LET'S LAUNCH A ROCKET!

- https://www.youtube.com/watch?v=OnoNITE-CLc

ACTUALLY, IT IS ROCKET SCIENCE!

2016 MIDDLE COLLEGE NATIONAL CONSORTIUM

"DRIVING EDUCATIONAL INNOVATION"

SAMUEL N. SAENZ, M.Ed.

HOUSTON COMMUNITY COLLEGE

EAST EARLY COLLEGE HIGH SCHOOL

HOUSTON, TEXAS

PURPOSE

- Address specific standards from the Next Generation Science Standards
- Address specific standards from the Common Core State Standards
- Use innovative designs to make and build model rockets using a quick and efficient process
- The use of ‘low budget’ model rocketry to promote and excite STEM awareness

Addressing the Next Generation Science Standards (NGSS)

Earth and Space Science:

- Using Mathematical and Computational Thinking Mathematical and computational thinking in 9–12 builds on K–8 experiences and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions. Use mathematical or computational representations of phenomena to describe explanations. (HS-ESS1-4)

NGSS (HS-ESSI-6)

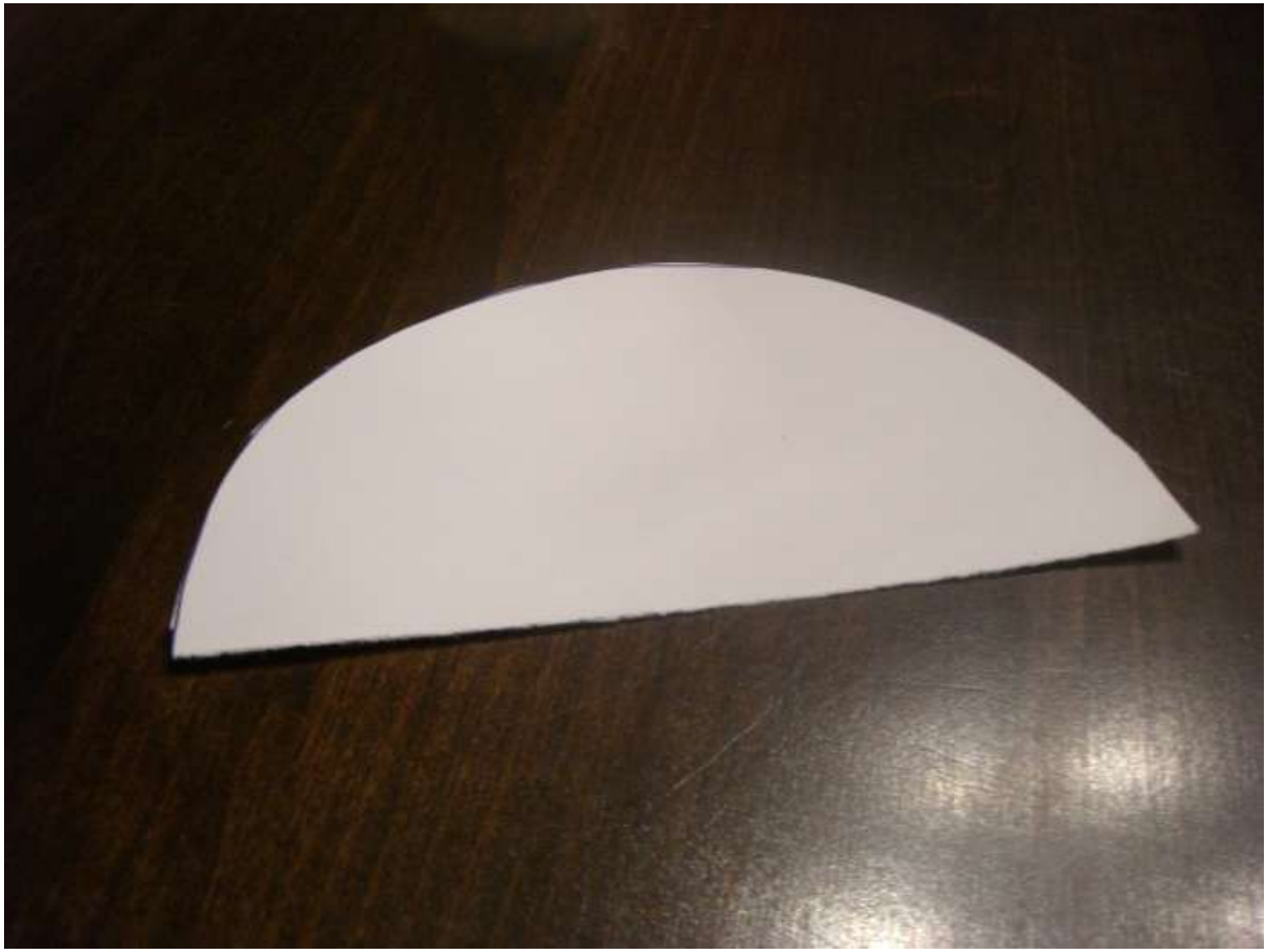
- Constructing Explanations and Designing Solutions Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.
- Construct an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-ESS1-2)
- Apply scientific reasoning to link evidence to the claims to assess the extent to which the reasoning and data support the explanation or conclusion. (HS-ESS1-6)

COMMON CORE STATE STANDARDS CONNECTIONS

- RST .11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. (HS -ESS1-5),(HS-ESS1-6)
- HSN-Q.A .1 Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data display s. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HS-ESS1-6)
- HSN-Q.A .3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-ESS1-1),(HS-ESS1-2),(HS-ESS1-4),(HS-ESS1-5),(HSESS1-6)
- HSA -CED.A.2 Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales. (HSESS1-1),(HS-ESS1-2),(HS-ESS1-4)

STEP ONE: MAKE A NOSECONE

TRACE OUT A CIRCLE AND CUT IT OUT
IT SHOULD BE ABOUT 5” IN DIAMETER

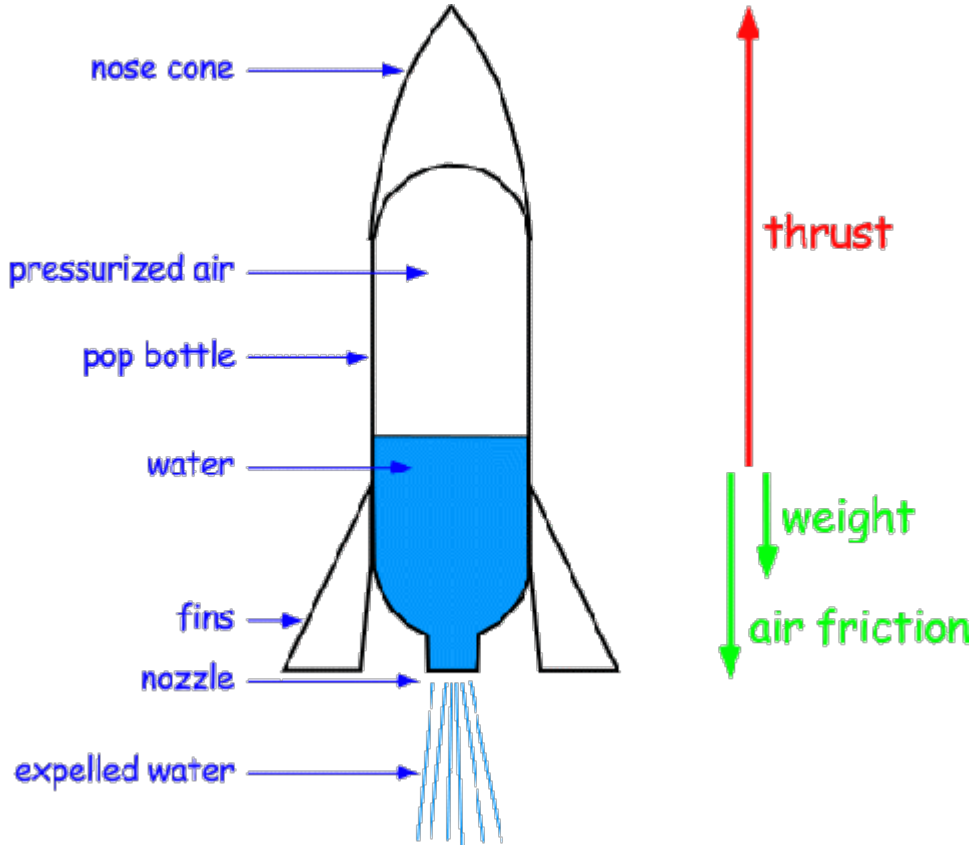


FOLD THE CIRCLE IN HALF TO MAKE A SEMICIRCLE AND CUT THE CIRCLE IN HALF

ROLL THE SEMICIRCLE INTO A CONE AND TAPE IT TOGETHER
THEN SET IT ASIDE.

