Activity Answers

Activity 1 answers

Before you go to Dayton to investigate the Wright Brothers, it is important to do some research and get some background information. You need to go to the library and/or the Internet and find out about the progress of attempts to build a flying machine up to the year 1900. Write a short paragraph about each of the following and their accomplishments up to 1900:

1. Otto Lilienthal  
2. Octave Chanute  
3. Samuel Langley

See whether you can answer the following questions:

1. Why do you think some of these early pioneers were using gliders instead of powered aircraft? Why didn’t their craft have engines?
   The glider wings they had constructed could not provide enough lift to handle the weight of the pilot plus the weight of the engine.

2. What was the record for distance and time aloft by a manned glider in 1900?
   d. Otto Lilienthal had glided over 1300 feet and stayed aloft 12 to 15 seconds.

3. Why was gliding so dangerous at the time?
   Fliers did not understand how to control the gliders in the air. Lilienthal thought that just by shifting his weight he could control the direction the glider flew. This proved to be inadequate, and he crashed from a height of over 50 feet. Pilcher also died in a similar fashion.

4. Why do you think Chanute chose to test his gliders at the Indiana Dunes on the southern shore of Lake Michigan?
   There are steady winds coming off the lake, which are needed to fly a glider. There were also hills (dunes) from which to launch and soft sand to land on.

5. How far is it from Cincinnati to Dayton? How do you think you might have travelled there in 1900?
   49.5 miles, travel by train.

Activity 2 answers

Now that you know something about the state of flying machines in 1900, pretend that you are a reporter for the Dayton Daily News. You are being sent to interview the Wright Brothers. What questions do you think you’d want to ask them about what they are attempting to do?

Student answers will vary.

Some possible questions might be:

   How will you control your glider?
   Where will you fly?
   Are you going to try to use a motor?
   Who will be the pilot?
   Are you afraid?
   How will you get your glider into the air?
   How will you land without getting hurt?
   What materials will you use to construct the glider?
   How are you going to finance your experiment?
   If you succeed, what will you do with your invention?
   How high and how far would you like to fly?
   How will you record your progress? Will you take pictures?
   How will you take off?
Activity 3 answers

1. From your trip, why do you think Wilbur was flying a large kite in the summer of 1899? What do you think he learned from doing it?

   He was learning how to control an object in the air.

2. Having arrived back in Cincinnati after visiting the Wrights in Dayton, you must make a written report to the Scientific Society. What are the key points that you need to report?

   A. The Wrights have learned to control a craft in the air by twisting the wings.
   B. They have constructed a very large craft to test their ideas.
   C. They will be testing somewhere in North Carolina in the fall.

3. Why do you think the Wright Brothers are headed to North Carolina? What kind of conditions do you think they are seeking to carry out their glider experiments?

   They are going to Kitty Hawk in North Carolina because it has nearly constant high winds, the strongest in the country. There are also hills (dunes) from which to launch, sand to land on, and few trees to crash into.

Activity 5 answers

Your report to the Cincinnati Scientific Society stimulates a lot of discussion. The members have many questions as they try to understand the Wright's experiments. How do you think you would answer this sampling of their questions?

1. Why did the Wrights use a two-wing (biplane) arrangement?

   Two wings provide twice the amount of lift.

2. What was the purpose of having the wings be curved or arched?

   Giving the wings a curved surface (called camber in modern planes) causes the air to turn as it flows over the wings, and this provides lift.

3. Why did the pilot of the Wright Glider lie down on the wing instead of hanging from the glider, as in Lilienthal and Chanute's gliders?

   Lying down on the wing greatly reduces wind resistance. It also makes control of the glider easier to achieve and protects the pilot from hard landings.

4. Why do you think twisting the wings caused the glider to drift left or right? How much did the wings twist? If they stayed twisted, do you think the glider would fly in circles or crash? Why?

   Twisting the wings changes the amount of lift they provide, so the craft rolls left or right. The wings only need to twist a small amount to cause a roll. If the wings stay twisted, the glider is likely to crash. For a glider to fly, it needs to stay facing into the wind like a kite, so it would not be able to circle.

