Look! Up in the Sky!
Agricultural Aviation

Objective
Students will read about the agricultural aviation industry and its history and answer comprehension questions. Students will discuss the need for regulation of the industry and research the government agencies that regulate the industry. Students will read about the division of land by townships and sections and use legal land descriptions to identify parcels of land in a map of a land section. Students will answer math word problems related to ag aviation. Students will conduct experiments with paper airplanes and O-Wings.

Background
In agriculture, producers sometimes get help from the sky from agricultural pilots. Ag pilots help growers manage their crops by dropping seeds and fertilizer on fields and by spraying fields for control of disease, insects and weeds. For ranchers, aerial application helps control livestock insects and pasture weeds, helps manage grasshopper infestations on range land and even melts snow in some areas. The industry is also involved in feeding and relocating fish.

Ag pilots are involved in public health programs, including mosquito abatement; fire control; insect and disease control in forests; elimination of cultivated and wild illegal plants, right-of-way brush control; and environmental clean-up such as oil spills.

Aerial application is often the only, or most economical, method for timely pesticide application. It permits large and often remote areas to be treated rapidly, far faster than any other form of application. When wet soil conditions, rolling terrain or dense plant foliage prevent other methods of treating an area, aerial application may be the only remaining method of pest treatment. Aerial applications are used on nearly all crops but most commonly on corn, wheat, barley, soybeans, pastures, rangelands and alfalfa.

Beginning in the late 1990s, unmanned aerial vehicles (UAVs) were used for agricultural spraying. This practice started in Japan and South Korea, where mountainous terrain and small family-owned farms required lower-cost and higher precision spraying. As of 2014, the use of UAV crop dusters was expanded to the US for use in spraying of vineyards.

Today's aircraft use sophisticated precision application equipment such as Global Positioning Systems (GPS), Geographic Information Systems (GIS), flow controls, real time meteorological systems and precisely calibrated spray equipment. Precision application equipment allows for less pesticide being applied to more acres and greater fuel efficiency and can ensure more targeted delivery by further avoiding off-target drift.

Adapted from National Aviation Association, Secondary Level Curriculum Guide: http://www.agaviation.org/Files/CurriculumGuides/secondary.pdf

Oklahoma Academic Standards

GRADE 6
English Language Arts—1.R.1,3; 3.R.6
Social Studies PALS—1.A.1,2,3, B.4,5,7,10; 2A.2, B4,5,6,7,8,9,10
Social Studies Content—1.2,3,4,5; 2.1C; 4.2,4; 5.1,2B,3,5AC
Science—MS.PS3.1
Math—N.3.1,2,3,4; 4.4; A.3.1; GM.1.1; 3.2

GRADE 7
English Language Arts—1.R.1,3; 3.R.6
Social Studies PALS—1.A.1,2,3, B.4,5,7,10; 2A.2, B4,5,6,7,8,9,10
Social Studies Content—1.2,3,4,5
Science—MS.PS3.6
Math—N.2.3; A.2.2,3; 3.1,3

GRADE 8
English Language Arts—1.R.1,3; 3.R.6
Social Studies PALS—1.A.1,2,3, B.4,5,7,10; 2A.2, B4,5,6,7,8,9,10
Social Studies Content—4.3,6AB
Science—MS.PS2.2

Materials
paper for making paper airplanes

plastic drinking straws

tape or glue

pencils

stiff cards

tape measure

scissors

Ag Career: Ag Pilot

An ag pilot or aerial applicator flies specially-equipped single-engine airplanes (and in some cases, helicopters) over farms and fields, usually at altitudes ranging from 30 to 50 feet, to apply either crop growth enhancers and fertilizers or pesticides. Ag pilots are either self-employed or work for an aerial application enterprise. The work can be seasonal or full time.

Specific Skills Necessary:

- Low altitude, precision flying at maximum gross weight.
- Keen observation for obstacles, and crop identification.
- Quick reflexes.
- Knowledge of products being applied.
- Mechanical knowledge of aircraft.

- Educational Requirements: Commercial Pilot License (FAA).
- Additional training in Ag Flying.
- Commercial Pesticide Applicators License (EPA).

Opportunities for Training:

- College (4 year and 2 year programs)
- Private Ag Aviation School.

English Language Arts

1. Read and discuss background and vocabulary. Provide copies of the Reading Page included with this lesson for students to read independently or in groups about the history of ag aviation.
   —Students will answer the comprehension questions and discuss their answers as a class.

Social Studies

1. Hand out copies of the "Reading Land Descriptions" pages.
   —Read through them and discuss them as a class.
   —Hand out copies of the "One Section of Land" worksheet.
   —Students will use information from the "Reading Land Descriptions" pages to fill in the blanks on the worksheet.
2. The aerial application industry is very highly regulated. Rules and regulations from several government agencies are implemented in the day to day business of an agricultural aviation operation.
   —Students will discuss why it would be important for government agencies to have rules regulating ag aviation.
   —The following federal agencies each have regulations, programs or services pertaining to the agricultural aviation industry. Students will select three of the agencies and research the following questions: When and for what purpose was the agency established? What role does the agency play in the ag aviation business?
   - Federal Aviation Administration (FAA)
   - Environmental Protection Agency (EPA)
   - Occupational Safety and Health Administration (OSHA)
   - National Transportation Safety Board (NTSB)
   - Food and Drug Administration (FDA)
   - Internal Revenue Service (IRS)
   - US Forestry Servicce
   - Department of Agriculture (federal and state)
   - Department of Health (federal and state)
   - Department of Labor (federal and state)
   - Department of Transportation (federal and state)
   - Agricultural Conservation and Stabilization Service
   - Soil Conservation Service
   - Small Business Administration
   - State Aeronautics Commission
   - State Land Grant Universities with Extension Services

Math

1. Hand out copies of the Ag Aviation Math Page for the appropriate grade level.
   —Students will show their work and calculate to answer the questions.

