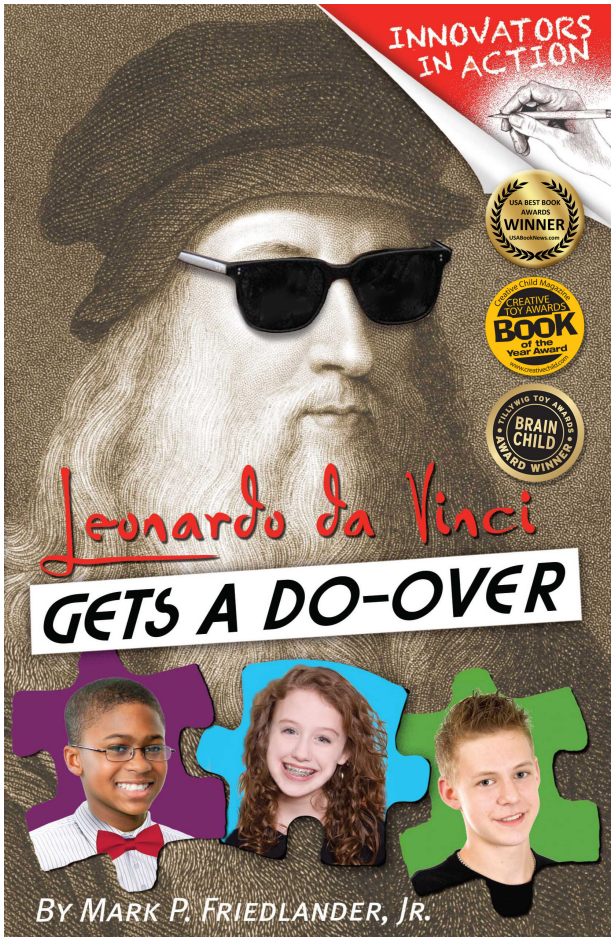


Teacher's Guide

for

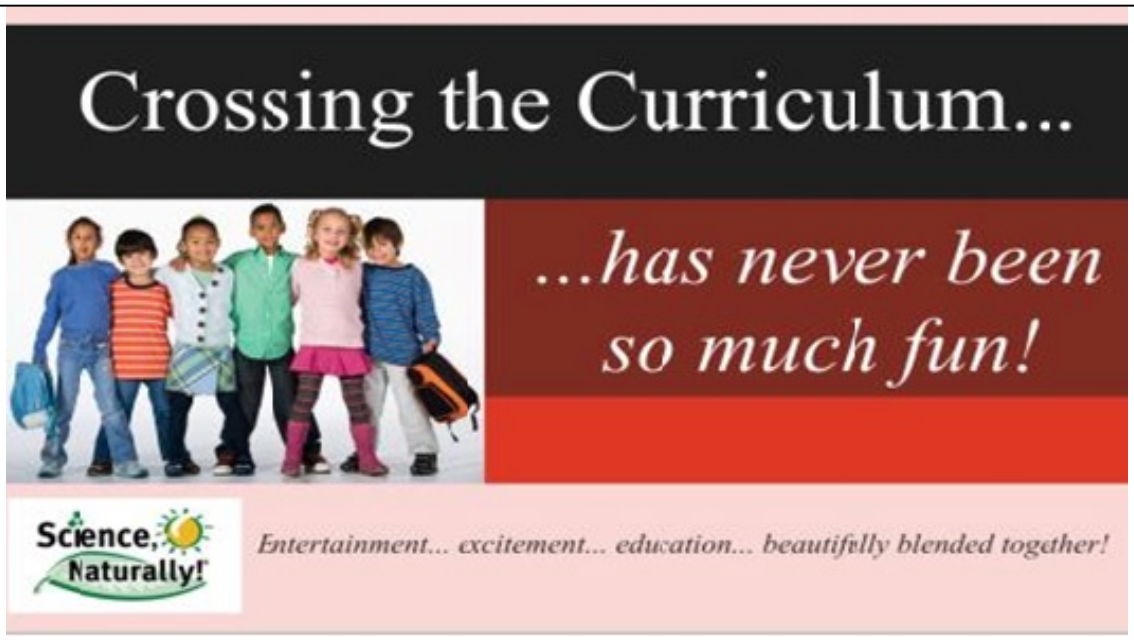
Leonardo da Vinci Gets A Do-Over

Written by Sue Garcia

Associate Writers: Joan Wagner, Joanne Dayton, and Melissa McClellan

Edited by Megan E. Murray

Available for Free Download at ScienceNaturally.com



Background

This Guide provides ideas and strategies for using the book as a teaching tool.
Cross-curricular opportunities are highlighted.
Hands-on activities across the curriculum can be found in the appendices.
You will also find articulations to the Next Generation Science Standards and Common Core State Standards Conncetions.

Book Summary

The passing of great Renaissance master Leonardo da Vinci—artist, anatomist, engineer, inventor—marked the end of an era. The world hasn't seen a visionary like him since … until now. On a school trip to Florence, three American middle school students think they're in for a treat when a man who claims to be Leonardo da Vinci, brought back to life with a mission to better humankind, crashes their tour. Too bad he isn't really the celebrated Master of the Renaissance…or is he? Will the students be able to help Leonardo evade the mayor of Florence's selfish grasp so he can complete his quest before his time runs out? Tag along with Max, Tad, and Gina as they assist Leonardo on his quest, discover the secrets of his life, and teach the Maestro about science, math, history, art, and more!

