STEM ACTIVITY 4
TEACHER NOTES

AIRDROPS

RAF 100

raf100schools.org.uk

EQUIPMENT REQUIRED PER PAIR OF STUDENTS:

- A copy of the STEM student instructions
- 5 metres of smooth string or thread (you will need to set this up before the activity- see figure 2)
- An additional 90 cm of string or thread (the release string)
- A sheet of A4 paper
- A sheet of A5 paper (eg A4 paper cut in half)
- A large sheet of paper (eg an A2 sheet, 4 sheets of A4 taped together or a strip of wallpaper)
- 7 paperclips
- Masking tape or transparent sticky tape
- A metre rule or tape measure
- Scissors
- Three different coloured pens/pencils
- Target Overlay copied onto a clear sheet
- A mobile phone with video camera (optional)

PREPARATION REQUIRED

Before carrying out the activity you may need to download the accompanying video: *Airdrops*. In preparation for each group of students, you will also need to tie a string in a gentle downward slope across a gap of about 5 metres. Use a high cupboard handle or window fitting as the upper fixed point and tie the other end to a stool or chair. Make sure that the string is slack, making a curved shape (see figure 2).

PHYSICS CURRICULUM LINKS: PRECISION, ACCURACY, OBJECTS IN FREE FALL.

STEM ACTIVITY: DROP ZONES

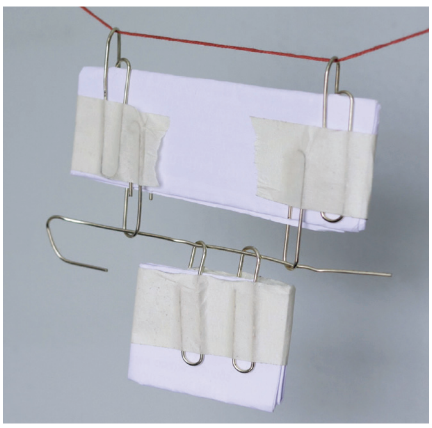
In this activity, students make a model of an airdrop and investigate how the landing positions of supplies dropped from a moving aircraft are grouped.

Introduce the activity by playing the accompanying video: *Airdrops*. Explain that the RAF has been involved in many relief operations over the years. The methods of delivery can vary depending on the situation and ground conditions, but accuracy and precision of delivery, whether by airdrop, with or without a parachute, or on a landing strip, are very important.

Students should follow the STEM activity instructions to make an airdrop model using folded paper, string and paperclips. They should start by folding the A4 paper to make their aircraft, then adding two paperclips to the top. The paperclips should be bent into hooks, which will be used to hang the aircraft from the long string. They will also need to attach two more paperclips to the bottom of the aircraft. This second set of paperclips will form clips to hold a release pin, which in turn will hold a supply package. The supply package is made out of two paperclips and a folded sheet of A5 paper. Students will need to attach the supply package to the aircraft by threading the release pin through the clips at the bottom of the aircraft and top of the supply package (see figure 1).

FIGURE 1:
PAPERCLIP AIRCRAFT AND SUPPLIES

The aircraft, supply package and release pin suspended from the long string.



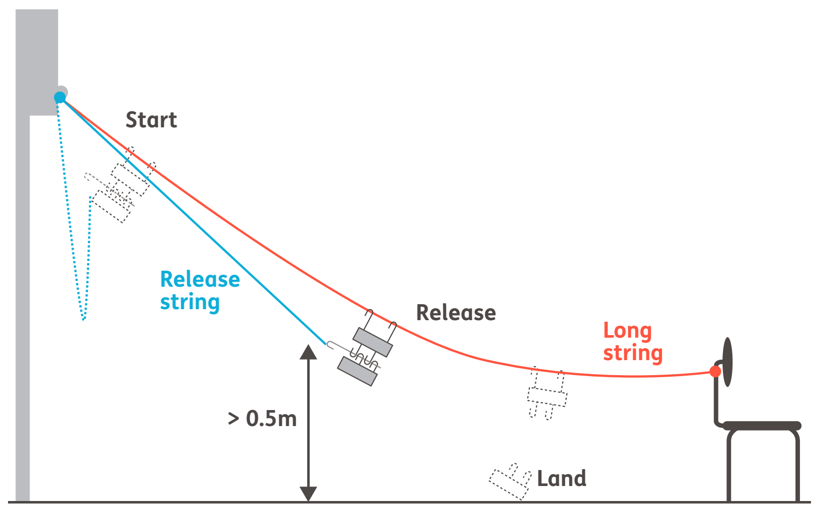
AIRDROPS

Students should attach one end of the release string to the release pin, then hang the aircraft from the long string and attach the other end of the release string to the same upper point where the long string is secured. Once launched, the aircraft should slide smoothly down the long string and the package should detach automatically when the release string becomes taut (see figure 2).

