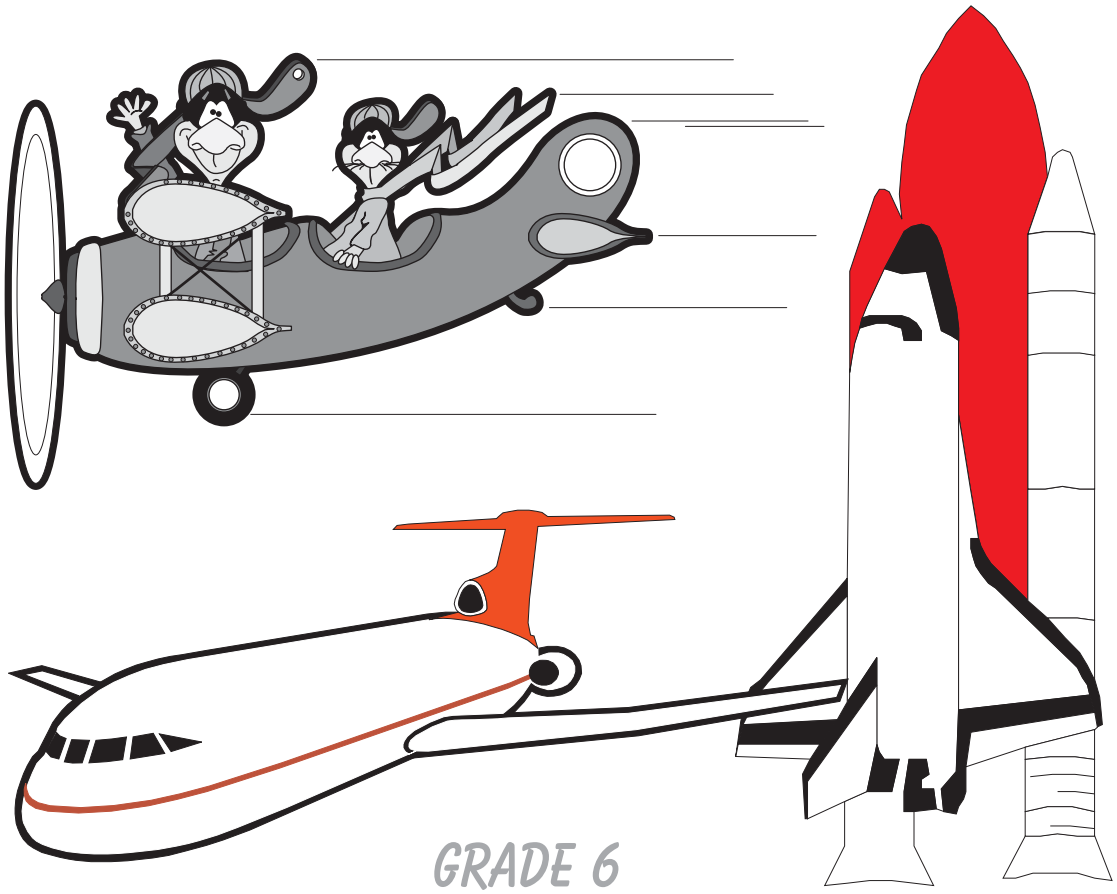
Introduction to Technology

PRINCIPLES OF FLIGHT



GRADE 6

BIGELOW

MIDDLE SCHOOL

Newton, MA

TECHNOLOGY EDUCATION

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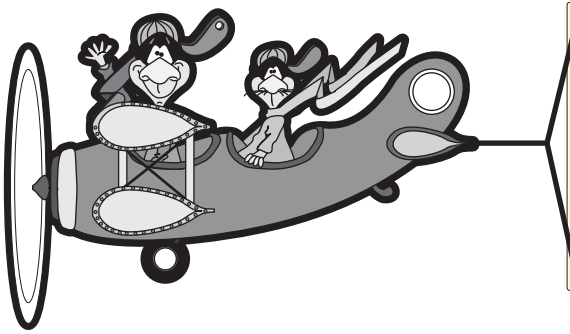


Principles of Flight

One of the most innovative and imaginative transportation inventions has been in the area of flight. People have been dreaming of flying for years. Even great inventors like Leonardo da Vinci thought people should be able to fly like birds. Flight was first developed to overcome passions and dreams, only later was it utilized for transportation. Each human journey into the sky involved ***Technology*** - designing, building, and using a device to extend the human potential.

