

Air, Aerodynamics, and Flight

Teacher Guide

Essential Questions

How do things fly in the air?



Targets

1. What is air?

- What is air made of?
- What are the properties of air?

2. What forces are involved in flight?

- How do flying devices and living things counter act gravity?
- How does air movement across a surface result in lift?
- How can drag be reduced?
- What means of propulsion are used in aircraft?

3. What parts are needed for things to fly?

- How does a hot-air balloon fly?
- What adaptations enable birds and insects to fly?
- How do the parts of an aircraft stabilize and control its flight?

Pre-Assessment

Student Activity

Answer the questions to see what you know about flight.

- How is the balloon being lifted into the air?
- What is the air around you made of?
- How are other types of aircraft able to fly (such as an airplane)?
- How are animals able to fly?

Jot your answers to the four questions in the boxes of the *Frayer Model*. This is not a quiz; your teacher wants to know what you already know.

Teacher Notes

Because this activity is a pre-assessment, students are not expected to know all these answers. Their responses should help you gauge how much background information they have already about the topic.

- How is the balloon being lifted into the air?
 - Air heated by the engines rises because it is less dense than the surrounding cool air. As the hot air rises, it fills the balloon canopy, lifting it into the air.
- What is the air around you made of?
 - Air is made of oxygen, nitrogen, carbon dioxide, hydrogen, and a mixture of gases.
- How are other types of aircraft able to fly (such as an airplane)? Answers will vary, but they should include references to the following:
 - Streamlined design allows air to pass over with minimal wind resistance.
 - Wings allow air to pass over and produce lift.
 - Engines provide propulsion to push the aircraft forward.
 - Control surfaces (ailerons, rudder, tail flaps) can change airflow to direct movement.
- How are animals able to fly? Answers will vary, but they might include references to the following:
 - Streamlined body allows air to pass over with minimal wind resistance.
 - Parts such as feathers and wings allow air to pass over and produce lift.
 - Birds have hollow bones; flying insects have light exoskeletons.

Flight	
How is the balloon being lifted into the air? Need a Hint? Which is lighter - the balloon or the air? Do you know why?	What is the air around you made of? Need a Hint? What do you breathe in or out? Is it a solid, liquid or gas?
Flight	
How are other types of aircraft able to fly (such as an airplane)? Need a Hint? What parts of an airplane help it fly? Do you know how they work?	How are animals able to fly? Need a Hint? What parts of a bird or a butterfly help it fly? Do you know how they work?

What is air?



Section 1 Vocabulary

Term	Definition
atmosphere	the thin layer of gas that covers the earth
gas	a state of matter where particles have no definite shape or volume
mass	quantity of matter in a substance
nitrogen	gas that makes up 78% of the earth's atmosphere
oxygen	gas required by all living things
pressure	force exerted by fluids in all directions
properties	how a substance behaves or reacts under certain conditions



Observe – What do you know about flight?

Teacher Notes

None Provided



KWLH chart - Flight

Teacher Notes

- What do I **KNOW** about Air, Aerodynamics, and Flight? (Which questions did you answer correctly?)
- What do I **WANT** to learn about Air, Aerodynamics, and Flight?
- **HOW** can I learn more about Air, Aerodynamics, and Flight?
- What did I **LEARN** about Air, Aerodynamics, and Flight?
- Students will be adding to KWLH chart throughout the unit. Answers will vary.

What is air made of?



Discover – Up in the Air

Teacher Notes

- Students will construct a mind map compiling information from two websites about the air in our atmosphere.
- Students have three options with varying degrees of scaffolding to guide them as needed.
- The focus of the activity should be for students to recognize the gases in the atmosphere



Observe – Proof in the Air

Teacher Notes

- Students view examples of evidence of the various gases in our atmosphere. By the end of this activity, students should be able to recognize some basic examples of everyday occurrences that involve the gases in the air around us.

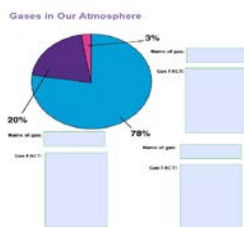
Video	Gas or Gases Involved
Burning Candle http://www.youtube.com/watch?v=4my_RjJRbfg	<ul style="list-style-type: none">• Oxygen is used by the burning candle.• Carbon dioxide is produced by the burning candle.
Rusting of Iron http://www.edewcate.com/Inner.aspx?FileName={FBC6E0CC-CCC1-4924-A793-09F19D3B2299}.flv	<ul style="list-style-type: none">• Oxygen• Water vapour
Exchange of Gases – Photosynthesis http://www.youtube.com/watch?v=pHDAZcWUq04	<ul style="list-style-type: none">• Oxygen is used by animals and made by plants.• Carbon dioxide is used by plants and made by animals.



Exit Pass

Student Activity

Complete the circle graph below with the gases that make up our atmosphere. In each section, place the name of the correct gas **plus** one **FACT** you learned about this gas (such as what does it do? or where does it come from? or how is it used?)



Possible Answers

- Oxygen (20%):
 - made by plants during photosynthesis
 - used by animals during respiration
 - involved in causing things to burn or rust
- Nitrogen (78%):
 - made when plants or animals decay
 - made during volcanic eruptions
- Possible answers included but not limited to the following (2%):
 - carbon dioxide: used by plants during photosynthesis, made by animals during respiration, and made when things burn
 - ozone: protects us from sun's harmful radiation
 - water vapour: formed during respiration

What are the properties of air?



Explore – Is Air Really There?

