Education Program *Grades 6-8*

iFLY's unique vertical wind tunnel provides the perfect environment to show students how exciting STEM can be! Our Education Program has been designed by professional educators to support and enhance 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 that compares students' predicted and measured wind tunnel speeds
- 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
- Photos and videos for the students to keep

"…all I can say is ***WOW!*** Best field trip in 18 years of teaching. My students couldn't stop talking about it today!"

– Raine Maggio, Austin teacher

Education Program *Grades 6-8*

iFLY field trips make STEM relevant, interesting and accessible for your students.

Our Learning Objectives include:

- Increasing awareness of exciting STEM careers
- Learning how STEM is used in the real-world
- Understanding the nature of fluids and how they exert forces on solid objects
- Using algebraic thinking to understand proportional relationships
- Using decimal, scientific notation, and unit conversions to do calculations
- Graphing and interpreting results
- Understanding variability, uncertainty, and error in experimental results

All iFLY field trips support the following standards:
Common Core Mathematics: 6.RP.A.3.B; 6.NS.B.3; 6.EE.A.1-3; 6.EE.B.6-7; 6.SP.B.5.D; 7.EE.B.3-4; 8.EE.A.2; 8.EE.C.7

NGSS: MS-PS2-2; MS-ETS1-1; MS-ETS1-3

iFLY Education Program
Teacher Guide
Grades 6-8

Program focus

The Middle 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
- Photos and videos for the students to keep

Learning objectives

- Increasing awareness of exciting STEM careers
- Learning how STEM is used in the real-world
- Understanding the nature of fluids and how they exert forces on solid objects
- Using algebraic thinking to understand proportional relationships
- Using decimal, scientific notation, and unit conversions to do calculations
- Graphing and interpreting results
- 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 the differences between solids and fluids. They will identify air as a fluid and learn that air can exert a force 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. 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" (the air velocity required to "fly" the

object) depends on an object's size, shape, and weight. Students will predict which balls fly at the fastest speeds, then see if their predictions were correct.

Classroom Experiment
Students move into a classroom and break into 2's and 3's to carry out an investigation. Students use scales and measuring tapes to measure the masses and surface areas of the demonstration balls using SI units. iFLY Educators help the students create an Excel graph of the relationships between mass, frontal area, and velocity. The class analyzes the data together, then uses it to make connections to other applications of wind tunnel testing.

Modification for advanced students: Each student will 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:

TEKS:
Math: 6.1, 6.3D-E, 6.4B, 6.4E, 6.5A, 6.6C, 6.8D, 6.9A, 7.1, 7.3, 7.4D, 7.4E, 7.6H, 7.9B, 7.11A, 8.1, 8.7B, 8.8C, 8.11A
Science: 6.2A-C, 6.2E, 6.3A, 6.4A, 6.8B-D, 7.2A-C, 7.2E, 7.3A, 7.4A, 7.7C, 8.2A-E, 8.3A, 8.4A, 8.6

Common Core Mathematics: 6.RP.A.3.B; 6.NS.B.3; 6.EE.A.1-3; 6.EE.B.6-7; 6.SP.B.5.D; 7.EE.B.3-4; 8.EE.A.2; 8.EE.C.7

NGSS: MS-PS2-2; MS-ETS1-1; MS-ETS1-3

Making the most of your field trip

1. Deliver the “Pre Field Trip” pdf slides to your students *(This is also available in .pptx format. Contact us and we can email you this file)*. 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. At the end of the slides, you will find a page containing 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 staff. 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 parents and other field trip chaperones to jump in and lend a hand!
5. Please help us improve and strengthen our program by completing the Teacher Survey. We value your feedback!
6. You will receive materials and suggested activities to complete back in the classroom. Having a follow-up discussion or activity with your students after the field trip will help support the concepts they learned during their visit.