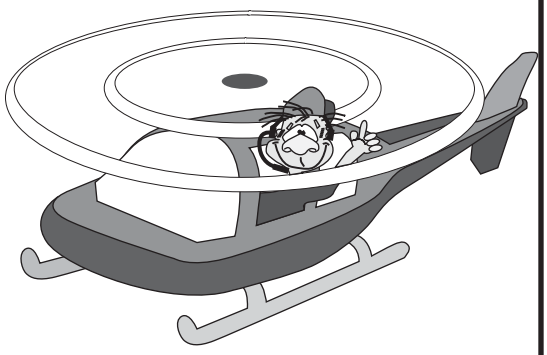
Aircraft can be divided into two categories: ***lighter-than-air*** craft and ***heavier-than-air*** craft. Lighter-than-air craft are able to float in the air (like a hot air balloon), while heavier-than-air craft (airplanes and rockets) must apply some sort of power to enable them to fly.

The first really successful aircraft of any kind was a hot air balloon designed by the ***French in 1783***. They weren't even really sure how the balloon went up, but it did. Have you ever heard of the ***Hindenberg***? What was it? How did it work? What happened to it? Today we use blimps instead of ***Dirigibles***. Blimps use ***helium*** gas, which is much safer than hydrogen. Have you ever seen a blimp? What do they look like? What are they used for? If you've ever seen a Super Bowl football game you have probably seen how blimps are sometimes used.

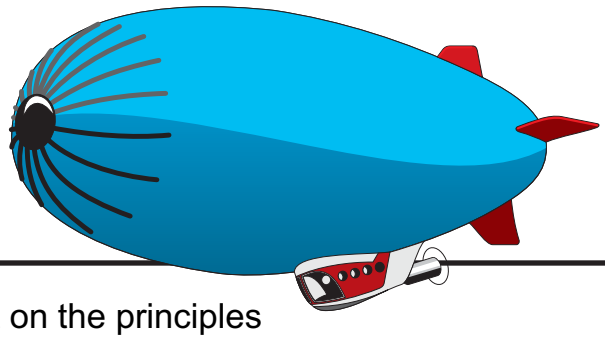
Do you know who made the first controlled flight in ***1903***? If you answered the ***Wright brothers'*** you are correct. The Wright brothers experimented with gliders and even built a wind tunnel to help them develop ways to control the plane in flight. In other words they had to know about the forces working against the plane in order to overcome them. The plane must overcome four forces: ***weight, lift, thrust, and drag***. It is like a four-way tug of war with the plane in the middle.

An eighteenth-century Swiss scientist named Daniel Bernoulli discovered, when air speeds up its pressure is reduced, and when air slows down its pressure is increased. Therefore the air that speeds up over the top of a wing creates a slight suction which pulls upward on the wing. At the same time, the air flowing below the wing slows down and bunches up which creates an upward force on the wing. Lift is a combination of these two forces.

Most all airplanes share the same six basic body parts: A ***fuselage***, an ***engine(s)***, ***wings***, a ***rudder***, ***elevators***, and ***ailerons***. In this activity you will be challenged to construct, fly, and test a paper airplane of your own. Your paper airplane will have all the parts of a real plane except you will supply the power by throwing it.



Unit overview



In this activity you will conduct a scientific experiment on the principles of flight. All students will construct a paper airplane, conduct tests about the plane's flight performance, make alterations to the airplane's structure and finally make a conclusion based on your findings. All testing is to be done inside the Tech Lab.

