Physics 100
Basic Rocket Design Principles

Name: Key

Purpose: To use simple paper rockets as a model for understanding water rocket design

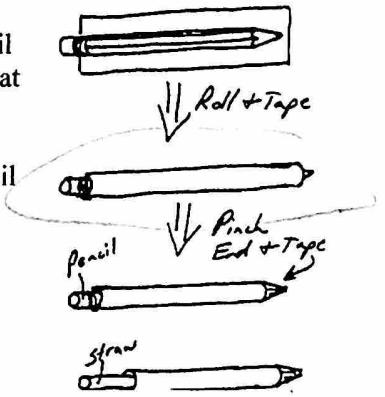
Materials:

- Scissors
- Paper
- Straw that is thinner than the pencil
- Sharpened pencil that is thicker than the straw (or pen, to wrap paper around for the rocket body)
- Clear Tape
- Paper Clip

Fuselage (body) Construction:

1. Cut a rectangular strip of paper that is almost (but not quite) as long as your pencil and around 3-5cm wide. Roll the paper around your pencil. Tape the paper so that it won't unroll and leave it on the pencil.

2. Form the end of the paper cylinder into a cone. Use the sharpened tip of the pencil to help form the cone. This may be easier if you make cuts in the end of the cylinder first. Use a small amount of tape to keep the cone from opening up.



Flight Testing:

3. **Bare Fuselage:** Your rocket isn't much of a rocket yet. But it's time to begin testing. Fly your rocket with no weight added and no fins. Briefly describe its flight and estimate the length of your longest attempt, in meters (long steps).

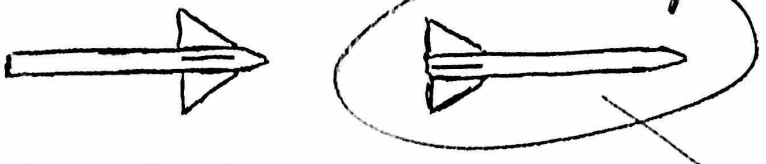
Went straight, then veered off

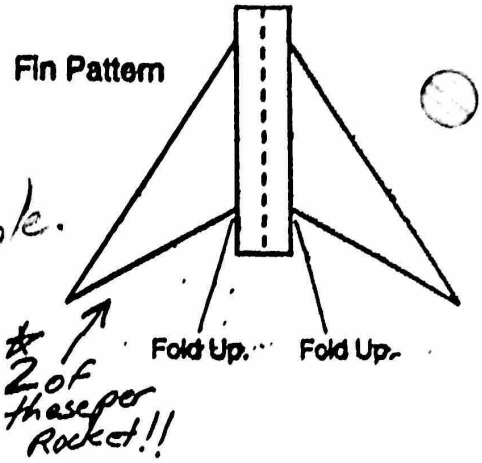
4. **Adding Weight:** Will the rocket fly better with weight added to its nose or its tail? Shift your rocket's center of mass by using a small amount of tape to attach a paper clip to one end of the rocket. Launch your rocket and see what happens. Then remove the paper clip and shift it to the other end of the rocket. Launch again. Which paper clip position works better? Briefly describe your observations and estimate the your longest flight distance, in meters.

Add weight to as far forward as possible

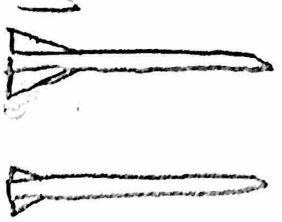
5. **Adding Fins:** Remove the paper clip and experiment with fins. Cut out two copies of the fin template on the right. Each template includes 2 fins. When you attach two templates, you can make a rocket with 4 fins. Try adding fins in a variety of locations. Where do they work best?

Fins as far back as possible.





6. **Reducing Drag:** You can probably make your rocket go even farther by cutting some material away from the fins. This reduces wind resistance (a.k.a. drag). If you are going for distance, there is probably a "best size" for your fins. Keep removing material until your rocket goes as far as possible. Unfortunately, you won't know how much to remove until you have removed too much. When your fins are too small, your rocket will lose stability.

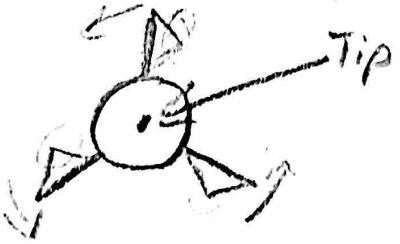


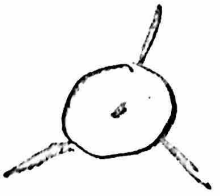
a. Were you able to increase distance by reducing your fins' size?

b. What was your longest distance (in the air, in meters)?

NA

7. **Adding Angular (rotational) Momentum:** If you made your fins too small, your rocket may no longer be stable. However, you may be able to regain stability by bending the fin tips to create a "pinwheel." This may allow your rocket to once again achieve stable flight (like a spiraling football). Bend your fins to make the rocket spin. Launch the rocket and describe how (or whether) this modification affected the flight distance.





8. If we were to shoot these paper rockets from a high-speed air gun, do you think a rocket will go farther if we add weight, add fins, or add both? [**We may have a launcher that we can use to test this.]

NA

9. You should have seen that adding fins and/or weights in the specific locations can make a rocket more stable during flight. Do you have any idea why this is? If you do, explain.

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