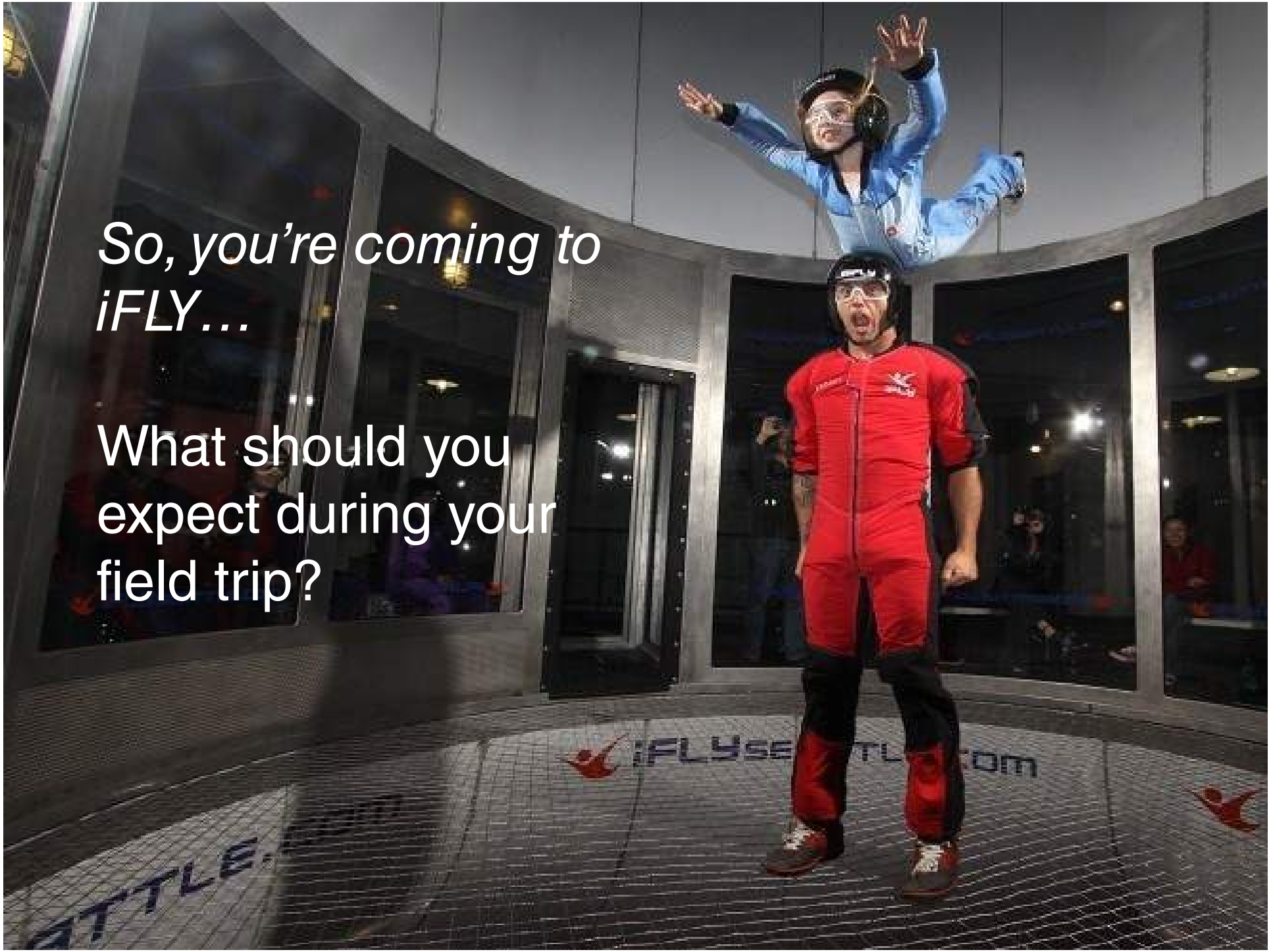
iFLY Education Program

Middle School Standards Alignment

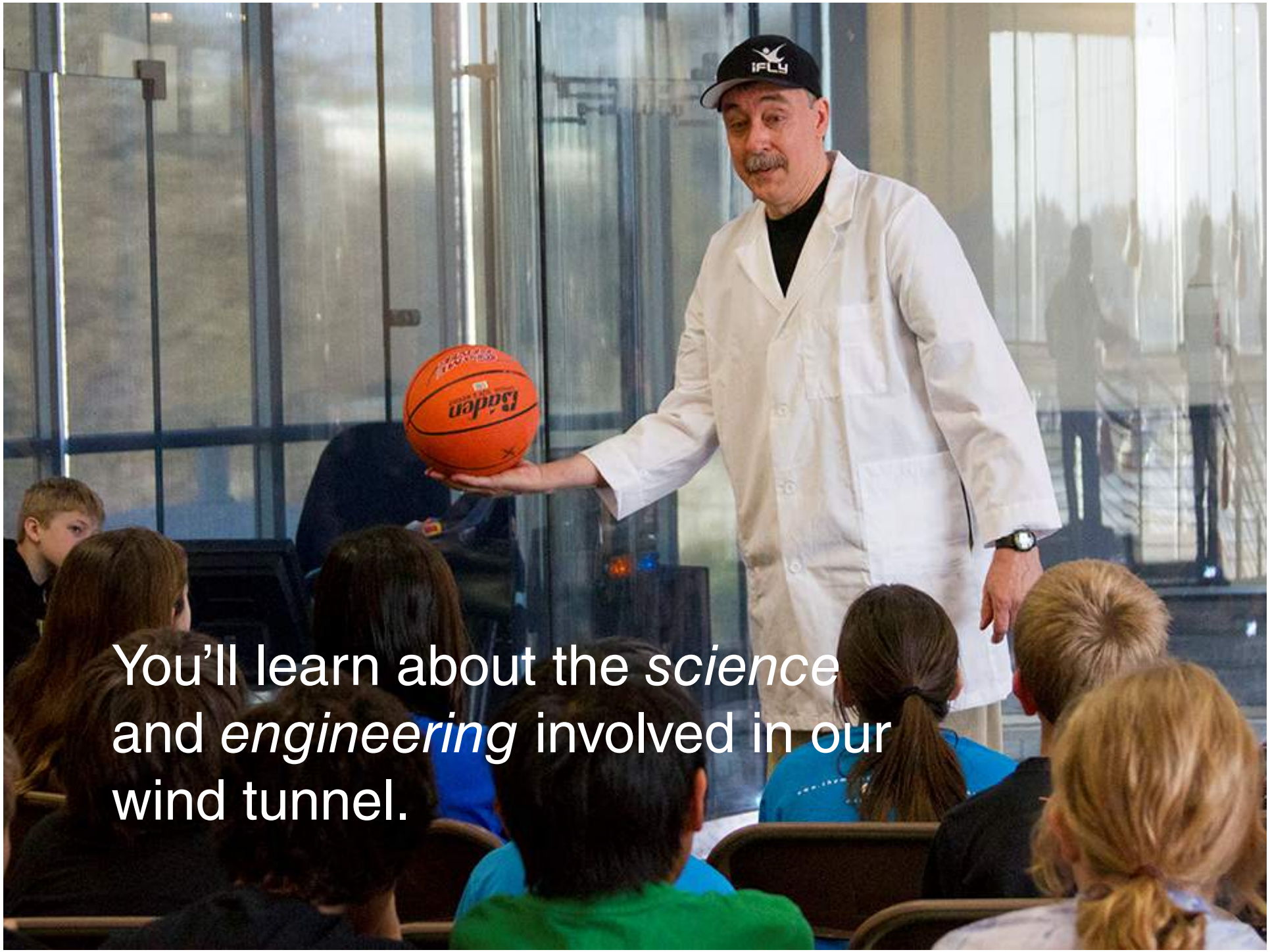
Field Trip Activity	Standard
Interactive Presentation: • Students use the pitot-static tubes in the wind tunnel to observe and record the velocities of different objects in the wind tunnel. • Use a free body diagram of a skydiver to discuss the forces acting on his/her body • Discuss that when forces are balanced (net force = 0), acceleration is zero, and a skydiver achieves "terminal velocity" • Discuss the differences between objects falling through air vs. a vacuum. Conclude that in a vacuum, mass has no effect on acceleration or velocity. • Discuss the difference in frames of reference between the wind tunnel and skydiving, i.e, in the wind tunnel the flyer is still and the air is moving, while in free flight the air is still and the skydiver is moving • Identify when the gravitational force or the force of air drag is dominant. Discuss the effect this has on a skydiver's velocity and acceleration. • Discuss that when forces are balanced (net force = 0), acceleration is zero, and a skydiver achieves "terminal velocity". • Discuss the differences between objects falling through air vs. a vacuum. Conclude that in a vacuum, mass has no effect on acceleration