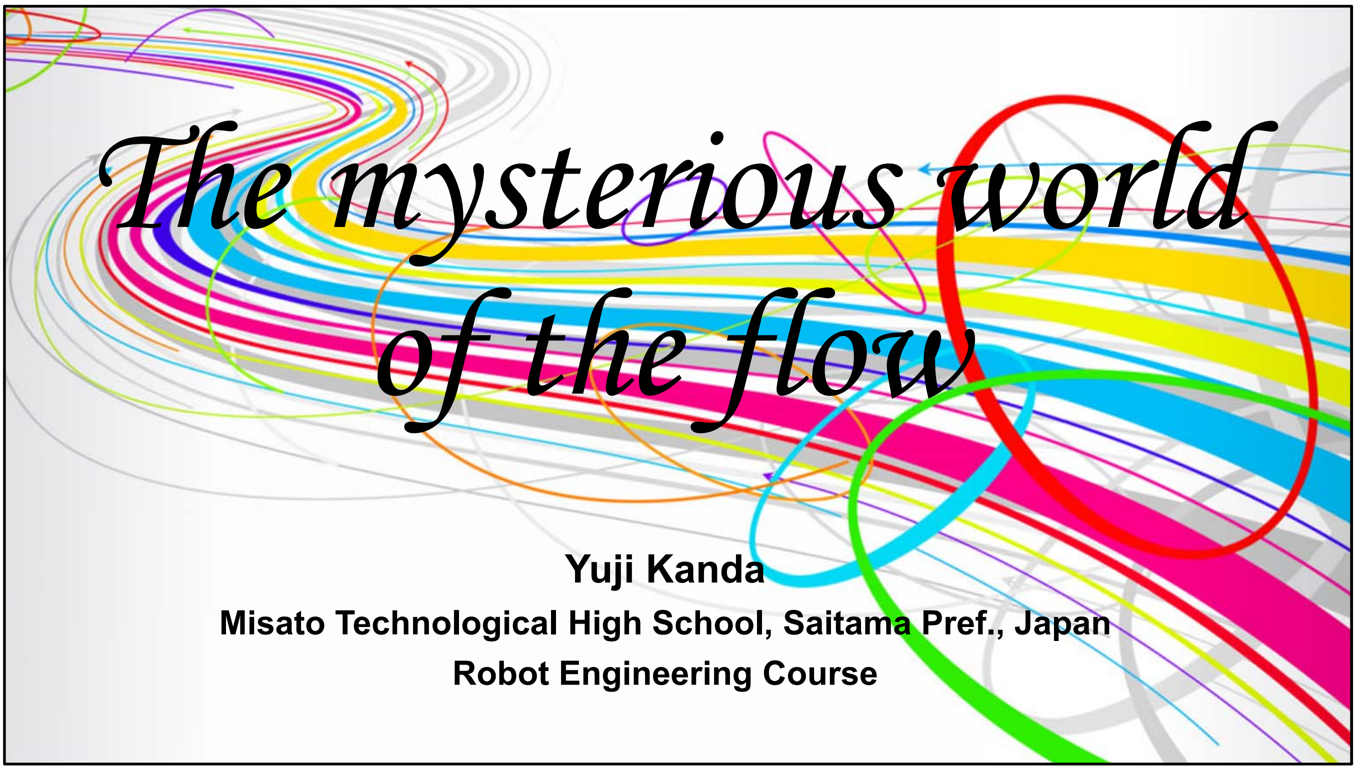


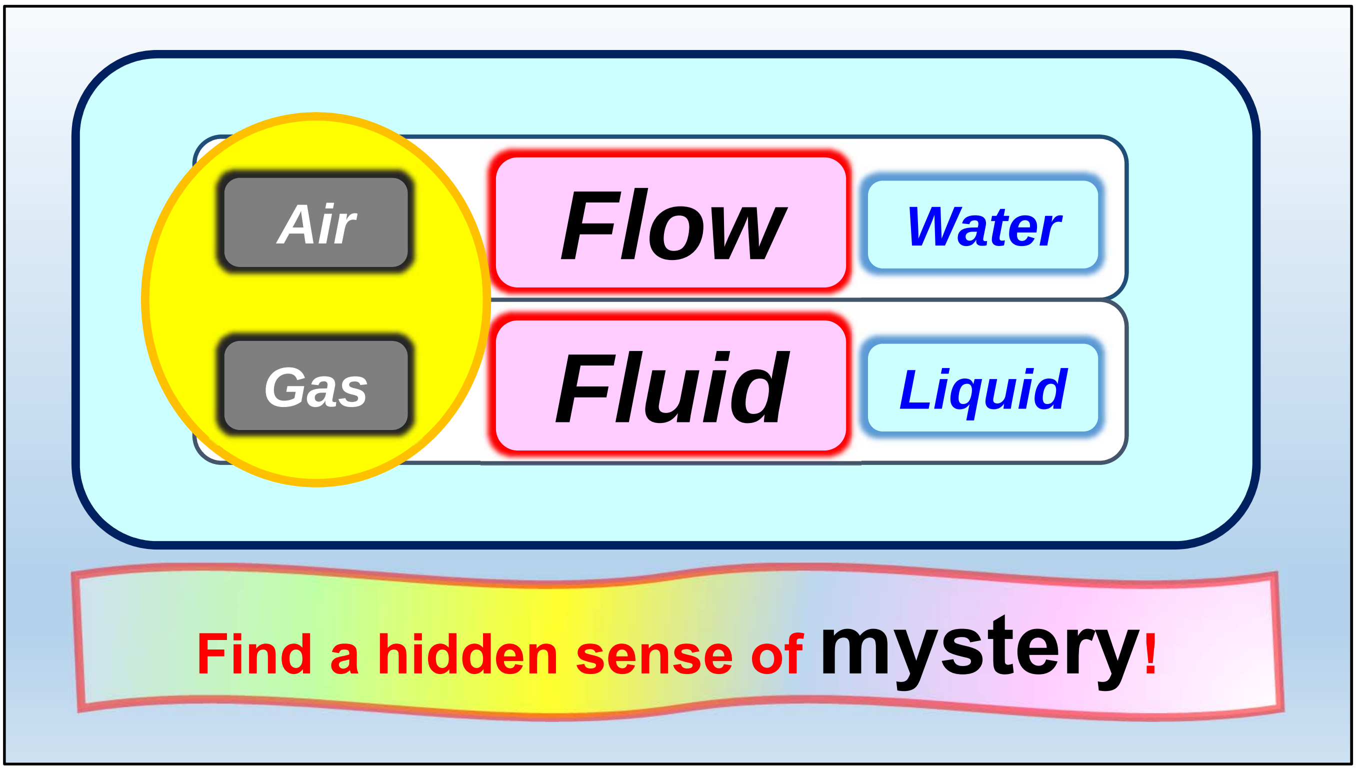
Good afternoon.

My name is Yuji Kanda from Japan.

I’m very happy to be here.

I’m a teacher of Robot Engineering at Misato Technological High School, Saitama Prefecture, Japan.

Today, I would like you to experience the mysterious world of flow.



What do you associate flow with?

Of course, air and water are flowing around us.

One general term for gases and liquids, such as air and water, is called fluid.

Though we aren't usually aware of this fluid, if you look at it more closely, there's a sense of mystery at work.

Today, I would like you to experience the mystery of air and gas.

Fujin - the Japanese god of the wind

How does a styrene foam ball behave?

First, do you know who this is?

In Japan, he’s called Fujin.

He is the Japanese god of the wind.

If Fujin were to direct the wind at the styrene foam ball now, how do you think the styrene foam ball would behave?

Maybe you think it would be blown away.

Let’s try!

So I am trying to perform like Fujin.

