Aerospace Engineering

Professional Aspects

- Bachelor's degree for entry-level positions
  - Aircraft industry, US Department of Defense, NASA
- Associate's degree
  - Aerospace engineering, aerospace engineering technology, manufacture or maintenance
- American Institute of Aeronautics and Astronautics (AIAA)

Aerospace Engineering

- Design, build, analyze, troubleshoot aircraft, spacecraft, missile, high-altitude vehicle components
- Aeronautical engineering
- Astronautical engineering

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Aeronautics

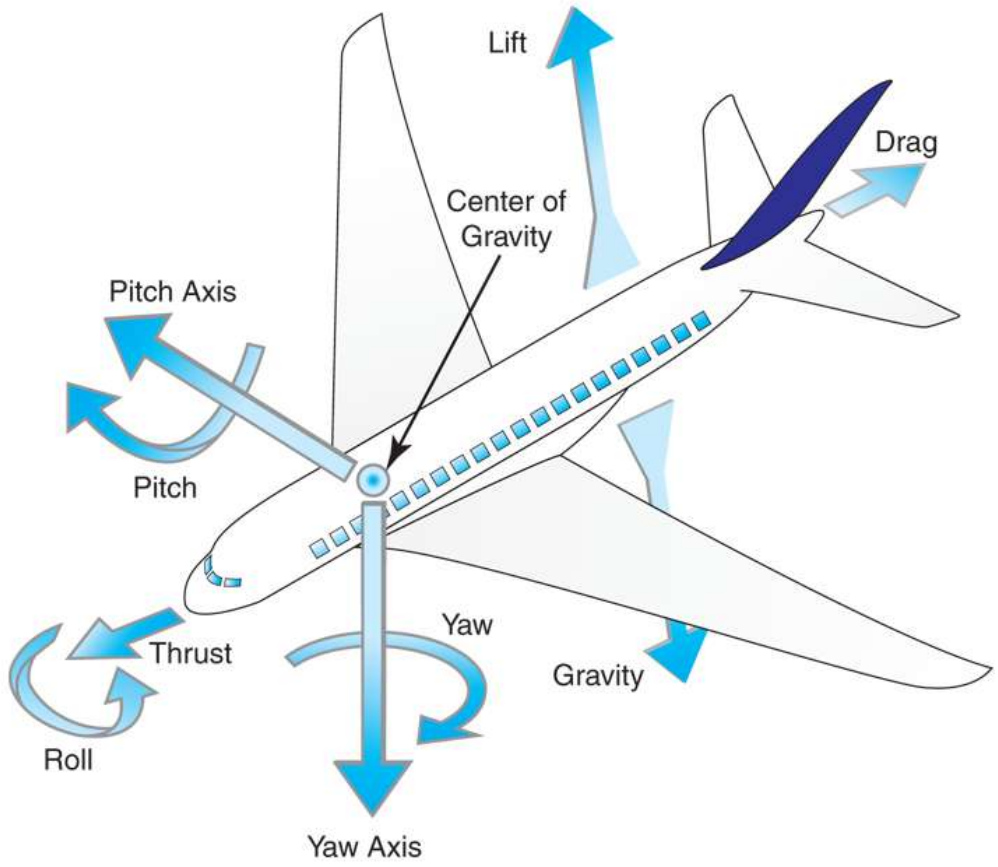
- Manned and/or uncrewed crafts that fly inside earth's atmosphere

Astronautics

- Manned and unmanned flight outside earth's atmosphere
- Complicated design considerations
- Engineering decisions depend on type of spacecraft being designed

Principles of Flight

- Lift
- Thrust
- Drag
- Gravity
- Pitch
- Yaw
- Roll



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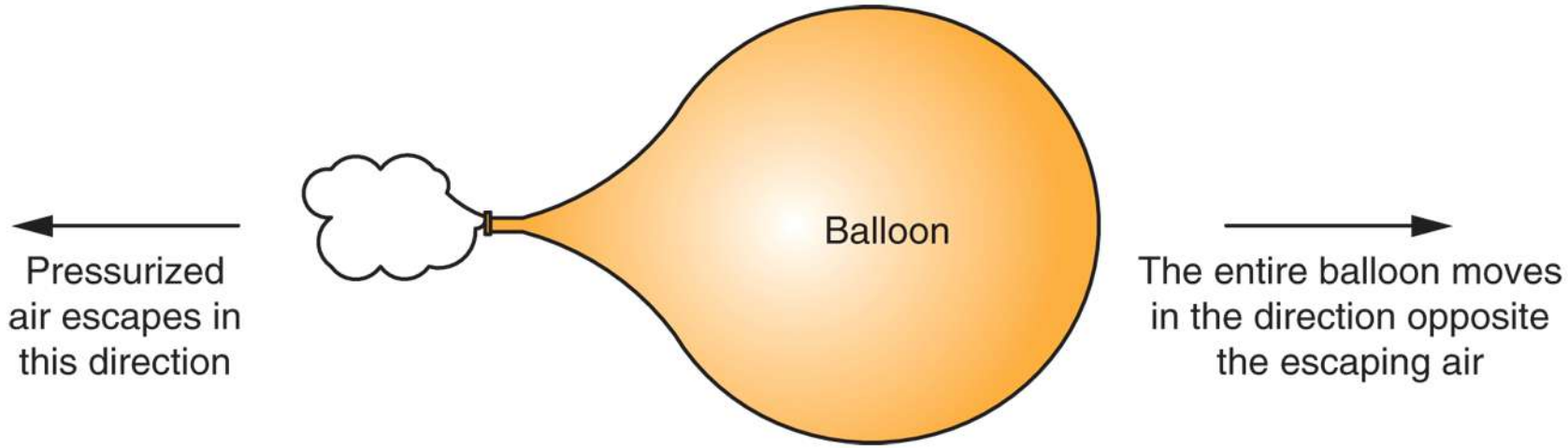
Newton's First Law of Motion

- Objects at rest stay at rest, objects in motion stay in motion unless acted on by outside forces
- Known as **Inertia**

A rocket that is HEAVIER has MORE Inertia, because it has MORE mass. Therefore, the wind will have LESS effect.

Newton's Third Law of Motion

- "For every action there is equal and opposite reaction."
  - **Thrust**
- Moves aircraft/rocket through air

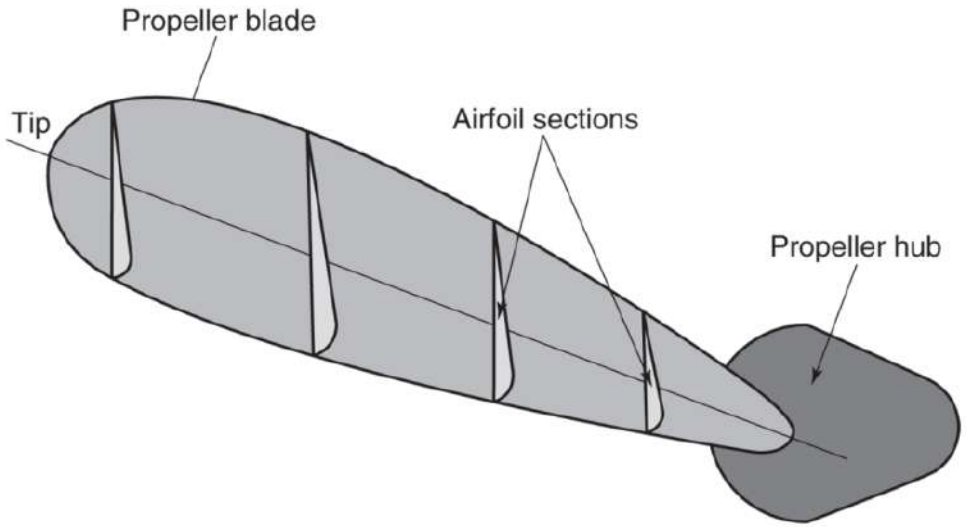


Propulsion

- Propulsion systems create thrust for movement
- Different systems work on principles of Newton’s third law
  - Propellers
  - Gas turbine engines
  - Rocket engines

Propellers

- Create thrust
- Work like rotating wings that spin around shaft
- Produces lift same way as wing but in forward direction



