INSPIRE

MAKE IT FLY ACTIVITY

Age: KS4

Lesson overview

In this hands-on science and business studies activity, students are set a mock challenge to build a paper plane that will generate a profit of at least £50,000.

They spend the first part of the activity considering the design and functionality of paper aeroplanes, and what makes them fly. They create different designs of plane to see which type flies the furthest. Then they turn their attention to the financial part of the activity: considering the 'cost' of building a paper plane and the amount they can generate from 'passengers' per cm the plane flies.

The activity concludes with a live flight challenge. Students calculate their flight distance and cost of their planes to find out if they have achieved the goal of generating a profit of at least £50,000. There is an accompanying leaderboard if you want to turn this into a competition.

The activity supports curriculum learning in science, business, studies and maths – as well as skills development in team working, problem-solving and time management.

Learning objectives

- Understand the forces that create flight;
- Work in teams to design two paper planes;
- Run an investigation to find out if wing shape and size affects how far a paper plane will fly;
- Determine the most cost-effective way to build the plane, taking into account increased prices once the project is underway;
- Produce a profit and loss table;
- Calculate the average flight distance, using the mean;
- Work as a team to solve the problem in a set time.

HPC Inspire

Inspire is Hinkley Point C's Education Programme in Somerset and the wider South West region. We offer a range of free and innovative activities – including hands-on STEM workshops, assemblies, events and resources – to help young people take advantage of the huge opportunities that the construction and operation of Hinkley Point C has to offer.
www.edfenergy.com/hpcinspire

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Subjects

Science (Physics: forces, Newton's Laws)
Business studies (profit and loss)
Maths (mean)

Employability skills

- **A positive attitude** – Show a 'can do' attitude, be proactive and demonstrate a willingness to try out new things.
- **Self-management** – Demonstrate time management, be willing to play an active role and take on responsibilities.
- **Team working** – Show willingness to cooperate with us and work together to achieve shared goals.
- **Problem solving** – Be proactive in coming up with solutions, willing to test new ideas and work to overcome challenges.
- **Entrepreneurship** – Willing to think differently, identify new opportunities and show resilience in the face of hurdles.

Gatsby Benchmarks

4: Linking curriculum learning to careers: The homework suggestions include ideas for researching jobs in aerospace engineering.

Timings

3 x 1-hour lesson blocks, depending on the abilities of students. You could also adapt the activity to fit with your lesson objectives: for instance, expanding the profitability section.

Materials and set-up

The **Resource Pack** contains the following materials:

Teacher-facing resources:
- These **Teacher notes**
- **Leaderboard**: use this to fill in each team's name, flight time and profit for the live flight challenge.

Student-facing resources:
- **Student handout**: a summary of what they need to do in the activity, including important information, such as the costs tables that they will reference in Part 3.
- **Calculations sheet**: a blank spreadsheet (including pre-calculated sums) for students to fill in with their calculations throughout the activity.

Materials needed

- If using a plane launcher you will need a table (near to an electrical socket) and to mark out the test area using tape (tape down any wires too). Ideally you want to carry out all 'flights' in a large area (e.g. the school hall) – see **page 9** for a guide to determining the test area
- Extension lead (if using plane launcher)
- An internet connection
- Paper for making the planes (A4, reused if possible), as well as scissors, sellotape, bulldog clips and paperclips
- Plane designs (find design ideas at Fold N Fly website: **www.foldnfly.com/#/1-1-1-1-1-1-1-1-2**)
- Certificates and prizes (optional)

How to run this activity

This activity can be adapted to suit your needs and time available. Here are some suggestions for how to use the activity with students:

- **In science or business studies lessons**: run over one or two lessons to support curriculum learning about forces and calculating profit/loss;
- **During an Enrichment or Enterprise Week,** or as a **topic-based learning exercise**: it is a good activity for encouraging teamwork and has a competitive element;
- A **fun Eco Club activity**;
- As an **inter-school competition**: Encourage students to get together in teams and work up to the live flight challenge. You could award certificates and/or prizes to the winning team(s).