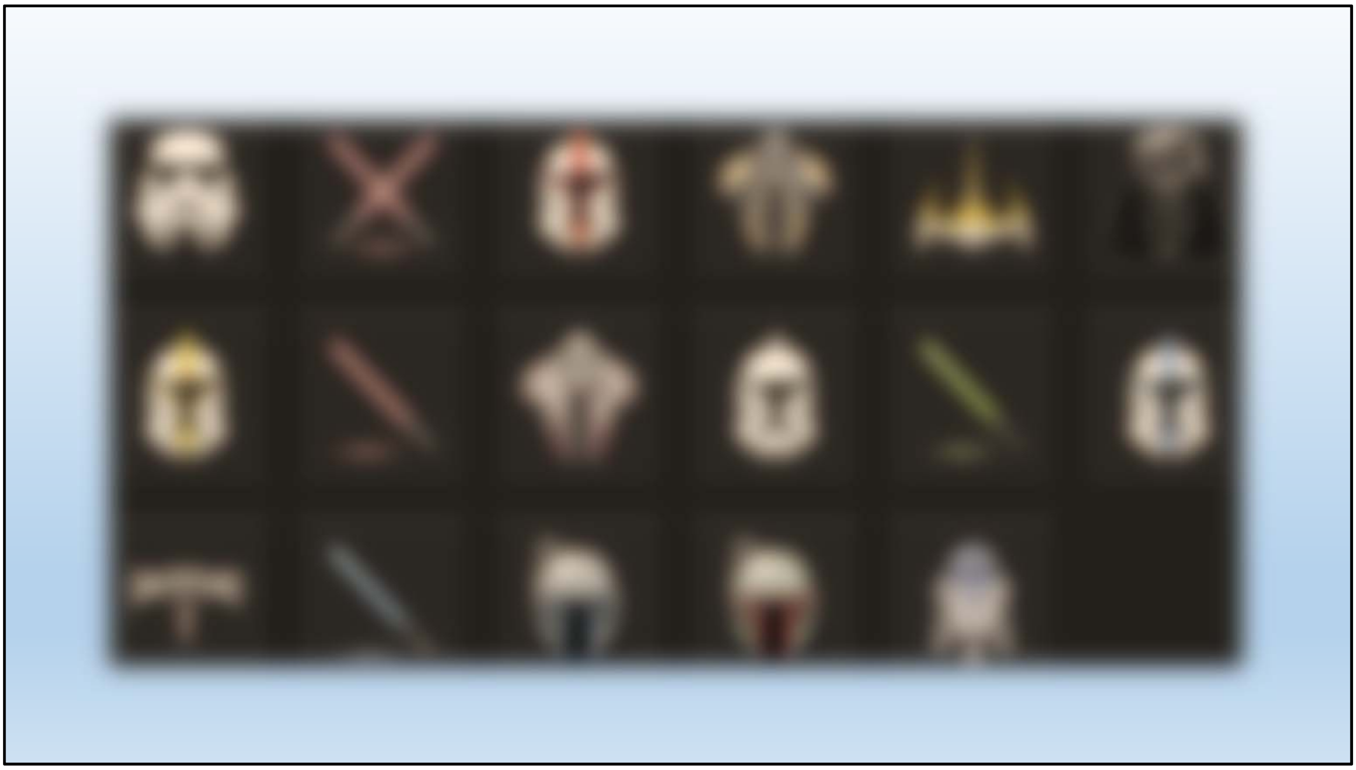
Instead of Fujin’s big bag, I’m going to use this hairdryer.

Is there anybody who would like to try?

Okay, you, please come here.

You know, from the start, I had a feeling that you’d raise your hand.

Because I can feel that you have a very powerful energy.



Do you know what this is?

Of course.

It's Star Wars.

Do you know the Force?

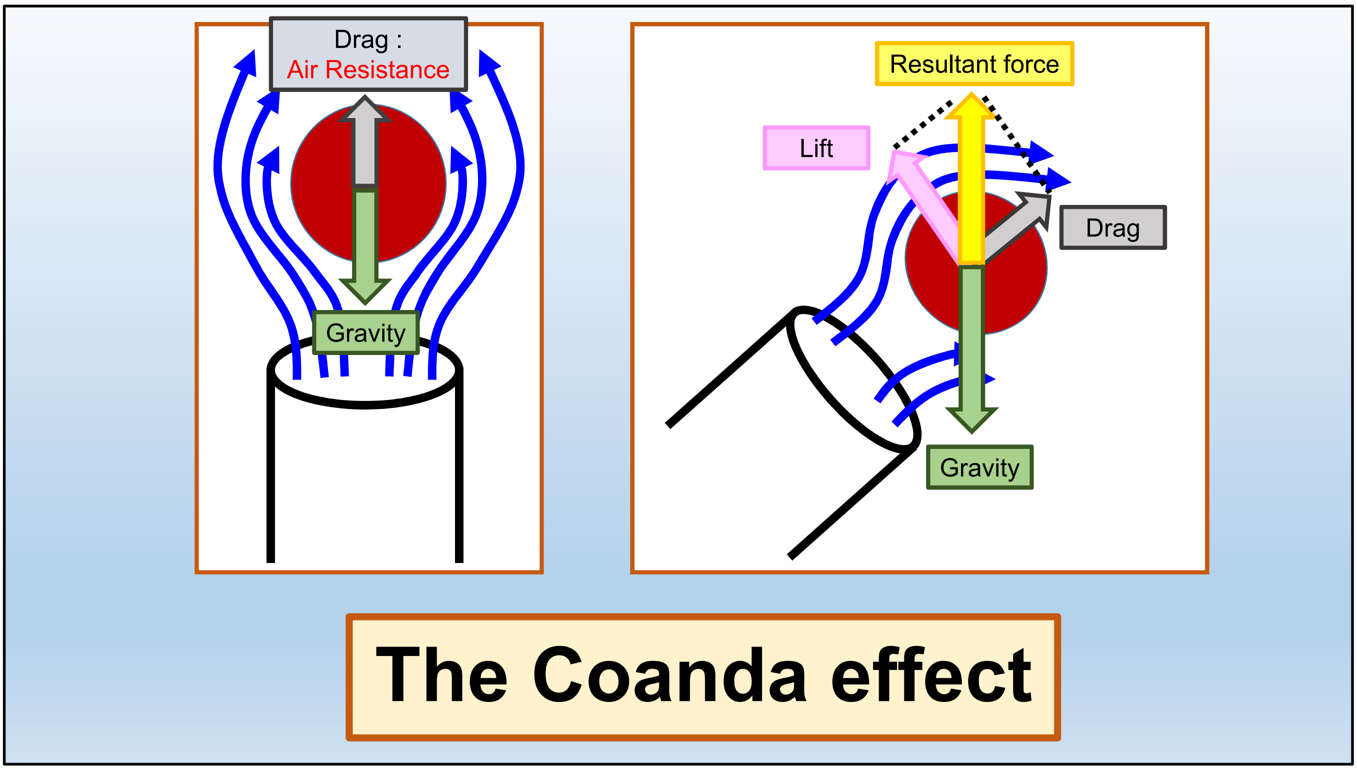
You can use the Force too -- you just won't be as strong as I am.

First, please put the styrene foam ball on the hairdryer.

Then, please tilt the hairdryer slowly.

Oddly enough, the styrene foam ball keeps floating at a certain position, without being moved by the wind.

Thank you.



I’m sure you’ve all figured it out, but this isn’t actually the Force.

Fluids such as air and water have the ability to change their flow direction along an object.

This is called the Coanda effect.

First, when the styrene foam ball is straight up, it floats at the point where there is a balance between the gravity and the drag, which means air resistance.

Next, when we tilt the hairdryer, the Coanda effect causes the airflow to bend along the styrene foam ball .

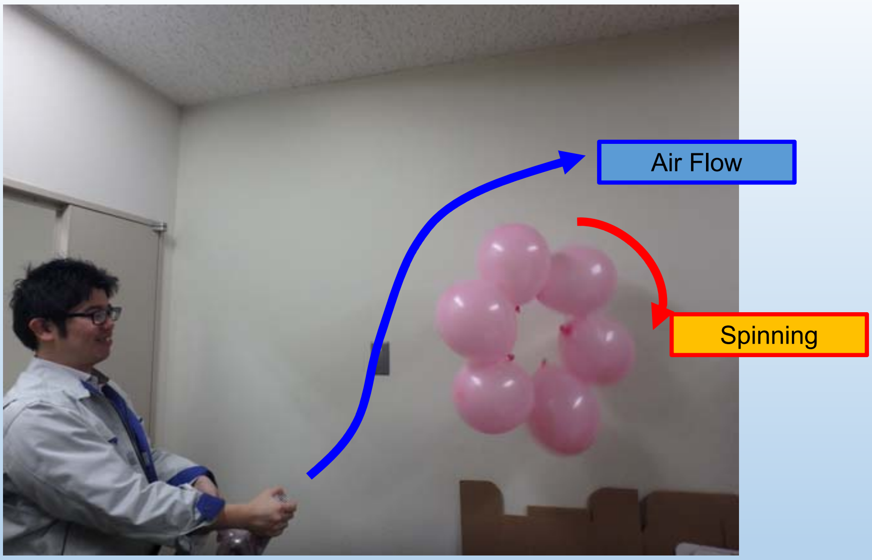
Then, a force vertical to the flow acts on the air.