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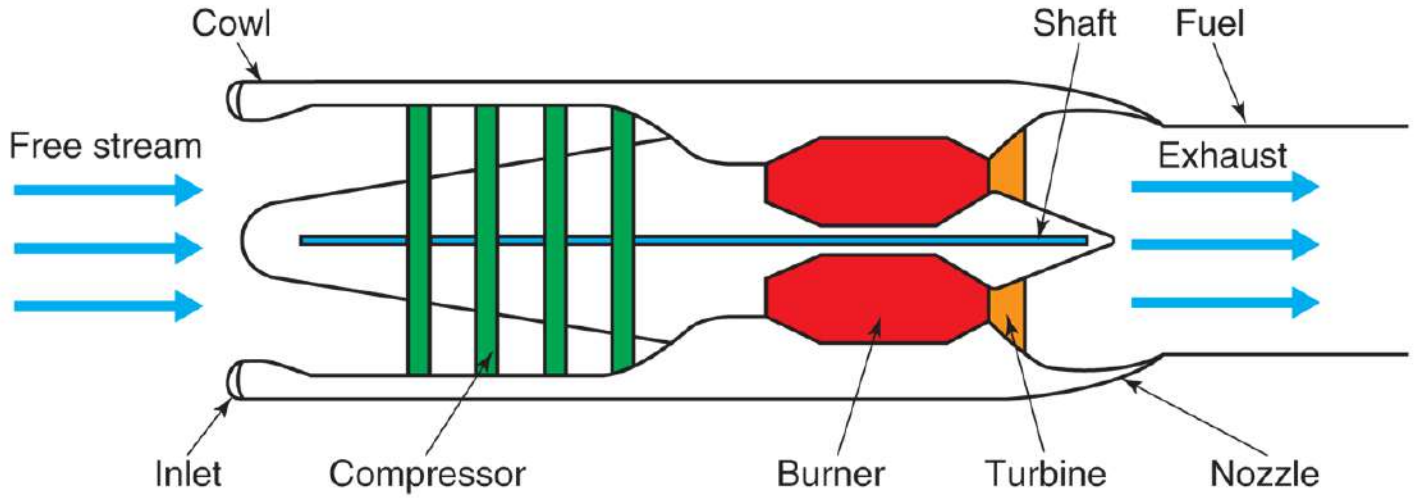
Gas Turbine Engines

- Draw air into engine front, compress it
- Inject fuel into compressed air, then ignite
- Burning gas escapes through rear of engine, turning compressor fan



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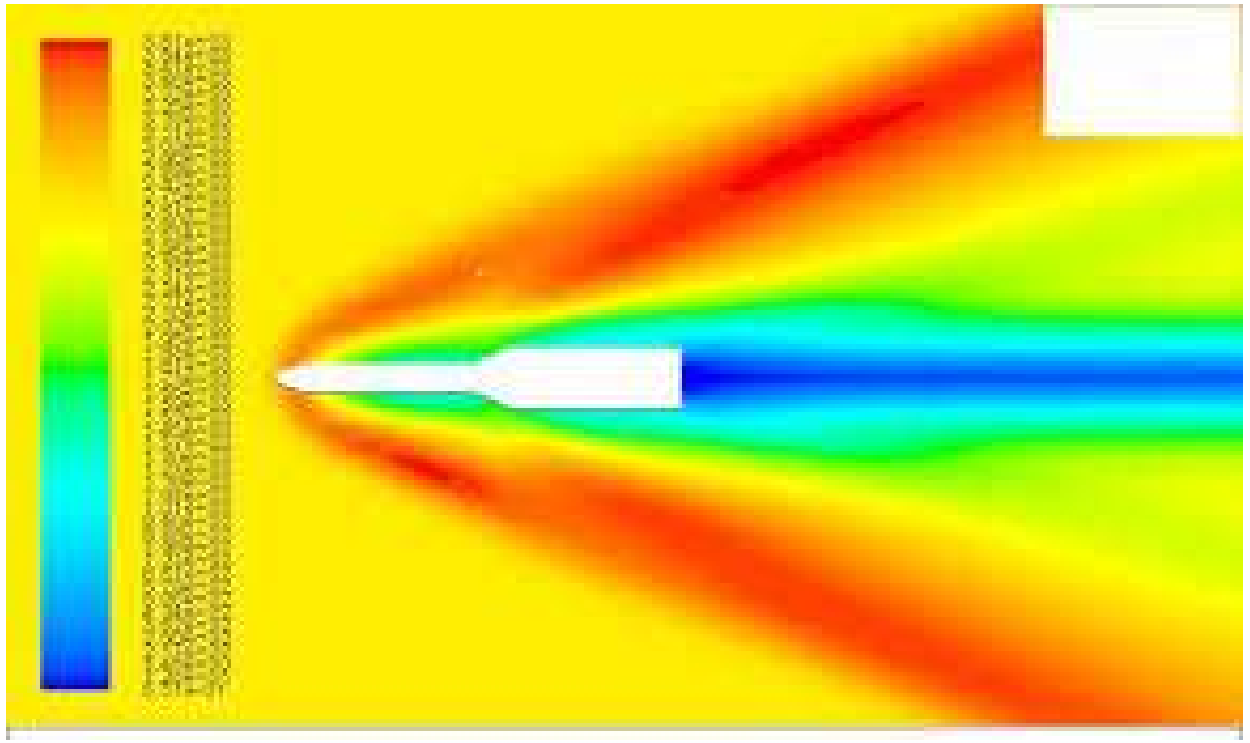
Rocket Engines

- Used on high-speed aircraft, spacecraft
- Fuel, oxygen mix then explode in combustion chamber
- Exhaust forced out through nozzle in one direction, rocket forced in other direction

NASA/Tony Gray and Tim Powers

Fluid Mechanics - Aerodynamics

- Study of fluids (liquid and gas) and forces that act on them
  - Airflow around solid objects



NASA Ames/Dominic Hart

Aerodynamics

- Airflow around solid objects
- Aircraft designed to be aerodynamic for given function
- Aerodynamic planes fly more efficiently

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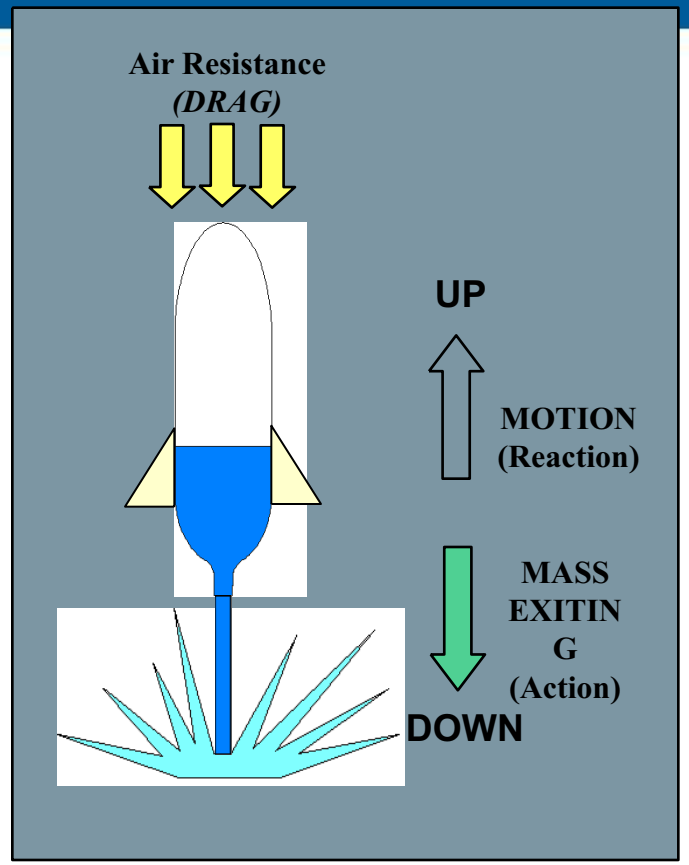
DRAG