or velocity. • Educator leads a discussion about engineering careers, the engineering process as applied to the design of iFLY tunnels, and other applications of wind tunnels in STEM	<u>Science TEKS:</u> 6.8B-D 7.7C 8.6 <u>Next Generation Science Standards:</u> HS-PS2-1
LAB ACTIVITY • Students break into small groups and brainstorm ways to measure the variables required for solving the lab activity • Students measure the mass and circumference of various objects using scales and tape measures. They use geometric formulas to calculate surface area. All calculations are made using SI units. • Students use Microsoft Excel to create class graphs depicting the relationship between mass, surface area, and velocity. • The educator leads the class through an analysis of the scatter plots, asking students to interpret the shapes of the plots and determine if a relationship exists between the variables and whether or not there is a linear relationship • The class makes connections between the lab activity and the activities of professional scientists and	<u>Science TEKS:</u> 6.2A-C,E, 6.3A, 6.4A 7.2A,B,C,E, 7.3A, 7.4A 8.2A-E, 8.3A, 8.4A <u>Math TEKS:</u> 6.1, 6.3D,E, 6.4B,E, 6.5A, 6.6C, 6.8D 7.1, 7.3, 7.4D,E, 7.6H, 7.9B 8.1, 8.7B, 8.8C, 8.11A <u>Next Generation Science Standards:</u> MS-PS2-2 MS-ETS1-1