This force is called lift.

Drag also acts in parallel to the airflow direction.

And at the point where the resultant force, which contains the lift and the drag, and gravity are in balance, an object can remain floating.

So that’s why the styrene foam ball didn’t fall down even when the hairdryer was tilted.



The Coanda effect

Now, I'll show you the mysterious phenomenon applying the Coanda effect.
Once we wind the connecting balloons like these, not only they float fluffy, but they spin.

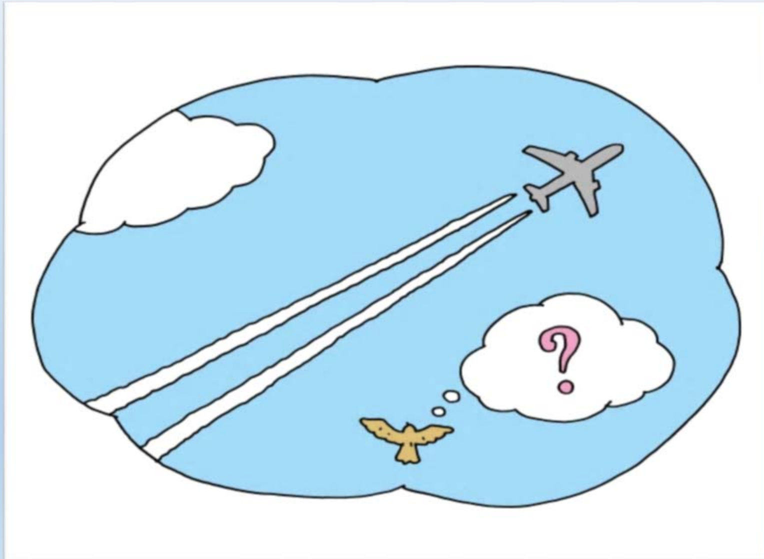
Floating fluffy is due to the Coanda effect explained earlier.
spinning is due to the air resistance created by the air flow that hits the balloon.
This air resistance is the force to rotate the balloons.

Utilizing the Coanda effect

The Coanda effect is also used for flying objects such as airplanes and kites.

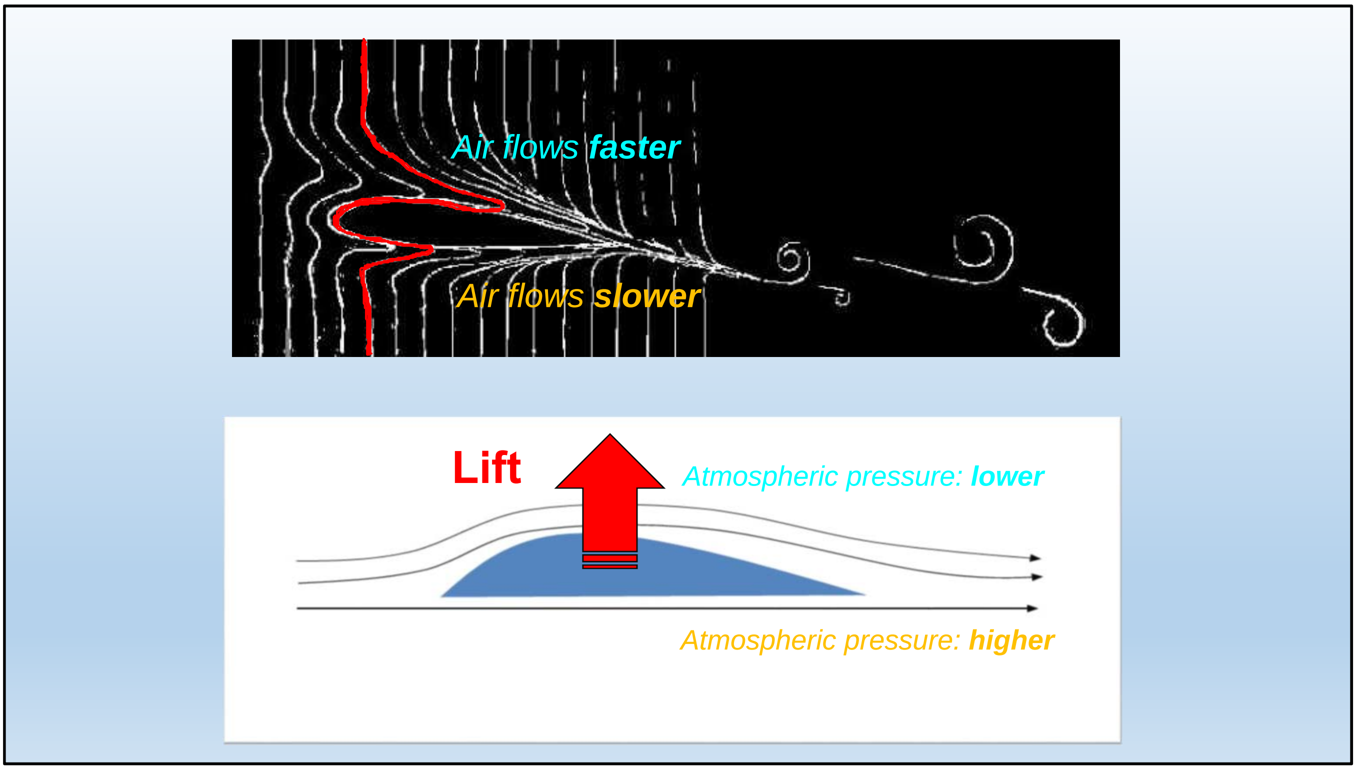
Let’s see how these are flying in the sky.

How can airplanes fly?



Do you know how airplanes can fly?

Try to imagine the wing of an airplane.



This shows a cross-section of a wing.

As you see, the upper side of the wing is curved and the lower side is flat.

The Coanda effect causes the air to flow so as to encompass the wing.

This figure shows the speed of the airflow around the wing.

If you look at this red line, you can see that the air flows faster along the upper side of the wing and slower along the lower side of the wing.

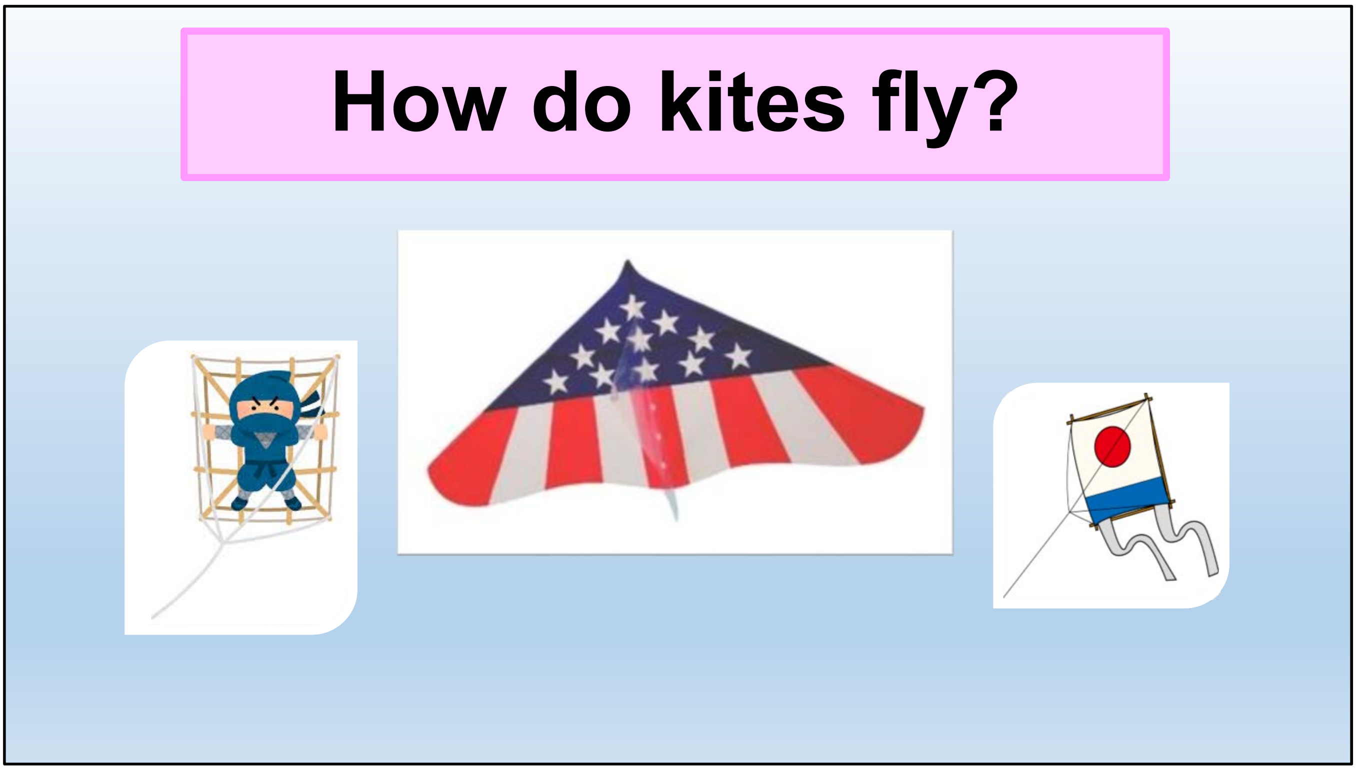
One of air's characteristics is that when it flows faster, Its pressure is lower than the atmospheric pressure.