Science

1. Hand out copies of the Paper Airplane Trials worksheets.
   —Divide students into groups to conduct the trials.
   —Use the questions on the first page to discuss the scientific method.
   —In groups, students will select their variables and answer the discussion questions.
   —Students will construct paper airplanes using the instructions provided.
   —Students will follow the procedures to conduct flight trials.
   —Students will record the results of their trials on the chart provided.
   —Students will answer and discuss the post trial questions included with this lesson.
2. Students will repeat the trials using another style of airplane. (Patterns for many different styles are available online.) Students will name their airplanes.
3. Students will use the directions included with this lesson to construct O-Wings and test variables that might affect flight.

Extra Reading

Hughes, John, *The Wild Ways of Tim O'Reilly*, Allswell, 2014.

Vocabulary

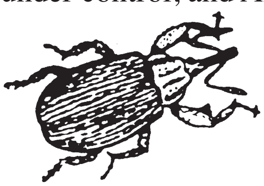
abatement—the act or process of making or becoming less
aerial— designed for use in, taken from, or operating from aircraft
aeronautical—dealing with the operation of aircraft
agricultural— of, relating to or used in the science or occupation of cultivating the soil, producing crops, and raising livestock
application— something put or spread on a surface
aviation— the operation of aircraft (as airplanes or helicopters) that are heavier than air
boll weevil— a gray or brown weevil whose larva lives in and feeds on the buds and bolls of the cotton plant
calibrated— made standard (as a measuring instrument) by finding out and correcting for the differences from an accepted or ideal value
cereal— relating to grain or to the plants that produce it
civilian— a person not on active duty in the armed services or not on a police or firefighting force
dispersal—the act of causing to become spread widely
epidemic— spreading widely and affecting many individuals at one time
fiber— a slender and very long unit of material (as wool or cotton) usually able to be spun into yarn
infestation— a state of being invaded or overrun by pests or parasites
infrared— being, relating to, producing, or using rays like light but lying outside the visible spectrum at its red end
insecticide—a chemical used to kill insects
fertilizer— a substance (as manure or a chemical) used to make soil produce larger or more plant life
foliage—the mass of leaves of a plant
fuel efficiency— capable of producing desired results without waste of fuel
livestock—animals kept or raised, especially farm animals kept for profit
meteorological— having to do with the science that deals with the atmosphere, weather, and weather forecasting
military— of, relating to, or characteristic of service members, arms, or war
parcel— a plot of land
pesticide— a substance used to destroy pests
precision—the quality or state of being exact
rangeland— open land over which livestock may roam and feed
terrain— the surface features of an area of land

Reading Page

History of Agricultural Aviation in the US

Shortly after the turn of the century, American farmers began to seriously consider the use of agricultural chemicals to control insects, weeds and plant disease. Although there were chemicals available that could control some of these problems, there was really no suitable way to apply them to the crops.

In 1921, the Ohio Department of Agriculture fitted an airplane with a metal container and filled it with a powdered insecticide. Two U.S. Army pilots applied the chemical to trees that were being destroyed by moths. The experiment was so successful that the government moved airplanes and agricultural scientists to the southern states, where cotton farmers were combating cotton boll weevils. In time, the epidemic was brought under control, and America's most important fiber crop, cotton, was secure.



Government programs continued to use airplanes to fight insect pests that were causing damage and destruction to America's forests. During the early years, the aircraft were all modified military or civilian airplanes, and the product dispersal systems were homemade. Although the work was exciting, it also proved dangerous to those who flew the early "crop-dusters," as both the men and their planes came to be called.

The development of an airplane designed specifically for aerial application occurred in the 1950s. These "ag-planes" gradually began to replace the converted aircraft of the previous three decades. Helicopters eventually joined the ranks of ag aircraft, and they are sometimes the best tool for the job

Agricultural chemicals have also kept pace with advancements in technology and have been influential in the growth of the agricultural aviation industry. In the 1930s aerial applicators arrived in the northern states to war against insect and disease pests which threatened fruit and vegetable crops. After World War II, the industry expanded into the western states, where the development of new chemicals made possible the control of weeds and insects in cereal grain crops.

Adapted from National Aviation Association, Secondary Level Curriculum Guide: http://www.agaviation.org/Files/CurriculumGuides/secondary.pdf

Comprehension Questions

What is the main idea? What are the supporting details? How is the information presented? What is the author's purpose?

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Reading Legal Land Descriptions