engineers	<u>Common Core Mathematics:</u> 6.NS.B.3 6.EE.A.1-3 6.EE.B.6-7 7.EE.B.3-4
Post-field trip classroom activity • Students measure their mass and surface area to calculate their predicted terminal velocity in the wind tunnel. • Students compare their predicted velocities to known velocities of other people and objects and determine if they have arrived at a reasonable solution. • Students brainstorm possible reasons for error in their theoretical values.	<u>Science TEKS:</u> 6.2A-C,E, 6.3A, 6.4A 7.2A,B,C,E, 7.3A, 7.4A 8.2A-E, 8.4A <u>Math TEKS:</u> 6.1, 6.3D,E, 6.4B,E, 6.5A, 6.6C, 6.8D, 6.9A 7.1, 7.3, 7.4D,E, 7.6H, 7.9B, 7.11A 8.1, 8.7B, 8.8C <u>Next Generation Science Standards:</u> MS-ETS1-3 <u>Common Core Mathematics:</u> 6.RP.A.3.B 6.NS.B.3 6.EE.A.1-3 6.EE.B.6-7 6.SP.B.5.D 7.EE.B.3-4 8.EE.A.2 8.EE.C.7

iFLY pre-Field Trip Introduction

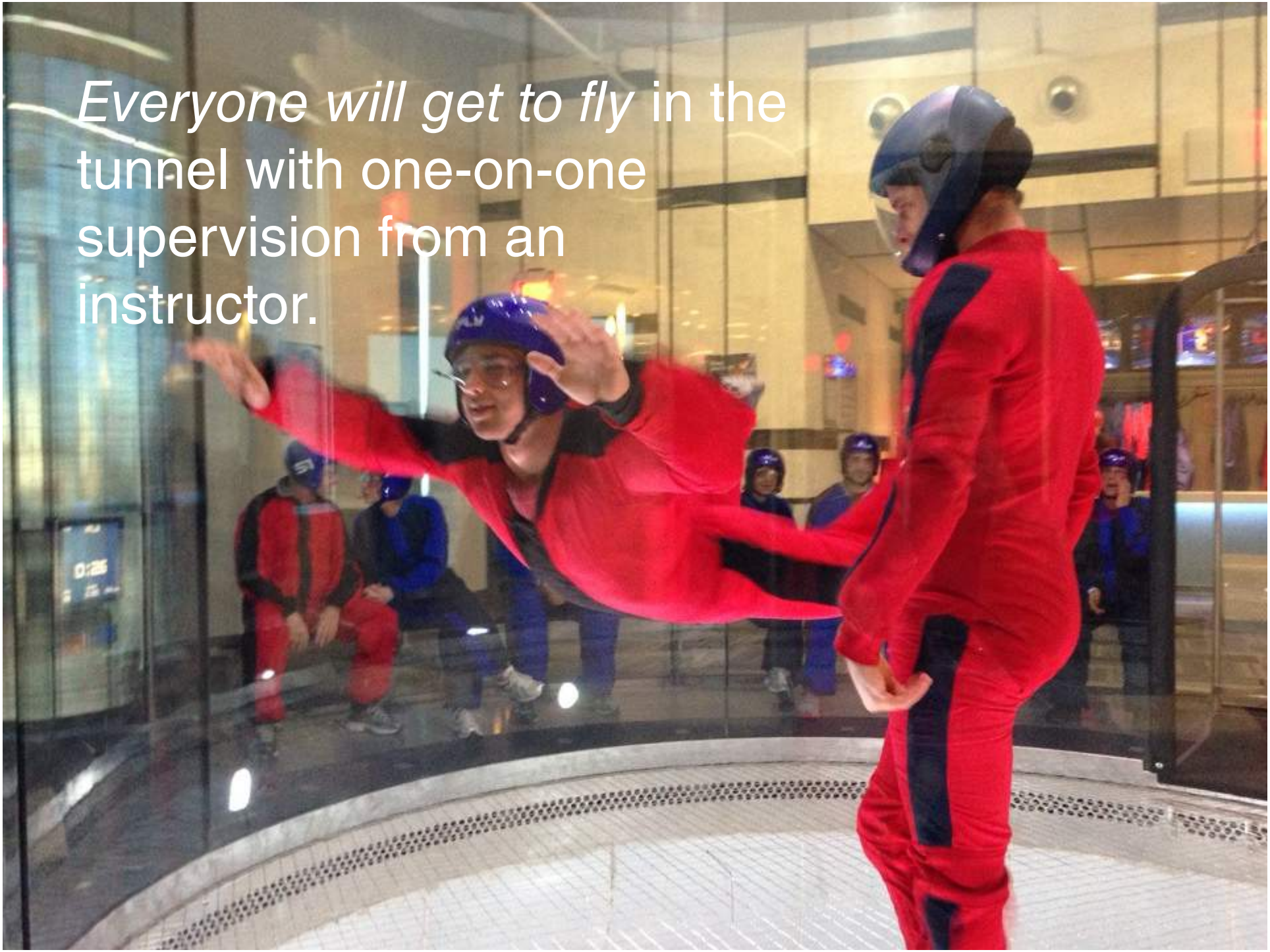

So, you're coming to iFLY…

What should you expect during your field trip?


You'll learn about the *science* and *engineering* involved in our wind tunnel.

You'll make measurements and do calculations to see if you can predict how fast the wind has to blow for you to "fly" in the tunnel.

Our certified flight instructors will lead you through flight and safety training.


Everyone will get to fly in the tunnel with one-on-one supervision from an instructor.

Here are a few things to think about before your field trip:

What are the differences between *solids* and *fluids*?

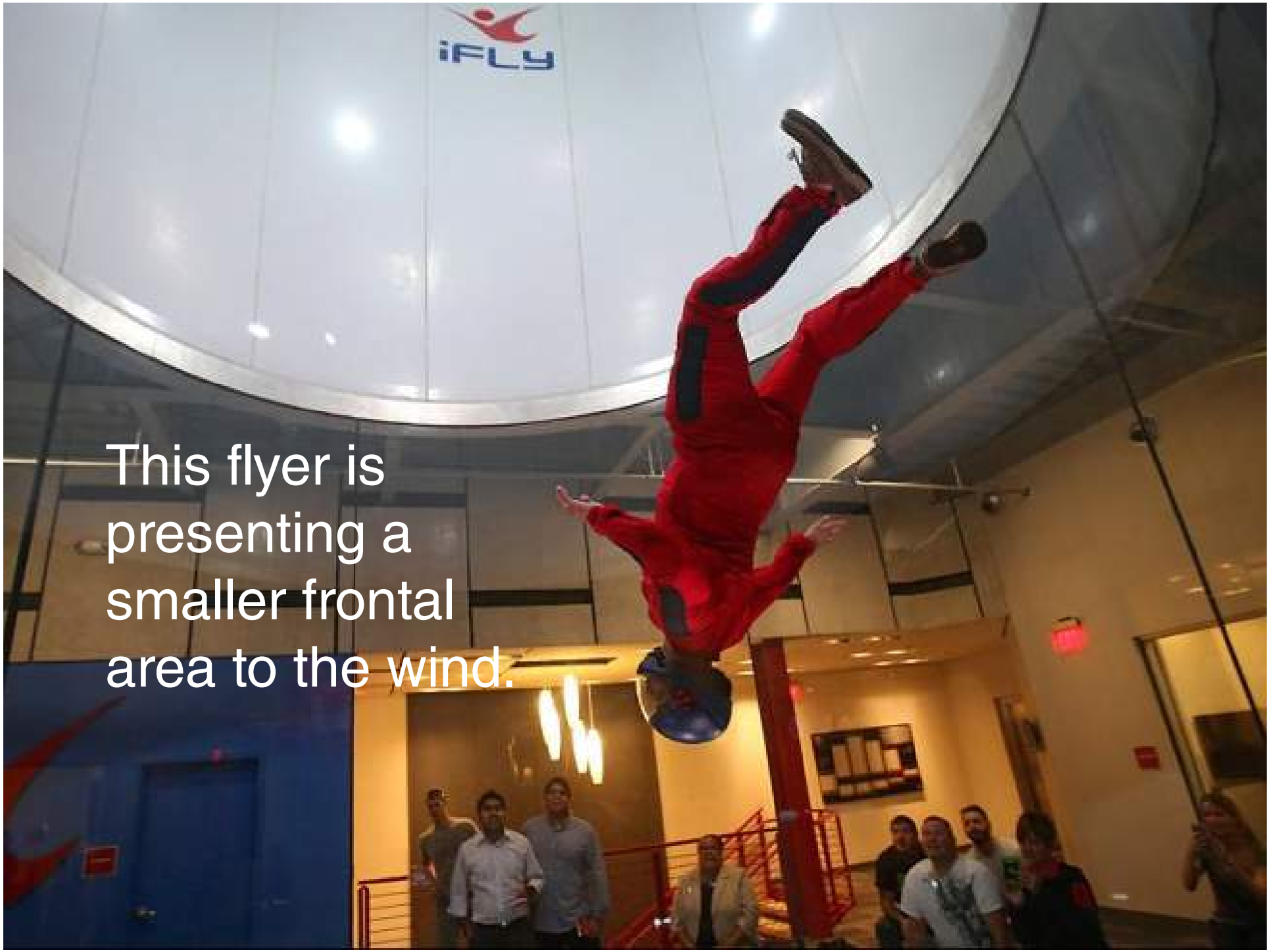
What are some examples of each?


