iFLY Education Program Teacher Guide
Grades 11-12

Program focus

The High School Education Program at iFLY uses iFLY's unique vertical wind tunnel facility to make STEM exciting, relevant, and accessible to students. Our curriculum has been designed by STEM educators and scientists to support STEM learning in your classroom. Every iFLY field trip includes:

- Interactive STEM presentation, delivered by iFLY STEM Educator
- Physics demonstration in the wind tunnel
- Classroom experiment to investigate the effects of parachute parameters on flight performance
- Flying instruction & safety training
- Flying time, with one-on-one supervision from a highly trained and certified instructor
- Pre and post-field trip activities to conduct in your classroom

Learning objectives

- Increasing awareness of exciting STEM careers
- Learning how STEM is used in the real-world
- Drawing and interpreting free-body force diagrams
- Understanding the nature of fluids and how they exert forces on solid objects
- Deriving equations to represent physical phenomena
- Applying engineering principles to think about tunnel design, energy efficiency, and safety factors
- Understanding variability, uncertainty, and error in experimental results

Program synopsis

Lecture and Demonstration

The program begins with a lecture and discussion with iFLY STEM Educators to introduce STEM concepts related to the wind tunnel. Students will discuss basic ideas of fluid dynamics and learn how fluids exert pressure forces on objects. The STEM Educator will discuss the different forces at work in the wind tunnel, and how changing the shape or "frontal area" of an object will affect its speed in the wind tunnel. The STEM Educator will lead students through an exercise to derive the equation for "terminal velocity" (the air velocity required to "fly" the object). Educators will also introduce engineering careers and how engineers use wind tunnels to test their designs.

The wind tunnel demonstration segment uses various objects such as inflatable balls to show how the terminal velocity depends on an object's size, shape, and weight.

Classroom Experiment

Students move into a classroom and break into 2's and 3's to conduct an experiment. The goal is for each student to predict his/her own terminal velocity in the wind tunnel. In other words, how fast must the air in the wind tunnel move to make each student "float"? The students will use algebraic reasoning to solve the air drag equation for "v". The groups will then use measuring tapes and scales to determine their weight and frontal area.

During their flights, an instructor will be recording their actual terminal velocities. Afterwards, the students will compare their actual velocities to their predicted values. The Educator will lead them through a discussion of error and the class will brainstorm possible reasons for the error. If time is running short, the classroom teacher will be given all the materials necessary to conduct this discussion back at school.

Flight Experience

All students are given flight instruction by a certified flight instructor, including an individual flight experience in the iFLY tunnel.

Grade level appropriateness

Our curriculum has been specifically designed to support the following standards:

	Science Understanding	SAAHE	*Science inquiry skills*
Unit 2: Linear motion and force	*Isaac Newton's interest in how objects fall and the orbits of planets led to the writing and publication of Principia Mathematica, which outlined the Laws of Motion. Newton's laws provided an explanation for a range of previously unexplained physical phenomena and were confirmed by multiple experiments performed by a multitude of scientists (ACSPH053)* Newton's laws of motion enable scientists to make reliable predictions, except when considering objects travelling at or near the speed of light, or very small objects like atoms or subatomic particles, or when very strong gravitational fields are involved (ACSPH058) Uniformly accelerated motion is described in terms of relationships between measurable scalar and vector quantities, including displacement, speed, velocity and acceleration (ACSPH060) Vertical motion is analysed by assuming the acceleration due to gravity is constant near Earth's surface (ACSPH062) Newton's Three Laws of Motion describe the relationship between the force or forces acting on an object, modelled as a point mass, and the motion of the object due to the application of the force or forces (ACSPH063)	Advances in science understanding in one field can influence other areas of science, technology and engineering (ACSPH055) Scientific knowledge can enable scientists to offer valid explanations and make reliable predictions (ACSPH058)	Identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes (ACSPH045) Conduct investigations, including the manipulation of devices to measure motion and the direction of light rays, safely, competently and methodically for the collection of valid and reliable data (ACSPH047) Represent data in meaningful and useful ways, including using appropriate SI units and symbols; organise and analyse data to identify trends, patterns and relationships; identify sources of random and systematic error and estimate their effect on measurement results; identify anomalous data and calculate the measurement discrepancy between the experimental results and a currently accepted value, expressed as a percentage; and select, synthesise and use evidence to make and justify conclusions (ACSPH048)
Unit 3: Gravity and electromagnetism	The movement of free-falling bodies in Earth's gravitational field is predictable (ACSPH093) Objects with mass produce a gravitational field in the space that surrounds them; field theory attributes the gravitational force on an object to the presence of a gravitational field (ACSPH095) When a mass moves or is moved from one point to another in a gravitational field and its potential energy changes, work is done on or by the field (ACSPH096) Gravitational field strength is defined as the net force per unit mass at a particular point in the field (ACSPH097)	ICT and other technologies have dramatically increased the size, accuracy and geographic and temporal scope of datasets with which scientists work (ACSPH086)	Identify, research and construct questions for investigation; propose hypotheses; and predict possible outcomes (ACSPH078) Represent data in meaningful and useful ways, including using appropriate SI units, symbols and significant figures; organise and analyse data to identify trends, patterns and relationships; identify sources of uncertainty and techniques to minimise these uncertainties; utilise uncertainty and percentage uncertainty to determine the uncertainty in the result of calculations, and evaluate the impact of measurement uncertainty on experimental results; and select, synthesise and use evidence to make and justify conclusions (ACSPH081) Select, construct and use appropriate representations, including text and graphic representations of empirical and theoretical relationships, vector diagrams, free body/force diagrams, field diagrams and circuit diagrams, to communicate conceptual understanding, solve problems and make predictions (ACSPH083)

Making the most of your field trip

1. Deliver the “Pre-Field Trip” slides found on our website to your students. This presentation will show students what to expect when they arrive at the wind tunnel. It will also introduce some of the vocabulary and STEM concepts we will cover in the field trip. There is even a “script” that you can read word-for-word to your students. No preparation necessary!

2. If you have questions before, during, or after your field trip, please do not hesitate to contact iFLY STEM Educator. We are happy to answer any questions that will make your students’ better!

3. Arrive on time. Students’ flight times are prescheduled and cannot be rearranged. Arriving promptly will ensure that your students do not miss any portions of their education experience.

4. During the classroom activity, the STEM Educator may ask for your assistance to help students with certain portions of their investigation. Please encourage any other field trip teachers or chaperones to jump in and lend a hand!

5. Help us improve and strengthen our program by completing the Teacher Survey. We value your feedback!

6. Please visit our website for post field trip activities. Having a follow-up discussion or activity with your students after the field trip will help support the concepts they learned during their visit.