TYPES OF CLASSROOM ROCKETS

▶THE WATER BOTTLE ROCKET



PITSCO WATER ROCKET LAUNCHER

COST: $225.00

ANOTHER CHOICE FOR WATER ROCKET LAUNCHING….HOMEBUILT

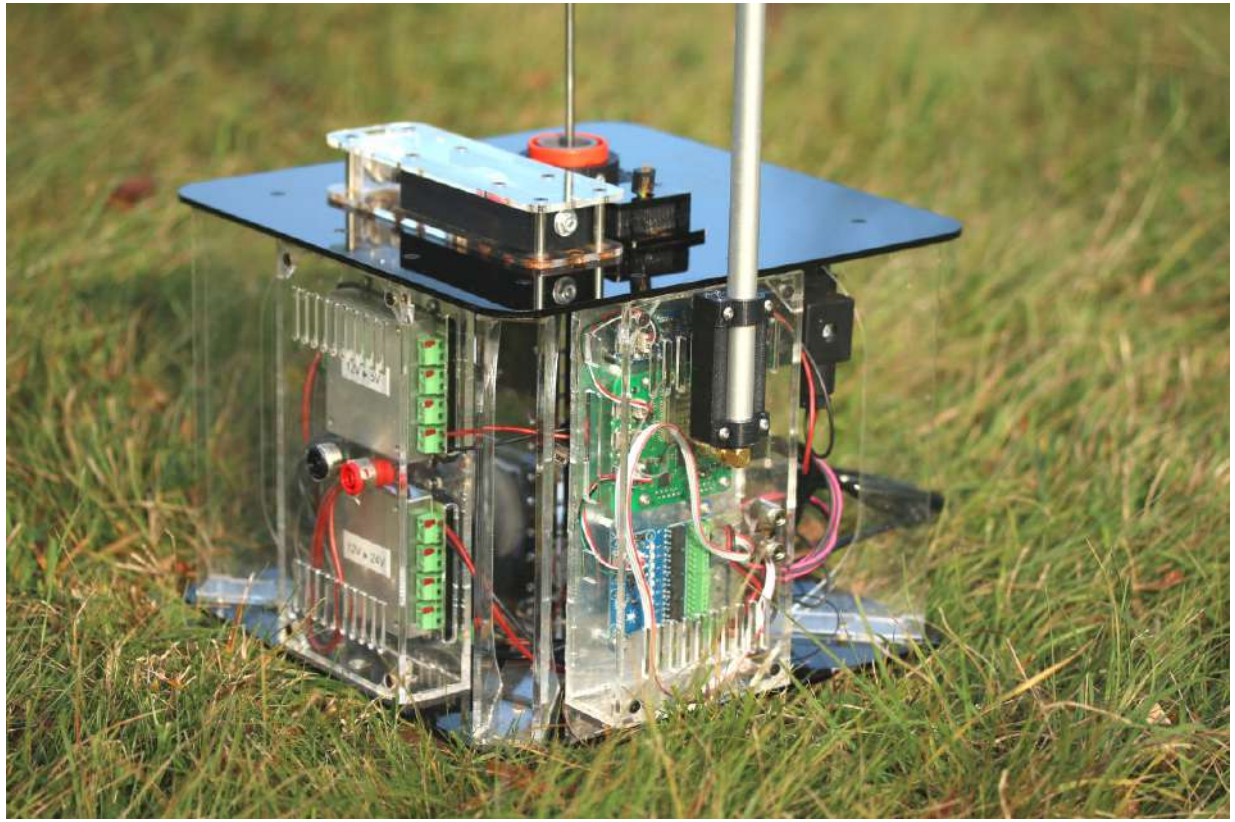
COST: +/- $30.00

THERE ARE AMPLE RESOURCES FOR BUILDING WATER ROCKET LAUNCHERS

SOME DESIGNS ARE QUITE SIMPLE!

www.icreatables.com/

...SOME ARE NOT SO SIMPLE



THIS ONE IS AUTONOMOUS!