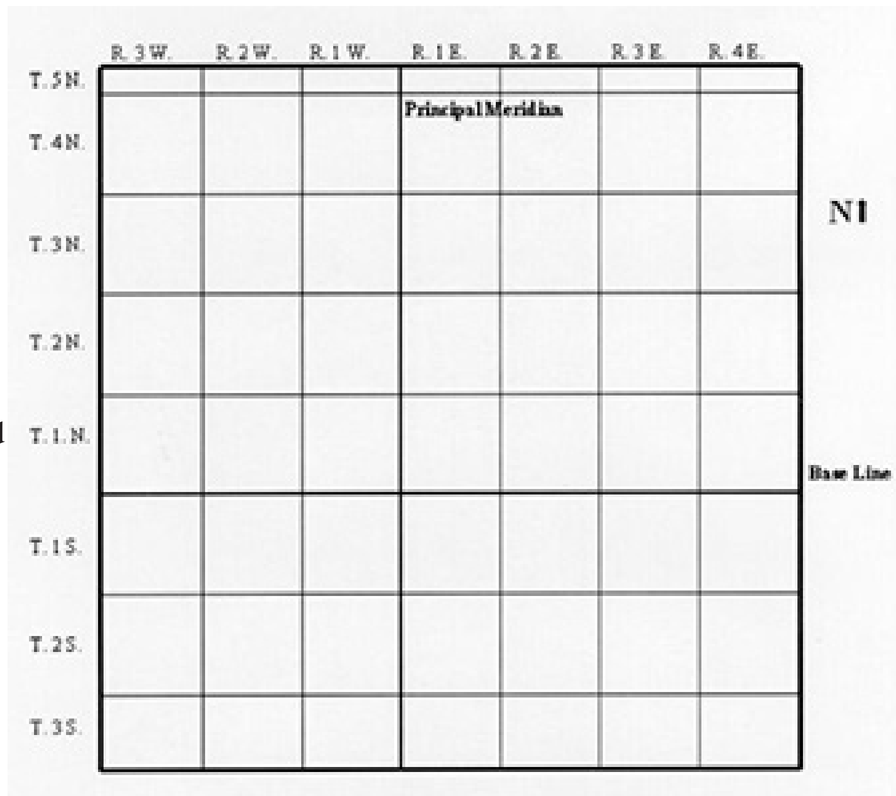
Interpretation of maps is an important skill in the ag aviation business. Aerial applicators must accurately read several types of maps: weather maps, aeronautical charts, infrared and aerial photo maps, and sometimes even simple sketches drawn by the customers. In the past the most commonly used maps in the business were the highway maps of counties where the work was being done. Today's aircraft use sophisticated precision application equipment such as global positioning systems (GPS), geographical information systems (GIS), and real-time meteorological systems.

When a farmer calls an ag aviator for service, he or she is asked to give the legal land description of the field to be treated. A legal land description is a description of a parcel of land in legally precise terms. It explains the exact location of the parcel and the number of acres it contains.

Township and Range System

Legal land descriptions may be based on the rectangular survey system (also known as the township and range system). This system is based on the idea of parallels and meridians that circle the globe. The equator and all horizontal lines north and south of it are known as PARALLELS. The vertical lines which converge at the north and south poles are known as MERIDIANS.

The rectangular survey system also has its own special meridians and parallels throughout the US. These meridians are known as "principal" meridians. Each principal meridian has a parallel which goes with it. These are known as "base" lines. The points where these two meet are known as initial points. In Oklahoma, land described using this system is referenced to either the Indian or the Cimarron Meridian.



Another set of lines is established at 24-mile intervals north and south of the base line and at 24-mile intervals east and west of the principal meridian. The east-west lines are called standard parallels or corrections lines.

The guide meridians and standard parallels form 24-mile squares. Each of these 24-mile squares is divided into 16 smaller units of land called townships. A township is, as nearly as possible, six miles by six miles. A row of townships extending north to south is called a RANGE (R) and a row east to west is called a TIER (T).

Source: Oklahoma County Assessor Mapping/GIS Department, http://www.oklahomacounty.org/assessor/mapping.htm

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Sections

An acre is a rectangular measure of land equal to 43,560 square feet. There are 640 acres in a square mile. This is called a section. Sections within a township can be subdivided into quarter sections (160 Acres, 1/2 mile square), half-quarter or eighth sections (80 Acres, 1/4 mile by 1/2 mile), and quarter-quarter or sixteenth section (40 Acres, 1/4 mile by 1/4 mile). The quarter-quarter section is the minimum legal subdivision under the general land laws, but it is common to divide the subdivision further for descriptive purposes.

All the sections are numbered, and the pattern of numbering is the same in every township. Section numbering proceeds from the northeast (upper right) corner to the southeast (lower right) corner of each section, as shown.

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

When working with rectangular land descriptions, square measure is expressed in terms of acres, and the location is expressed in terms such as S1/2 (south half), NW 1/4 (northwest quarter), etc., as illustrated

FIGURE A

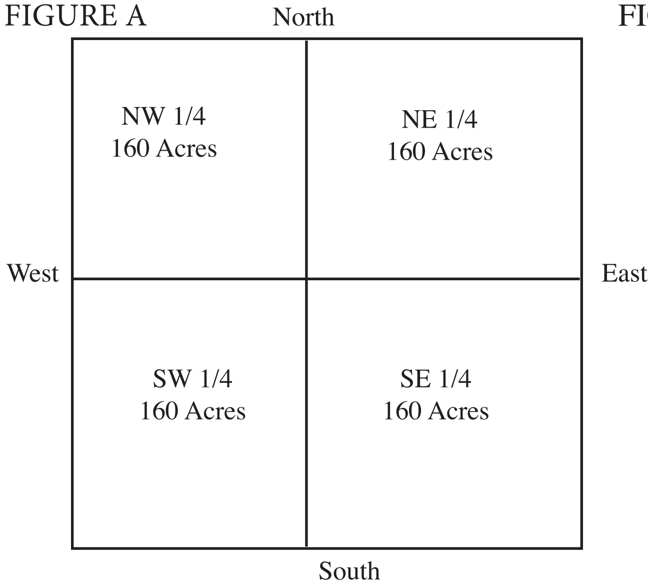
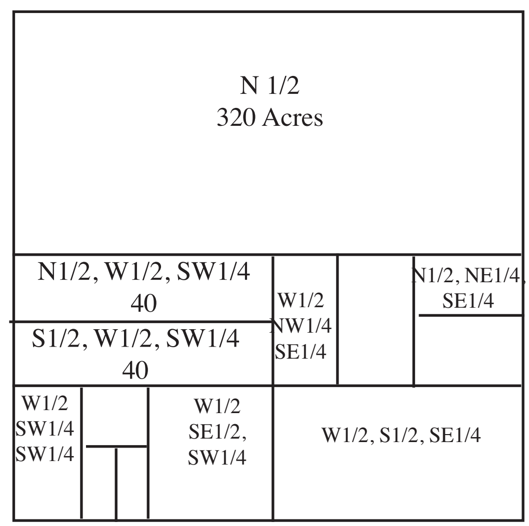


FIGURE B



As you can see in FIGURE A a quarter section is 160 acres (640 ÷ 4 = 160). If a farmer described his field as the SW1/4 of the section and there were 160 acres then the pilot would know where to find the field and how to load his aircraft to do the job.

