The Forces of Flight Calculations – Version ii

The questions below have been kindly set by Geoff Coxon from The SkyLab.

There are two tasks in this challenge which combine mathematics and science. In the first task you must work out the area of the wings of a Spitfire and a Typhoon. In the second task you will use calculations to compare the performance between the two aircraft. You will be amazed at the difference!

Task 1

In the pictures below you will see the Spitfire and Typhoon wings have been simplified into triangular shapes which will help with your calculations to establish the total wing area of each aircraft.

The Spitfire

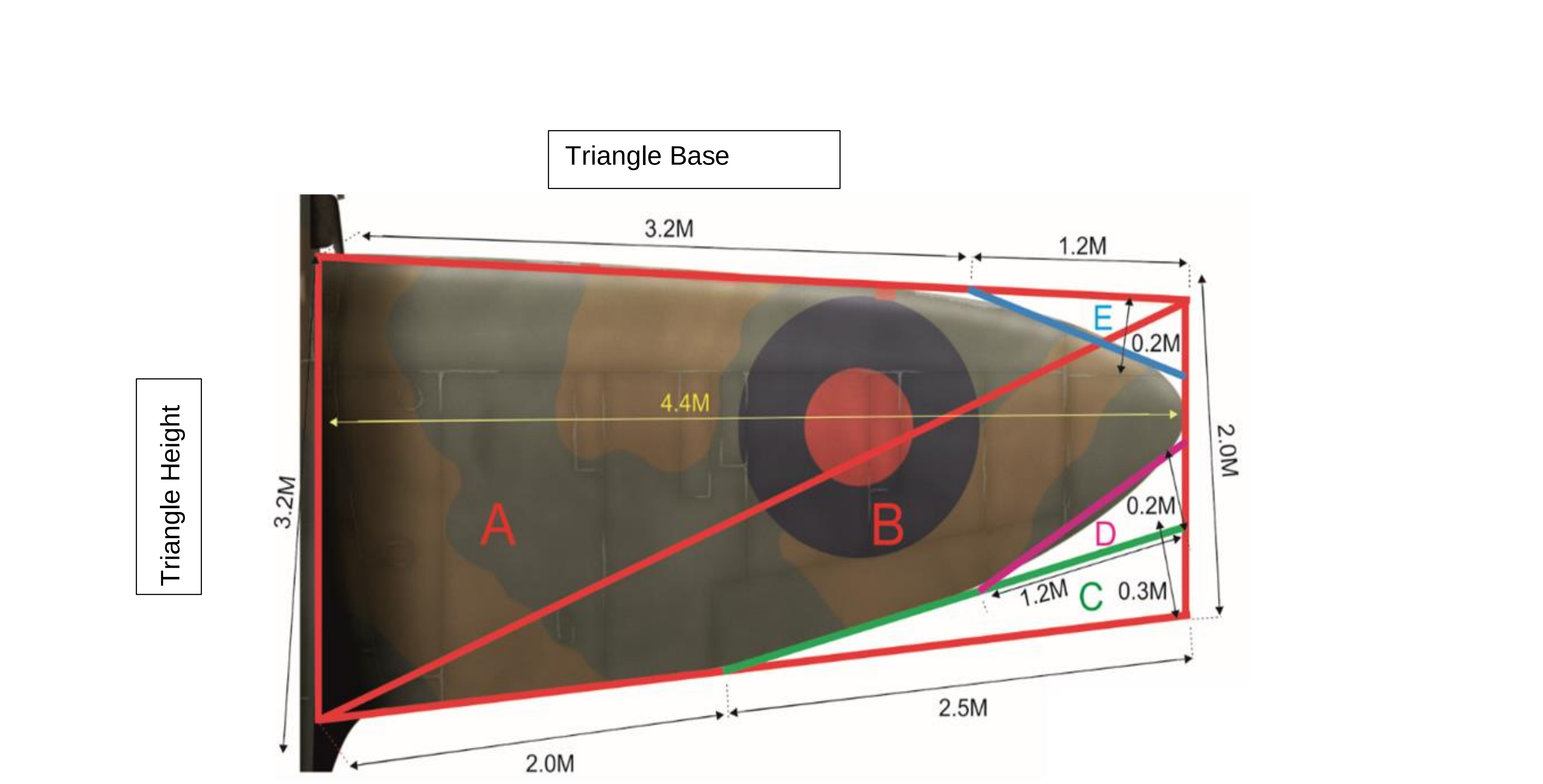
Look at the picture of the Spitfire's starboard wing below. You will see that it is made up of triangles and by working out the area of these triangles you can work out the area of the wing.

To make this easier, the areas we need to work out have been given a letter. The total area of one wing will be the areas of triangles A + B – (C + D +E).

Tip. To make it easier if your answers are close to a whole number you can round them up and down. So, for instance if you have a figure of 4.9, you can round it up to 5.

To help you, we have worked out the area of triangle A. Use this to help guide you to work out the area of the other triangles.