Having got the system to work reliably, they should lay a large sheet of paper on the floor to make a drop zone. They will use the paper to record landing positions for different release string lengths. They should start with a release string length of (approximately) 90cm, and then go on to try shorter release strings. For each string length they will collect 10 data points, before using their Target Overlay to analyse the precision of the landings (see figure 3). If there is time, they can also consider what factors might cause variations in the landing position, both in their experiment and in a real airdrop (see figure 4).

FIGURE 2:
THE AIRDROP MODEL

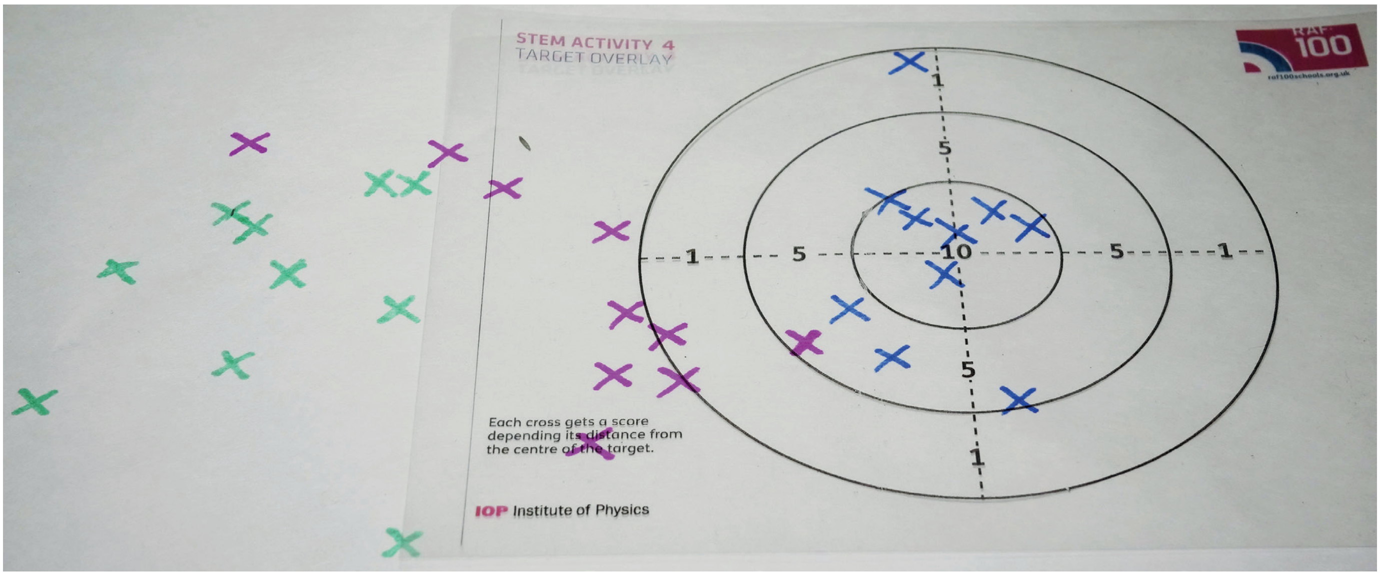
The start and release positions for the aircraft and supply package.



You may get questions about the trajectory of the falling package. If drag forces are very low, its horizontal velocity will stay almost constant while the package accelerates downward due to gravity. The package will follow a parabolic path (see figure 5 in next section).

