ජල පීඩක රොකට්ටු

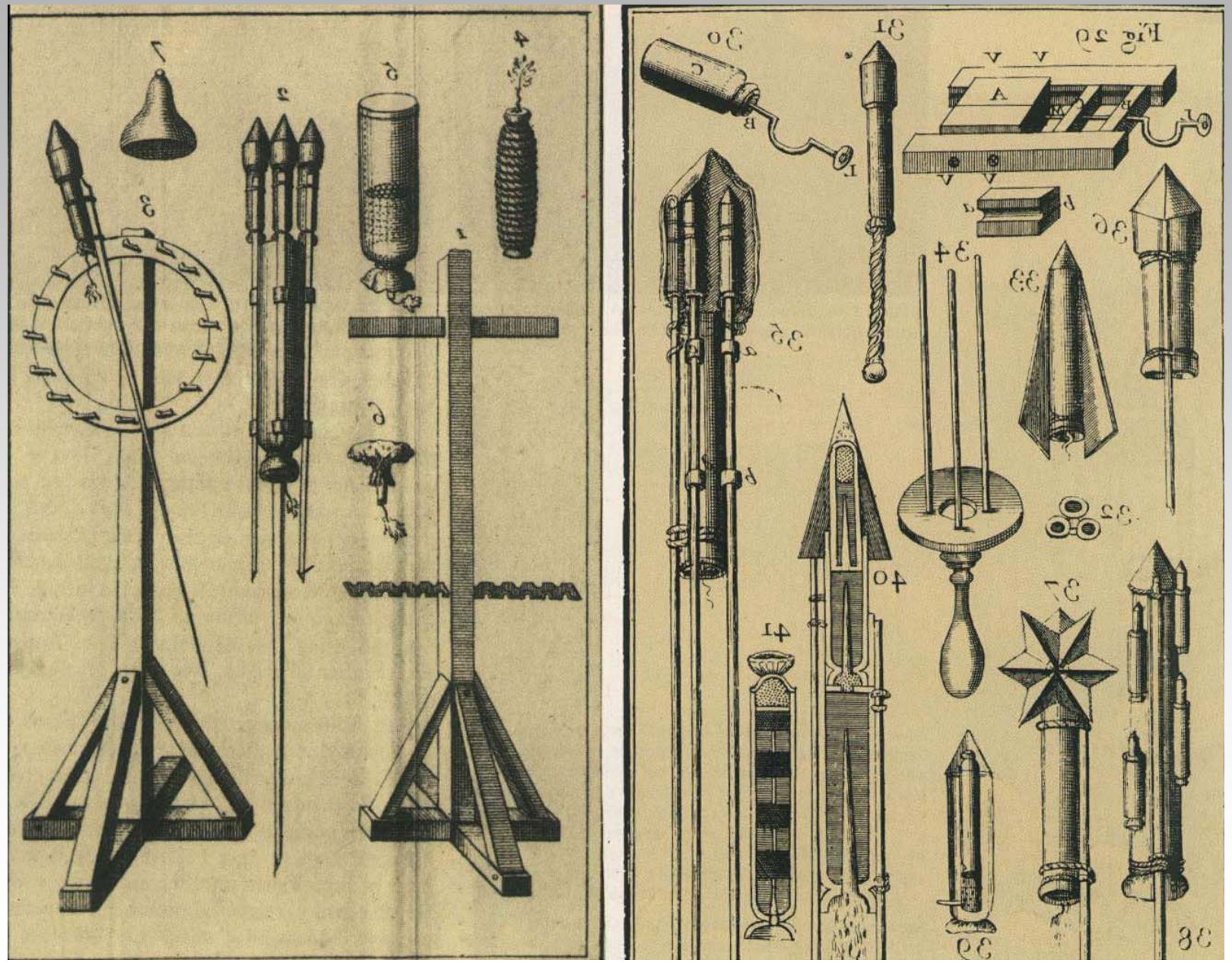
(Water Boost Rockets)

ජනක අඩස්සූරිය

පර්යේෂණ විද්‍යාඥ

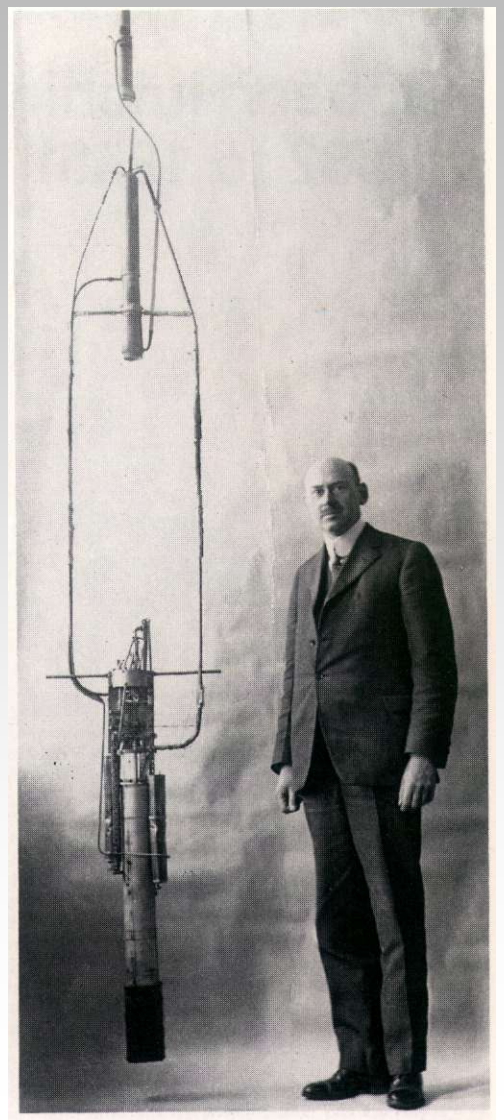
නවීන තාක්ෂණය පිළිබඳ ආතර් සී ක්ලාක් ආයතනය

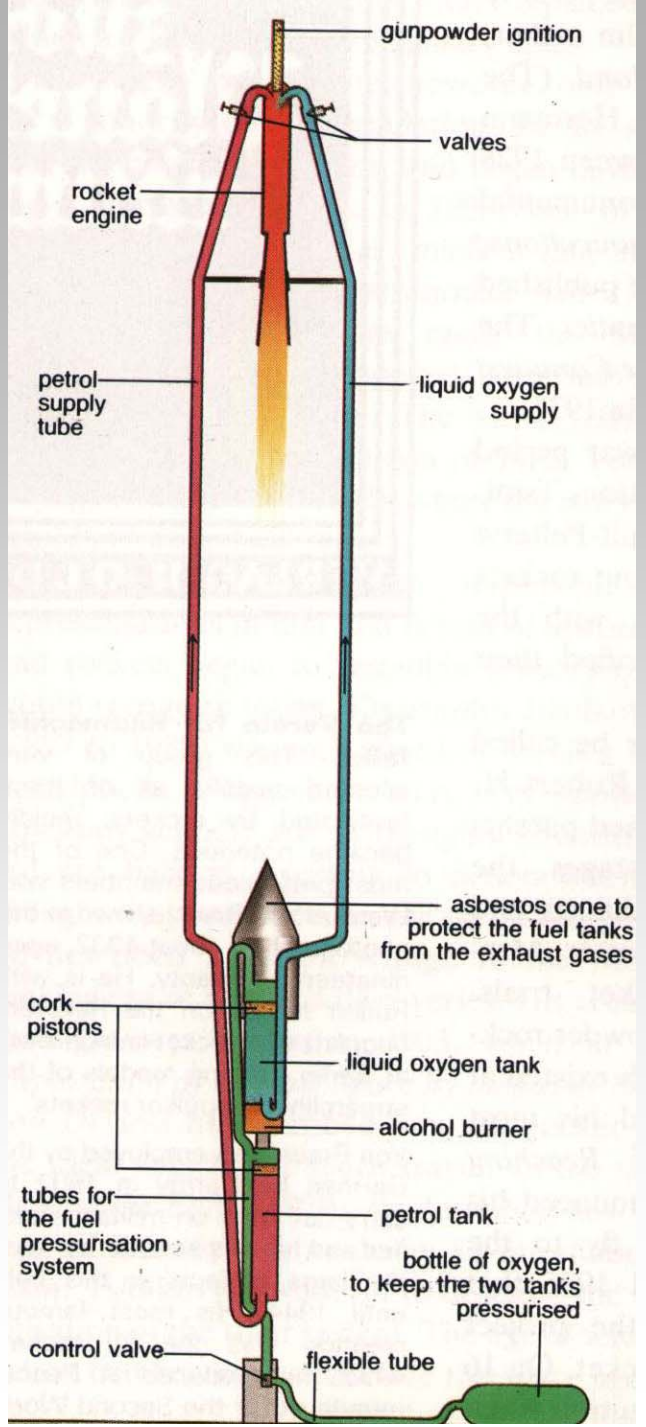
පුරාතන රොකට්ටු



දැව ඉන්ධන රොකට්ටුවේ නිර්මාතෘ

රොබට් එච් ගොඩාඩ්
(Robert H Goddard)
1926 මාර්තු 16 වන දින
ප්‍රථම ඉන්ධන රොකට්ටුව
ගුවන් ගත කරන ලදී.

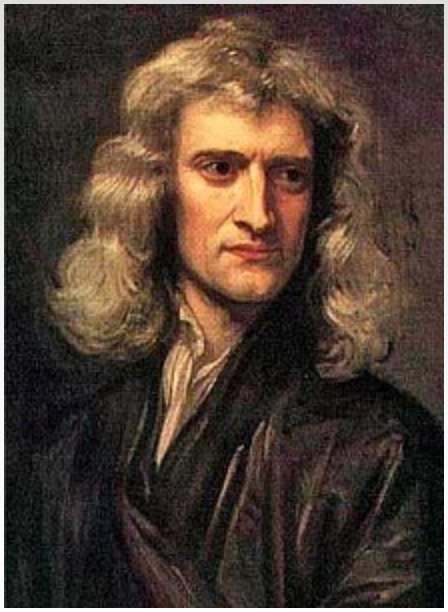


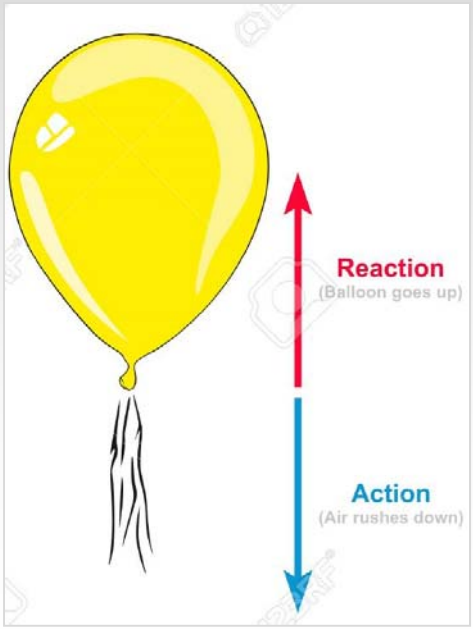


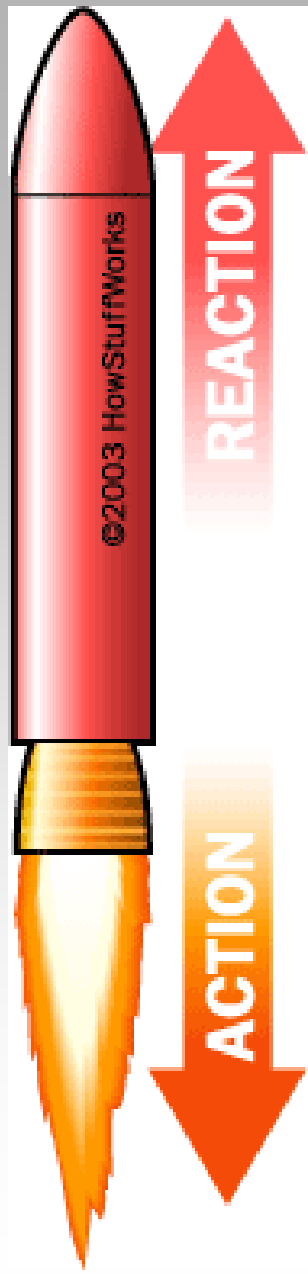
රොකට් එන්ජිමක ක්‍රියාකාරිත්වය.