The activity

Lesson 1

Warm-up (5 mins)

Split the class into small groups and ask them to decide on team names. Distribute copies of the **Student handout** and **Calculations sheet**.

Part 1 (20 mins):
The theory – What makes a paper plane fly?

Start the activity with a class discussion about forces and flight. Remind students that a 'push or a 'pull' force is needed to make something move, speed up, slow down, or change direction. A paper plane needs a forward 'push' from the person throwing it (or plane launcher) – called 'thrust' – and an upwards 'push' from the wings, called 'lift'.

Optional: Depending on time available, you could dedicate some of the lesson to discussing Newton's First and Second Laws of Motion (or make this a homework challenge – see **page 5**) and how these apply to a paper plane at take-off, landing and in flight.

Explain that the amount of lift can depend on the shape of the plane's wing. Look at the pictures at the end of the **Student handout** of a glider and jet plane. What differences do students notice about the wing shapes? You could also share this article (**boldmethod.com/blog/article/2015/02/your-guide-to-glider-flying/**), which looks at the topic in more detail, and run through the following questions in their **Student handout**:

- How do each of these fly?
- What difference does the shape make to how they fly?
- Does size matter? Do bigger gliders fly further?

You could end this session by watching a film (**youtube.com/watch?v=gUyftfN3jdI**) on the physics of paper planes. This film (**youtube.com/watch?v=aFO4PBolwFg**) might also be helpful: it explains how air moves around a plane's wing and the implications for its design.

Part 2 (35 mins): The practical – Have a go at building some planes!

What we want to do in this exercise is see which type of plane design flies the furthest.

Show students where the materials are that they can use for creating their paper plane. If they need some ideas to get started, bring up the Fold N Fly website (**www.foldnfly.com/#/1-1-1-1-1-1-1-1-2**) to give students some different designs to try – but encourage them to improvise too, using extras like paperclips, scissor cuts to the planes and bulldog clips, to see if this has any impact on their planes' flights. Also refer them to what was discussed in **Part 1**, and the questions in their **Student handout** (e.g. about the wing aspect ratio – see below) to help guide them.

- Does making the design more complicated or intricate (e.g. adding more folds) make it fly further?

- Can sellotaping folds help it fly better? How can paperclips or bulldog clips help?

- What are the best angles to shape the nose? How important is accurate or firm creasing?

Think about drag factors too. And what about the wings? Generally, gliders have long, thin wings to get more lift. Students could calculate the wing aspect ratio.

Wing aspect ratio = wing length (cm) / wing width (cm)

Long, thin wings will have a higher wing aspect ratio than shorter, fatter wings, so they might want to consider this when creating their planes.

Students may need some practical advice while honing their designs at this stage: For instance, if their glider veers to the left, curl up the rear edge of the left wing (and vice-versa: so if it turns right, turn up the right wing). If it dips, curl up both rear edges. And if any plane's wings need some extra stability, trim 1.5cm off each wing, then cut and fold the ends once more to make new wing tips. This should help the plane fly more smoothly.

Students can test their paper planes unofficially at this stage (i.e. not using the marked out flight path). You might want to agree a point in the lesson when everyone can go into the hall or another large space together to test their planes safely, or you could take them over in groups. Remind them to be scientific in their testing i.e. ensure fair conditions for each flight to avoid any bias, such as:

- Using the same person to throw the plane each time;

- Making sure the conditions are equal each time;

- Measuring the length of flight accurately and recording it in the same way; etc.

Health and safety warning: Stress the importance of students ensuring their flight path is clear before they release their plane.See **CLEAPSS** for more guidance.

If there's going to be a break before you resume the next part of the activity, make sure students label their planes and you keep them somewhere safe, as they'll need these in Part 4.

Lesson 2

Part 1 (35 mins): Do your paper planes make at least £50,000 profit?

Get students into their same teams from **Lesson 1**, and ask them to locate their paper planes.

Remind them that this isn't just a challenge to see who can make the paper plane that flies the furthest... They need to think about making at least £50,000 profit from their paper plane, which means thinking about how much their plane costs to build too.

