

The Scientific Method

Goals and Objectives:

1. Review the steps of the Scientific Method.
2. Understand the difference between variables – independent, dependent, and constants
3. Identify the control and understand its purpose
4. Write a title using the format: The Effects of _____ on _____
5. Write a hypothesis as a cause and effect statement using: If..., then....
6. Identify parts of an Experimental Design: Title, Hypothesis, Independent Variable, Dependent Variable, Constants, Control, and Trials
7. Design an experiment
8. Identify errors and suggest improvements
9. Write a simple lab report.

Assessment:

Criterion D: scientific inquiry

Students are expected to carry out scientific investigations independently.

Achievement Level	Descriptor
0	Not turned in or completed
1-2	The student attempts to define the purpose of the investigation and makes references to variables but these are incomplete or not fully developed. Student can complete investigation with support .
3-4	The student defines the purpose of the investigation and provides an explanation/prediction but this is not fully developed. The student acknowledges some of the variables involved and describes how to manipulate them.
5-6	The student defines the purpose of the investigation formulates a testable hypothesis using correct format. The student identifies all relevant variables including independent, dependent, constants, and control

The Scientific Method Review

Problem: Question you are investigating or purpose; describes why you are doing the experiment.

Research: Background information to help you write a hypothesis

Hypothesis: An educated guess or prediction

Experiment: Tests the hypothesis using an Experimental Design

Observations: Collected data about what you see and measure

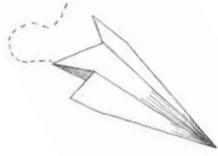
Results: organizes data into tables and graphs

Conclusion: discuss whether you accept or reject a hypothesis; it is based on whether the data supports your prediction



Variables - A Lesson in Change

Introduction:



Whether you know it or not, you just performed an experiment. In an experiment, you change something - *a variable* - to see what happens. Variables you changed on purpose are called *independent variables*. When you change an independent variable - such as the design of the paper airplane - you are looking for an effect, or response, in another variable. In this case, you wanted to know how the flight path changed. This responding variable is called a *dependent variable*. It is also usually the data we want to *measure* and collect. In an experiment, it is important to make only one change. All of the other factors should remain *constant* or the same. Finally, you want to identify the normal condition, or standard as the *control*.

A. Factors that stay the same. _____

What factors remained the same for *all* the paper airplanes?

