Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
1990 Volume VII: What Makes Airplanes Fly? History, Science and Applications ofAerodynamics

# What Makes Airplanes Fly . . . Why Me

Curriculum Unit 90.07.04
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## Outline

*The Journal Entry (J.E.) method was so effective last year, I will use this excellent organizational procedure in this year's unit also.*

## *INTRODUCTION*

I. The primary goals of this unit will be to:

1) Have students understand the historical development of human attempts to fly. A lot of this appreciation will come in their own personal attempts in trying to make certain objects fly.

2) The motivational level and curiosity expansion of investigating man's attempts at flying.

3) The practice of keeping recorded data for historical reasons and comparative sampling with one's peers.

As I have previously indicated, you will not be working with the usual guideline of chapter headings, but the guideline of Journal Entries.

## II. IN THE BEGINNING OF ALL J.E. WILL BE:

1) Goals and objectives of that lesson

2) Materials needed for unit work

3) Explanation to teacher as to what principle a child is trying to find out, but this formal explanation should only be given after all of the student's investigation is completed.

I believe that they will better comprehend, by actually seeing what the principle actually represents.

4) Books, films and other media communication (if any) will be included in the beginning of each J.E. This is because, I am concentrating on motivational interest not abstract reading theories, etc., which will allow the student to have the visualization and hands-on experience.

Remember the children are creating their own book of data, which in reviewing should be thorough enough to

give them all of the comprehensible written information that they will need, for now.

***JOURNAL ENTRY I***

"Helping Students Set Up A 'Scientific' Journal"

***ITEMS NEEDED :***

(1) Oak tag manila folders (schools should be able to supply these from their own stock)
(2) Three ring lined notebook paper. About 10 pages to start within each folder.
(3) Punch three holes in folder and put in 3 clip pins to hold papers.
(4) Books on crystals for children. (See Bibliography for students and teachers at the end of the *First Journal Entr* y.)

***LESSON OBJECTIVE : To have students begin to set up, in an organized fashion, a record keeping journal:***

(1) their observations and good description, preferably in writing.
(2) what occurred in the experiment; explain thoroughly, preferably in writing.
(3) what chemical, natural or synthetic, was used;
(4) apparatus used, including measurement devices;
(5) after each experiment, the student will, in three brief paragraphs (or more), state:
    a) what he learned from the experiment and
    b) in what way does this experiment relate to something in your everyday life.
(6) new words learned ( *Glossary* )

*These six objectives should be clearly-printed by each student in the front cover of the manila folder left side* . In this way, they will always know what their guidelines are for each experiment.

Start a glossary list which will be posted for all to see (e.g. on a size of oak tag paper—like the multiplication table charge poster). Also I would have students make their own identical word chart in their journals with definitions from the dictionary. (Use the noun definitions.) Use word that you (teacher) think is most important

from each J.E. for your spelling list.

*You may want to start giving these words on student weekly spelling test .*

## *JOURNAL ENTRY II*

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***LESSON OBJECTIVE : Mental preparation for setting the theme of flight throughout history.***

a) “The Greek Fable of Pegasus”
b) “ *Mercury,* ” with his golden winged sandals. The patron traders and robbers (I wonder why): messenger to the gods
c) *Daedalus* and his son *Icarus,* on wings of bird feathers and wax, and their daring escape from King Minos; and the tragedy that follows from over zealous youth.
d) *Leonardo da Vinci* turned his genius to mechanical flight. His early drawings “anticipated” the flying marvels of the 20th century—helicopters and other attached wings to aircraft.
e) From this point on, draw a time line to retrace what you (teacher) have covered, and put all other major flight historical events on this time line scale (see Exhibit A, Exhibit B, and Exhibit C).
f) Etienne and Joseph Montgolfier were two Frenchmen who took the principle that warm air rises. With an ornately decorated balloon made of linen over paper on November 21, 1783, the Montgolfier Balloon carried two occupants to an *altitude* of 900 meters (3,000 feet) above Paris. This is the first successful experiment in sustained flight with people.