- රොකට් එන්ජින් ප්‍රතික්‍රියක එන්ජින් (***reaction*** engines) වර්ගයකි.
- නිව්ටන්ගේ තුන්වන නියමය.

සෑම ක්‍රියාවකටම සමාන වූද ප්‍රතිවිරුද්ද වූද ප්‍රතික්‍රියාවක් ඇත. ("every action there is an equal and opposite reaction")



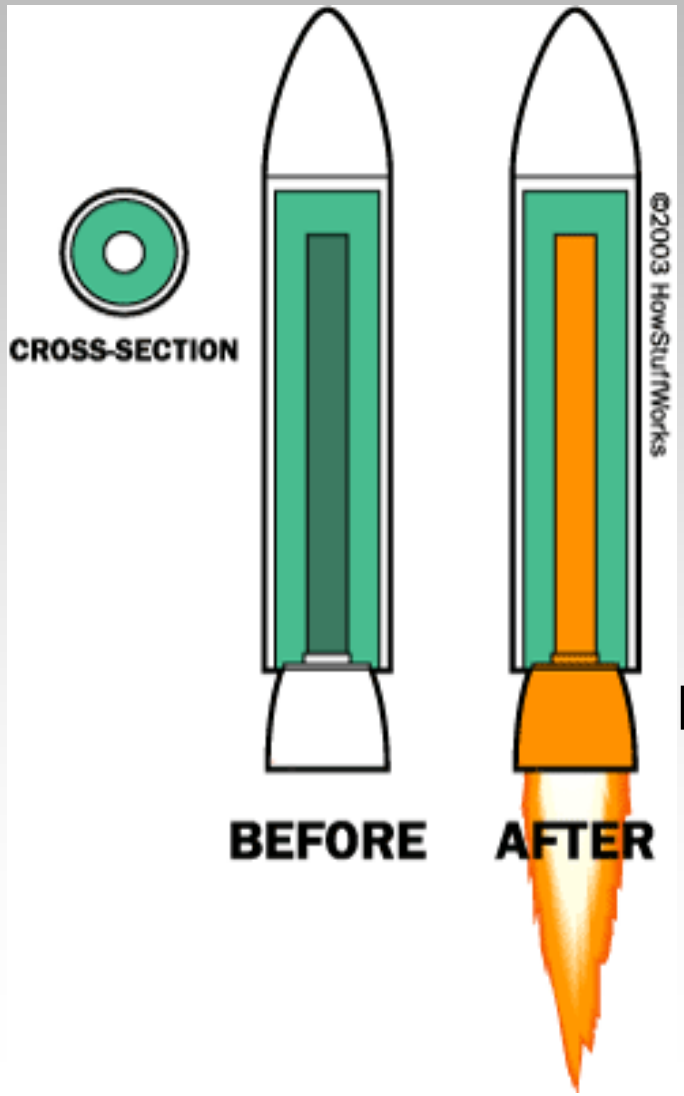




රොකට් එන්ජිම මගින් වාතස්කන්දයක් දහනය කරන අතර එම ස්කන්දය ඉතා වේගයෙන් රොකටයෙන් තෙරපනු ලබයි. මෙම ක්‍රියාවට ප්‍රතික්‍රියාව ලෙස රොකටය ඉදිරියට තල්ලුවේ.

Solid Fuel Rockets

ඝන ඉන්ධන රොකටය



Solid fuel contains

Fuel : fine aluminum powder
Oxidizer : ammonium perchlorate

Solid-fuel rocket engines have three important advantages:

- **Simplicity**
- **Low cost**
- **Safety**

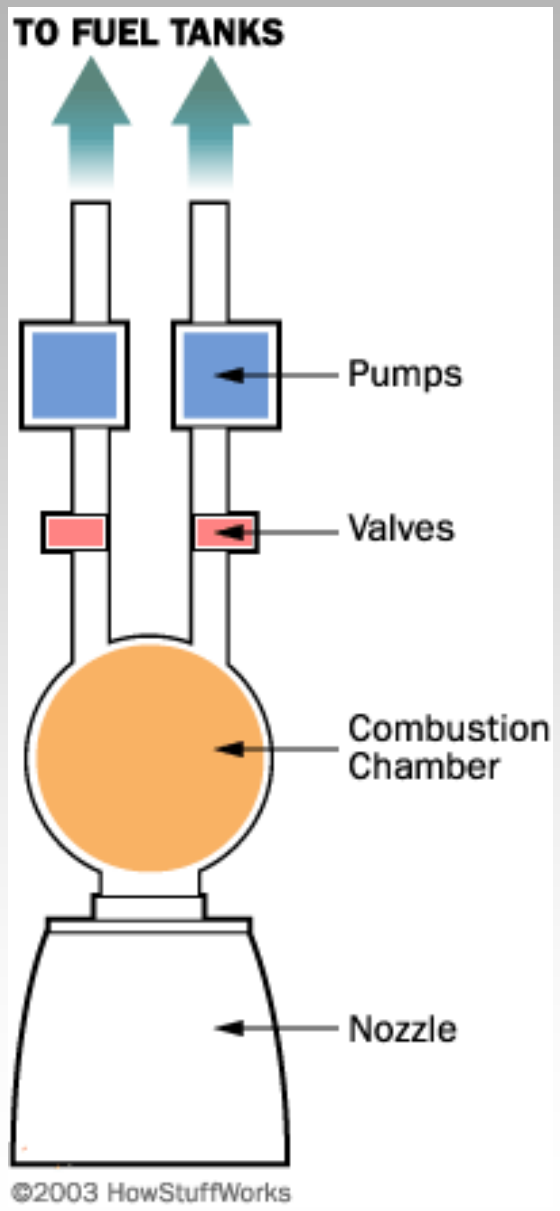
They also have two disadvantages:

- **Thrust cannot be controlled.**
- **Once ignited, the engine cannot be stopped.**

• Solid-fuel rockets are useful for short-lifetime (like missiles), or for booster systems.

• When you need to control the engine, you must use a liquid propellant system.

Liquid-Propellant Rockets



- **Liquid hydrogen and liquid oxygen** - used in the Space shuttle main engine
- **Gasoline and liquid oxygen** - used in Goddard's early rockets
- **Kerosene and liquid oxygen** - used on the first stage of the large saturn V boosters in the Apollo program
- **Alcohol and liquid oxygen** - used in the German V2 rockets
- **Nitrogen tetroxide/monomethyl hydrazine** - used in the Cassini engines

Water Rocket Propulsion

(ජල රොකට්ටුවේ මූලධර්මය)

- Water rockets are propelled by the principle of conservation of momentum (*mass x velocity*)

ජල රොකට්ටුවක් ඉදිරියට ගමන් කරන්නේ ගම්‍යතා සංස්ථිති නියමයට අනුව වේ.

- Newton's Third Law, Water expelled in one direction must be balanced by the rocket accelerating in the opposite direction.

ජල රොකට්ටුවෙන් ඉතා වේගයෙන් පිටවන ජලයේ ගම්‍යතාවයට සමාන ගම්‍යතාවයක් රොකට්ටුව මත ප්‍රතිවිරුද්ධ දිශාවට යෙදේ.

Thrust (තෙරපුම)

- The strength of a rocket is given by the Thrust.

  රොකට්ටුවක් මත බලය තෙරපුමෙන් ලබාදේ.

- Rocket thrust depends on both the nozzle size and the air the pressure.

  රොකට්ටුවේ තෙරපුම එහි ජලයේ පිඩනය මත සහ නොසලයේ වර්ගඵලය මත රදා පවති.

$$Thrust = 2PA$$

$$= 2P\pi\left(\frac{D}{2}\right)^2$$

When pressure in (Pa) and diameter in (m), Thrust is (N)

Thrust Duration (තෙරපුම් කාලය)

- Nozzle size - නොසලයේ ප්‍රමාණය
- Water volume - ජලය ප්‍රමාණය
- Air pressure - ඇතුලත වාත පීඩනය

Longer duration can be achieved

(වැඩි තෙරපුම් කාලයක් ලබා ගැනීමට)

- Narrow nozzle - කුඩා නොසලයක්
- More water - වැඩි ජල ප්‍රමාණයක්
- Lower pressure - අඩු පීඩනයක්

Drag (වාත ප්‍රතිරෝධය)

Force of the air resistance on the rocket's motion

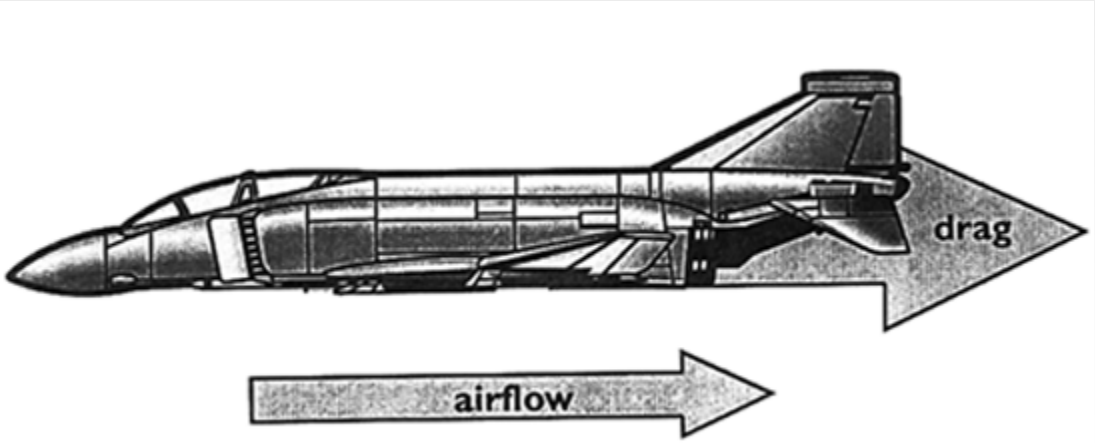
$$Drag = \frac{1}{2}\left[Cd \times A \times d \times v^2\right]$$

