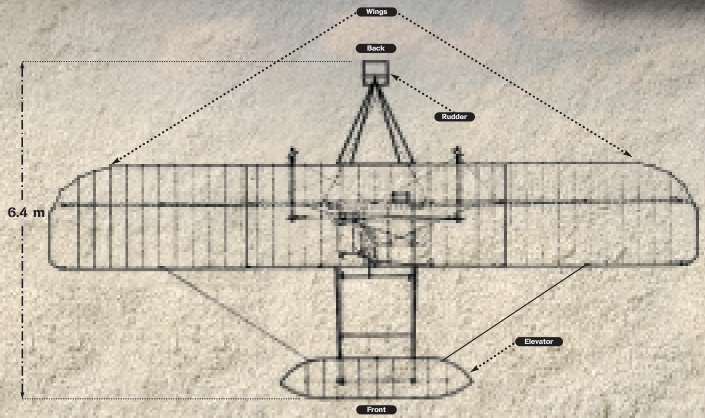
10 20 30 40 50 60 70 80 90
10 Decimeters

The Wright Way: Innovation Through Engineering

NASA

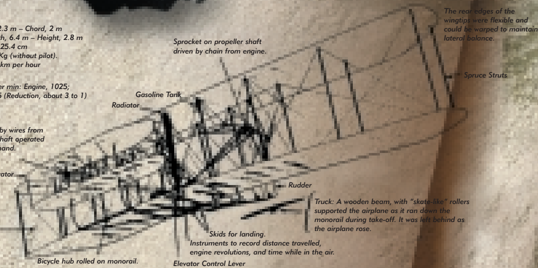
North Carolina—First in Flight



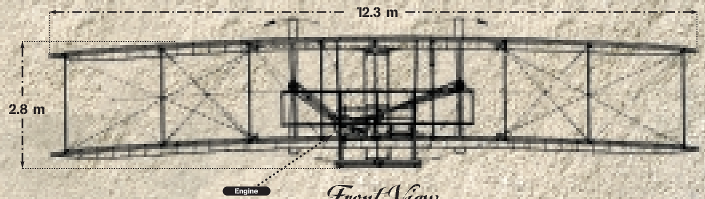
Top View

Wingspan, 12.3 m – Chord, 2 m
Overall Length, 6.4 m – Height, 2.8 m
Wing Droop, 25.4 cm
Weight, 229 Kg (without pilot).
Airspeed, 50 km per hour

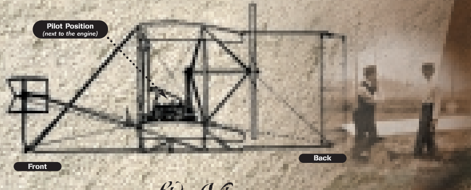
Revolutions per min: Engine, 1025; propellers 325 (Reduction, about 3 to 1)



Pilot lay prone with head forward, his left hand operating the elevator lever, his hips in a saddle. (Shifting the hips from side to side pulled the wires attached to the cradle, warping the wings and turning the rudder, both with one action, thus balancing and steering the airplane.)



Front View



Side View

CENTENNIAL OF FLIGHT
1903-2003
www.centennialofflight.gov

100th 1903-2003
Anniversary of Powered Flight

1000 millimeters
100 Centimeters
1 meter

Celebrating a Century of Powered Flight

The Wright brothers turned their dreams into reality and revolutionized the world.

ABOUT THE POSTER

This poster was designed to honor the accomplishments of the Wright brothers, two brilliant, self-trained engineers from Ohio who designed, built, and flew the first power-driven, heavier-than-air machine in which humans made free, controlled, and sustained flight.

The historic event occurred on the morning of December 17, 1903, at a place known as Kill Devil Hills, four miles from the village of Kitty Hawk, North Carolina. At about 10:35 a.m., the Wright brothers' machine began to move down a rail into a frigid wind that was gusting up to 12 meters per second. The airplane rose and fell for 12 seconds until it struck the sand approximately 37 meters from where it had become airborne. For the first time in history, an airplane had taken off, moved forward under its own power, and landed at a point at least as high as that from which it had started—all under the complete control of the pilot. The photograph of the first flight, depicted on the front of this poster, was taken just as the Wright brothers' machine left the rail. The Wright brothers completed three additional flights that day, each farther than the one before.

The centennial of powered flight presents a unique opportunity to focus on the historical significance of the aviation-related events leading up to, and following, December 17, 1903. More importantly, the 100th anniversary of flight will inspire a new generation of inventors, innovators, and dreamers. In the span of a single century, the vision, persistence, and ingenuity of many have taken us from the first powered flight on the sand dunes of North Carolina's outer banks to a permanent presence in space.