B. Factors that you change. _____

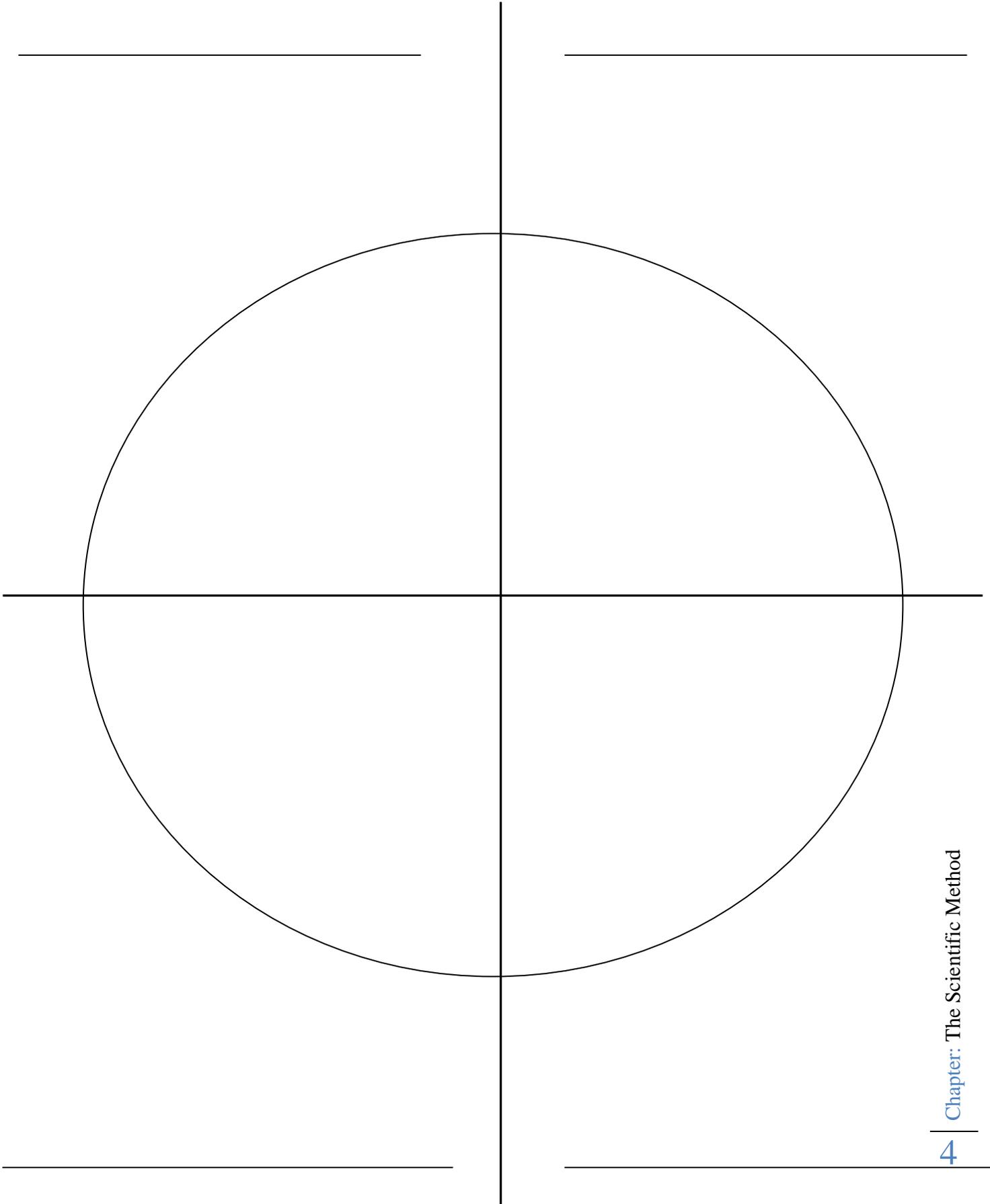
List the changes that your classmates made on the paper airplanes.

C. Factors that respond to the change and can be measured _____

List the responses we wanted from the planes as a result of our change.

D. Construct a variable wheel.

- Independent Variables – Divide the circle into 8 sections (pieces of pie). In each section, write an independent variable that could be tested on paper airplanes.
- Dependent Variables – In each quadrant, write a dependent variable and how it will be measured.



E. There can be several levels for an independent variable.

The standard level for comparison is your _____.

Identify three levels for each independent variable on your wheel

IV: _____

-
-
-

F. Write a hypothesis. Use the If..., then... format for three of your independent variables.

Predict which level will be most effective for your independent variable.

1. _____

2. _____

3. _____

G. Write a title. Use the formula:

The effects of _____ on _____

1.

2.

3.

H. Repeated Trials. _____

How many times do you think you should repeat each level of the experiment?

Parts of an Experimental Design

Title:	*	Identifies the cause and effect (the IV and DV)
	*	
Hypothesis:	*	a prediction of how a change will cause an effect
	*	
Independent Variable	*	a change you are testing
Levels	*	varying degrees of change
	*	
Control	*	used as a standard of comparison
	*	
Dependent Variable	*	response to the change
	*	what will be measured
	*	
Constants	*	factors that stay the same
Repeated Trials	*	how many times you repeat an experiment
	*	

Check Your Understanding

Constants	Repeat	Independent Variable
Levels	Dependent Variable	Control
Research	Hypothesis	Conclusion

Now that you've learned the basics of a good experiment, answer the following questions using the vocabulary from the word bank above.