C_d = coefficient of drag

A = front area of the rocket - ඉදිරිපස වර්ගඵලය

d = air density (typically 1.2kg/m^3) - වාත ඝනත්වය

v = velocity - රොකට්ටුවේ වේගය



Aerodynamic Stability

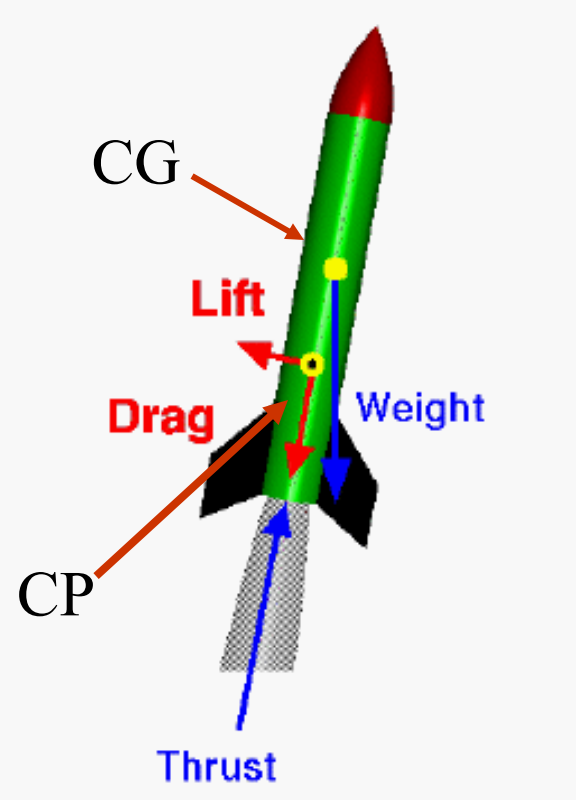
වායු ගතික සමතුලිතතාවය

For a stable flight, the center of gravity (CG) is ahead of the center of pressure (CP).

රොකටයක් ස්ථායි වීමට එම රොකටයේ ගුරුත්ව කේන්ද්‍රය පීඩන කේන්ද්‍රයට වඩා ඉහලින් පිහිටිය යුතුයි.

Center of pressure is the point on a body where the sum of the aerodynamic pressure acts, causing a force and no movement about that point.

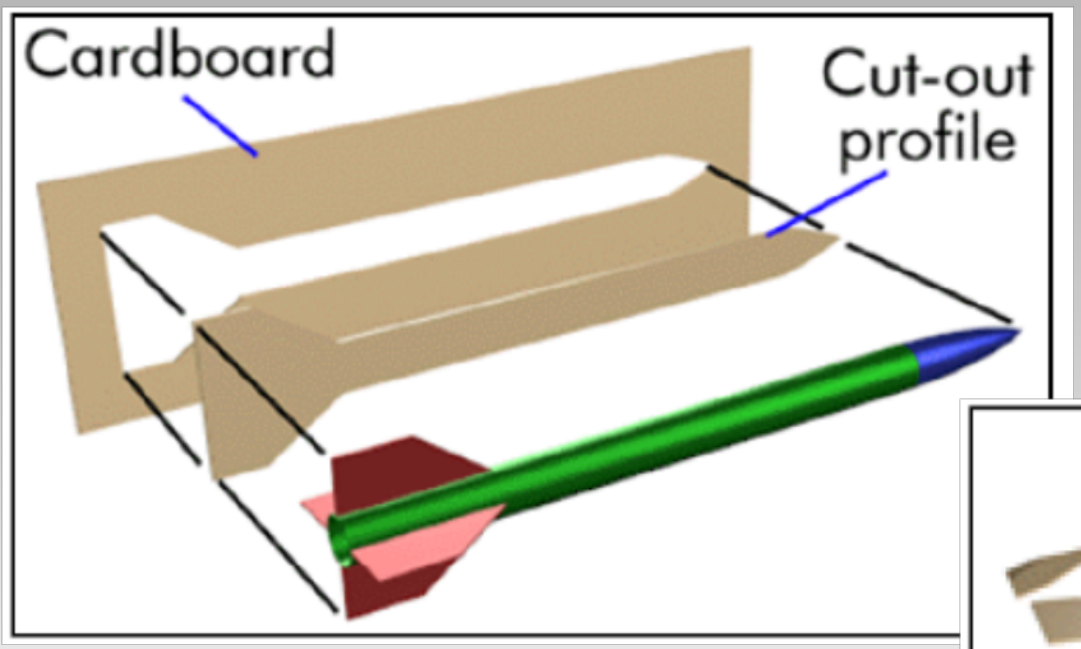
පීඩන කේන්ද්‍රය යනු සම්ප්‍රයුක්ත වායු ගතික පීඩන යෙදෙන ලක්ෂ්‍යය වේ.

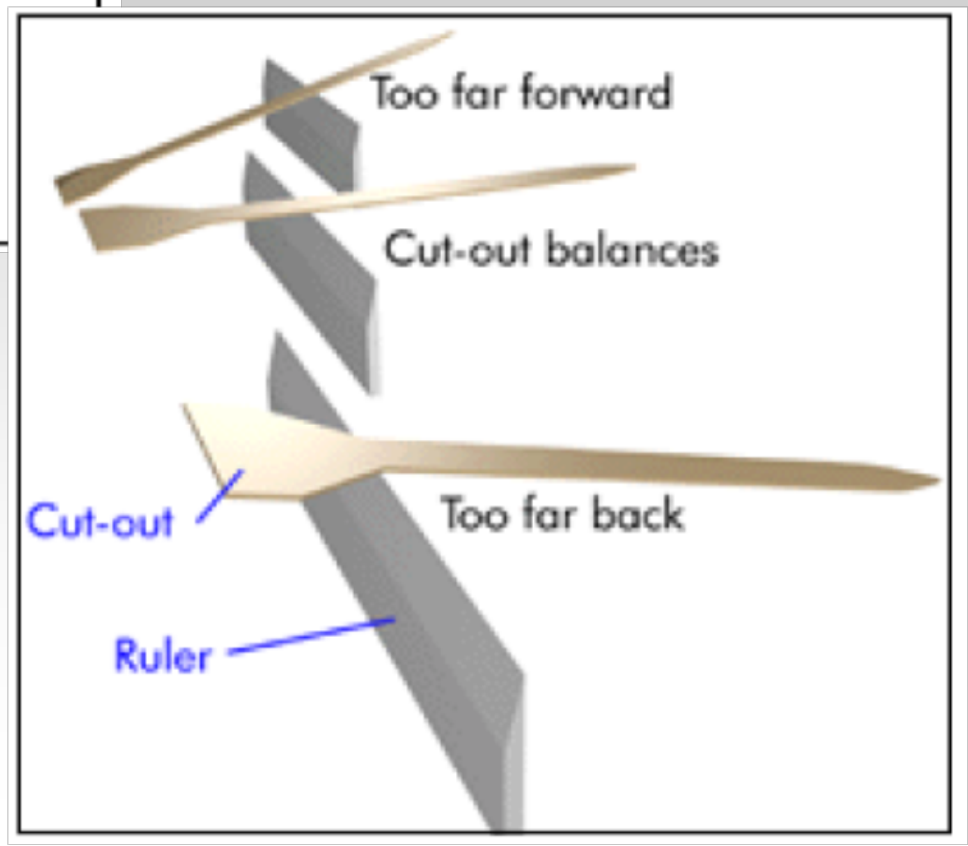


Center of mass of a system of particles is a specific point at which, for many purposes, the system's mass behaves as if it were concentrated.

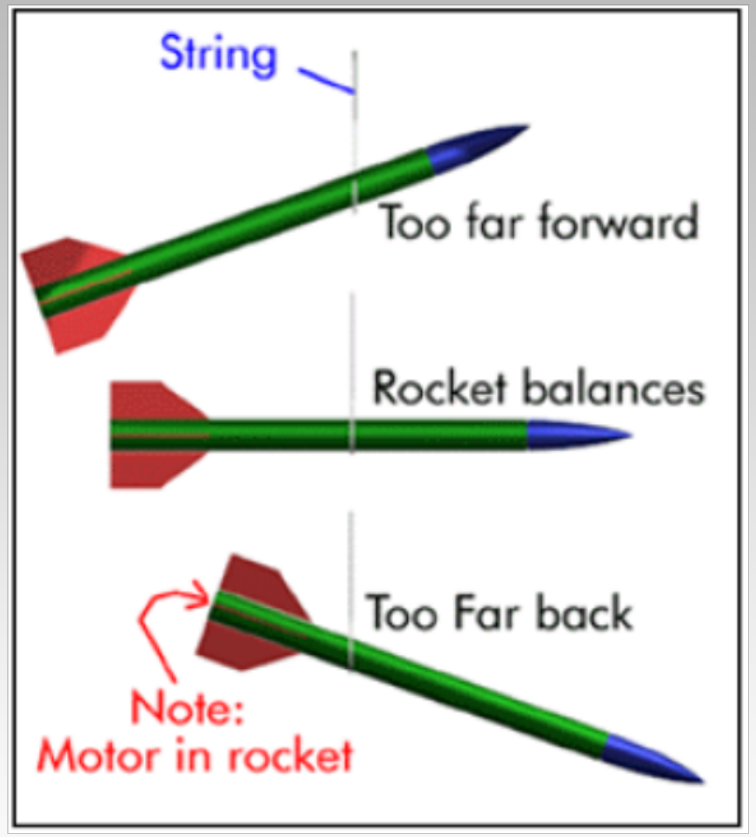
ගුරුත්ව කේන්ද්‍රය යනු රොකටයේ සම්ප්‍රයුක්ත බර යෙදෙන ලක්ෂ්‍යය වේ.