What *forces* are at work on your body when you're flying in the wind tunnel?

You'll learn about the term **frontal area.** This is the part of an object's surface area that the wind "sees".

Changing your frontal area in the wind tunnel will change how you fly.

This flyer is presenting a large frontal area to the wind.


iFLY
This flyer is presenting a smaller frontal area to the wind.

How would you find the *frontal area* of the basketball?

How is it different from the *surface area* of the entire basketball?


Now, think about what
questions you have
for *us!*

See you soon!

iFLY Pre-Field Trip Presentation script for teachers

1. *Title Slide*
2. Are you excited to visit iFLY? First, let's go over what to expect during your field trip.
3. You'll start off by sitting in front of our state-of-the-art wind tunnel. One of iFLY's science educators will give a brief introduction to the science and engineering concepts involved in the wind tunnel. They'll do a demonstration of how some everyday objects behave in the tunnel. Then a flight instructor will show you how they use fluid dynamics to do their expert moves. Prepare to see some cool tricks!
4. Our class will head to our "lab" to do an activity. Each object flies at a different velocity, or speed, in the wind tunnel. You and your team will measure some different objects and try to predict how fast each object will fly in the tunnel.
5. Highly-trained flight instructors will lead you through a flight and safety training. You'll learn all the basics that will allow you to have a safe and enjoyable flight. Next, it's time to gear up and get ready to fly.
6. Every student will have the chance to fly in the wind tunnel! Your flight instructor will stay right there with you to make sure you're safe and having the best flight possible. You'll be experiencing all the physics for yourself!
7. Here are a few STEM concepts to think about before you come…
8. *Read students the questions on this slide. The answers are given here:* Solids have a definite shape and volume. When you apply a force to a solid, it may change its volume, but usually only by a small amount. Examples of solids in this photo: the glass, the table, the ice cubes. Fluids don't have a definite shape….they take on whatever shape they are contained in. When you apply a force on a fluid it flows around the solid. Fluids may be liquid or gaseous. Examples of fluids in this photo: the air, the soda, the gas bubbles trapped in the soda.
9. *Read students the questions on this slide. The answers are given here:* The two main forces we are concerned with in the wind tunnel are GRAVITY and AIR DRAG. Gravity is the force pulling you down to earth. Drag is the force the moving air exerts on your body. Your size, shape, and the way you hold your body will affect your drag force.
10. In the demonstration portion of the field trip, you'll be learning about frontal area. This is different from the surface area.
11. A flyer can increase their frontal area by spreading out their bodies.
12. Leave this trick to the experts! This flight instructor has decreased his frontal area by pointing his body straight down.
13. Here's a quick activity to make sure you understand the difference between frontal area and total surface area. The frontal area of the basketball is (pi*r^2), where r is the radius of the basketball (This is also the area of a circle with radius, r). The surface area of the entire basketball is (4*pi*r^2).
14. What questions do you have about your upcoming field trip? What are you curious about? What do you wonder? Jot these down and the iFLY educators will do their best to answer them when you come!