Teacher Notes

- These are a series of simple hands-on activities to illustrate some basic properties of air. For students who are unable to complete these activities, a video option is offered.
- Encourage students to do the activities themselves, and have them consider the many properties of air that can help explain what they are observing.



Explore – Under Pressure

Teacher Notes

- This hands-on activity allows students to see if they can use air to lift a book.
- Larger, sturdier freezer bags will work better, but if they are unavailable, sandwich bags will work. If you use the smaller bags, students need to use lighter or smaller books.



Discover – Air as a Fluid

Teacher Notes

- Students observe some simple demonstrations showing how air exhibits the properties of a fluid.
- The Gas Properties PhEt simulation has numerous settings that are beyond the scope of this course. The main objective is for students to see how the gas expands to fit the size of the container. All other settings can be ignored. If they want, students can play around with the various settings after completing the activity.
- The Pouring Air video shows a simple activity that students can do themselves easily in a bathtub or sink. Encourage them to try it.



Exit Pass

Student Activity

Watch this demonstration of blowing up a balloon inside a bottle. Then, answer the questions about what is happening in the video.

<http://weirdsciencekids.com/Ballooninbottle.html>

1. What is inside the bottle at the start of the experiment when the balloon is put into the bottle?
2. Why does the hole in the bottle allow you to blow up the balloon?
3. What happens to the air inside the bottle when the balloon fills the bottle if you keep blowing air into it?

Student Activity

1. The bottle is full of air.
2. The hole allows the air inside the bottle to escape as the balloon is being blown up. This way, the balloon can inflate inside the bottle. If the hole were not there, the balloon would have no room to grow because air occupying the inside of the bottle already.
3. The air inside the balloon will become compressed and under more pressure if you keep blowing into it after the balloon fills the bottle.

Assessment 1 – Alien Air

Student Assessment

Aliens from another galaxy have landed!! They are from a planet that has no atmosphere and they are not familiar with how the air on Earth behaves. They do not need air to breathe, and they have never before seen the effects of air. You have been given the task of trying to explain to them what air is and what it does on Earth.

You can choose to teach these aliens about air in any format you choose. You can choose from these ideas, but you can be creative, too.

- PowerPoint
- photo story
- poster or Glogster
- Animoto video
- Blog
- brochure or pamphlet
- video
- other (Be sure it is approved by your teacher before you begin.)

Criteria

Your informative “Alien Air” lesson should include the following:

- ☐ A description of the gases that are in our atmosphere
- ☐ two examples of what the gases in our atmosphere do
- ☐ an explanation and/or demonstration of at least 3 things that air can do
- ☐ a description of how air behaves as a fluid
- ☐ two examples of how air can be useful

Remember to study the criteria and Alien Air Rubric first because they will help you know what is expected of you.

Alien Air Rubric

	Excellent	Proficient	Adequate	Limited
Shows that air is made up of different gases	Describes accurately and clearly various gases in the atmosphere with descriptive examples of what they do.	Describes the major gases in the atmosphere with general descriptions what they do.	Identifies the major gases in the atmosphere.	Describes partially or inaccurately the gases in the atmosphere.
Explains the properties of air (takes up space, exerts pressure, and behaves as a fluid)	Identifies accurately and effectively major properties of air with detailed examples of each.	Identifies clearly major properties of air with appropriate examples for some of them.	Presents some properties of air with vague or incomplete examples.	Describes inaccurately the properties of air with limited or unclear examples.
Provides examples of the effects of air	Provides several clear and detailed examples of effects of air and everyday applications of air.	Provides a few appropriate examples of effects of air and everyday applications of air.	Identifies some examples of effects of air and everyday applications with minimal explanation.	Identifies vaguely an example of effects of air or an everyday application with minimal explanation.
Provides examples of how air can be used in everyday applications	Provides several clear and detailed examples of everyday applications of air.	Provides a few appropriate examples of everyday applications of air.	Identifies some examples of everyday applications with minimal explanation.	identifies vaguely an everyday application with minimal explanation.

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities. This assessment is ideal to invite peer review.

Check It

When your 'Alien Air' project is complete, share it to your group for feedback.

1. Post your guide in our class discussion board.
2. Upload the Alien Air Rubric to our class discussion board/blog.
3. Ask your group members to check your project and provide feedback.
4. They will leave feedback based on the rubric and these criteria:
 - Has the student described the gases in the atmosphere?
 - Has the student provided examples of what these gases do?
 - Identify the two properties of air or examples that are described well, and explain why you feel that way.
 - Identify one property of air or example you would revise, and be specific suggestions to how it might be improved.
 - Suggest two additional examples that the student might consider including.
 - What is your general impression of the project? Select three words or phrases to describe the work.

Sample Feedback Form

Has someone in your group asked you to view his or her guide and give feedback?

1. Read the **Alien Air Rubric**.
2. Then, open the project and look at it carefully.
3. Think about the following criteria before you provide feedback:
 - Has the student described the gases in the atmosphere?
 - Has the student provided examples of what these gases do?
 - Identify the two properties of air or examples that are described well, and explain why you feel that way.
 - Identify one property of air or example you would revise, and make specific suggestions to how it might be improved.
 - Suggest two additional examples that the student might consider including.
 - What is your general impression of the guide? Select three words or phrases to describe the work.
4. Look at the project two or three more times as you consider the rubric and criteria.
5. Write what you would like to say as feedback. Then, provide your feedback to the group member.

Sentence starters for providing feedback:

- You might think about _____.
- You might consider _____.
- What if you _____?
- I had trouble understanding _____. You might want to clarify this part.
- I noticed that _____.
- It helped when you _____.
- I liked _____ because _____.

Please provide your feedback here:

What forces are involved in flight?