In honor of the 100th anniversary of flight, the U.S. Congress established the U.S. Centennial of Flight Commission. The Commission will encourage, enable, and amplify the efforts of all the organizations and individuals planning to celebrate the achievements of the Wright brothers and a century of powered flight by serving as a catalyst for activities and a central resource. The Commission is encouraging and promoting national and international participation in the commemoration of the centennial of powered flight by the public; educators and students; Federal, state, and local government officials; members of civic and cultural organizations; and members of the aviation and aerospace industry.

We invite you to visit the U.S. Centennial of Flight Commission's Web site (**www.centennialofflight.gov**) where you will find information about the Commission, the centennial of powered flight, and the history of aviation and aerospace. The site has been designed to be used by educators and their students, aviators, aviation enthusiasts, the media, and all organizations planning to participate in the celebration. The Web site also includes a calendar that provides information about upcoming events related to the centennial of flight, the history of aviation and aerospace, and aviation in general. A "Submit an Event" feature is available for event planners who wish to post information on the U.S. Centennial of Flight Commission's calendar. New information and resources will be added regularly to the site through December 2003.

Measurement Standard, Pre-K–2

Understand measurable attributes of objects and the units, systems, and processes of measurement

Expectations:
- Recognize the attributes of length, volume, weight, area, and time
- Compare and order objects according to these attributes
- Understand how to measure using nonstandard and standard units
- Select an appropriate unit and tool for the attribute being measured

Apply appropriate techniques, tools, and formulas to determine measurements

Expectations:
- Measure with multiple copies of units of the same size, such as paper clips laid end-to-end
- Use repetition of a single unit to measure something larger than the unit, for instance, measuring the length of a room with a single meterstick
- Use tools to measure
- Develop common references for measurers to make comparisons and estimations

Implications/Emphases for the Classroom:
- Measuring devices need to be readily available for students
- Daily opportunities need to exist to use measurement tools
- Students need to understand what it means to measure
- Connections in spatial concepts and number concepts need to occur
- Direct comparison of objects by attributes, such as putting airplanes in order by length
- Emphasis on linear measurement
- Emphasis on finding relationships: "Can you find objects in the room that are 1 centimeter in length, 1 decimeter in length, and 1 meter in length?"
- Students need to build a rich vocabulary including words such as deep, large, long, length, height, etc.
- Cause and effect implication: "What if the unit of measure were twice the size? Would the length stay the same? Would the answer be the same? Why/why not?"
- Which measurement tool is appropriate to use and why?
- Movement from direct comparison of nonstandard to standard, to specific tools

Measurement Standard, Grades 3–5

Understand measurable attributes of objects and the units, systems, and processes of measurement

Expectations:
- Understand such attributes as length, area, weight, volume, and size of angles; select the appropriate type of unit for measuring each attribute
- Understand the need for measuring with standard units and become familiar with standard units in the customary and metric systems
- Carry out simple unit conversions, such as from centimeters to meters, within a system of measurement
- Understand that measurements are approximations and understand how differences in units affect precision
- Explore what happens to measurement of a two-dimensional shape, such as its perimeter and area when the shape is changed in some way

Apply appropriate techniques, tools, and formulas to determine measurements

Expectations:
- Develop strategies for estimating the perimeter, area, and volume of irregular shapes
- Select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles
- Select and use benchmarks to estimate measurements
- Develop, understand, and use formulas to find the area of rectangles and related triangles and parallelograms
- Develop strategies to determine the surface area and volume of rectangular solids

Implications/Emphases for the Classroom:
- Measurement tools need to be readily available
- Maps need to be readily available for use in determining distance and scale
- Measurement should serve as a connector to many areas of mathematics
- Vocabulary should include such words as area, volume, angle, perimeter, width, height, circumference, distance
- Reinforce mental images of customary and metric units by frequent reference to length, width, etc., of objects
- Establish benchmarks, such as a doorknob being a little less than a decimeter, and acute and obtuse angles being less than or more than a right angle
- Opportunities need to exist for students to see patterns to enable them to develop formulas for area and volume
- Students should witness change over time, such as their own growth, the growth of plants, or population shifts
- Opportunities need to exist for students to share, compare, and evaluate ideas

Measurement Standard, Grades 6–8

Understand measurable attributes of objects and the units, systems, and processes of measurement

Expectations:
- Understand both metric and customary systems of measurement
- Understand relationships among units and convert from one unit to another within the same system of measurement
- Understand, select, and use units of appropriate size and type to measure angles, perimeter, area, surface area, and volume

Apply appropriate techniques, tools, and formulas to determine measurements

Expectations:
- Use common benchmarks to select appropriate methods for estimating measurement
- Select and apply techniques and tools to accurately find length, area, volume, and angle measures to appropriate levels of precision
- Develop strategies to determine the surface area and volume of selected prisms, pyramids, and cylinders
- Solve problems involving scale factors using ratios and proportions
- Solve simple problems involving rates and derived measurements for such attributes as velocity and density