DRAG = Air Resistance

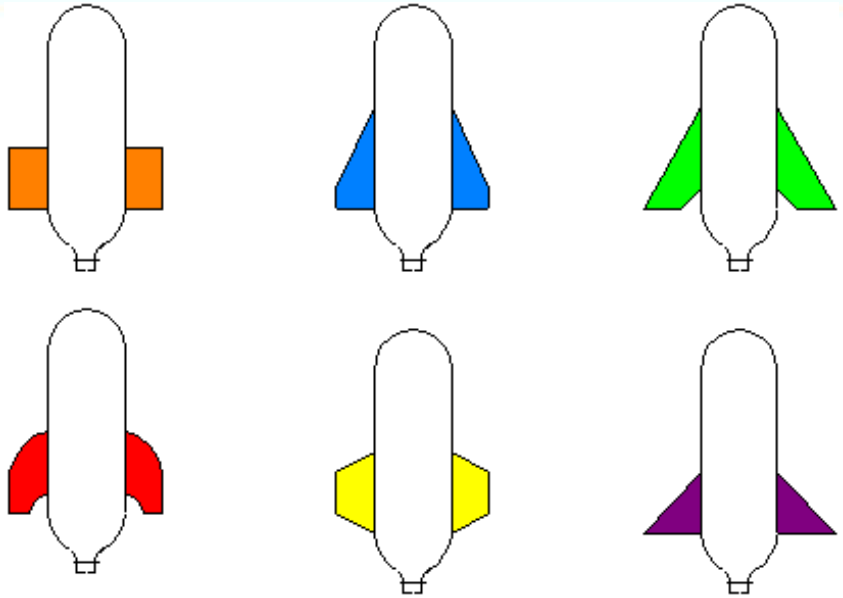
Air Resistance causes friction which ***slows down*** the Rocket. Friction always works in the opposite direction of the Rocket's motion.

TIPS: REDUCING DRAG

AERODYNAMIC **or pointed nose cone:** This causes the air to "part" around the bottle.

More Aerodynamic fins:
Thinner, more streamlined fins reduce drag.
Position fins toward the tail of the rocket.

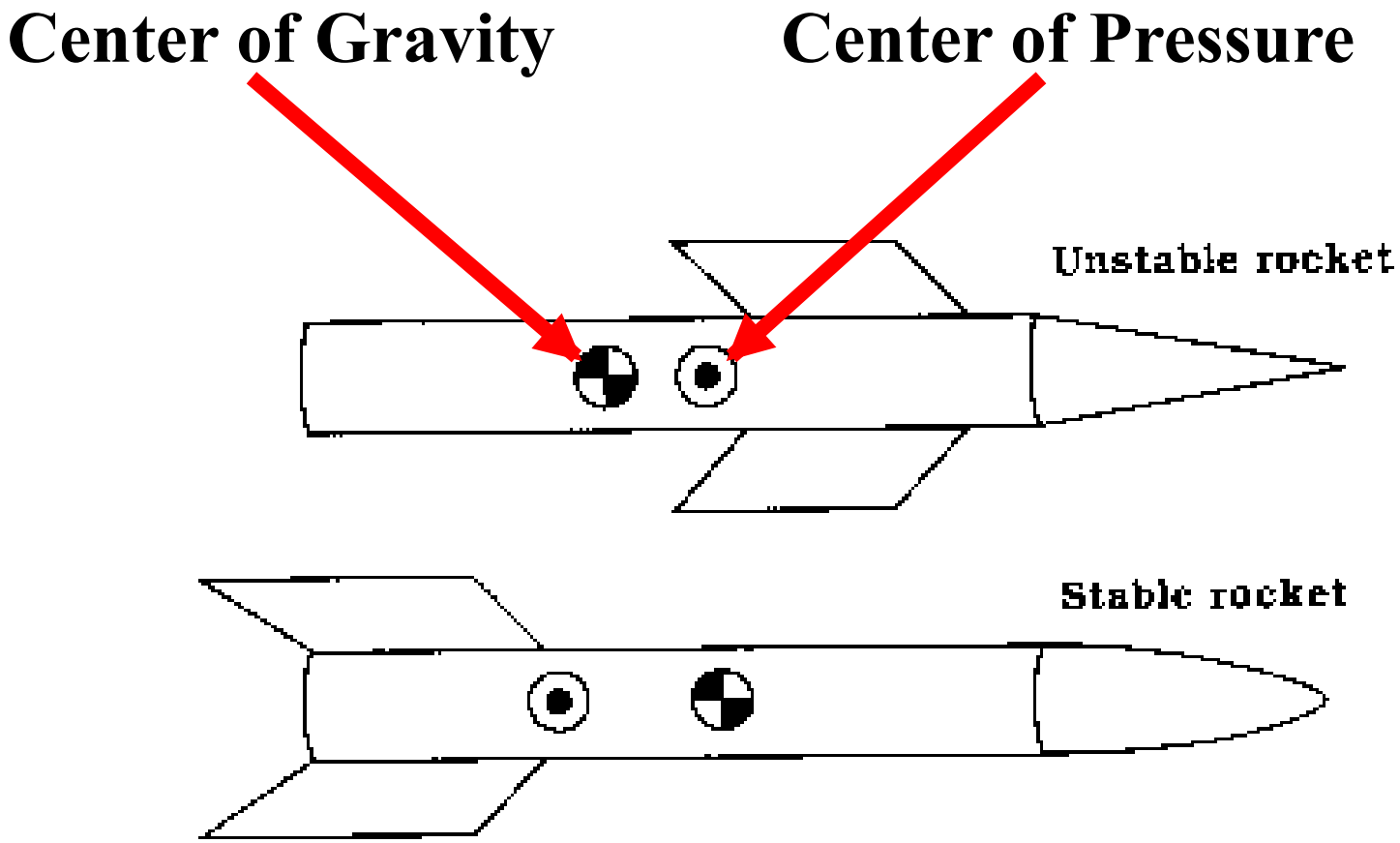
Rocket Fin Shapes



- **Square/Trapezoidal** Fins yield MORE stability, but create MORE ***drag***.
- **Triangular/ Epsilon** Fins introduce LESS ***drag***, but yield LESS stability.

Stability

The orientation of fins and distribution of mass help make the rocket stable.



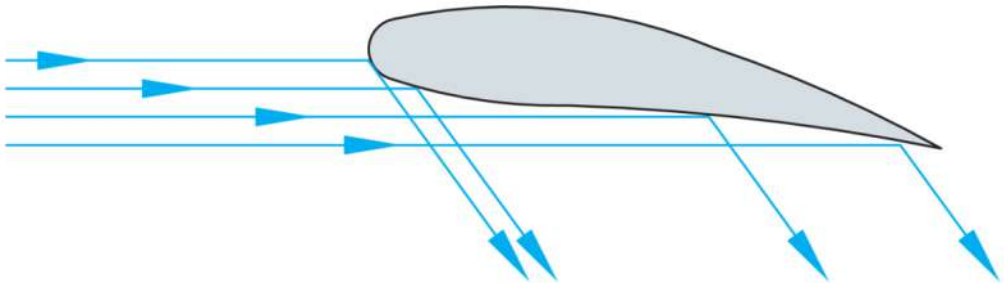
Tips

- **Lengthen** the rocket
- Extend **fins** towards the end of the rocket.
- Add a little **mass** to the nose cone
- Heavy rockets have **more inertia** and therefore more stability

Watch Out! *Too much weight will not allow the rocket to travel fast enough and it will prematurely run out of thrust.*

Lift

- Bernoulli theory of lift
  - Increased air speed on wing tops creates lower pressure, causing lift
  - Wings create lift