Section 2 Vocabulary

Term	Definition
aerodynamics	forces acting on objects in flight
air resistance	movement of air particles pushing against something as it moves past
Bernoulli's Principle	Faster moving air has lower pressure, and slower moving air has higher pressure. This difference in air pressure can produce lift.
density	mass contained in a certain volume (related to how heavy something is)
drag	force of air pushing against an object in motion
force	a push or a pull
gravity	downwards forces pulling on objects on earth
lift	upward force produced by air pressure
manipulated variable	factor or condition that is being tested in an experiment
Newton's Third Law	For every action, there is an equal and opposite reaction.
propeller	revolving fan or blades that are spun by an engine
propulsion	upward or forward thrust provided by engines
thrust	force required to move a flying object forward
weight	force of gravity acting on an object

How do flying devices and living things counter act gravity?



Observe – Defying Gravity?

Teacher Notes

None Provided

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities.

Synchronous Session

Instructions

You will take part in a synchronous session. The purpose of the session is to discuss in more detail how the force of gravity can be overcome in various ways. It will also offer you an opportunity to ask your questions about these methods. Your teacher will keep track of the questions, and you will discuss their answers in later sessions as you go through the unit. To prepare for the session, complete the following:

1. Contact your teacher to determine the day and time of the session.
2. Open the *Defying Gravity worksheet* provided, and read the questions. These questions will help you focus on the important information provided on the website.
3. Complete the “Basics of Gravity” section on your worksheet as you read carefully through the Forces of Flight-Weight website.
4. In the second section of your worksheet, look at the various pictures showing ways of overcoming gravity.
5. For each picture, check off which method of overcoming gravity is being shown: lift, buoyancy, or propulsion. In some cases, more than one method may be used.
6. Save your worksheet in your *Flight Notebook*.

On the day of the session:

1. Open your *Defying Gravity worksheet*.
2. Login to the synchronous session.
3. Your teacher will ask you about what you read on the website and what you thought were important characteristics.
4. Be sure to ask your questions. Your teacher may answer your questions now, or he or she will record them for a future session.
5. After the session, make any changes or additions you wish to your worksheet.
6. In the second section of the worksheet, you may wish to add a brief explanation of how each example is overcoming gravity.



Exit Pass

Student Activity

Use the picture to answer the questions:

1. What four forces are acting on the paper airplane after it is thrown?
2. What are the two ways that the airplane is able to overcome gravity?
3. After the initial throw, why does the airplane eventually fall to the ground?

Possible Answers

1. What four forces are acting on the paper airplane after it is thrown?
 - gravity (weight)
 - thrust
 - lift
 - drag
2. What are the two ways that the airplane is able to overcome gravity?
 - propulsion (or thrust) from the throw
 - lift from the air pressure under the wings
3. After the initial throw, why does the airplane eventually fall to the ground?
 - The forces of gravity and drag are stronger than the lift provided by the airplane's wings.
 - The temporary propulsion and thrust provided by the throw is unable to keep the plane in the air.

How does air movement across a surface result in lift?



Observe – Air in Motion

Teacher Notes

- Students will look at how the Bernoulli Principle works and how it is applied in aerodynamics.
- Bernoulli's Principle states that a region of fast-moving air has lower pressure than a region of slow-moving air. This phenomenon is why the airfoil shape of wings can produce lift. As air moves over the curve of a wing, it speeds up and moves faster than the air flowing under the wing. Therefore, the air under the wing has **higher** pressure than the air on top of the wing. The high pressure air under the wing lifts it upwards.
- Although this principle may seem complex at first for some students, emphasize the basic idea that **FASTER** air = **LOWER** pressure, **SLOWER** air = **HIGHER** pressure. If they can remember that, they can apply the idea that the higher pressure will push into the area of lower pressure.
- These activities demonstrate various ways this principle can be applied although students need to understand how it applies to the process of flight.



Observe – Bernoulli Basics

Teacher Notes

- Students will watch some brief video clips to learn the basics of Bernoulli Principle.
- They will explore the application of Bernoulli's Principle later in this unit.



Explore – Bernoulli Brainteasers

Teacher Notes

- These series of simple hands-on activities illustrate some basic applications of Bernoulli Principle.
- Encourage students to do the activities themselves and have them consider how ideas can be applied to aerodynamics.



Exit Pass

Student Activity

Explain how the shape of a bird's wing is adapted to produce lift. Be sure to include the following in your answer:

- An explanation of how Bernoulli's Principle works
- How the air flows over the wing
- How the regions of low and high pressure create lift

Possible Answers

Student should answer the following points:

- Wing shape causes air to flow faster over the top of the wing.
- Bernoulli's Principle states that faster moving air equals lower pressure.
- The higher pressure air underneath the wing pushes upwards producing lift.

How can drag be reduced?



Explore – What is Drag?

Teacher Notes

- Students will explore first the concept of drag in water and then apply these ideas to flight in the air.



Explore – Parachute Plunge

Teacher Notes

- Students will apply their knowledge of drag to design and build their own simple parachutes.
- Encourage students to be creative and **not** to get frustrated if their drag does not work the first few tries. This activity is meant for students to work on their problem-solving skills and to appreciate that science is an imperfect process.



Exit Pass

Student Activity

For each of the following pictures, explain why drag should be increased or decreased and how this is accomplished in the example shown.

Possible Answers

1. Drag is being increased by the parachute to slow the person as he or she falls. The wide shape of the parachute has more air resistance to slow their descent.
2. Drag is being decreased by the form of the swimmer. By pointer his or her hands and toes, the swimmer is making a long, narrow form that has less resistance as the swimmer moves through the water. This allows the swimmer to go faster.