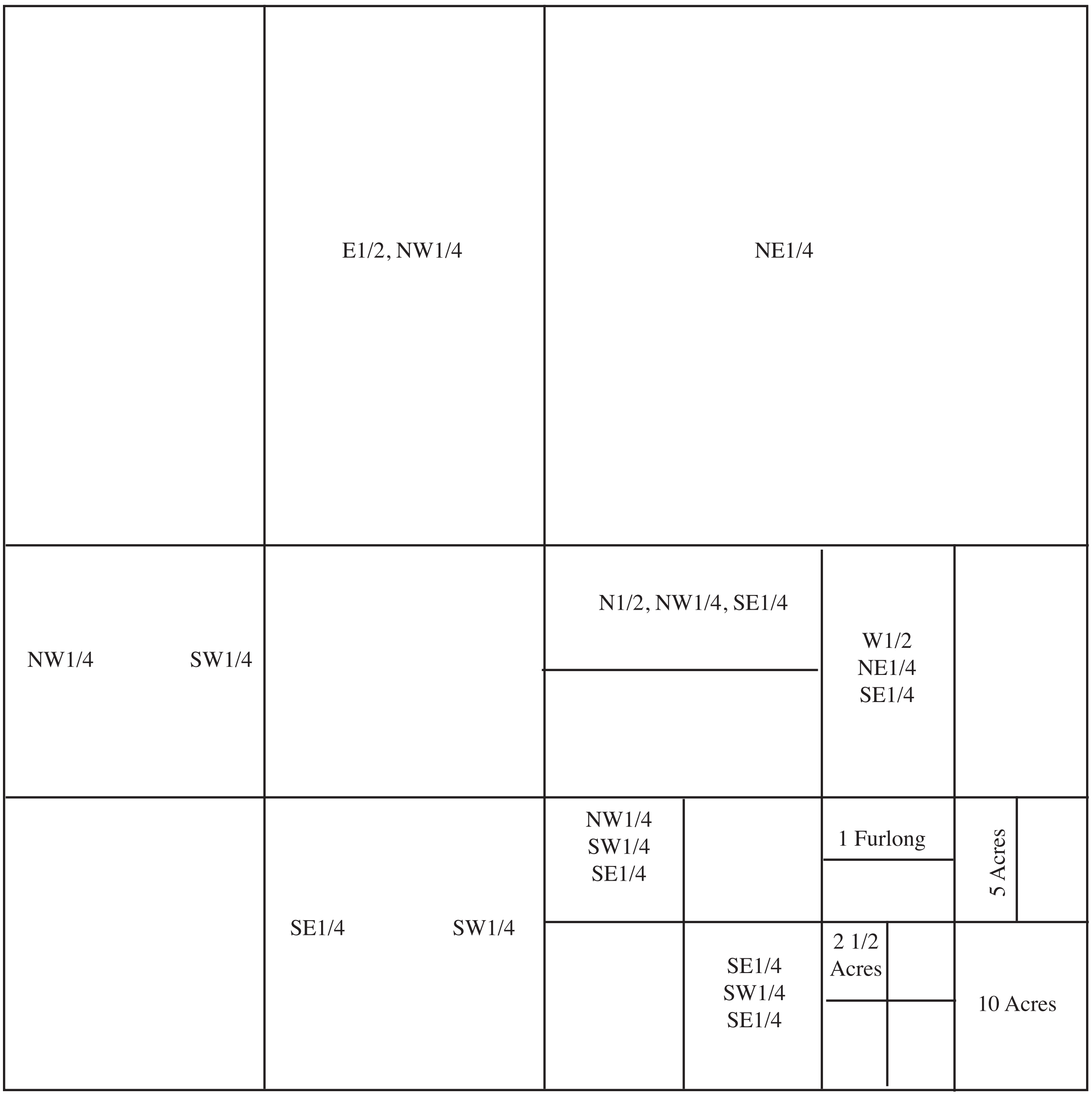
Sometimes the legal description is more difficult to interpret, such as the location of the 20-acre field in FIGURE B with the description of W1/2, NW1/4, SE1/4 of the section. The key to reading a longer legal description is to read it from right to left, or backwards: Follow the steps listed below to find the parcel of land described as W1/2, NW1/4, SE1/4.

1. Start with SE1/4 and locate the square 160 acres in the southeast corner of the section.
2. Then find the NW 1/4 of the 160 acres. (This would be 40 acres, 160 ÷ 4 = 40.)
3. Find the W1/2 of this parcel by separating it into east and west halves. 40 ÷ 2 = 20. This is the 20-acre field you set out to identify.

Name____________________________________

One Section of Land

Based on the information presented in the "Legal Land Descriptions" page, fill in the blank parcels below with the correct legal description.