Implications/Emphases for the Classroom:

- Many opportunities should exist for students to use measuring devices daily
- Measurement should be connected to many areas of mathematics, especially geometry, algebra, and data analysis
- Rich vocabulary development should include: similarity, velocity, vertex, scaling, proportionality
- Opportunities must exist to examine relationships and patterns between shape and size, area and perimeter, volume and shape
- Skills in estimating and the use of benchmarks should be strengthened
- Opportunities must exist for students to compose, decompose, and recompose shapes to find volume, area, and surface area
- Opportunities must exist for students to discuss estimations, reasonableness of an answer, and accuracy of measurement
- Opportunities must exist for students to find patterns and relationships as they relate to length, area, volume, and perimeter
- Scale drawings, maps, and blueprints can be used to strengthen everyday connections to the classroom

Measurement Standard, Grades 9–12

Understand measurable attributes of objects and the units, systems, and processes of measurement

Expectation:

- Make decisions about units and scales that are appropriate for problem situations involving measurement

Apply appropriate techniques, tools, and formulas to determine measurements

Expectations:

- Analyze precision, accuracy, and approximate error in measurement situations
- Understand and use formulas for the area, surface area, and volume of geometric figures, including cones, spheres, and cylinders
- Apply informal concepts of successive approximation, upper and lower bounds, and limits in measurement situations
- Use unit analysis to check measurement computations

Implications/Emphases for the Classroom:

- Measurement connections should occur throughout high school in mathematics, technology, and science classes
- Students need opportunities in selecting which tools and units are best to use and why
- Opportunities should occur to allow students to make decisions with respect to efficient use of tools, data collecting, and reporting of data
- Students need to see methods and purposes of clear representation of data

References:

Principles and Standards for School Mathematics***, published by the National Council of School Mathematics, copyright 2000.***

To the Educator

The purpose of this poster is to help you inspire, educate, and encourage your students to learn about the Wright brothers, the celebration of the 100th anniversary of flight, and the history of aviation and aerospace. The classroom activities are designed to provide hands-on experiences for your students that relate to some of the engineering processes employed by the Wright brothers and others. All of the activities utilize the metric system and relate to the National Mathematics Standards of Measurement. As students, printers, and bicycle mechanics, Wilbur and Orville Wright used the traditional inch/pound system that is still the standard measurement system used in the United States. However, during their flight tests in North Carolina, they measured wind speed in meters per second as opposed to miles per hour. As your students investigate how the Wright brothers solved the mysteries of mechanical flight, perhaps they will discover why the metric system was used. We encourage you to use the information provided on this poster to teach your students about the metric system, its history, use, and importance.

Three sources of information—The U.S. Centennial of Flight Commission's Web site (**www.centennialofflight.gov**), the page titled "NASA Resources for Educators," and the "Extensions and Technology Connections" section—will help you and your students locate additional information, educational products, and activities related to the Wright brothers and the history of aviation and aeronautics.

A Few Questions to Get Your Students Started

The State motto of North Carolina is "First in Flight." How and why did two brothers from Ohio select this location for their first flight? How did they get there? How often did they go to North Carolina? How long did they stay? Where did they live? Who helped the Wright brothers when they conducted their experiments? Were their machines transported from one State to the other? If so, how?

Why is the State of Ohio known as "The Birthplace of Aviation?" Where did the Wright brothers live in Ohio? What did they do there? How did they become interested in aviation?

Although the States of North Carolina and Ohio are well known for early developments in aviation, many people from other States and countries around the world were thinking about flight, building aircraft, and conducting experiments before, during, and after the Wright brothers' involvement in flight. Who were these people? Where did they live? What contributions did they make?

Study your State's aviation and aerospace history. Discuss how the advances in aviation and aerospace during the past 100 years have affected you and your family. Imagine what changes will occur in aviation and aerospace in the next 100 years. Design a poster representing the history of aviation and aerospace in your State. Create a calendar with information about significant people, places, and historical aviation and aerospace events in your State. Share your poster and calendar with others in your school, community, or State. Send an electronic copy of your poster and your calendar to the U.S. Centennial of Flight Commission's Web site e-mail address (**centennialofflightadmin@hq.nasa.gov**). Plan your own centennial of flight celebration. If you believe your event meets the criteria for inclusion on the Commission's calendar, complete and submit the electronic form found on the Centennial Web site.