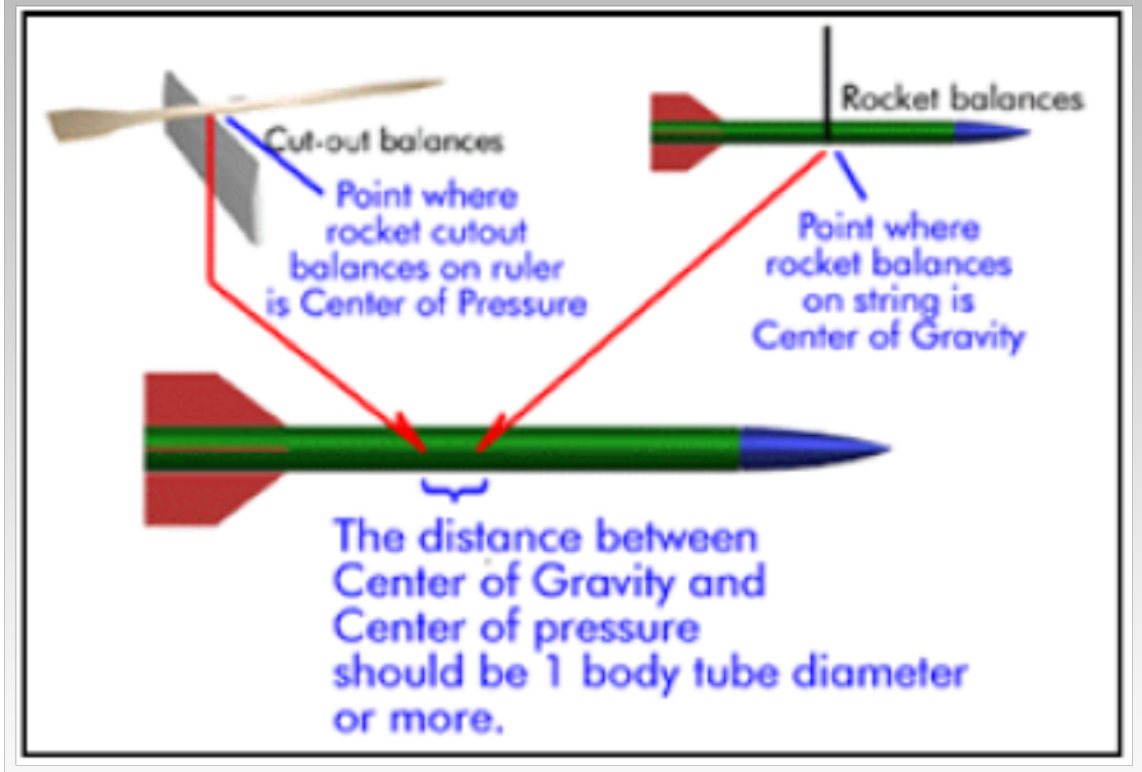
How to find the center of pressure (CP) of the rocket

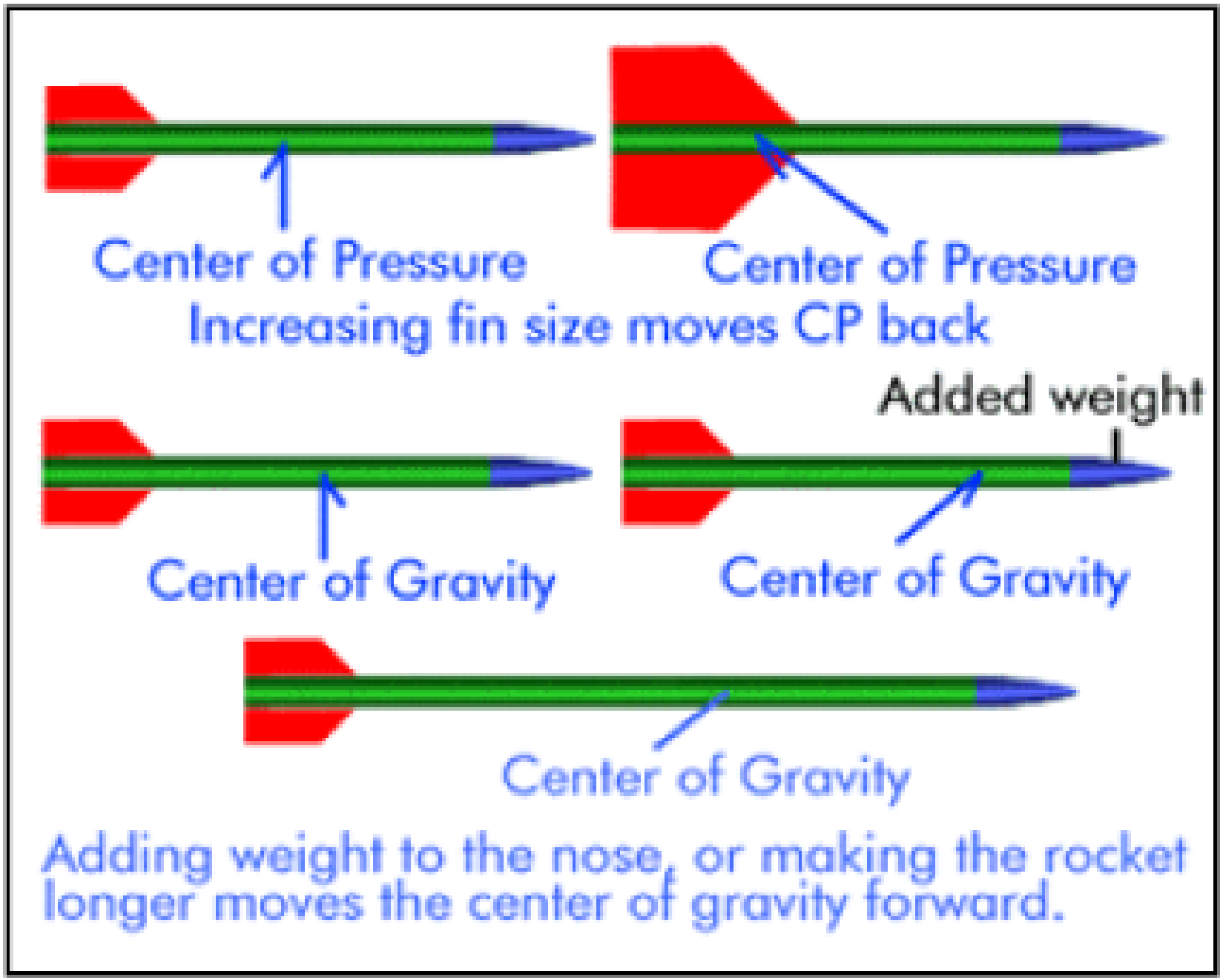




How to find the center of gravity (CG) of the rocket

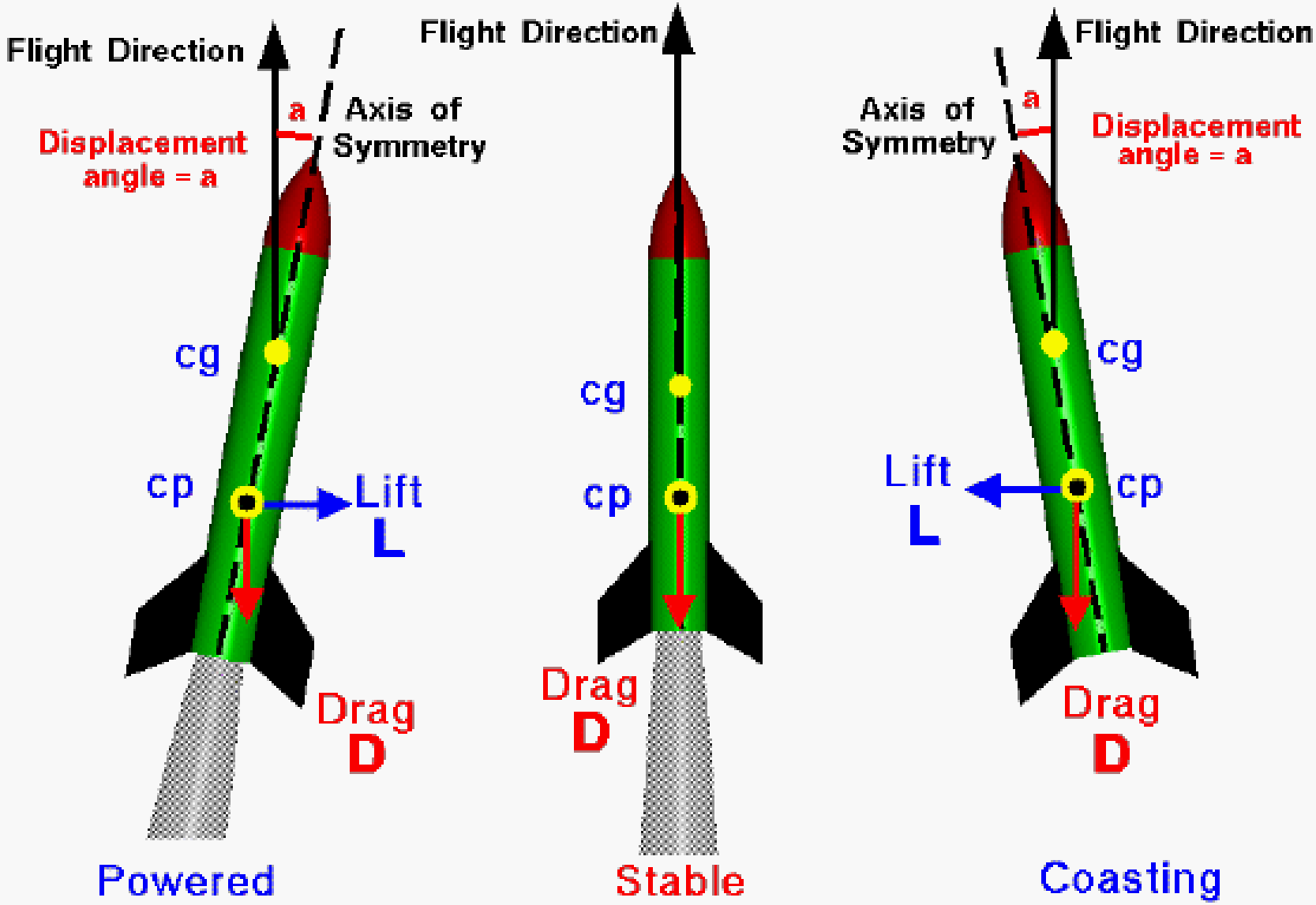





Center of Pressure
Center of Pressure
Increasing fin size moves CP back
Added weight
Center of Gravity
Center of Gravity
Center of Gravity
Adding weight to the nose, or making the rocket longer moves the center of gravity forward.