Make sure all of the following steps are completed

- ☐ Construct a paper airplane using one 8 1/2" x 11" piece of paper only (No tape)
- ☐ ***Step 1*** Observe the overall design of your plane. Answer the "Hypothesis" questions for you plane.
- ☐ ***Step 2*** Label the wing diagram to illustrate Bernouli's Principle.
- ☐ ***Step 3*** Complete the duration tests by measuring the amount of time that your plane stays in the air each time you throw it. Count "one thousand one", "one thousand two", "one thousand three"... until the plane lands.
- ☐ ***Step 4*** Complete the distance tests by measuring the distance your plane flies each time you throw it. Count the squares on the floor to get the distance flown. (Each square is 1 foot)
- ☐ ***Step 5*** Complete the aerobatics tests by recording the number of loops, turns, twists, dips, dives, etc. that your plane makes during each test flight. You will be conducting 9 test flights in all, 3 tests throwing your plane straight ahead, 3 tests throwing it upward, and 3 tests throwing it downward.
- ☐ ***Step 6*** In the spaces provided, list all of the places you have flown in your life. List the departure city and the destination city for each flight and indicate if it was a round trip. After all trips have been listed use the map of the world to estimate the distance you travelled (in miles) for each trip and record the miles in the space provided. Finally add all of the miles you have flown together and record the total miles you have flown
- ☐ ***Step 7*** Think about the total miles you have flown in your life. WOW! My guess is that it is a HUGE number. Imagine driving all that way or taking a boat or train. Answer the question in the space provided.
- ☐ ***Step 8*** Label the parts of the 747 Jet Airliner diagram.
- ☐ ***Step 9*** This is where we get a chance to alter our plane in different ways. First, you will add weight to the plane and test it 3 times each. Second, you will make ailerons on the wings and record the effect they have on the way the plane flies. Last, you will try to make your plane do specific things, like turn to the left or right, do a loop or a twist, fly up in the air or downward, etc.
- ☐ ***Step 10*** The Final step in completing this TLA is to reflect on all the data we have collected from this experiment and to write a conclusion based on your findings. Good Luck! ☺

WHY PAPER AIRPLANES CRASH

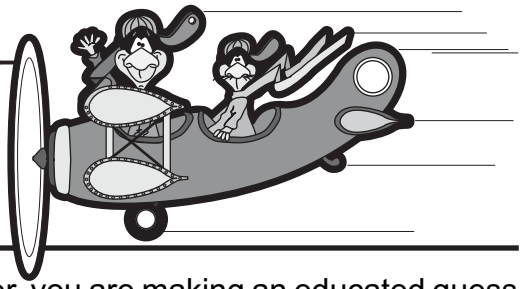
"Y" SHAPE

In order to keep your plane flying, you must make sure the plane is stable. ***Stability*** keeps the plane balanced and symmetrical and also assures the plane will fly smoothly forward. There are three types of stability: pitch stability, directional stability, and roll stability.

In order to assure the plane is ***pitch*** stable you need weight in the front of the plane. This keeps the plane's nose from diving up or down. ***Directional*** stability is what keeps the plane flying straight. Keeping the plane symmetrical (left side = right side) will help you do this. ***Roll*** stability keeps the plane level. A plane without roll stability will have a tendency to spiral to the ground. To give the plane roll stability make sure the wings form a slight **"Y"** shape. (see below)

HINT:
Sometimes adding a rudder, ailerons, or corner flaps help to keep the plane stable in all areas..

Name:_____ Class:_____



Hypothesis

Answer the following questions in complete sentences. Remember, you are making an educated guess as to how your plane will perform in the following tests. Look closely at your plane design and consider many things when making your decisions. *(Overall plane design, wing size, wing shape, fuselage size and shape, balance of plane design, etc.)*

1. **How long do you think your plane will stay in the air in seconds?**_____.
_____.
_____.
_____.

2. **How far do you think your plane will fly in feet?**_____.
_____.
_____.
_____.

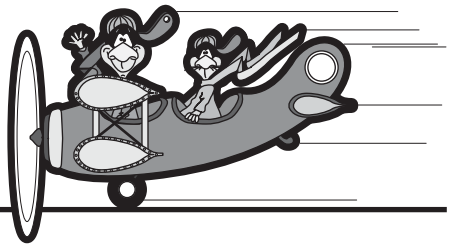
3. **Describe what your plane will do when you throw it. (fly straight ahead, do flips, loops, turns, dips, etc.)**_____.
_____.
_____.
_____.

4. **Do you think your plane will mostly be a "duration" flyer, a "distance" flyer, ans "aerobatic" flyer, or a "combination" flyer?**_____.
_____.
_____.
_____.

5. **Explain why you think your plane will behave this way.**_____.
_____.
_____.
_____.