LAUNCHING A WATER BOTTLE ROCKET

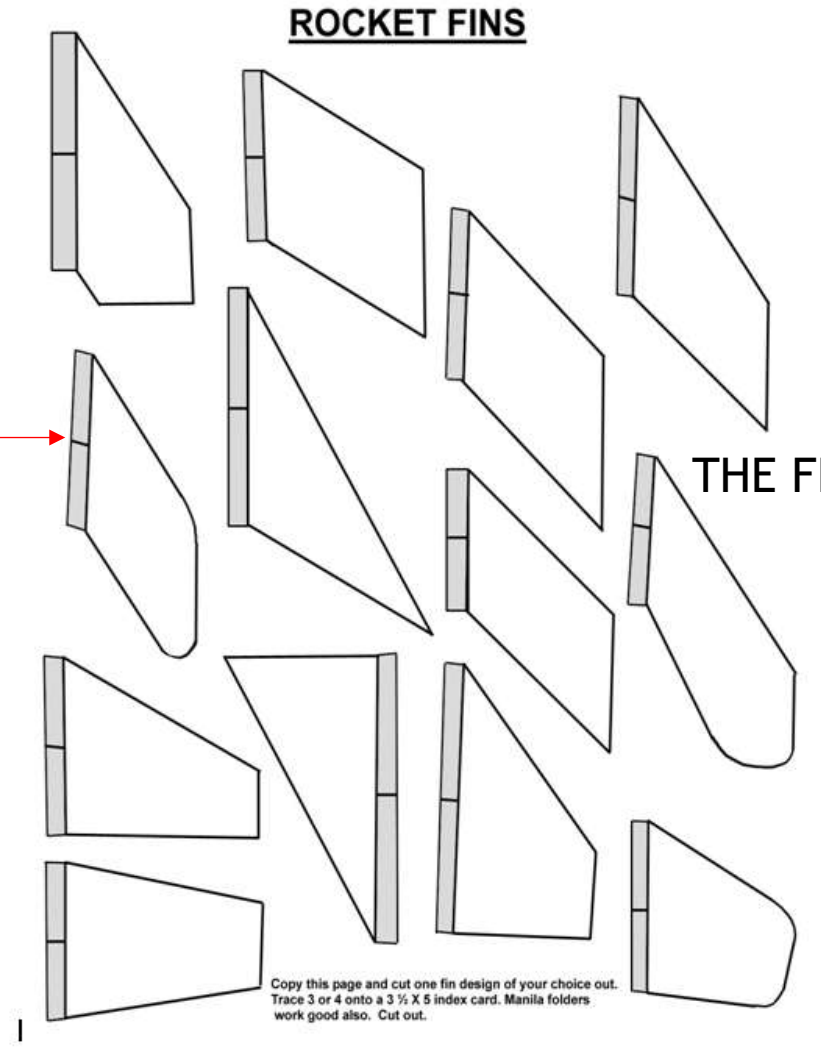
THESE ARE BOTH PITSCO LAUNCHERS

LET'S MAKE THE FINS:
HERE ARE SOME SHAPES

PICK A DESIGN YOU LIKE AND CUT OUT THREE FINS

THE SHADED AREAS WILL BE USED TO ATTACH TO THE ROCKET

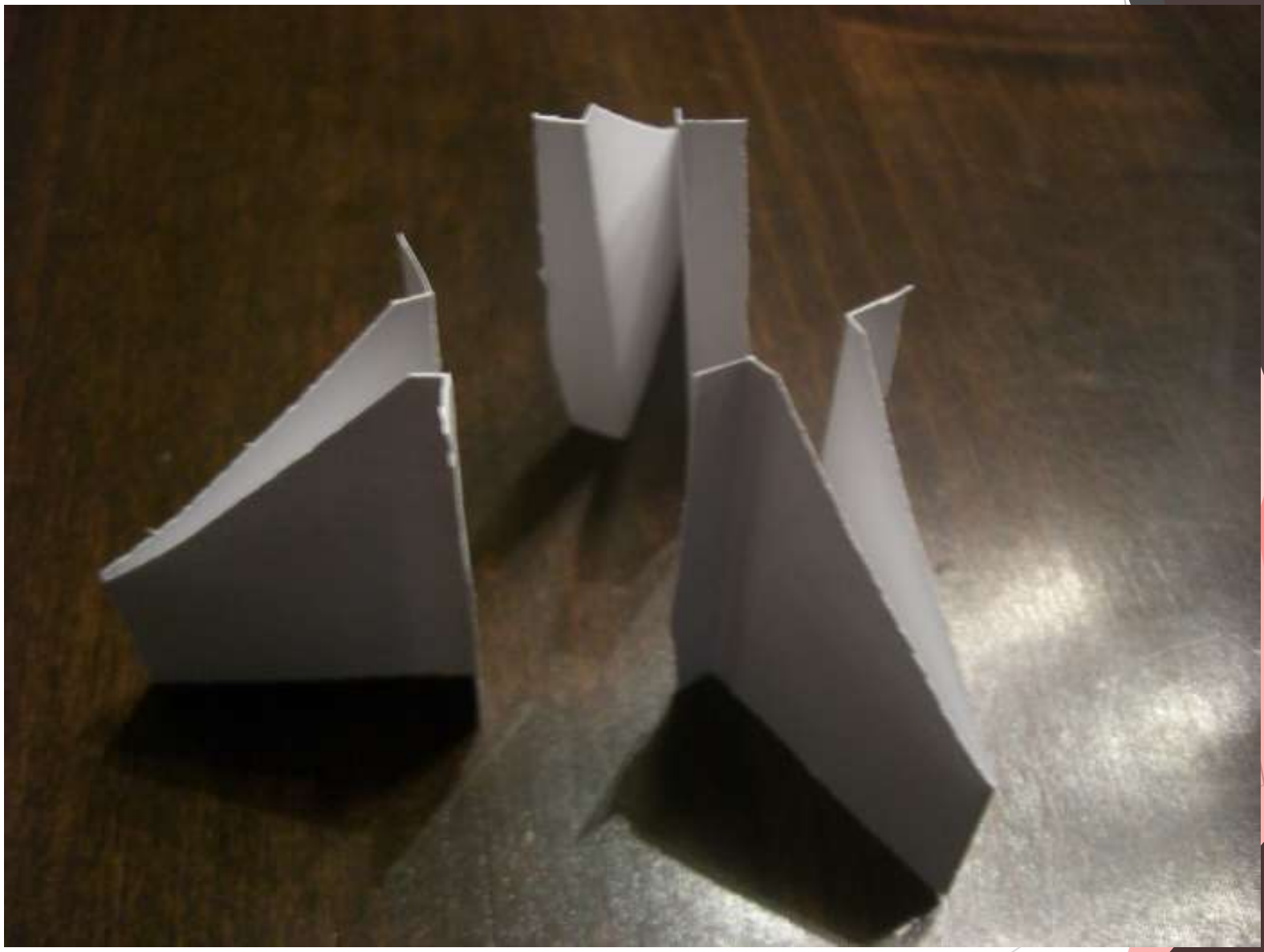
DO NOT GLUE THE SHADED AREAS TOGETHER



THE FIN-CARD WILL BE FOLDED HALF

GLUE THE HALVES TOGETHER