Stability of a Model Rocket

Glenn Research Center

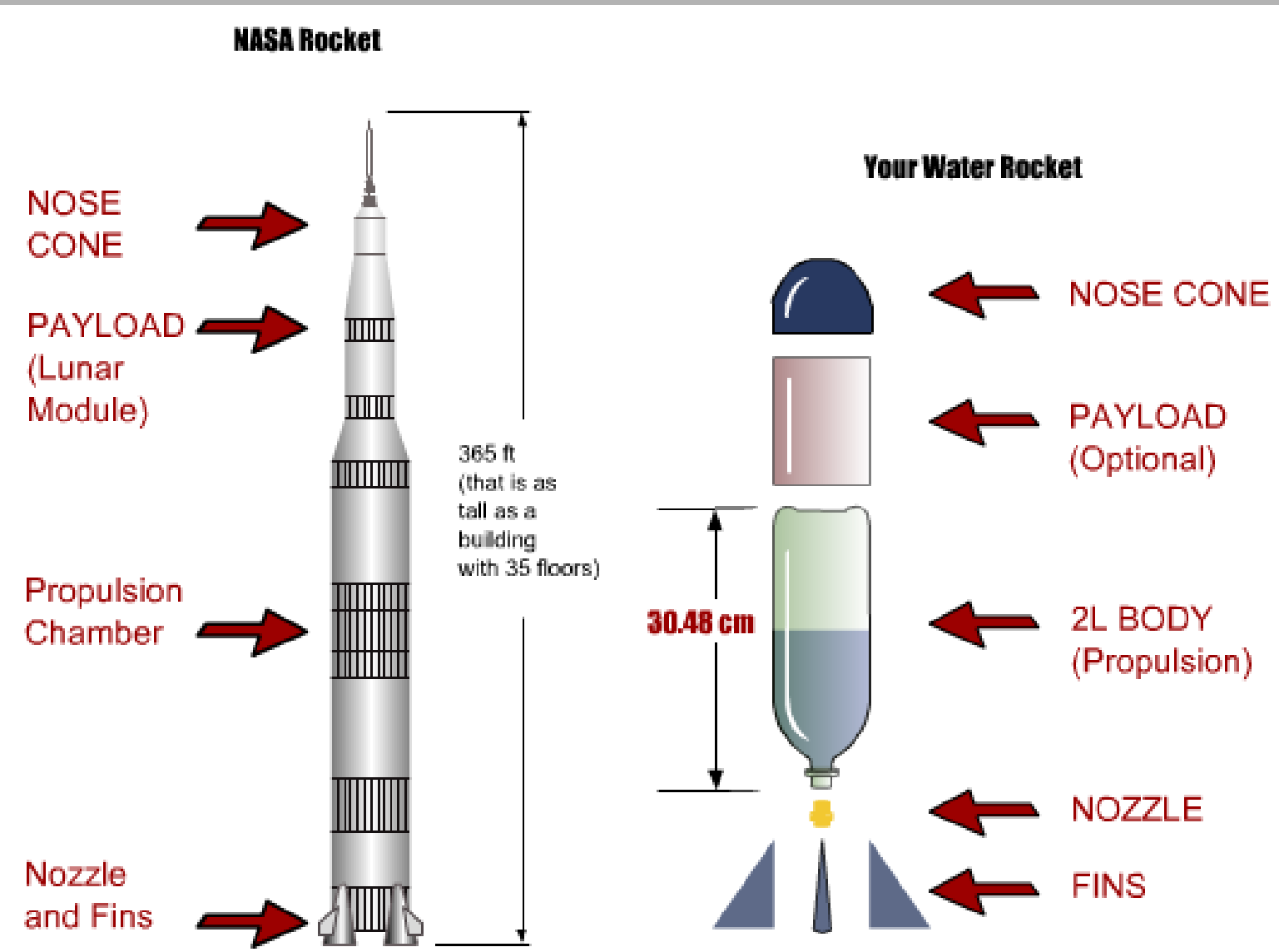


ජල පීඩක රොකට්ටු

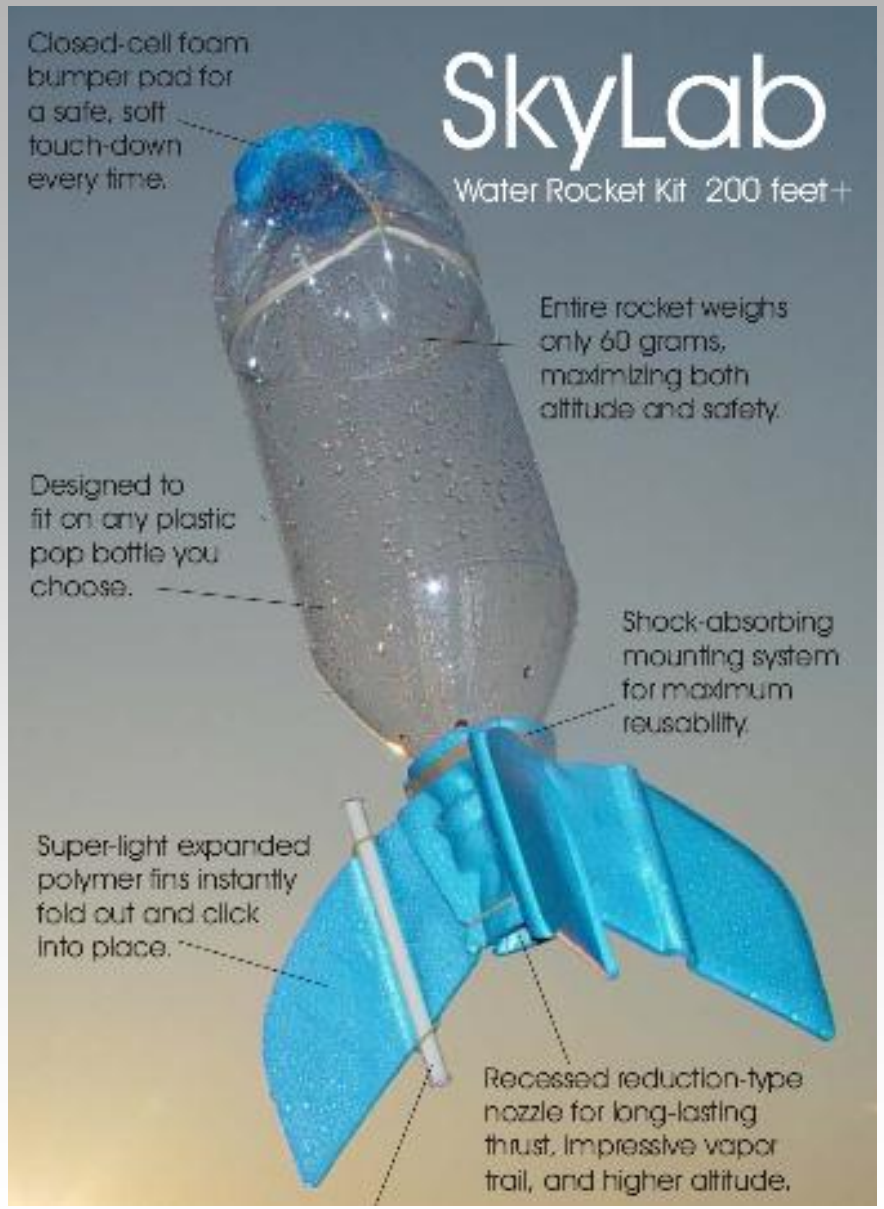
(Water Boost Rockets)

ජල පීඩක රොකට්ටු වර්ග කිහිපයකි.

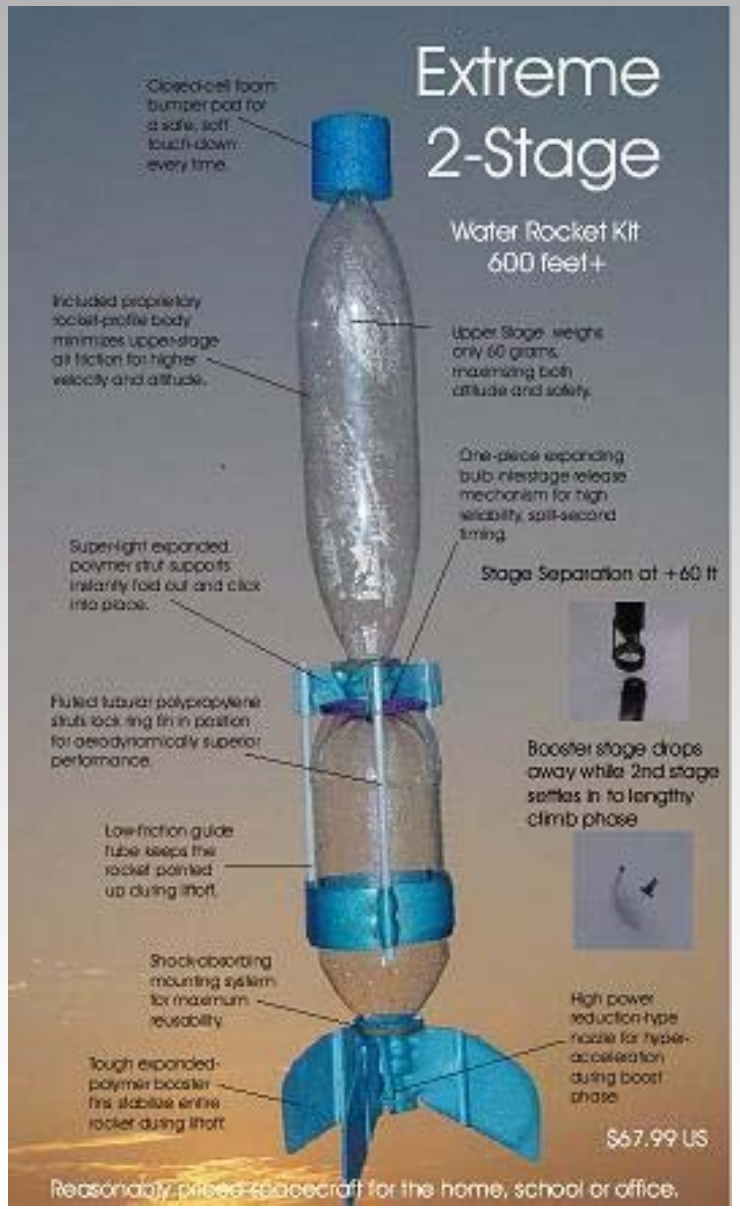
- ඒක පියවර රොකට්ටු (one stage rockets)
- බහු පියවර රොකට්ටු (multi-stage rockets)
- පැරෂුට මුදාහැරීම (parachute deploying)

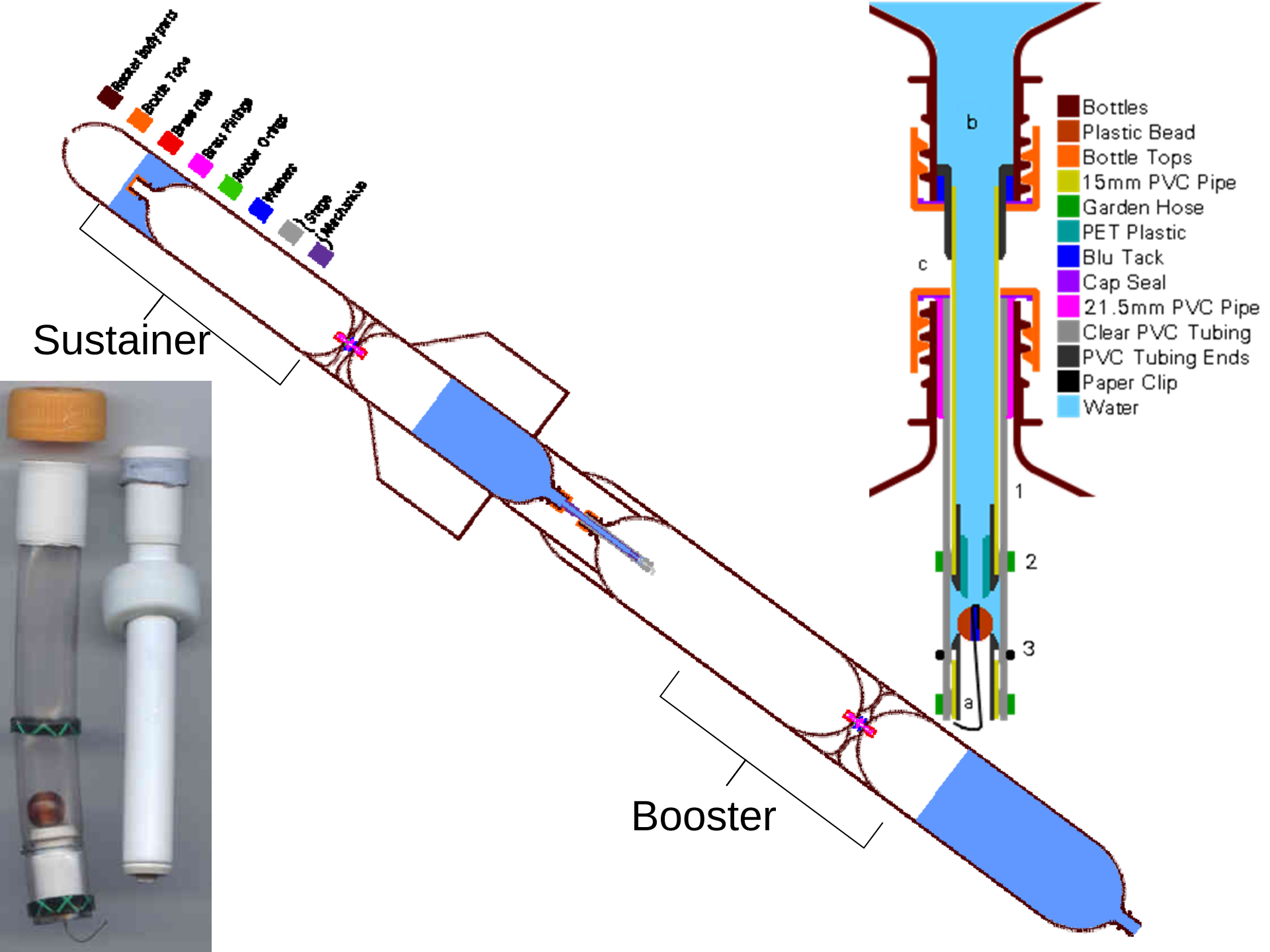

NASA Rocket
NOSE CONE
PAYLOAD (Lunar Module)
Propulsion Chamber
Nozzle and Fins
365 ft (that is as tall as a building with 35 floors)
Your Water Rocket
NOSE CONE
PAYLOAD (Optional)
30.48 cm
2L BODY (Propulsion)
NOZZLE
FINS