Name:_____ Class:_____

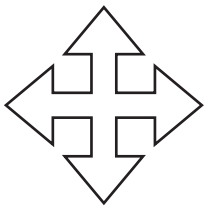
Worksheet 1

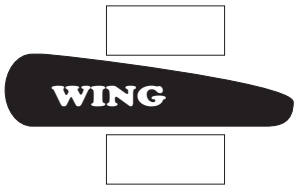


1. Write the hypothesis and conclusion on the back of this sheet. (10 pts.)_____

2. Illustrate Bernoulli's Principle: (5 pts.)_____

- **Shade in the 2 directions the wing will move in when flying.**
- **Label the wing to show the high pressure (HP) and low pressure (LP) zones by writing HP or LP in the boxes.**





3. Duration (5 pts.)_____

For this category, make three separate test flights. Count the number of seconds your plane stays in the air. Simply count... 1 alligator, 2 alligator, 3 alligator, etc. Round up to the nearest second. Time the plane from the moment it leaves your hand to the moment it lands. If the plane hits a wall or an object, the flight doesn't count. Add the three test flights and divide by 3 to get the average duration time.

Test	1	2	3	Average
Time (in seconds)				

4. Distance (5 pts.)_____

Again, make three separate test flights. For each flight use the squares on the tiled floor to determine the distance the plane flies. (HINT: each tile is 1 foot square) If the plane hits a wall or an object, the flight doesn't count.

Test	1	2	3	Average
Distance (in feet)				

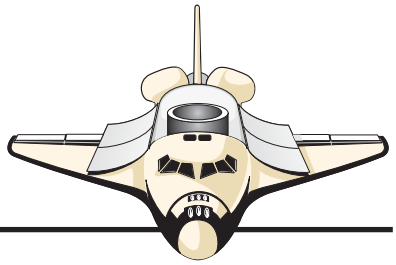
5. Aerobatics (5 pts.)_____

For this category, you must fly your plane straight ahead, tilted upward, and tilted downward three times each. (You will make nine test flights in all) Record the number of loops, sharp turns, dips, rises and other aerobatic maneuvers the plane makes on the chart below. Be as specific as possible.

Test	1	2	3
Straight Ahead			
Tilted Upward			
Tilted Downward			

Name:_____ Class:_____

Worksheet 2



6. In the spaces below list all the places you have ever flown. Use the map of the world to determine how far (round trip in miles) each trip was and record the mileage. Add all of the mileage up and record the total miles flown. (10 pts.)_____

Departure City	Arrival City	Miles

Departure City	Arrival City	Miles

Total miles flown: _____

Try to imagine how long it would take to drive as far as you have flown. Is it possible to drive to every location you have flown to? Perhaps you could reach some of the destinations by boat, if so think how long that would take you.

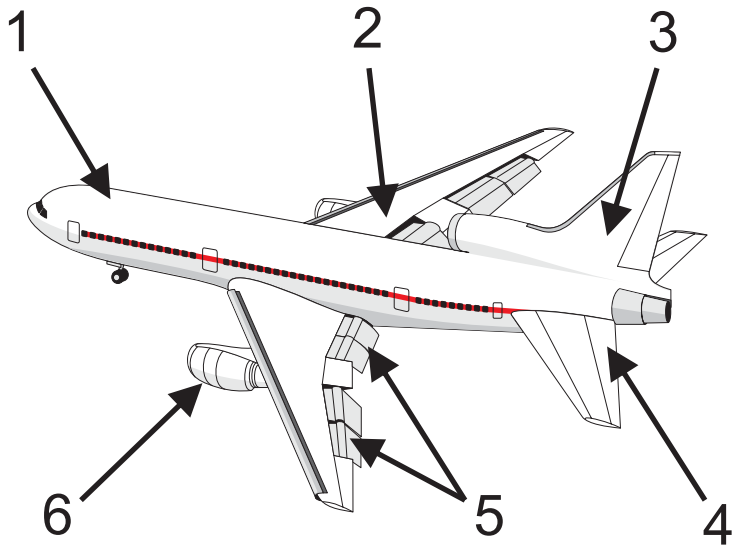
7. How does traveling by boat, car, or train compare to flight? (10 pts.)_____

_____.

_____.

_____.

8. Use the numbers below to label the parts of the plane. (10 pts.)_____



Rudder _____.

