, or Explosion Rocket.
Fig.2.
Six Inch Carcaſs, or Explosion Rocket.
Fig.3.
Fig.14.
42 Pounder Carcaſs.
32 Pounder Carcaſs.
32 Pounder Shell.
24 Pounder Shell.
24 Pounder Case Shot.
Fig.4.
Fig.5.
Fig.6.
18 Pounder Shell.
18 Pounder Case Shot.
Fig.15.
Fig.11.
12 Pounder Shell.
12 Pounder Case Shot.
Fig.7.
Fig.8.
Fig.9.
Fig.13.
Fig.12.
9 Pounder Shell.
9 Pounder Case Shot.
6 Pounder Shell.
Fig.10.
Feet

Robert Goddard
"Father of Modern Rocketry"

*1

Wernher **Von Braun** (1912-1977)

*1

Newton

I. Every object in a state of uniform motion tends to remain in that state of motion unless an external force is applied to it.

II. The relationship between an object's mass *m*, its acceleration a, and the applied force *F* is *F* = *ma*. Acceleration and force are vectors (as indicated by their symbols being displayed in slant bold font); in this law the direction of the force vector is the same as the direction of the acceleration vector.

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

Rocket Fundamentals

Fundamental Physics

- Gravitation-Force of attraction between all matter within the universe
- Gravity- Gravitation force with a body or mass on or near the Earth (Galileo)
- Newton's Law of Universal Gravitation: $F = \frac{Gm_1m_2}{d^2}$
- Newton's Three Law's of Motion:
  1) Inertia
  2) F=ma
  3) Action=Reaction

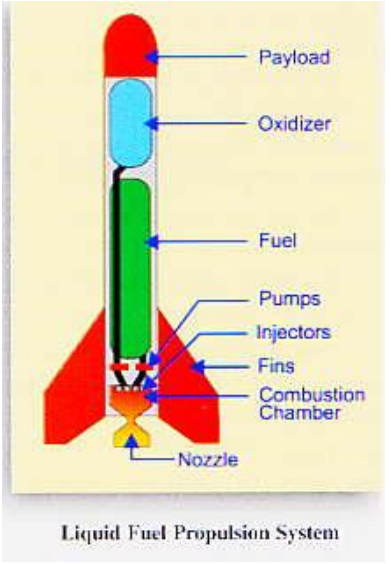
Momentum = m x V

Acceleration = rate of change of velocity

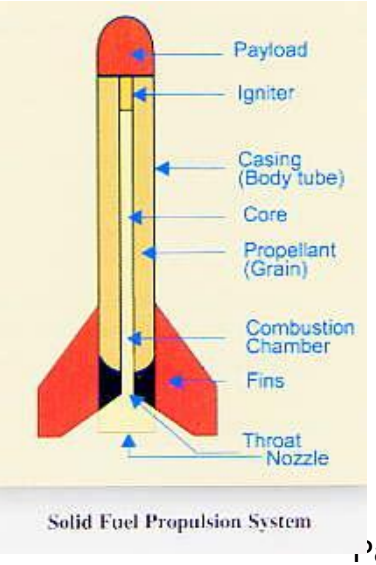
Rocket Systems

Specific Impulse (Isp) = lbs of thrust delivered by consuming 1 lb of propellant in 1 second

- Airframe-Structure
- Propulsion
  - Engines - Liquid Propellant
  - Motors- Solid Propellant
- Guidance Systems - "Brain", inertial platform, star tracking
- Control Systems - "Steering", thrust vector control, reaction control