Conversely, when it slower, its pressure is higher than the atmospheric pressure.

This means that a pressure difference is generated between the upper and lower sides of the wing.

Therefore, a force from the higher pressure to the lower pressure acts on the wing.

This force is called lift, and it pushes the wing upward.

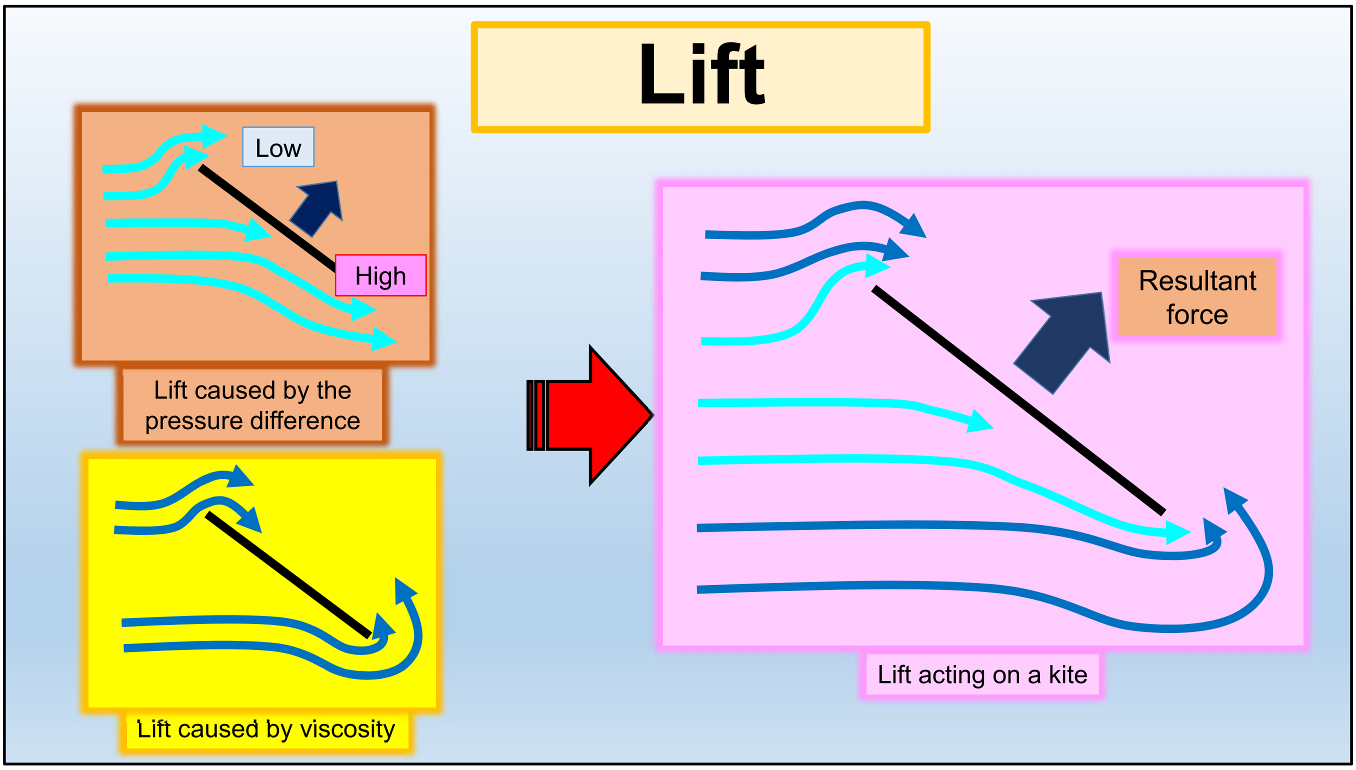


Now, have you ever flown a kite?

This is a traditional Japanese kite. It’s called a *wadako*.

As you can see, a kite has a simple shape, but it can make good use of air characteristics in order to fly.

Now I’d like to briefly explain the principle behind how a kite flies.

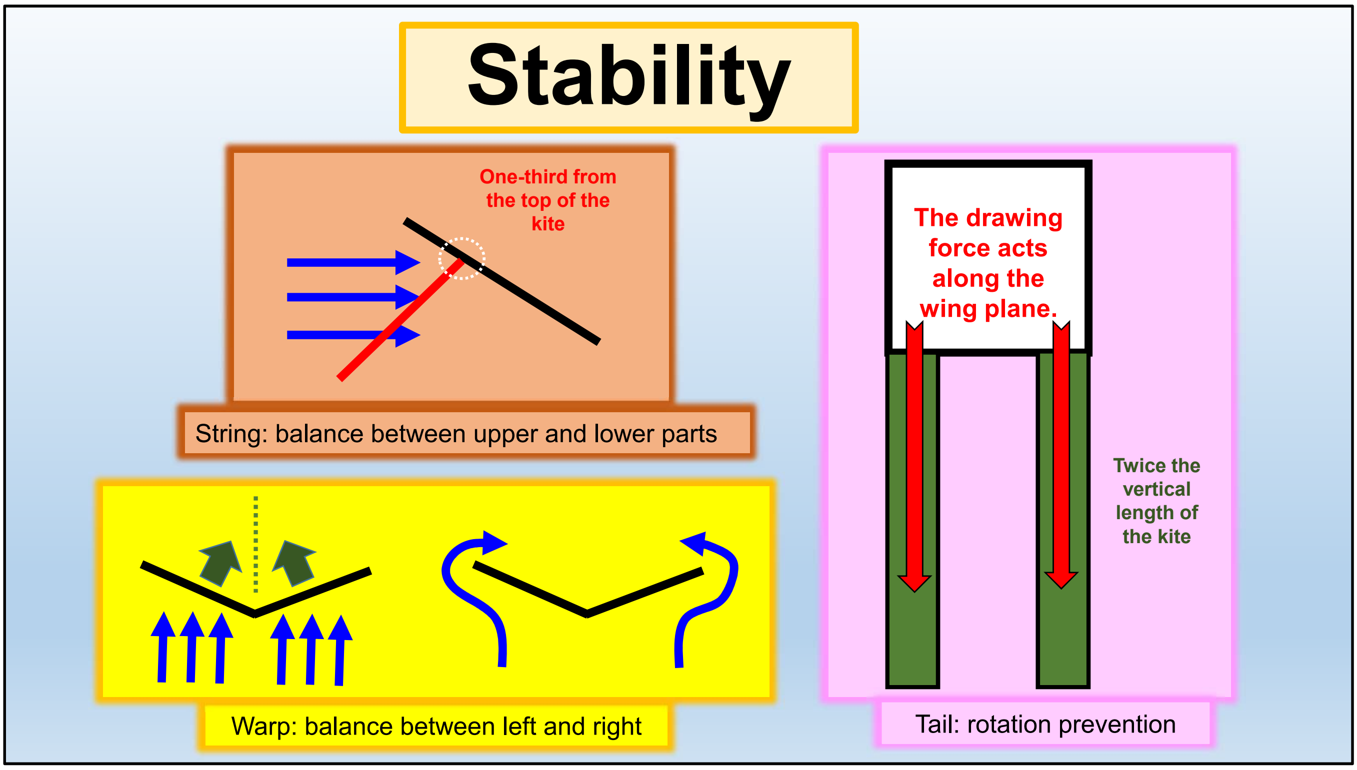


First, let's talk about lift.

For kites, like airplane wings, air pressure is lower on the upper side and higher on the lower side, a lift force acts to push the kite up.

Also, since the air has viscosity, it flows so as to be caught on the back of the kite.