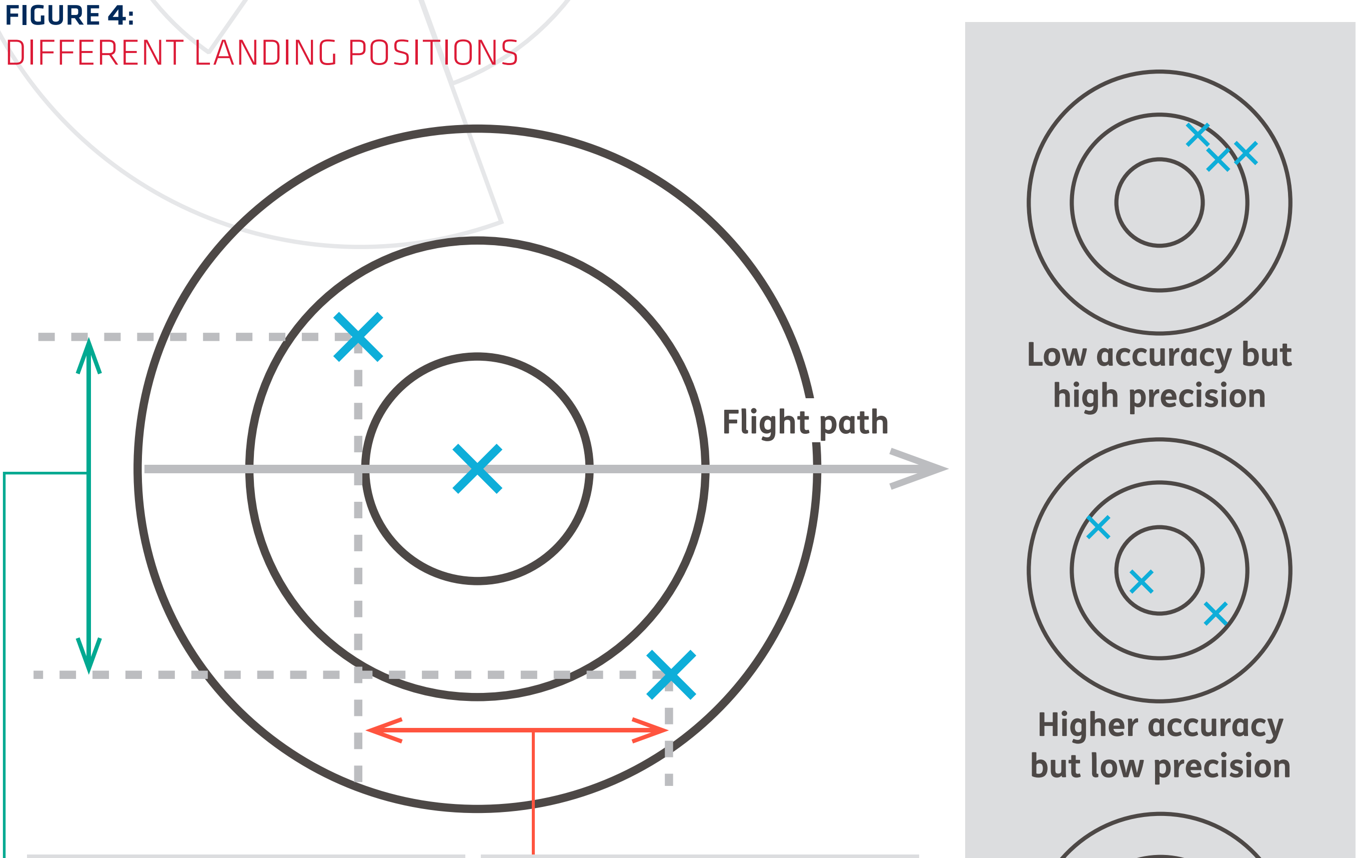
FIGURE 3:
ANALYSING THE RESULTS

Data for three lengths of release string with the Target Overlay positioned to find the score for one of the data sets.



