High Altitude Inspiration

Pages 1-4 High Altitude Inspiration with Major Jay Park

Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per student	Calculators
10-25	Stopwatch
10	Thermometers
10	Meter Sticks or measuring tape/wheel
2	Wooden blocks
10	Pieces of 100 m string
20	Plastic cups
	Masking tape
Per student	Scissors

Pages 5-8 High Altitude Inspiration with Captain Barrington Irving

Watch the Video Here

Materials Required for This Lesson/Activity	
Quantity	**Description**
Per group	Cardboard boxes
Per group	Cardboard tubes
Per group	Foam sheets
Per group	Foam trays
Per group	Foil
Per group	Cardstock
2 boxes	Paperclips
1 box	Rubber bands
4 boxes	Popsicle sticks
1 pack of 10 per group	Balsa wood

Per group	Glue
1 per group	Scissors
	Making tape
1 per group	Ruler
6 per group	Plastic cups
5 pieces per group of 5	string

High Altitude Inspiration: Major Jay Park

Grade/ Grade Band 6-12	**Topic:** Energy	
Brief Lesson Description: In High Altitude Inspiration, Major Jay Park shares his experience of flying at Mach 1 and Mach 1.2 and breaking the sound barrier. In this lesson, students will examine the speed of sound.		
Performance Expectation(s): **MS-PS4-2 Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.** **HS-PS3-3 Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.**		
Specific Learning Outcomes: Students will be able to calculate the speed of sound. Students will illustrate what happens during a sonic boom.		
Narrative / Background Information		
Prior Student Knowledge: Students should be able to calculate speed. Students should be able to define energy and describe how it can manifest as motion, sound, light, and thermal energy.		
Science & Engineering Practices: **Developing and Using Models** Modeling in 6-8 builds on K-5 and progresses to developing, using, and revising models to describe, text, and predict more abstract phenomena and design systems. ● Develop and use a model to describe phenomena. (MS-PS4-2) **Constructing Explanations and Designing Solutions** Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories. ● Design, evaluate, and/or refine a solution to a complex real-world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. (HS-PS3-3)	**Disciplinary Core Ideas:** **PS4.A: Wave Properties** ● A sound wave needs a medium through which it is transmitted. (MS-PS4-2) **PS3.D: Energy in Chemical Processes** ● Although energy cannot be destroyed, it can be converted to less useful forms—for example, to thermal energy in the surrounding environment. (HS-PS3-3) **ETS1.A: Defining and Delimiting an Engineering Problem** ● Criteria and constraints also include satisfying any requirements set by society, such as taking issues of risk mitigation into account, and they should be quantified to the extent possible and stated in such a way that one can tell if a given design meets them. (HS-PS3-3)	**Crosscutting Concepts:** **Structure and Function** ● Structures can be designed to serve particular functions by taking into account properties of different materials, and how materials can be shaped and used. (MS-PS4-2) **Energy and Matter** ● Changes of energy and matter in a system can be described in terms of energy and matter flows into, out of, and within that system. (HS-PS3-3) **Influence of Science, Engineering and Technology on Society and the Natural World** ● Modern civilization depends on major technological systems. Engineers continuously modify these technological systems by applying scientific knowledge and engineering design practices to increase benefits while decreasing costs and risks. (HS-PS3-3)
Possible Preconceptions/Misconceptions: Students may believe that sound travels only to the person who hears it. Sound waves actually travel from the source in all directions like a 3-D sphere.		
LESSON PLAN – 5-E Model		
ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions: Begin the lesson showing the High Altitude Inspiration video. Ask students to record 3 interesting facts about Major Jay Park. After viewing the video, students will discuss in pairs the facts they noted and explain why the facts interest them.		