Activity 6 answers

Orville told you that he and Wilbur are determined to create a flyable machine, and that to do this they are going to have to get more lift out of their craft so it can support a pilot. When you report this to the Cincinnati Scientific Society, the members start to debate about what they think is the best way to accomplish this. It is decided to have a contest to see who can produce the best design to improve upon the Wright Glider.

1. If you were to enter this contest, what specific changes would you make to give the 1900 Glider more lift? Answers will vary. Longer wings, wider wings, more curved wings, lighter weight material
2. How do you think each change would improve the original design?  
   Answers should focus on providing more lift through bigger wings and/or less weight.

3. This is a drawing of the 1900 Glider. It had a wingspan of 17 feet and a wing area of 165 square feet. On another sheet of paper draw a sketch of your proposed glider, showing a top view and a front view. Be sure to put dimensions on your sketch. How long, wide, and high will your glider be?  
   See student drawings. They should have two views and labeled dimensions.

Activity 8 answers

The picture below shows the Wright Brothers at Kitty Hawk, NC, with their 1901 Glider being flown as a kite. It weighed 98 pounds and had a wingspan of 22 feet. The kite appears to be floating in the air, but it is actually being held motionless because the forces that are acting on it are “balanced.”

1. You know that wind is needed to fly a kite, so draw an arrow on the picture to show which way the wind would be pushing on the glider.

2. There are three other forces that are acting on the kite. One of these is the lift caused by the wind acting on the wings of the glider. Draw an arrow to show the direction that this force acts on the glider.

3. The third force acts on you and all other objects on Earth all the time. It is called gravity. Draw an arrow to show the direction that this force acts on the glider.

4. Look at the men in the picture and see if you can determine the direction of the fourth force. Keep in mind that the glider is motionless, so the fourth force must act to balance out the other three forces. Draw an arrow to show the direction of the fourth force.

5. Do you see anything in the picture that shows that all the forces are canceling each other out? If yes, what is it? Yes, because the glider is not moving.

6. If the speed of the wind increased, what would happen to the glider? The glider would fly up and away.
Activity 9 answers

The report of the summer of 1901’s activities caused quite a stir in the Cincinnati Scientific Society. When you mailed sketches of the new craft back in July, many members had thought that the additional surface added to the wings would provide the lift needed. Clearly something was wrong.

1. Why do you think that the new glider with its larger wings failed to perform as expected? 
   Answers will vary. Some possibilities might be that it was too heavy, the wings weren’t curved enough, the big wings caused too much drag, inaccurate design data, etc.

2. If you were Wilbur or Orville Wright, what would you do at this point? Why would you do this? 
   Answers will vary. Some possibilities might be to quit, ask an expert for help, do more research, change the wing shape, change the wing size, make it lighter, reevaluate your data, etc.

3. To solve a problem, the Wright Brothers would only make a single change at a time. Why is this a scientific way to do an experiment? 
   Because if there is a difference in data after making a single change, it will be clear why it happened.

Activity 10 answers

Advances in science are often hindered by making wrong assumptions, making assumptions based on incorrect information, or by not understanding information or data in the right context. The Wright Brothers thought the reason their 1901 Glider did not perform up to expectations was that Lilienthal’s data, on which they had based their calculations, were wrong.

Choose one or more of the following ideas that were once accepted as correct in science. Find out who challenged these ideas and how our thinking changed as a result. Write down your answers.

1. The Earth is flat.
   Answers will vary. Eratosthenes used the Sun shining into a well to calculate the Earth’s diameter in 230 BC. Columbus did not sail off the edge of the Earth. Magellan was able to circumnavigate the Earth.

2. The Sun revolves around the Earth.
   In 1530, Nicolas Copernicus showed that the Earth revolved around the Sun in addition to turning on its axis. Galileo observed moons orbiting Jupiter in 1630.
Activity 11 answers

The Wright Brothers are credited with a number of “firsts” in the science of aeronautics. One of these firsts was using a wind tunnel of their own design (a 6-foot long rectangular box) to gather data and to design wing shapes (called airfoils). Wind tunnels are still used for many kinds of research. Some of them are very large; some are supersonic; some are very cold; and some simulate very high altitudes.