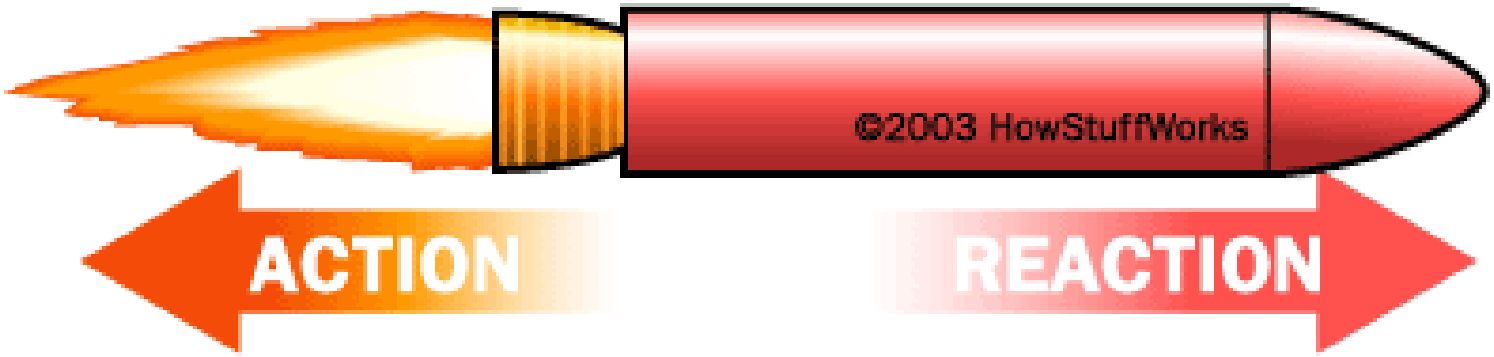


Liquid Fuel Propulsion System



Solid Fuel Propulsion System

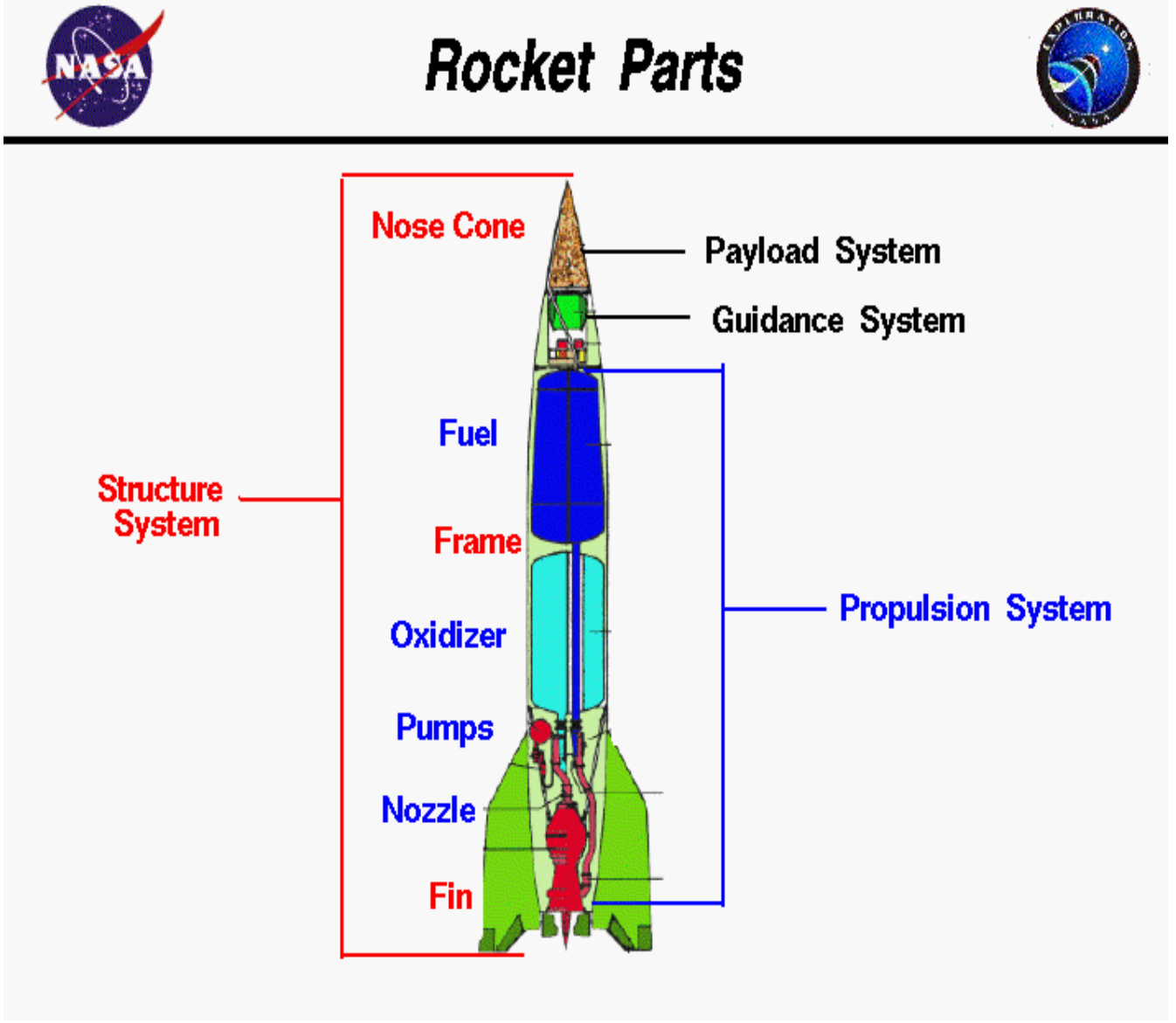
