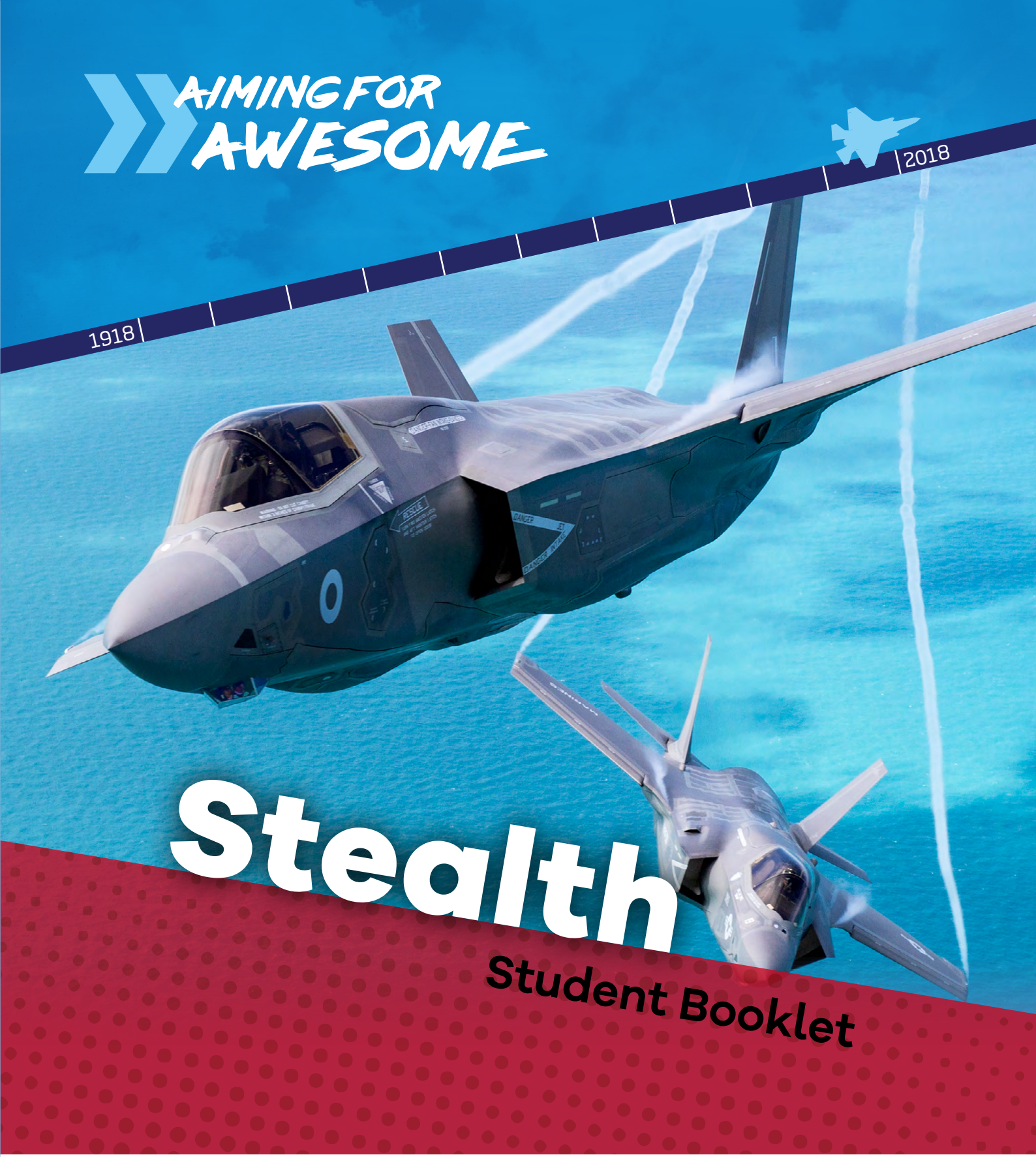
AIMING FOR AWESOME

1918 2018



Stealth

Student Booklet

Royal Academy of Engineering

THIS IS ENGINEERING

ROYAL AIR FORCE Youth STEM

The aim of this resource is to give students the opportunity to investigate the impact of science, technology, engineering and mathematics (STEM) on making stealth vehicles.

