

## PAPER TUBE ROCKET (revised)

### Introduction

The paper tube rocket consists of a tubular rocket body and a set of stabilizer fins. Teachers and students can print out a rocket body on a sheet of 70 or 80 g/m<sup>2</sup> A4 paper (ordinary office paper). They can also print out sets of stabilizer fins on the A4 office paper. After that, following the assembly instructions they can build up paper tube rockets.

We can use rubber bands as the power source of the launcher. The launcher consists of rubber bands which produce 5 N thrust and two short strong plastic straw pieces.

This rocket and launcher system is simple and safer than other rocket activities.

A paper tube rocket	The mass of the rocket is 6.5 g.	A launcher

### How to launch the rocket

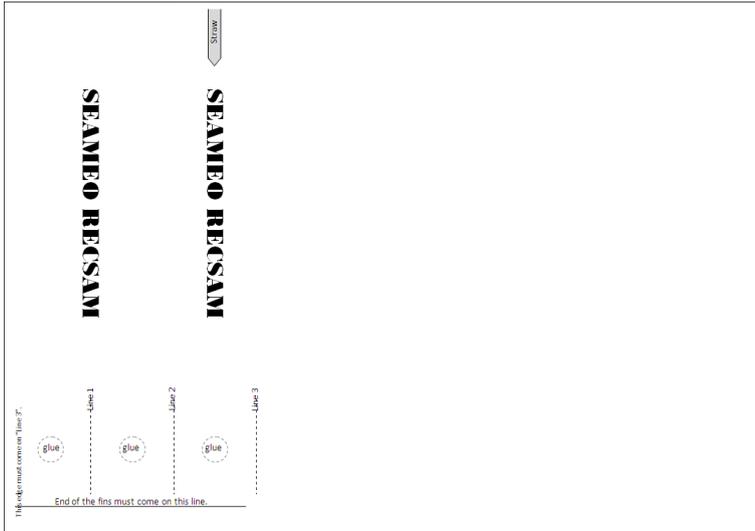
- 1) Make sure there is no person and valuable items around the rocket flight direction.
- 2) Hold the launcher with your left hand then connect the end of the rubber chain of the launcher with the hook on the rocket nose.
- 3) Pinch the rocket tail with your right thumb and index finger.
- 4) Stretch your left arm forward and stretch the rubber bands by pulling the rocket backward.
- 5) Release the rocket and watch how it flies.



### Materials and tools

Materials	Tools
A 4 paper, a good 5.0 - 5.5 mm in diameter plastic straw, a strong 7.0 mm in diameter plastic straw or a disposable chopstick + cotton string, double sided foam sticky tape 24 mm in width, a thin shopping plastic bag, good rubber bands	A cutting mat, a cutter, a pair of scissors, one-hole punch, a ruler, a stapler, a glue stick, cellophane sticky tape 24 mm in width

## 1. Rocket body



Print out a paper tube rocket body.

When a dialogue box with “The margins of section 1 are set outside the printable area of the page. Do you want to continue?” appears, click “Yes”.

If the distance from the left edge to the line 3 is shorter than 96 mm, please do the followings.

(e.g. Word 2007) Remove the tick from the red option.

Word options > Advanced > Print > **Scale content for A4 or 8.5 x 11 " paper sizes**

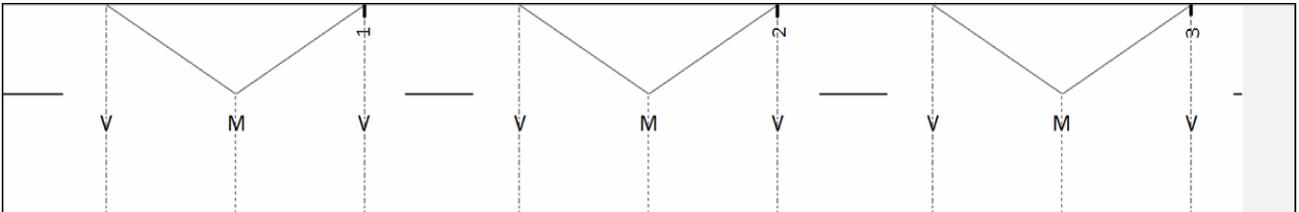


Start making a rocket body (a paper tube) using good sticky tape. An end of the paper must come on the line 3.

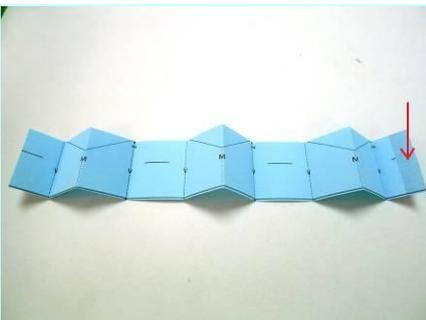


You can use three strips of sticky tape to make a tube.