How A Rocket Works



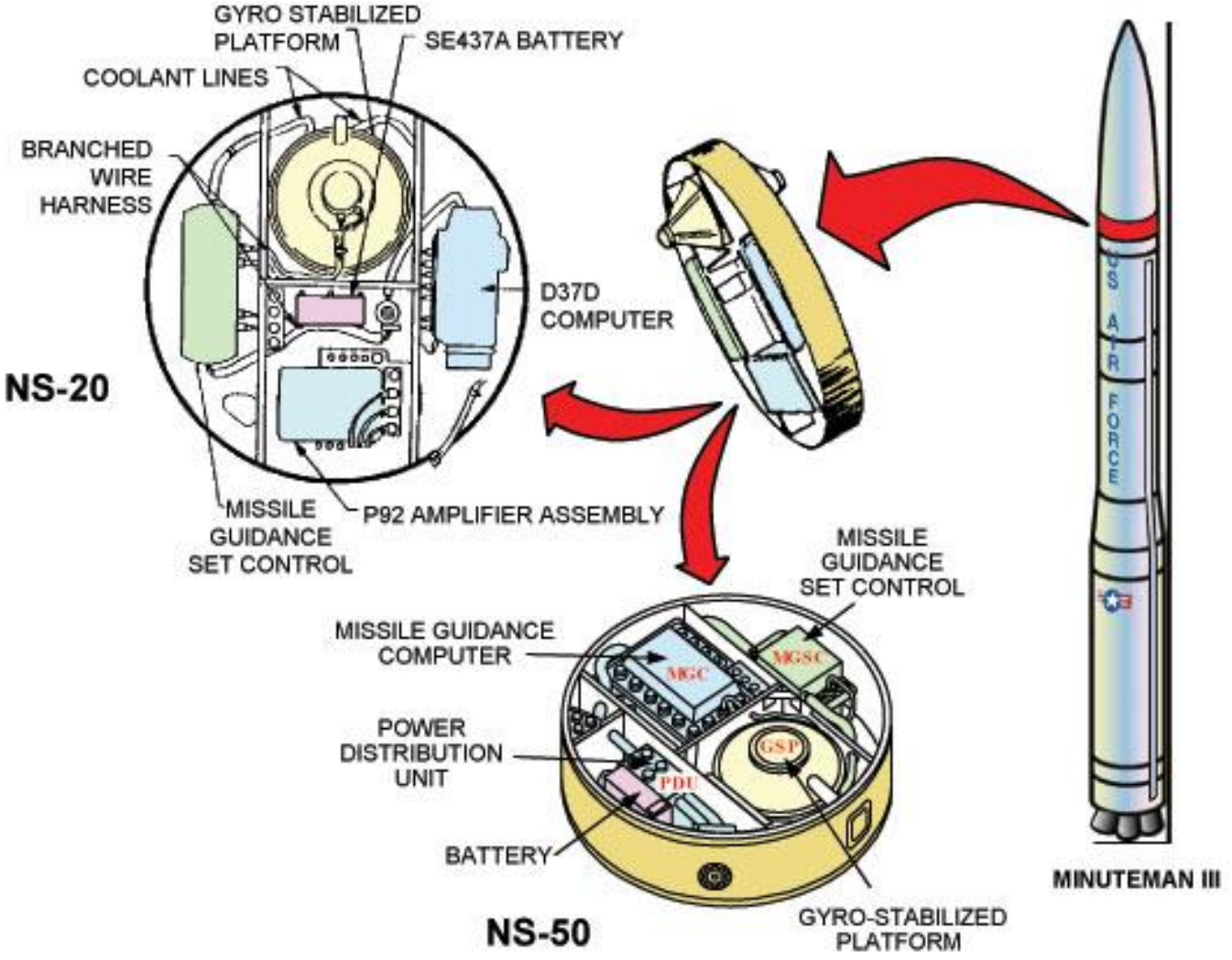
*2

How do we choose what type of propulsion and how much thrust it needs to produce?

