KS4 Science – ZERO EMISSION FLIGHT ENERGY CHALLENGE
Glider Launch Methods & Energy Transfer - Teacher Notes

This unit consists of: Teacher notes, Student Worksheet, video 'KS4 Science Zero Emissions Flight Energy Challenge' and a model answer print-out and video animation 'Launch Energy Transfer Diagram'.

Note - If time or space does not permit the students to make the launch machine, they can instead watch a flight in the video 'Launch ramp and flight'.

This resource is ideal as a follow-up to Design and Technology unit 'Zero Emissions Glider Launch Machine' in which students design and construct a launch machine. See gogliding.uk/STEM for this unit.

This unit builds students' ability to work scientifically, investigating different types of energy and the transfer that occurs between them as a glider is launched into the air, flies and then lands.
Essential prior knowledge:

- The seven types of energy
- Drawing an energy transfer diagram
- Conservation of energy

Introduction

Gliders fly hundreds of kilometres at speeds of over 100kph, just using renewable energy from the sun and the wind. But they need help to get into the air - they have to be launched using a winch, a bungee or be towed by a light aircraft (aerotow). Play the 'Glider Launching' video to meet a gliding role model and see the launch methods in action.

A time-lapse of a winch launch (Photo cred: Callum McEachen)

An aerotow (Photo cred: Lucy Wootton)

Student Activity

The student activity examines the transfer of energy between different forms for a glider launched using a bungee, then as it flies and until it lands.

Materials are listed in the Student Worksheet below. The students build a ramp with whatever they have available, such as a pile of books or a chopping board resting on some blocks. They make a glider and launch it by placing the elastic band around the back of it while on the ramp and 'pinging' it into the air.

Hint: To make it fly smoothly and in a stable way, attach a paperclip to the glider nose as ballast. If this is not enough, add successive paperclips until it flies smoothly. Students may have to make adjustments to the glider design, the force with which they pull the elastic band or the ramp itself to achieve stable flight.

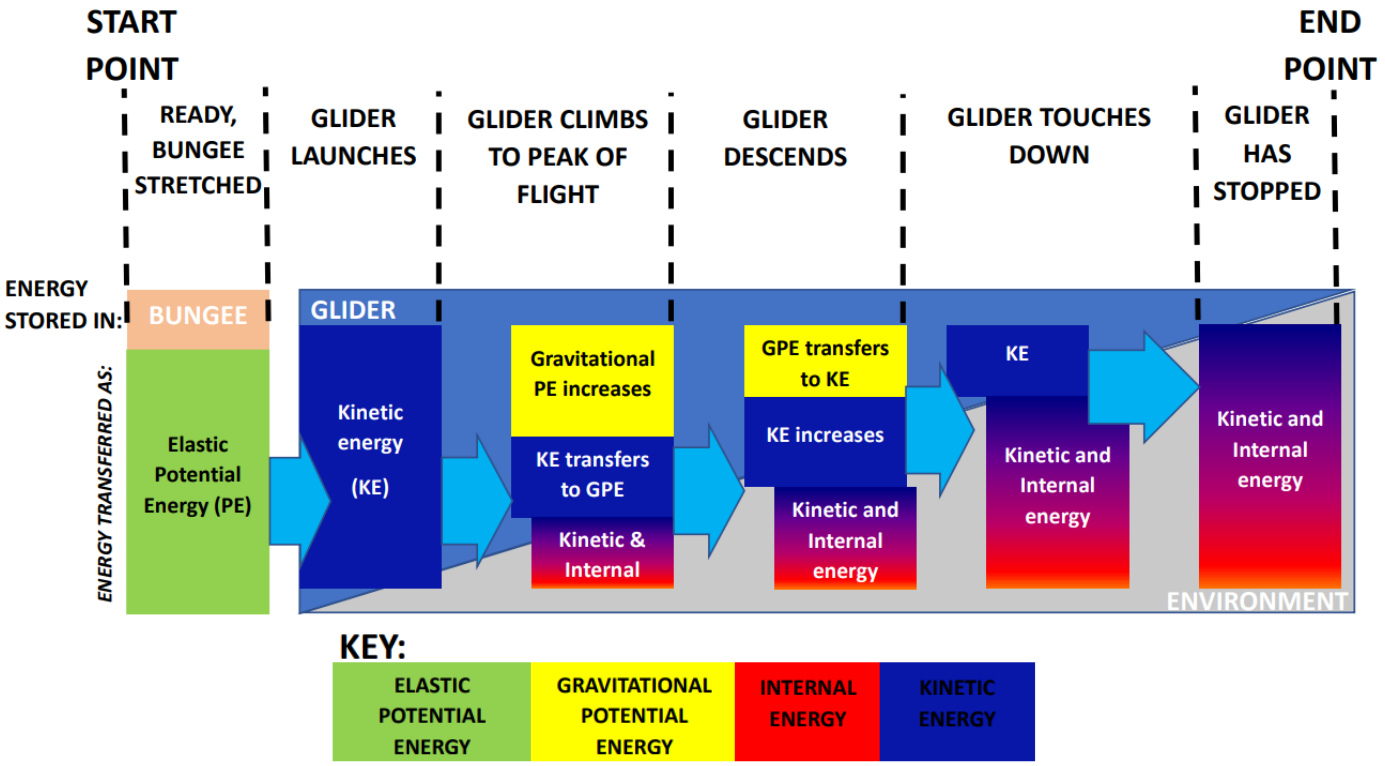
Students observe the glider in flight and then answer the 'Challenge Questions.'