Here are the key financial factors they need to consider (these are also in the **Student handout**):

- **The minimum profit students need to achieve is £50,000** – So students need to balance the cost of their plane against how far it can fly (see the next point). If you're running this as a competition with the group, the challenge will be to see who can make the most profitable plane i.e. the one which flies the furthest for the lowest cost.
- **Students receive passenger fees of £1,000 per cm of flight within flight path** – so the further their plane flies, the more money they'll make.
- **The more materials students use, the higher their costs will be.** So the further their plane will need to fly to achieve the minimum profit of £50,000.
- **The costs are higher in the 'live' flight stage.** So they should think about only making minimal changes to their designs at this stage.

Ask students to review their paper plane designs in light of the costs involved in building them – see the next page (these are also in their **Student handout**). Ask them to fill in **Steps 1 & 2 in the Calculations sheet** – remind them that the spreadsheet will do the calculations for them! They can duplicate the tables in Step 2 if they are testing out more than four plane designs.

Costs for planning / build stage

Material	Cost
Each piece of A4 paper	£10,000
Use of scissors	£5,000
Bulldog clip	£1,000
Paperclip	£1,500
Sellotape (per cm)	£1,000
Each test flight (max of 5)	£2,500

5-min warning! Give students a brief amount of time to decide which of their 2 plane designs they want to take forward to the live flight stage.

Optional: If the paper planes are a bit worse for wear – and you have time available – you could give students time to re-build them, before they enter the live stage of the challenge.

Part 2 (25 mins): Get ready for take-off!

Make sure the flight path has been marked out and the plane launcher is ready – if you're using this – ideally in a large-sized room (e.g. the hall). If you are using a plane launcher, explain to students how it works and that it ensures fairness (since each plane is given an equal amount of thrust).

Each team can conduct two test flights (using the plane launcher) for each of their paper planes. If they want to log their times, they can create a table in the spreadsheet. In-between test flights 1 and 2, they can make any modifications to their planes. Be aware, however, that these will incur additional higher costs (see below).

Costs for live testing stage

Material	Cost
Each piece of A4 paper	£50,000
Use of scissors	£10,000
Bulldog clip	£5,000
Paperclip	£8,000
Sellotape (per cm)	£2,000
Each test flight (max of 5)	£10,000

Students need to fill in the table on **Step 3 of the Calculations sheet** if they make any changes to their design that require new materials. Remind students that they only pay for NEW materials at this stage, to avoid repeating their costs from Step 2.

Once they're happy with their two designs, they can complete **Step 4 of the Calculations sheet** to calculate their final build cost for both models.

Lesson 3

Part 1 (60 mins): The official flight

It's time for the official flight! Remind students that their plane MUST stay within the flight path otherwise it will be disqualified. Consider appointing a neutral party to be responsible for measuring the distance each plane travels and monitoring if any travel outside the flight path. Also, make it clear that students must not fly their planes until they've been told to do so, to avoid injury.

Each group is allowed to fly their two paper planes FIVE times. This is to give an 'average' overall flight distance. Note: the average we recommend they use is the mean and the cells in the **Calculations sheet** include pre-calculated sums.

Ask the groups to record their flight distance –as agreed by the neutral party recording the results! – in **Step 5 of their Calculations sheet**. They need to fill in the tables for both models and the averages will be calculated automatically.

It's crunch time! Ask groups to work out **Step 6 in the Calculations sheet** to calculate their profit (or loss!) from each plane. Record each group's results on the **Leaderboard**. Who achieved the highest profitability?

Some follow-up questions to ask students:

- Did you achieve the minimum profit of £50,000?
- If you didn't, how many additional passengers (i.e. how many extra cms) would your plane need to travel to make £50,000 profit?

Part 2: Wrap up (10 mins)

If you've run the activity as a competitive challenge, you could hand out awards e.g. for the furthest flight of a plane within the flight path; the most profitable plane, the plane that flew the straightest / highest etc. You could also discuss some of the features of the 'winning' planes: was their design radically different to others? Did they use more or less materials than other groups?

Would students do anything differently next time? For instance, spend more/less on materials?