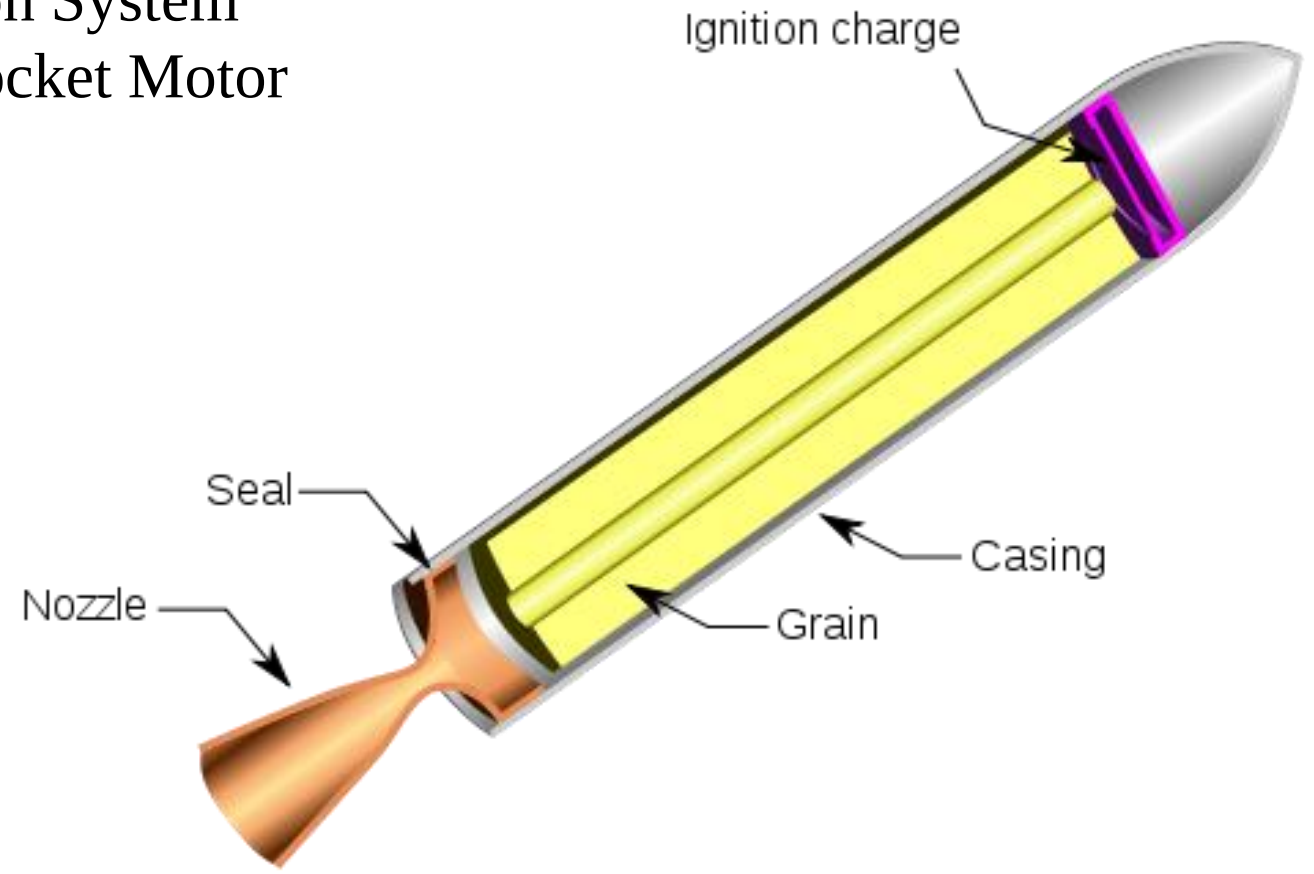
1. Airframe
2. Propulsion
3. Guidance
4. Control



