# *Always Keep Your Rockets Safe and Stable*
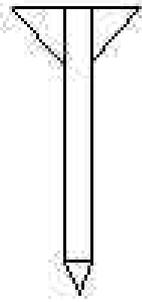


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Southeast Alabama Rocketry Society
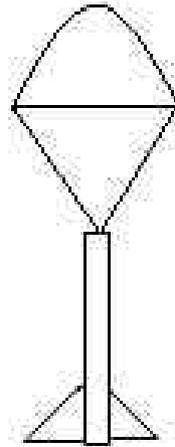www.sears572.com**

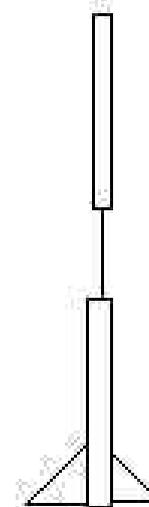# *You must have a recovery device for safety!*

Chute    Streamer

No recovery device

No recovery device means the rocket falls too fast

A proper recovery device means a slow fall to the ground

*A rocket falling too fast will likely damage the rocket and could cause damage to property or people*

Note: some light weight objects with a lot of drag can be their own recovery device, like a saucer rocket.

# *What is Stable?*

*A stable rocket continues in the direction it is pointed*



Wind

Stable    Unstable    Overstable
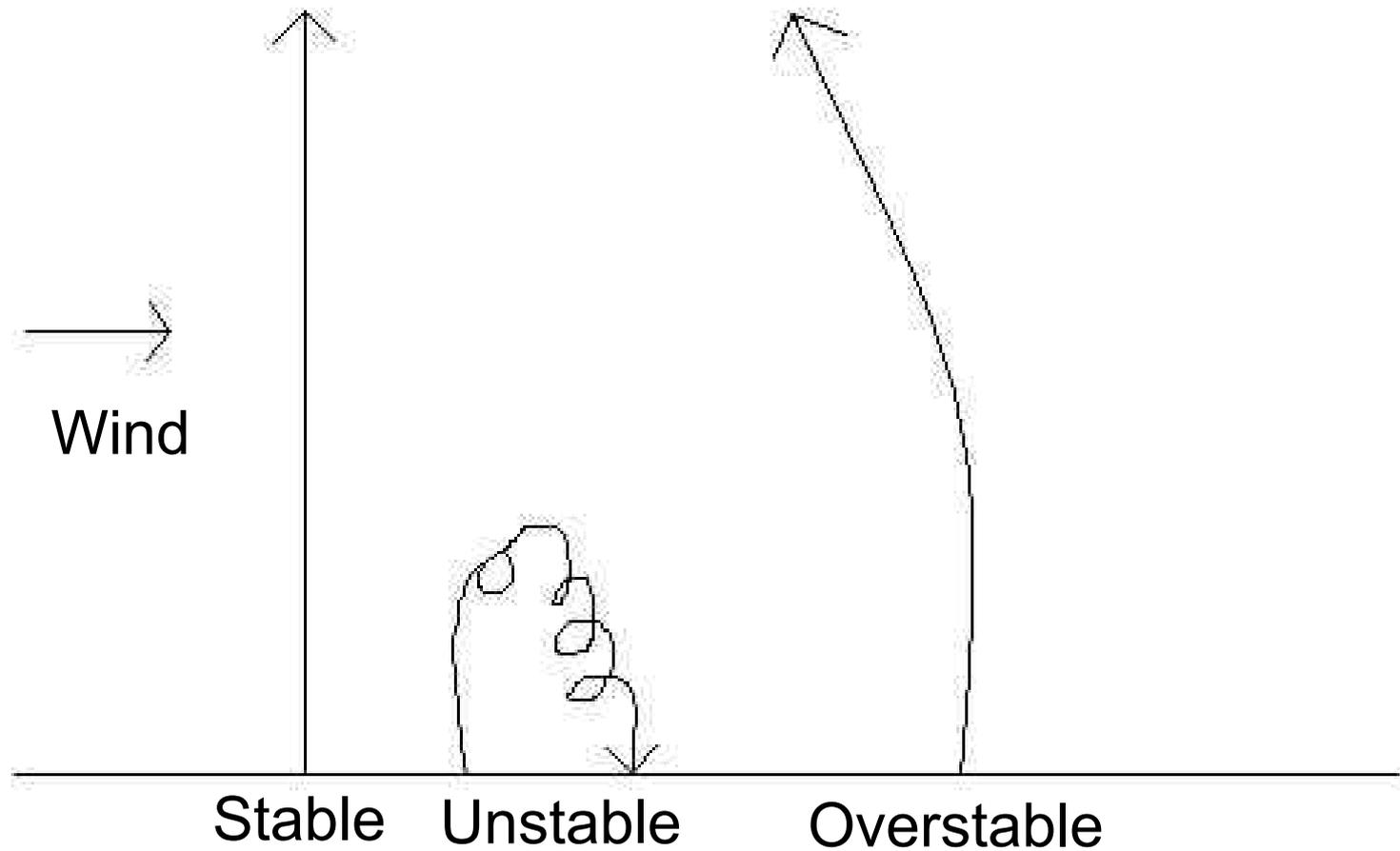
**Unstable rockets can hit cars or bystanders**