Calculating the area of the starboard Spitfire wing using triangles

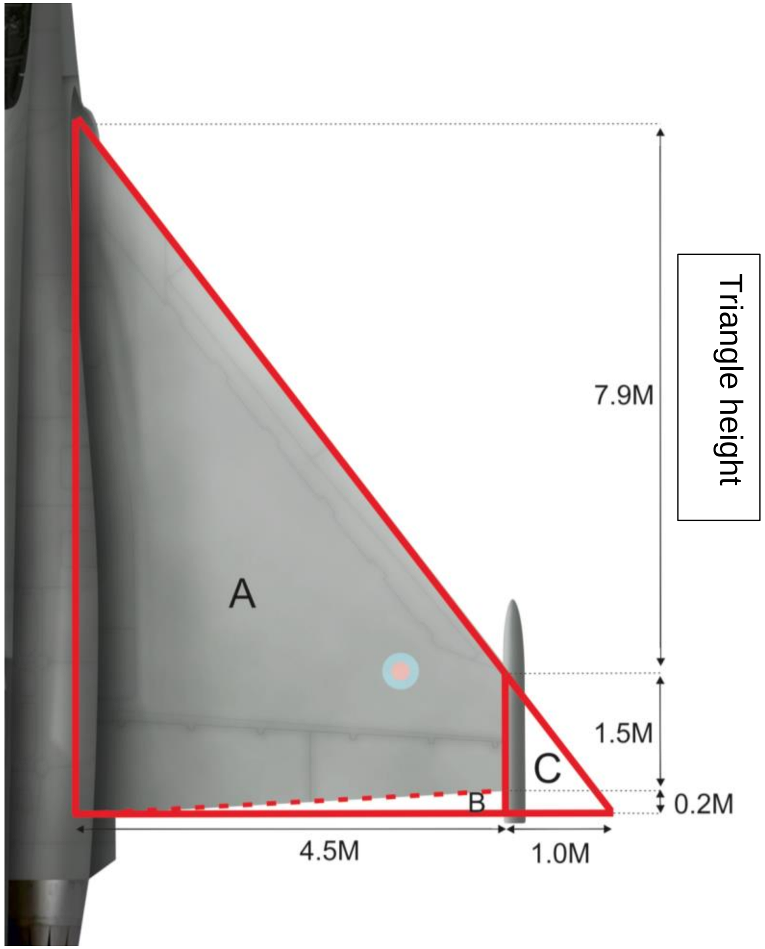


Triangle A	Triangle B	Triangle C	Triangle D	Triangle E
Area = ½ x base x height Area = ½ x (3.2 + 1.2) x 3.2 Area = ½ x 4.4 x 3.2 Area = 2.2 x 3.2 Area = 7 M^2	Area = ½ x base x height	Area = ½ x base x height	Area = ½ x base x height	Area = ½ x base x height
Area of starboard wing A + B – (C + D + E) = Area of port wing = Total wing area =				

The Typhoon

We now want you to do exactly the same with the Typhoon. This time we need only work out the area of the large triangles A and then subtract the areas of B and C.

Calculating the area of the starboard Typhoon wing using triangles



Triangle A	Triangle B	Triangle C
Area = ½ x base x height	Area = ½ x base x height	Area = ½ x base x height
Area of starboard wing = Area of port wing = Total wing area =		

Task 2.
Using the areas of the wings and the data in the aircraft comparison table below, answer the following questions.
Tip: remember to round your answers up or down to the nearest whole number

Parameter	Spitfire Mk2A	Typhoon FGR4
Maximum speed (mph)	**354**	**1320**
Maximum rate of climb (m/s)	**15**	**318**
Maximum range (miles)	**430**	**1800**
Service ceiling (metres)	**10500**	**19800**
Maximum take-off mass (kg)	**2800**	**23500**
Fuel capacity (kg)	**800**	**5000**
Maximum thrust (kN)	**6.5**	**180**

Q1. Which aircraft should be the most manoeuvrable?
The greater an aircraft's wing loading, the more manoeuvrable the aircraft will be.

You can work out the wing loading by dividing the take-off mass of the aircraft by the area of the wings.
In aviation wing load is measured in kilogram per square metre (kg/m^2).

1st calculate the wing loadings

The wing load of the Spitfire =   The wing load of a Typhoon =
How many times larger is the wing load of the Typhoon compared to the Spitfire?   The Typhoon wing load is ____ times more than the Spitfire, so the more manoeuvrable   aircraft is ___________________________

Q2. At maximum speed, how many times more powerful is the Typhoon compared to the Spitfire?

Tip: power = thrust

Q3. How many times faster is the Typhoon compared to the Spitfire?

Tip: use the maximum speed

Q4. How many times quicker can the Typhoon climb than the Spitfire?

Tip: use the maximum rate of climb

Q5. How many times more is the Typhoon's fuel capacity compared to the Spitfire's and why do you think it needs so much more?

Tip: Use the fuel capacity

Q5. What subjects at school do you think you would need to use if you wanted to work in aviation technology?

Glossary:

- Port – the pilot's left wing if they are facing forward in the cockpit
- Starboard – the pilot's right wing if they are facing forward in the cockpit
- Weight is the force of gravity. It acts in a downward direction - usually measured in *Newtons* — toward the centre of the Earth
- Thrust is the force that propels an aircraft in the direction of motion. Engines produce thrust
- Drag is the force that acts opposite to the direction of motion. Drag is caused by friction and differences in air pressure
- Lift is the force that acts at a right angle to the direction of motion through the air. Lift is enabled by an aircraft's wings
- kN stands for kilonewton(s)– a Newton is a measurement of pressure and force used in engineering. A kilonewton is 1,000 Newtons.
- Service ceiling – the maximum height a pilot will fly the aircraft before its performance is affected
- Mass is a measure of how much matter is in an object measured in kg
- Max take-off mass – the maximum mass at which the aircraft is certified to take-off
- mph – miles per hour
- m/s – metres per second