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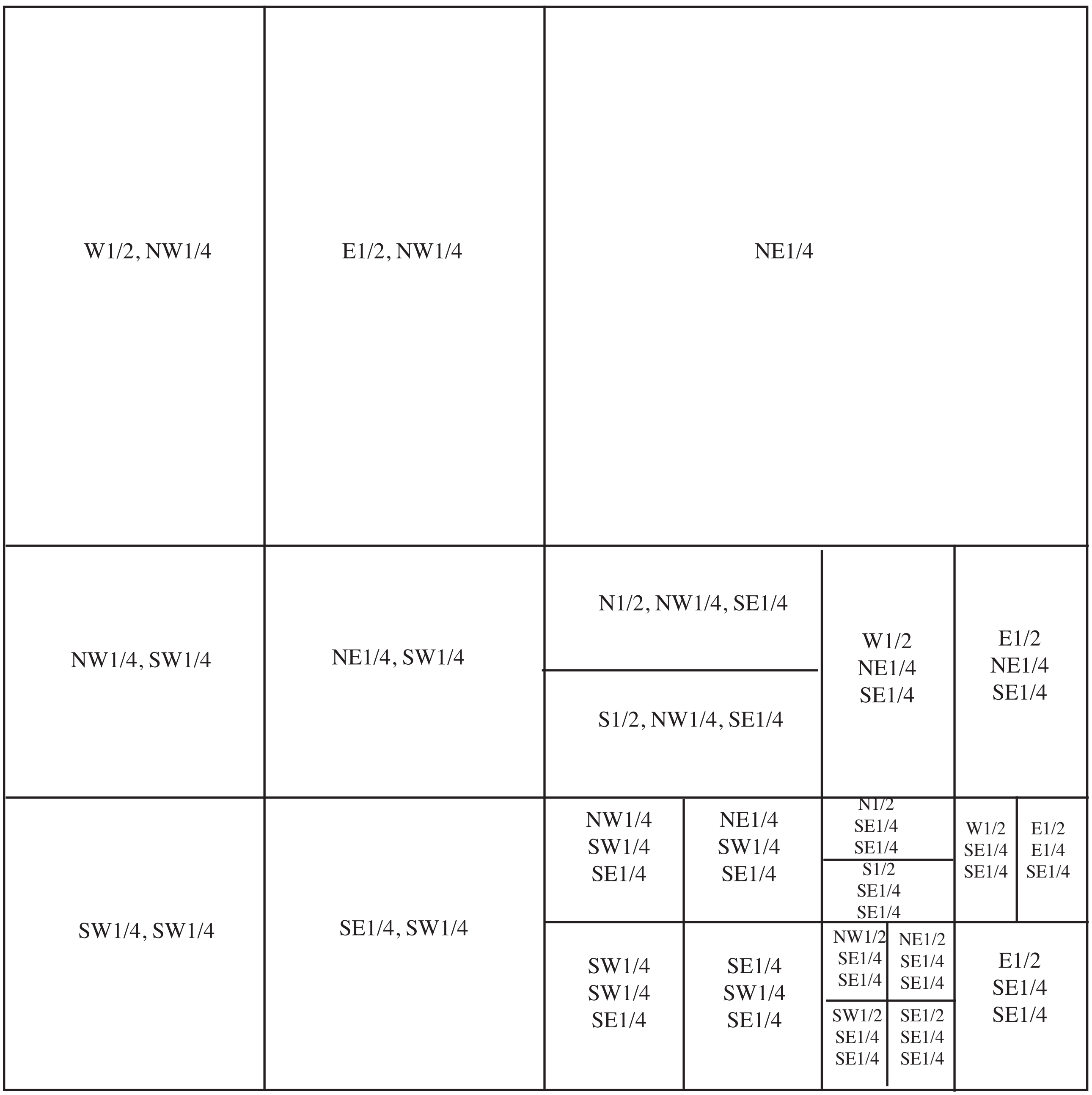
Name____

One Section of Land (answers)

Based on the information presented in the “Legal Land Descriptions” page, fill in the blank parcels below with the correct legal description.



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Name____

Ag Aviation Math (Grade 6)

Important: 1 section = 160 acres

1. In the produce department of the grocery store, apples sell for $1.80/lb., grapes for $1.94/lb, oranges for $1.25/lb., carrots for .68/lb, potatoes for .93/lb and onions for $1.02/lb. You purchased 2 lbs. of each of the fruits and 3 lbs. of each of the vegetables.
   a. What is the total cost of the produce you purchased?
   b. Insects infested the apple orchards in Washington. Many producers chose not to treat for insects. Because of the losses the apple price rose 20% per pound to the consumer. Along with the insect problem in the apples, the potato production in Minnesota and North Dakota was cut in half due to a fungus problem left untreated because of a lack of chemical. Of the potatoes harvested, most were of poor quality and small. This caused the per pound price to double. When buying the same quantities of, what is the cost of the produce?
   c. What was the cost increase to the consumer due to the untreated insect and fungus problems?

2. Oklahoma growers Jane and Stan each have a quarter section of wheat with weeds that should be sprayed to avoid a loss. Jane contacted Pilot Bob to order his quarter sprayed with the herbicide at a cost of $15 per acre. Stan decided not to spray his wheat. When harvested, Jane's wheat yielded 55 bushels/acre, and Stan's yielded 39 bushels/acre. Each grower sold their wheat for $6/bushel.
   a. What did it cost Jane to have her field sprayed?
   b. How much money did Jane receive when she sold all her wheat?
   c. How much did Stan receive when he sold all his wheat?
   d. What was the difference between the amount each grower received from their grain?

3. Water is the primary carrier for chemicals that aerial applicators spray. If Pilot Ann sprays 80 acres with a chemical requiring 10 gallons/acre of total solution (water and chemical), what is the total number of gallons sprayed? If the chemical required is 5 gallons/acre? If the chemical required is 2 gallons/acre? If the chemical required is 1 gallon/acre?

4. Pilot Bob sprayed 1/8 of a section with an insecticide. How many acres did he spray? (Replace 1/8 with 1/6, 3/4, 3/3, 1/2, etc.