ADD A TOOTHPICK IN BETWEEN THE HALVES WHEN GLUING FOR MORE REGIDITY



SET THE FINS ASIDE TO DRY

THE STOMP ROCKET

STOMP ROCKET DESIGNS

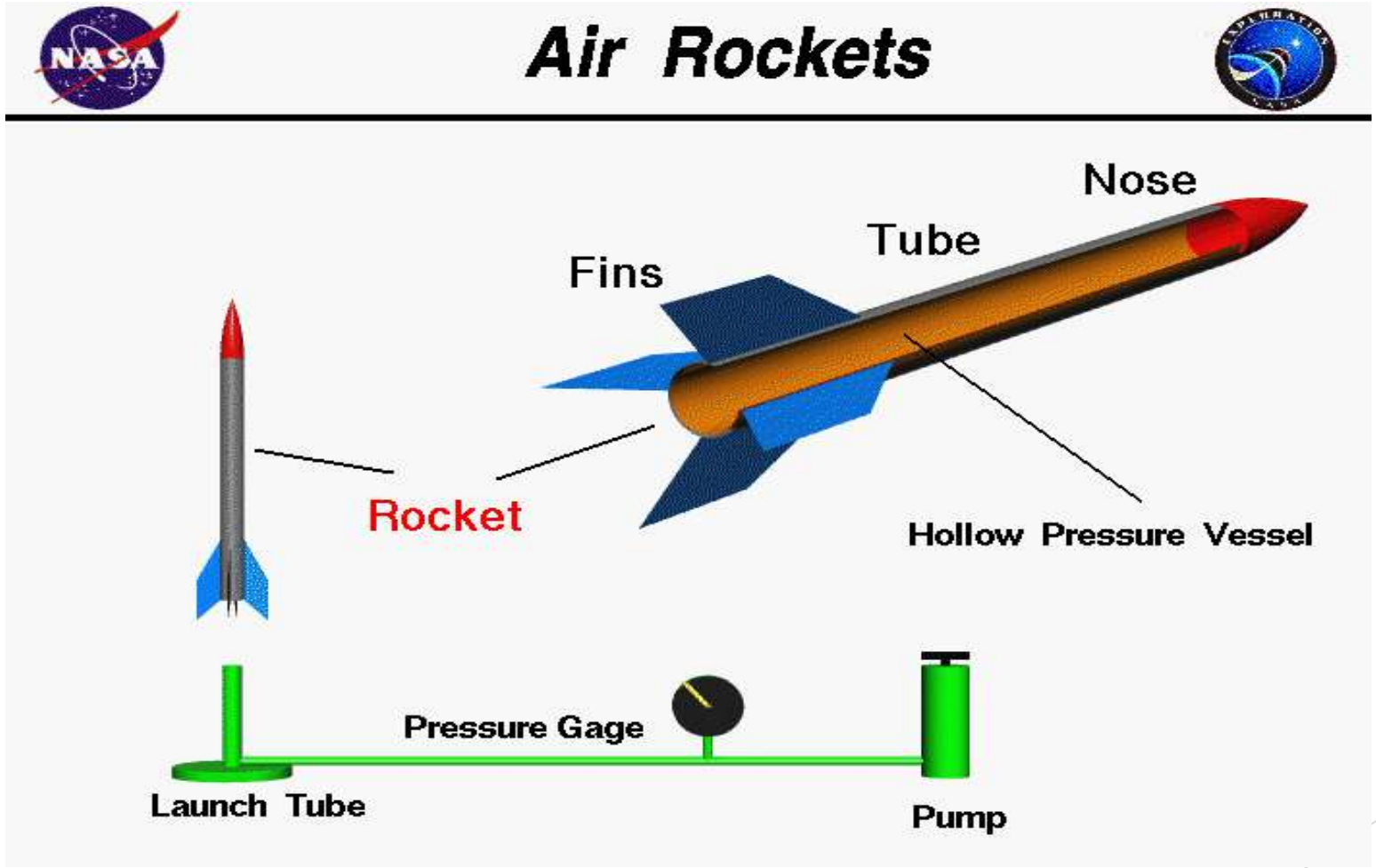
GET CREATIVE!

STOMP ROCKET LAUNCHERS

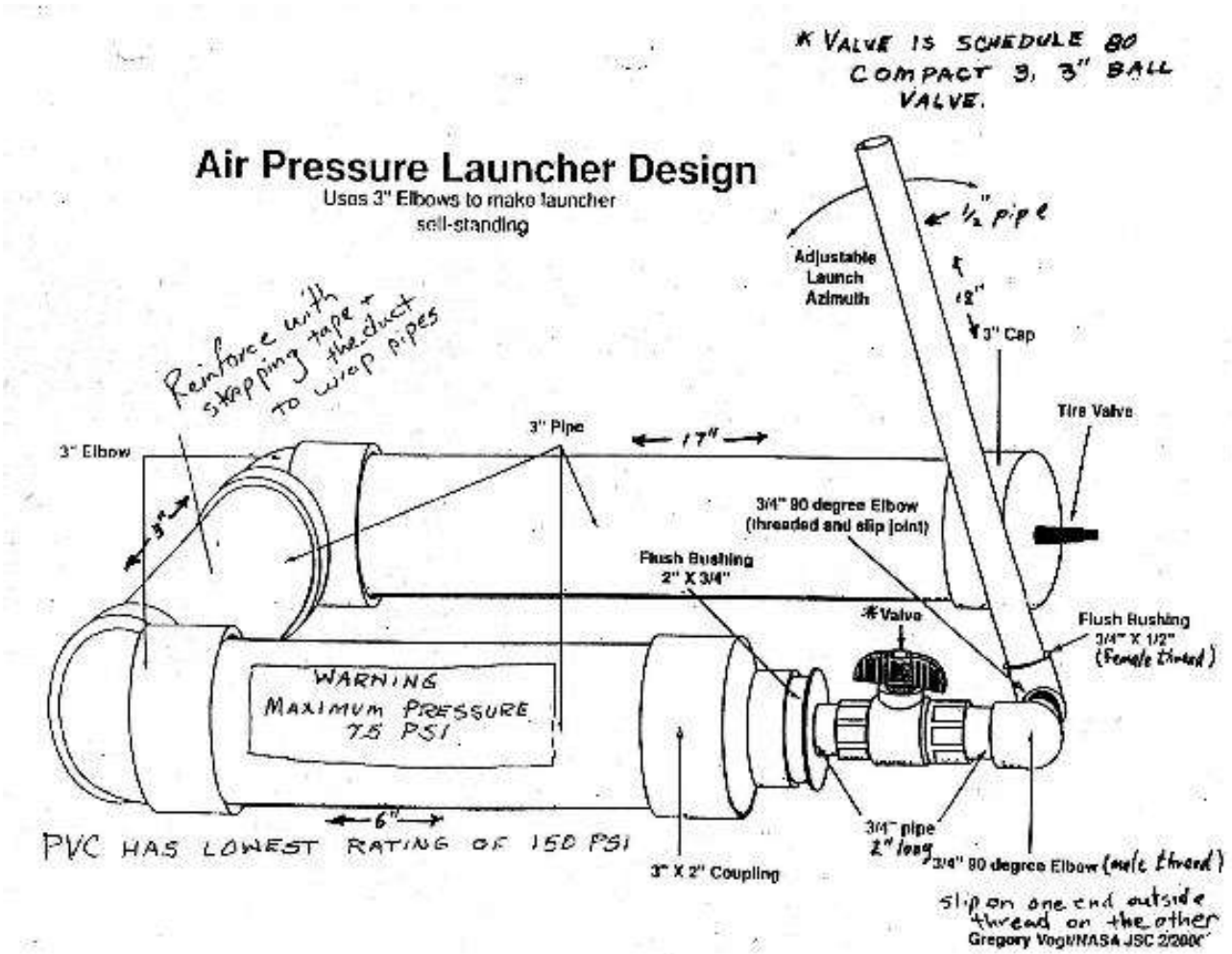
LAUNCHING THE STOMP ROCKET

THE AIR PRESSURE ROCKET

THESE ARE SIMILAR TO STOMP ROCKETS BUT OFFER MORE CONTROL OF THE LAUNCHING PRESSURES.