NASA Resources for Educators

NASA's Central Operation of Resources for Educators (CORE) was established for the national and international distribution of NASA-produced educational materials in audiovisual format. Educators can obtain a catalogue and an order form by one of the following methods:

- NASA CORE
  Lorain County Joint Vocational School
  15181 State Route 58
  Oberlin, OH 44074-9799
- Toll Free Ordering Line: 1-866-776-CORE
- Toll Free FAX Line: 1-866-775-1401
- E-mail nasaco@leeca.org
- Home Page: http://core.nasa.gov

Educator Resource Center Network (ERCN)
To make additional information available to the education community, NASA has created the NASA Educator Resource Center (ERC) network. Educators may preview, copy, or receive NASA materials at these sites. Phone calls are welcome if you are unable to visit the ERC that serves your geographic area. A list of the centers and the regions they serve includes:

AK, Northern CA, HI, ID, MT,
NV, OR, UT, WA, WY
NASA Educator Resource Center
Mail Stop 253-2
NASA Ames Research Center
Moffett Field, CA 94035-1000
Phone: (650) 604-3574

IL, IN, MI, MN, OH, WI
NASA Educator Resource Center
Mail Stop 8-1
NASA Glenn Research Center
21000 Brookpark Road
Cleveland, OH 44135-3191
Phone: (216) 433-2017

CT, DE, DC, ME, MD, MA, NH,
NJ, NY, PA, RI, VT
NASA Educator Resource Laboratory
Mail Code 130.3
NASA Goddard Space Flight Center
Greenbelt, MD 20771-0001
Phone: (301) 286-8570

CO, KS, NE, NM, ND, OK, SD, TX
Space Center Houston
NASA Educator Resource Center for
NASA Johnson Space Center
1601 NASA Road One
Houston, TX 77058-3696
Phone: (281) 244-2129

FL, GA, PR, VI
NASA Educator Resource Center
Mail Code ERC
NASA Kennedy Space Center
Kennedy Space Center, FL 32899-0001
Phone: (321) 867-4090

Virginia Air & Space Center
Educator Resource Center for
NASA Langley Research Center
600 Settlers Landing Road
Hampton, VA 23669-4033
Phone: (757) 727-0900 x 757

AL, AR, IA, LA, MO, TN
U.S. Space and Rocket Center
NASA Educator Resource Center for
NASA Marshall Space Flight Center
One Tranquility Base
Huntsville, AL 35812-0001
Phone: (256) 544-5812

MS
NASA Educator Resource Center
Building 1200
NASA Stennis Space Center
Stennis Space Center, MS 39529-6000
Phone: (228) 688-3965

NASA JPL Educator Resource Center
Village at Indian Hill
1460 East Holt Avenue, Suite 20
NASA Jet Propulsion Laboratory
Pomona, CA 91767
Phone: (909) 397-4420

AZ and Southern CA
NASA Educator Resource Center for
NASA Dryden Flight Research Center
45108 N. 3rd Street East
Lancaster, CA 93535
Phone: (661) 948-7347

VA and MD's Eastern Shores
NASA Educator Resource Center
Visitor Center Building J-17
GSFC/Wallops Flight Facility
Wallops Island, VA 23337-5099
Phone: (757) 824-2298

Regional Educator Resource Centers offer more educators access to NASA educational materials. NASA has formed partnerships with universities, museums, and other educational institutions to serve as regional ERCs in many states. A complete list of regional ERCs is available through CORE, or electronically via NASA Spacelink at http://spacelink.nasa.gov/ercn/

NASA's Education Home Page serves as a cyber-gateway to information regarding educational programs and services offered by NASA for the American education community. This high-level directory of information provides specific details and points of contact for all of NASA's educational efforts, Field Center offices, and points of presence within each state. Visit this resource at the following address: http://education.nasa.gov

NASA Spacelink is one of NASA's electronic resources specifically developed for the educational community. Spacelink is a "virtual library" in which local files and hundreds of NASA World Wide Web links are arranged in a manner familiar to educators. Using the Spacelink search engine, educators can search this virtual library to find information regardless of its location within NASA. Special events, missions, and intriguing NASA Web sites are featured in Spacelink's "Hot Topics" and "Cool Picks" areas. Spacelink may be accessed at: http://spacelink.nasa.gov

NASA Spacelink is the official home to electronic versions of NASA's Educational Products. A complete listing of NASA Educational Products can be found at the following address: http://spacelink.nasa.gov/products

NASA Television (NTV) features Space Shuttle mission coverage, live special events, interactive educational live shows, electronic field trips, aviation and space news, and historical NASA footage. Programming includes a 3-hour block for Video (News) File, NASA Gallery, and Education File. Programming begins at noon Eastern time and is repeated five more times throughout the day. Live feeds preempt regularly scheduled programming.

Check the Internet for programs listings at:
http://www.nasa.gov/ntv
For more information on NTV, contact:
NASA TV
NASA Headquarters
Code P-2
Washington, DC 20546-0001
Phone (202) 358-3572

EW-2000-11-134-HQ
The Wright Way: Innovation Through Engineering
Please provide feedback on how this poster has been used. Complete the survey at
https://ehb2.gsfc.nasa.gov/edcats/educational_wallsheet

Sled Kite

Grades: Preschool—5th

The Wright brothers first built kites, then gliders, and finally a powered airplane.