5. Pilot Ann flies to the field in her Cessna Ag Wagon at a speed of 105 mph. It takes 10 minutes to get to the field. How far was the field from the airport?

Problems adapted from National Aviation Association, Secondary Level Curriculum Guide: http://www.agaviation.org/Files/CurriculumGuides/secondary.pdf

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Name____

Ag Aviation Math (Grade 7)

1. A grower ordered herbicide, at the rate of 1 pint/acre, to be applied to a full quarter section of soybeans.
   a. How many gallons of chemical are needed to complete the job?
   b. If Pilot Bob applies a total of 5 gallons of spray solution (water and chemical) per acre, how many gallons of solution will be applied? 5 gallons
   c. When using a Thrush with a 400-gallon hopper, how many loads will it take to do the soybean field?
   d. If the chemical costs $65 a gallon and Pilot Bob charges $9.60 per acre for the spraying, what is the per acre cost to spray the soybean field?
   e. What will it cost the grower for the entire job?
   f. If sprayed, the potential yield for this soybean field is 30 bushels to the acre. Untreated, the expected yield would be 24 bushels to the acre. Soybeans sell for about $9 per bushel. What is the dollar value of the crop loss if the grower chooses not to spray? Did the spraying pay for itself?

2. If Pilot Bob bought 50 gallons of fungicide and it is to be applied at 4 ounces per acre, how many acres can be sprayed with the 50 gallons?

3. Pilot Bob can spray 40 acres per load with his Cessna Ag Wagon and has 475 acres of cotton to spray.
   a. How many equal loads are there to spray, and how many acres in each?
   b. If each load takes 45 minutes, how many hours will it take?

4. Pilot Ann sprayed 4 less than 3 times as many acres as Pilot Al. Pilot Al sprayed 92 acres. How many acres did Pilot Ann Spray?

5. An ag aircraft consumed 35 gallons of gas per hour, at a cost of $2.35 per gallon, and sprayed 750 hours during a season. How much fuel was consumed, and what was the cost?

6. To get to a field from the airport, Flagger Amy must travel 5 miles south and then travel 12 miles west. Pilot Bob, in his Pawnee, flies directly to the field from the airport.
   a. How many miles does Pilot Bob fly?
   b. Pilot Bob, in his Pawnee, travels at 100 miles per hour and the flagger at 45 miles per hour. How long does it take each of them to get to the field?
   c. Pilot Bob wants to arrive at the field 5 minutes after Flagger Amy. How many minutes should he wait before he takes off?

Adapted from National Aviation Association, Secondary Level Curriculum Guide: http://www.agaviation.org/Files/CurriculumGuides/secondary.pdf

Ag Aviation Math (Grade 6 answers)

1. In the produce department of the grocery store, apples sell for $1.80/lb., grapes for $1.94/lb, oranges for $1.25/lb., carrots for .68/lb, potatoes for .93/lb and onions for $1.02/lb. You purchased 2 lbs. of each of the fruits and 3 lbs. of each of the vegetables.
   a. What is the total cost of the produce you purchased? **$17.87**
      Fruit: $1.80 + $1.94 + $1.25 = $4.99 X 2 lb. = $9.98
      Vegetables: .68 + .93 + $1.02 = $2.63 X 3 lb. = $7.89

   b. Insects infested the apple orchards in Washington. Many producers chose not to treat for insects. Because of the losses the apple price rose 20% per pound to the consumer. Along with the insect problem in the apples, the potato production in Minnesota and North Dakota was cut in half due to a fungus problem left untreated because of a lack of chemical. Of the potatoes harvested, most were of poor quality and small. This caused the per pound price to double. When buying the same quantities as above, what is the cost of the produce? **$21.38**

   c. What was the cost increase to the consumer due to the untreated insect and fungus problems? **$3.51**

2. Oklahoma growers Jane and Stan each have a quarter section **(160 acres)** of wheat with tansy mustard* which should be sprayed to avoid a yield loss. Jane contacted Pilot Bob to order his quarter sprayed with the herbicide at a cost of $15 per acre. Stan decided not to spray his wheat. When harvested, Jane's wheat yielded 55 bushels/acre, and Stan's yielded 39 bushels/acre. Each grower sold their wheat for $6/bushel.
   a. What did it cost Jane to have her field sprayed? **$2,400**
   b. How much money did Jane receive when she sold all her wheat? **$52,800**
   c. How much did Stan receive when he sold all his wheat? **$37,440**
   d. What was the difference between the amount each grower received from their grain after you deduct the amount Jane paid for spraying? **$12,960**

3. Water is the primary carrier for chemicals that aerial applicators spray. If Pilot Ann sprays 80 acres with a chemical requiring 10 gallons/acre of total solution (water and chemical), what is the total number of gallons sprayed? **80 X 10 = 800 gallons**
   5 gallons/acre? 80 X 5 = **400 gallons**
   2 gallons/acre? 80 X 2 = **160 gallons**
   1 gallon/acre? 80 X 1 = **80 gallons**

4. Pilot Bob sprayed 1/8 of a section **(640 acres in a section**)with an insecticide. How many acres did he spray? **80 acres**
   Replace 1/8 with 1/6 = **640;** 3/4=**480 acres**; 2/3**=426.66 acres**; 1/2 **= 320 acres**

5. Pilot Ann flies to the field in her Cessna Ag Wagon at a speed of 105 mph. It takes 10 minutes to get to the field. How far was the field from the airport? **17.5 miles**
   10 minutes / 60 minutes = 1/6 of an hour
   105 mph X 1/6 of an hour = 17.5

*a weed

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Ag Aviation Math (Grade 7 answers)