You could also recap on the conditions everyone followed to ensure a fair test (e.g. all flights used the same flight path, were flown in the same room, used the same plane launcher in the same conditions etc.) What elements could introduce bias?

You could finish with some world records!:

- This film is of the team winning the world record for a paper plane travelling the furthest distance (68.9 metres in 2012): **www.youtube.com/watch?v=wedcZp07raE**
- This article is about the largest paper plane ever made (13.7 metres long by 7.3 metres wide): **newatlas.com/great-paper-airplane-project/21961/**

Homework suggestions

1. You could set a homework task about **Newton's Laws of Motion**; for instance, set some challenges to work out the acceleration of a plane at take-off and in constant motion. Or ask students to identify the four forces acting on a plane in flight.

2. There is an **urban myth** that no plane company in the history of aviation has been able to make a profit. Ask your students to look at the table below (and in their **Student handout**) to establish whether a profit can be made – and, if so, how much?

Note: the average ticket price is £55.22 and there are, on average, 154 passengers per flight.

Rough costs per customer of running an average flight[1]

Outlay	Amount allocated per ticket
Plane insurance	£0.17
Crew salaries (1 pilot, 4 cabin attendants)	£1.03
Fuel	£1.72
Cost of running the airline	£6.90
Paying off price of plane	£7.93
Airport costs (landing fees, etc)	£9.32
Aircraft maintenance fees	£9.66
Taxes and charges	£10.77

Source: www.telegraph.co.uk/travel/travel-truths/what-airlines-really-spend-your-airfare-money-on/

Can students imagine any way that they could increase the airline's profit without increasing the cost of the ticket? Would that compromise safety?

Answer: The cost of taxes, charges, maintenance and all the other fees comes to £47.50. The average one-way ticket price is £55.22. There are on average 154 passengers per plane, which gives a profit of £1,188.88 per flight.

3. Research careers in aerospace engineering. This job profile from the National Careers Service provides a good starting point: **https://nationalcareersservice.direct.gov.uk/job-profiles/aerospace-engineer#**

CURRICULUM LINKS

Completing the activities in this lesson plan will help students meet the following objectives / outcomes:

AQA GCSE Combined Science: Synergy

1. Development of scientific thinking

Students should be able to:

WS 1.2 Use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.

WS 1.5 Evaluate risks both in practical science and the wider societal context, including perception of risk in relation to data and consequences

2. Experimental skills and strategies

WS 2.2 Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.
WS 2.6 Make and record observations and measurements using a range of apparatus and methods.
WS 2.7 Evaluate methods and suggest possible improvements and further investigations.

4.6 Interactions over small and large distances

4.6.1.1 Forces as vectors

Recall examples of ways in which objects interact: by gravity, electrostatics, magnetism and by contact (including normal contact force and friction), and describe how such examples involve interactions between pairs of objects which produce a force on each object, representing such forces as vectors

AQA GCSE Combined Science: Trilogy / AQA GCSE Physics

As above and:

6.5 Forces

6.5.1.2 Contact and non-contact forces

A force is a push or pull that acts on an object due to the interaction with another object. All forces between objects are either:

- contact forces – the objects are physically touching
- non-contact forces – the objects are physically separated.

Examples of contact forces include friction, air resistance, tension and normal contact force.

Examples of non-contact forces are gravitational force, electrostatic force and magnetic force.

Force is a vector quantity.

Students should be able to describe the interaction between pairs of objects which produce a force on each object. The forces to be represented as vectors.

6.5.4.2 Forces, accelerations and Newton's Laws of motion

6.5.4.2.1 Newton's First Law

Newton's First Law:
If the resultant force acting on an object is zero and:

- the object is stationary, the object remains stationary
- the object is moving, the object continues to move at the same speed and in the same direction. So the object continues to move at the same velocity.

So, when a vehicle travels at a steady speed the resistive forces balance the driving force.

So, the velocity (speed and/or direction) of an object will only change if a resultant force is acting on the object.

Students should be able to apply Newton's First Law to explain the motion of objects moving with a uniform velocity and objects where the speed and/or direction changes.

(HT only) The tendency of objects to continue in their state of rest or of uniform motion is called inertia.