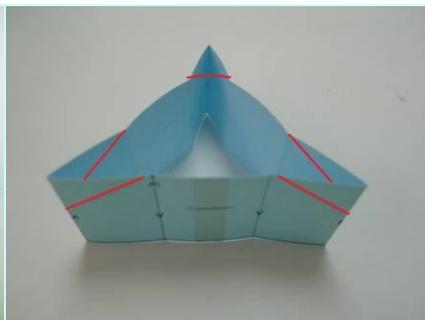
## 2. Stabilizer fins



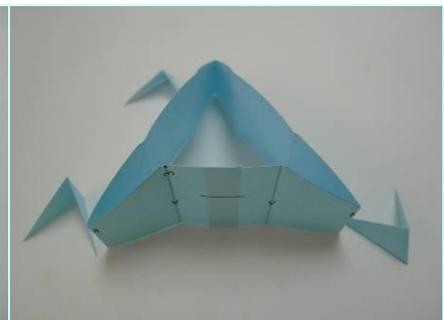
Print out stabilizer fins.



“V”s and “M”s on the template mean valley and mountain folds respectively. After the folding, apply glue to the shaded part (indicated by a red arrow.)



Cut along red lines



Your stabilizer fins are ready.

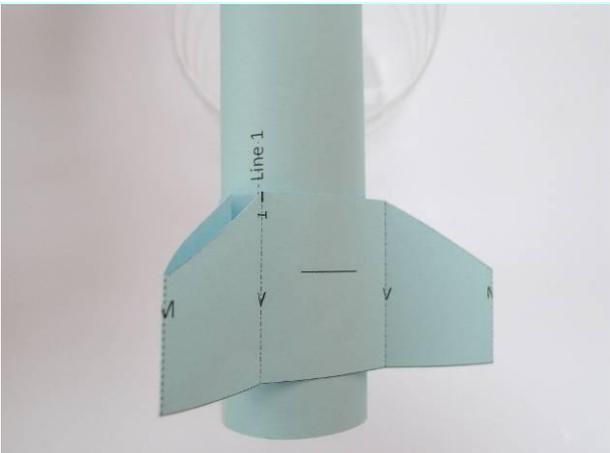
### 3. How to connect the body and the fins



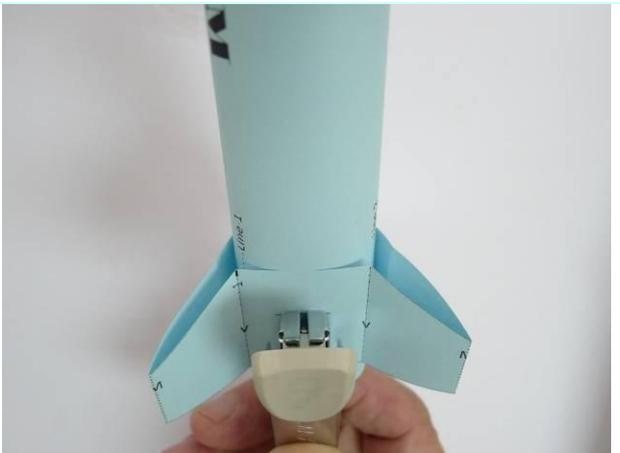
Apply small amount of glue to the three spots between lines.



Insert your rocket body into the fin unit.



Align "1" on the stabilizer fin unit with "Line 1" on the body. Repeat this along "2" & "Line 2", and "3" & "Line 3".

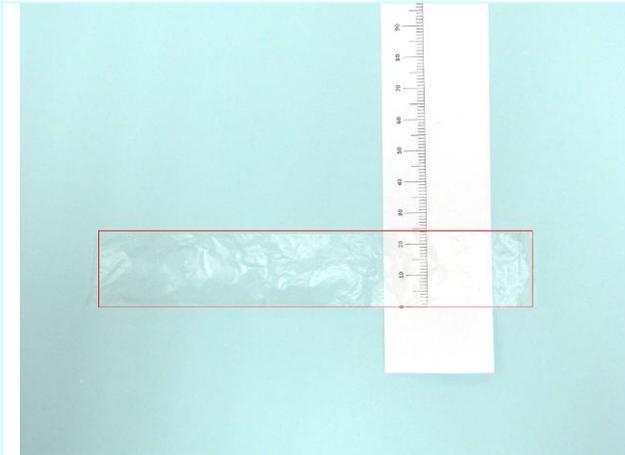


The horizontal lines on the fin unit show where we should use a stapler. Do not staple under the lines. Staple on the lines or above. Using your right hand pinch the body with the stapler and use your left thumb to press the stapler.