Awards and Acclaim

Smart Book Award Winner, Academic's Choice
Brain Child Award Winner, Tillywig Toy Awards
Book of the Year, Creative Child Magazine
Finalist, International Book Awards

Innovators in Action: Leonardo da Vinci Gets a Do-Over

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Mark P. Friedlander, Jr. was born in Washington, D.C. and raised on the farms of Fairfax County, Virginia. He attended and graduated from the University of Virginia with a major in procrastination and served in the Air Force as an aviator during the Korean War. After the war, he earned a law degree from the University of Virginia and then launched a career as a trial lawyer.He has authored and coauthored books on subjects including Shakespeare, aviation history, immunology, contagious diseases, forensic science, humor, and now Leonardo da Vinci. His passion for learning about new subjects and passing this excitement on to kids helps keep him young at heart. He can be reached at Mark@ScienceNaturally.com.

About the Illustrator

Worachet Boon Sakprayoonpong was born in Bangkok, Thailand in 1994, and then moved to the U.S. at an early age. He started drawing in high school and has designed artwork ever since. Boon is currently enrolled at George Mason University, studying graphic design. He enjoyed researching the Renaissance for this project- his first book. He can be reached at Boon@ScienceNaturally.com.

Meet the Teacher's Guide Writers

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Sue Garcia: After 32 years in the classroom, 19 years math (4th-HS), 9 years science (6th-9th), 4 years language arts (7th-8th), 3 years History (6th), and 2 years art (middle school), she has "retired" from the classroom. However, she is still actively engaged in mentoring, consulting, and writing curriculum for science. Her hobbies include scrapbooking, horseback riding, and swimming on a Masters swim team. She can be reached at Sue@ScienceNaturally.com.

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Joan Wagner is the Director of Focus on Learning, a science education-consulting firm. She is a former president of the Science Teacher's Association of New York, where she currently acts as Conference Speaker coordinator and Grant Chair. She is also the director of the Greater (NY) Capital Region Science and Engineering Fair. Joan lives in Saratoga Springs, NY. She can be reached at Joan@ScienceNaturally.com.

Joanne Dayton taught school in West Genesse Central School and Scotia Glenville Central School in New York State for over 32 years. Most of her career was teaching grades 4 and 5 with an emphasis on Social Studies. She is a grandmother of 5 and has 5 step grandchildren. She enjoys volunteering in her grandchildren's'classes along with babysitting. She and her husband have crossed the country over 10 times in their B Van that they call "their Spirit Van." She and her husband split their time between the Adirondack Mountains in New York and the Cascade Mountains in Bend, Oregon. She can be reached at Joanne@ScienceNaturally.com.

Melissa McClellan is a graduate of Longwood University in Farmville, VA where she majored in English with a concentration in Professional Writing and Rhetoric. She enjoys combining her interest in literature with her love of science. When Melissa is not at school, she lives in Blacksburg, VA. She can be reached at Melissa@ScienceNaturally.com.

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Table of Contents

Why Teach with an Interdisciplinary Curriculum?

- Interdisciplinary instruction helps students connect big ideas and skills from different disciplines and optimizes the use of classroom time, allowing reinforcement of concepts and skills across subjects.
- Students do not always recognize that what they learn in one lesson or subject area can often be applied in other instances or scenarios.
- Knowledge gained from different approaches to the topic will allow optimal opportunities for student learning based upon their own interests, involvement, and background knowledge.
- When students are presented knowledge and encounter it in multiple ways, the potential to create more effective learning occurs.
- When students' learning is based upon multiple sources, disciplines, and approaches, they will actively build their knowledge rather than just acquire it in incremental unrelated sections.
- Curriculum requires new paradigms for educating all of our students, emphasizing the interconnectedness of all subjects, allowing students to be better prepared for the 21st Century.

Introduction to this Teacher's Guide

- This guide is designed to emphasize, using an interdisciplinary approach, exploration and extension of ideas that are encountered in the chapters.
- Its purpose is to provide teachers guidance, suggestions, and techniques to assist in their pursuit of an interdisciplinary curriculum.
- Each chapter provides a focus for the topic ideas (for each content area) being discussed.
- Several suggestions for each content area topic idea are identified, to help teachers expand their classroom practices, based upon the focus of the text.
- Interdisciplinary instruction is a way of organizing content and processes from more than one discipline around a central theme, purpose, issue, topic, or experience. In this book, the topic that the interdisciplinary instruction is being designed around is Leonardo da Vinci, who is considered one of the world's greatest painters as well as scientist, mathematician, botanist, anatomist, musician, architect, and engineer.
- Starting with the central theme, purpose, issue, topic, or experience; teachers can start the interdisciplinary unit of study by examining the standards of their particular subject, finding the commonalities.
  - Teachers present the topic through multiple formats or models that address different dimensions of the same concept.
- Next, teachers design the contents of their lessons to build learning experiences that allow students to bridge their thinking with the specific ideas set by state and national standards.
- This starts with the teacher identifying which part of the topic needs to be understood, and how to convey that understanding to the student.
- Finally, using the learning cycles to teach the other subjects, teachers will find they can maximize the connections that students make in their learning.

Possible Ways to Foster Collaborative Learning

- Work in teams/small groups.
- Research a topic, and then write up their results in the format required for publication.
- Make an oral presentation about a topic.
- Present their work through use of a multimedia format.

Examples of How to Use the Guide

- This guide works best with a team approach. Find out which teachers would be willing to collaborate:
  - Science, Math, Language Arts, World History, World Geography, Social Studies, Music, Engineering, and Art are all possible choices.
  - You do not need to have every area represented, but this makes for a more multifaceted approach.

- Choose the Theme that you wish to focus on.
  - Suggestion: Leonardo da Vinci

- Each teacher finds something that their subject has in common with the centraltheme. After determining what their sub-theme will be about, teachers can examine the local, district, state, and national standards to see which ones your lesson(s) will need to support.
  - For example:
    - In the "Prologue," Francis I,the King of France,is mentioned. This is a perfect starting point for World History to encourage study about the politics of the Middle Ages (or during the Renaissance).
    - In the "Prologue," several cities in Europe are mentioned. Using Google Earth, World Geography can explore differences between Europeof the Middle Ages and present day Europe.