What means of propulsion are used in aircraft?



Observe – Types of Propulsion

Teacher Notes

- Students will refer to the website resources for some basic information on various methods of propulsion. The website offers a great deal more detail than is required by curriculum outcomes.
- A note-taking guide is provided to focus students on the main ideas.



Explore – Propellers in Action

Teacher Notes

- Students will be testing various propeller designs to see which are most effective
- This activity is intended for students to work on their problem-solving skills and to appreciate that science is an imperfect process.



Explore – Propulsion Pop!

Teacher Notes

- Students will apply their knowledge of propulsion to design and build their own simple rockets.
- Encourage students to be creative and not to be frustrated if their rocket does not work on the first few tries. This activity is intended for students to work on their problem-solving skills and to appreciate that science is an imperfect process.
- The testing of the rockets works best outside because it can be messy. Indoor testing is possible if students have access to a large open space, but clean up is a consideration.
- Be sure students have considering the following elements in their design:
 - What method of propulsion are they using?
 - Of what is their rocket made? Will it be too heavy? Will it be sturdy enough to survive landing?
 - How will they execute the launch? What safety precautions should they consider? If students are launching in an indoor space, warn them about covering the floors with garbage bags to contain the mess. Warn them of the possibility of hitting the ceiling. Have them check with parents first!

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities.

Synchronous Session

Instructions

You will take part in a synchronous session to share your rocket design before you test it.

To prepare for this session, complete the following:

1. Contact your teacher to determine the day and time of the session.
2. Next, begin designing your rocket:
 - Use the Planning and Design portion of the Rocket Design worksheet to guide your planning.
 - Be sure you consider all parts of your design and be sure you have access to the materials you will need.
 - Save the rocket design to your *Flight Notebook*.
 - Start building your rocket. Write any questions you might have for your teacher if you have any problems with your rocket.
 - Do **not** test your rocket until you have met with your teacher.

On the day of the session:

1. Login to the synchronous session. Share your rocket design with your teacher. Explain what method of propulsion your rocket will use and other parts of the design you have included. You can even show a picture of your rocket if you have finished building it.
2. Your teacher will ask you questions to be sure you have considered all important parts of your design before you test your rocket.



Exit Pass

Student Activity

Submit the following:

1. a picture, video, or labelled diagram of your rocket
2. an explanation of which fuel combination worked best and how it produced propulsion for your rocket
3. an explanation of one way you could improve your rocket for future launches

Possible Answers

Submit the following:

1. a picture, video, or labelled diagram of your rocket
 - Answers will vary
2. an explanation of which fuel combination worked best and how it produced propulsion for your rocket
 - Exact fuel proportions will vary.
 - The Alka-Seltzer and water react to produce carbon dioxide gas. The build-up of pressure from the gas causes the cap to pop off. The pressure from the gas pushes downwards to cause the rocket to launch upwards (Newton's Third Law).
3. an explanation of one way you could improve your rocket for future launches
 - Answers will vary but may include the following:
 - Lighter materials, fewer pieces, or smaller rocket (Students tend to learn that simple is better – fewer things to go wrong.)
 - Use a different type of fuel or combination for propulsion
 - Use a different base for the rocket – something other than a film canister

Assessment 2 – Forces in Flight

Student Assessment

It's a bird! It's a plane! It's... anything that flies!!

They are all subject to the same forces involved with flight. All flying things must have some way to produce lift and thrust to overcome gravity and drag. Usually, these methods are incorporated into the structure and design of the flying object.

Choose one of the following aircraft shown in the pictures (or choose your own photo - check with your teacher first for approval).

Pretend you are the designer of that aircraft and you are trying to sell your design to a potential buyer. The buyer wants to be sure the aircraft will fly properly. You will need to explain the various forces of flight to your buyer and how your aircraft manages to fly. You can choose to

- Construct a pamphlet or poster
- or**
- Construct a PowerPoint (using relevant images or diagrams)

Criteria

Your “Forces in Flight” sales pitch should include the following:

- ☐ How the various forces act on the aircraft (lift, weight, drag, and thrust)
- ☐ How the aircraft overcomes weight (gravity) and drag
- ☐ What Bernoulli's Principle is and how it is acting on your aircraft
- ☐ An explanation of the kind of propulsion used by your aircraft and what it does
- ☐ Picture and diagrams to accompany your explanations

Remember to study the criteria and **Forces in Flight Rubric** first because this will help you know what is expected of you.

Forces in Flight Rubric

	Excellent	Proficient	Adequate	Limited
Recognizes the forces involved in flight	Describes accurately and clearly the forces of flight with thorough explanation of how each acts on the aircraft.	Describes the forces of flight with general explanations of how each acts on the aircraft.	Identifies the forces of flight with vague references to how each acts on the aircraft.	Describes partially or inaccurately the forces of flight.
Explains how Bernoulli's Principle is able to produce lift	Explains accurately and effectively Bernoulli's Principle with a detailed description of how it relates to the aircraft.	Explains clearly Bernoulli's Principle with some description of how it relates to the aircraft.	States Bernoulli's Principle with a vague description of how it relates to the aircraft.	States inaccurately Bernoulli's Principle with no description of how it relates to the aircraft.
Demonstrates how to overcome gravity for flight to occur	Provides a detailed description of how the aircraft is able to overcome gravity.	Provides a general description of how the aircraft is able to overcome gravity.	Provides a vague or incomplete description of how the aircraft is able to overcome gravity.	Provides an incomplete or inaccurate description of how the aircraft is able to overcome gravity.
Demonstrates how to overcome drag for flight to occur	Provides a detailed description of how the aircraft is able to overcome drag.	Provides a general description of how the aircraft is able to overcome drag.	Provides a vague or incomplete description of how the aircraft is able to overcome drag.	Provides an incomplete or inaccurate description of how the aircraft is able to overcome drag.
Identifies the means of propulsion and what it does	Explains the means of propulsion with a clear and detailed explanation of how it works.	Identifies the means of propulsion with a general explanation of how it works.	Identifies the means of propulsion with a vague explanation of how it works.	Identifies inaccurately the means of propulsion with no explanation of how it works.