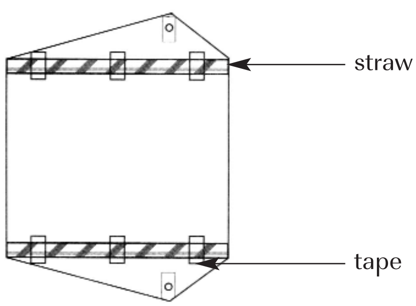
tape

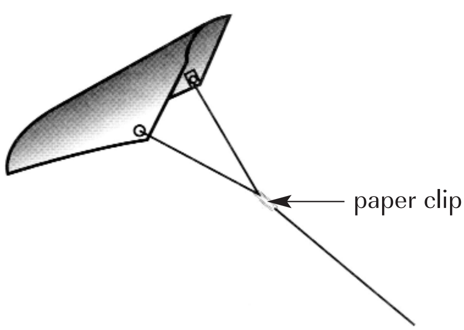
Objectives

The student will 1) construct and fly a simple sled kite; 2) demonstrate how to make the kite fly at varying heights.

tape straw here

Materials (per kite)
Sled Kite Template (black outline)
Two drinking straws
Tape
Scissors
Two 45 cm lengths of string
One 1 m length of string
Metric ruler
Single-hole paper puncher
One paper clip
Markers, crayons, pencils
Selection of paper (crepe, tissue, newspaper)





Activity Instructions

1. Make a copy of this Sled Kite Template. Carefully cut out the kite.
2. Decorate the top of the sled kite using crayons, markers, or other media.
3. Trim the length of the two drinking straws so they will fit in the area marked for the straws. Tape them in place.
4. Place two or three pieces of tape in the marked areas covering the black circles.
5. Using a single-hole paper puncher, carefully punch the two holes marked by the black circles.
6. Cut two pieces of kite string 45 cm each. Tie a string through each hole.
7. Tie the opposite end of both strings to a paper clip.
8. Tie one end of the 1 m long piece of string to the other end of the paper clip. Your sled kite is ready to fly!
9. Outside in a clear area, hold the 1 m length of string and run with the kite to make it fly.
10. Run slow and run fast, and observe how the kite flies at different towing speeds.
11. Record observations on the "Sled Kite Flying Journal" page.

tape straw here

tape

Can kites be used to lift objects? (Parasail)
Why are kites made of lightweight material?
Have students explain how their kites were built.
Have students demonstrate ways to make their kites fly higher and lower.

From *Aeronautics: An Educator's Guide with Activities in Science, Mathematics, and Technology Education* EG-1998-09-105-HQ

Sled Kite Flying Journal

Date ___________________ Student Name _______________________________________

Weather ____

Sled Kite Flight
What happened when I walked with my sled kite?

____

What happened when I ran with my sled kite?

____

Sled Kite Tail
What if I add a tail to my sled kite? I think it will make my sled kite fly like this:

____

After I added a tail to my sled kite, it flew like this:

____

What if I shorten the tail? I think it will make my sled kite do this:

____

After I shortened the tail on my sled kite, it flew like this:

____

What if I lengthen the tail? I think it will make my sled kite do this:

____

After I lengthened the tail on my sled kite, it flew like this:

____

First Flights

Grades 6–12

Objective: Students will analyze and interpret data from the four flight trials of the Wright brothers on December 17, 1903, and use communication skills to write explanations of the events.

Activity A Procedure:

1. Use the data below and calculate the average speed of each flight trial.

Speed = Distance/Time			
Flight	Distance (meters)	Time (seconds)	Average Speed (m/sec)
1	37	12	
2	53	12	
3	61	15	
4	260	59	

2. Make a graph comparing the average speeds of the four trials. What factors might have influenced the flight of the plane and caused such different speeds?

3. Analyze the graph of "Speed vs. Time" below. Identify the events that occurred in sections A, B, and C of the graph. Write a paragraph about what happened during the flight.

Extensions:

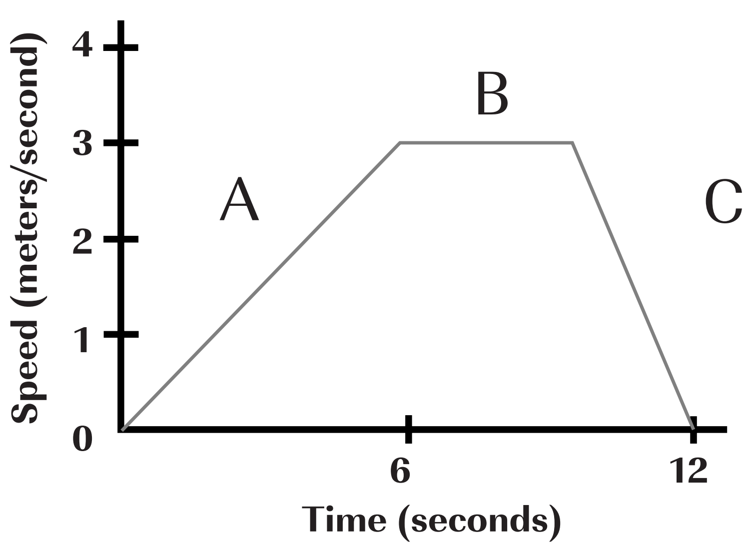
• The velocity of the wind at Kitty Hawk that day was up to 12 meters/second and the speed of the machine over the ground against the wind was 3.05 meters/second. What would have been the speed of the machine in calm air? How far would it have traveled during the first flight with calm winds?