Then write the term **sound** on the board. Ask students to brainstorm what they know about sound. Record their responses.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Prior to the lesson collect the following materials:

- Stopwatch (10-25)
- Thermometers (10)
- 10 meter sticks or measuring tape/wheel
- 2 wooden blocks
- 10 pieces of 100 m string
- 20 plastic cups
- Masking tape
- Scissors
- Calculators
- Find an outdoor space to measure 100 meters (i.e., your football field)

Students are going to calculate the speed of sound (343 m / s). Take the class outside to the field. Students measure off 100 meters. Have 1 student stand at one end of the field (origin) with the two blocks they will clap together. Give 9 students a thermometer and a stopwatch. These students will stand 10 meters apart (at the 10m, 20m, 30m, etc. marks); they will record the temperature for each trial when they hear the clap sound and record in Table A. Give the remaining students a stopwatch and stand them 100 meters away from the student with the blocks (origin). Students will start the stopwatch when they see the blocks touch (clapped together) and stop the stopwatch when they hear the clap sound. Record in Table B.2. Repeat trials 5-10 times.

Table A (to track temperature only)

Trial	Distance (m)	Time (s)	Temperature (°C)

Table B.1 (Temperature measured)

Trial	Temp (°C) @ 10m	Temp (°C) @ 20m	Temp (°C) @ 30m	Temp (°C) @ 40m	Temp (°C) @ 50m	Temp (°C) @ 60m	Temp (°C) @ 70m	Temp (°C) @ 80m	Temp (°C) @ 90m	Average

Trial	Student 1 Time	Student 2 Time	Student 3 Time	Student 4 Time (s)	Student 5 Time (s)	Student 6 Time (s)	Student 7 Time (s)	Student 8 Time (s)	Student 9 Time (s)	Average

Table B.2 (Time measured)

After collecting data, students will average their results and share with their classmates in Table C. Then they will calculate the speed.

Table C

Trial	Distance (m)	Averaged Time (s)	Speed (m/s)	Temperature (°C) (averaged)
	100m			
	100m			
	100m			
	100m			
	100m			

Note: the timing will be very short, hence multiple students collecting data which will be averaged before using to calculate speed; also, students standing at the 100 meter mark are spread out to illustrate that sounds travel in waves.

EXPLAIN: Concepts Explained and Vocabulary Defined:

Sound is a form of energy that travels in the form of vibrations through the air or any other medium. The speed of sound is the measure of the distance traveled per unit of time by a sound wave. At 20°C (68°F) the speed of sound is 343 m/s. Ask students, "how close were their calculations for the speed of sound?", "were there any differences based on where you were standing to collect the measurements?", "do you think the sound changed?", and "what are possible sources for any error?". (Possible errors: human error when measuring time, temperature fluctuations, human error when measuring distance, clapping blocks at different forces). You want to emphasize that sound travels in waves from the source through whatever medium.

Explain to students that Major Park shared he had traveled faster than the speed of sound and that traveling at that speed causes a loud explosive noise known as the sonic boom. Show this video clip from NASA explaining the sonic boom and how engineers are designing new aircrafts to eliminate the noise.

Vocabulary:

Sound - is a vibration that propagates as an acoustic wave, through a transmission medium such as a gas, liquid or solid

Sonic Boom - a loud explosive noise caused by the shock wave from an aircraft or other object traveling faster than the speed of sound

ELABORATE: Applications and Extensions:

Prior to starting the elaboration section of this lesson, you will need to gather the following materials (per group): 100 m string, 2 plastic cups (with a hole poked in the middle of the bottom), 4 pieces of masking tape, a stopwatch, and calculator

Students are going to assemble their own "telephone" by inserting the one end of the string in the bottom of each cup and securing it with the tape.

Students are going to repeat the experiment of calculating the speed of sound using their "telephone". Student A will hold their cup to their mouth and speak into it when Student B signals and starts their stopwatch. Student B will stop the stopwatch when they hear the sound Student A spoke into the cup. Students should repeat this experiment for at least 5 trials and then calculate the speed.