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities. This assessment is ideal to invite peer review.

Check It

When your 'Forces in Flight' project is complete, share it to your group for feedback.

1. Post your project in our class discussion board/blog to share it with your group.
2. Upload the **Forces in Flight Rubric** to our class discussion board/blog.
3. Ask your group members to check your project and provide feedback.
4. They will leave feedback based on the rubric and these criteria:
 - Has the student described the various forces of flight and how aircraft deal with them?
 - Has the student explained Bernoulli's Principle and propulsion?
 - Identify the two forces of flight described well, and explain why you feel that way.
 - Identify one explanation or example you would revise, and make specific suggestions to how it might be improved.
 - What is your general impression of the project? Select three words or phrases to describe the work.

Sample Feedback Form

Has someone in your group asked you to view his or her guide and give feedback?

1. Read the **Forces in Flight Rubric**.
2. Then, open the project and look at it carefully.
3. Think about the following criteria before you provide feedback:
 - Has the student described the various forces of flight and how aircraft deal with them?
 - Has the student explained Bernoulli's Principle and propulsion?
 - Identify the two forces of flight described well, and explain why you feel that way.
 - Identify one explanation or example you would revise, and make specific suggestions to how it might be improved.
 - What is your general impression of the project? Select three words or phrases to describe the work.
4. Look at the project two or three more times as you consider the rubric and criteria.
5. Write what you would like to say as feedback. Then, provide your feedback to the group member.

Sentence starters for providing feedback:

- You might think about _____.
- You might consider _____.
- What if you _____?
- I had trouble understanding _____. You might want to clarify this part.
- I noticed that _____.
- It helped when you _____.
- I liked _____ because _____.

Please provide your feedback here:

What parts are needed for things to fly?



Section 3 Vocabulary

Term	Definition
adaptation	changes in structures or behaviours that help an animal survive
ailerons	control roll of plane left or right (on airplane wings)
airfoil	shape of a wing
buoyancy	upwards force exerted by fluids
elevators	control pitch (on airplane wings)
fuselage	carries crew, cargo, and passengers
helium	a gas that is less dense than air (usually used to fill balloons)
horizontal stabilizer	balance forward and backward motions
parachute	large canopy used to slow the descent of falling objects
pitch	tilting forward and backward, especially of an airplane
roll	movement left and right while also going up and down, especially of an airplane
rudder	controls yaw, which is temporary deviation from a straight course
tail	provides control and stability
vertical stabilizer	balance side to side motions
wing	produce lift and allow gliding
yaw	moving left and right without moving up and down, especially of an airplane

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities. This activity could be done with a partner.

Partner Up

Complete this activity with a partner. Follow these steps:

1. Post a request in our class discussion board or talk to your teacher to see if anyone is available to work with you.
2. Talk with your partner and decide when you will meet in Google Docs to work on this activity.
3. Remember to share the list in the Google Docs with your partner so that you are both able to work in the same document.
4. Set a date for completion. "Let's have this done by..."
5. Read your partner's entries in the list. Do you have any questions?
6. Plan a day and time when you can phone, text, chat, Skype, Facetime, VSee or use any other medium discuss how your list turned out and if you or your partner needs to make changes.
7. Save a copy of the completed list in your *Flight Notebook*.

How does a hot air balloon fly?



Observe – Lighter Than Air?

Teacher Notes

- Students will work through an interactive website to learn how buoyancy of hot air balloons work.
- A note-taking guide is used to focus students on the main ideas.



Observe – Fly Your Own Hot Air Balloon

Teacher Notes

- Students will work through an interactive website to learn how hot air balloons work and they will try to fly one on their own.



Exit Pass

Student Activity

Label the names of the forces shown acting on the hot air balloon.

1. Explain one way to make the hot air balloon rise higher.

2. Explain one way to make the hot air balloon change directions.

Possible Answers



1. Explain one way to make the hot air balloon rise higher.
 - Turn on the burners to add more hot air, or remove a sandbag (or something else) to reduce the weight of the balloon.
2. Explain one way to make the hot air balloon change directions.
 - Have the balloon either rise or lower to catch a wind current that will take it in a different direction.

What adaptations enable birds and insects to fly?



Observe – Airplanes vs. Birds?

Teacher Notes

- Students will use the website as a resource for comparing how airplanes are similar to birds.

- This starts as a brainstorming activity for students to draw upon previous knowledge; then, they use the website to add information.



Observe – Build a Bird?

Teacher Notes

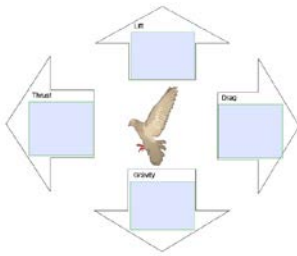
- Students will work through an interactive website activity to review the forces of flight and how they apply to birds in flight.
- A worksheet guides students through the activities.