• The flight speeds were not as constant as the data might indicate. Instead, there were control problems and erratic speeds. Find out how the Wright brothers solved these problems in later airplane designs.

• Depending on the experience of your students, use the graph "Speed vs. Time" as a model to create a graph that shows the changes in acceleration of the Wright Flyer during the flight.

The graph below represents a mathematical model of how the Wright brothers' first flight may have happened.

SPEED vs. TIME

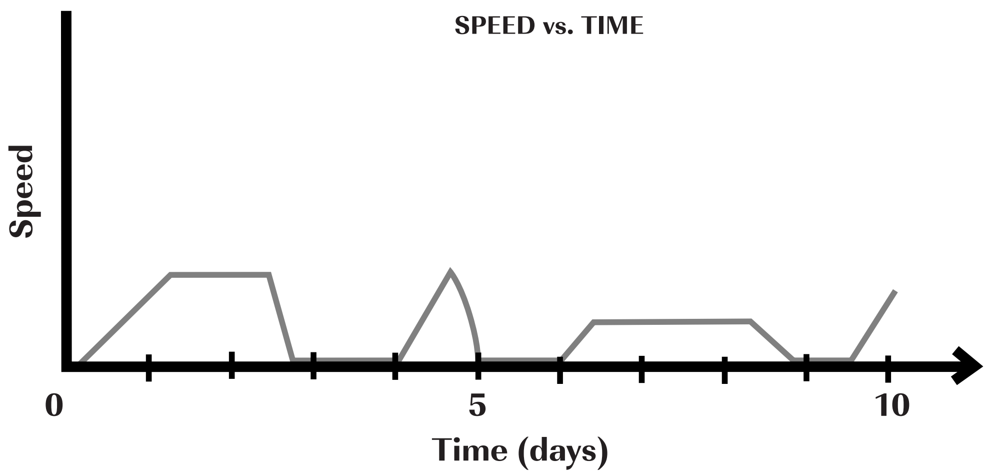


Activity B Procedure:

The Vin Fiz™ was a Wright brothers Model EX airplane built in response to a Hearst prize of $50,000 to be given to the first person to fly across the United States in 30 days.

Below is a "mathematical model" of the flight that took place in 1911 when pioneer aviator "Cal" Rodgers attempted a coast-to-coast 30 day journey in this Wright EX airplane. Unfortunately his flight took 49 days and was plagued by many problems, which included crashes when he collided with trees, chicken coops, and other obstacles. He replaced numerous parts of his plane during the 70 stops along the way, but managed to keep the Nation's interest focused on flying.

1. Using this "mathematical model" of "Cal" Rodgers' flight in the Vin Fiz™*, write a story about the first 10 days of Rodgers' trip. Research the various speeds of his plane, the events that took place between days 3, 4, and 5 and explain why the shapes of the "mathematical model" changed.
2. Present the story to the class using the "mathematical model" as a visual aid.
3. Create a graph of the entire flight.



Extensions and Technology Connections:

Web sites:
- Centennial of Flight
  www.centennialofflight.gov
- Wright Flyer Online
  www.quest.arc.nasa.gov/services/lessons.html#wright
- Newton's Second Law and Airplane Problems
  www.grc.nasa.gov/WWW/K-12/BGA/Sheri/newton's_second_law_act.htm
- Basic Airplane Balance—The Wright Brothers Bicycle Test
  www.grc.nasa.gov/WWW/K-12/Missions/Rhonna/wright.htm
- Beginner's Guide to Aerodynamics
  www.grc.nasa.gov/WWW/K-12/airplane/bga.html
- X-Gliders: Exploring Flight Research with Experimental Gliders
  http://spacelink.nasa.gov/products/X.Gliders/

Video:
- NASA CONNECT: "Measurement of All Things: Tools of the Aeronautics Trade"
  (Grades 5-8)
- NASA CONNECT: "Geometry and Algebra: Glow with the Flow"
  (Grades 5-8)