AIR PRESSURE LAUNCHER GRAPHIC



AIR PRESSURE LAUNCHER

LAUNCH TUBE

TIRE VALVE

PRESSURE RELEASE VALVE

INSTALLING THE TIRE VALVE AVAILABLE FROM MOST AUTO SUPPLY STORES

AIR PRESSURE LAUNCHER WITH BATTERY OPERATED SOLENOID RELEASE

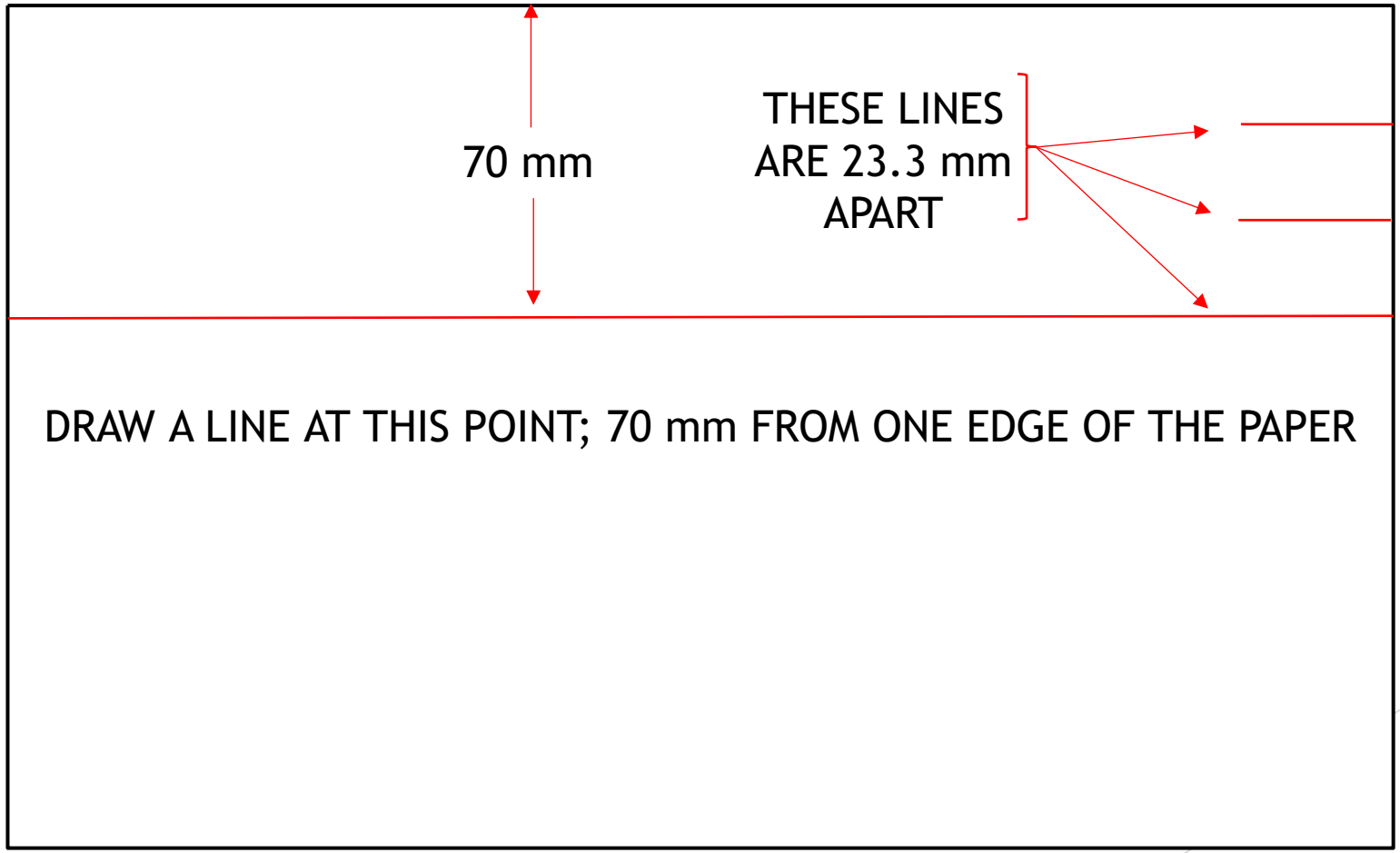
SOLENOID RELEASE

STAND

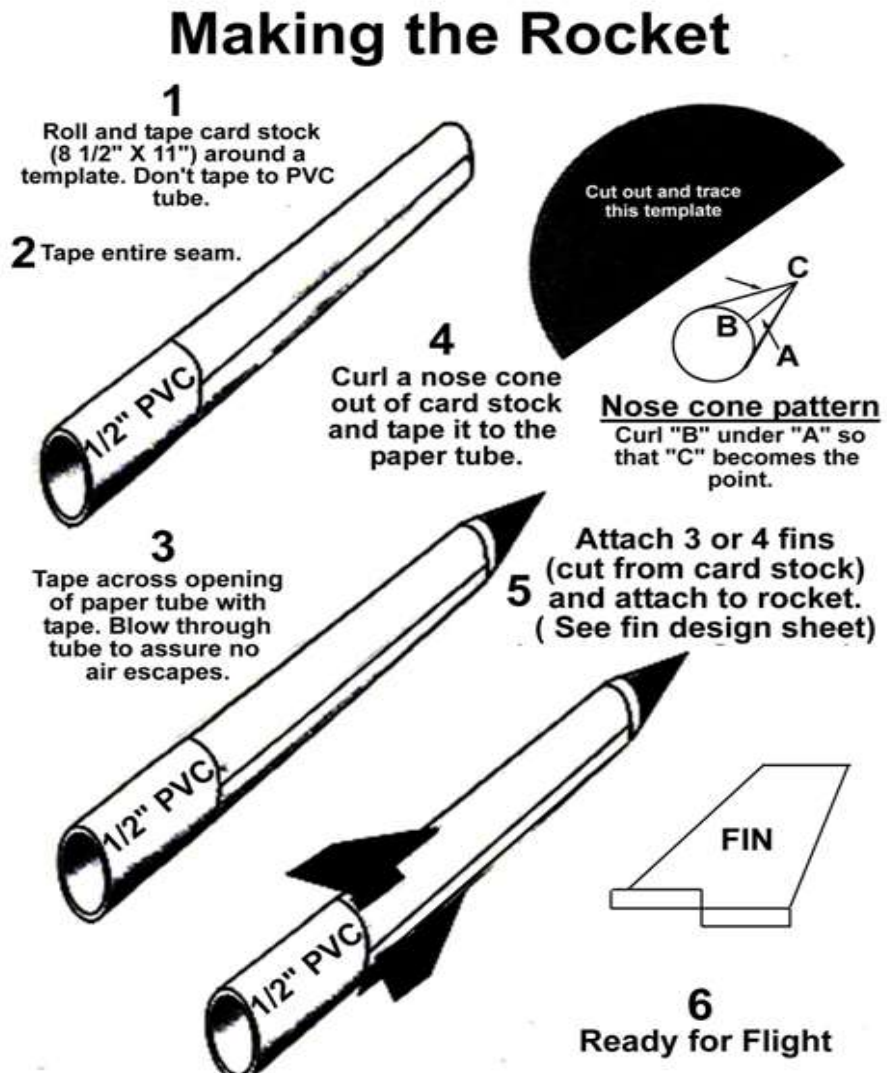
PRESSURE VESSEL

CONTROL DEVICE

MEASURING THE DECORATED AREA AND FIN PLACEMENT



PREPARE THE BODY TUBE OF THE ROCKET USING ½” PVC PIPE

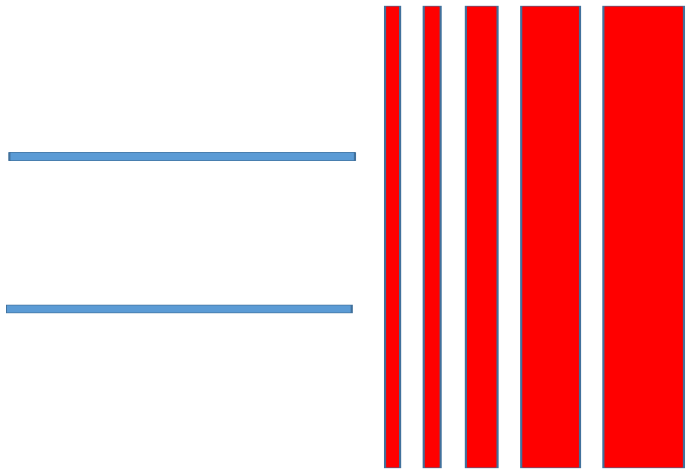


FORM THE BODY TUBE AND GLUE IT TOGETHER SO THAT IT REMAINS A CYLINDRICAL SHAPE

GLUE THE NOSECONE AND FINS TO THE BODY TUBE

SET THE ROCKET ASIDE TO DRY

MAKE YOUR OWN COLORFUL TEMPLATES FOR YOUR STUDENTS



MIDDLE COLLEGE NATIONAL CONSORTIUM

JERSEY CITY, NEW JERSEY JUNE 2016

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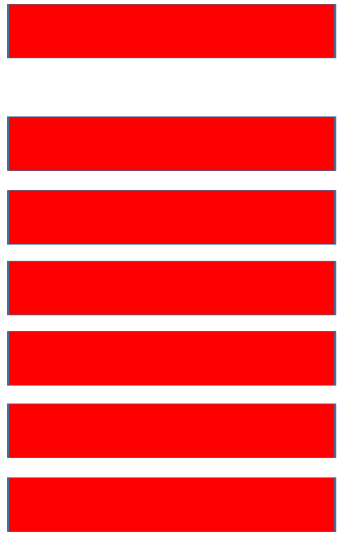
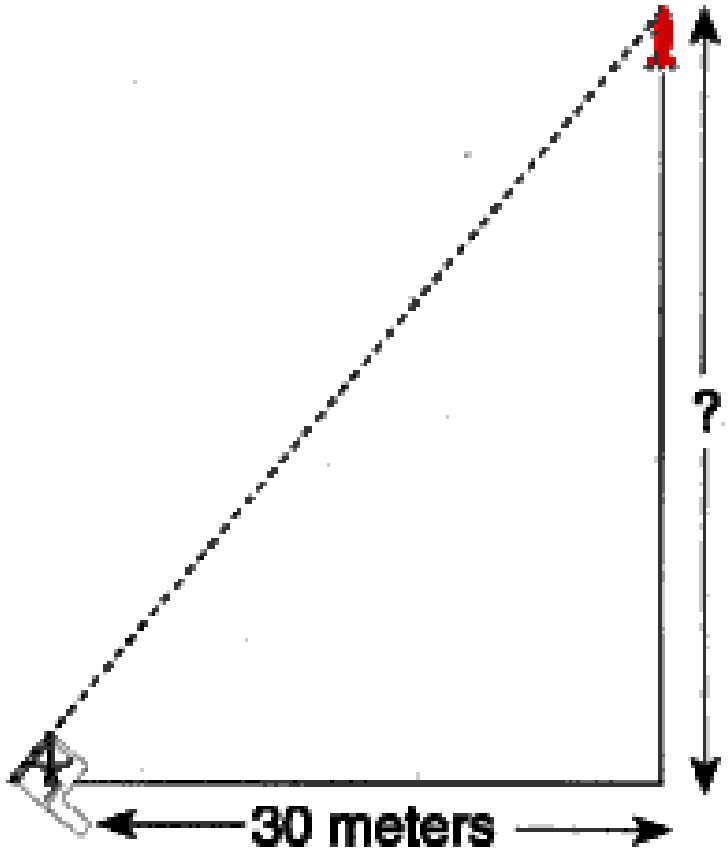
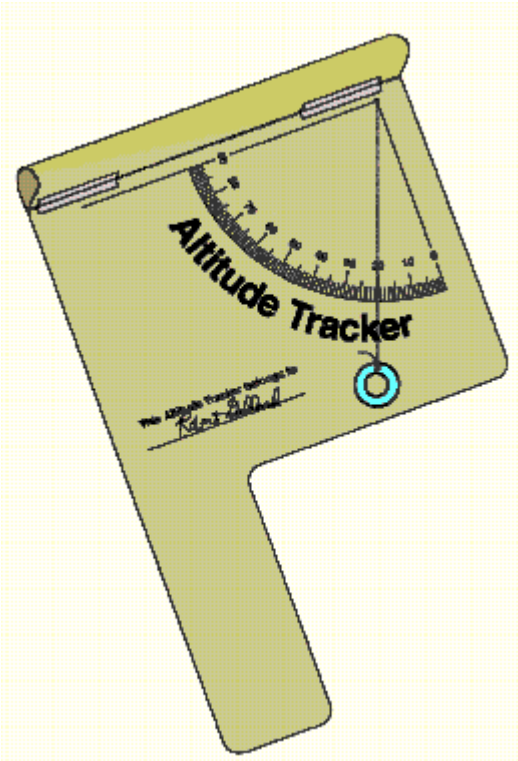


QUESTIONS TO CONSIDER ABOUT THE FLIGHT

- How high did it go?
- How fast did it go?
- How far did it go?
- How long was it aloft?
- Center of mass?
- Center of pressure?
- Surface area of fins?
- Design of Fins?
- Amount of ‘fuel’ to use?
- Thermodynamics?
- Drag Coefficients?
- Reynolds Numbers?
- Effects of different pressures?
- …and much, much more!

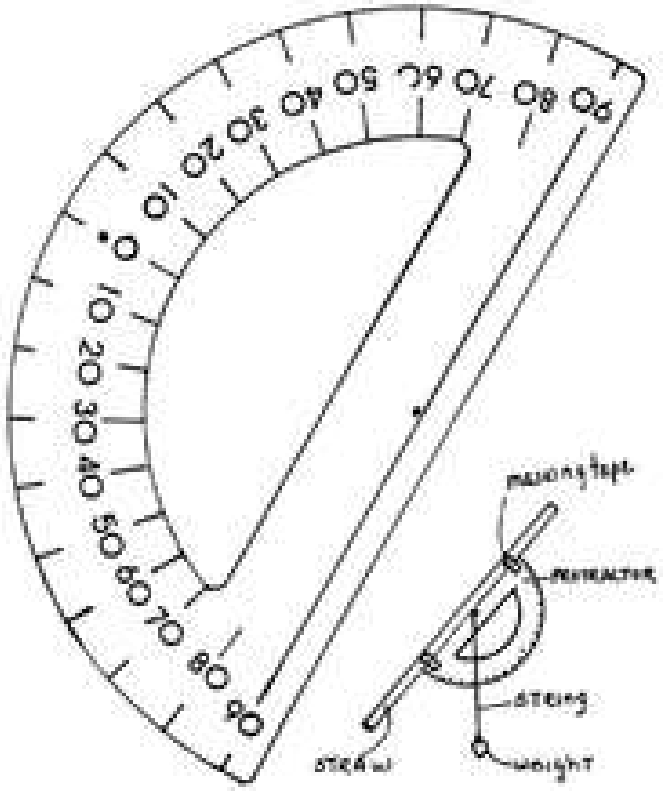
LET'S GATHER SOME DATA





https://spaceflightsystems.grc.nasa.gov/education/rocket/TRCRocket/altitude_tracking2.html