Exit Pass

Student Activity

Give **one** example of how a bird produces or reduces each force shown in the diagram:



Possible Answers

Lift produces by

- airfoil design of wings that produces higher pressure under the wings – Bernoulli's Principle
- flapping of wings

Gravity produced by

- hollow bones and feathers that make the bird lighter

Thrust produced by

- jumping into the air
- flapping wings

Drag produced by

- streamlined shape of body, wings, and feathers
- small body shape
- slower flying
- not flying into the wind

How do the parts of an aircraft stabilize and control its flight?



Observe – Parts and Movements of Airplanes?

Teacher Notes

- Students will work through an interactive website to gather information about the parts of an airplane and how they control the movement of the airplane.



Observe – Airfoil Design?

Teacher Notes

- Students will work through an interactive website comparing various types of airfoils.



Exit Pass

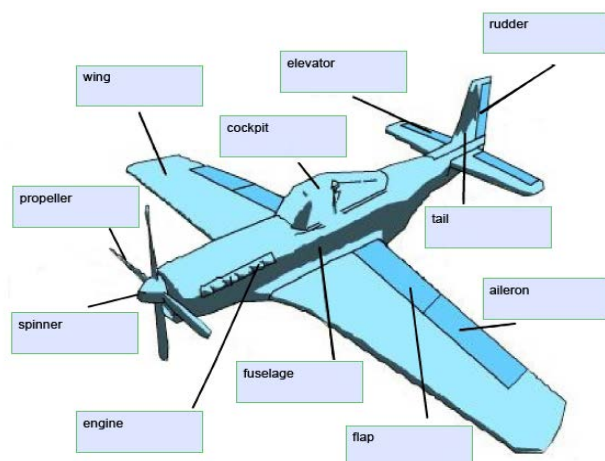
Student Activity

Label the parts of the plane (diagram shown below):

Choose 3 parts of the plane, and describe what each does:

- _____
- _____
- _____

Possible Answers



fuselage – carries cargo, crew, and passengers

engine – provides propulsion and thrust

propeller – produces thrust to pull the plane forward

aileron – controls roll

flap – increase lift during take-off and landing

wing – produces lift and allows gliding

elevator – controls pitch

rudder – controls yaw

tail – provides control and stability

Assessment 3 – Comparing Things That Fly

Student Assessment

There has been much discussion in this section about the similarities between airplanes and birds. In fact, many of the very early flying devices were modelled directly on what was observed in birds. Of course, today's designs for flying machines are much more advanced, but some common guiding principles exist.

Choose one of the flying devices you have learned about in this unit, and compare it any type of bird that flies. You must demonstrate the similarities and differences between the aircraft and the bird.

You can choose to do this comparison as a written report or a photo story.

Depending on the aircraft or bird you choose, you may need to do some additional research on your own. You need to refer to the information you have learned in this unit.

Criteria

Your informative 'Comparing Things That Fly' project should include the following:

- ☐ A description or labelled diagram of the various parts of the aircraft
- ☐ A description or labelled diagram of the various parts of the bird
- ☐ An explanation of how the aircraft uses the forces of flight (lift, drag, gravity, and thrust)
- ☐ An explanation of how the bird uses the forces of flight (lift, drag, gravity, and thrust)
- ☐ A description of what the bird and the aircraft have in common
- ☐ A description of how the bird and the aircraft are different

Remember to study the criteria and **Comparing Things that Fly Rubric** first because this will help you know what is expected of you.

Comparing Things that Fly Rubric

	Excellent	Proficient	Adequate	Limited
Explains how the parts of <u>birds</u> are used with the various forces of flight	Describes accurately and clearly the various parts with detailed descriptions of how they are used in flight with specific reference to lift, drag, gravity, and thrust.	Describes generally the various parts with descriptions of how they are used in flight with specific reference to lift, drag, gravity, and thrust.	Describes some of the parts with descriptions of how they are used in flight with some reference to lift, drag, gravity, and thrust.	Identifies partially some of the parts with limited explanation of how they are used in flight and minimal reference to lift, drag, gravity, and thrust.
Explains how the parts of <u>aircraft</u> are used with the various forces of flight	Describes accurately and clearly the various parts with detailed descriptions of how they are used in flight with specific reference to lift, drag, gravity, and thrust.	Describes generally the various parts with descriptions of how they are used in flight with specific reference to lift, drag, gravity, and thrust.	Describes some of the parts with descriptions of how they are used in flight with some reference to lift, drag, gravity, and thrust.	Identifies partially some of the parts with limited explanation of how they are used in flight and minimal reference to lift, drag, gravity, and thrust.
Demonstrates similarities and differences between the bird and the aircraft	Provides several clear and detailed examples of both similarities and differences.	Provides a few appropriate examples of both similarities and differences.	Identifies some examples of both similarities and differences with minimal explanation.	Provides limited examples of similarities and differences with minimal or no explanation.

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities. This assessment is ideal to invite peer review.

Check It

When your 'Comparing Things that Fly" project is complete, share it to your group for feedback.

1. Post your project in our class discussion board/blog to share it with your group.
2. Upload the **Comparing Things that Fly Rubric** to our class discussion board/blog.
3. Ask your group members to check your project and provide feedback.
4. They will leave feedback based on the rubric and these criteria:
 - Has the student described the parts of the aircraft and the bird?
 - Has the student explained how the parts are used with the forces of flight?
 - Identify the two examples of similarities or differences that are described well, and explain why you feel that way.
 - Identify one example of a similarity or difference you would revise, and make specific suggestions to how it might be improved.
 - Suggest two additional examples that the student might consider including.
 - What is your general impression of the project? Select three words or phrases to describe the work.

Sample Feedback Form

Has someone in your group asked you to view his or her guide and give feedback?