Lightning

Stealth is the ability to evade detection by radar, infrared sensors or emission interception.

Stealth provides greater survivability, and makes it easier for aircraft to operate in contested areas without being detected.

The Lightning aircraft was designed to be hard to detect.

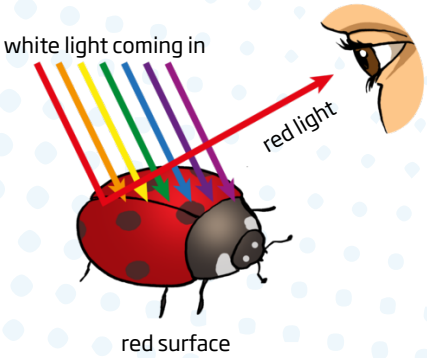
Engineers used a combination of the aircraft's shape and stealthy, radar-absorbent materials to make it a very-low-observable aircraft.

The Lightning is a single-seat, single-engine supersonic jet and has the most advanced computers and networking abilities of any aircraft so far.

The F-35B has short take-off and vertical landing (STOVL) capabilities, meaning it can hover.

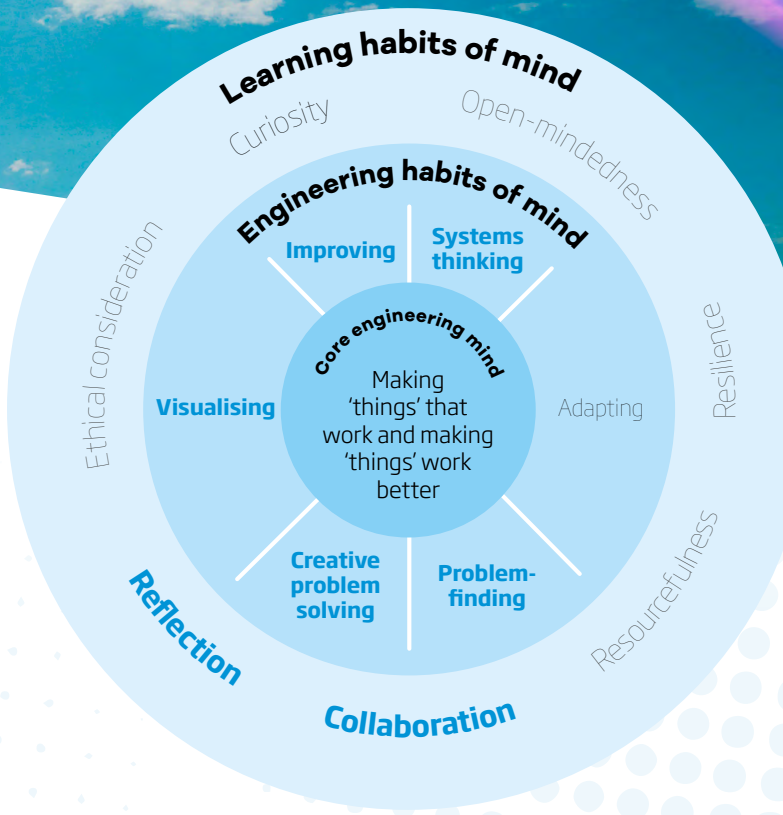
Camouflage

Objects reflect different colours of light. The colours that are not reflected are absorbed. This ladybird is red, because it reflects red light.



Some animals can use this to camouflage themselves. Most chameleons change colour as social signalling or a reaction to external temperatures. However, some chameleons can change their colour to camouflage themselves.

Aircraft can also be coloured to camouflage. For example, until 1941, the top of Royal Air Force (RAF) fighter aircraft were painted in dark green and brown to blend in with the ground, and sky colours underneath to avoid being seen from the ground. However, aircraft were lost and pilots reported that the colours used made their fighters conspicuously darker than the sky.



TIME TO INVESTIGATE – 1

How are different colours made?

White light is made up from the colours of the rainbow.

A coloured filter allows some colours to pass through and absorbs the others. For example, a red filter transmits red light only and absorbs all the others, whereas a blue filter will absorb all colours except blue.

The primary colours of light are red, green and blue. View a red, green and blue coloured object through the different filters.