Trial	Distance (m)	Time (s)	Speed (m/s)
	100m		
	100m		
	100m		
	100m		
	100m		

Ask students, "how close were their calculations to their calculated speed of sound?" in the previous activity, "how close were their calculations to the actual speed of sound?" and "what are possible sources for any errors?". Students then create an illustration of how the sound traveled from the origin to the receiver based on the 2 investigations.
EVALUATE: **Formative Monitoring (Questioning / Discussion):** Students will demonstrate their understanding based on their calculations of speed (distance ÷ time) and the source of errors. **Summative Assessment (Quiz / Project / Report):** Students create illustrations of how sound travels as waves radiating from the origin source.
Elaborate Further / Reflect: Enrichment: Students create a model of a sonic boom and explain the difference between what happens to the sound waves during the sonic boom and their sound investigations**.**
SOCIAL EMOTIONAL LEARNING ACTIVITY
CASEL Competency: Self-Awareness During Major Jay Park's presentation, he discusses his personal and cultural assets that led him to become who he is. Self-awareness is the ability to understand one's own emotions, thoughts, and values and how they influence behavior across contexts. In this activity, students will recognize their strengths and limitations with a well-grounded sense of confidence and purpose. Begin this activity with students writing for 3 mins: "Who are you? What do you want the world to say about you?" Next share the video: Teen Voice: Who Are You on Social Media? from commonsense.org. Ask students the following questions: 1. Whose perspectives stand out and why? 2. Which perspectives do you agree/disagree with and why? 3. How do you curate your life on social media? 4. Does your social media tell the same story about you that you wrote about at the beginning of class? Why or why not? Allow time for the discussion to develop so most students share personal experiences and make a connection between who they are, who they show on social media, and who they want to be. Next step is a skills dump where the students brainstorm a list of their skills (academic, social, soft, personal) they use to complete a task. After creating the list of skills, students revisit the story they wrote at the start, compare to their list of skills, and re-write their story to include their strengths and areas of development to build onto their limitations.
INTERDISCIPLINARY CONNECTIONS/IDEAS
During this lesson students are calculating speed using the equation s=d/t, math common core standard 8.EE.B.5: ***Graph proportional relationships, interpreting the unit rate as the slope of the graph. Compare two different proportional relationships represented in different ways.***

Materials Required for This Lesson/Activity

Quantity	Description
Per student	Calculators
10-25	Stopwatch
10	Thermometers
10	Meter Sticks or measuring tape/wheel
2	Wooden blocks
10	Pieces of 100 m string
20	Plastic cups
	Masking tape
Per student	Scissors

High Altitude Inspiration: Barrington Irving (TPT Science of Flight)

Grade/ Grade Band 6-8	**Topic:** Design Engineering	
Brief Lesson Description: Captain Barrington Irving actually built the airplane he flew around the world. In this lesson, students explore how flight is possible and how engineers have improved aircraft designs and materials to improve flight accuracy and distance. Students explore the forces that make flight possible and learn about how material choice and shape impact flight. Student teams will design and test a simple glider using basic materials that can fly straight for 4.5 meters.		
Performance Expectation(s): **MS-ETS1-3 Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success** **MS-PS2-2 Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object**		
Specific Learning Outcomes: Students will be able to design, test, and revise a device that glides through the air.		
Narrative / Background Information		
Prior Student Knowledge: Students should be able to explain Newton's Laws of Motion Students should be able to explain the forces that impact flight		
Science & Engineering Practices: **Analyzing and Interpreting Data** Analyzing data in 6–8 builds on K–5 experiences and progresses to extending quantitative analysis to investigations, distinguishing between correlation and causation, and basic statistical techniques of data and error analysis. ● Analyze and interpret data to determine similarities and differences in findings. **Planning and Carrying Out Investigations** Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions. ● Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how much data is needed to support a claim. (MS-PS2-2)	**Disciplinary Core Ideas:** **ETS1.B: Developing Possible Solutions** ● There are systematic processes for evaluating solutions with respect to how well they meet the criteria and constraints of a problem. ● Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. (MS-ETS1-3) **ETS1.C: Optimizing the Design Solution** ● Although one design may not perform the best across all tests, identifying the characteristics of the design that performed the best in each test can provide useful information for the redesign process—that is, some of those characteristics may be incorporated into the new design. (MS-ETS1-3) **PS2.A: Forces and Motion** ● The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2-2) ● All positions of objects and the directions of forces and motions must be described in an arbitrarily	**Crosscutting Concepts:** **Stability and Change** ● Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales. (MS-PS2-2)

	chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared. (MS-PS2-2)	