1. Read the **Comparing Things that Fly Rubric**.
2. Then, open the project and look at it carefully.
3. Think about the following criteria before you provide feedback:
 1. Has the student described the parts of the aircraft and the bird?
 2. Has the student explained how the parts are used with the forces of flight?
 3. Identify the two examples of similarities or differences that are described well, and explain why you feel that way.
 4. Identify one example of a similarity or difference you would revise, and make specific suggestions to how it might be improved.
 5. Suggest two additional examples that the student might consider including.
 6. What is your general impression of the project? Select three words or phrases to describe the work.
4. Look at the project two or three more times as you consider the rubric and criteria.
5. Write what you would like to say as feedback. Then, provide your feedback to the group member.

Sentence starters for providing feedback:

- You might think about _____.
- You might consider _____.
- What if you _____?
- I had trouble understanding _____. You might want to clarify this part.
- I noticed that _____.
- It helped when you _____.
- I liked _____ because _____.

Please provide your feedback here:

Final Assessment

Essential Question

How do things fly in the air?

Student Assessment

Imagine that you are one of the Wright brothers in the beginning stages of designing an aircraft. You are not ready to build a manned aircraft yet, but you have spent a long time studying the properties of air and how it affects flying. You spent countless hours watching the birds and testing out how the various forces of flight can be affected. Using everything that you have learned, you are now ready to design your first prototype glider.

1. Choose one of the following options for your "Glider Design Project":
 - Make your own video or use Animoto to make a video demonstrating your glider design.
OR
 - Produce a scrapbook with entries explaining the designing and testing process for your glider
OR
 - Write a diary with entries explaining the designing and testing process for your glider
2. Be sure to read carefully the criteria and Glider Design Rubric first because they will help you know what is expected of you.

Criteria

Your Glider Design should be **creative and original**. The final project should include descriptions or demonstrations of

- ☐ how air helps your glider to fly (Bernoulli's Principle)
- ☐ the forces of flight acting on your glider
- ☐ the various parts of your glider and what they do
- ☐ how far your glider went during testing (Glider Test Log)
- ☐ improvements you made to get to your final design

Glider Design Rubric

	Excellent	Proficient	Adequate	Limited
Organizes and present information	Presents information in a well-organized and creative format.	Presents information in a detailed and interesting format.	Presents information in a simplistic or somewhat disorganized format.	Presents information that is vague and does little to sustain interest.
Describes properties of air	Includes accurate and detailed descriptions of Bernoulli's Principle and other properties of air.	Includes clear descriptions of Bernoulli's Principle and other properties of air.	Includes appropriate descriptions of Bernoulli's Principle and other properties of air, but may be incomplete or inaccurate.	Includes vague, irrelevant, or inaccurate descriptions of Bernoulli's Principle and other properties of air.
Explains the forces of flight acting on the glider	Provides in-depth description of lift, drag, gravity and thrust with detailed explanation of how they affect the glider.	Provides clear description of lift, drag, gravity and thrust with some explanation of how they affect the glider.	Provides partial description of lift, drag, gravity and thrust with little reference to how they affect the glider.	Provides vague description of lift, drag, gravity and thrust with little or no explanation of how they affect the glider.
Describes the various parts of the glider	Provides in-depth description of the various parts of the glider and what they do.	Provides clear description of the various parts of the glider and what they do.	Provides partial description of the various parts of the glider and what they do.	Provides vague or incomplete description of the various parts of the glider and what they do.
Able to conduct tests and modify glider designs	Provides innovative design with clear and logical modifications following rigorous testing.	Provides effective design with reasonable modifications following thorough testing.	Provides simple design with basic modifications following limited testing.	Provides impractical design with few modifications following little or no testing.

Collaboration Opportunity

Students who are moving through this course as a cohort would benefit from collaboration activities. This assessment is ideal to invite peer review.

Check It

When your Glider Design is complete, share it to your group for feedback.

5. Post your Glider Design on our class discussion board/blog to share it with your group.
6. Upload the **Glider Design Rubric** to our class discussion board/blog.
7. Ask your group members to look at your Glider Design and give you feedback.
8. They will leave feedback based on the rubric and these criteria:
 - Has the student demonstrated a good understanding of the properties of air and forces of flight?
 - Identify the two best parts of the glider design, and explain why you think they are the best.
 - Identify one part in the glider design you would revise, and make specific suggestions to improve it.
 - What is your general impression of the glider design? Select three words or phrases to describe the work.

Sample Feedback Form

Has someone in your group asked you to view his or her guide and give feedback?

1. Read the **Glider Design Rubric**.
2. View the glider design.
3. Think about the following criteria before you provide feedback:
 - Has the student demonstrated a good understanding of the properties of air and forces of flight?
 - Identify the two best parts of the glider design, and explain why you think they are the best.
 - Identify one part in the glider design you would revise, and make specific suggestions to improve it.
 - What is your general impression of the glider design? Select three words or phrases to describe the work.
4. Look at the Glider Design two or three more times as you consider the rubric and criteria.
5. Write what you would like to say as feedback. Then, provide your feedback to the group member.

Sentence starters for providing feedback:

- You might think about _____.
- You might consider _____.

- What if you _____?
- I had trouble understanding _____. You might want to clarify this part.
- I noticed that _____.
- It helped when you _____.
- I liked _____ because _____.

Please provide your feedback here:

Resource Reference List

Below is a complete list of all the resources that are used to support learning in this unit.