- These sub-themes in the content areas might only occur in only 2 or 3 chapters, not in every chapter.

- Whenever communicating, use the Language Arts Common Core standards. (See the "Common Core State Standard Connections" at the end of this Guide.)

Layout of Chapter by Chapter Contents

In each chapter, we have pulled out material for you to work with, broken down by subject area.

The subject areas you find in this guide include:

- Vocabulary
- World History
- World Geography
- History of Scientists
- Art
- Math
- Science
- Engineering Practices
- Art/Music
- General Question(s)
- Possible Activities

In addition to the subject matter/content/ideas, we have also identified the NGSS and Common Core Connections referenced in this book.

Working with the Book, Chapter by Chapter

Prologue(pp. 17-20)

Vocabulary:
entourage, manor house, salves, ailment, notary, vortex

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Leonardo's last memory was of dying: May 2, 1519
  - World History can do a short research project, poster board, power point, etc…focused on Leonardo's life achievements.
- The King of France, Francis I, is mentioned.
  - This is a perfect starting point for World History to encourage study about the politics of the Middle Ages (or during the Renaissance).
- Medical treatment in the form of salves from local plants and herbs are mentioned.
  - Social Studies could compare and contrast medieval and modern day medicines.
- Extensions into the European Middle Ages.
  - Do short research projects focused on historical events that occurred during the Middle Ages.
    - Use multiple resources to gather information.
    - Cite evidence when writing about the topic.
    - Use multimedia formats for presentations.
    - Oral presentations.
  - Develop a Timeline of the Renaissance in which Europeans began to search for a better understanding of the world they lived in.
    - Research and draw a timeline including relevant data showing the important changes in scientific knowledge, events, and famous people.
- Extensions into the Renaissance Ages.
  - Short research papers, "Chained Notes" activity.
    - Possible questions to explore about the Renaissance:
    - What was the importance of the Renaissance?
    - What type of social structure existed during the Renaissance?
    - What influence did the Renaissance have on present day European civilization?
    - What influence did the government have on art?

World Geography

- Several cities in Europe are mentioned.
- Using Google Earth, World Geography can explore differences between Europe of the Middle Ages and present day Europe.
    - The manor of Clos Lucé, France
    - The city of Florence, Italy
        - Birth place of the Renaissance
        - Birth place of Leonardo da Vinci

History of Scientists

- Leonardo da Vinci is credited as being a multitalented individual. Explore his skills.
    - Inventions
    - Paintings
        - Mona Lisa
        - Last Supper
    - Sculptures
    - Mathematician
    - Architect

Art

- Leonardo's painting, the *Mona Lisa*, and the famous statue of *David* were mentioned.
    - This is a great spot for Art to introduce some of the famous Renaissance artists.
        - Pictures of famous Renaissance artists and pictures of their work
        - Videos
        - Slide shows
- Art questions that can be explored further:
    - Why is art created?
    - What influence did the government have on art?

Chapter 1: "The Meeting" (pp. 21-34)

Vocabulary:
blustery, campaign, piazza, plethora

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3, 7.RP.A.2, 8.EE.A.3

- *Math Counts*, a math competition, is mentioned.
  - If a math contest is part of your school's presently scheduled curriculum, now is a great time to discuss it (…or start it.)
  - Ratios & Proportions
    - Ratios using the traditional: "Find the height of the flagpole."
    - Students can practice this ratio with the text examples.
    - Students can practice this ratio with actual examples.
  - Conversions
    - Starting with the example in the book, have students give a different example (instead of marbles, use tennis balls, M&M's, etc…)
  - Pose question to students:
    - How long would it take to count to 1,000,000,000?
    - Count 1 number per second, non-stop until the number 1 billion is reached.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Florence was mentioned as the birthplace of the Renaissance.
  - World History can explore the meaning of the word *Renaissance*.
    - Why was it called "The Renaissance?"
- Florence was mentioned as the center of government and Middle Ages politics of the Renaissance.
  - World History can explore the type of government in Italy and politics of the Middle Ages.
  - King of France; Francis I
- Leonardo talks about America and the islands discovered by Columbus.
  - World History can examine the early Explorers.
    - Columbus
    - Amerigo Vespucci
    - Discovery of the Americas

World Geography

NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8,

- World Geography can compare and contrast between the cities of the Middle Ages and the current cities using maps and/or Google Earth.
  - Florence
  - Milan

Social Issues

- Class discussion about bullying.
  - What type of bullying do you think could have existed during the Renaissance?
  - Have the issues changed over the centuries?
    - What type of bullying was happening in the book?
    - Does bullying occur at your school? How can it be reduced or eliminated?

Famous men during the Middle Ages

- Several famous men during the Middle Ages were mentioned.
  - Activity: Do a "Wanted Poster" (like ones made for criminals during the Wild West in America). Include all pertinent information that would be needed to highlight the famous individual chosen.
    - Leonardo da Vinci
    - Galileo
    - Machiavelli
    - Medici
    - Columbus

Art

- Leonardo da Vinci and Michelangelo Buonarroti were called the artistic heroes of Florence.
  - Create a visual presentation examining the lives and work of famous Renaissance artists.

Chapter 2: "The Adventure Begins" (pp. 35-42)

Vocabulary:
codices, parchment, treatise, maestro

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Leonardo sees a photograph and mistakes it for a painting.
  - The study of light can be introduced here.
    - Activity: Using a variety of prisms, explore their properties.
  - The physics behind how a photograph is made can be taught.
    - Activity: Make a "pin hole" camera. (See page 51)

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3, 7.RP.A.2

- Leonardo talks about proportions of a man's body.
  - Following Leonardo's Vitruvius treatise, examine the proportions of the human body.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Leonardo talks about witches and superstitions.
  - Research the history of witches.
  - How and why did/do superstitions develop?
  - Do we still have superstitions?