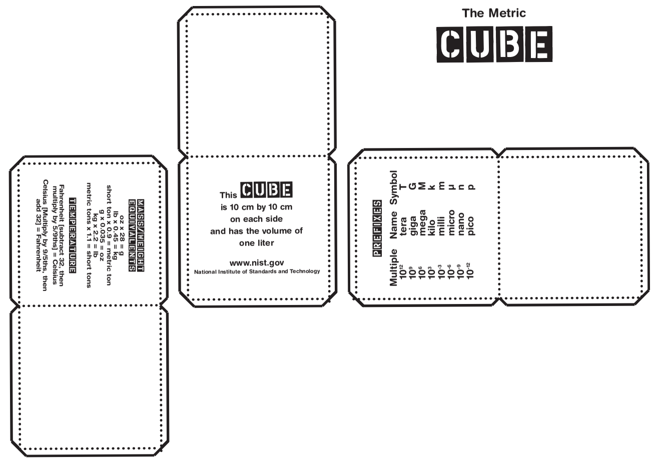
*TM 2000 Vin Fiz is a registered trademark of Inventing Flight: Dayton 2003.

To Assemble:

Cut along solid lines. Score & fold along dotted lines. Connect with tape where edges of cube meet.

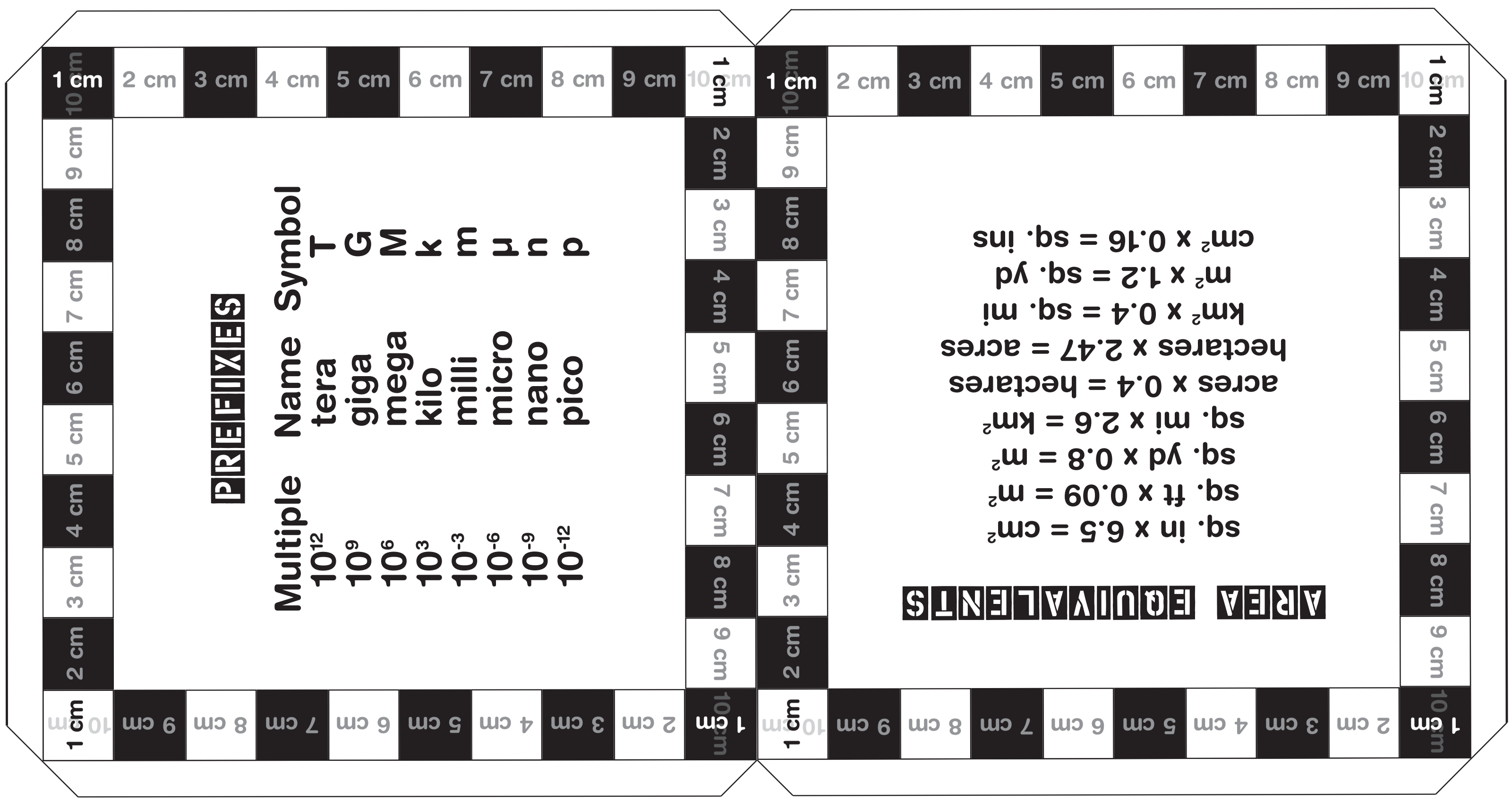
Please Note:

While the initial measurements of the cube are based on increments of one centimeter, the exact measurements of the final, assembled cube may vary depending on the printer on which the document is produced.



