
MAKE
YOUR
OWN AIRCRAFT
BACKGROUND

BACKGROUND

MAKING PAPER PLANES

There are lots of different design approaches to making paper planes. Some are very simple - others are elaborate, but often the most simple designs are the best.

Iterative design

Even when aircraft engineers develop new designs they test them. This is the iterative design process that engineers go through to solve problems such as building an aircraft. By building and testing a prototype, engineers are able to look at what worked and what didn't. They then use what they learnt from these tests to develop a second and third version that improves each time. This is something you might do when making paper planes.

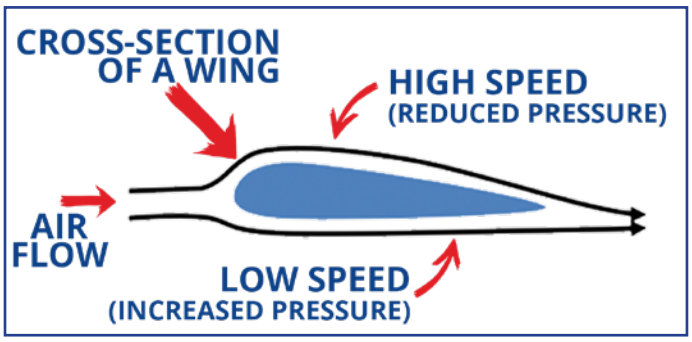
Activity link

"Making paper planes"

Activity link

"Model aircraft and aircraft design"

WHAT HAPPENS WHEN YOUR PAPER PLANES FLY?



As air flows over a wing the speed of the air and the shape of the wing causes lift and that's how an aircraft gets off the ground.

WHAT ARE THE FOUR PRINCIPLES OF FLIGHT?

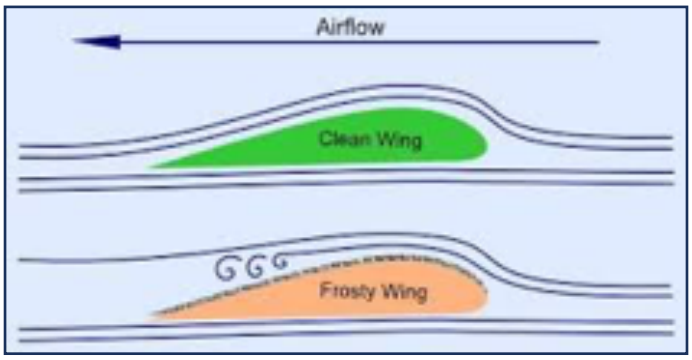
They are: Lift, Weight (or Gravity), Thrust and Drag.
Which force would be important if:
We wanted to go faster (Thrust).
We wanted to slow down (Drag).
We wanted to go higher (Lift).

Aircraft wings are shaped to make air move faster over the top of the wing. When air moves faster, the pressure of the air decreases. So, the pressure on the top of the wing is less than the pressure on the bottom of the wing. The difference in pressure creates a force on the wing that lifts the wing up into the air. The air entering the low pressure area on top of the wing speeds up. The air entering the high pressure area on the bottom slows down. That is why air on top moves faster. That results in deflection of the air downwards, which is required for generation of lift due to conservation of momentum (which is a true law of physics).

BACKGROUND

PREVENTING ICE

Deicing fluid, a mixture of a chemical called glycol and water, is generally heated and sprayed under pressure to remove ice and snow on the aircraft. While it removes ice and snow, deicing fluid has a limited ability to prevent further ice from forming.



HOW DOES ICE AFFECT THE AIRFLOW OVER THE WINGS?

Ice reshapes the surface of the lift-producing parts of the aircraft (the wings and the tail). The roughness that the ice causes, is enough to change the aerodynamics of the wing such that there's more drag and less lift. This is dangerous because at some point air cannot flow over the icy upper surface, and the aircraft will go into an aerodynamic stall, lose its lift and could crash.

Activity link

"Who can make the best paper plane - a flying contest!"

Competiton criteria could include:
Straight glide, Extra thrust, Paper clip on nose, Paper clip on centre, Paper clip on tail, Pea sized blue-tac on nose, Pea sized blue-tac on centre, Pea sized blue-tac on tail.

NEED INSPIRATION WHEN MAKING PAPER PLANES?

In 2018, the Royal Air Force celebrated its birthday - it was 100 years old! During its first 100 years of operation it has used lots of different aircraft. You can take a look at the ones currently being used on their 'aircraft' site - there are 32 different types. (https://www.raf.mod.uk/aircraft/). You can even take a look around some of them because they are in 3-D.

