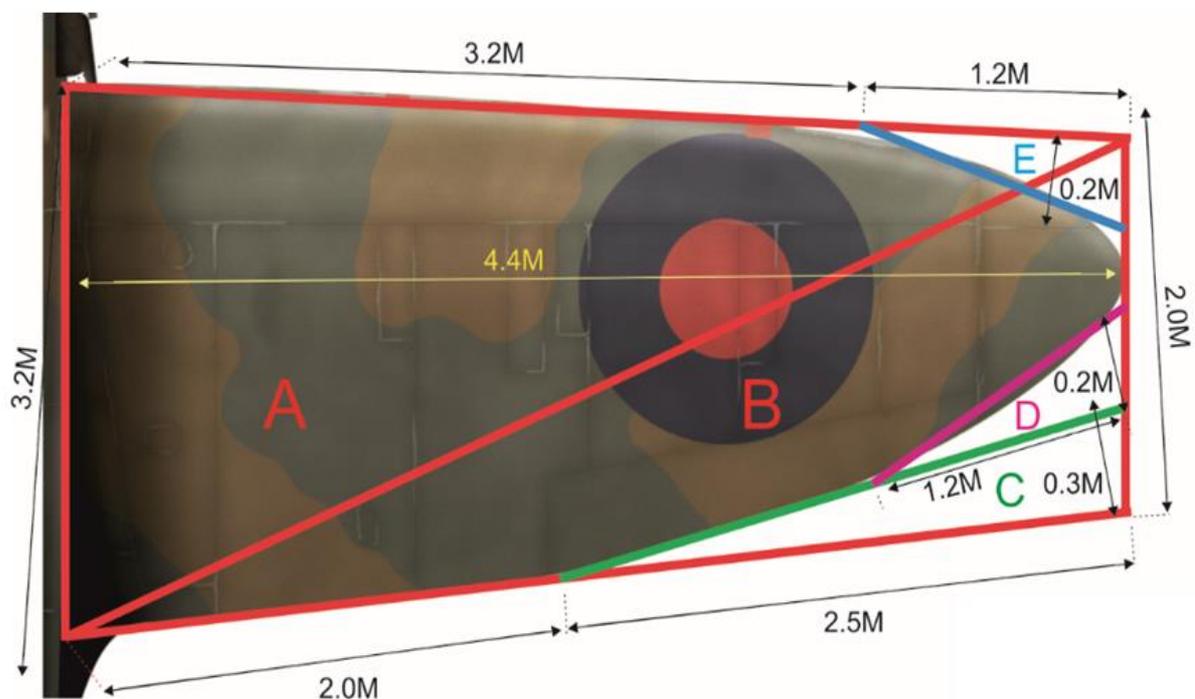


The Forces of Flight Calculations

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

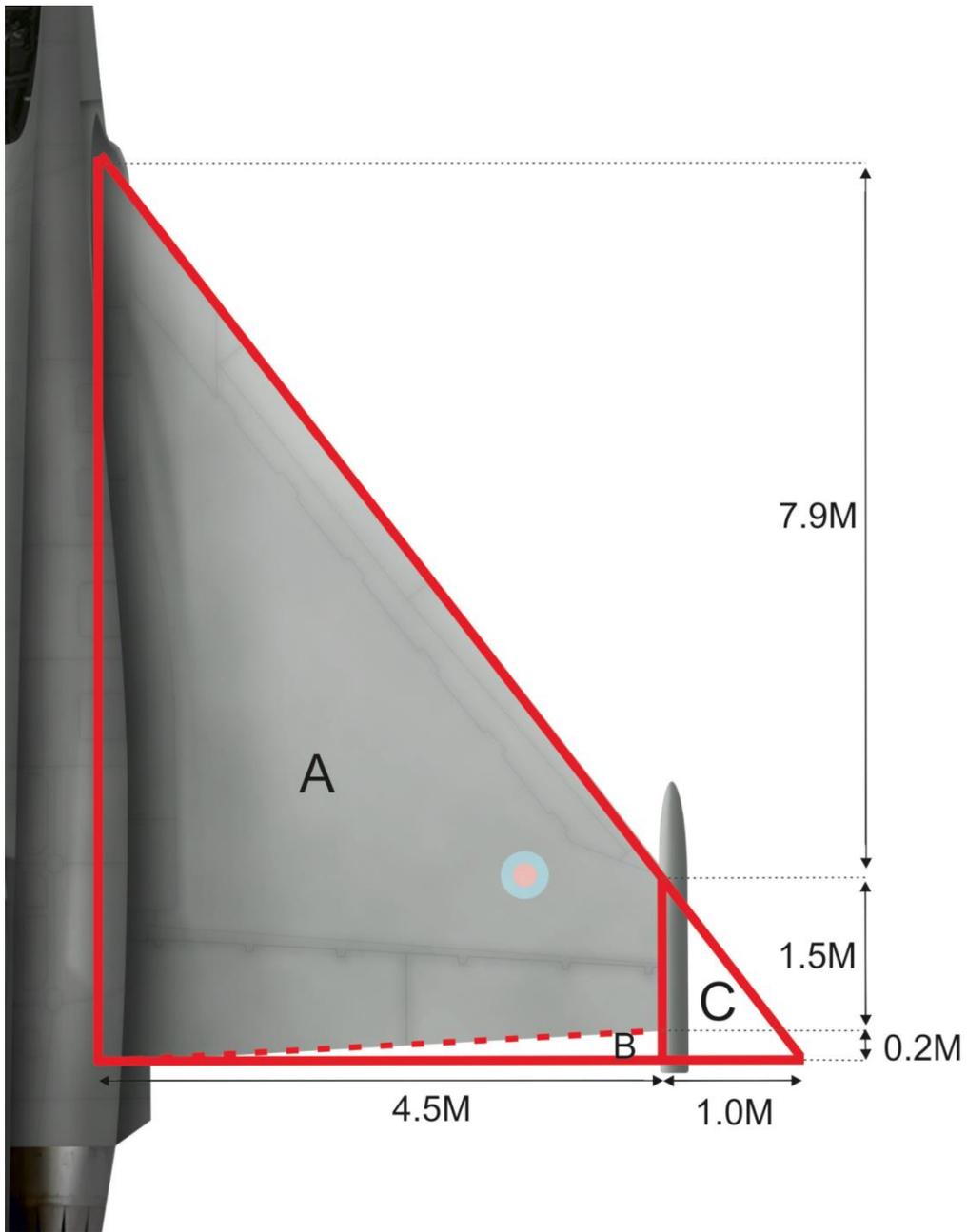
The pictures below show the starboard wing of a 1938 Spitfire and the starboard wing of a 2008 Typhoon. By imagining they are made up of triangles we can work out their surface areas. The surface area of an aircraft's wing can be used to calculate something called *wing loading*.

The higher the wing loading the more lift the wing creates and the better the aircraft's manoeuvrability.



Area of the Spitfire wing = 11 m^2

For both the starboard and the port wings = $2 \times 11 = \mathbf{22 \text{ m}^2}$



Area of a Tornado wing = 25 m^2
 For both the starboard and the port wings = $2 \times 25 = \mathbf{50 \text{ m}^2}$

Using the areas of the wings and the data in the aircraft comparison table below, answer the following questions.

Tip: 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/m²).

1st calculate the wing loadings

$$\begin{aligned} \text{The wing load of the Spitfire} &= 2800/22 \\ &= 127 \text{ kg/m}^2 \end{aligned}$$

$$\begin{aligned} \text{The wing load of a Typhoon} &= 23500/50 \\ &= 470 \text{ kg/m}^2 \end{aligned}$$

How many times larger is the wing load of the Typhoon compared to the Spitfire?

$$470/127 = 3.7$$

The Typhoon wing load is 4 times more than the Spitfire, so the more manoeuvrable aircraft is Typhoon

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

Tip: power = thrust

180/6.5 = 27.7 so 28 times more powerful

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

Tip: use the maximum speed

1320/354 = 3.7 so 4 times faster

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

Tip: use the maximum rate of climb

318/15 = 21.2 so 21 times quicker

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

5000/800 = 6.25 so 6 times more fuel

It has two powerful jet engines that need more fuel to give the huge difference in power.

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

Maths, science, design & technology, IT, Code