The aim of these questions is to be able to draw an energy transfer diagram similar to the ones given below, understanding how and why each energy transfer takes place. Key points are below, and are in the video 'Launch Energy Transfer Diagram' with flight phases and an animation building the diagram.

The key points in a glider flight when energy is transferred are:

1. **Start point - the stretched bungee with the glider ready to launch**
    - The bungee stores Elastic Potential Energy.
    - I used my own Internal Energy to stretch the bungee!
2. **The glider launches**
    - The bungee transfers its Elastic Potential Energy to the glider as Kinetic Energy
3. **The glider climbs, slowing as it climbs**
    - As the glider climbs, some of its Kinetic Energy is converted into Gravitational Potential Energy.
    - Air resistance means that the glider transfers energy to the surrounding air as Internal and Kinetic Energy all the time the glider is flying.
4. **The glider descends, speeding up**
    - As the glider descends, the glider transfers its Gravitational Potential Energy to Kinetic Energy in the glider.
    - It continues to transfer Kinetic Energy and Internal Energy to the environment
5. **The glider touches down and slows rapidly**
    - As the glider comes back down to ground level, it converts its remaining Gravitational Potential Energy to Kinetic Energy, as well as continuing to transfer energy to the environment
6. **End point - the glider has stopped**

Gliding STEM Resources



A key lesson is that conservation of energy means that the glider's energy is not 'lost' - it has all been transferred to the environment where it is spread out enough that it would be difficult to measure.

☺ ***Fascinating fact:*** the glider at the bottom of the Student Worksheet is dumping water ballast. Gliders race round pre-set courses of up to 500km. Gliders have wing tanks which can be filled with water to make the glider heavier – a heavier glider can race faster! The pilot opens a valve to release the water before landing - or sometimes whilst in the air if race conditions become less good.

Extension Task (not included in Student notes)

Ask students to create an energy transfer diagram for a winch or aerotow launch.

Student notes are shown overleaf.

If you and your class enjoyed this, explore our other STEM activities!

We hope you found this useful and a fun way to encourage young people into the world of STEM and aviation. Girls in particular are under-represented in these areas and we are working to change this. Inspire them with videos of our STEM role models along with other exciting gliding-based STEM resources covering various elements of the National Curriculum on gogliding.uk and at www.gliding.co.uk/STEM.