Single stage

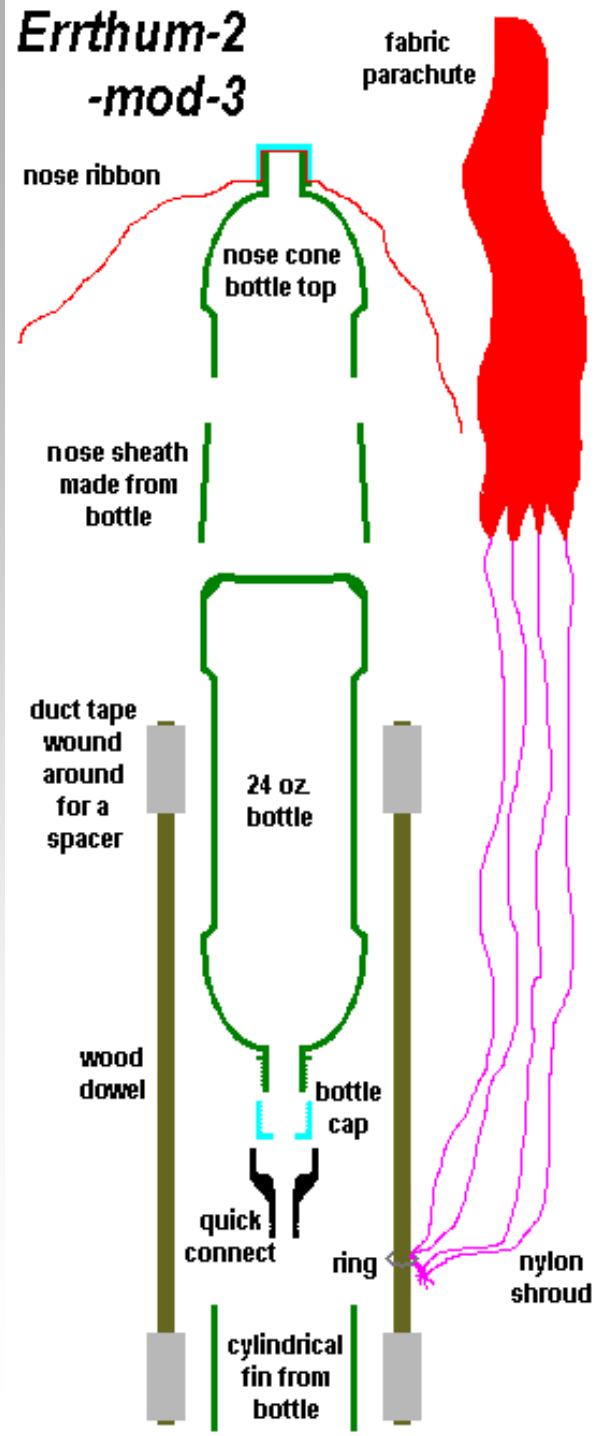


Double stage



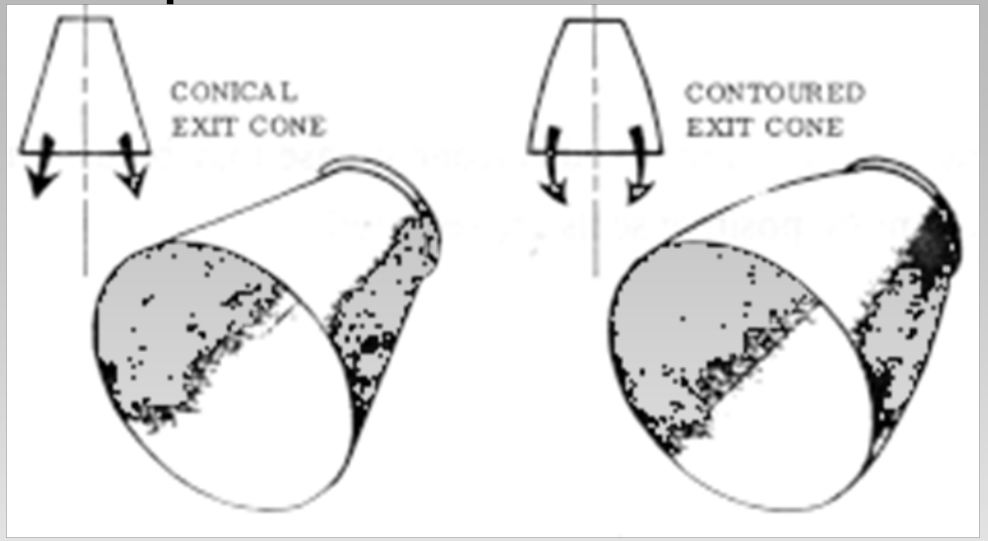

Sustainer
Booster
Bottles
Plastic Bead
Bottle Tops
15mm PVC Pipe
Garden Hose
PET Plastic
Blu Tack
Cap Seal
21.5mm PVC Pipe
Clear PVC Tubing
PVC Tubing Ends
Paper Clip
Water
a
b
c
1
2
3

Rocket with a Parachute

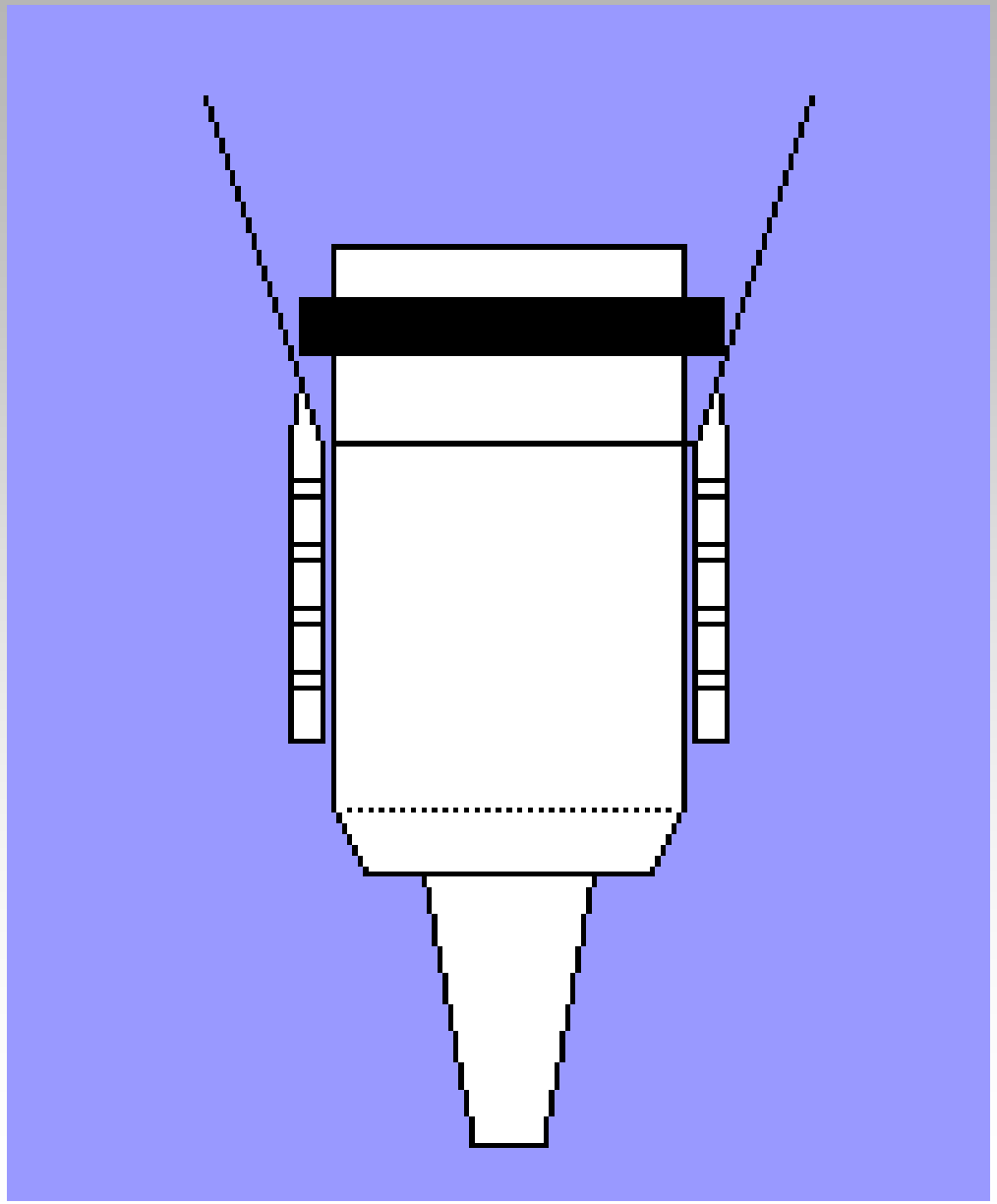


Nozzles

open-mouth nozzle



Restricted nozzles

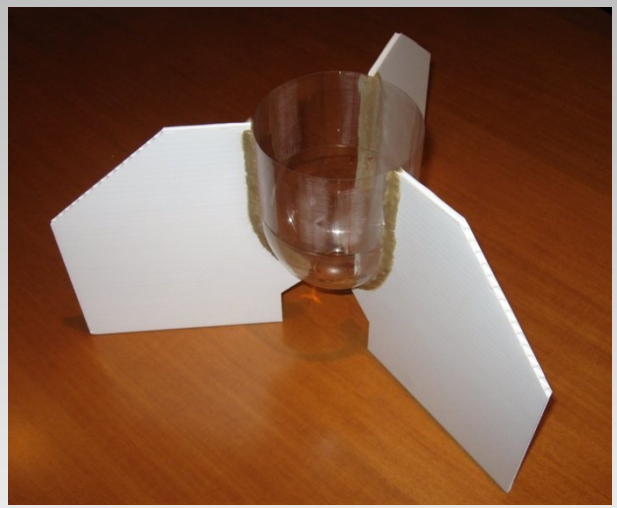


Fin Sets

Ring Fin set

Use with restricted nozzle

Tripod Fin set



- Construct in many ways
- Minimize the drag created by them- small & Thin
- Small fins far back be as effective as larger fins further forward

Safety - ආරක්ෂාව

- Only use bottles that made to contain carbonated drinks.
- Do not use more than 75 psi or 500kPa in 2 liter bottles.
- Cutting bottles can be dangerous.
- Releasing the rocket should not be done hands directly. It should be done by some remote mechanism.