Engine _____.

Fuselage _____.

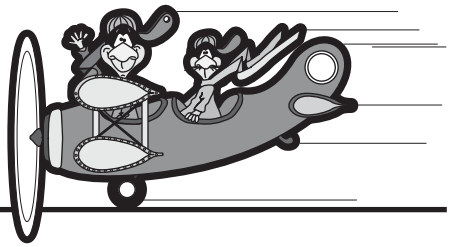
Elevators _____.

Wing _____.

Ailerons _____.

Name:_____ Class:_____

Alterations #1



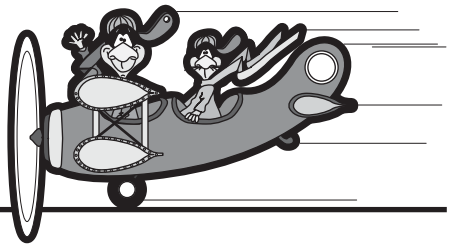
9. Now it's time to make some alterations to your plane. For this part of the activity it is important to test your plane at least 3 times and record the results after each alteration you make. Be sure to be as descriptive as you can, because eventually youcould win prizes if you can remember how to make your planes do the following stunts. (10 pts.)_____

Test	1	2	3
Add a paper clip to the front of the fuselage			
Move the paper clip to the middle of the fuselage			
Move the paper clip to the back of the fuselage			

For the next few tests you will need to add an aileron to the back of each wing. Cut 2 slots the same length on the back side of each wing with scissors. The ailerons can be bent up or down to control the plane in flight. Record what the plane does in the space provided **(10 pts.)_____**

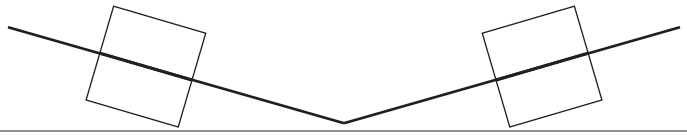
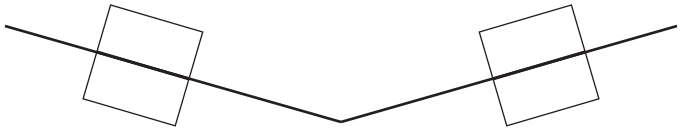
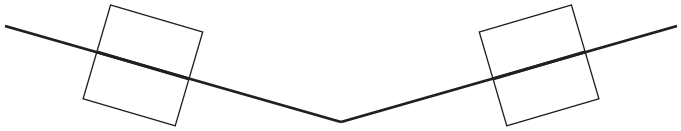
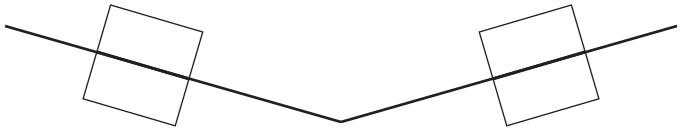
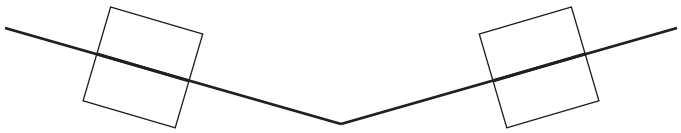
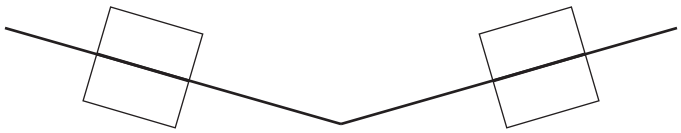
Test	1	2	3
Bend both ailerons up and test three times			
Bend both ailerons udown and test three times			
Bend one aileron up and one down and test three times			