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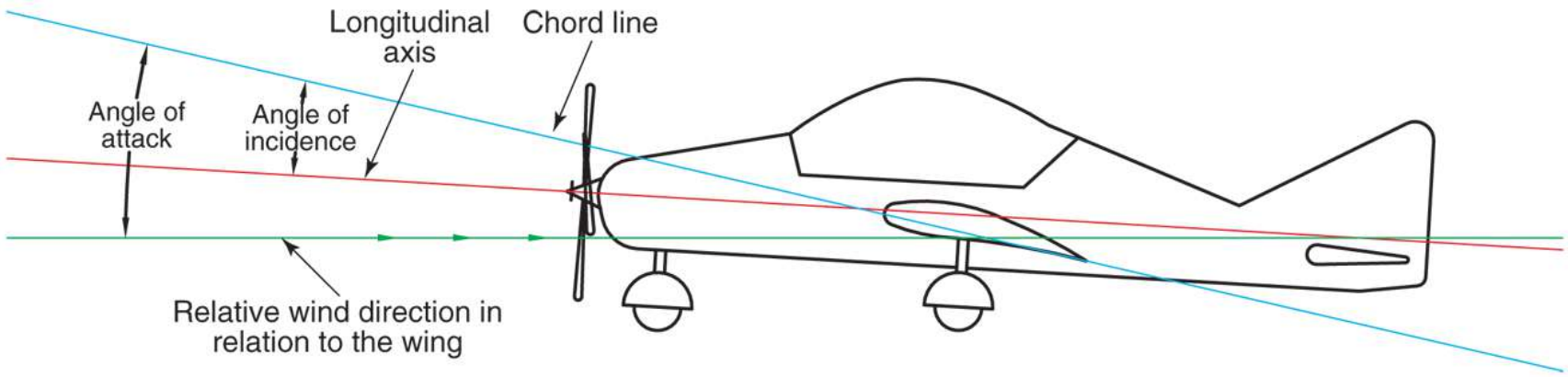
Lift Factors

- Speed (**want maximum speed at take off**)
- Angle of attack and incidence (**Launch rockets at 45 degrees**)



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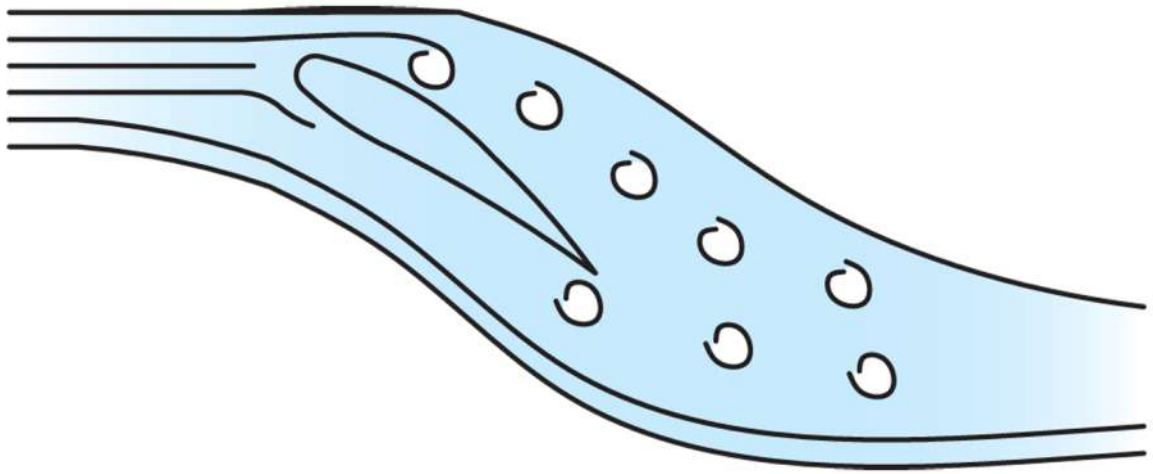
Stall

- Angle of attack is too steep (**too much of an angle at launch**)
- Smooth laminar airflow changes to turbulent flow
- Lift is lost



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Gravity

- Weight is force from earth's gravitational pull
- Heavier planes have more gravitational pull
- Increased weight requires increased lift to stay at same height

Aerospace Engineering in Action

- Wind farms generate electricity on large scale
- Wind turbine blade design similar to wing and propeller design
- Aerospace engineers designed efficient wind turbine blades

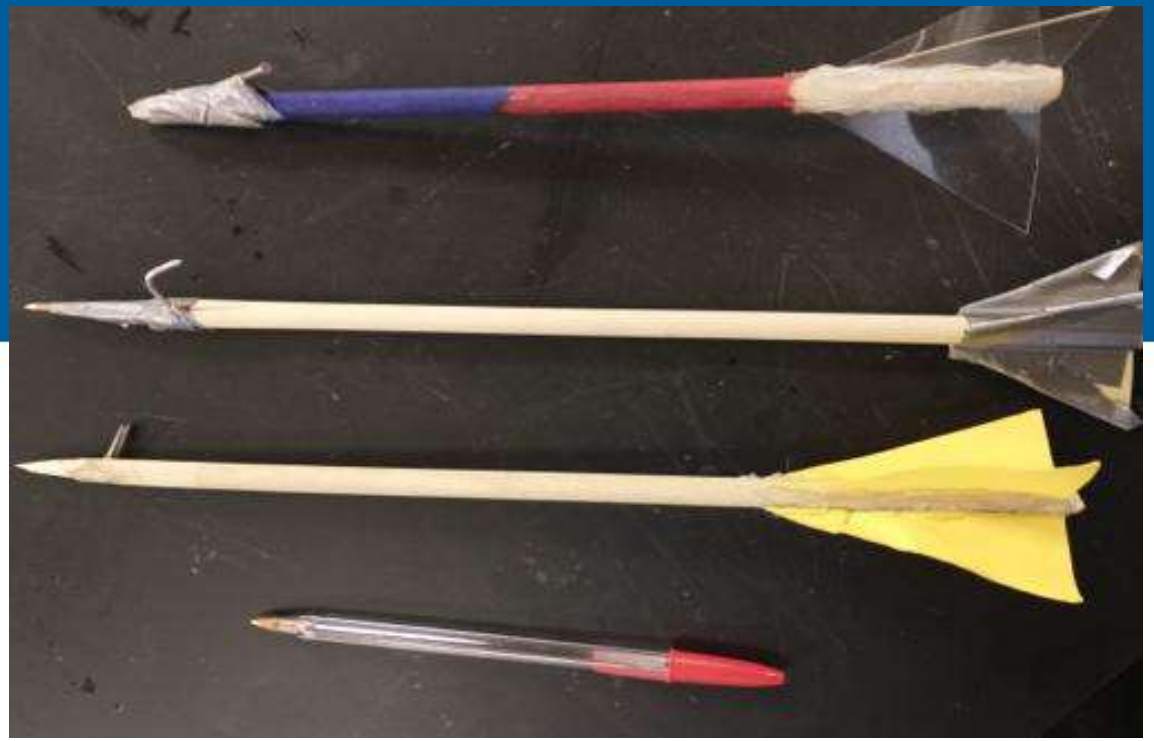
TebNad/Shutterstock.com

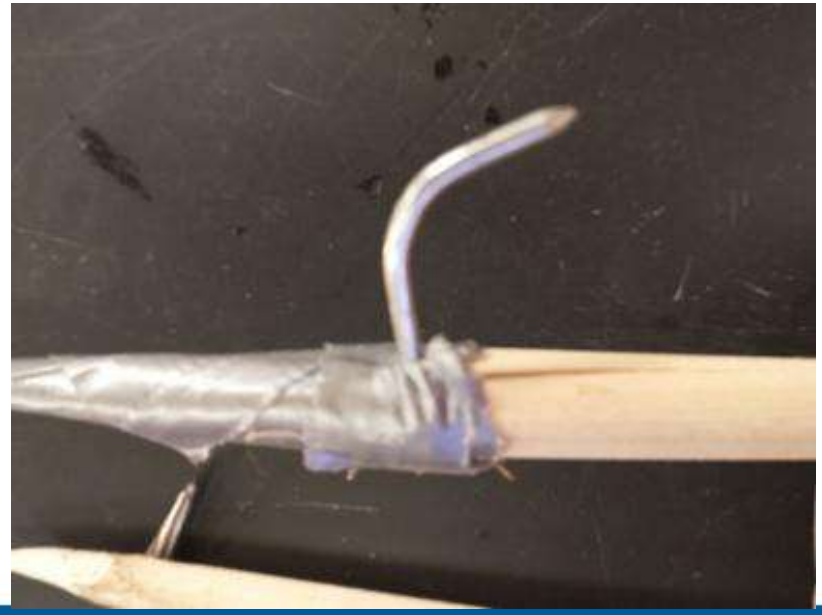
Air Rockets Rubric

- 70 – Rocket reaches Under 55m
- 80– Rocket reaches 55m
- 90– Rocket reaches 65m
- 100 – Rocket reaches 75m
- ***Curve available***