Activity link

"Take a look at some of these RAF aircraft".

BACKGROUND

PRODUCING THE POWER TO FLY

When you look at the different aircraft that have been used by the RAF in its first 100 years, you can see that as technology has advanced aircraft have become more powerful.

Propellors

During the early years of flight, aircraft used propellors to produce power. Propellers are like fans in reverse. They have spinning blades connected to a piston engine (similar to those found in cars) that push air backwards to create a forward force.

Jet engines

Jet engines also push air backwards, but work in a different way to propellers. They can produce more thrust because they heat and compress the air so that it is pushed backwards at a higher speed. The force required to lift the aircraft into the air is created by airflow around the wings. A fixed wing aircraft can only take off when the air is moving quickly around the wings. They need runways to reach take-off speed.

Rotor

A helicopter can take off vertically because it has the propeller (called a rotor) mounted on its top, which pushes air downwards to produces an upward force. The rotor needs a much more complex design than a propeller because the blades need to be hinged so that they can move independently of each other to allow the pilot to be able to provide both lift and thrust using just the rotor.

Activity link

"Test your research skills - find out the names of these aircraft"

Answer:
(from top to bottom of page, left to right pages)
Dakota, Harrier Jump Jet, Foland Gnat, Sea King, Hurcules, Typhoon, F35 Lightening, E-3D Sentry (AWACS).

Activity link

"Take a look at some of these RAF aircraft"

Activity link

"Online video: Being an engineer with the RAF"
Video content.

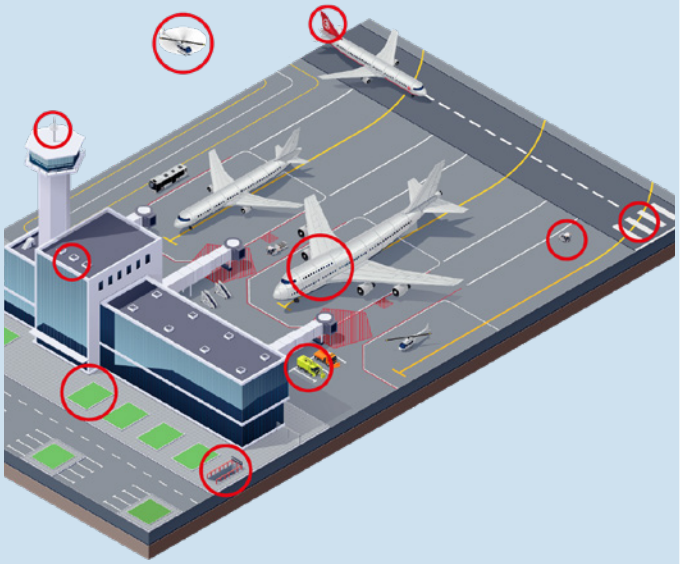
HOW OBSERVANT ARE YOU?

Working at an airfield, airport or air-base is exciting because there is always so much going on. Flying is a great thing to do and safety is a top priority. To be a good member of the aircrew team you need to be observant and spot things that might not look quite right. Are you very observant? Can you help and identify 10 differences in the activity below?

Activity link

"Are you observant?"

Answers:



Activity link

"Find the names of the aircraft in the grid"

D	L	Z	L	C	H	I	N	O	O	K	O	H
S	A	J	E	L	S	L	L	K	L	L	U	E
T	M	Y	L	S	B	D	Z	S	S	C	E	R
O	E	A	Z	S	T	S	X	O	C	A	P	C
R	V	C	H	E	L	L	L	S	E	U	R	U
N	S	L	X	A	W	D	R	B	M	W	C	L
A	K	E	A	K	W	V	E	A	L	B	N	E
D	E	S	L	I	F	K	D	A	W	E	A	S
O	N	K	S	N	L	O	N	L	S	R	I	L
G	D	E	K	G	R	W	A	N	Y	U	S	A
H	H	W	S	E	Z	A	L	W	S	L	C	S
S	E	O	E	A	M	B	S	S	N	S	L	O
W	N	R	E	T	H	G	I	F	O	R	U	E

BACKGROUND

FLYING WITHOUT A PILOT (IN THE AIRCRAFT)

Unmanned vehicles are becoming increasingly common, with driverless pods at Heathrow airport that transport passengers between terminals and self-driving cars already being tested on roads. In 2005 the RAF began to use remotely piloted air systems (RPAS) when a new unit, No. 1115 Flight, was formed at Creech Air Force Base in Nevada. The squadron has now relocated to RAF Waddington in Lincolnshire.