Possible Preconceptions/Misconceptions:
One misconception that students may hold is that heavier objects fall faster than lighter ones. In this experiment, students should understand that objects move downward with the same acceleration and there is another force, air resistance, acting on objects that is proportional to the area of the object.

LESSON PLAN – 5-E Model

ENGAGE: Opening Activity – Access Prior Learning / Stimulate Interest / Generate Questions:

Begin this lesson with a few questions to spark student interest: “would you like to participate in a Flying Classroom, what do you think you would be learning in the Flying Classroom?” Then show the High Altitude Inspiration video featuring Barrington Irving. After watching the video, students discuss what they learned about Captain Irving’s Flying Classroom.

EXPLORE: Lesson Description – Materials Needed / Probing or Clarifying Questions:
Prior to the lesson collect the following materials:

- Cardboard
- Construction paper
- Cardstock
- Foam sheets
- Foil
- Foam trays
- Paperclips
- Rubber bands
- Popsicle sticks
- Balsa wood
- Scotch tape
- Glue
- Scissors
- Rulers
- Plane Template/Jet Template (optional)

In advance create models of the plane and the jet using the templates (click photos for credits).

Tell students they are going to design and build a model plane that can travel 4.5 meters. Discuss with students what factors they think might affect the flight (shape, size, type of material). Depending on the students’ level and knowledge of engineering design. In teams of 4 students will plan and sketch their plane, using the template if necessary. The plan should include the list of materials the team will use to construct the model.

Next is the construction phase of the lesson. Students will gather the materials they outlined in the design plan and build their aircraft.

After the have constructed the airplane, they should answer the following questions:

1. How similar is your airplane to your design template?
2. How did you decide which materials to select for final construction? What was it about the materials that you thought might help your airplane fly?
3. How did you decide on the shape of the parts of your airplane? What was it about the shape of each part that you thought might help your airplane fly?
4. Did you need to adjust or change your design once construction began? If so, describe the changes and explain why they were made.
5. Do you think that engineers often change their original plans during the manufacturing phase of development? How do you think this would impact the planned design or manufacturing budget?

EXPLAIN: Concepts Explained and Vocabulary Defined:
Define the four forces that impact flight: weight, lift, drag, and thrust. Weight is a result of gravitational forces. Inform students that the materials they design to use will have a weight that must be offset by the lift to fly. Lift is a force that helps to counteract weight and the heavier an object is the harder it is for lift to work against it. The thrust or velocity/forward motion will have an impact on the lift. The final force act on the aircraft will be drag, Drag is the force that acts opposite to the forward motion, and it is impacted by the thrust, the greater the thrust, the greater the drag.

Now ask students what parts of their planes do they think will impact the weight (type of material, size of plane), the lift (the material, shape of plane/wings), the thrust (how the person throws the plane), and the drag (the shape and material as well as the air temperature and humidity). Explain to students that these forces are interrelated and when they are in balance a plane will move at a constant velocity.
Vocabulary:
Weight is a result of gravitational forces
Lift is the sum of all forces on an object that force it to move perpendicular to the direction of flow (https://kids.kiddle.co/Lift_(force))
Thrust is the force which moves an aircraft through the air
Drag is the resistance force of air

ELABORATE: Applications and Extensions:
Prior to starting the elaboration section of this lesson, you will need to gather the following materials for the class:

- Cardboard
- Construction paper
- Cardstock
- Foam sheets
- Foil
- Foam trays
- Paperclips
- Rubber bands
- Pop sticks
- Balsa wood
- Scotch tape
- Glue
- Scissors
- Rulers

The Flight Test

Students will design the test for their aircraft. The purpose of the test is to ensure their model will consistently fly 4.5 m and should consist of at least 3 trials. Students will record data from the trials that includes distance flown, description of the path the aircraft flew in, and if the target was met.