# *Is Your Rocket Stable?*

- If you are building popular kits they are usually stable.
- If you modify a kit or use a heavier motor the kit may become unstable.
- If you build your own design from scratch parts then you must figure out how to make it stable before you fly it.
- *The following slides will give you the tools to know the stability of your rocket*
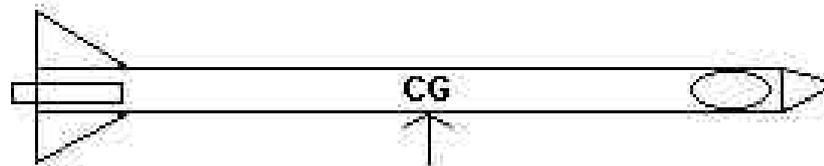
# Center of Gravity (CG)

*Center of gravity is the point you can balance the rocket on your finger*
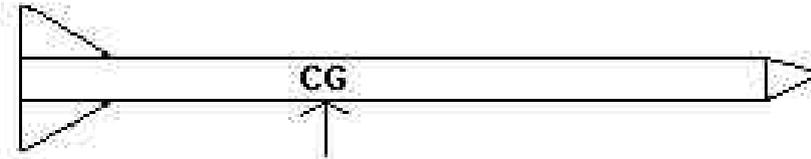

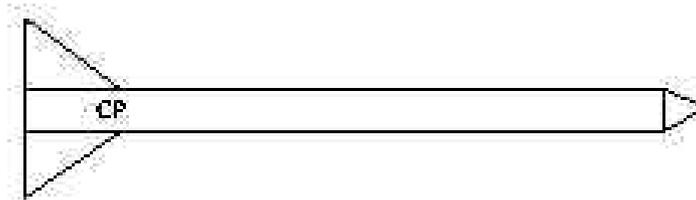
An empty rocket may have CG here
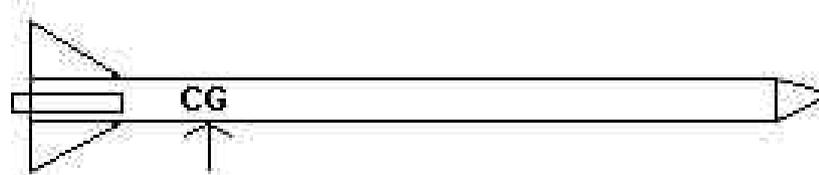