1. Why did the Wrights construct their own wind tunnel?
   Because they wanted to gather their own aerodynamic data. They wanted to test the Lilienthal data. They did not understand how to apply the Lilienthal data.

2. When they ran their tests, the Wrights only allowed one person in the room and that person always had to stand in exactly the same place. Why do you think they had to take this precaution?
   Constant conditions are required to get consistent data. If a person moved, the airflow through the wind tunnel could be changed.

3. A grid was placed in the end of the box where the air entered. What function would you guess this served?
   The grid served to straighten the airflow. If the air swirled around, the conditions would not be constant.

4. What advantages are there to testing airfoils in a small box? (Try to list at least three.)
   1. It is cheaper to build models than full-size aircraft.
   2. It is safer to test a bad model than to fly a bad airplane or glider.
   3. It takes less time to test several designs.
   4. It is faster because the wind is constant in the tunnel and unpredictable outside. You don’t have to wait for good weather.
   5. It is easier to change or modify designs.

5. If you were to try to get good data on how well a wing design worked, which of the following wind tunnel arrangements do you think would be the best?
   “A” would be the best wind tunnel design.

A.  
B.  
C.  
D.  

What factors made you decide on this as the best design?
The air is pulled through the grid to straighten the flow before it goes over the model. That way, it has the least turbulence.
Part D.

Students should recognize that a glider with long, slender, curved wings is more efficient.
Activity 14 answers

Below are drawings of the gliders the Wright Brothers tested in 1900, 1901, 1902. Notice that Wilbur Wright is the same size in all three, which means all three are drawn to the same scale.

1. Try to list five ways in which all the gliders are alike.
   Answers will vary. Some possible answers could be that they all have two wings. They all have a pilot lying on the lower wing. They all have a small wing in front, etc.

2. What are some of the ways that they are different?
   Answers will vary. Some possible answers could be that they are different sizes. They have different wingspans. The small front wing is shaped differently, etc.

3. The 1901 and the 1902 gliders both have about the same wing area and they weigh nearly the same. Why do you think the 1902 is a better glider?
   The wings are longer and thinner. This gives the glider more lifting force and less drag.

4. Notice that in all three gliders, Wilbur is lying down. What do you think the effect would be if he sat up while flying them?
   If he sat up he would cause more air resistance. This would slow the glider down.

Activity 15 answers

1. If you made $100 a month in 1900, and a camera cost $1, what percentage of your monthly salary would it take to buy a camera in 1900?
   1 percent

2. If your yearly salary today is $36,000 and you want to buy a camera that costs $100, what percentage of your monthly salary would you have to spend? How does this compare to 1900?
   Your monthly salary would be $3000. You would have to spend about 3.3 percent of your salary to buy a $100 camera. The Brownie was much cheaper in 1900.

3. The Wright Brothers had to buy all the food to stock their camp and ship it by boat and horse-drawn wagon. In 1900, a loaf of bread cost 5 cents. Today it costs about $1, or 100 cents. The price of bread has increased by 100 cents divided by 5 cents, or 20 times. Find out how many times these items have increased in price since 1900 by completing the following table. You will need to find out today's prices.
   Here are some examples:

<table>
<thead>
<tr>
<th>Food</th>
<th>1900 price</th>
<th>Price today</th>
<th>Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 pounds flour</td>
<td>13 cents</td>
<td>$1.65</td>
<td>12.7 times</td>
</tr>
<tr>
<td>1 pound butter</td>
<td>26 cents</td>
<td>$2.50</td>
<td>9.6 times</td>
</tr>
<tr>
<td>1 dozen eggs</td>
<td>21 cents</td>
<td>$1.25</td>
<td>6 times</td>
</tr>
<tr>
<td>1 gallon milk</td>
<td>27 cents</td>
<td>$2.50</td>
<td>9.3 times</td>
</tr>
</tbody>
</table>

   Which item showed the biggest change in price? Flour
Activity 17 answers

If you were either Orville or Wilbur Wright, and it came time to design a flying machine with an engine, where would you place the engine and where would you place the pilot? Do you think that the pilot should sit up or lie down on the wing? Don’t forget that there had been numerous crashes in the brothers’ gliders over the past 3 years. Give some serious thought to the reason or reasons for your decision.