1) Why do you think balloons could spy across enemy lines in the American Civil War?
2) How can balloons help in scientific research of weather?

g) The important missions of our space craft today.

1) Introduce books, in bibliography section, for students to read and get a picture in their minds of.
2) Children enjoy hearing teacher read mythology.

# J.E. II—Exhibit A

*Assembling a Time Line for: Who, What, and When*

***Purpose: Students identify some of the significant people and aircraft in the development of flight.***

***Task: Students construct an aviation timeline and explain the significance of events on the timeline.***

***Supplies***

1) Reference materials, roll of paper (e.g., adding machine tape or butcher paper), paste stick, photocopies of the "Who's Who and What's What" list and diagrams in this activity.

2) 15' scroll paper.

***Procedure***

1. Allow students sufficient time to find the date, significance in aviation history, biographical data, and other interesting information for the items on the list.
2. Discuss the relationship of invention and technological development to today's society.
3. Have students create an aviation timeline, cutting out the strips of paper from the photocopied sheets and then gluing the strips together so they look like a yardstick.
4. Have students illustrate the timeline. They color the eight circles that have drawings. They also create illusions for the four blank circles. In one of the blank circles, the student might draw a self-portrait as he or she appears today, and label it with the current date. In another circle, the self-portrait might be one of the student 25 years from today, with the appropriate date. The two remaining circles might be filled in with drawings of people, preferably from another generation, that the student knows (e.g., parents and grandparents), and labeled with their dates of birth.
5. Have each student place each circle in the appropriate spot on his or her timeline.
6. Students may hang their timelines at home, and explain the concept and contents to family members.
7. For students who wish to draw their own timeline, large enough to go on a wall, have them draw the various airplane styles on a large scroll. This is a good whole class project.

## J.E. II—Exhibit B

*(figure available in print form)**

*Have children look through bibliography books to see what mode of flight was used in this decade. Also, use a world map to stress the geographical travels of the main countries where the “Thinkers of Flight originated.”

## J.E. II—Exhibit C

*(figure available in print form)*

## *JOURNAL ENTRY III*

***MATERIALS NEEDED :***
1. metric tape

2. metric ruler

3. standard American ruler and tape measure

***OBJECTIVE :*** Having students become aware of metric measuring.

1. Have students measure everything that is measurable with a tape or ruler. This is just to get them started in thinking metric measurement.
2. If you wish to compare the metric measurement with the American standard do so, but keep in mind that these may confuse some children.
3. Word problems to use to relate standard math to flight (Exhibit J.E. 11 A)
    *1 inch = 25.4 millimeters
    *1 foot = 0.305 meters
    *1 yard = 0.914 meters
    *1 mile = 1.609 kilometers
    *These should be in students’ permanent Journal Entry vocabulary page.

# J.E. III—Exhibit A

***EXAMPLES OF FLIGHT MATH (in mph)***

1. If Charles Lindbergh got nine people to sponsor his flight across the Atlantic Ocean and the Spirit of Saint Louis cost $27,000 how much would each person give to C.L.? (B.K.)
2. If an average small commercial jet airplane carries 73 people that all weigh 125 pounds, and has 1,967 pounds of gas, how much weight is the plan carrying?
3. If an airplane's wing span is 200 feet long, and an eagle's wing span is 7 feet, how many eagle's wing spans equal the wing span of an airplane? (A.K.)
4. If I fly 2000 miles in an airplane a day, how many miles will I fly in a year? (W.T.)
5. To fly around the world the trip would take 12000 miles. If you're plane travels at a top speed of 200 MPH how long would it take to fly around the world 5 times?
6. The missile fired 5750 miles down the Pacific to hit an island target. It was traveling at 250 miles a minute. How long did it take to reach its target? (J.R.)
7. There are 17 planes in a hangar on a small field. If 6 planes are missing from each of 2 hangars, and there are 27 hangars, how many planes are there in all? (J.G.)
8. There were 600 planes in an air show. 35 crash and 26 get lost. How many are left? (T.N.)
9. There are 40 kids on the island of Krakatoa and there are 20 husbands and 20 wifes and Professor Sherman. There are also three mines of diamonds and in each mine there are 3965 diamonds. If every person on the island is entitled to an equal share of diamonds, how many will each person get?
10. Octave Chanute glided 927 feet, but Olga Klepkova has the record of 465 miles. How much farther did Klepkova go than Chanute? (1 mile = 5,280 feet.) (M.G.)
11. Charles A. Lindbergh had 3 tanks in his plane. Each tank was filled with 160 gallons of gas. Amelia Earhart had 2 gas tanks. Each had 200 gallons of gas. How many gallons did everyone have? (S.G.)