The resultant force of the lift caused by the pressure difference and the lift due to viscosity becomes the lift force that acts on the kite.



Next, let's talk about stability.

The first point is the position at which we attach the kite string, called the string.

Usually, it is attached at a position one-third from the top of the kite, and the position is a balance between up and down.

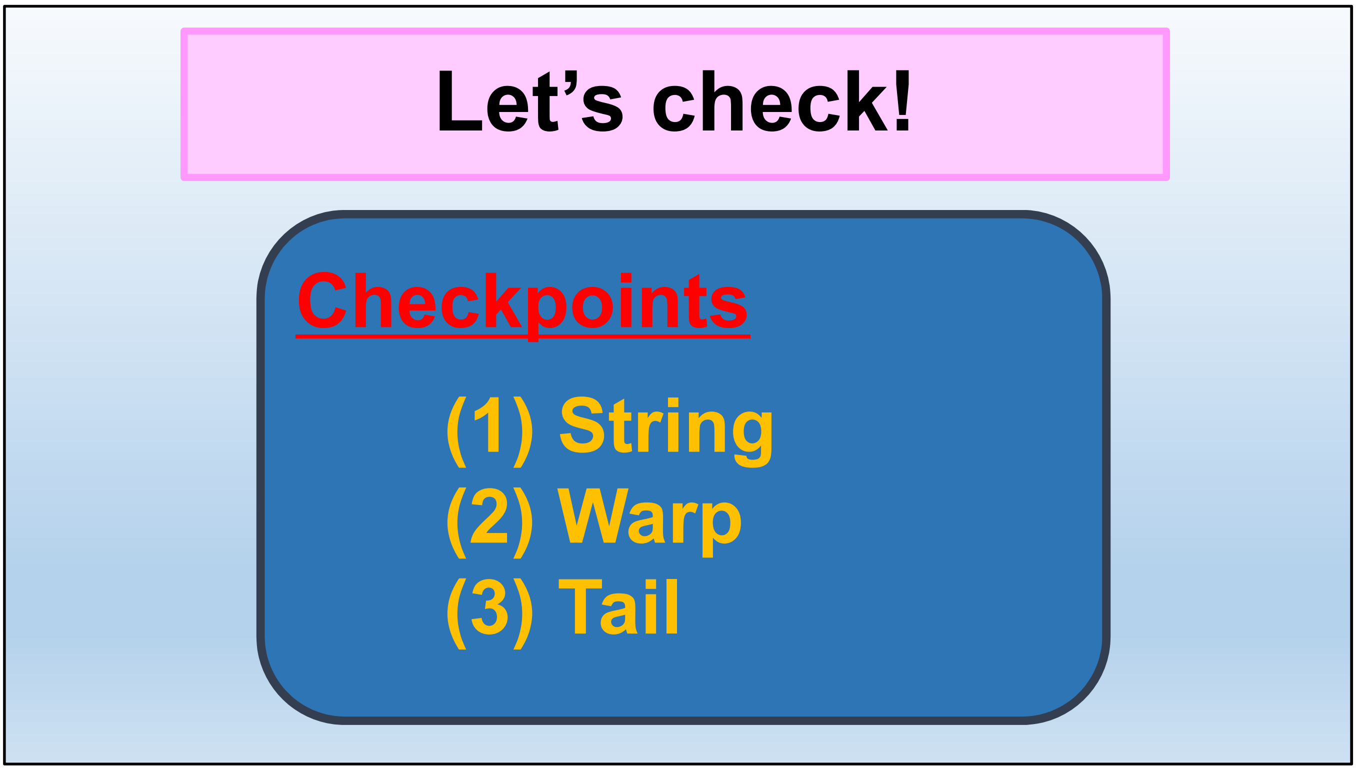
The second point is the warp.

The warp is a balance between the left and the right.

The third point is the tail.

The tail is prevent the kite from rotating.

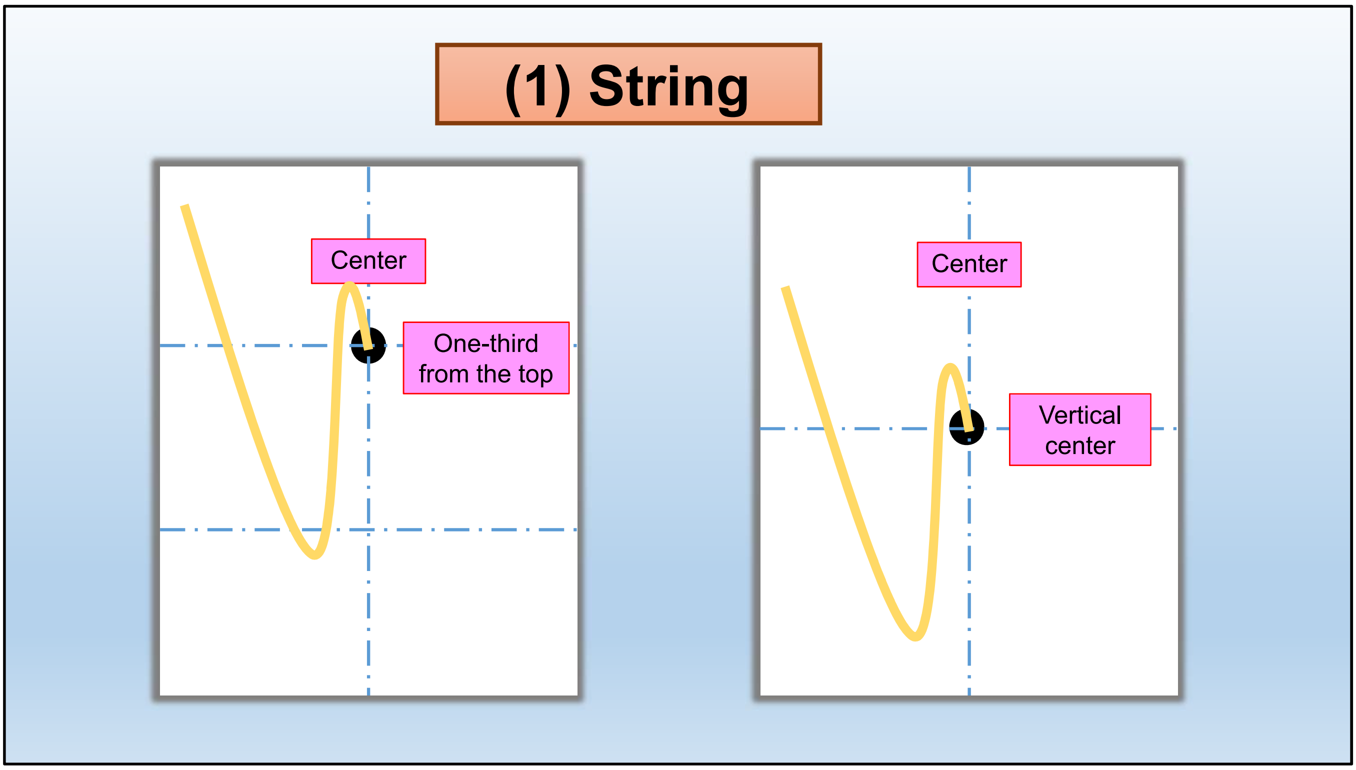
Usually, the tail length is twice the vertical length of the kite.



Let’s review the points that make the kite fly.

You have...

the string,
the warp,
And the tail.



First, the string.