Elastic Rockets

- Use paper (cardstock or regular), tape, and any materials you choose – PVC, Dowel Rods, Cardboard to build a rocket.
- Rubber band is not attached to rocket – ONLY power source is rubber band





Elastic Rocket Rubric

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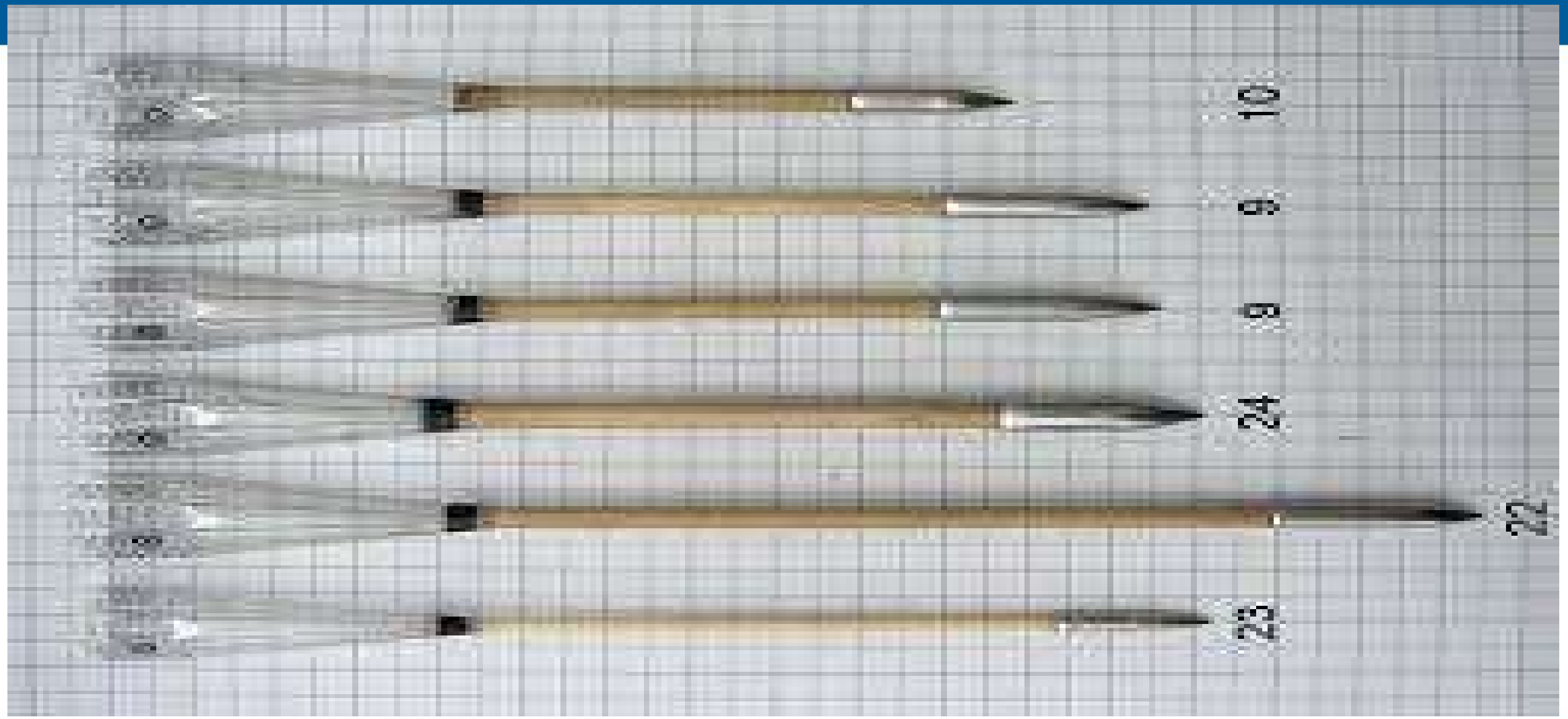
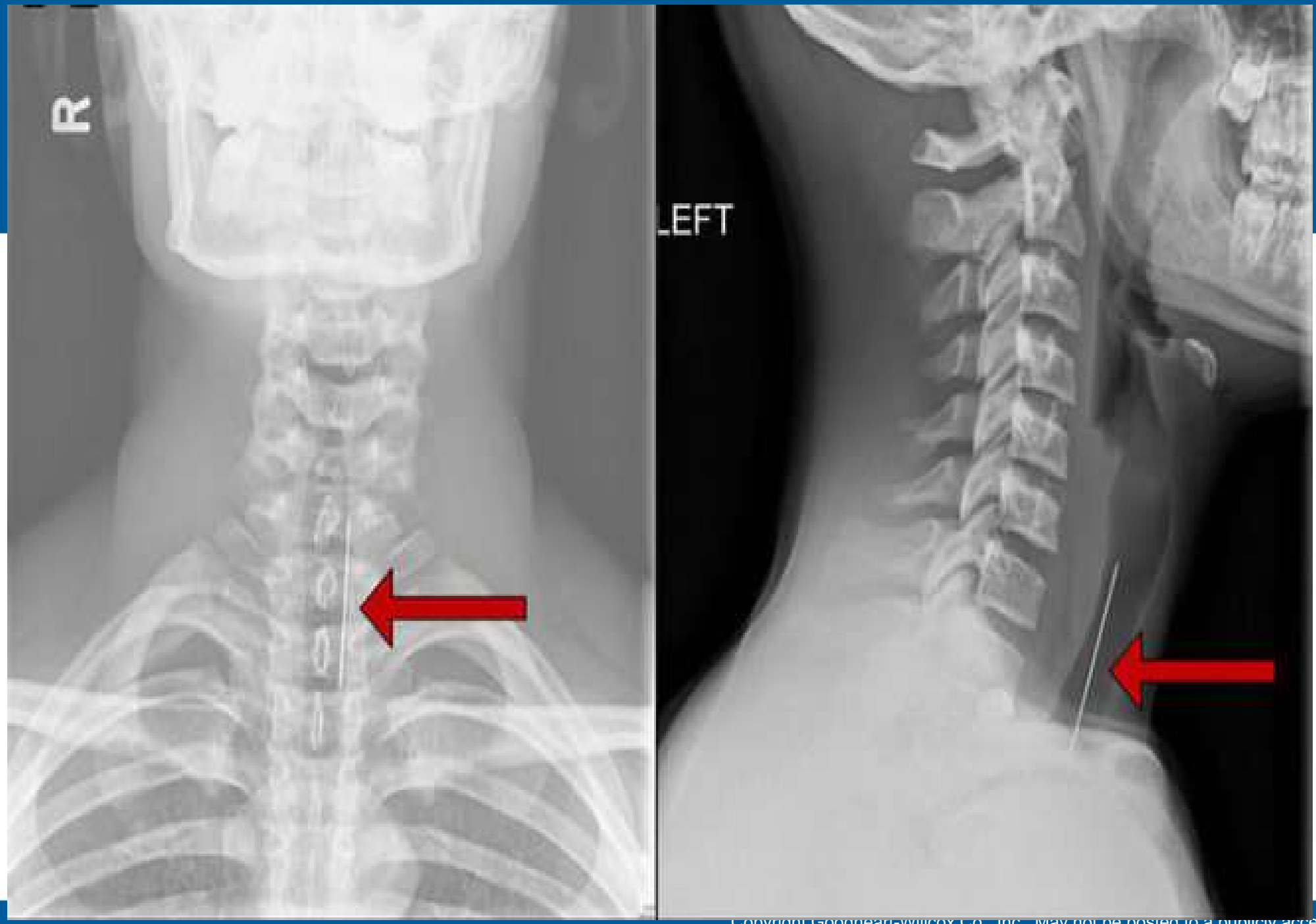
Blow Darts





Blow Dart Project

- You will build a blow dart
- Everyone will shoot from a pvc pipe (clean the end after each use please).
- Farther gets higher score.