1. What are the advantages in the way you placed the engine and pilot?  
   Student answers will vary. If the pilot and engine are placed side by side, this would be safer in a crash. If one is placed behind the other, this would allow for better balance in the aircraft.

2. What problems do you think might be created with your placement?  
   Side-by-side placement might create balance problems. If the pilot is in front of the engine, it might land on him in a crash. If the pilot is behind the engine, his vision might be blocked and he would have to sit up.

3. Does your pilot sit up or lay down?  
   Varied answers.

4. Circle the direction that each propeller needs to turn to create the least amount of torque (twisting) of the aircraft.  
   The propellers should turn in opposite directions, either both toward the center of the airplane (one clockwise and one counter-clockwise), or both outward, away from the nose of the airplane. Turning outward away from the nose is probably best. The contrary motion helps to cancel out the torque each propeller creates.
Activity 18 answers

In constructing their 1903 Flyer, the Wright Brothers chose to place the engine on the wing next to the pilot. They felt that this would be safer for the pilot because the engine would not land on him if the flyer crashed. The problem that this created for them was one of balance. Neither Wilbur nor Orville weighed as much as the engine, and the wings needed to be level in order to have control of the plane. Try the following activity to see how to solve the problem:

Take a string and tie it around a 12-inch ruler in the exact middle. Now hook two paper clips together to represent the pilot and four paper clips together to represent the engine. Open up one of the end paper clips on each group as shown so that they can hang on the ruler (you can also cut the paper clip to size with a wire cutter). Hook the groups on either side of the center and then slide the paper clips along the ruler until the ruler hangs level.

When the ruler is level, the total weight of one set of paper clips times the distance from the center is equal to the total weight of the other set of paper clips times their distance from the center. Write down the inch readings for each group of clips.

Two paper clips set at \( 2 \) inches from the center
Four paper clips set at \( 4 \) inches from the center

Since one group weighs twice as much as the other group, it should only be half as far from the center. Check the inch marks and see if this is true.

For any distance that the two paper clips are set, the four paper clips must be set half as far from the center.

The Wright Brothers needed to stay near the center of the plane in order to control it, so rather than move farther out on the wing to balance the engine, they made the wings on the engine's side of the plane 4 inches longer than on the pilot's side. This caused extra lift force on that side to counteract the extra weight of the engine and keep the wings level!

You can simulate this by moving the four-paper-clip weight 1/4 inch farther away from the center so things are no longer balanced. Now, instead of moving the two-clip weight to rebalance, move the location of the string holding the ruler until everything is back in balance. Did you move the string toward the two-clip weight or the four-clip weight? **Toward the four-clip weight.**

Activity 19 answers

Questions
1. Whose stick was the closest to the actual 120-foot mark? Do you think this is a very far distance to fly? Answers will vary. The Wright Brothers' flight was not a very far distance to fly.

2. Could the Wright Brothers have flown
   A. From home plate to first base on a baseball field? **Yes**
   B. From home plate to the outfield wall of the nearest professional baseball stadium? **No**
   C. From one wing tip of a Boeing 747 jumbo jet to the other? **No**
   D. From one goal line to the other goal line on a football field? **No**

3. Make a graph showing the distance from each person's marker to the actual 120-foot mark of the first flight. Did the group make good estimations of the distance? Find the average distance from the 120-foot mark. Answers will vary.

4. Make a graph showing how long it took each person to run 120 feet. Did the group run faster than the Wright Flyer flew? **Yes**. Find the average time for the group.
### Activity 20 answers

This diagram represents the derrick (shown on page 34) used to launch the 1904 Flyer, which would rest on the small wheeled trolley (or launch cradle) shown on the launch track. The problem is how to get the launch cradle to move forward when the weight drops. Can you draw ropes (lines) and pulleys (circles) in a way to make this happen? Draw arrows to show the direction each section of rope would move when the weight is dropped.

1. If the wind generally comes from the west, which way should the launch cradle travel? Toward the west, into the wind.

2. What are the difficulties in using this launch system? **Lifting the weight.**

3. Why didn’t they just use the force from the flyer’s propellers to take off like planes do today? The flyer’s propellers couldn’t produce enough thrust to take off, although they produced enough to fly.