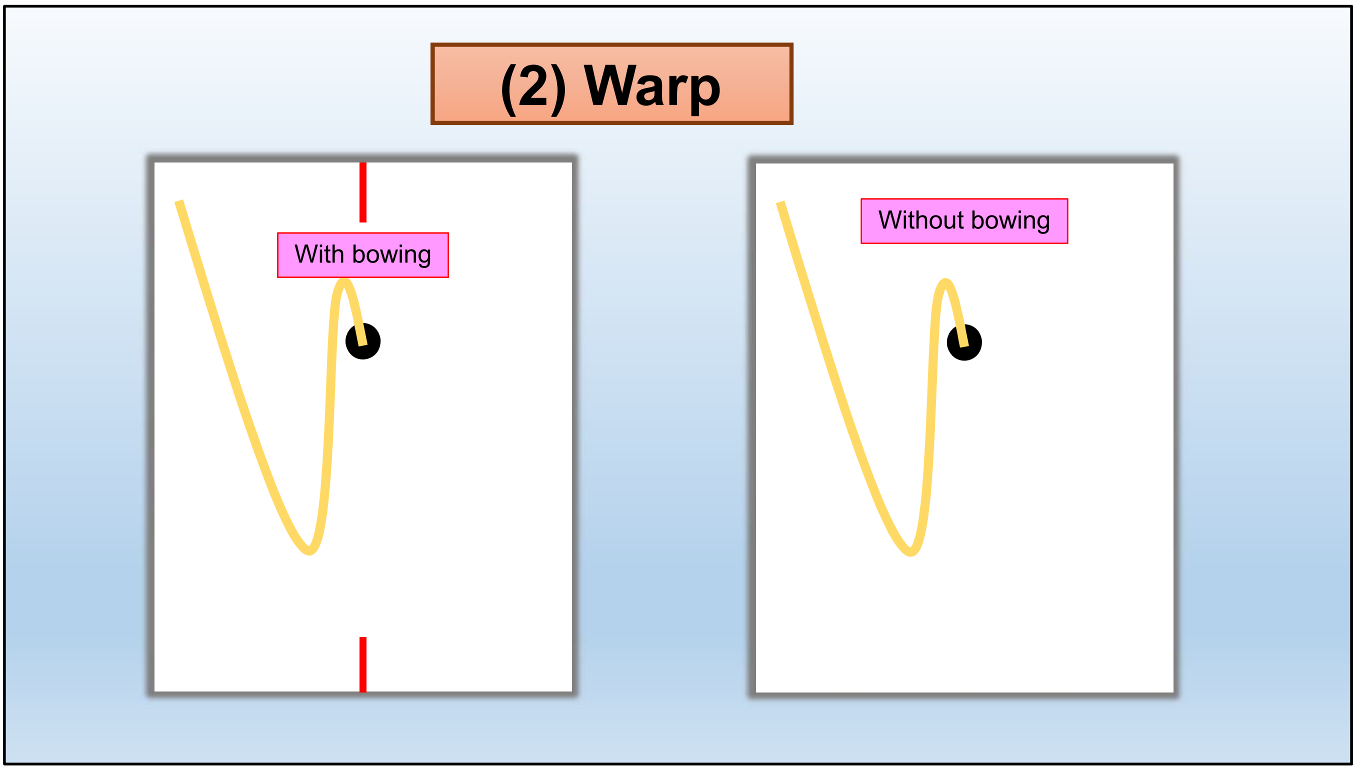
I have two types of kites.

For this one, the string is attached at a positon one-third from the top.

And, for this one, the string is attached at a positon vertical center.

Let's try frying a kite.

The kite with the string attached one-third down flew better.



Next, warp.

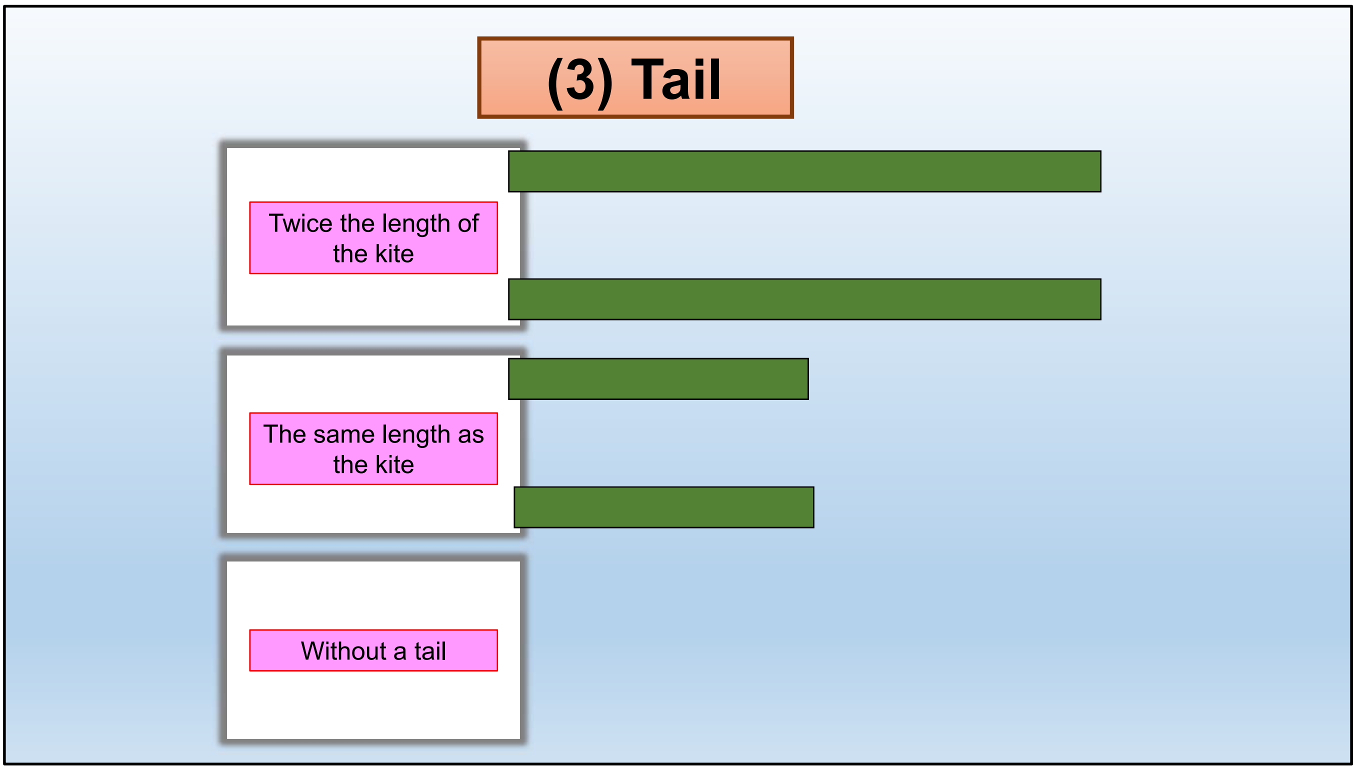
I have two types of kites.

This one has warp.

This one doesn’t.

Let's try frying a kite.

The kite with the warp flew better.



Last, let’s talk about tails.

I have three types of kites.

This one has a tail length twice the kite length.

This one’s tail is the same length as the kite.

And this one has no tail.

Let's try frying a kite.

The kite whose tail was twice its length flew better.

Now let’s make some basic kites for real.

Let’s go over the materials.