Social Studies

- When Leonardo first meets the students, he bows instead of shaking hands.
  - What's the significance of bowing to people that you do not know?
  - How does this compare to shaking hands?
  - What type of customs do you think changed between the Middle Ages and present day Europe?

Art

- Leonardo was surprised at the texture of paper.
  - Activity: Show or discuss how to make paper or parchment.
  - What other types of paper, or ways to record information, have been used in the past?
- Leonardo explains his treatise on proportions.
  - Art can show a picture of the Vitruvian Man.
    - Have students draw figures of man using Leonardo's treatise on proportions.

Chapter 3: "The Awakening" (pp. 43-47)

Vocabulary:
squalor, Duomo

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Leonardo sees a booklet with pictures of skyscrapers. He immediately starts asking questions.
  - Engineering Challenge:
    - Give to each group, a pre-prepared amount of material (toothpicks, straws, tape, glue, gumdrops, etc…) to build a structure.
  - The group that can build the tallest structure that can last overnight wins the challenge.
    - Or supports the greatest amount of weight….
    - Or survives a simulated earthquake…
  - This can be a starting point for "Simple Machines"
    - Groups are challenged to build, using all the simple machines at least once in their invention.
  - Design and build a Rube Goldberg Project.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHT.6-8.8, WHST.6-8.9

- Leonardo mentions that he was used to being around people that he considered ignorant.
  - During the 15th and 16th century, life styles were considerably different from modern times.
    - Make a "Compare and Contrast Table" identifying the similarities and differences between medieval Italian peopleand contemporary people in the United States.
    - Draw a "Venn Diagram" to identify the similarities and differences between medieval and contemporary people.

Chapter 4: "The Bicycle" (pp. 49-60)

Vocabulary:
sprocket, pneumatic, vendor, easel

Language Arts:
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Leonardo exclaims that the concept of a bicycle is a mathematical marvel. (Similar to Math)
  - Follow the history of the bicycle, from it's beginning to present day.
  - Examine the relationship between gear ratios.
    - Use the example given in the text to calculate speed.
- Mr. Neville tells Max that they are in Italy where they use the metric system. (Both Science and Math)
  - Practice and apply conversions between metric and standard measurement.
  - Why doesn't the United States use the metric system?

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3, 7.RP.A.2, 7.EE.B.4, 8.EE.A.3

- Leonardo exclaims that the concept of a bicycle is a mathematical marvel. (Similar to Science)
  - Examine the relationship between gear ratios and the advantage one gear gives another.
    - Use the example given in the text to calculate speed.
- Mr. Neville tells Max that they are in Italy where they use the metric system. (Both Science and Math)
  - Practice and apply conversions between metric and standard measurement.
  - Why doesn't the USA use the metric system?

Art

- The *Last Supper* and the *Mona Lisa* are mentioned.
  - Show each of these paintings and discuss the history of each painting.

Chapter 5: "The Department Store" (pp. 61-68)

Vocabulary:
palate, archaic, reincarnation, florins, numismatic

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Dr. Kastleboro questions whether the gold florins are real or not. This leads into the investigation of density.
  - Lab Inquiry about the property of density
    - How can the density of different objects be determined?
    - Experiment with several different ways to determine density.
    - Brainstorm scenarios in which density is a factor.
  - Extension: Demonstration and discussion of buoyancy.

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3,

- The characters try to figure out the value of a gold florin.
  - Practice conversions between florins, liras, dollars, soldi, and Euros.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Leonardo hands Dr. Kastleboro several 16th century Florentine gold florins.
  - Short research paper about currency/money used during the Middle Ages.
    - What were florins and what was unique about them?

Chapter 6: "The Afternoon" (pp. 69-82)

Vocabulary:
Black Plague, garrisoned, grotesque, quarantine, gyrate, entourage, infestation, four humors

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Gina is asked to explain what germs are.
  - Using microscopes with prepared slides, virtual web sites, or videos, observe microbes.
  - Illustrate and describe the four basic types of microbes.
  - What characteristic does each microbe have?
  - Which microbe was responsible for the Black Plague?
- Gina tells Leonardo about the human immune system.
  - Discuss what a cell is.
    - Use the analogy between the function of a cell and a factory.
    - Elaborate by making models of different cell types

Engineering Practices:

- Leonardo says he once designed a machine for manned flight.
  - The principals of flight can be introduced in this chapter.
  - What was the problem with Leonardo's dream of flying like a bird?

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Leonardo is asked what he knew about the Black Plague.
  - Research and write a paper about the Black Plague.
    - Causes of the Plague.
    - Social and political effects of the Plague.
    - Research modern pandemics or outbreaks of contagious diseases and how they are controlled.
- Leonardo felt that the beliefs held in medieval Europe about the four humors was wrong.
  - Research and write a paper, give an oral report, or any type of multi-media presentation.
    - What are the four humors?
    - How were they supposed to cure people?

World Geography
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- Leonardo is asked what he knew about the Black Plague.
  - Research and illustrate, with labels and dates, on a map showing the progression the Black Plague took as it ravaged Europe.

Chapter 7: "The Plan" (pp. 83-86)

Vocabulary:
tabloid, breached

Art

- Antonio Gigliardi from the local television station tells the mayor about two famous paintings; *Battle of Anghiari* (an incomplete painting by Leonardo)and *Battle of Cascina* by Michelangelo.
  - Art can show pictures of these two paintings.
    - Discuss their history.
    - Practice techniques

Chapter 8: "The Airplane" (pp. 87-100)

Vocabulary:
Bernoulli'sPrinciple, concierge, torque

Language Arts
NGSS Cross-Cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- The pilot starts explaining to Leonardo how birds fly.
  - Science now has the opportunity to start discussing Bernoulli's Principle and Fluid Dynamics.
    - Activity: Study Bernoulli's Principle using any of the methods described on page 48-51.