Rocket Guidance Systems

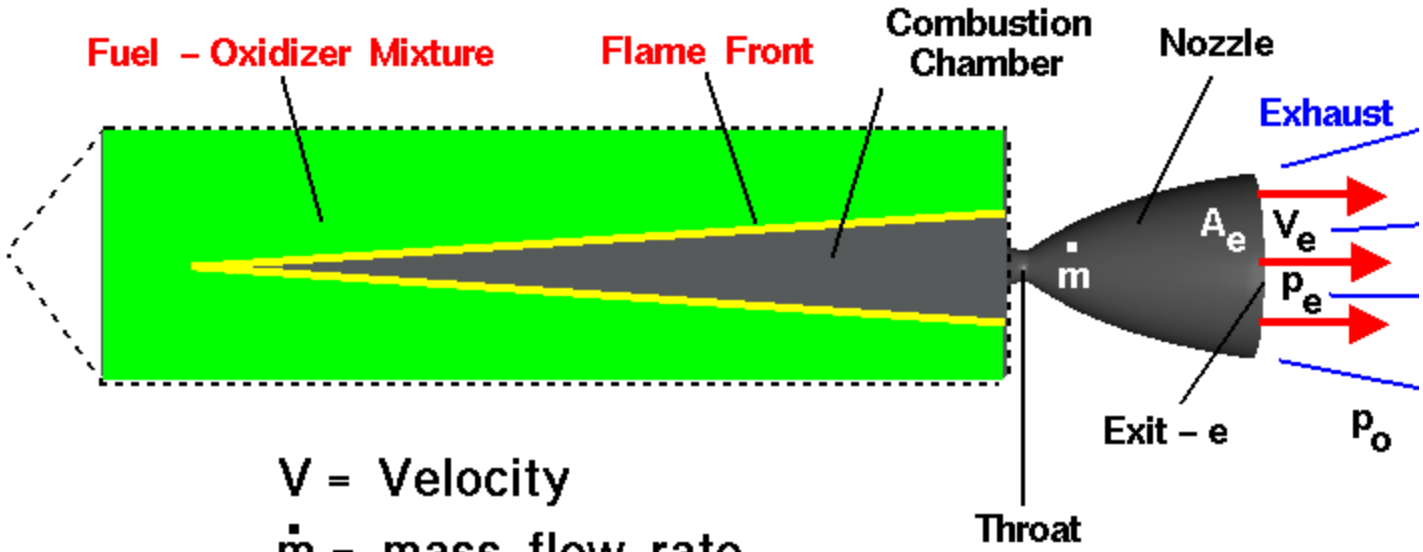


Propulsion System
•Solid Rocket Motor



Solid Rocket Engine

Glenn Research Center



V = Velocity

$\dot{m}$ = mass flow rate

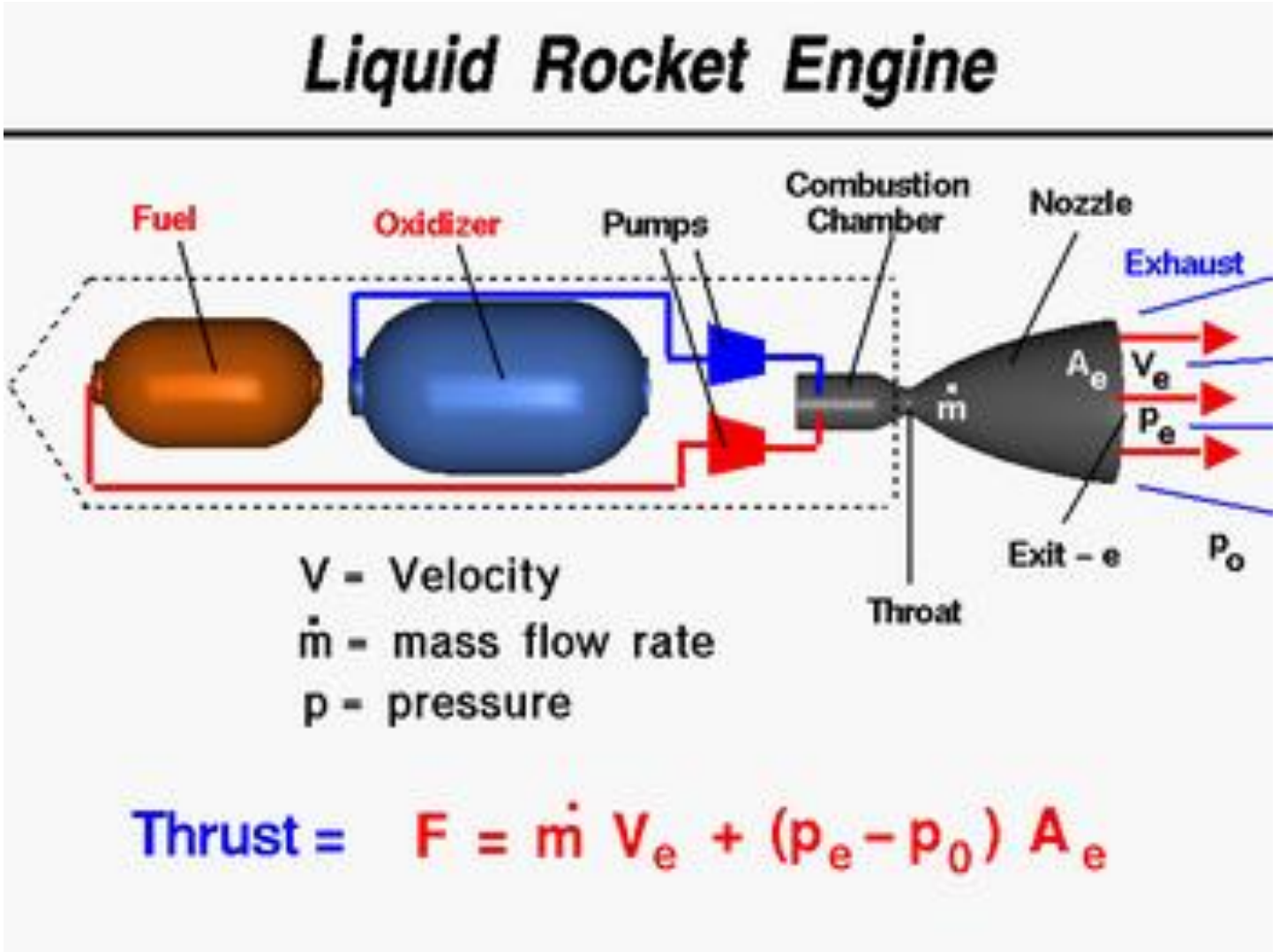
p = pressure

Thrust = $F = \dot{m} V_e + (p_e - p_0) A_e$

*3

Propulsion System

•Liquid Fuel



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Chemical Propulsion

Oxidizers & Reducers

- Oxidation - combination of oxygen with another substance. Time it takes for this process determines if substance rusts, corrodes, burns, or explodes
- Combustion - Rapid oxidation
- Oxidizer - Chemical element of Oxygen used to facilitate oxidation