## JOURNAL ENTRY IV

***MATERIALS NEEDED :.***
Stop watch (for measuring time)

meter sticks or tapes

scratch paper

stapler

Use Exhibits J.E. IV, A, B, C, D

***OBJECTIVE :***
1) To become aware of how the shape of a piece of paper effects how it falls.

2) To measure time.

3) Averaging skills.

4) Calculating and hypothesizing on rates of fall.

5) Measuring centimeters and turning them into meters.

## J.E. IV—Exhibit A

*(figure available in print form)*

## J.E. IV—Exhibit B

*(figure available in print form)*

## J.E. IV—Exhibit C

*(figure available in print form)*

## J.E. IV—Exhibit D

*(figure available in print form)*

## *JOURNAL ENTRY V*

***MATERIALS NEEDED :***
Worksheets to help put newly learned terminology to practice. Exhibits A, B, C, D

***OBJECTIVE :***
Students will learn the parts of a real plane.

***DEFINITIONS :***

Ailerons—Surfaces on the outer edge of wing that move up and down, enabling the craft to turn about on the longitudinal (roll) axis. Used to control the rolling movement of an airplane so that it stays level and turns and banks easily.
Cockpit—Control center housing pilot and instrumentation and navigational aids used in flying.
Elevator—Surface on the horizontal part of the tail section that moves up or down to assist the aircraft in maintaining level flight and adjusting the pitch of the aircraft. (See also Stabilizer.)
Engine—The part of the aircraft that provides power for take-off and landing, and sustains flight.
Fin—Fixed vertical section of tail that keeps tail section from swinging. (See also Rudder.)
Flaps—The retractable trailing edge of a wing that moves down to increase wing surface and increase lift on take-off. On landing, flaps also act as air brakes as their increased surface will create drag, slowing the aircraft and permitting a smoother landing.
Fuselage—The body of an airplane, excluding wing and tail section.
Landing gear—The wheels or floats of an aircraft and their supporting structure. They may be fixed or retractable.
Propeller—A twisted airfoil, or turning blade, powered by the engine and providing thrust.
Rudder—The vertical part of the tail section that moves left or right to assist the aircraft in its turn about the vertical (yaw) axis so that horizontal motion is controlled. Also used to stabilize the aircraft during crosswind take-offs and landings or in severe wind conditions.

## J.E. V—Exhibit A

Spinner—The part of the shaft that covers the center of the propeller and helps smooth the airflow over the engine.
Stabilizer—The fixed, horizontal portion of the tail section that keeps the tail from moving up and down in flight. On many modern airplanes, the stabilizer and elevator are combined into a "stabilator." (See also Elevator)
Tail Section—The section of the plane housing the elevator, stabilizer, fin, rudder, and in some cases, the rear wheel and support struts. The elevator and rudder are movable.
Trim Tab—An auxiliary airfoil attached to a control surface for the purpose of reducing the control force, or trimming the aircraft; also used on ailerons.
Wing— Airplane's airfoil, producing lift as the craft moves through the air. It has two movable controls: ailerons and flaps.

