Measuring Forces On a Wing
- KS3 Science Student Worksheet

Aims

1. Practically measure force of lift on a wing

2. Explain how forces can oppose to create a state of equilibrium

3. Use your understanding of moments to balance an equilibrium

4. Be able to explain how a wing creates lift

Equipment and materials required

The following will be required for each student, or each group of students.

- Pre-assembled "wing-balance" apparatus **

- Blu tack

- Hair drier

- Balance (accurate to 0.1g)

** For instructions on how to build the wing balance see teachers' notes

What you do

1. Assemble the wing profile as shown in the photo below. The wing part of the balance should be below the platform.

Platform
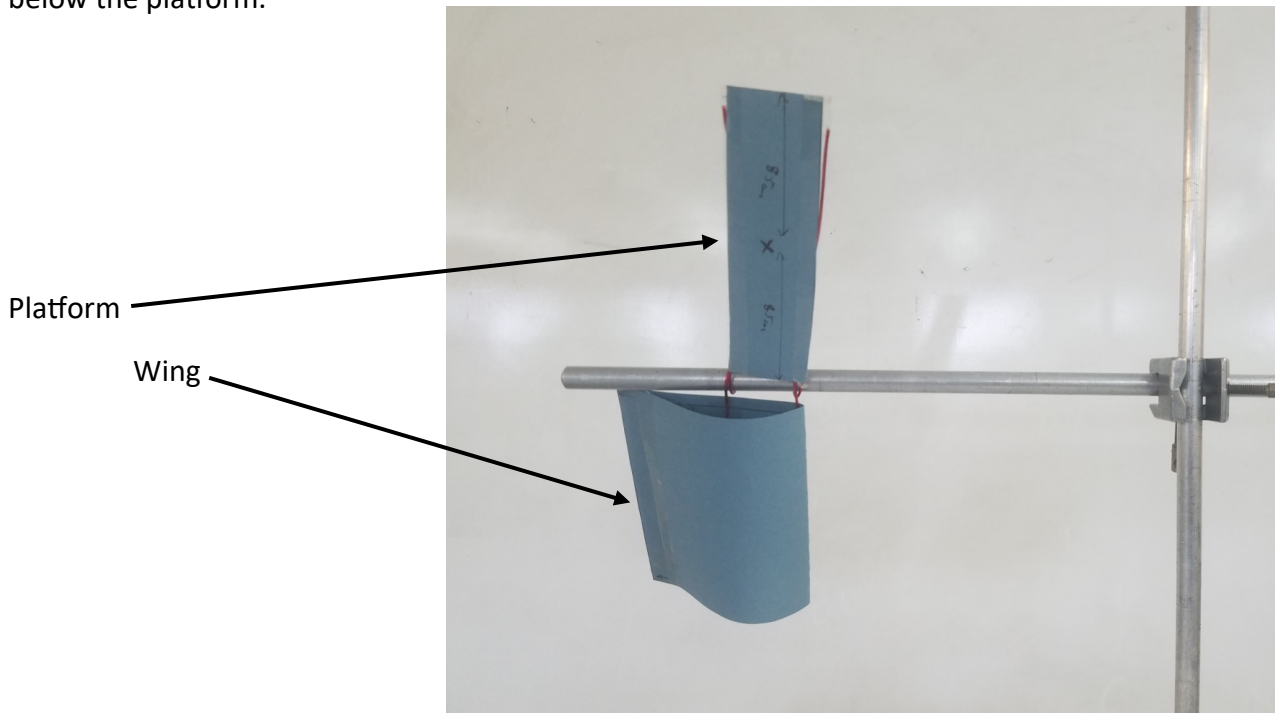
Wing

2. Use the hair dryer to blow air directly at the front "leading edge" the wing – do not blow from the top or bottom. The wing when air is blowing over the wing should be level. See photo below.

Aim hairdryer at the middle
of the "Leading Edge"

- Possible problems
  - **Wing doesn't lift much?**
    - *Add some Blu tac to the underneath of the platform.*
    - *Hold the hair dryer a little closer and blow directly at the front of the wing.*

  - **Wing lifts too high?**
    - *Remove some Blu tac from underneath the platform.*
    - *Do not blow the wing from below.*

  - **Wing lifts erratically?**
    - *Make sure the hairdryer isn't too close to the wing and you are blowing directly at the front "leading edge" of the wing.*