THE ALTISCOPE FOR USE OF TRIGONOMETRIC APPLICATIONS



http://wikieducator.org/Come_fly_with_me/K-6/Activities_77_-_95

THE MODEL ROCKET ALTIMETER

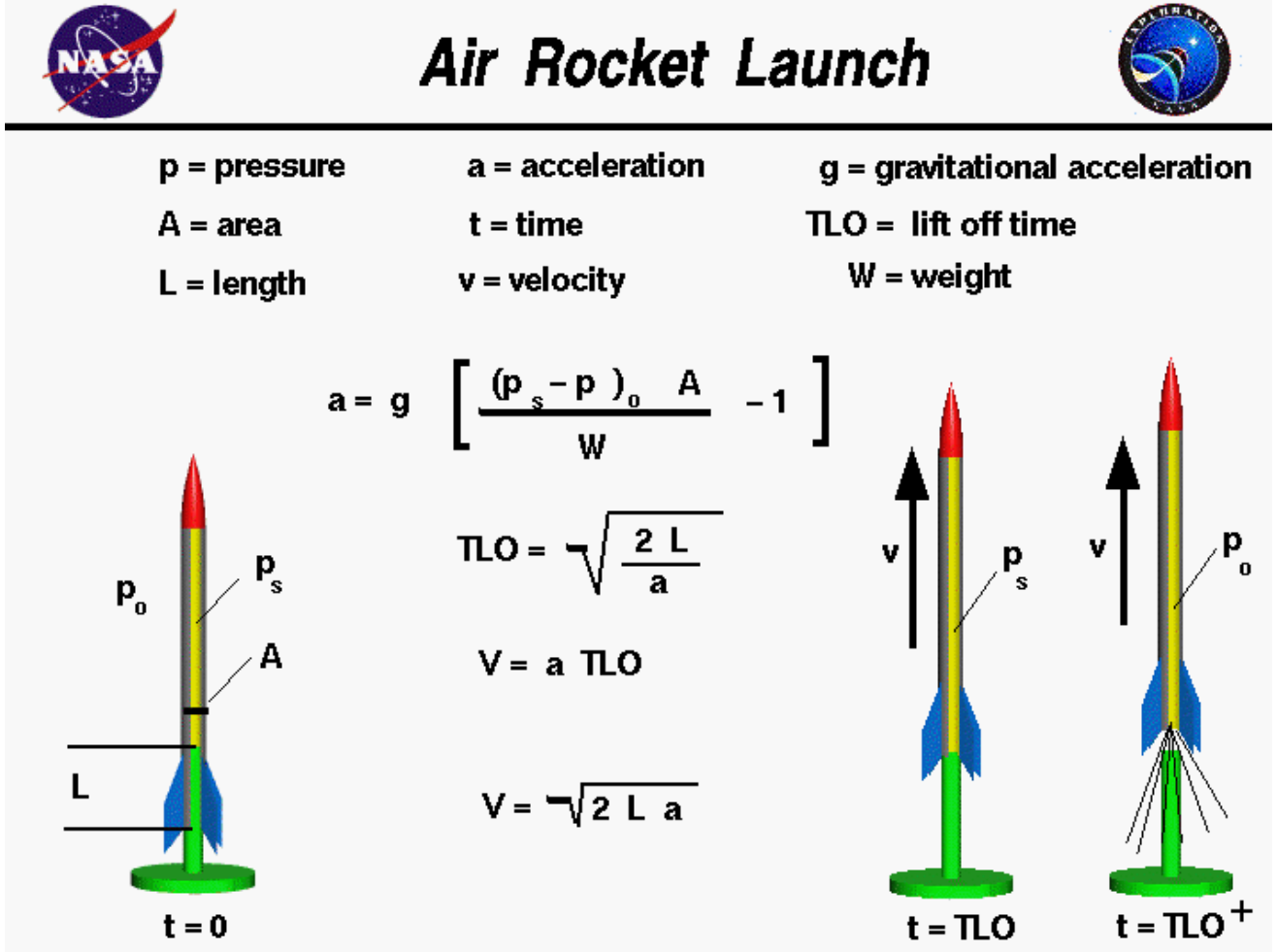
COST: $30.00

https://www.jollylogic.com/products/altimeterone/

CALCULATIONS NOMENCLATURE:

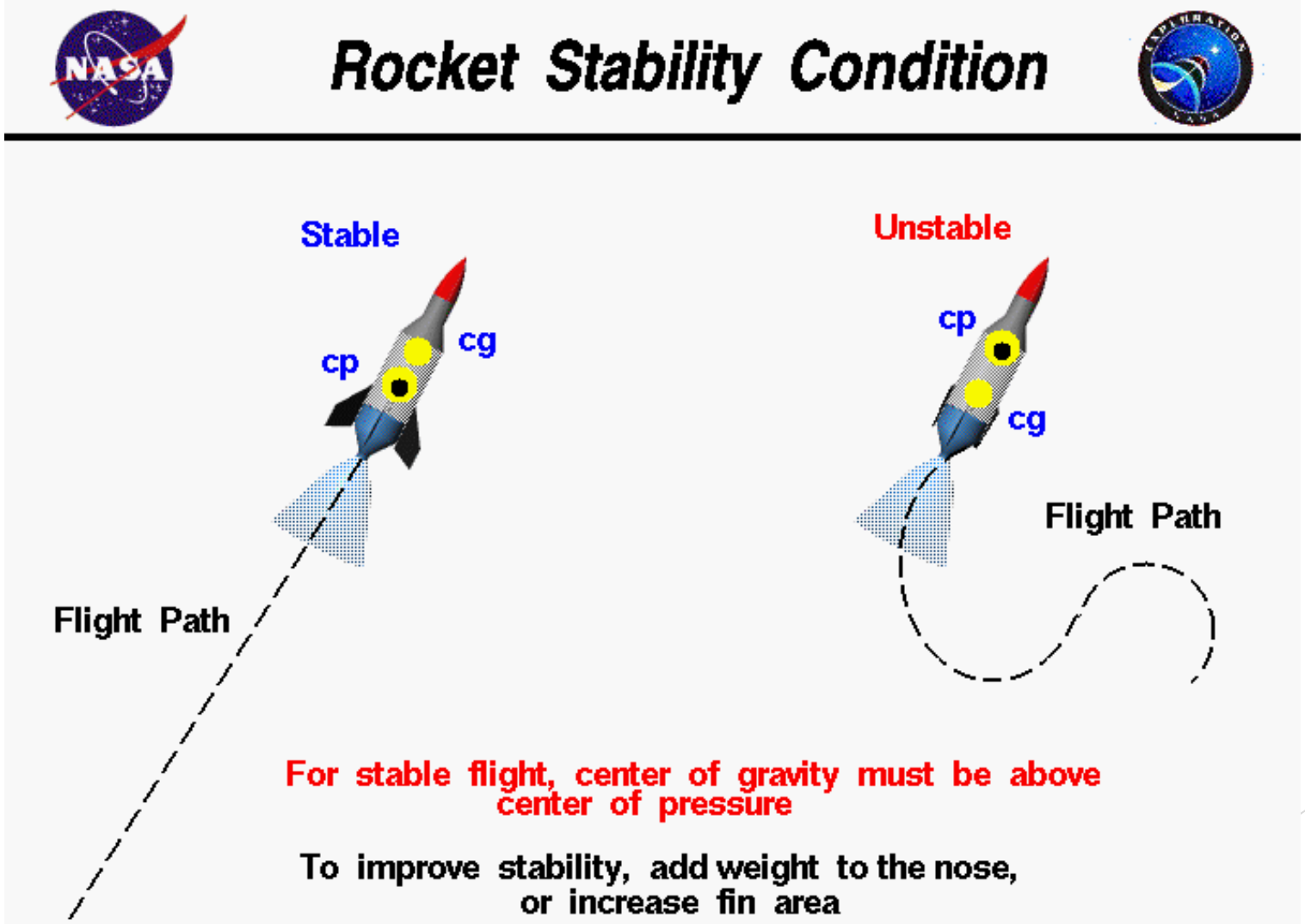
- V= air volume inside rocket
- p= air pressure insider rocket
- p_{atm} =atmospheric pressure
- F=rod force on launch rod $( )_c$ charge condition, start of Phase 1
- $( )_0$ =final condition, end of Phase 1
- ℓ= length of launch rod
- A_e =area of launch rod and nozzle exit
- ρ_w= water density $\dot{m}$
- w =water mass flow rate
- u_e water exhaust velocity
- T =thrust
- http://web.mit.edu/16.unified/www/FALL/systems/Lab_Notes/wrocket.pdf

POSSIBLE CALCULATIONS



https://www.grc.nasa.gov/www/k-12/rocket/rktslaunch.html

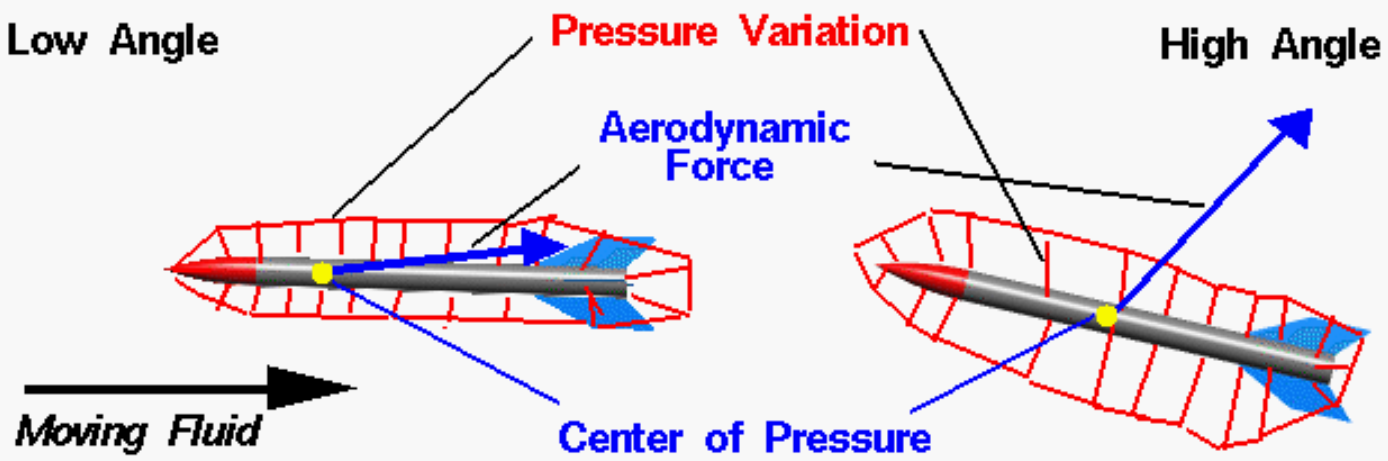
ROCKET STABILITY



https://spaceflightsystems.grc.nasa.gov/education/rocket/rktstabc.html

CENTER OF PRESSURE VS. CENTER OF MASS

Center of Pressure – cp



Center of Pressure is the average location of the pressure.
Pressure varies around the surface of an object. P = P(x)