Name:_____ Class:_____

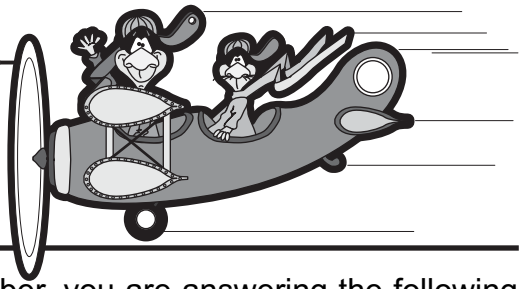


Alterations #2

Anyone who flies an airplane must be able to control the plane and make it do what he/she wants it to do. For this part of the activity you will be using the data you have collected to try to make your plane behave the way <u>you</u> want it to. (You may adjust the weight of your plane, the balance, or the ailerons) Refer back to the previous worksheets to determine the best combination of alterations to accomplish each task. Record what you did to your plane to make it do the specific tasks.
For instance: To make my plane fly to the right I put the left aileron in the up position and the right aileron flat with the wing. (simply shade in the aileron combination that worked for your plane) **(10 pts.)_____**

Test	Left Aileron	Right Aileron	Notes
Right turn			
Left turn			
Fly up			
Fly down			
Do a loop			
Do a twist or spiral			
Make any other change you want and record the results in this space			

Name:_____ Class:_____



Conclusion

Answer the following questions in complete sentences. Remember, you are answering the following questions as they apply to your plane test results. (10 pts._____)

1. How close were your hypothesis predictions to your actual flight data?

Test	Hypothesis	Actual Data
Average Duration		
Average Distance		
What kind of plane *(circle one)*	Distance flyer Duration flyer Aerobatic flyer Combination flyer	Distance flyer Duration flyer Aerobatic flyer Combination flyer

2. Explain why your plane flew the way it did before making any changes to it. ***(Did it crash, fly straight, do flips or turns and why did it do that?)***

_____.

_____.

_____.

3. Which part or parts of the plane made it fly the way it did? (wing size, wing shape, fuselage, balance, stability, etc.)_____.

_____.

_____.

4. What were you able to do to your plane when you added ailerons to the wings?_____.

_____.

_____.

5. Explain one way that you improved the way your plane flew. (adding weight, ailerons, a rudder etc.._____.

_____.

_____.

_____.

6. Why did we only make one change at a time when testing our planes?

_____.

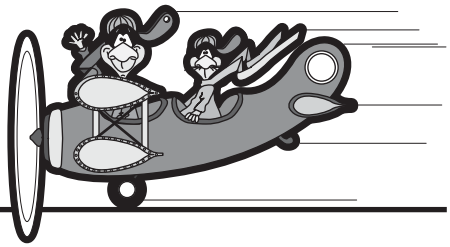
_____.

_____.

7. If you had a chance to make and test another airplane, what would you do differently?_____.

_____.

Name:_____ Class:_____



Unit Summary

Now that we have finished the "Principles of Flight" Technology Learning Activity, let's see how much you have learned as a result. Answer the following questions the best you can. You may use all of the worksheets you have completed in your design portfolio.

1. Why was flight first developed?_____.

2 What is flight mostly used for today?_____.

3. List the two categories that all aircraft can be separated into and give one example of each.
   1._____. Example:_____.
   2._____. Example:_____.

4. What was the first really successful aircraft to fly designed by the French in 1783?_____.
   _____.

5. What kind of aircraft was the Hindenberg? (Hint: it was not a blimp)_____.

6. What is the major difference between the Hindenberg and blimps as we know them today?_____.
   _____.

7. List two common uses for blimps today. 1._____ 2._____.

8. Who made the first controlled flight in 1903?_____.

9. What is a wind tunnel used for?_____.

10. How do wind tunnels help engineers when designing new aircraft or testing existing ones?_____.
    _____.

11. List the four fources a plane must overcome in order to fly
    1._____. 2._____. 3._____. 4._____.

12. List the six basic body parts of an airplane. 1._____. 2._____.
    3._____. 4._____. 5._____. 6._____.

13. How did your plane behave when you added a paper clip to it?_____.
    _____.

14. How did your plane behave differently when you added ailerons to the wings?_____.
    _____.

15. What changes(s) did you make to your plane on your own to make it do special stunts?_____.
    _____.

16. Explain how Bernoulli's Principle is the science behind the way a plane flies.
    _____.
    _____.

17. Explain how flight plays a very important role in our lives today._____.
    _____.

18. What physical characteristic(s) of your plane made it fly the way it did? Explain._____.
    _____.

19. On a scale from 1 to 10, how well did you like this TLA? 1 2 3 4 5 6 7 8 9 10

20. What other activities would you like to do next year in Engineering Technology Class?_____.
    _____.
    _____.