6.5.4.2.2 Newton's Second Law

Newton's Second Law:
The acceleration of an object is proportional to the resultant force acting on the object, and inversely proportional to the mass of the object.

As an equation:
resultant force = mass × acceleration
$F = ma$
force, F, in newtons, N
mass, m, in kilograms, kg
acceleration, a, in metres per second squared, m/s2

(HT only) Students should be able to explain that:

- inertial mass is a measure of how difficult it is to change the velocity of an object
- inertial mass is defined as the ratio of force over acceleration.

WJEC Science (Double Award) GCSE / WJEC Physics GCSE

2.6 Unit 6

6.2 NEWTON'S LAWS

Overview
This topic introduces the concepts of inertia, mass and weight and the relationship between them. The relationship between force, mass and acceleration is developed. Newton's laws of motion are used to explain the behaviour of objects moving through the air, and the concept of terminal speed.

Working Scientifically
The specified practical work in this topic gives learners the opportunity to know and understand a range of techniques, practical instruments and equipment appropriate to the knowledge and understanding included in the specification; to safely and correctly use practical equipment and materials; to make and record observations; to present information and data in a scientific way.

Mathematical Skills
There are a number of opportunities for the development of mathematical skills in this topic. These include applying the relationship between resultant force, mass and acceleration; calculating the weight of a mass in a given gravitational field. These topics afford learners the opportunity to recognise and use expressions in decimal form; to recognise expressions in standard form; to use ratios, fractions and percentages; to change the subject of an equation; to substitute numerical values into algebraic equations using appropriate units for physical quantities.

Learners should be able to demonstrate and apply their knowledge and understanding of:

(a) the concept of inertia, that mass is an expression of the inertia of a body

(b) Newton's first law of motion and be able to state it

(c) how unbalanced forces produce a change in a body's motion and that the acceleration of a body is directly proportional to the resultant force and inversely proportional to the body's mass

(d) Newton's second law of motion, and be able to state it, in the form: resultant force = mass × acceleration; F = ma

(e) the distinction between the weight and mass of an object, the approximation that the weight of an object of mass 1 kg is 10 N on the surface of the Earth and use data on gravitational field strength in calculations involving weight (W = mg) and gravitational potential energy weight (N) = mass (kg) × gravitational field strength (N/kg)

(f) forces and their effects to explain the behaviour of objects moving through the air, including the concept of terminal speed

Specified practical work
- Investigation of the terminal speed of a falling object

CCEA GCSE Double Award Science

3.5 Physics Unit P1: Motion, Force, Moments, Energy, Density, Kinetic Theory, Radioactivity, Nuclear Fission and Fusion

Force

1.2 Force

Students should be able to:
1.2.1 demonstrate understanding that forces arise between objects, that the forces on these objects are equal and opposite, and that friction is a force that always opposes motion;

1.2.2 demonstrate understanding that:
- force is measured in newtons (N); and
- a force acting in one direction can be given a positive value and one acting in the opposite direction can be given a negative value;

1.2.3 calculate the resultant of two one-dimensional forces using the rule stated in 1.2.2;

Newton's laws

1.2.4 recall that Newton's first law states that in the absence of unbalanced forces an object will continue to move in a straight line at constant speed; and

1.2.5 investigate experimentally Newton's first and second laws, for example using an air track and data logger, or a computer simulation, to study the effect of balanced and unbalanced forces on an object, and through mathematical modelling derive the relationship between resultant force, mass and acceleration.

Mass and weight

Students should be able to:
1.2.6 explain that Newton's second law states that a resultant force will cause an object to accelerate and that the acceleration is proportional to the size of the resultant force;

1.2.7 recall and use the equation:
resultant force = mass x acceleration
or F = m x a

SQA National 5 Physics

Dynamics
Newton's laws

Application of Newton's laws and balanced forces to explain constant velocity (or speed), making reference to frictional forces.

Application of Newton's laws and unbalanced forces to explain and/or determine acceleration for situations where more than one force is acting.