- කාබනික බීම බෝතල් පමණක් භාවිතයට ගත යුතුවේ.
- ජල රොකට්ටුවේ පීඩනය කිසි විටෙක 75 PSI හෝ 500KPa නොඉක්මවිය යුතුයි.
- රොකට්ටුව නිදහස් කිරීම අතින් සිදු නොකල යුතු අතර ඒ සඳහා දුරස්ථව ක්‍රියාත්මක කරනයක් භාවිතා කල යුතුය.

Pressure Conversions

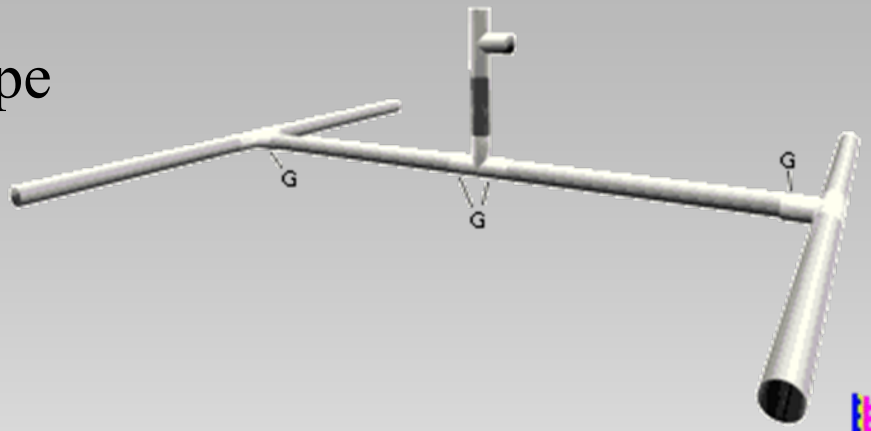
Unit	Conversion
1 torr	133.32 Pa
1 psi	68.948×10^{-3} bar
1 bar	10^5 Pa