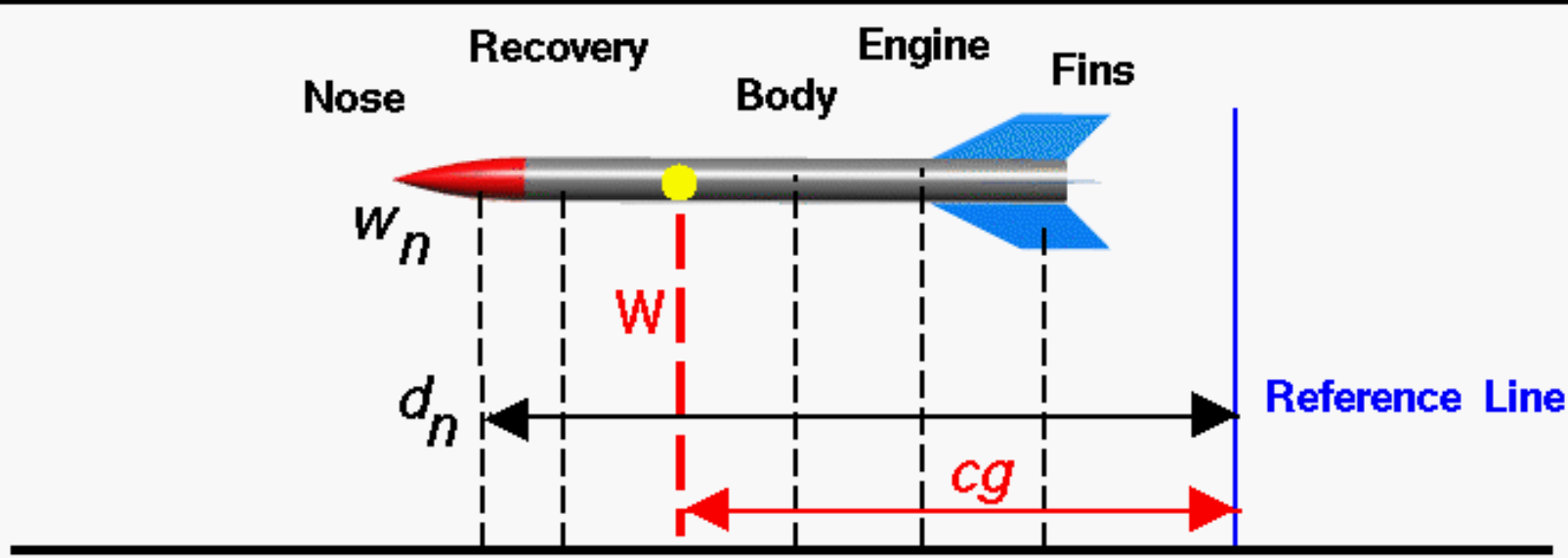
$$cp = \frac{\int x\ p(x)\ dx}{\int p(x)\ dx}$$

Aerodynamic force acts through the center of pressure.

Center of pressure moves with angle of attack.

CENTER OF GRAVITY (MASS)

Determining Center of Gravity – cg

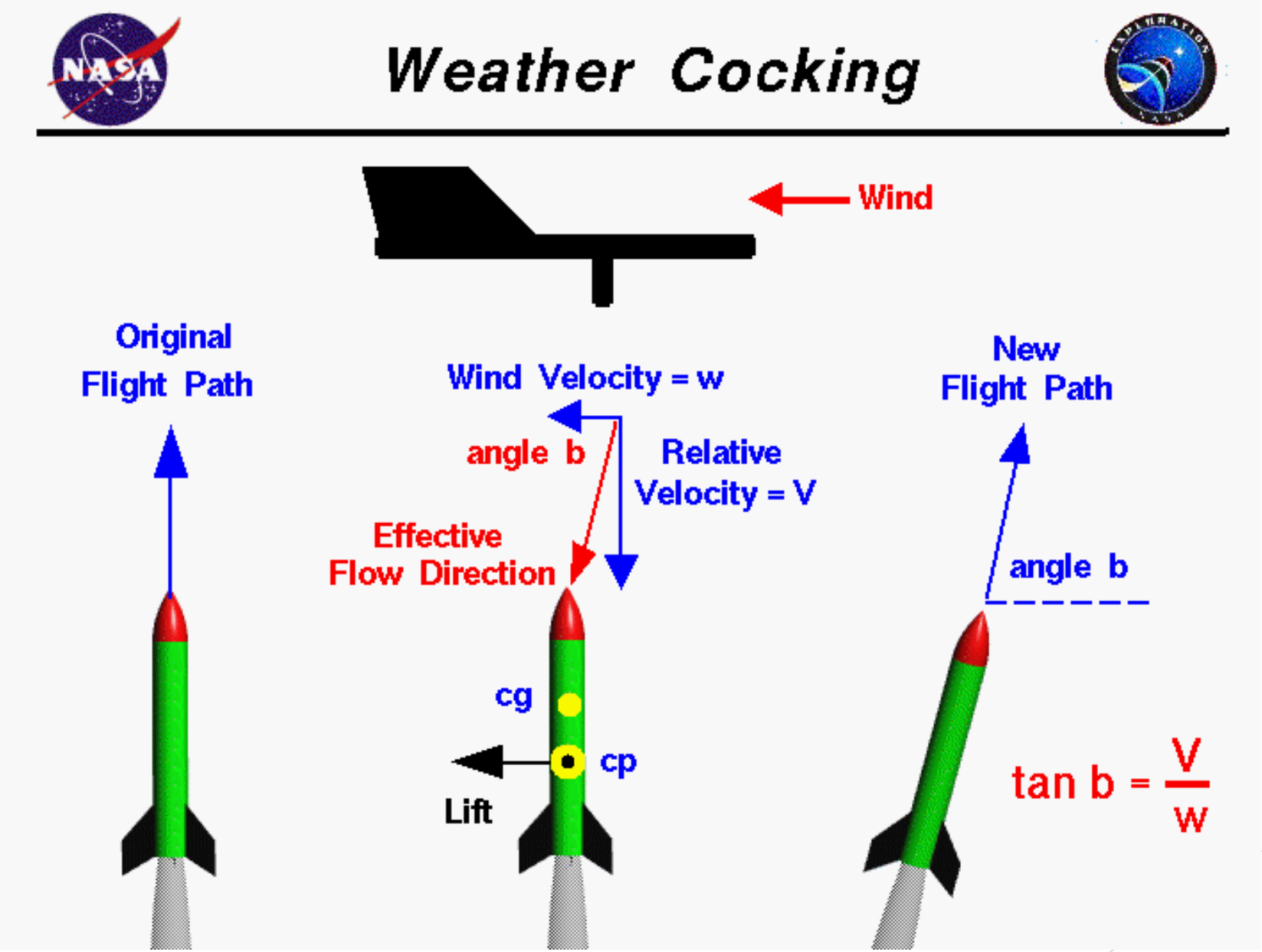


Each component has some weight w_i
located some distance d_i from the reference line.

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

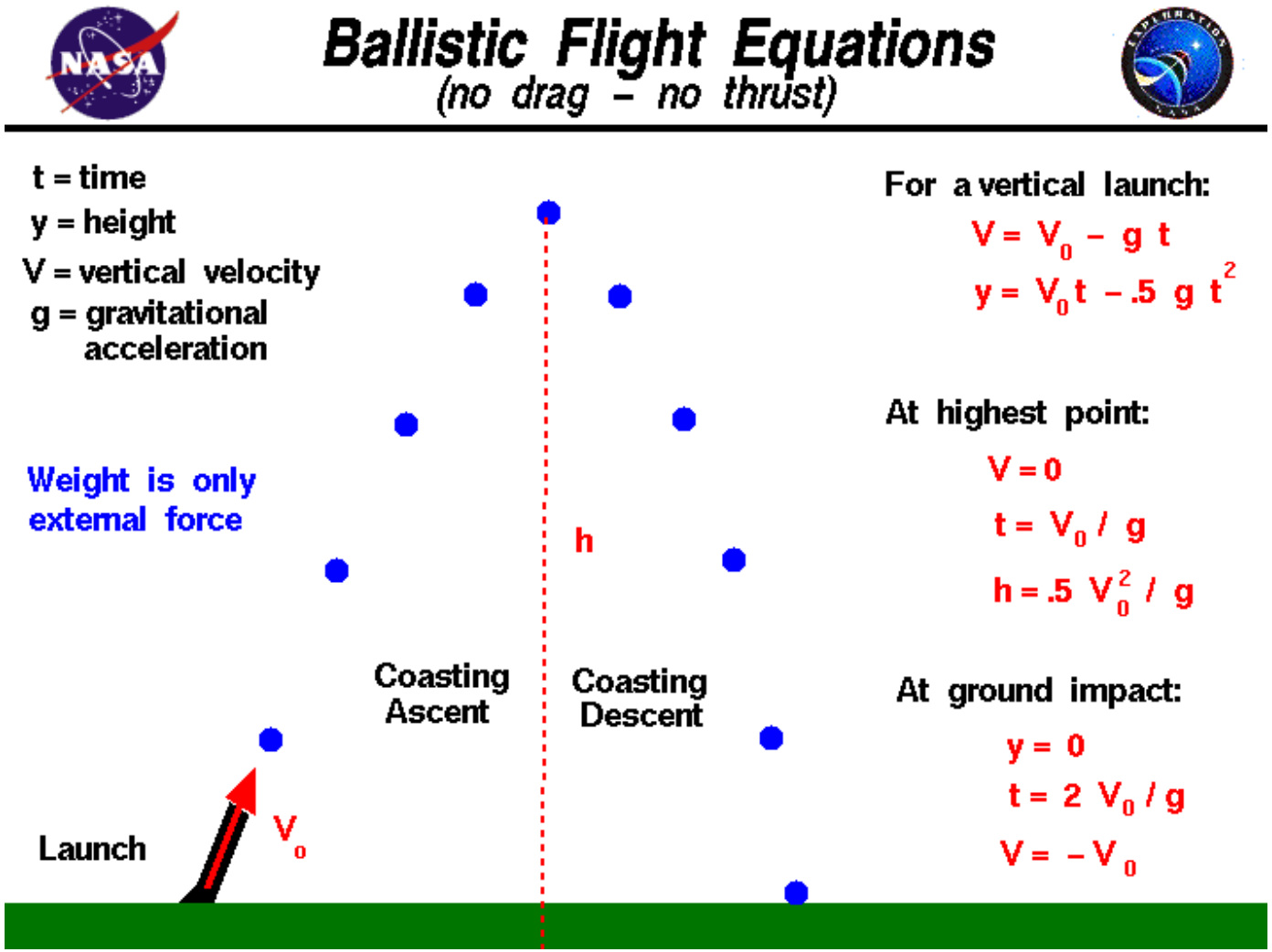
$$cg\ W = d_n w_n + d_r w_r + d_b w_b + d_e w_e + d_f w_f$$