As of March 2009, the squadron operated 12 three-man teams to pilot its Reaper aircraft, supporting intelligence specialists, information communications technicians, signallers, and meteorologists.

Activity link

"Flying without a pilot (in the aircraft)"

Notes:
Materials in this activity developed for RAF100 Aiming for Awesome. Teacher/Facilitator notes have also been produced:

https://www.raeng.org.uk/RAE/media/Publications/Curriculum%20resources/RAF100/9-RPAS-Teacher.pdf

MEASURING SPEED

When an aircraft is moving through the air, not only is the aircraft itself moving, but the air is moving too. To understand the motion of an aircraft, you need to understand three different measures of speed: wind speed, ground speed and airspeed.

Activity link

"A question of speed"

Answers:

Wind speed

The wind speed is the speed at which the air moves relative to a reference point on the ground.

Ground speed

The ground speed is the speed at which the aircraft moves relative to a reference point on the ground.

Airspeed

The airspeed is the relative velocity between the aircraft and the air, or the difference between the ground speed and the wind speed:

Airspeed = Ground speed – Wind speed
WINDSPEED = 30


MAKE
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ACTIVITIES

MAKE YOUR OWN AIRCRAFT

ACTIVITY

MAKING PAPER PLANES

There are lots of designs of paper planes online. Scan the QR code here or search yourself using "paper plane design" as search terms.

In pairs work together to make a paper plane and carry out a test flight. Examine your design and see if you can make some changes or improvements to make your aircraft fly further. When you've made your changes, test your aircraft again. Does it fly further?

You could also look at the design of paper planes produced by others in your group. Who has produced the best design?

MODEL AIRCRAFT AND AIRCRAFT DESIGN

If you'd like to find out more about aircraft design, take a look at the **Aiming for Awesome** materials sponsored by the Royal Air Force.

You can also find the materials yourself by using the search terms: "Aiming for Awesome".

WHO CAN MAKE THE BEST PAPER PLANE - A FLYING CONTEST!

First of all make a paper plane.
You will need:
Paper (differing thicknesses)
Blue-tac
Paper clips
Tape measure
Hula hoop (optional)
Stopwatch (optional)

You can get some great ideas for designs from this website:
http://www.10paperairplanes.com/

WHY NOT TRY THE FOLLOWING TO MAKE IT EVEN MORE EXCITING!

- A 'longest flight' competition, where the flights are timed using a stopwatch.
- An accuracy contest to see who can get closest to a target six metres away or through a hula hoop hanging from the ceiling.
- Trick flying around a corner.
- Stunt flying - see who can perform the most impressive piece of aerial acrobatics?
- Try using different thicknesses of paper – which works best?
- Which style of plane is the best for distance - and which is the best stunts?

YOUR INSTRUCTIONS:

1. Throw the plane and measure the distance it travels.
2. Then increase the thrust of the plane and measure the distance it travels this time. The same forces that work on a real aircraft also work on a paper plane, but instead of engines it is the arm providing the thrust so to increase the thrust you need to throw the plane with more energy.
3. Now add some weight to the plane. Use the blue-tac and paper clips to make the plane heavier. Throw the plane and measure the distance it travels.
4. Try experimenting by moving the blue-tac and paper clips to different positions along the length of the plane. What do we notice about how the extra weight affects the distance travelled by the plane?
5. Fold the trailing edge of one of the wings. Throw the plane and watch what happens to the flight path.
6. Now try holding a flying contest.