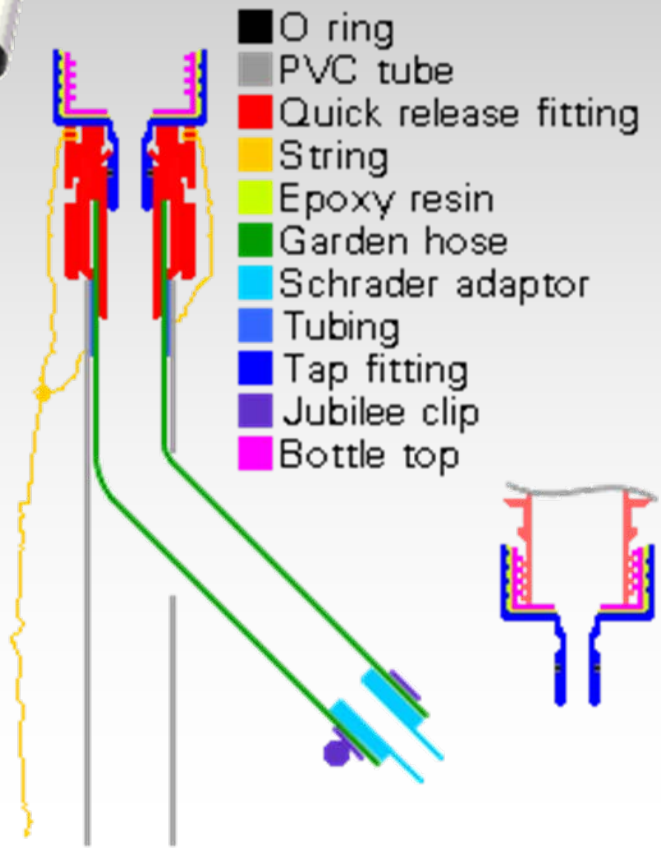
Launchers and Release Mechanisms

- *Rubber stopper*
- *Garden hose fitting*
- *The Copper Tube Launcher*

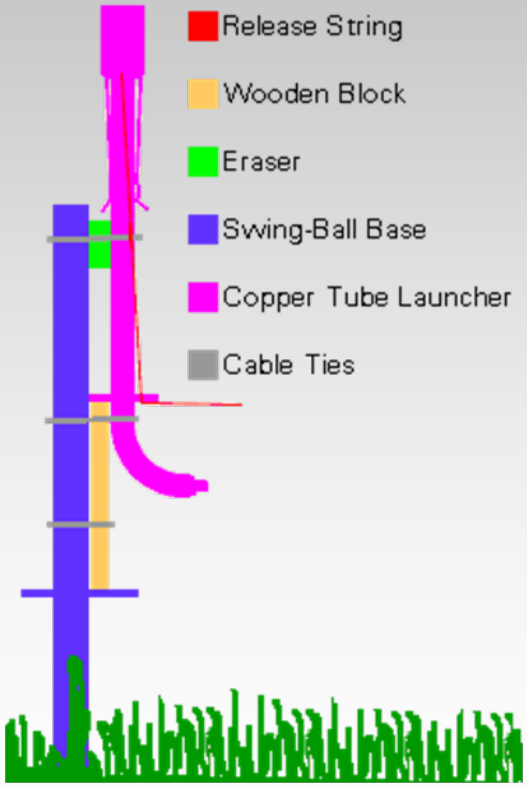
Launching Mechanism

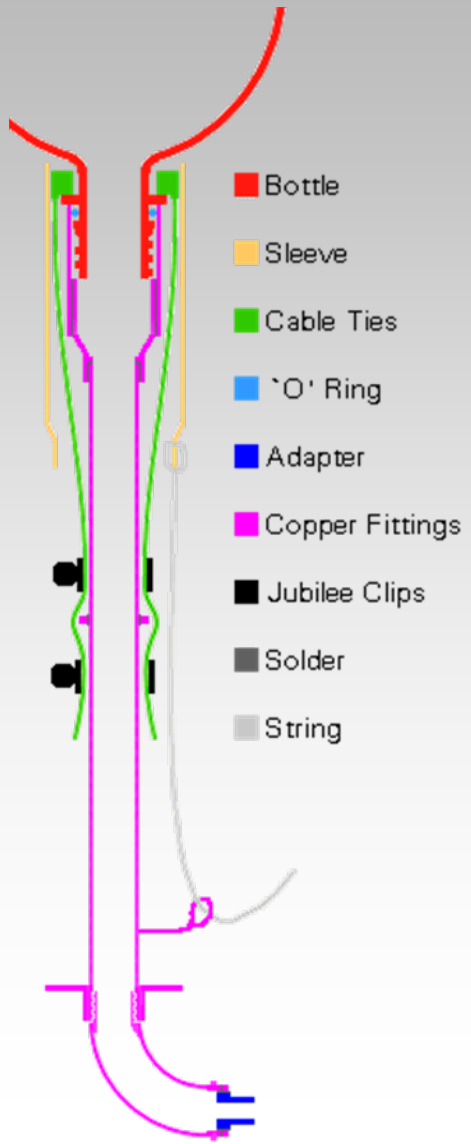
Garden hose type with H Base



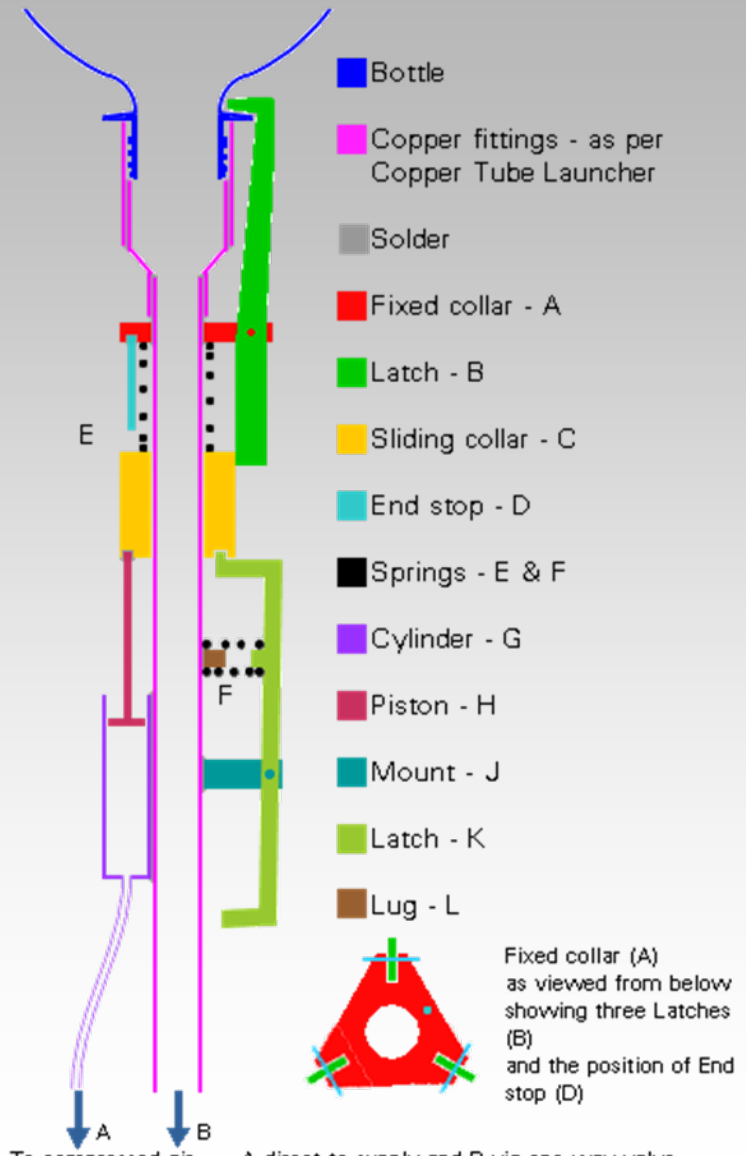


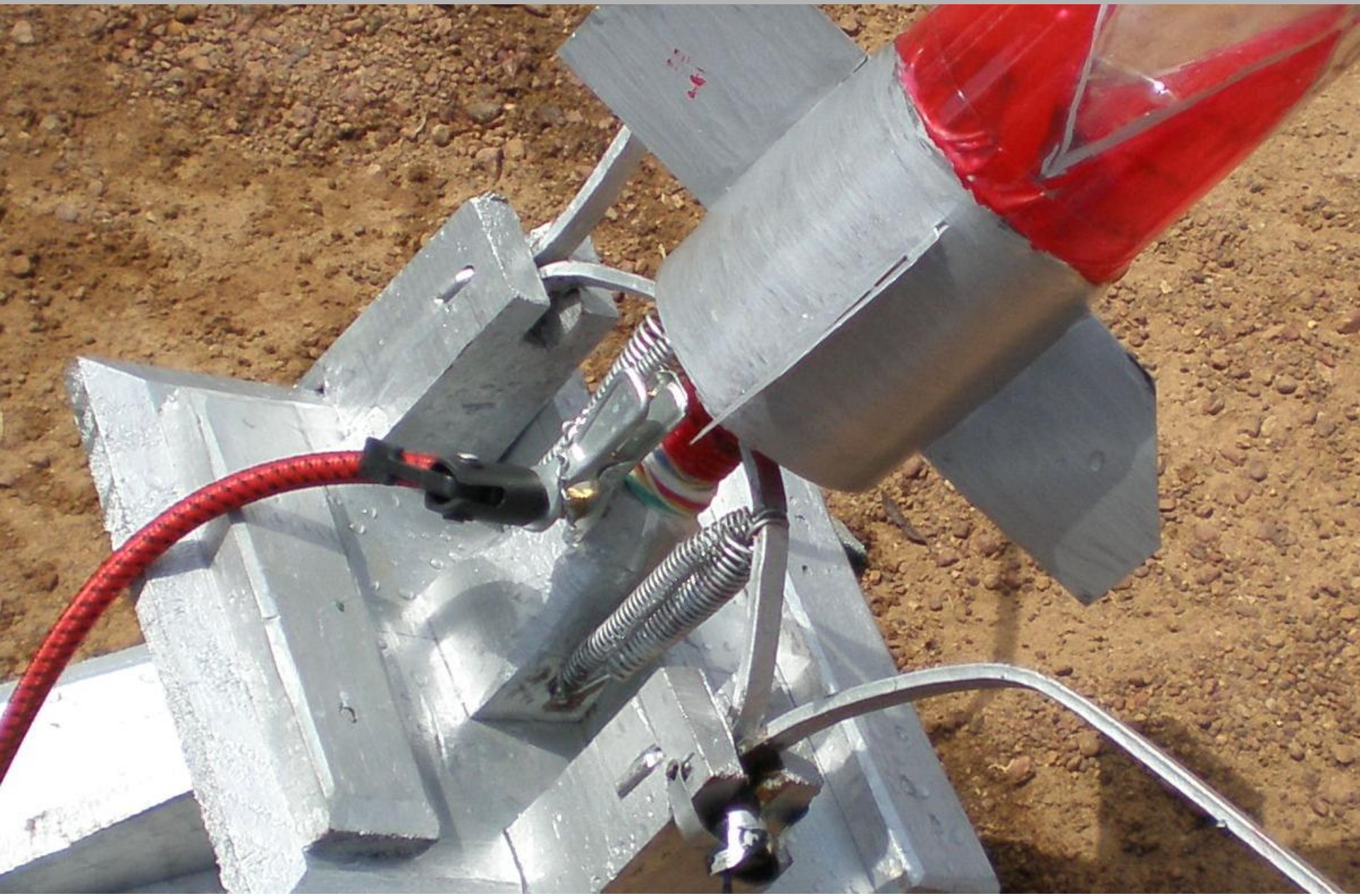
The Copper Tube Launcher

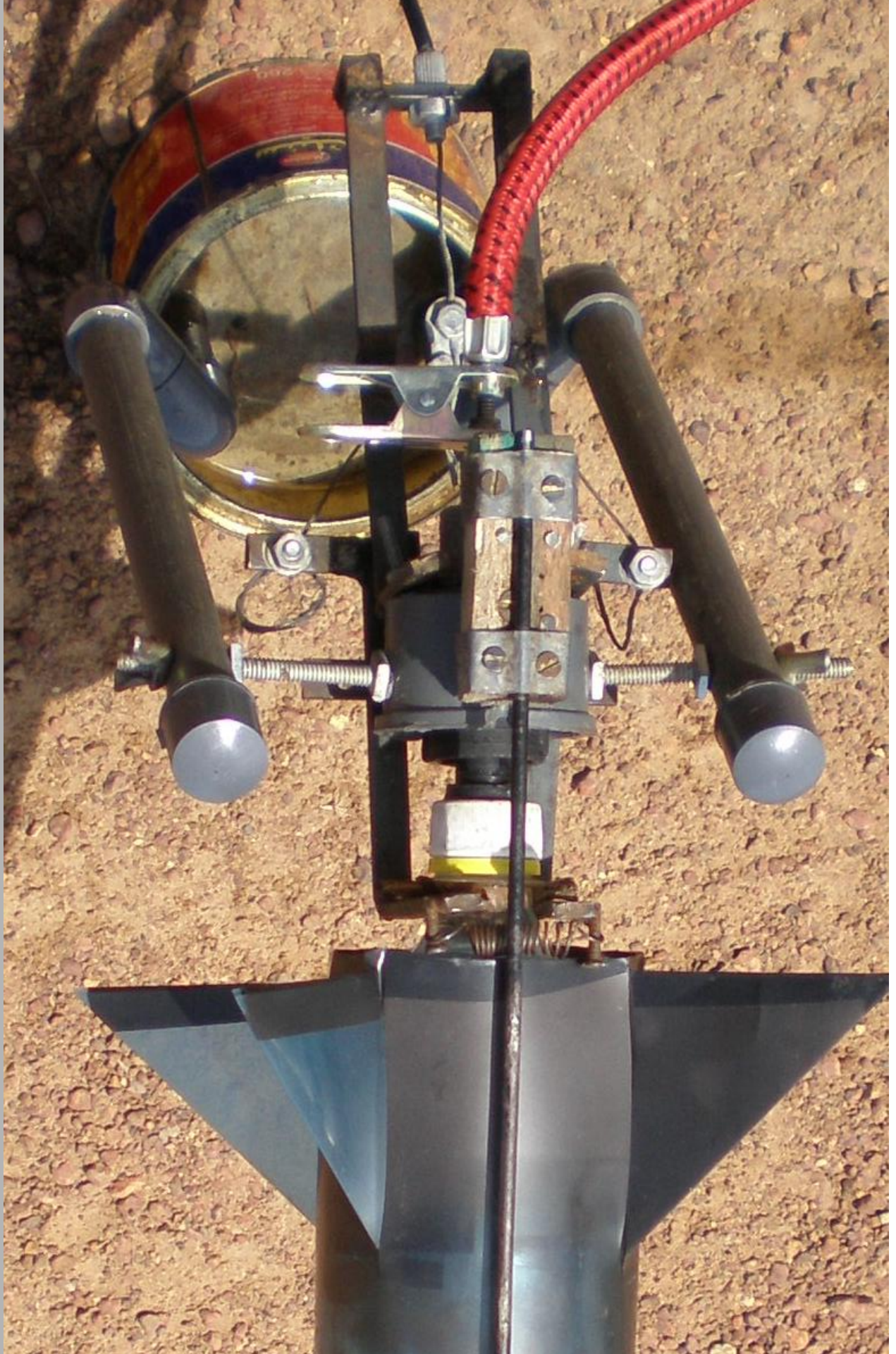


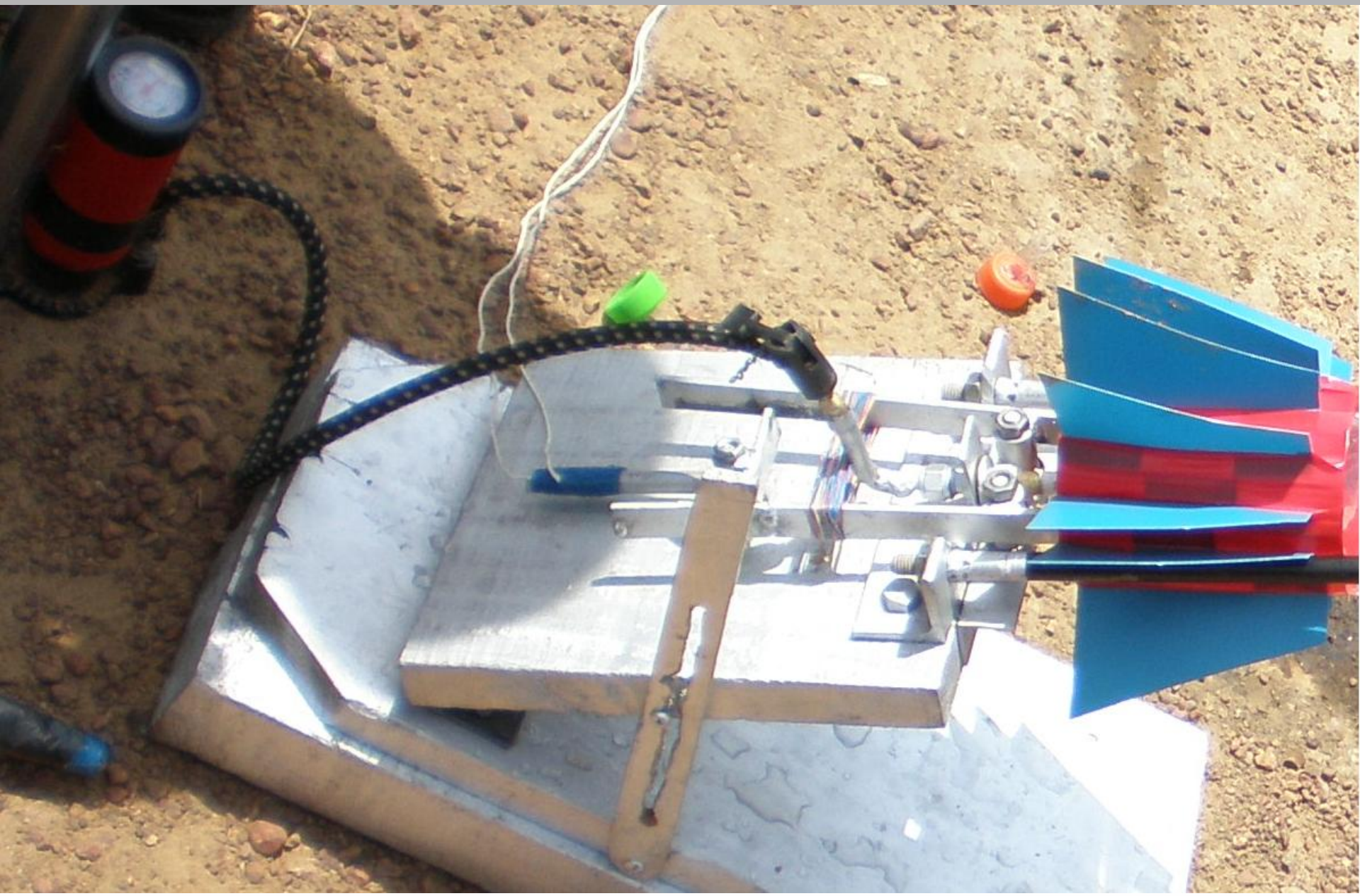


Modified Copper Tube Launcher









Different Uses of Water Rockets

- Product drop-tests
- Remote sensor delivery
- Acceleration/deceleration profiling
- Camera deployment
- Aerial photography
- Team-building exercises
- Engineering labor-pool development

Thank you
&
Be a Rocket
Engineer