STABILITY AND WEATHERCOCKING



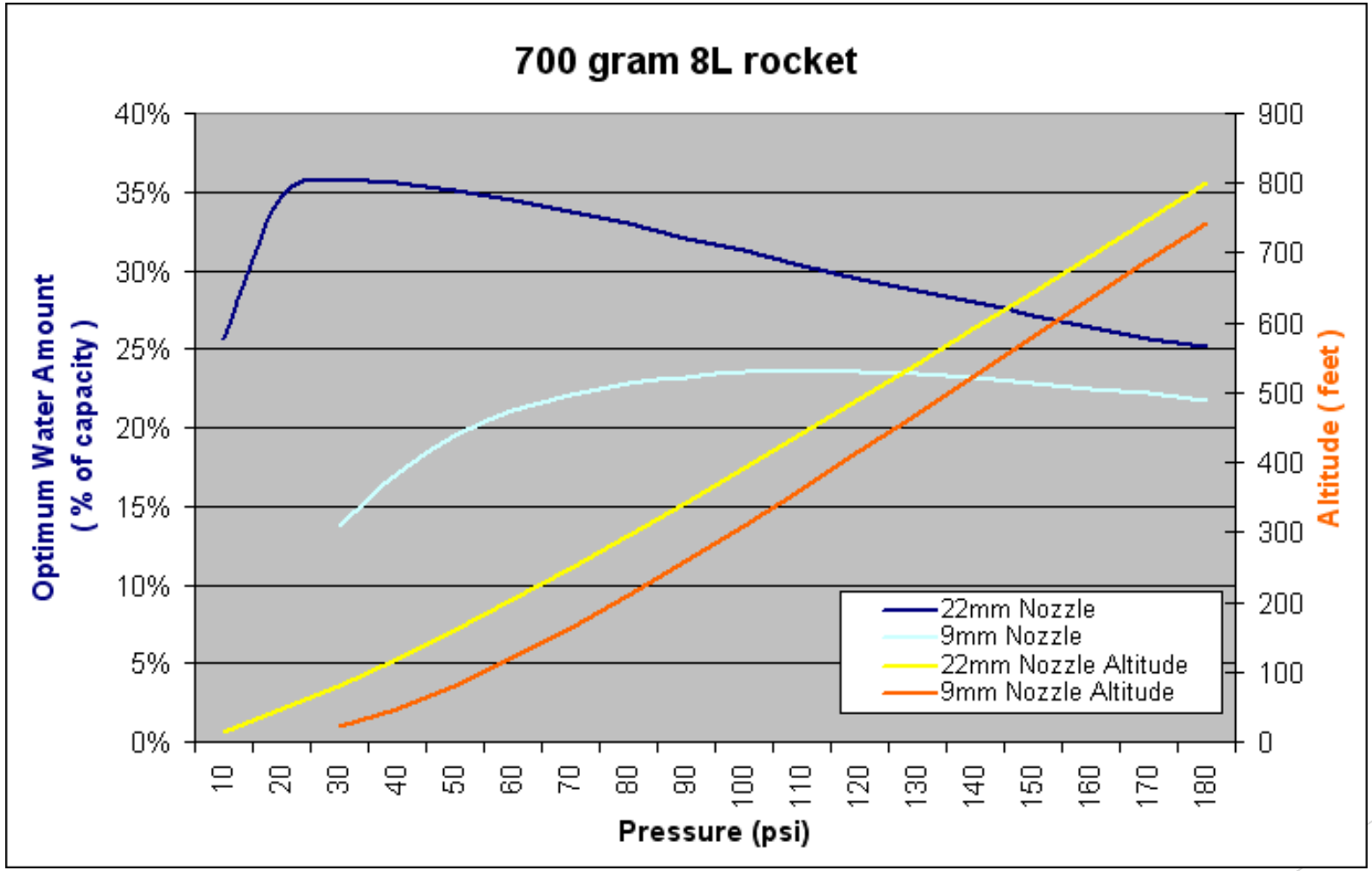
https://spaceflightsystems.grc.nasa.gov/education/rocket/rktcock.html

BALLISTIC FLIGHT CONDITIONS



https://www.grc.nasa.gov/www/k-12/rocket/ballflght.html

GRAPHICAL ANALYSIS OF DATA



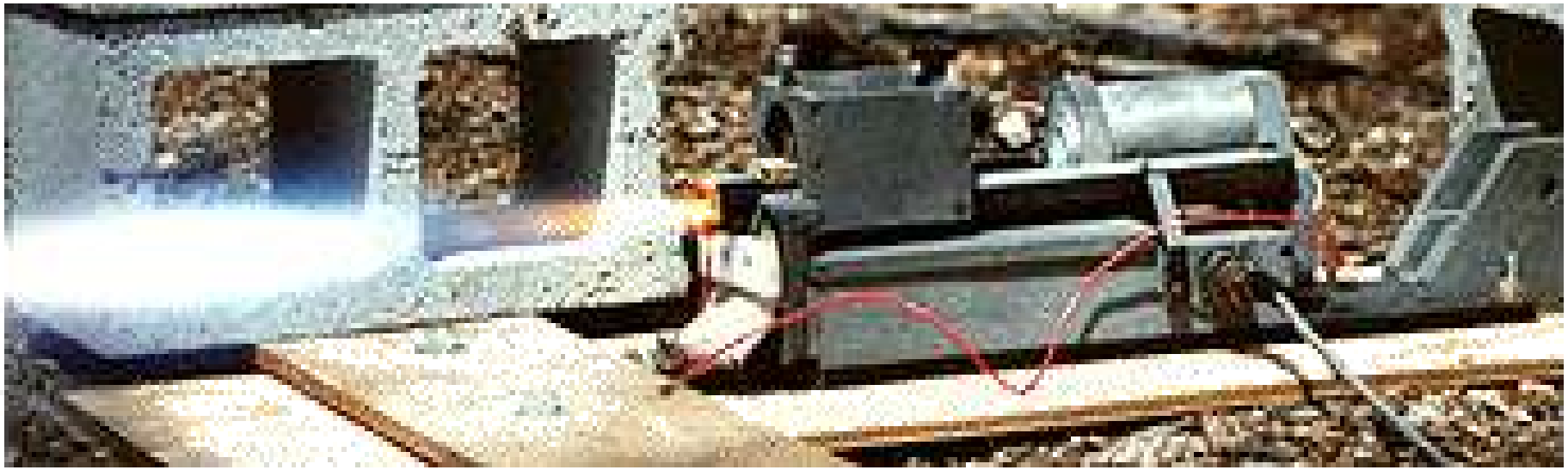
http://www.aircommandrockets.com/water.htm

SOLID FUEL (BLACK POWDER) ROCKETS

MAKING YOUR OWN BLACK POWDER ROCKETS

http://www.erockets.biz/brands/Totally-Tubular.html

ROCKET THRUST CALCULATIONS



ESTES TYPE SOLID FUEL MOTOR BEING TESTED

http://www.nar.org/standards-and-testing-committee/

REFERENCES AND RESOURCES

- ssaenz3@houstonisd.org
- www.youtube.com
- http://www.aircommandrockets.com/water.htm
- http://www.arborsci.com/CoolStuff/New_CoolStuff_Articles/Downloads/P4-2050.pdf https://www.grc.nasa.gov/www/k-12/rocket/ballflght.html http://www.questaerospace.com/ https://spaceflightsystems.grc.nasa.gov/education/rocket/TRCRocket/altitude_tracking2.html www.**icreatables**.com/ http://web.mit.edu/16.unified/www/FALL/systems/Lab_Notes/wrocket.pdf http://makezine.com/projects/make-15/compressed-air-rocket/ http://wikieducator.org/Come_fly_with_me/K-6/Activities_77_-_95 https://www.jollylogic.com/products/altimeterone/ http://www.nar.org/standards-and-testing-committee/ https://spaceflightsystems.grc.nasa.gov/education/rocket/rktstabc.html http://www.erockets.biz/brands/Totally-Tubular.html www.papermodels.com