Tips

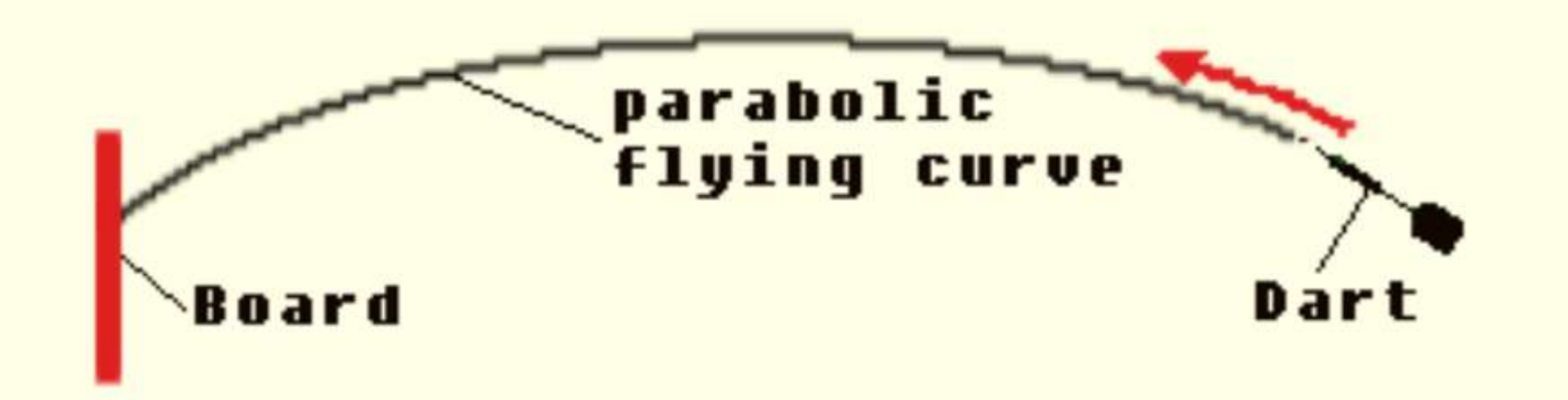
- Frayed tips help to build pressure.
- Shape like a cone

Rubric

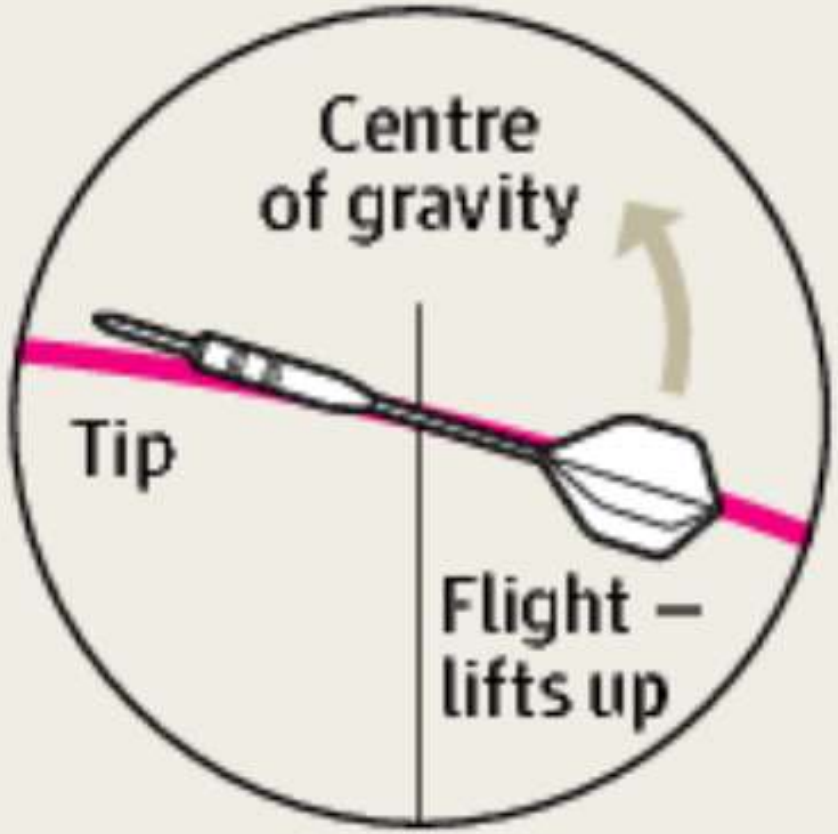
- 10 – Dart reaches 5m
- 20 – Dart reaches 10m
- 30– Dart reaches 15m
- 40– Dart reaches 20m
- 50– Dart reaches 25m
- 60– Dart reaches 30m
- 70– Dart reaches 35m
- 80– Dart reaches 40m
- 90– Dart reaches 45m
- 100 – Dart reaches 50m

Darts

- Barrel of dart is 22 grams
- The dart board is 5'8" high
- The thrower stands 7'9 1/4" away from the board



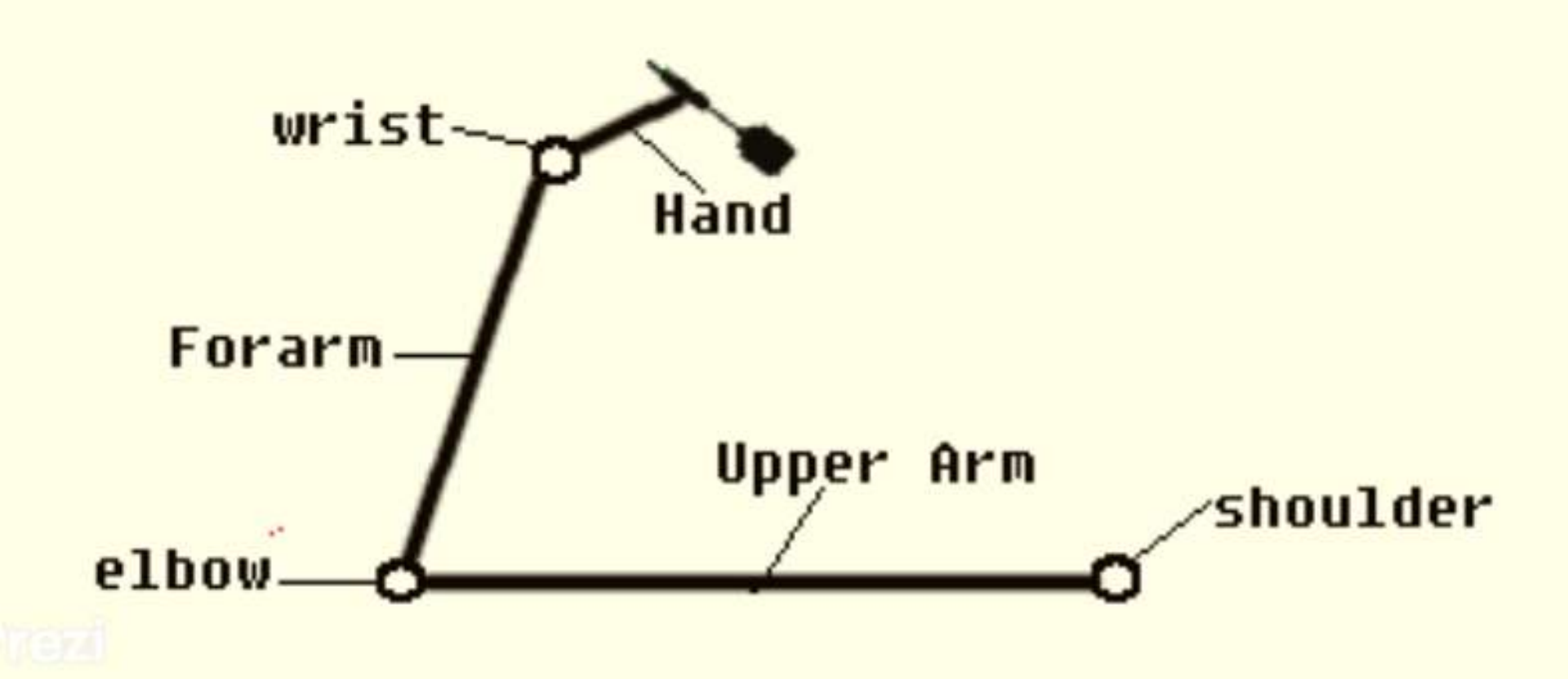
- The center of gravity is towards the front end of the dart
- This causes the front of the dart to dive downward