Students can find out all about gliding at the British Gliding Association website and the Junior Gliding and Women Gliding communities at the links below. There's information about flying with and without an engine and all types of aviation at https://stem.caa.co.uk/ & www.airleague.co.uk – aviation is not just about being a pilot! The CAA STEM site is particularly good, showcasing the breadth of aviation and associated careers. You can contact the Go Gliding team at gogliding@gliding.co.uk.

ZERO EMISSION FLIGHT ENERGY CHALLENGE

Student worksheet

Do you know about gliding?

A time-lapse of a winch launch (Photo cred: Callum McEachen)

An aerotow (Photo cred: Lucy Wootton)

Do you know what a glider can do? It's an awesome way to fly, and glider pilots fly hundreds of kilometres at speeds of over 100kph, just using renewable energy from the sun and the wind. To get into the air, they have to be launched using a winch, a bungee or be towed by a light aircraft.

Your challenge: **Launch and fly a glider and observe how energy is transferred during the flight**

What you need:

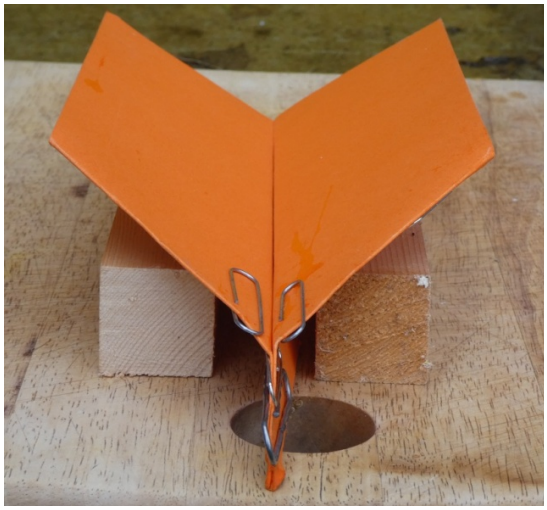
- A4 card and paperclips for the glider
- A launch machine comprised of ramp and a launch bungee – a board, elastic bands, drawing pins – or use the launch machine made as part of a Gliding Design and Technology STEM unit.

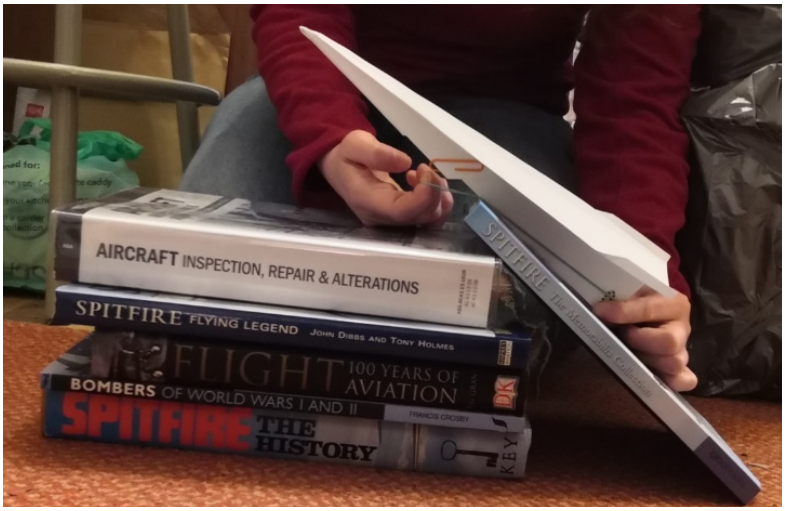
The Challenge:

1. Make your glider out of card or paper and use paperclips to adjust the nose-weight so it is stable when it flies - **the glider must fly smoothly, not pitch up and stall.** Templates for two 'standard' designs of glider are attached which match the designs shown in the photographs below.
2. Make your launch machine.
3. Launch a glider!

4. Adjust the glider and launch machine until you can repeatedly achieve stable flight. You might need to adjust:
    - the amount of energy transferred to the glider during the launch i.e. how much you stretch the elastic band
    - the angle of the launch ramp
    - the ballast on the nose of the glider
    - the angle of the glider wings to the fuselage.
5. Carefully observe the stages in the flight from start until the glider has landed and stopped.
6. Answer the challenge questions.