- Reducers - Fuel used to combine with Oxygen to produce combustion.
- Propellant - Common reference to both oxidizer and fuel
  - Bipropellant - Propellant with separate storage of oxidizer and fuel.
  - Monopropellant - Oxidizer and fuel stored in same container.

Solid Motors-Oxidizer and fuel are mixed together in solid state

- Storable
- No thrust control
- Cannot stop or throttle

Liquid Propellant

- Hard to store/handle
- Can stop or throttle

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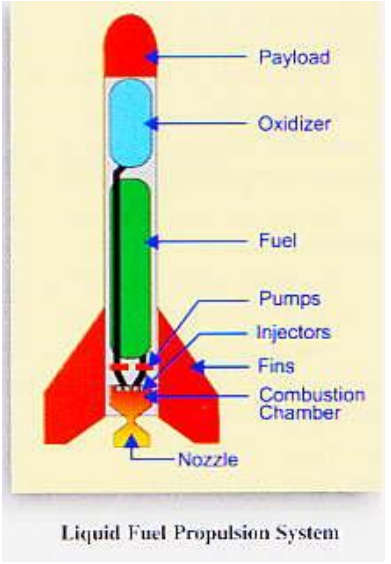

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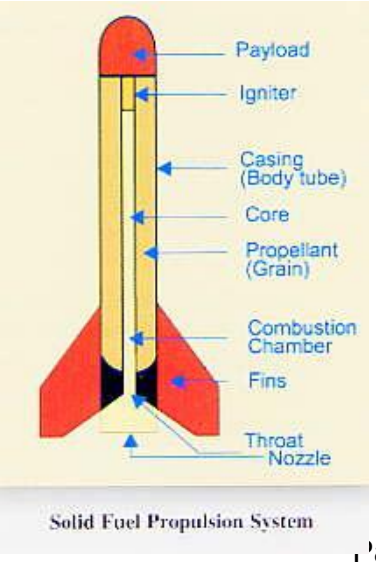

Solid Fuel Propulsion System

Questions???????