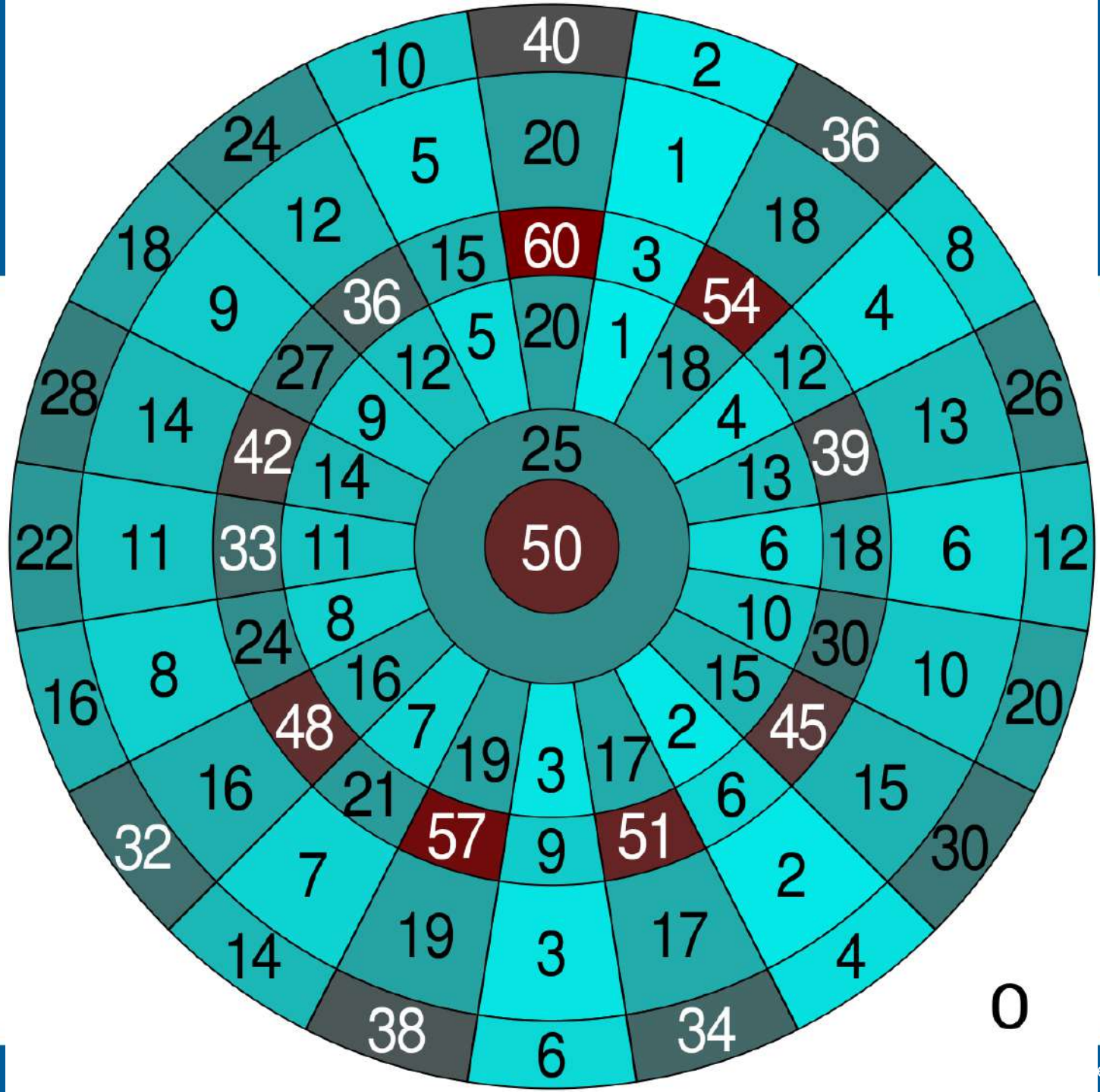


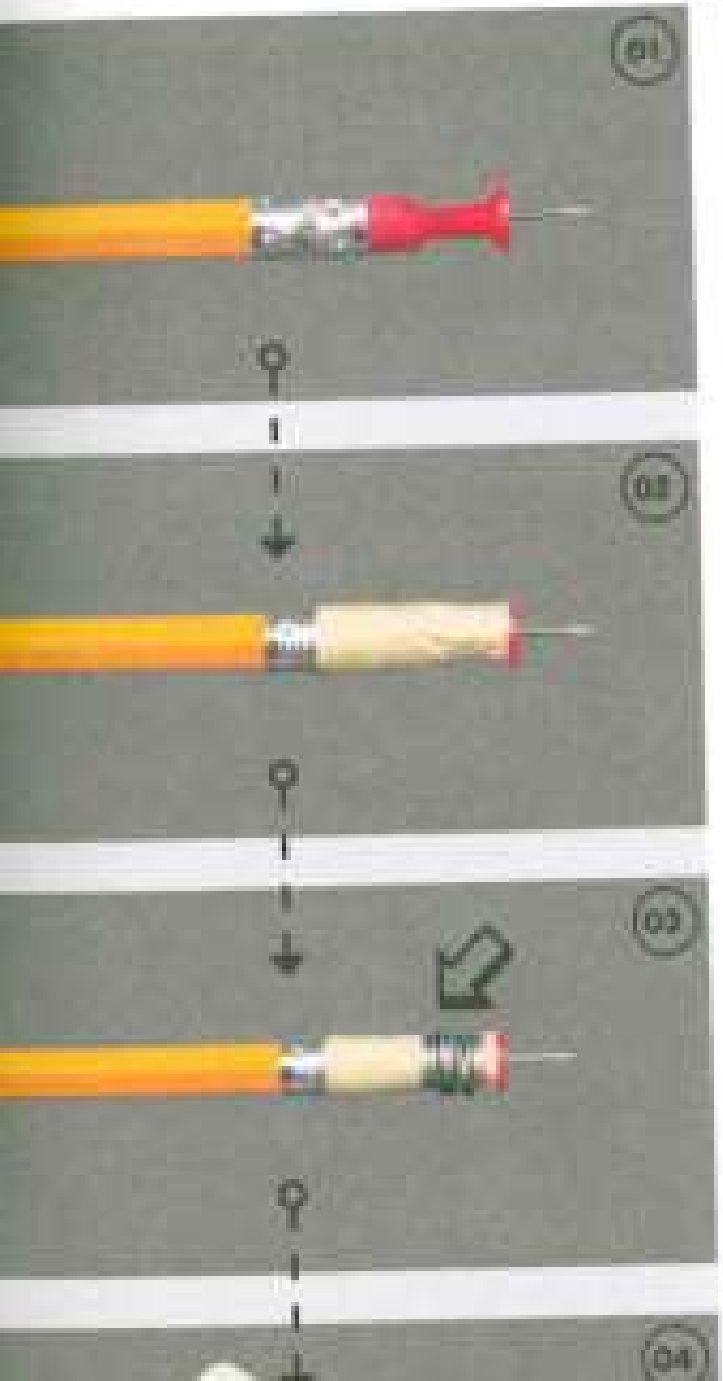
Dipping into the board

All darts swing like a pendulum during a throw. If the tip is released point up, the flight lifts the rear end to level the dart and it will dip into the board

- Shoulder stays still
- Bend the elbow
- Flick the wrist
- Dart travels on a parabolic flying curve