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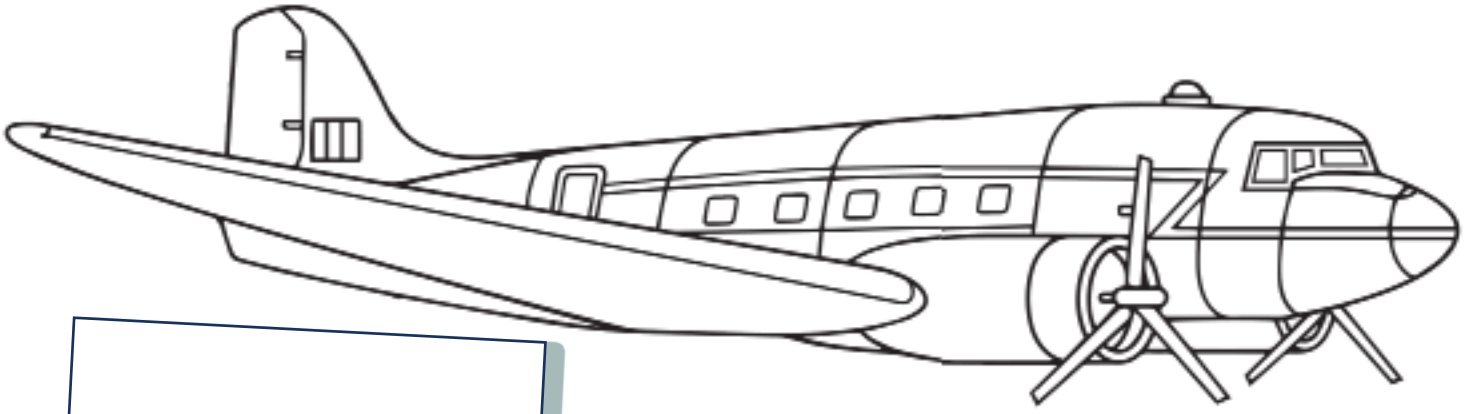
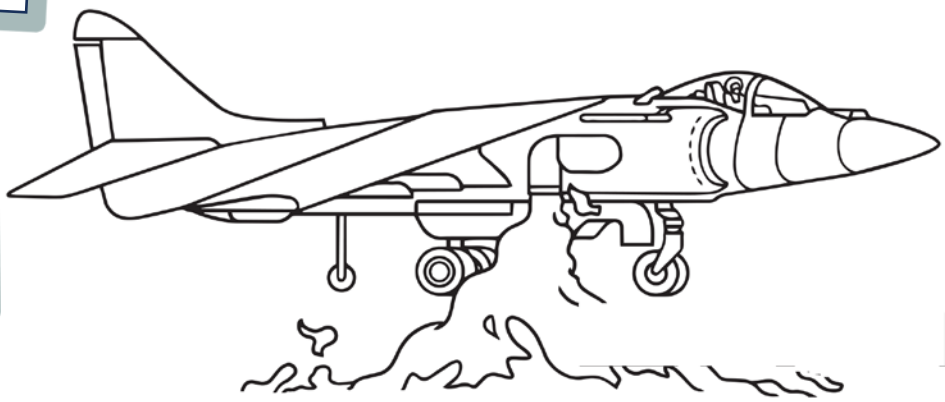
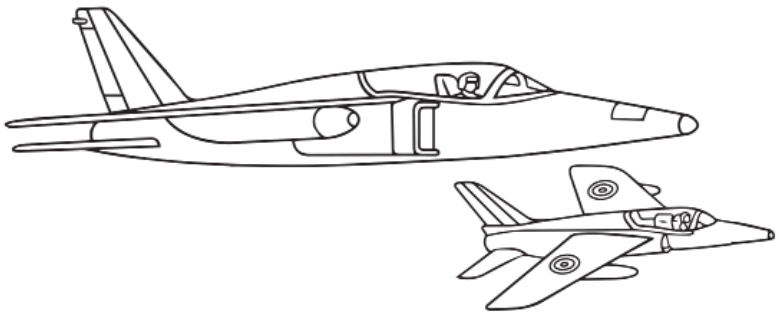
TEST YOUR RESEARCH SKILLS - FIND OUT THE NAMES OF THESE AIRCRAFT

(you can match them up with the names we've included on the opposite page)

When you have identified them, why not colour them in?