*Fill in the blanks from Plane Parts Sheet*

A (2) _____ is a turning blade on the front of an airplane. The (4) _____ turns the propeller, which propels the airplane through the air. The main body portion of an airplane is the (1) _____. The pilot flies the plane from the (2) _____, where instruments and controls are. The (1) _____ provides lift and supports the plane while in flight. On the wings are movable sections close to the plane's body called (3) _____, which help the airplane fly slower during takeoff and landing. Turns are made by moving the (3) _____, which are on the outer part of the wing. When the airplane is on the ground, the (3) _____ supports the plane. Retractable landing gear fold up inside the plane while in flight; fixed landing gear do not fold. In the back of the airplane is the (4) _____. This section contains the (4) _____, which moves to make the plane go up and down, the (1) _____, which controls sideward movement, the (2) _____, which provides smooth vertical flight, the (5) _____ controlling pitch attitude of the craft, and the (5) _____ providing vertical balance.

## J.E. V—Exhibit B

*Fill in the Numbers*

Have students refer to the exploded view of the airplane and fill in the blanks below with the correct number.

___ spinner

___ landing gear

___ elevator

___ fuselage

___ fin

___ right aileron

___ wing

___ left flap

___ propeller

___ trim tab

___ right flap

___ cockpit

___ left aileron

___ stabilizer

___ rudder

*(figure available in print form)*

## J.E. V—Exhibit C

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*Unscramble the Words*

Study the drawing of the airplane and unscramble the words below.

*(figure available in print form)*

| | | | | |
|---|---|---|---|---|
| 1) gniw | dedrur | useeflag | | |
| | ___ | ___ | | ___ |
| 2) potckic | lorepplер | rilibatsez | | |
| | ___ | ___ | | ___ |
| 3) lanieros | slafp | | dinglan egra | |
| | ___ | ___ | | ___ |

4) eelavort gennie lait noitces

___ ___ ___

5) pinerns nif bat mirt

___ ___ ___

## J.E. V—Exhibit D

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***SOLUTION TO FILL IN THE BLANKS***

A **propeller** is a turning blade on the front of an airplane. The **engine** turns the propeller, which propels the airplane through the air. The main body portion of an airplane is the **fuselage** . The pilot flies the plane from the **cockpit** , where the instruments and controls are. The **wing** provides lift and supports the plane while in flight. On the wing are movable sections close to the plane's body called **flaps** , which help the airplane fly slower during take off and landing. Turns are made by moving the **ailerons** , which are on the outer part of the wing. When the airplane is on the ground, the **landing gear** supports the plane. Retractable landing gear fold up inside the plane while in flight; fixed landing gear do not fold. In the back of the airplane is the **tail section** . This section contains the **elevator** , which moves to make the plane go up and down, the **rudder** , which controls sideward movement, the **stabilizer** , which provides smooth vertical flight, the **trim tabs** controlling pitch attitude of the craft, and the **fin** providing vertical balance.

*UNSCRAMBLE THE WORDS SOLUTION*

1) wing rudder fuselage
2) cockpit propeller stabilizer
3) ailerons flaps landing gear
4) elevator engine tail section
5) spinner fin trim tab

*FILL IN THE NUMBERS SOLUTION*

1 spinner 4 right aileron 6 right flap
2 landing gear 3 wing 11 cockpit
14 elevator 7 left flap 5 left aileron
8 fuselage 12 propeller 13 stabilizer
9 fin 10 trim tab 15 rudder

## *JOURNAL ENTRY VI*

***MATERIALS NEEDED :***

Photocopies of the diagrams interspersed in this activity, paper strips 2 inches wide and 4 inches long, a rubberband-powered model airplane made of balsa-wood, a balloon, baseball, whiffle ball or styrofoam ball the same size as the baseball, a hand-held hair dryer, modeling clay, protractor, graph paper, and a candle.

***OBJECTIVE :***

Students are introduced to the four basic principles of flight. Students watch or get involved n demonstrations of the four principles, air pressure and the axis of rotation. Exhibits A, B, C, D, E, F, and G.