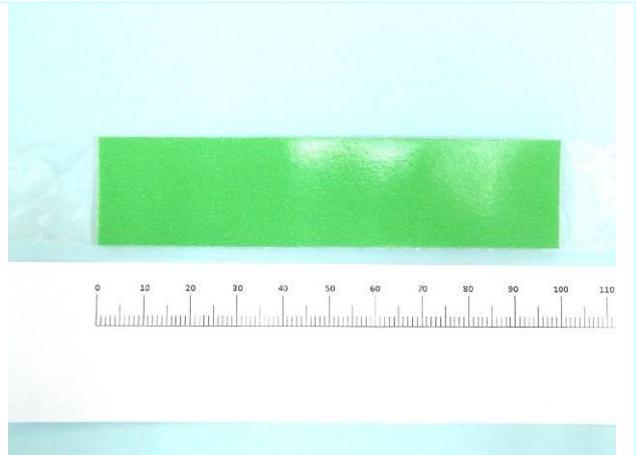


Your paper tube rocket body and fins are ready.

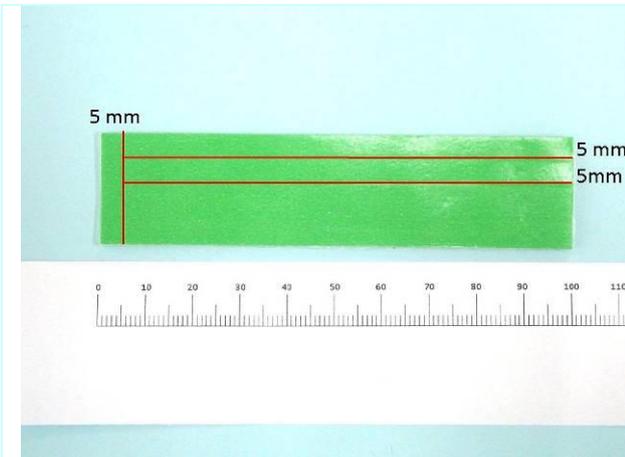
#### 4. Shock absorber



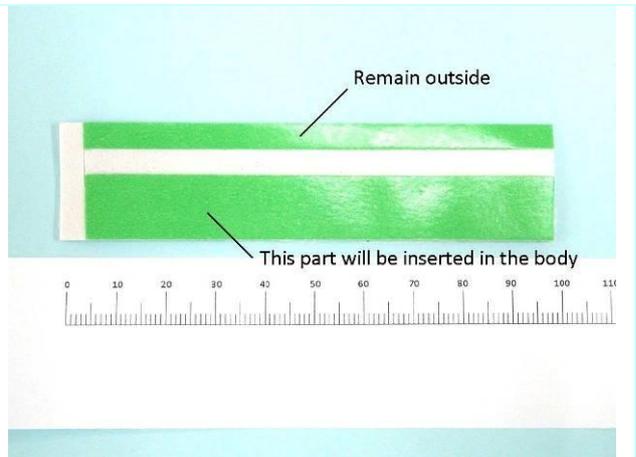
Cut a thin plastic bag and take a 24 mm x 14 cm strip.



Cut double sided foam sticky tape into 24 mm x 100 mm like the photo above and paste the tape on to the thin plastic strip. Trim off the thin plastic strip ends.



Give shallow cuts to the sticker release paper (green paper on the foam sheet) along the red lines. Please do not cut the foam deep but give complete cuts to the paper.



Remove two strips of the sticker release paper like the photo above. Thick green part will be inserted in the rocket body.



Using the sticky end of the strip make a cylindrical shape.

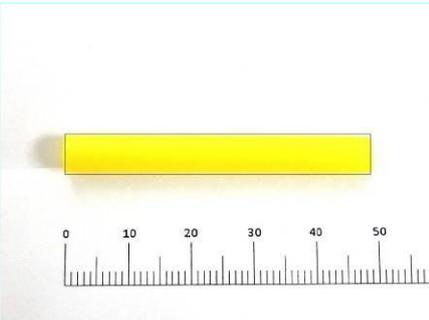


Insert the foam cylinder into the rocket body until the white sticky part disappears.

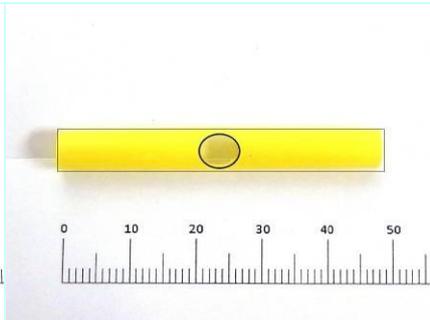


Press the top of the rocket nose and the foam to make them fix firmly.