Introduction to Air, Aerodynamics, and Flight

Albatross – Video

<http://www.gettyimages.ca/detail/video/wandering-albatross-flying-above-ocean-antarctica-stock-video-footage/1410-59?Language=en-GB>

Daedalus and Icarus – History for Kids

<http://www.historyforkids.org/learn/greeks/religion/myths/daedalus.htm>

Plane Game

<http://www.grc.nasa.gov/WWW/k-12/UEET/StudentSite/games/theplanegame.htm>

What is air?

How Air Brakes Work

<http://auto.howstuffworks.com/auto-parts/brakes/brake-types/air-brake1.htm>

• **What is air made of?**

What is in the air – Geology for Kids

<http://www.kidsgeo.com/geography-for-kids/0042-composition-of-the-atmosphere.php>

Stuff in the Sky

<http://eo.ucar.edu/kids/sky/air1.htm>

Burning Candle Experiment

<http://www.youtube.com/watch?v=qUwxq7QmSmQ>

The Causes of Rusting

<http://www.youtube.com/watch?v=l1bFxGRXIRc>

Photosynthesis Song

http://www.youtube.com/watch?v=8u_hwwztRqI

- **What are the properties of air?**

That's Just Nuts

http://www.youtube.com/watch?v=kYfTJPY_2Xg&feature=relmfu

Paper Chase

<http://www.ohio4h.org/flight/airhand1.html>

Balloon Balance – Video

http://www.youtube.com/watch?v=Bv_tS6-qCJ4

Air Underwater

<http://www.youtube.com/watch?v=WBNNfKT6Kk0>

ADLC Digital Lesson: Pressure

http://www.youtube.com/watch?v=PQtb_q8_Lus&feature=youtu.be

Air Bag Recovery System

http://www.youtube.com/watch?v=GKKzIXy_mRc&feature=related

Pouring Air

<http://www.pbslearningmedia.org/resource/phy03.sci.phys.matter.zbubble/density-and-buoyancy-pouring-air-into-water/>

Gas Properties

<http://phet.colorado.edu/en/simulation/gas-properties>

Balloon in a Bottle

<http://weirdsciencekids.com/Ballooninbottle.html>

What forces are involved in flight?

Aerodynamics of Planes and Cars

<http://www.youtube.com/watch?v=YQwh2fdfYiM>

How Things Fly

<http://howthingsfly.si.edu/>

- **How do flying devices and living things counter act gravity?**

Forces of Flight – Weight

<https://www.youtube.com/watch?v=Vqg2uDYOyTA>

- **How does air movement across a surface result in lift?**

Air in Motion

<http://howthingsfly.si.edu/aerodynamics/air-motion>

Bernoulli's Principle Explained

<http://www.youtube.com/watch?v=O8qCA2mZvVI>

The Thrill of Flight

<http://www.learnalberta.ca/content/setf/html/StudentResource/source/Welcome.html>

That's Science?? – Curveballs – Video

<http://www.youtube.com/watch?v=Xqu3jpQeJG8>

• How can drag be reduced?

Apollo 15 Proves Galileo Correct

<http://www.youtube.com/watch?v=ZVfhztmK9zI>

Mars Rover Animation

<http://www.jpl.nasa.gov/video/index.php?id=1001>

Zoom Kids Parachute

<http://pbskids.org/zoom/activities/sci/parachute.html>

Aero Parachutes

<http://www.aero.com/publications/parachutes/makeprch.htm>

Toy Parachutes

<http://zakkalife.blogspot.ca/2011/06/how-to-make-toy-parachute.html>

Design and Test a Parachute

<http://www.sciencekids.co.nz/experiments/freefall.html>

• What means of propulsion is used in aircraft?

ADLC Digital Lesson: Newton's Third Law

<http://www.youtube.com/watch?v=Fh9SoKQi7cl&feature=youtu.be>

Propulsion

<http://howthingsfly.si.edu/propulsion>

Thrust: Propellers – Video

<http://howthingsfly.si.edu/media/thrust-propellers>

Thrust: Rocket Engines – Video

<http://howthingsfly.si.edu/media/thrust-rocket-engines>

Film Canister Rocket

<http://www.youtube.com/watch?v=7nE0Ksi3o9o>

Steve Spangler Science

<https://www.youtube.com/watch?v=C0xD9O-gSAw>

What parts are needed for things to fly?

The Wright Brothers

<http://airandspace.si.edu/exhibitions/wright-brothers/online/>

• How does a hot air balloon fly?

How Hot Air Balloons Work – Video

http://www.youtube.com/watch?v=77Ej_Ayugxk

Buoyancy

<http://howthingsfly.si.edu/gravity-air/buoyancy>

Hot Air Balloons by Masha and Patsy: Dragon Fly TV – Video

<http://pbskids.org/dragonflytv/show/balloon.html>

Wonderopolis – How Does a Hot Air Balloon Fly?

<http://wonderopolis.org/wonder/how-does-a-hot-air-balloon-fly-2/>

What adaptations enable animals to fly?

Why can a Bird Fly?

<http://www.mysciencesite.com/science6airflight2.html>

Butterfly flight

<http://phys.org/news/2012-02-butterfly-flight-bug-size-robots.html>

Airborne Experiment - Wonderville

<http://www.wonderville.ca/asset/airborne-experiment>

• How do the parts of an aircraft stabilize and control its flight?

Design your own aircraft

<http://www.juniorflyer.com/posts/design-your-own-aircraft/>

Becoming an Airline Pilot

<http://www.videojug.com/interview/becoming-an-airline-pilot-2>

Airplanes

<http://www.learnalberta.ca/content/setf/html/StudentResource/source/Welcome.html>

Lift and Drag – NOVA

<http://www.pbs.org/wgbh/nova/space/lift-drag.html>