1. EXPLAIN: Four basic principles govern flight. Two involve natural forces; two must be created.

*Gravity* —is the natural force that keeps an airplane on the ground or pulls it to Earth when in flight. The Earth pulls any object toward it, and so do the moon, planets and stars. Isaac Newton's law of gravitational action states that there is a force of attraction between any two massive particles in the Universe.

*Lift* —The force supporting the weight of an airplane. This force of lift must be equal to the weight of the airplane in order for the airplane to maintain level flight. If the lift is more than the weight, the airplane accelerates upward. If the lift is less than the weight, the airplane accelerates downward.

*Drag* —The resistance of air to an object moving through it. The faster an object moves, the more drag it creates. Drag is proportional to the square of the speed. The more streamlined an airplane is designed, the less drag it produces, everything else being equal. The less drag an airplane produces, the faster it can fly.

*Thrust* —The force created by engine power to overcome drag. For an airplane to maintain constant air speed, the thrust and the drag must be equal. If thrust is greater than drag, the airplane speeds up; if thrust is less than drag, the airplane slows down.

2. EXPLAIN: For an airplane to fly, lift must be equal to or greater than gravity. Because gravity acts on all objects according to the mass of the object, the heavier the plane, the greater the lift needed to overcome gravity. For this reason, airplanes are designed to be as light as possible.

## J.E. VI—Exhibit A

DEMONSTRATE: Have the students compare the whiffle ball or styrofoam ball with the baseball. Although the size and shape are the same, their weights are different.

3. EXPLAIN: Lift can be produced by an airfoil, a curved surface that moves through the air. A sail, a wing, and a propeller are examples of airfoils.

DEMONSTRATE: Ask students to blow down the long edge of the paper strips. They will see that the strips tend to rise. Tell the students to vary the force of the air. As they blow harder, the paper strips flutter higher. Refer to the following diagrams so you can go on to relate this experiment to lift on an airplane.

*(figure available in print form)*

*(figure available in print form)*

4. EXPLAIN: When air moves under the relatively flat, bottom surface of the wing's surface, it presses the wing upward. Air flowing over the curved, top surface, however, has a longer path to follow because the curve in the wing obstructs the wind's path. To compensate for the added distance it has to travel over the upper surface, the airflow speeds up slightly, thereby exerting less pressure on the top surface of the wing. The difference between the pressure on the upper and lower surfaces forces the airfoil upward, creating lift. As an airplane picks up speed on a runway, its wings meet the oncoming air—similar to the increased force of a breath on a strip of paper—more rapidly, and the principle of lift takes effect. By changing the angle at which an airfoil meets the air (the angle of attack)—that is, by tilting the wing up or down—lift can be increased or decreased to some extent.

5. EXPLAIN: For an object to move forward, it must overcome air friction, or drag. The size and shape of the object determine how easily this is accomplished. The larger the object and the more corners and other barriers to the free flow of air the object presents, the greater the drag. Designing an object so that it offers as little resistance as possible to the current of air flowing around it is called "streamlining."

## J.E. VI—Exhibit B

*(figure available in print form)*

## J.E. VI—Exhibit C

*(figure available in print form)*
The thrust (power) of an aircraft's engines pushes it forward. At the same time, the movement of the wings through the air produces lift (a lifting force) that carries it up. A balloon also has lift but the wind pushes it forward through the air.

*Air Pressure*

The pressure of the air around us is caused by the weight of all the air above our heads pressing down on everything on the ground. It is equal to a mass of about 1 kg placed on every sq cm of a surface. We do not normally feel this pressure because the air inside our bodies is at the same pressure.

We can increase the pressure of air inside a container, for example, by heating it or pumping air into it. If the container can expand, like a balloon, the increase in pressure will make it get bigger. If we lower the pressure, the container will get smaller if possible.

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(Children enjoy it when you (teacher) reads mythology to them).

*Indicates best books for children.