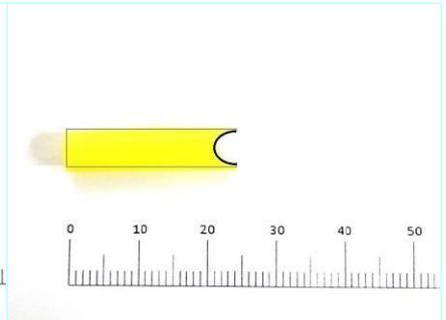
### 5. Hook



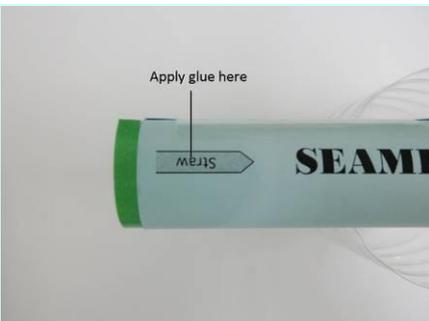
Using a good 5.0 - 5.5 mm diameter straw, make a 50 mm long piece.



With a one hole-punch make a hole in the middle of the straw.



Cut it into two. We can make two hooks



Apply small amount of glue on the "straw" mark on the rocket nose. Then place the hook on it.



Place the hook on the "Straw" mark.



A view from a different angle.



Using approximately 24 mm x 6 cm strong sticky tape, fix the hook on the rocket body.

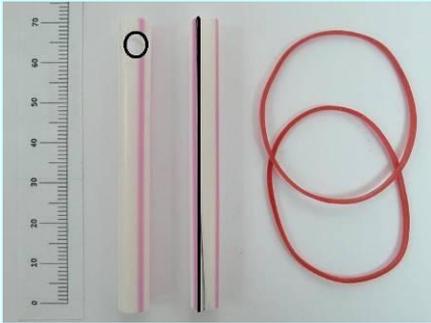


If you use narrower tape, the hook might come out while it is connected to the launcher.



Your paper tube rocket is ready.

## 6. Launcher



We need two pieces of 7 cm long strong straws. Make a hole with the one-hole punch on one of the pieces (the outer straw) and give a whole longitudinal cut to another piece (the inner straw).



Connect a rubber band to the outer straw using the hole.



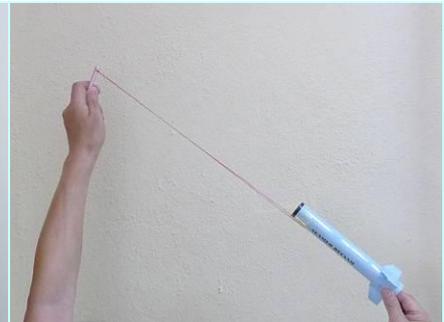
Connect the second rubber band. The two rubber bands in the photo produces 5 N thrust.



Insert the inner straw into the outer straw.



You can use a short disposable chopstick instead of the straws.



**When you launch the rocket, please make sure there is no person and valuable items around the rocket flight direction.**

## 7. The role of the stabilizer fins



Figure 1

Figure 1 shows a paper tube rocket without the stabilizer fins does not fly straight.

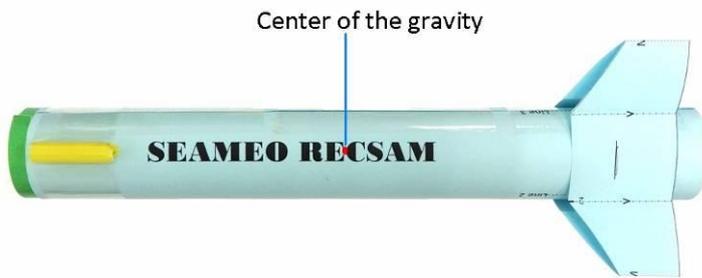


Figure 2

The centre of gravity of the paper tube rocket exists inside of the tube. It is inside between "E" and "C" like figure 2.

When the rocket tilts, the centre of gravity works like an axis of a wheel.



Figure 3

If the rocket tilts like figure 3, the upper fin has much air resistance and the lower fin has less air resistance. Therefore the rocket starts rotating upward to adjust the flying direction (pitching adjustment).

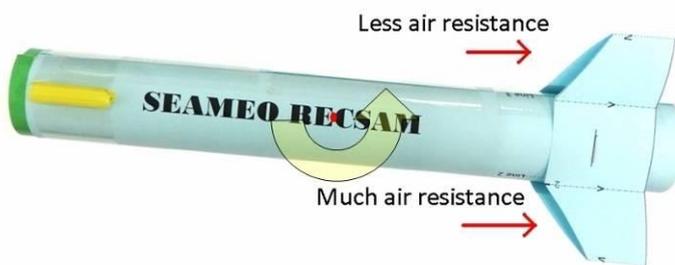


Figure 4

If the rocket tilts like figure 4, the lower fin has much air resistance. Then the rocket starts rotating downward.

While the paper tube rocket is flying in the air, "figure 3 - figure 4" adjustment occurs to the rocket continuously around three axes.

This is the role of the stabilizer fins.