Use of an appropriate relationship to solve problems involving unbalanced force, mass and acceleration for situations where one or more forces are acting in one dimension or at right angles.
$F = ma$

OCR Business GCSE (9-1)

5. Finance

5.3 Revenue, costs, profit and loss

- The concept of revenue, costs and profit and loss in business and their importance in business decision- making
- Calculation of costs and revenue
- Calculation of profit/loss

5.4 Break-even
- The concept of break-even

WJEC GCSE in Business

4.2 Revenue and costs

What is meant by revenue, costs, profit and loss
Calculate and interpret:
- Fixed costs
- Variable costs
- Total costs
- Total revenue
- Profit/loss

What is meant by break-even

4.3 Profit and loss accounts (income statements)

The main components of a profit and loss account
Construct and calculate a profit and loss account
Interpret a profit and loss account
Recommend and justify how to improve profit/reduce costs

CCEA GCSE in Business Studies

Finance

Income statement

prepare an income statement that includes:
- sales revenue;
- cost of sales;
- expenses; and
- gross and net profit and loss;

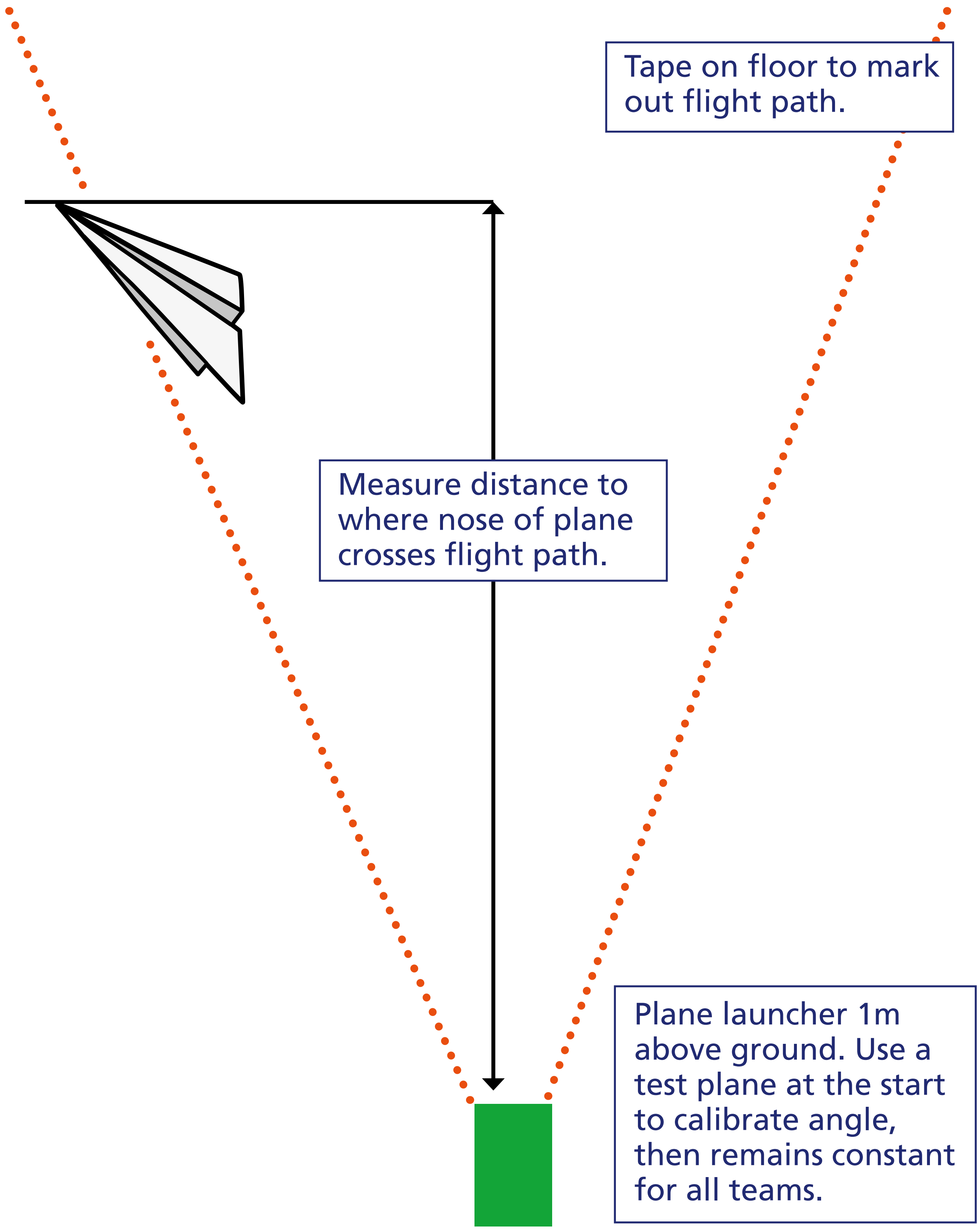
Break-even
distinguish between fixed and variable costs;