Object colour	Filter colour	Observation
Red	Red	
	Green	
	Blue	
Green	Red	
	Green	
	Blue	
Blue	Red	
	Green	
	Blue	

Explain why the red object appears red through a red filter but black through a blue filter.

STRETCH AND CHALLENGE

Use the filters to work out how to make the secondary colours of light.

Object colour	Filter colour	Observation
Yellow	Red	
	Green	
	Blue	
Cyan	Red	
	Green	
	Blue	
Magenta	Red	
	Green	
	Blue	

Yellow is made of ..... and ..... light.

Cyan is made of ..... and ..... light.

Magenta is made of ..... and ..... light.

Radar detection

Radar can also be used to detect aircraft.

A bistatic radar system has a transmitter and receiver separated by a distance, whereas a monostatic radar has the transmitter and receiver in the same place.

There are many different methods to detect aircraft using bistatic radar, one of which is forward scatter radar. The forward scatter radar technique uses bistatic radars to emit a radar that hits the object and is blocked from the receiver, much like how a shadow is formed. Forward scatter radar is useful because it is not effected by stealth coatings.

TIME TO INVESTIGATE – 2

The size and shape of an aircraft is also important to consider to avoid it being detected.

Shine a torch on the cut-outs of the RAF aircraft through the ages. What do you notice about the area of the shadows?

Write a method to investigate how the shadow changes for each of the cut-outs.

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To make sure the experiment is reproducible you need to control all the variables, except the independent and dependant variable. The independent variable is what you change each time, in this case the aircraft shape, and the dependent variable is what you measure, in this case the area of the shadow.

What variables are you keeping the same each time?

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Use the table below to record your results.

Aircraft	Area of shadow cm²

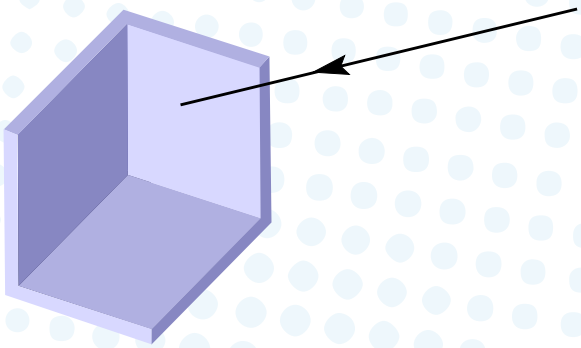
Which aircraft is the best for avoiding forward scatter radar detection?

The backscatter technique uses the reflection of radar to detect and aircraft.

TIME TO THINK

What do you think you will see if you look into the corner cube, or retroreflector?

Do you think it will be different if you look at the vertex from the other side?



Stealth

Royal Academy of Engineering

The Royal Academy of Engineering is harnessing the power of engineering to build a sustainable society and an inclusive economy that works for everyone.

In collaboration with our Fellows and partners, we're growing talent and developing skills for the future, driving innovation and building global partnerships, and influencing policy and engaging the public.

Together we're working to tackle the greatest challenges of our age.

What we do

Talent & diversity

We're growing talent by training, supporting, mentoring and funding the most talented and creative researchers, innovators and leaders from across the engineering profession.

We're developing skills for the future by identifying the challenges of an ever-changing world and developing the skills and approaches we need to build a resilient and diverse engineering profession.

Innovation

We're driving innovation by investing in some of the country's most creative and exciting engineering ideas and businesses.

We're building global partnerships that bring the world's best engineers from industry, entrepreneurship and academia together to collaborate on creative innovations that address the greatest global challenges of our age.

Policy & engagement

We're influencing policy through the National Engineering Policy Centre – providing independent expert support to policymakers on issues of importance.

We're engaging the public by opening their eyes to the wonders of engineering and inspiring young people to become the next generation of engineers.

ROYAL AIR FORCE Youth STEM

The RAF Youth STEM programme is designed to engage and inspire young people by building their interest in engineering and technical career pathways.

From cyber specialists to aerospace, aviation, electronics, and mechanical disciplines, the RAF is committed to widening participation in STEM, extending opportunities to all, and encouraging greater diversity in this critical area of national skills shortages.

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