STEM ACTIVITY 4
TEACHER NOTES
AIRDROPS

FIGURE 4:
DIFFERENT LANDING POSITIONS



Lateral differences in landing position (left or right of the flightpath) could be due to:

- The main string swinging from side to side as the aircraft descends
- The supply package being thrown sideways by the release pin

Longitudinal differences in landing positions (along the flightpath) could be due to:

- Differences in the speed of the aircraft when the package is released (eg due to differences in the aircraft's starting positions)
- Differences in friction between paperclips and string

Factors a pilot would need to consider in real airdrop :

- Aircraft height (altitude)
- Aircraft speed and direction
- Wind direction and strength
- Air resistance (especially for high altitude airdrops where parachutes are used to slow the packages' descent)
- Time-delay between giving the command to drop supplies and the release mechanism deploying
- If dropping more than one supply package, the time delay between dropping first package and subsequent packages

STEM ACTIVITY 4
TEACHER NOTES
AIRDROPS

RAF 100

raf100schools.org.uk

EXTENSION (OPTIONAL): PROJECTILE MOTION

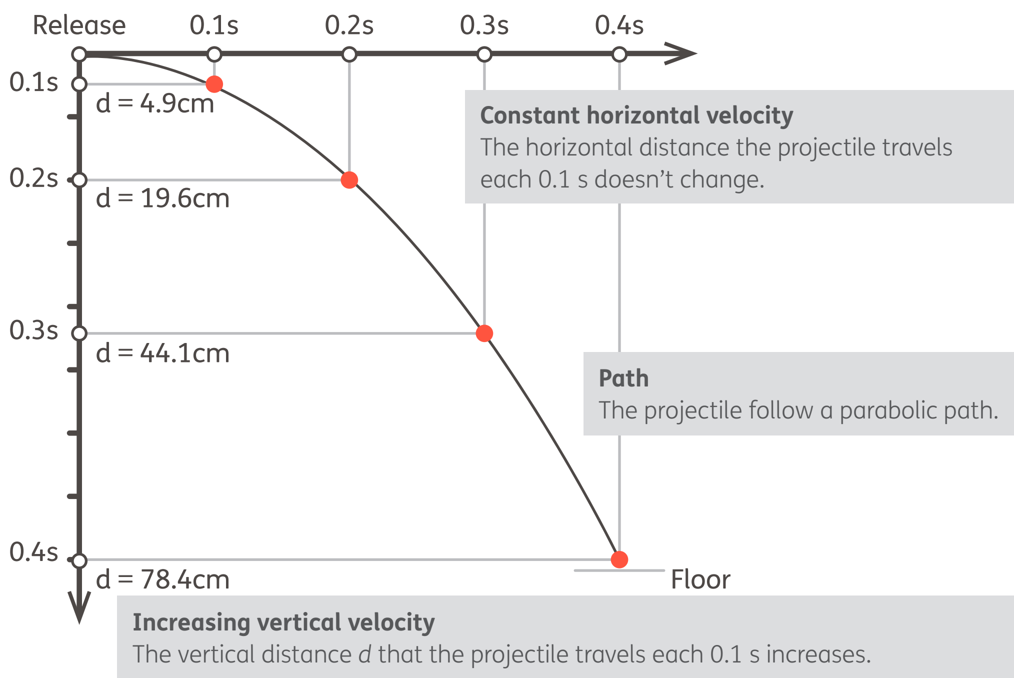
As an extension, students could analyse the horizontal and vertical components of the supply package's motion.

Students will need access to a video camera, eg on a smartphone or tablet. For a quantitative analysis they could also use video analysis software such as Tracker (downloadable free of charge at **physlets.org/tracker**). When they play back the experiment in slow motion and/or analyse the motion using the software they should find that their package follows a parabolic path because its horizontal velocity remains (almost) constant while it accelerates downwards (see figure 5).

They could also try increasing the mass of the projectile by taping a 1p coin, 5g masses, or disc of Blu-tac to the package. As long as they ensure that they don't change the shape or size of the package too much (so that the air resistance remains small), the only force acting on the package will be gravity. So, as with all objects in free-fall, it will accelerate downwards at 9.8 ms^{-2}. All packages dropped from the same height will have the same time of flight irrespective of the mass of the object.

FIGURE 5: PROJECTILE MOTION

The path and components of the motion of a projectile.



MAKING THE HISTORY CONNECTION

The linked history activity is designed to show how technology was used in the past. The history activity here is about the role of the RAF in disaster relief. Team up with a history teacher to help students explore how air drops have allowed the UK to maintain its role in international affairs by responding to manmade and humanitarian crises.

FURTHER INFORMATION

The National Physical Laboratory website illustrates the difference between accuracy and precision very well and provides a free poster for schools to download at **bit.ly/RAF-NPL**. Other experiments for projectile motion are available on the IOP Practical Physics Website at **bit.ly/RAF-Projectiles**