1. A grower ordered herbicide, at the rate of 1 pint/acre, to be applied to a full quarter section of soybeans.
    a. How many gallons of chemical are needed to complete the job? **20 gallons**

    b. If Pilot Bob applies a total of 5 gallons of spray solution (and water) per acre, how many total gallons of solution will be applied? **800 gallons**

    c. When using a Thrush with a 400-gallon hopper, how many loads will it take to do the soybean field? **2 loads**

    d. If the chemical costs $65 a gallon and Pilot Bob charges $9.60 per acre for the spraying, what is the per acre cost to spray the soybean field? **$21.80 per acre**

    e. What will it cost the grower for the entire job? **$2,836**

    f. If sprayed, the potential yield for this soybean field is 30 bushels to the acre. Untreated, the expected yield would be 24 bushels to the acre. Soybeans sell for about $9 per bushel. What is the dollar value of the crop loss if the grower chooses not to spray? **$8,640**

    Did the spraying pay for itself? **Yes. Cost to spray was $2,836**

2. If Pilot Bob bought 50 gallons of fungicide and it is to be applied at 4 ounces per acre, how many acres can be sprayed with the 50 gallons? **1,600 acres**

3. Pilot Bob can spray 40 acres per load with his Cessna Ag Wagon and has 475 acres of cotton to spray.
    a. How many equal loads are there to spray, and how many acres in each? **12 loads of 39.58 each**

    b. If each load takes 45 minutes, how many hours will it take? **9 hours**

4. Pilot Ann sprayed 4 less than 3 times as many acres as Pilot Al. Pilot Al sprayed 92 acres. How many acres did Pilot Ann Spray? **272 acres**

5. An ag aircraft consumed 35 gallons of gas per hour, at a cost of $2.35 per gallon, and sprayed 750 hours during a season. How much fuel was consumed, and what was the cost? **26,250 gallons, costing $61,687.50**

6. To get to a field from the airport, Flagger Amy must travel 5 miles south and then travel 12 miles west. Pilot Bob, in his Pawnee, flies directly to the field from the airport.
    a. How many miles does Pilot Bob fly? **13 miles**

    b. Pilot Bob, in his Pawnee, travels at 100 miles per hour and the flagger at 45 miles per hour. How long does it take each of them to get to the field? **Pilot Bob—.13 of an hour, or 7.8 minutes; Flagger Amy—.38 of an hour, or 22.8 minutes**
    c. Pilot Bob wants to arrive at the field 5 minutes after Flagger Amy. How many minutes should he wait before he takes off? **20 minutes**

Name____

Paper Airplane Trials

1. Make a list of modifications you could make to a "regular" paper airplane to make it go farther. (example: weight—could make it heavier or lighter) List at least 5 possible modifications.

2. Choose ONLY ONE of the modifications (variables) to test. Describe how you will make modifications for this variable. (For example if you choose to change the weight, how will you add or subtract weight?) This variable is called your independent variable; it is the ONE thing you change in the experiment. Choose an **independent variable** that you can increase and decrease (for example make heavier or lighter).

   What is your independent variable?______________________________

3. The purpose of running trials is to determine how far the plane will fly. This is the distance you will measure. In an experiment what you measuring is called the **dependent variable**, because the distance it flies is dependent on the independent variable you are changing. Because you won't get the same distance every time, you will need to run a series of trials. You should do your best to use the exact same technique every time. These are called constants. Constants are the ways you keep the environment and methods the same so they won't influence your results. What are some constants you will use to help keep the trials the same?

4. A **hypothesis** is a statement that describes a connection between your independent variable and dependent variable. For example, "If I increase the weight of my plane, it will fly farther."

   What is your hypothesis for your experiment?

5. If your hypothesis is correct, what do you predict will happen? Which trials (control, experimental group #1 or #2) will fly the farthest? Which trial will fly the shortest distance.

Oklahoma Ag in the Classroom is a program of the Oklahoma Cooperative Extension Service, the Oklahoma Department of Agriculture, Food and Forestry and the Oklahoma State Department of Education.

Procedure:

1. Choose a paper airplane style and construct it.
2. Run eight trials of this airplane. For each trial, record how far the airplane flies. Take any other notes about that trial in the data table. For example, if the plane hits the wall or ceiling, record this.
3. Introduce a low level of your independent variable. This is called your experimental group #2. Run eight trials with this variable.
4. Increase the level of your independent variable again, and run eight more trials for experimental group #3.
5. Calculate mean, median, mode, and range for the control and experimental groups.

PAPER AIRPLANE DATA TABLE

Trials	Control Trials Airplane without modifications	Experimental Group # 1 Airplane with	Experimental Group #2 Airplane with
1			
2			
3			
4			
5			
6			
7			
8			
total			
mean			
median			
mode			
range			

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1. Which of the central tendency calculations most accurately describe the three sets of data? Why? [Use this calculation to answer the following post lab questions.]

2. Which group did you predict would go the farthest? (From prelab question #5.) Were you correct? Why do you think that is?

3. Which group did you predict would go the shortest distance? (From prelab question #5.) Were you correct? Why to you think that is?