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3, 7.RP.A.2

- While riding in a taxi, Leonardo was amazed at its speed.
  - Math can practice conversions.
    - Miles to kilometers and kilometers to miles.
    - Feet to meters and meters to feet.
    - Extensions can include other standard to metric conversions.

Chapter 9: "The New Challenge" (pp. 101-110)

Vocabulary:
disinherit

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Max pulls out his notebook and begins writing in it.
  - What was the purpose of this?
    - Discuss: Is this an important skill for a scientist to know?
    - What kinds of information should he be recording?

Chapter 10: "The Entertainer" (pp. 111-126)

Vocabulary:
mercenary, cherub, caricature, Vitruvian Man, indulgences

Art/Music

- Leonardo was reminded by the Mayor that he still had a debt to repay: an unfinished mural.
  - Art: Can show the mural of the *Battle of Anghari* in class.
    - Show how pigmentsare made and have students make their own pigments to paint with.
    - Can show a picture of the Vitruvian Man.
      - Have students draw figures of man using Leonardo's treatise on proportions.
  - Choir: Leonardo sang a Latin Catholic hymn.
    - Can listen to a Gregorian chant.
      - *Dies Irae* or *The Day of Wrath*.
    - Can study about Leonardo also being a famous singer.
      - Leonardo explains his treatise on proportions.

Chapter 11: "A Lesson Learned" (pp. 127-136)

Vocabulary:
Golden Rectangle, hypotenuse, Fibonacci Sequence

Language Arts
NGSS Cross-Cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Math
NGSS Cross-cutting Concepts for Middle School Math:
6.RP.A.1, 6.RP.A.3, 7.RP.A.2, 7.EE.B.4, 8.EE.A.3

- Max talks about the Golden Rectangle and the Fibonacci Sequence.
  - Math has the opportunity to talk about the Fibonacci Sequence.
    - Provide opportunities for students to identify Fibonacci Sequences in both math and nature.
- Math has the opportunity to talk about what the Golden Rectangle is.
  - Using the Golden Rectangle formula, have students make their own Golden Triangle.

Art

- Gina had several questions that she asks about the *Mona Lisa*.
- Art can show a picture of the *Mona Lisa* in class.
  - Pose some questions that are still mystifying people.
    - Why did Leonardo paint it?
    - Who was the model? What did she mean to Leonardo?
    - How did Leonardo create the painting?
    - What is the relationship between the Golden Rectangle and the painting?
- Leonardo talked a little about the power struggles between the great city-states and the Roman Catholic Church. He stated that his loyalties were with whomever could pay for his services.
  - How does this statement support the claim that governments and the wealthy shape the form that art takes?
    - Class discussion along with examples.
    - Does this still hold true today?

Chapter 12: "The University: (pp. 137-154)

Vocabulary:
hoax, armada

Language Arts
NGSS Cross-Cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

- At the end of the chapter, Leonardo realizes something about his "do-over."
  - What did Leonardo realize?
  - Could this have anything to do with his disappearance on the last page of the chapter?

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- Leonardo is introduced to the use of a microscope.
- Science can begin their introduction into the use of microscopes.
  - Using microscopes with prepared slides, virtual web sites, or videos, observe bacteria.
    - Illustrate and describe the four basic types of microbes
    - What characteristic does each microbe have?
- Leonardo asks what photosynthesis is.
  - Science can begin their study of plants.
    - Study photosynthesis.
    - Use a of variety of inquiry based labs.

World History
NGSS Cross-cutting Concepts for Middle School Social Studies:
WHST.6-8.2, WHST.6-8.7, WHT.6-8.8, WHST.6-8.9

- In Chapter 12: "The University," Professor Montebello asks Leonardo if he had received any of his ideas from the *NungShu*.
- History can do a short research paper about the *NungShu*.
  - Why is the *NungShu* called the book that ignited the Renaissance?
  - How did the information presented in the *NungShu*, such as maps of the world, astronomical tables, and technological treatises, help European mariners?
    - Columbus
    - Magellan
  - What is the controversy between Leonardo's diagrams of inventions and the drawings in the *NungShu* that were presented to Pope Eugenius?

World Geography

- Professor Montebello asks Leonardo if he hasreceived any of his ideas from the *NungShu*.
- World Geography can discuss the *NungShu* that was carried from China to Venice and Florence by Chinese ambassadors.
    - What was in it?
    - What inventions and technological advances did the *NungShu* introduce to the Europeans from the Chinese?
- World Geography can trace the route that the Chinese armada followed to establish trade with nations far from China.

General Question:

- Leonardo realizes something about his "do-over."
    - What did Leonardo realize?
    - Could any of this have anything to do with his disappearance on the last page of the chapter?

Chapter 13: "Back Home" (pp. 155-168)

Vocabulary:
remorse, Gregorian chant, insular, photosynthesis

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

- Leonardo meets Max, Gina, and Tad under different circumstances.
- What was Leonardo's explanation for the events?
    - Classroom discussion about education being essential for this century.

General Question:

- In Chapter 13: "Back Home," Leonardo meets Max, Gina, and Tad under different circumstances.
- What was Leonardo's explanation for the events?
    - Classroom discussion about education being essential for this century.