3. Turn off the hair dryer and this time balance the wing using Blu tac. To do this add just enough Blu Tac to the cross on the platform so the platform and wing are level.
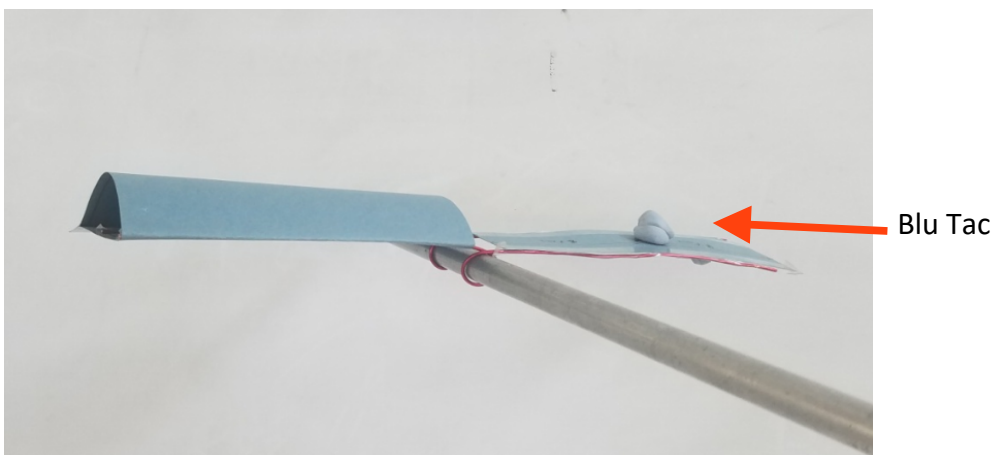
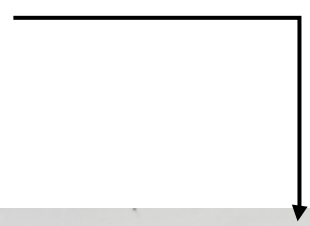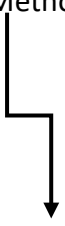Blu Tac

4. Remove the Blu Tac from the platform and weigh it

Mass of Blu Tac = …………………………… grams
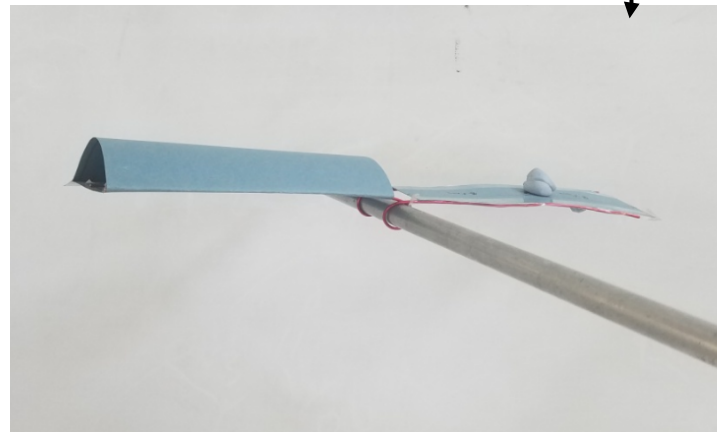
Theory and Calculations

In this practical you have balanced the wing using 2 different methods

Method 1: Balanced the wing by blowing air over it with the hair dryer

Method 2: Balanced the wing by adding Blu Tac to the platform

Method 1

Method 2

In both methods when the wing is balanced the force on both sides of the balance is equal

The force created by the air blowing over the wing is equal to the force of the Blu Tac needed to balance the wing without the hair drier.

To calculate the force in Newtons (N) of the Blu Tac that is needed to balance the wing the we use the formula:

FORCE (N) = Blu Tac Mass (kg) x gravity

First the units of the Blu Tac mass need to be converted from grams → kilograms using the relationship below:

Mass (kg) = Mass (g) ÷ 1000

Use the above formula to calculate the mass in kg of the Blu Tac you added
to the wing

Mass of Blu Tac = ... kilograms

Now we can use the formula below to calculate the force of the Blu Tac that was needed to balance the wing. We know that gravity on the surface of the earth is constant

Gravity = 10 m/s^2

FORCE (N) = Blu Tac Mass (kg) x 10 m/s^2

Force of Blu Tac need to balance the wing = ... Newtons

Therefore, the force you have just calculated - **balancing the wing with Blu Tac** - is the same as the lift force - **balancing the wing with lift from the hairdryer.** So, you have also calculated the lift the wing generates.

We hope you had fun learning about wings and lift!
Find out more about GLIDING at the links below, all types of AVIATION at airleague.co.uk & CAREERS at stem.caa.co.uk/careers-in-aviation-and-aerospace

Why not **Go Gliding**?
Find your nearest gliding club at https://www.gliding.co.uk/club-finder/

We hope to see you on an airfield soon!