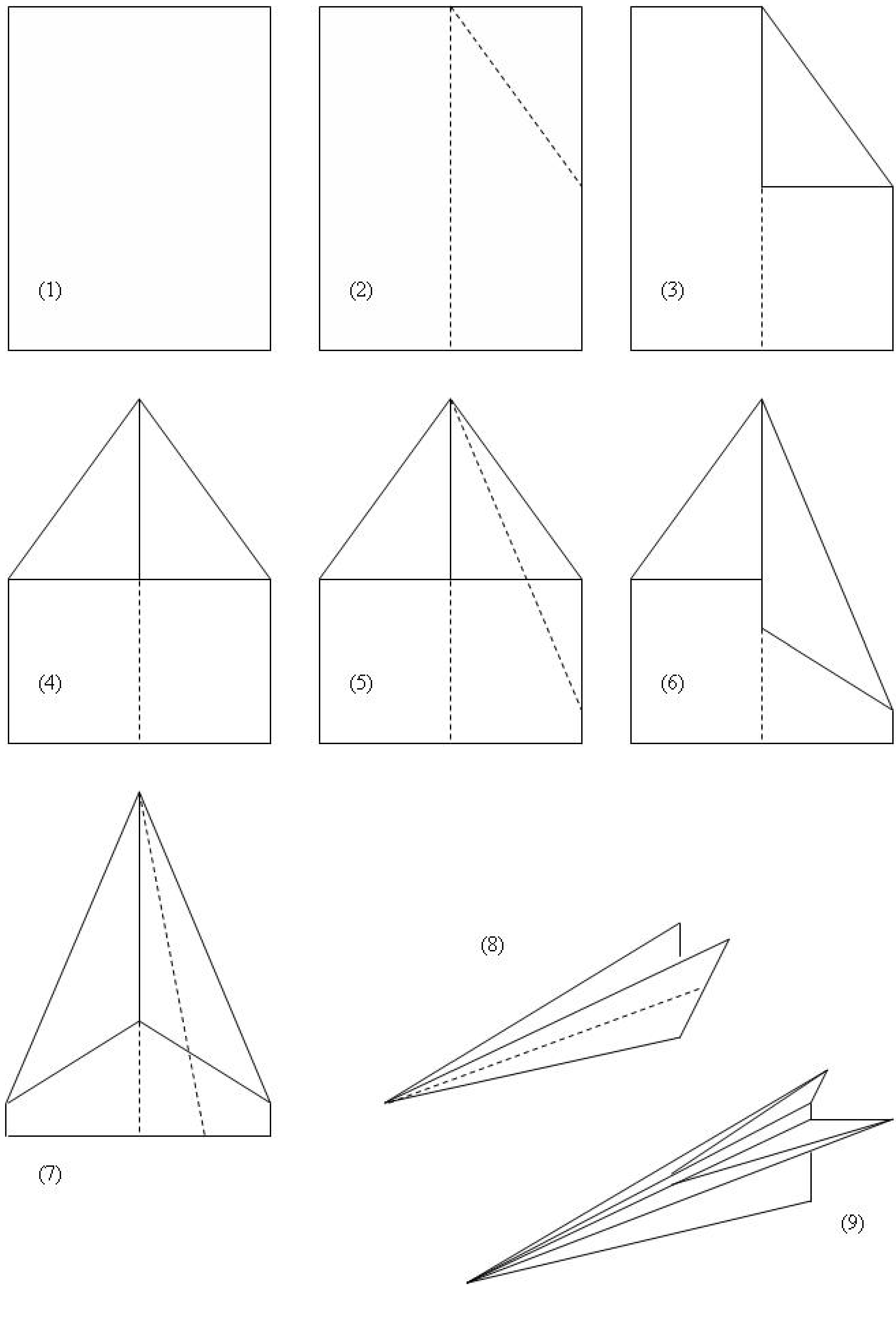
4. Was your hypothesis supported?

5. How confident are you that the independent variable (what you changed) influenced the dependent variable (how far it flew)? Is there a strong or weak connection?

6. How reliable (consistent) were your data? Why is that?

7. Were there things you could have kept constant that you didn't? If you were to perform the experiment again, how would you change your methods to improve the reliability of your data?

8. Describe another way to test your independent variable. Why might this have resulted in better or different results?


(1)
(2)
(3)
(4)
(5)
(6)
(7)
(8)
(9)

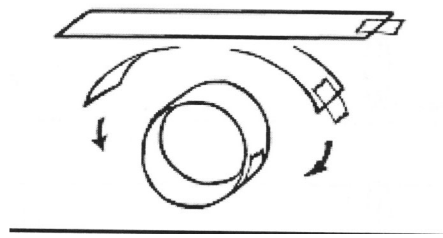
O-Wings Construction

Materials

4 plastic drinking straws	tape	pencils
stiff cards	tape measure	scissors

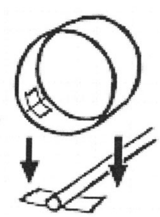
1. Carefully measure and cut 8 strips of card, as follows
   5 strips cut 1 inch by 10 inches
   1 strip cut 1 inch by 8 inches
   1 strip cut 1 inch by 6 inches
   1 strip cut 1 inch by 4 inches.

2. Follow the directions below to construct four rings from the strips you have cut.
   —Place a piece of sticky tape on the end of one of the strips, as shown.



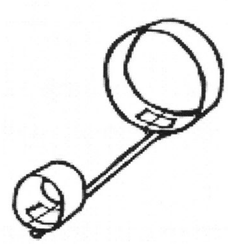
   —Curl the strip over so the ends overlap a little and secure it with the tape. Secure the inside where the two ends meet with another small piece of tape.

3. Lay a piece of tape on the table, sticky side up. Place the end of a straw onto the center of the tape. Push one of the 10-inch rings onto the tape on top of the straw and secure carefully.



4. Repeat at the other end of the straw with another 10-inch ring.

5. — Place a 10-inch ring at the end of each of the remaining four straws with one of the smaller rings at the other end.



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Name______________________________________

O-Wings Test Flight Results

Conduct test flights with your O-Wings and record your results in the table below. Write your observations in the space provided about how well each O-Wing flew (Did it glide or spin out of control?)

	Test 1 Distance	Test 2 Distance	Test 3 Distance	Average Distance
10 X 10 inches				
10 X 8 inches				
10 X 6 inches				
10 X 4 inches				

Observations

What conclusions can you draw from the results of the experiment?

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