Chapter 14: "The Final Adventure" (pp. 169-185)

Vocabulary:
supersonic, subsonic, resonant, exorbitant, eclectic, xylem, chloroplasts, Ginkgo tree, posthumously, egotistical, optimistically, prestigious

Language Arts
NGSS Cross-cutting Concepts for Middle School Language Arts:
R1.8.8, SL.8.1, SL.8.4, SL.8.5
Used when communicating in all disciplines.

Science
NGSS Cross-cutting Concepts for Middle School Science:
RST.6-8.1, RST.6-8.2, RST.6-8.3, RST.6-8.7, RTS.6-8.8, RST.6-8.9

- The adult Leonardo sends tickets for the fictitious supersonic Concorde III airplane to his three friends so they can visit him.
  - The Concorde is an airplane that can exceed the speed of sound.
- Discuss the characteristics of sound waves.
- Demonstrate the principles of waves.
- Leonardo mentions a lesson he learned from Thomas Edison.
  - What was the lesson he mentioned?
- Do a short research paper on Thomas Edison.
  - What other ideas was Thomas Edison credited for?
- Leonardo takes his three friends into his laboratory to show them a *Ginkgo biloba* tree.
  - What is unique about the Ginkgo Bilbo tree?
  - What does Leonardo plan to use this tree for?
  - Class discussion: is this possible?
    - Have students research current energy sources and energy conservation.

Vocabulary

Listed below are the vocabulary words and definitions from the book.
Additional words and definitions can be found in the glossary (page 193) in the book.

Prologue Vocabulary

Ailment
A minor illness.

Entourage
A group of people attending or surrounding an important person.

Manor House
A mansion, or the "capitol" house, within a territorial piece of organized land.

Notary
A public officer or an authorized person used to perform legal duties.

Salves
A medicinal ointment for healing wounds or sores.

Vortex
A whirling mass of water or air that pulls everything near it toward its center.

Chapter 1 Vocabulary

Blustery
To be loud, noisy or with a disorderly roar like wind.

Campaign
A systematic course of activities or operations for a specific purpose.

Piazza
A large open public place in a city or town.

Plethora
An excessive amount of something.

Chapter 2 Vocabulary

Codex
An ancient manuscript book, especially for Scripture.

Maestro
A master of any form of art.

Parchment
Made from the skin of an animal and used as a writing surface.

Treatise
A written work dealing systematically within a specific subject, but longer and more detailed than an essay.

Chapter 3 Vocabulary

Duomo
An Italian cathedral.

Squalor
A state of being extremely dirty.

Chapter 4 Vocabulary

Easel
A self-supporting frame for holding an artist's art work while they paint or draw.

Pneumatic
Containing or operated by air or gas under pressure, as a tire.

Sprocket
A projection on the rim of a wheel that engage with the links of a chain.

Vendor
A person or company offering something for sale, especially on the street.

Chapter 5 Vocabulary

Archaic
Old-fashioned characteristics.

Florins
A coin made of gold first minted in Florence in 1252.

Numismatic
Consisting or relating to coins, paper money, medals, etc..

Palate
A person's appreciation and sense in taste and flavor.

Reincarnation
The belief that the soul, upon death, returns to earth in another body or form.

Chapter 6 Vocabulary

Black Plague
A devastating disease carried by fleas and small rodents. It killed nearly half the people in Western Europe during the fourteenth century.

Four Humors
Four bodily fluids (black bile, yellow bile, phlegm, and blood) once thought to dictate temperament and health.

Garrison
A body of troops stationed at a fortified place.

Grotesque
Fantastically ugly or absurd in shape, appearance, or character.

Gyrate
Moving quickly in a spiral or circular motion.

Infestation
The state of being invaded or overrun by pests or parasites.

Quarantine
A place or state of isolation in which people or animals that have been exposed to a contagious disease are placed.

Chapter 7 Vocabulary

Breach
The act or result of making a gap in and breaking through barriers.

Tabloid
A newspaper concentrating on lurid and sensational stories.

Chapter 8 Vocabulary

Bernoulli's Principle
A physical principle stating that as the speed of a moving fluid (liquid or gas) increases, the pressure within the fluid decreases.

Concierge
A staff member of a hotel in charge of special services for guests, as arranging for theater tickets, tours, flights, and dinner reservations.

Torque
A twisting force that causes rotation.

Chapter 9 Vocabulary

Disinherit
Change in one's will to prevent someone from inheriting one's property.

Chapter 10 Vocabulary

Caricature
A picture, painting, or description with certain exaggerated characteristics.

Cherub
A winged angelic being.

Indulgences
Catering to someone's mood by humoring them.

Mercenary
A person hired to serve in a foreign army, merely for money or other reward.

Vitruvian Man
A drawing by Leonardo da Vinci depicting a man with his arms and legs apart based on human proportions described by the ancient Roman architect Vitruvius.

Chapter 11 Vocabulary

Fibonacci Sequence
A series of numbers in which each number is the sum of the two previous numbers.

Golden Rectangle
A rectangle that can be cut into a square and another rectangle with the same dimensions as the original rectangle.

Hypotenuse
The longest side of a right triangle.

Chapter 12 Vocabulary

Armada
A large force or group of vehicles, airplanes, or warships.

Hoax
A humorous or malicious deception.

Chapter 13 Vocabulary

Gregorian Chant
Church music sung in a single vocal line in free rhythm.

Insular
Ignorant or uninterested in cultures, ideas, or peoples outside of one's own experiences.

Photosynthesis
The process by which green plants use sunlight to synthesize foods from carbon dioxide and water while generating oxygen as a byproduct.

Remorse
Deep regret or guilt for a wrong committed.

Chapter 14 Vocabulary

Chloroplasts
A specialized part of green plant cells that contains chlorophyll, the pigment in which photosynthesis occurs.

Eclectic
Deriving ideas, style, or taste from a diverse range of sources.

Egotistical
Self-centered or excessively absorbed in one-self.