Install a motor and the CG moves aft
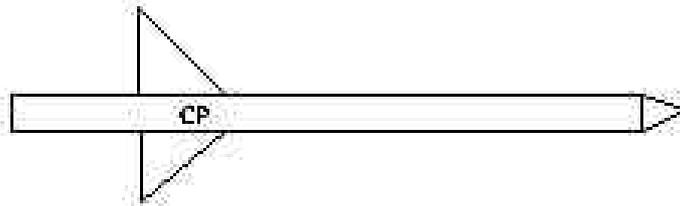


A payload or nose weight will move the CG forward

# Center of Pressure (CP)

Fins aft give you an aft CP

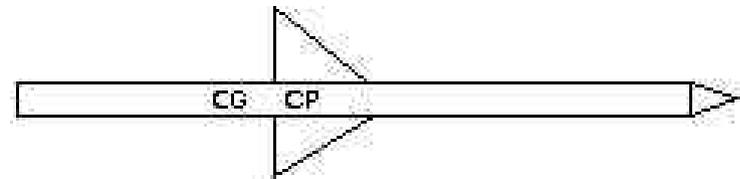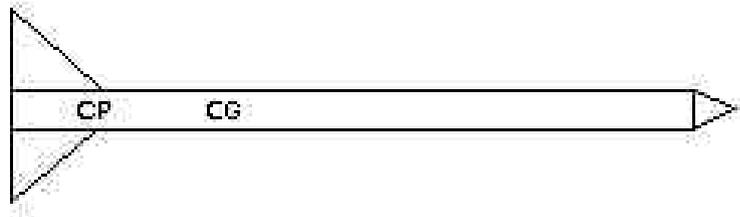Fins forward give you a forward CP
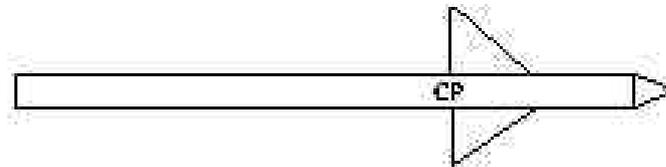
*The CP is the point at which wind forces pushing on the rocket broadside are focused.*

# *Stability Rule*

Stable Rocket: CG in front of CP



Unstable Rocket: CP in front of CG

*Having the CG in front of CP allows the rocket to correct for a slight wind broadside*

**Rule: To have a stable rocket the CG should be at least one body diameter in front of the CP**

# *Stability Tips*

- Use a program like SpaceCAD, RockSim or VCP to calculate where your CP is located.
- It is also possible to do swing tests.
- Remember installing a heavier motor moves the CG aft and can make a stable rocket become unstable
- To make a rocket more stable
  - Move the CP aft by
    - Moving the fins aft
    - Making the fins larger (if they are aft fins)
  - Or move the CG forward by
    - Adding nose weight
    - Making the body tube longer
- Overstable is OK but rocket will tend to weathercock into the wind

# *Thrust to Weight Rule*

◆ If your rocket weighs too much for the motor then the speed off the launch rod will not be enough to let the fins work.

◆ If the fins do not work the rocket can go unstable easily and become a hazard

◆ The Thrust to Weight Ratio should be greater than 5

◆ The thrust is the second number for the motor code. For C6-5 motor the thrust is 6 newtons

◆ Note: 1 lb equals 4.45 newtons

◆ minimum thrust = (wt lbs * 4.45) * 5

◆ So for a 1 lb rocket you need a minimum thrust of 22.25 newtons

# *Review*

- ◆ Use a sufficent recovery device to slow your rocket down before it hits the ground.
- ◆ Keep CG at least one body diameter ahead of the CP for stability.
- ◆ Use a motor with enough thrust for the weight of the rocket, motor and payload combined. Thrust to weight > 5.

# *Bottom Line*

◆ Know your rocket is safe and stable before you fly it.
◆ Be able to show the RSO the CP and CG
◆ Unstable rockets may be funny but they are not safe.
◆ If your are in a contest like TARC, a safe and stable rocket will give you repeatable performance and can win. Unstable rockets are not going to win.
◆ *Always Keep Your Rockets Safe and Stable*

# *Resources (1 of 2)*

◆ *Model Rocket Safety Code* by The National Association of Rocketry www.nar.org/NARmrsc.html
◆ *Handbook of Model Rocketry* by G. Harry Stine www.questaerospace.com/pages/products_edu.htm
◆ *Model Rocket Design and Contruction* by Tim Van Milligan www.apogeerockets.com/design_book.asp
◆ Stability References on Apogee Components web site www.apogeerockets.com/education/rocket_stability.asp

# *Resources (2 of 2)*

- *RockSim Software* by Apogee Components
www.apogeerockets.com/rocksim.asp
- *Visual Center of Pressure (VCP)* Program by Gary Crowell Sr. v-serv.com/vcp/
- SpaceCAD www.spacecad.com/
- EMRR CP Library
http://www.rocketreviews.com/cp_library.shtml