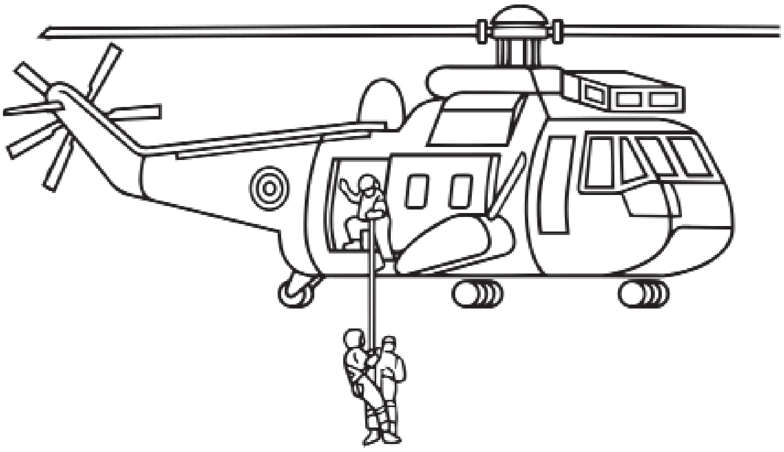


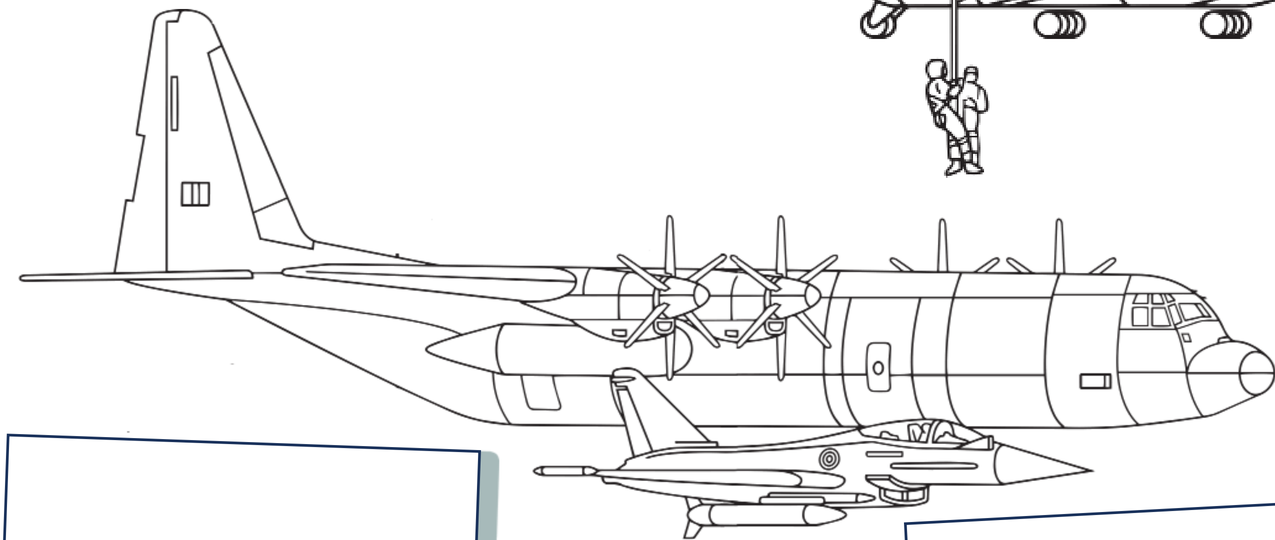


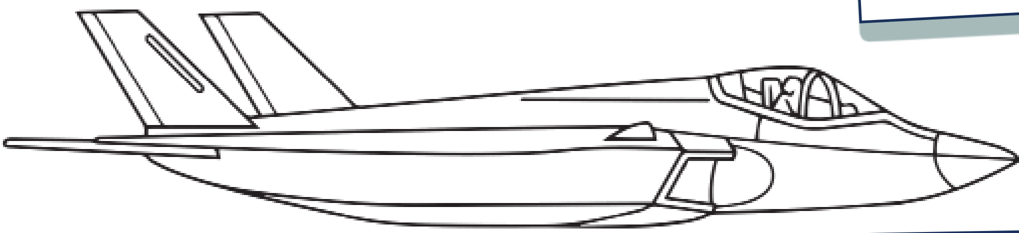
WANT TO KNOW MORE?

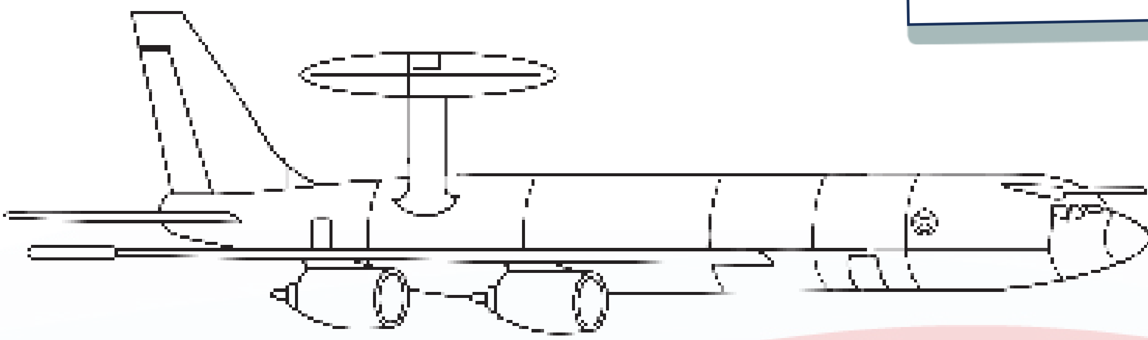
If you'd like to find out more about the history of modern aircraft technology and the RAF scan this QR code:

If you can't scan the QR code, use this URL instead:
https://www.raf100schools.org.uk/activity/64/5-the-jet-age-helicopters









AIRCRAFT on these two pages: F35 Lightening, Hurcules, E-3D Sentry (AWACS), Typhoon, Sea King, Harrier Jump Jet, Dakota, Foland Gnat.

MAKE YOUR OWN AIRCRAFT

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TAKE A LOOK AROUND SOME OF THE RAF AIRCRAFT

Take a look around these 6 aircraft by scanning the QR codes. Make notes about the following for each aircfraft you look at:

- Where is it based?
- What is its wingspan/rotor diameter?
- What is its cruising speed (how fast does it go)?

Scan the QR code here for information about the **Typhoon**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/typhoon-fgr4/

Scan the QR code here for information about the **Atlas**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/atlas-a400m/

Scan the QR code here for information about the **Chinook**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/chinook/

MAKE YOUR OWN AIRCRAFT ACTIVITY

Scan the QR code here for information about the **F35 Lightening**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/f-35b-lightning/

Scan the QR code here for information about the **E-3D (AWACS)**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/e-3d/

Scan the QR code here for information about the **Lancaster**.

If you can't scan the QR code, use this URL instead:
https://www.raf.mod.uk/aircraft/lancaster/

BEING AN ENGINEER WITH THE RAF

Want to know more about what it is like to be an engineer for the RAF? Take a look at our short video especially produced for this activity.

LINK TO VIDEO HERE

(you can download this Mp4 file so that you can use it anywhere)

ACTIVITY

ARE YOU OBSERVANT?

Can you identify 10 differences in the two pictures? Circle them in the second image below.

FIND THE NAMES OF THE AIRCRAFT IN THE GRID BELOW

D	L	Z	L	C	H	I	N	O	O	K	O	H
S	A	J	E	L	S	L	L	K	L	L	U	E
T	M	Y	L	S	B	D	Z	S	S	C	E	R
O	E	A	Z	S	T	S	X	O	C	A	P	C
R	V	C	H	E	L	L	L	S	E	U	R	U
N	S	L	X	A	W	D	R	B	M	W	C	L
A	K	E	A	K	W	V	E	A	L	B	N	E
D	E	S	L	I	F	K	D	A	W	E	A	S
O	N	K	S	N	L	O	N	L	S	R	I	L
G	D	E	K	G	R	W	A	N	Y	U	S	A
H	H	W	S	E	Z	A	L	W	S	L	C	S
S	E	O	E	A	M	B	S	S	N	S	L	O
W	N	R	E	T	H	G	I	F	O	R	U	E

Sea King
Chinook
Hercules
Puma
Eurofighter
Tornado
Hawk
Islander

MAKE YOUR OWN AIRCRAFT

ACTIVITY

FLYING WITHOUT A PILOT (IN THE AIRCRAFT)

In this activity you will explore the advantages and disadvantages of unmanned vehicles.
You will also work out a flight-path for an unmanned vehicle.

Scan the QR code here to access the materials linked to this activity:

If you can't scan the QR code, use this URL instead:
https://www.raeng.org.uk/RAE/media/Publications/Curriculum%20resources/RAF100/9-RPAS-Student.pdf

A QUESTION OF SPEED

Match up the defintion to the correct term here (by drawing a line) and then complete the equation by writing in the correct words in the gaps.

WIND SPEED

GROUND SPEED

AIRSPEED

This is the difference between the speed of the air and the speed of the aircraft. This is the speed used in the flight plan. It is monitored by the pilots during the flight.

This is the speed that the aircraft moves at. If you divide the distance an aircraft moves by the time it takes to move from point A to point B, you will get this speed.

This is the speed that the air moves at. It is the speed that would be shown on a weather forecast

_____ speed = _____ speed - _____

Now work out the missing element of a journey if:
AIRSPEED = 90
GROUNDSPEED = 60