Exorbitant
Unreasonably high, as with prices or amount charged.

Ginkgo Tree
One of the oldest living trees on Earth with fan-shaped leaves and foul-smelling yellowish fleshy seeds with edible kernels.

Optimistic
Disposed to take a favorable view of events or conditions.

Posthumous
Something that happens to a person after they die, as in dealings with their estate or life's work.

Prestigious
Inspiring respect and high admiration.

Resonant
A deep, clear, and continuing sound or ring.

Subsonic
Relating to or flying at a speed(s) less than that of sound.

Supersonic
Relating to or flying at a speed(s) greater than that of sound.

Xylem
The tissue in plants that conducts water and dissolved nutrients upward from the root and also helps to form the woody element in the stem.

Discussion Questions

General Questions

Were you surprised that da Vinci felt he did not do anything great in his life such as finding a cure for a disease or inventing something such as the telephone?

Leonardo da Vinci had no formal education. He learned by doing, experimenting, and thinking. What are some important things you have learned in non-educational settings?

What are some of the things da Vinci noticed were different in Florence between when he grew up and the time he came back? How are things different from 100 years ago? 200 years ago? 300 years ago?

Leonardo da Vinci decided to see if he could find a source of more abundant clean energy. Do humans consume more energy than they did in the past? Why? How is this affecting the planet?

What kinds of things can an individual do to reduce energy consumption? A community? A country?

In the book, Leonardo da Vinci has to do something to better mankind. What would you do to help humankind?

Black Plague Discussion Questions

Instructions

Research more information about the Black Plague and answer the following questions.

How did the Black Plague impact life?

What is the Black Plague? What is the cause of the disease? How is it transmitted? What are some of the other ways infectious diseases get transmitted? Are there new ways for diseases to spread today?

Have there been plagues in the U.S. and other parts of the world? Describe some of them.

What are scientists and healthcare professionals doing to prevent the outbreak of the plague today?

What can individuals do to avoid getting sick from infectious diseases?

What role did superstition play in fighting diseases in medieval times?

What are some of the modern ways we fight plagues, epidemics, and pandemic diseases?

What countries are most affected by plagues?

Pandemic disease outbreaks have occurred all over the world, past and present. What does it mean when a disease is pandemic? Give examples.

Why are some countries/places more prone to diseases than others?

The Golden Ratio

Instructions:
The Golden Ratio was used by da Vinci and many other artists and architects.
Do some research and answer the following questions.

What is the Golden Ratio?

What are Fibonacci numbers?

What do they have to do with the Golden Ratio?

Leonardo da Vinci's paintings incorporate the Golden Triangle and Golden Rectangle. What are they?

Find an example of one of Leonardo da Vinci's paintings that uses the Golden Triangle and Golden Rectangle. Explain how you know each principle is at work.

On a separate piece of paper draw a picture of your own that uses the Golden Ratio.

Hands-On Activities

Hands-On Activities

The hands-on activities listed here are just suggestions. You may have activities that you feel are more appropriate. These are intended to assist teachers who want to try something that they may not have tried before. Revise and/or alter the activities to meet the needs of your students.

Chained Notes

- Begins with a question printed at the top of a paper. This paper is circulated between students/groups. Each student/group responds by adding to the question with one or two original sentences that relate to the original question then it is passes to the next group.

- Provides the students the opportunity to examine other student's ideas and compare them to their own. This activity then encourages the student/groups to move beyond fact recall because they must first synthesize and evaluate what others have recorded before adding their own comments.

Acrostics

- Begin by choosing one word to represent a major concept or focus on the topic that is being taught. Write this word vertically on a sheet of paper. Then write related words that start with each letter of the vertical word.

Give Me Five!

- Provide a reflection prompt such as…What was the most significant thing you learned about…?
- Invite five open responses from the students to share in the classroom.

I Think, You Think

- In teams of two, the first person tells the second student something they knew/learned about the topic they were just reading about, then the second student tells the first student something different. This can continue as long as you want.

Let's Look Back

- In either teams of two or small groups, each student tells the other student(s) something that they did not understand. The other student (or group) clarifies what that student did not understand. The next student then does the same thing.

Muddiest Point

- Similar to Let's Look Back, except each student (or group) writes down on a piece of paper a part of the lesson that they found was unclear. These slips of paper (anonymous) are collected and discussed by the class to help clarify the concept.

The *Ah-ha* Point

- Similar to both "Let's Look Back" and the "Muddiest Point," but it is the opposite. As an "exit ticket" ask students to write down the most significant point they learned in the lesson on a slipof paper, then give that paper to the teacher as they leave the class. Students may also add questions if there are things that they would like to know or explore.

Social Studies Projects

Background

Many different areas of social studies are covered in the book.
Have your kids pick one of the following options to complete as a project.

1. Write a speech for a ruler in Florence, Italy in da Vinci's time, pretending they are a presidential hopeful in our time. Then, dress as that person in Old Florence costumes and give your speech to the townspeople about an important topic of the day.

2. Design a map of the city-states in and around Italy at the time of da Vinci. Be sure to label the cities, states, mountains, rivers, etc. Label the warring factions.

3. What invention made it possible for more people to learn to read? Draw a picture explaining it. Write an explanation to accompany it.

4. Create a "Reality Show" segment about a familyliving in the same house today versus in the same house in da Vinci's time. Include the kinds of food they cooked, how they bathed, where they slept, what they wore, the importance of animals in their lives, what the kids did for recreation, what adults did to pass the time, etc. If you want, do this one as a group and put on a performance of now versus then.

5. Research and create a travel brochure of 16th century Florence. Then create a travel brochure for a city of your choice (or the student's own town) in present times. Compare and contrast different aspects of life, such as how news was communicated in those two centuries, how art is viewed, or the major ways art is created.