The Metric CUBE

The Metric CUBE



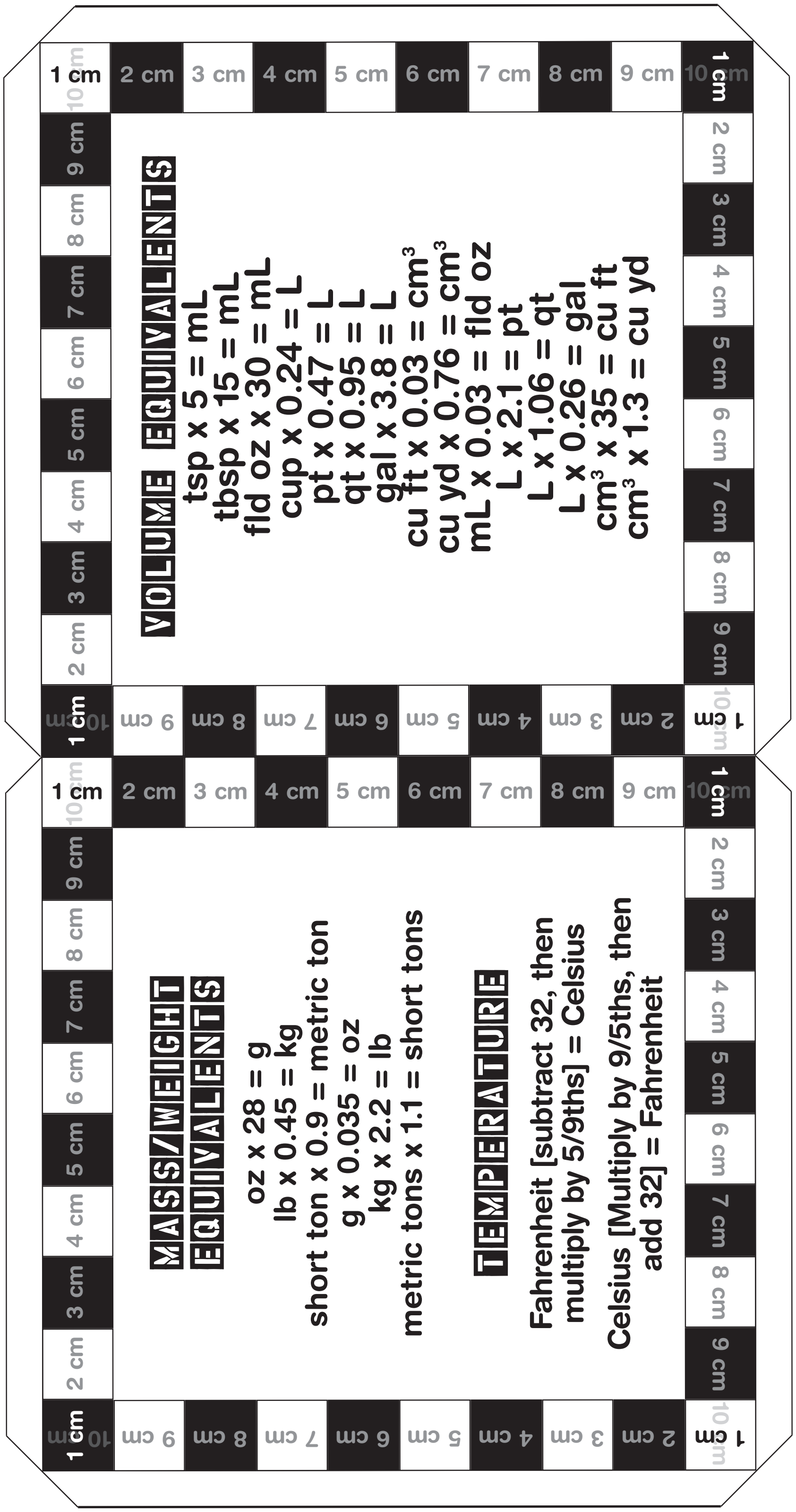
If the Cube were filled with water
it would have a mass of one kilogram

This **CUBE**
is 10 cm by 10 cm
on each side
and has the volume of
one liter

www.nist.gov
National Institute of Standards and Technology

LENGTH EQUIVALENTS

in x 2.54 = cm
ft x 30 = cm
yd x 0.91 = m
mi x 1.6 = km
mm x 0.04 = in
cm x 0.4 = in
m x 3.3 = ft
km x 0.62 = mi



Assembled, the Metric Cube can be a useful tool for conversion from the English System to the Modern Metric System