Example:
Trial Ex.
Distance Flown: 3.5 m
Flight Path: Aircraft curved to the right
Target: Missed

After the three trials, students may make changes to their original design (i.e., alter shape, increase, or decrease weight, or change the person throwing the aircraft (thrust)). All teams repeat the test for 3 more trials and record observations.

For the final test, teams submit the aircrafts then the teacher will test them to maintain consistency. Students record the observations of each airplane tested and include notes about the differences in each other's designs.

Students then answer the following questions:

1. Did your aircraft land on the target?
2. What was the best aspect of your team's design? Describe why you believe it is the best feature.
3. Which aspect of the design did you change during the construction phase? During the testing phase? Explain why the team made the adjustments and if they worked to improve the aircraft.
4. Was there an aircraft that performed better than yours? If so, describe the differences between that aircraft and yours.
5. What changes would you make to improve your airplane based on the final flight tests?
6. What would you do differently if the aircraft needed to hit a target 9 m away? 2.25 m away?

EVALUATE:
Formative Monitoring (Questioning / Discussion): Students create a design plan and build their aircraft.

Summative Assessment (Quiz / Project / Report): Student responses to the questions will assess their understanding of the engineering design process and how the forces of flight interact.

Elaborate Further / Reflect: Enrichment: Students revise their designs and rebuild their airplanes to hit a target 2.25 m away or 9 m away.
SOCIAL EMOTIONAL LEARNING ACTIVITY
CASEL Competency: SELF-MANAGEMENT Capt. Barrington Irving exhibits a great deal of perseverance. Explain to students that perseverance is the ability to continue with something even though it is difficult. Ask students to identify examples of Capt. Irving's perseverance (i.e., becoming a pilot, building an airplane, becoming the youngest to fly around the world, launching his nonprofit). Ask students to share an example of their perseverance. Explain to students that perseverance is acutely aligned to self-management. Define self-management as the abilities to manage one's emotions, thoughts, and behaviors effectively in different situations and to achieve goals and aspirations. In this activity students will practice self-management and perseverance through teamwork. For this activity you need the following materials for each team: 6 paper cups 1 rubber band 5 pieces of string (one per student in the group) Directions: 1. Students are divided into groups of 5 and handed a piece of string. 2. Each student will tie their string to the rubber band. 3. Students will work together to stack their cups into a pyramid with 3 cups as the base, 2 cups in the middle and 1 cup at the top. 4. Give teams 10 minutes to build their pyramids using only their string and rubber band to move the cups. 5. At the end of 10 mins conduct a class discussion using the following prompt questions: a. Did your team achieve the pyramid? Why or why not? b. Was anyone frustrated during this activity? How did you handle the frustration (yours or your teammates)? c. What did you learn about yourself and the group you worked with? d. How is this activity good practice for developing your self-management?
INTERDISCIPLINARY CONNECTIONS/IDEAS
Students are using reason abstractly (MP.2.7.EE.3) to determine the relationship between weight, lift, thrust, drag and the distance of flight.

Materials Required for This Lesson/Activity

Quantity	Description
Per group	Cardboard boxes
Per group	Cardboard tubes
Per group	Foam sheets
Per group	Foam trays
Per group	Foil
Per group	Cardstock
2 boxes	Paperclips
1 box	Rubber bands
4 boxes	Popsicle sticks
1 pack of 10 per group	Balsa wood
Per group	Glue
1 per group	Scissors
	Making tape
1 per group	Ruler
6 per group	Plastic cups
5 pieces per group of 5	string

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