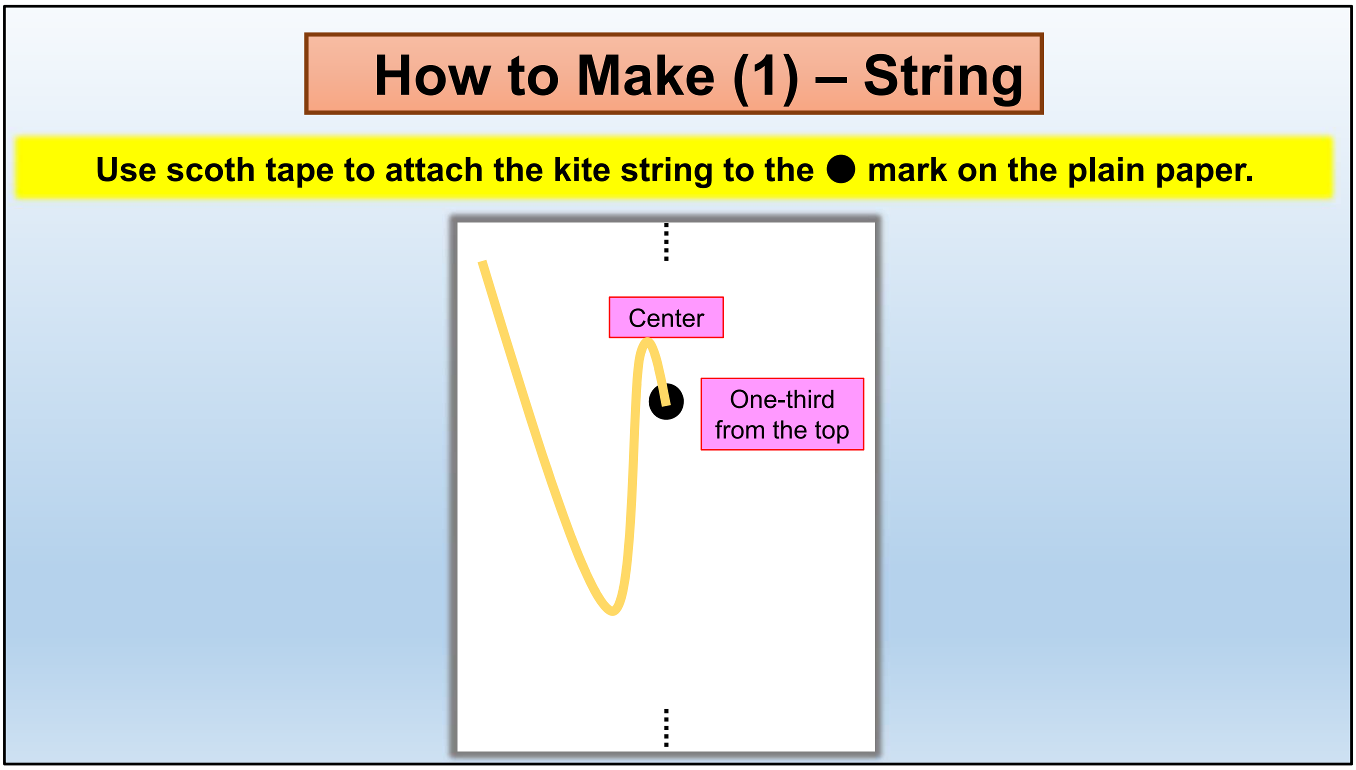
Plain paper

Kite string

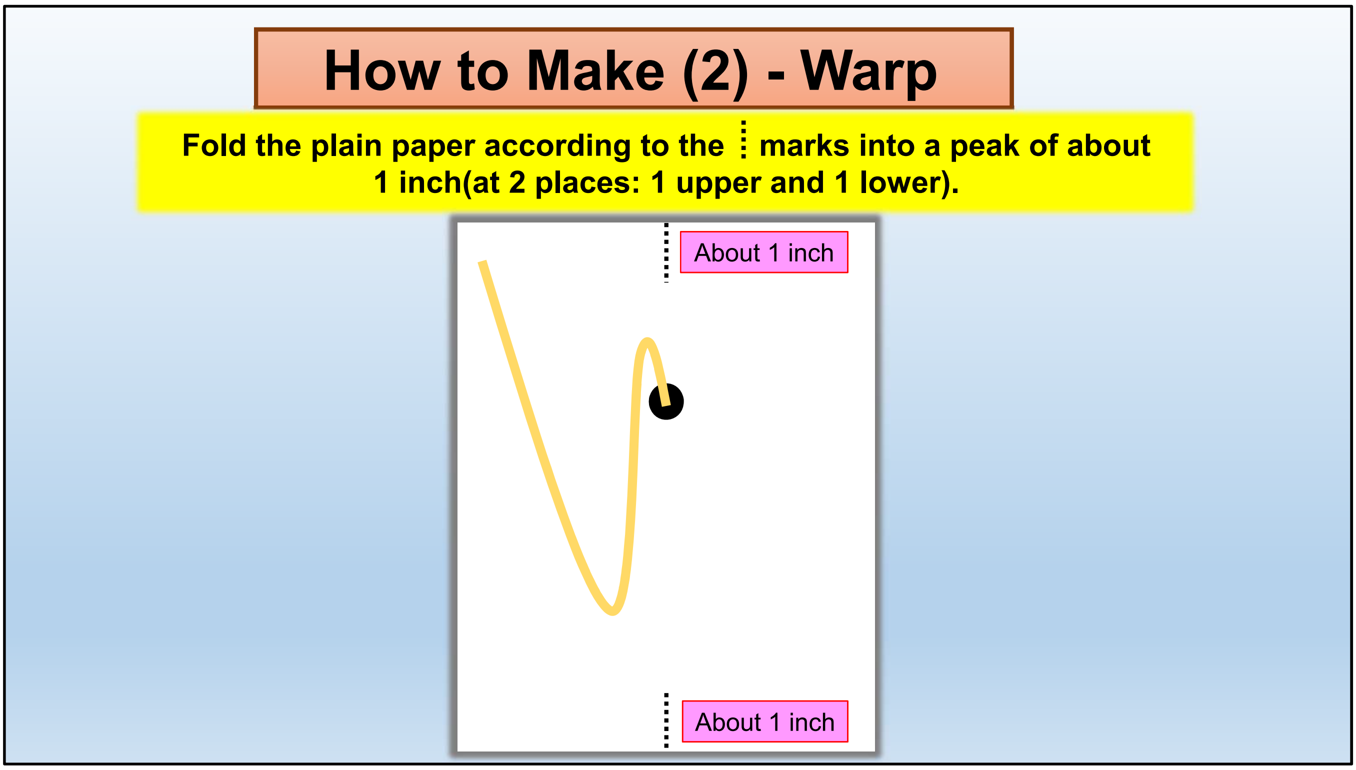
Scotch tape

Paper tape

That’s all.



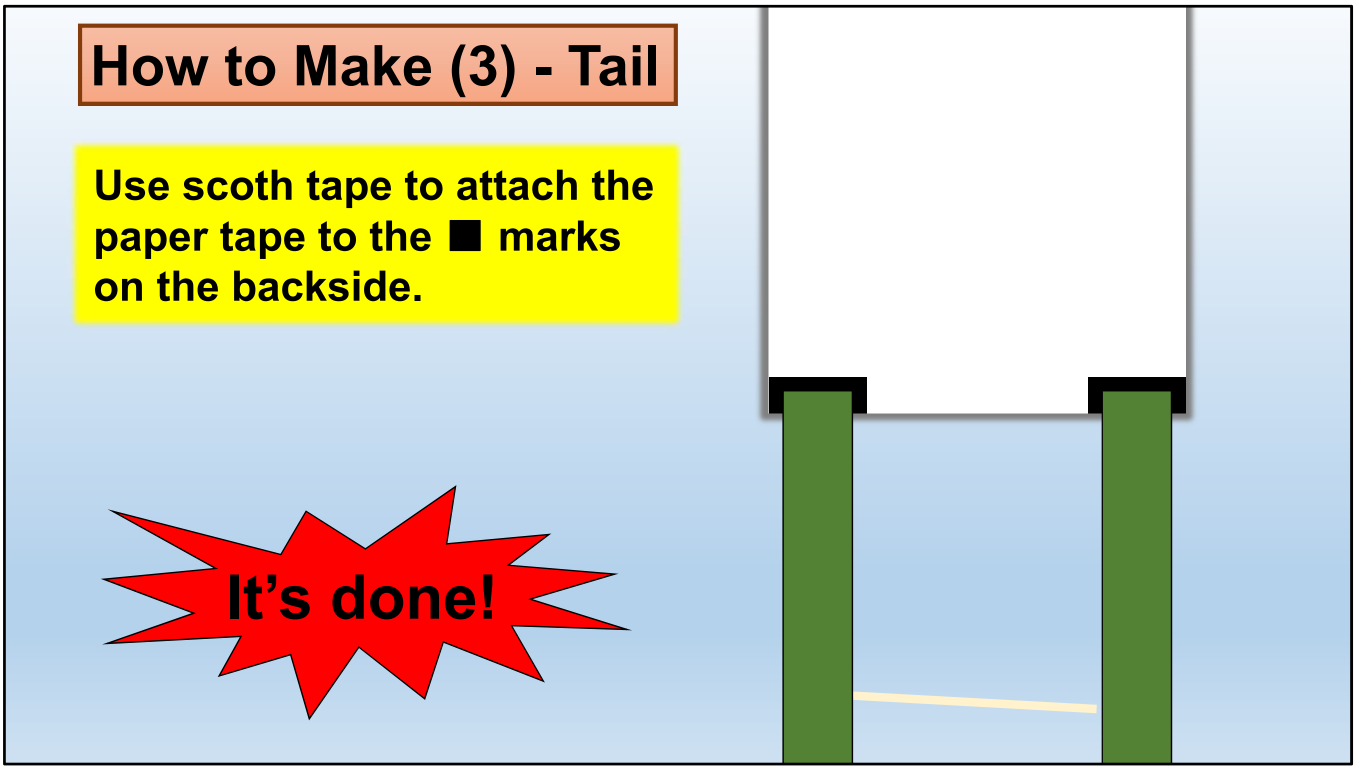
First, use scotch tape to attach the kite string to the ●(black circle/point) mark on the plain paper.



Next, form the bowing.

Fold this lined part into a peak along the length of the line.

Fold this lined part in the same way.



Last, attach the tails.

Turn over the plain paper, then use scotch tape to attach a piece of paper tape to this ■(black square) mark.

Attach the tape to the other mark in the same way.

Now we are done.