1. The variable that you change on purpose is called the _____.
2. The ways in which you vary the variable that you change on purpose are called _____.
3. The variable that responds to the change is called _____.
4. The part of the experiment that is used as the standard of comparison is called the _____.
5. The part of the experiment that you must keep the same in each trial is _____.
6. A prediction of your results or what is going to happen is called a _____.
7. When you _____ an experiment several times, it allows you to see if your results are consistent.
8. In the _____, you state whether you accept or reject your hypothesis.
9. Before you write a hypothesis, you should _____ your topic first so that you have some background knowledge.
10. Thought Question: Why do you think it's important for scientists to tell others about their experiment using the scientific method and publish their results?

Variables

Practice identifying the three types of variables using the scientific investigation problems below. Don't forget the **CONTROL!** The first one has been done for you.

Problem	Independent Variable/Levels	Dependent Variable/ What is being measured	Constants What stays the same
How will the shape of a pebble affect its movement in water?	IV: shape of pebble Levels: round, flat, jagged (no control)	The distance the pebble moves from start	Same place in the river Same speed of river Same size of pebble
What is the effect of wind speed on drying of soil?	IV: Levels:		
How does salt affect evaporation rate?	IV: Levels:		
Can the type of soil influence plant growth?	IV: Levels:		
How does the launching angle of a projectile affect the distance the object travels?	IV: Levels:		
Does heating a cup of water allow it to dissolve more sugar?	IV: Levels:		

For each problem, circle the level of the control (if there is one).

Experimental Design Format

Title: _____

Hypothesis: _____

	IV:
Levels →	
Repeated Trials →	

DV: _____

Constants: _____

Practicing the Experimental Design

Directions: For each experiment below, answer questions A-D.

- First, identify the independent variable, levels of the independent variable, dependent variable, number of repeated trials, constants, and control (if present).
- Identify the hypothesis for the experiment. If the hypothesis is not present, write one for the experiment.
- Complete the experimental design diagram, which includes an appropriate title and hypothesis.
- State at least one way to improve the experiment described in the scenario.

Experiment: Ten seeds were planted in each of 5 pots found around the house that contained 500 grams of “Pete’s Potting Soil.” The pots were given the following amounts of distilled water each day for 40 days: Pot 1, 50 ml; Pot 2, 100 ml; Pot 3, 150 ml; Pot 4, 200 ml; and Pot 5, 250 ml. Because Pot 3 received the recommended amount of water, it was used as a control. The height of each plant was measured at the end of the experiment.

Title: _____

Hypothesis: _____

IV:

DV: _____

Constants: _____

Improvements or Flaws:

Experimental Design Review



Complete the experimental design using the components of the experiment below.

1. Gloria wanted to find out if the color of food would affect whether kindergarten children would select it for lunch. She put food coloring into 4 identical bowls of mashed potatoes. The colors were red, green, yellow and blue. Each child chose a scoop of potatoes of the color of their choice. Gloria did this experiment using 100 students. She recorded the number of students that chose each color.

Title:

Hypothesis: _____

IV:

DV: _____

Constants: _____

Improvements or Flaws:

2. Susie wondered if the height of a hole punched in the side of a quart-size milk carton would affect how far from the container a liquid would spurt when the carton was full of the liquid. She used 4 identical cartons and punched the same size hole in each. The hole was placed at a different height on one side of each of the containers. The height of the holes varied in increments of 5 cm, ranging from 5 cm to 20 cm from the base of the carton. She put her finger over the holes and filled the cartons to a height of 25 cm with a liquid. When each carton was filled to the proper level, she placed it in the sink and removed her finger. Susie measured how far away from the carton's base the liquid had squirted when it hit the bottom of the sink.