SQA National 5 in Business Management

Understanding business
Objectives: Profit, provision of a service, social responsibility, survival, customer satisfaction, market share, and enterprise

Management of finance
Break-even: Types of costs, profit, and break-even point

MARKING OUT THE FLIGHT PATH



MAKE IT FLY ACTIVITY

Background

It may be some time since you made a paper plane. Or you may never have done so! Either way, there's a surprising amount to be learned from this simple task – and the way you conduct the experiment and record your results. Did you know even NASA has instructions on how to fold a plane? **www.grc.nasa.gov/www/k-12/airplane/glidpaper.html**.

In this activity, you'll be making paper aeroplanes and considering aerodynamics (from the Greek word *aerios*, concerning the air, and *dynamis*, meaning force) to investigate what type of paper planes fly the furthest. As the further your plane flies, the more income your plane will generate.

But to make matters more interesting, you'll also need to consider the 'cost' of building your plane. So your challenge is to balance the cost of your materials against the distance your plane travels in the flight challenge to generate a profit of at least £50,000.

OBJECTIVE: Make a paper plane that will generate a profit of at least £50,000.

Your task

Part 1: The theory – What makes a paper plane fly?

▶ What forces are needed to make paper planes fly? What extra force do aircraft need to operate?

▶ The amount of lift can depend on the shape of the plane's wing. Look at the pictures on **page 4** of a glider – what differences do you notice about the wing shapes?

▶ You could also read this article (**boldmethod.com/blog/article/2015/02/your-guide-to-glider-flying/**) about the difference between gliders (the type of plane you're replicating in paper) and jet planes. How do each of these fly? What difference does the shape make to how they fly?

▶ Does size matter? Do bigger gliders fly further?

Part 2: The practical – Let's build some planes!

Have a go at building various designs (you can get some ideas on the Fold N Fly website (**www.foldnfly.com/#/1-1-1-1-1-1-1-1-2**).

The aim is investigate which type of paper plane design flies the furthest.

▶ Think about what might help your paper plane fly. For instance: its shape, the number of folds, its weight, whether it has a tail or not, how it's thrown or launched.

▶ Does making the design more complicated or intricate (e.g. adding more folds) make it fly further?

▶ Can sellotaping folds help it fly better? How can paperclips or bulldog clips help?

▶ What are the best angles to shape the nose? How important is accurate or firm creasing?

Think about drag factors on your plane too. And what about the wings? Generally, gliders have long, thin wings to get more lift. You could calculate the wing aspect ratio.

Wing aspect ratio = wing length (cm) / wing width (cm)

Long, thin wings will have a higher wing aspect ratio than shorter, fatter wings, so you might want to consider this when creating your planes.

Consider giving your plane's wings some extra stability if it's having trouble flying smoothly. You can do this by trimming 1.5cm off each wing, then cutting and folding the ends once more to make new wing tips.

When you're testing your planes, remember to work scientifically to ensure fair conditions for each flight to avoid any bias, such as:

▶ Using the same person to throw the plane each time;

▶ Making sure the conditions are equal each time;

▶ Measuring the length of flight accurately and recording it in the same way; etc.

Part 3: Do your paper planes make at least £50,000 profit?

Remember: this isn't just a challenge to see who can make the paper plane that flies the furthest... You need to think about making at least £50,000 profit from your paper planes, which means thinking about how much they cost to build too.