If you are not using a launch machine made in another STEM session, the pictures below give you some ideas of how you could make your glider and ramp:





Challenge Questions

1. What gives the glider energy to start its flight?

    ……

    ……

2. List the different energy stores involved during the flight

    ……

    ……

    ……

    ……

3. List the key points in the flight where energy has transferred from one store to another

   ……
   ……
   ……
   ……

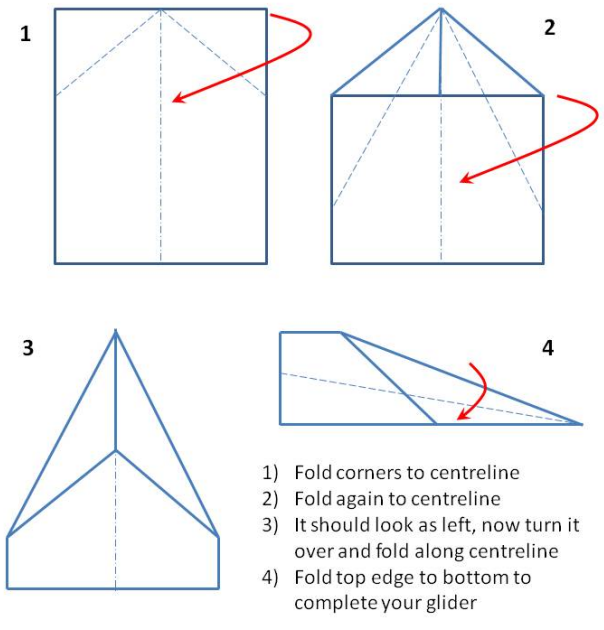
4. Why doesn't the glider carry on forever?

   ……
   ……

5. Construct an energy transfer diagram for the flight – use a separate sheet of paper.

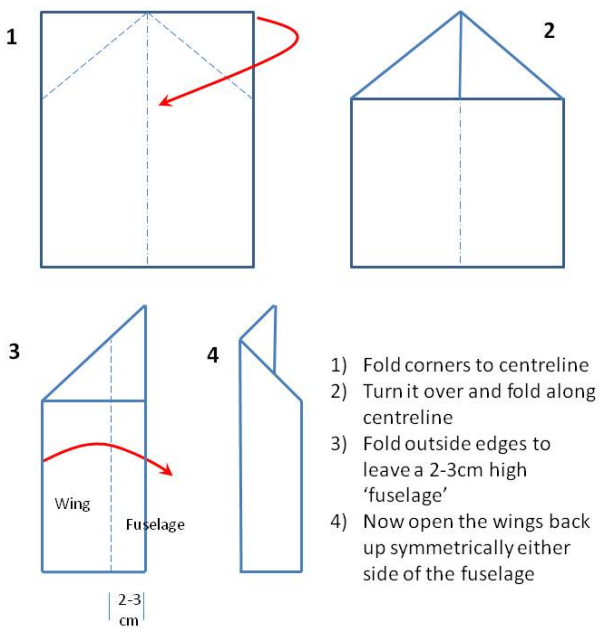
Glider Designs:

Glider Design 1



1) Fold corners to centreline
2) Fold again to centreline
3) It should look as left, now turn it over and fold along centreline
4) Fold top edge to bottom to complete your glider

Glider Design 2



1) Fold corners to centreline
2) Turn it over and fold along centreline
3) Fold outside edges to leave a 2-3cm high 'fuselage'
4) Now open the wings back up symmetrically either side of the fuselage

We hope you had fun demonstrating energy transfer and looking at the types of energy used to launch and fly gliders.

Try gliding for real at a gliding club near you – did you know that you can fly a glider solo aged 14 once you have completed your training? Find your nearest club at https://www.gliding.co.uk/club-finder/

glider dumping water ballast

Find out more about GLIDING at the links below, all types of AVIATION at airleague.co.uk & CAREERS at stem.caa.co.uk/careers-in-aviation-and-aerospace

We hope to see you on an airfield soon!