Title: _____

Hypothesis: _____

IV:

DV: _____

Constants: _____

Improvements or Flaws:

Simple Lab Report Format

Question:

Title:

Hypothesis:

IV:

DV:

Constants:

Observations:

Conclusion:

Objective	Criteria	Yes	No
Problem	Written as a question	1 = present 2 = correct punctuation	
Title	Correct format	1 = present 2= correct format	
Hypothesis	Correct format	1 = present 2 = correct format	
Independent variable	Identified	1 = present	
Levels	2 or more levels	1 = present 2 = control identified	
Repeated trials	Appropriate number	1	
Constants	Minimum of 2 identified	1 = 2 identified 2 = 3 or more	
Observations	Details	1 = minimum 2= provides details	
Conclusion	Answers the question	1 = minimum 2 = detailed and thorough	
Variable Wheel	Identifies potential variables	3 = 8 variables 2 = 6 variables 1 = 4 or less	
Dependent variables	Identifies potential variables	3 = 4 variables /Measured 2 = 2 variables/Measured 1 = variable/not measured	
Total		25 points	

Scientific Method Study Guide

Test Date _____

Directions: Match each term in Column II with its definition in Column I.

- _____ 1. An educated guess
- _____ 2. Any factors that remain the same
- _____ 3. A group or sample that is used as a standard of comparison.
- _____ 4. Used to produce more reliable results
- _____ 5. The factor in an experiment that is changed on purpose
- _____ 6. The factor in an experiment that responds to the change and can be measured.
- _____ 7. The purpose or question you want to investigate
- _____ 8. Sequence of steps to show how your experiment was done.
- _____ 9. Collected observations or results investigate.
- _____ 10. Supports or rejects the hypothesis.

- A. Problem**
- B. Hypothesis**
- C. Independent Variable**
- D. Dependent Variable**
- E. Control**
- F. Constants**
- G. Repeated Trials**
- H. Conclusion**
- I. Procedures**
- J. Data**

In the experimental design diagram below, each letter, A through E, represents a component of an experiment. Identify the component that each letter represents.

Title:

Hypothesis:

A.				
B.				
C.				
D.	_____			
E.	_____			



The Scientific Method

Experimental Design Components	
Repeated trials	Dependent Variable
Constants	Levels
Independent Variable	

In the experimental design diagram shown here, the various components of an experiment on the effectiveness of different gasoline are illustrated.

Title: Life is a Gas

Hypothesis: Sam predicted that Ace was best.



Brand of Gasoline		
Speedy	Ace	Roll-on
3 round trips	3 round trips	3 round trips

DV: Miles per gallon

C: Same make, model, and horsepower cars

Using the information in the experimental design diagram, identify each component in the blanks below.

1. What was the independent variable? _____

2. What was the dependent variable? _____

3. How many trials were completed? _____

4. What were the levels of the independent variable?

5. What were the constants?

6. Rewrite the hypothesis using the If, then format.

7. Rewrite the title using the correct scientific format.

8. What improvement or flaw can be identified in this experiment?

Evaluate the experiment for improvements and flaws.

**SUCCESS
PLANNER**

SHINE YOUR DESIGN

Even for a science pro, practice makes perfect.

A sloppy experimental design is like a poorly planned football play: Nothing goes as you hoped, and you don't get anywhere. But if you think out your experimental design cleverly—touchdown!

Want some practice designing experi-

ments? You've come to the right place. Review the parts of an experimental design diagram (see page 9). Then use the checklist (opposite page) to find the flaws in the examples given here. Some of the flaws are obvious, others are tougher to find. Good luck. (Solutions in Teachers' Edition.)

1. Suppose you're tired of always sliding off your skateboard in the middle of a trick. You want footwear that will help your feet grip the board.

So you're going to experiment—slide four different kinds of shoes down a ramp. Try: bowling shoes; shoes with soles of rubber and plastic; soles with cleats. Time how long it takes for each to slide down the ramp.

TITLE: Momma said slide your shoes

HYPOTHESIS: If shoes with different soles are slid down a ramp, then shoes will slide in this order (slowest to fastest): rubber-soled, plastic-soled, shoes with cleats, bowling shoes.

IV: Type of shoe sole			
Bowling	Cleats	Plastic	Rubber
1 trial	1 trial	1 trial	1 trial

DV: How silly you look in the shoes
C: Same ramp, length of ramp, tilt of ramp, surface of ramp, weight of shoes, size of shoes

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Improvements and Flaws. Identify 3 flaws and suggest how to improve them.

Flaw - What component is wrong?	Correction or improvement
1.	
2.	
3.	