Here are the key financial factors to consider:

▶ **The minimum profit you need to achieve is £50,000** – So you need to balance the cost of your plane against how far it can fly (see the next point). The ideal scenario is to build a plane which flies the furthest for the lowest cost.

▶ **You receive passenger fees of £1,000 per cm of flight within flight path** – so the further your plane flies, the more money you'll make.

▶ **The more materials you use, the higher your costs will be...** So the further your plane will need to fly to achieve the minimum profit of £50,000!

▶ **The costs are higher in the 'live' flight stage.** So you should think about only making minimal changes to your designs at this stage.

It's now time to review your paper plane designs in light of the costs involved in building them – see below.

Costs for planning and build stage

Material	Cost
Each piece of A4 paper	£10,000
Use of scissors	£5,000
Bulldog clip	£1,000
Paperclip	£1,500
Sellotape (per cm)	£1,000
Each test flight (max of 5)	£2,500

Fill in **Steps 1 & 2 in the Calculations sheet** – the spreadsheet will do the calculations for you! If you created more than four plane designs, you can duplicate the tables in Step 2.

And finally... Before the lesson is up, decide **which two plane designs** you think work best in terms of the time it makes to build them (i.e. simplicity) and the distance it might achieve (i.e. functionality).

Part 4: Get ready for take-off!

Each team can conduct two test flights (using the plane launcher) for each of their paper planes. If you want to log your times, you can create a new table in the **Calculations sheet**. In-between test flights 1 and 2, you can make any modifications to your planes. Be aware, however, that these will incur additional higher costs (see below).

Costs for live stage

Material	Cost
Each piece of A4 paper	£50,000
Use of scissors	£10,000
Bulldog clip	£5,000
Paperclip	£8,000
Sellotape (per cm)	£2,000
Each test flight (max of 5)	£10,000

Fill in the table on **Step 3 of the Calculations sheet** IF you make any changes to their design that require new materials. Remember: you only pay for NEW materials at this stage, so DON'T repeat your costs from Step 2 otherwise you'll be paying twice!

Once you're happy with your two designs, complete **Step 4 of the Calculations sheet** to calculate the final build cost for both models.

Part 5: The official flight

The rules:

- Your plane must stay within the flight path otherwise it will be disqualified.
- You must not fly your plane until your teacher tells you to do so, to avoid injury.
- You will fly your two models FIVE times each.

Record your flight distance – as agreed by the neutral party recording the results! – in **Step 5 of your Calculations sheet**. Fill in the tables for both models and the averages will be calculated automatically.

It's crunch time! Work out **Step 6 in the Calculations sheet** to calculate your profit (or loss!) from each plane. Consider the following:

- Did you achieve the minimum profit of £50,000?
- If you didn't, how many additional passengers (i.e. how many extra cms) would your plane need to travel to make £50,000 profit?

Wrap up

What did you discover? Were you surprised by the designs of the most profitable planes? Would you do anything differently next time? For instance, spend more/less on materials?

Homework

There is an **urban myth** that no plane company in the history of aviation has been able to make a profit. Look at the table below and work out whether a profit can be made – and, if so, how much could it be?

Note: the average ticket price is £55.22 and there are, on average, 154 passengers per flight.

Can you imagine any way that the airline could increase its profit without increasing the cost of the ticket? Would that compromise safety?

Rough costs per customer of running an average flight[1]

Outlay	Amount allocated per ticket
Plane insurance	£0.17
Crew salaries (1 pilot, 4 cabin attendants)	£1.03
Fuel	£1.72
Cost of running the airline	£6.90
Paying off price of plane	£7.93
Airport costs (landing fees, etc)	£9.32
Aircraft maintenance fees	£9.66
Taxes and charges	£10.77

Source: www.telegraph.co.uk/travel/travel-truths/what-airlines-really-spend-your-airfare-money-on/


1. Glider


2. Jet plane

INSPIRE

MAKE IT FLY LEADERBOARD

Team name	Distance (cm)	Profit (£)

EDF ENERGY

HINKLEY POINT C

CGN