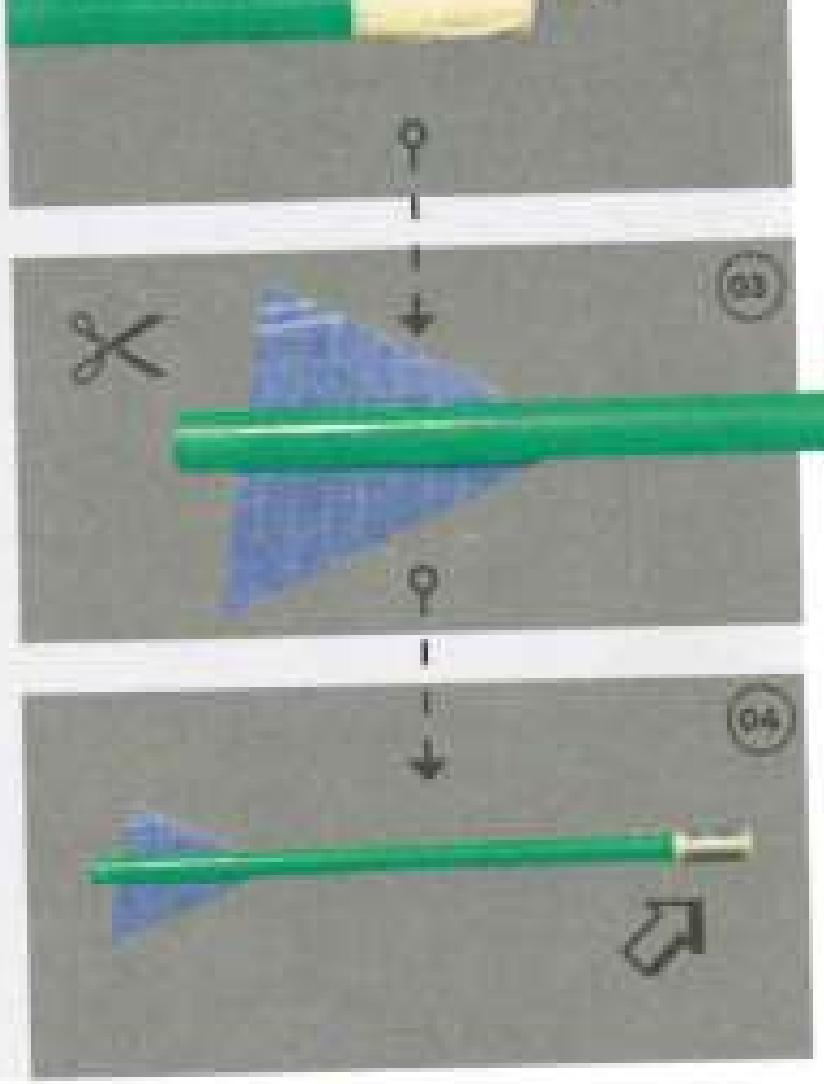




03 > Create fins for the dart as in step 3 of **Pen Darts.** The fins shown here are made of a business card, which is very thin but also very rigid.

04 > Wrap the front end of the dart with wire to add leading weight. Secure the ends of the wire with glue.

05 > Set up a corrugated cardboard target and see what you can do. Adjust the leading weights of your darts as necessary for better control.

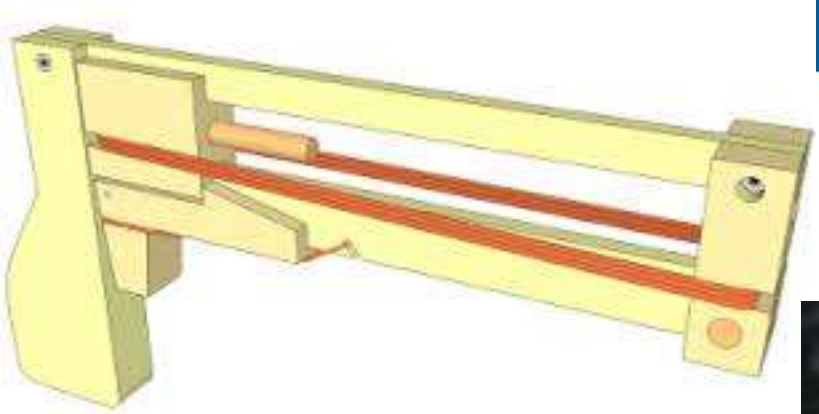


The perfect dart

Darts Rubric

- Must have 4 darts per person
- Each player will throw their darts 3 times and add up round – darts must stick and stay stuck entire round
- Next person will throw 3 darts and add up score
- Repeat for 3 rounds – most points scored by a person wins.
- Each player will play every player – 1 point for winning; 0 points for loss

Jenga Gun

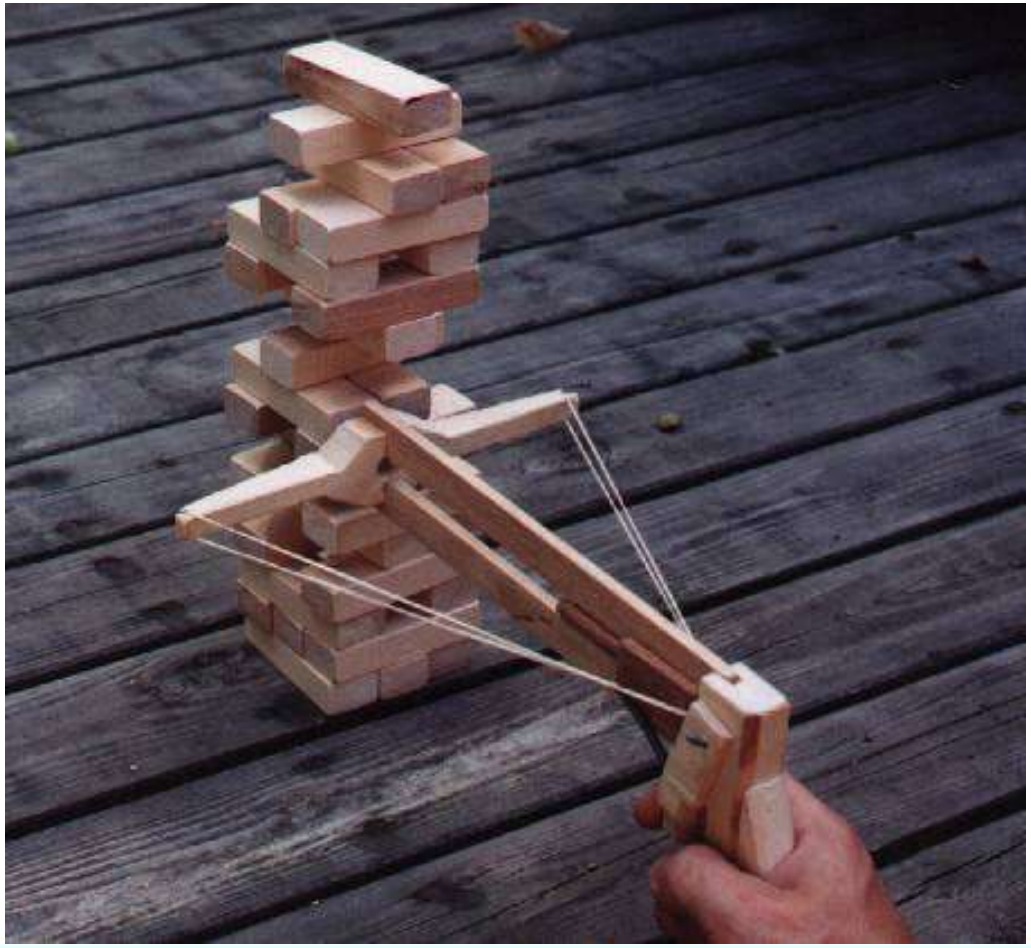


- The flimsy card table is out of the question to play Jenga because the slightest bump will send your tower tumbling. The sturdy kitchen table is a solid choice, because it doesn't rumble around as easily as the card table. **DON’T bump the tables or sit on them during matches!**
- Structural engineers must also consider the surface they're building their structure on. If you put a 15-story building onto loose soil, the structure might settle unevenly, causing cracks in the walls or even a collapse. That's why all modern buildings, small and tall alike, are built upon foundations.

- Experienced Jenga players know that the quickest way to a falling tower is to pull away the two outside pieces of the bottom row, leaving the whole structure balancing on a single narrow wooden block. With only one support at the bottom, every bump and nudge of the tower is magnified, causing it to sway precariously from side to side.

Jenga Gun

- Must be powered by a rubberband
- Youtube “Jenga Gun” to build



Jenga Rules

- No touching any pieces.
- After you shoot a piece out, you put it on top.
- Each person in class will play every person
- Each match you win, you get a 1 point
- Each match you lose, you get 0 points
- Whoever has the highest points at the end of all the rounds gets the highest grades.