Extension Tasks

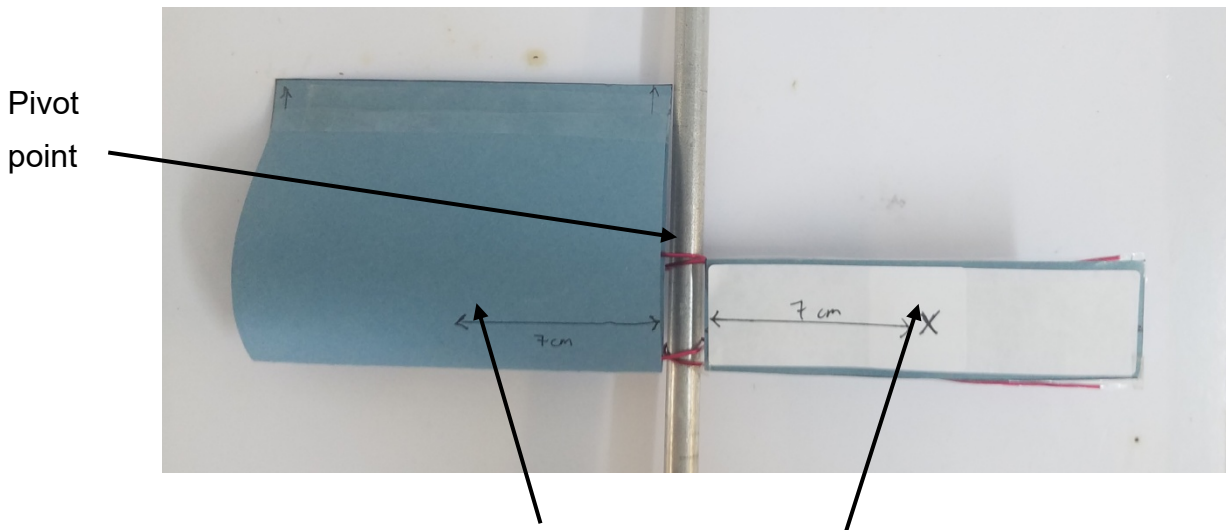1. How do you think can you increase the lift of the wing?

…………………………………………………………………………………………

Try out your idea and report your findings below:

…………………………………………………………………………………………

…………………………………………………………………………………………

…………………………………………………………………………………………

2. The wing and the platform pivot around the bar. The cross on the platform – where the Blu Tac is added, is the same distance from the bar as the centre of the wing to the bar – see diagram below.

Pivot point

Equal distances from pivot point.

Using your understanding of moments what mass of Blu Tac would be needed to balance the wing if the cross was moved from 7cm to 14cm?

………………………………………………………………………………. grams

Now test out your prediction with the wing balance apparatus.

3. When air passes around a wing lift is produced. This happens because the air passing over the wing travels faster than the air underneath wing. Because the air travels faster over the wing the pressure is lower above the wing and higher below this wing. This difference in pressure creates lift.
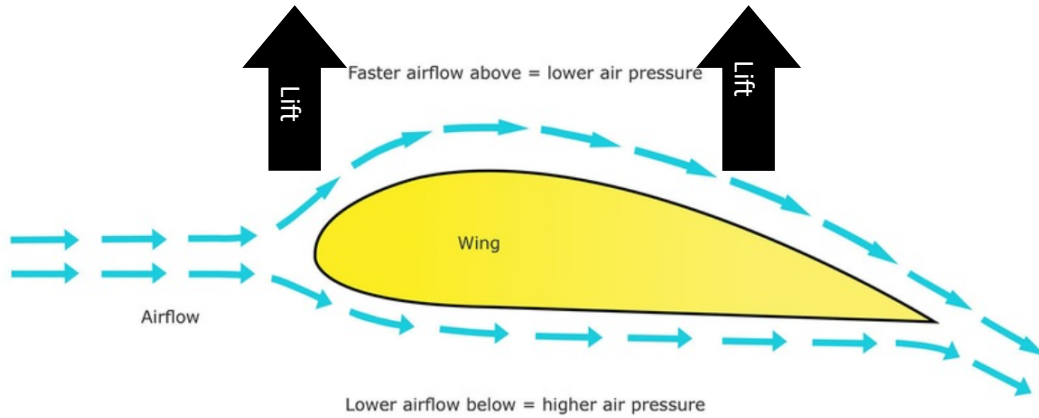
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Source: *https://www.sciencelearn.org.nz/resources/300-wings-and-lift*

Experiment how the shape of the wing changes the lift it can produce. Do this by carefully removing the Sellotape that holds the top and bottom edges of the wing together and then reattach it making a fatter or thinner wing.

Drawing of new proposed shape of wing

……………………………………………………………………..

How did the lift produced change?

……………………………………………………………………..

……………………………………………………………………..