First, let me explain how to fly a kite.

Work in pairs to hold the kite together.

The person who draws the kite string should walk faster.

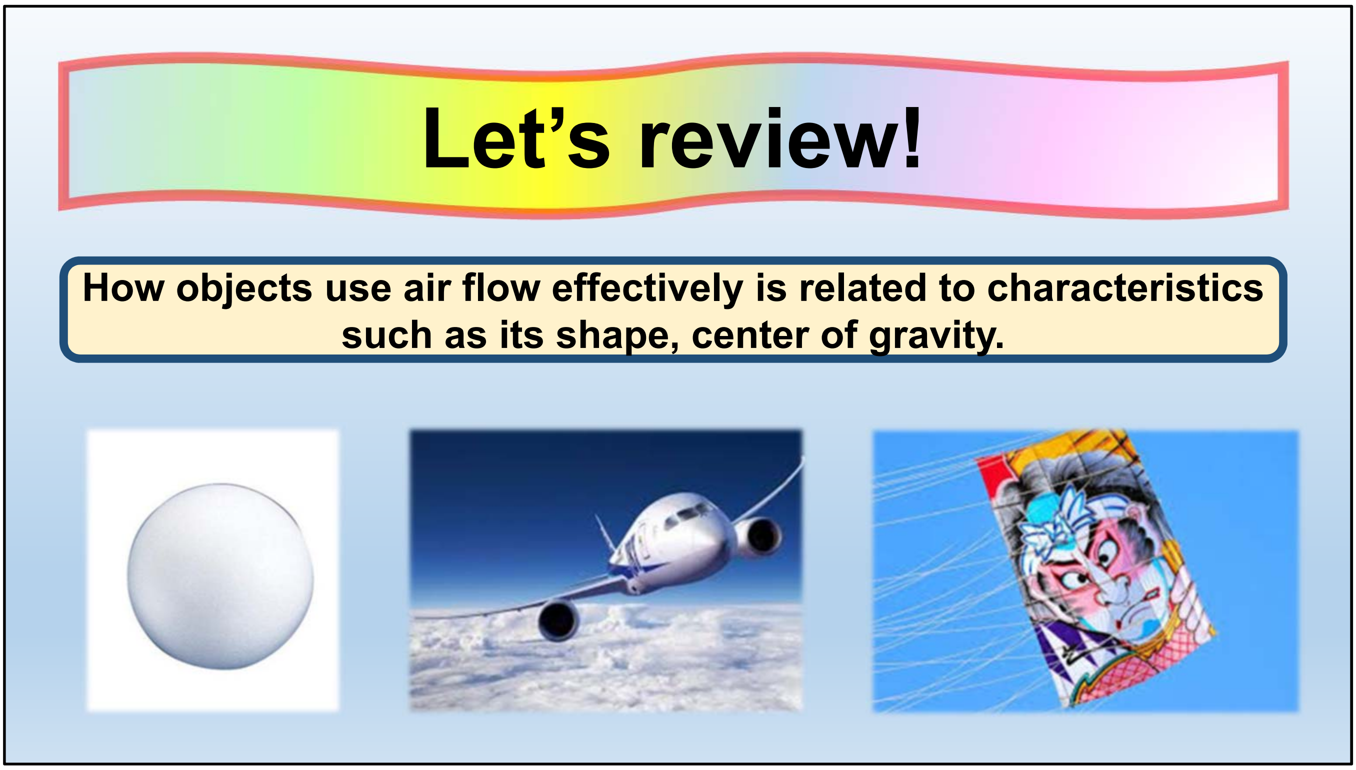
And the person holding a kite should let go of the kite at the same time as their partner.

Then the kite will fly like this.

Let’s try to fly the kites.

So how was it?

Did your kite fly well?



What do you think about the mysterious world of air?

We learned that an object’s shape, center of gravity, and so on are related to how to use the airflow effectively.

In the future, it is expected that further researching and utilizing this airflow will make our society safer and richer.

Today, airplanes fly at a speed slower than sonic speed. Their speed is about Mach 0.8(zero point eight), which means that traveling can take a long time.

This means that there’s a need for planes that will make high-speed travel possible.

JAXA has proposed the concept of an air frame for low-noise supersonic passenger aircraft with a reduced sonic boom.

We are also moving forward with research and development aiming to achieve hypersonic passenger aircraft that fly at a speed on the level of Mach 5.

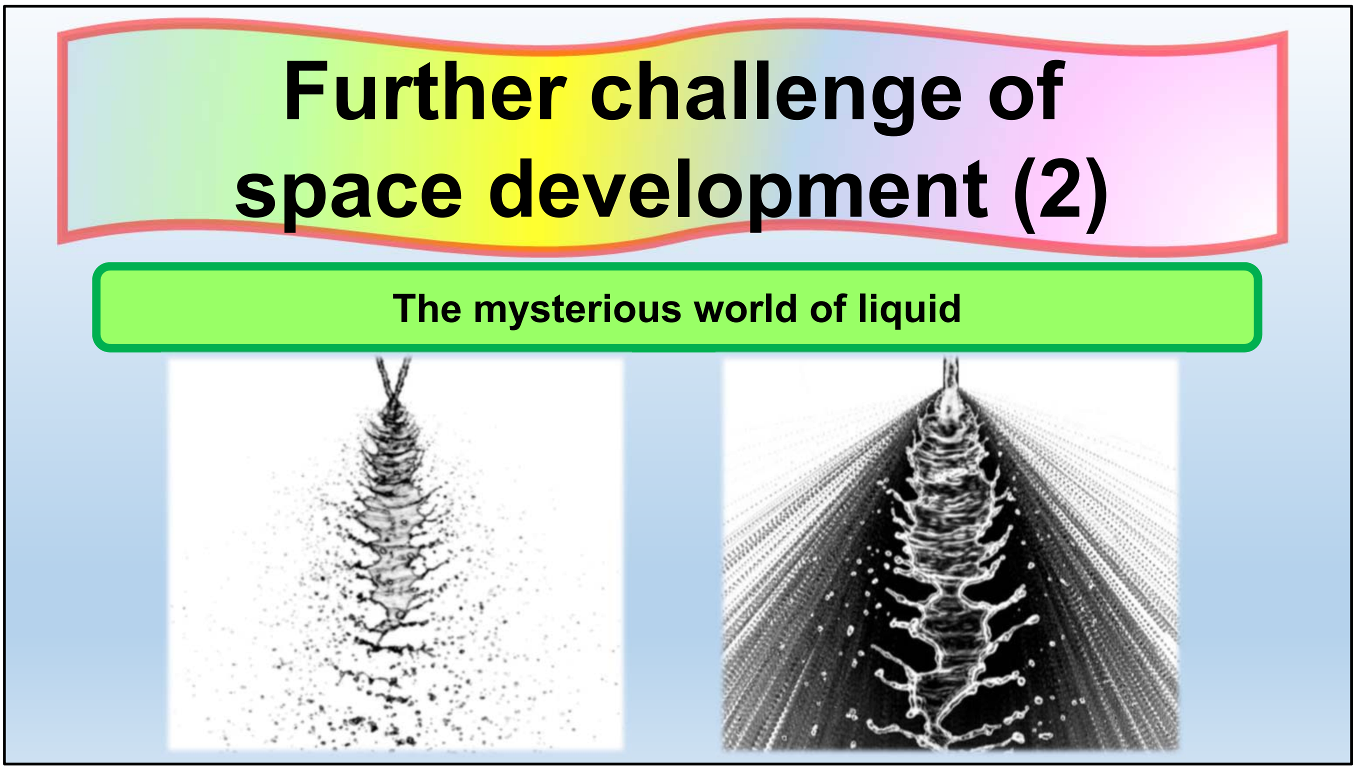
Further challenge of space development (1)

The world of flow in outer space

This picture shows the aerodynamic design of Mars Airplane to explore Mars (whose space development JAXA is working on),

And this picture shows the aerodynamic stability of the reentry capsule of the asteroid explorer HAYABUSA, which brought surface material from Asteroid Itokawa down to Earth.

Aerodynamics is also deeply related to them.



The study of fluid hydrodynamics will be necessary to move space development forward.

Many large rockets have liquid fuel engines.

Studying the phenomenon that occurs when liquid propellant is sprayed in the engine can lead to improvement of thrust force performance and engine stability.

So in order to move forward with the study of aerospace science, it is necessary to have a detailed understanding of the deeply related subject of hydrodynamics.

This is the end of my presentation

Thank you for your attention.

I hope to see you.