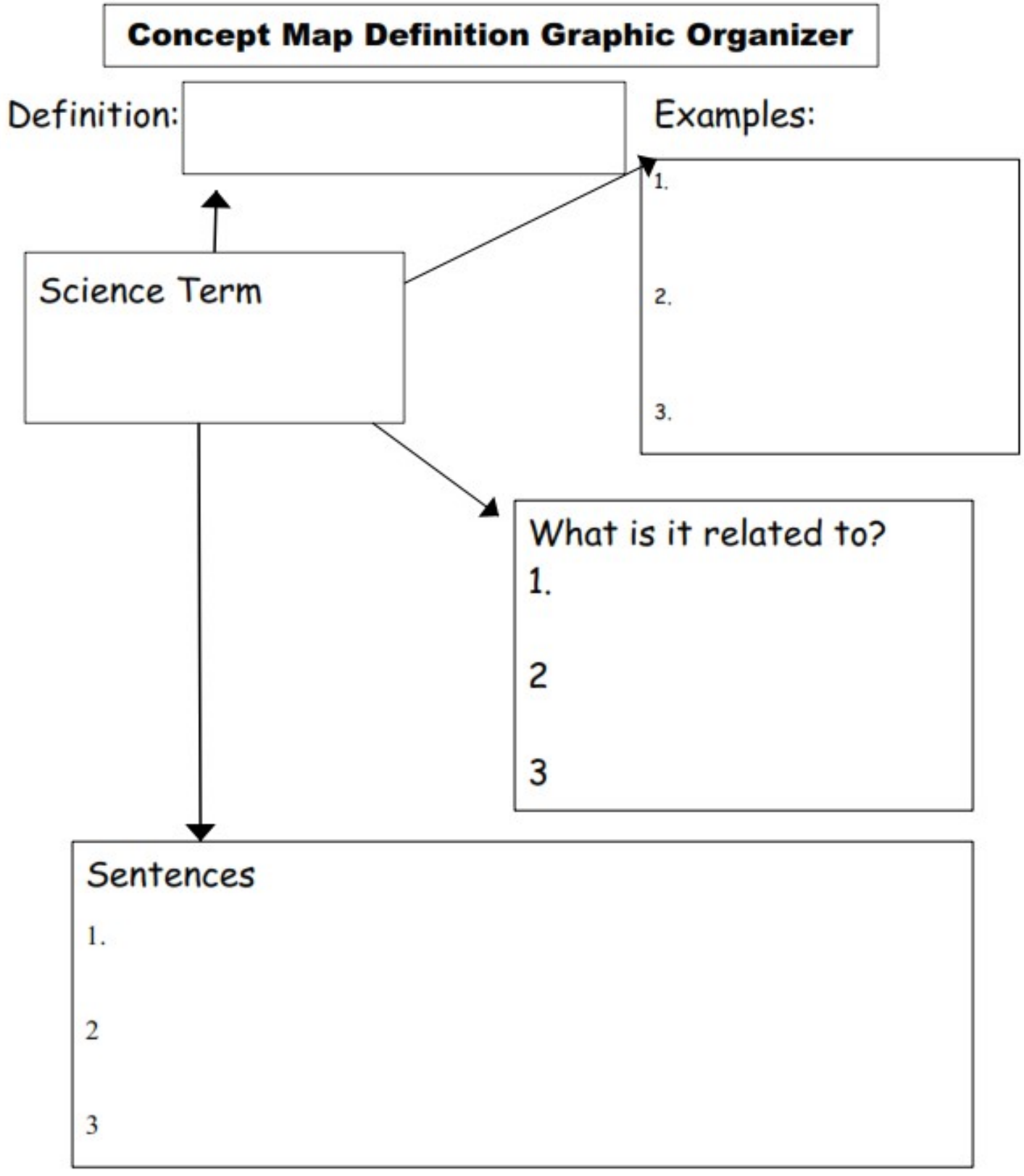
6. Research important jobs in the 16th century. Make a comparison chart of the Top 10 Jobs Today vs. the Top 10 Jobs of the 16th Century.

7. Compare and contrast the construction of skyscrapers today with construction of cathedrals in da Vinci's time. Make a poster using photos of the buildings with explanations or create a model of one of the buildings you researched using sugar cubes, Legos, or other materials.

8. Michaelangelo and da Vinci were competitors in the art world of their time. Think about competition today in sports. Complete a PowerPoint or a report about two fierce competitors today and compare them with the artists of da Vinci's time.

9. Research superstitions in previous centuries. Prepare a speech or report on your findings. You can do it as a rap song.

10. Direct and produce a TV show recreating one aspect of da Vinci's life. Compare clothing of the 16th and 21st centuries. Include sketches. Perform a "fashion show" showing the differences.



By Joan Wagner

Be a City Planner

Background

Leonardo da Vinci lived during outbreaks of the Black, or Bubonic, Plague in Milan. He noticed that people in urban areas were more affected than those in rural places. Being very logical, he felt it was related to sanitation issues such as polluted water. Though he designed what he felt would improve the health of Milan, he could not find a patron to pay for the changes.

Your challenge is to design an ideal city. Have a plan for trash removal, fresh water, transportation, recreation, and anything else you think is needed to maximize the quality of life for the people living there.

Materials

Poster board
Drawing materials
Craft supplies

Resources

http://en.wikipedia.org/wiki/Urban_planner
http://www.princetonreview.com/careers/aspx?cid=162
http://www.theatlanticscities.com/jobs-and-economy/2012/08/brief-history-birth-urban-planning/2365/

Conclusions:

Describe your city.

_____

_____

_____

What are some of its unique features?

_____

_____

_____

What could you do to further improve the quality of life?

_____

_____

Paper Chromatography

Background

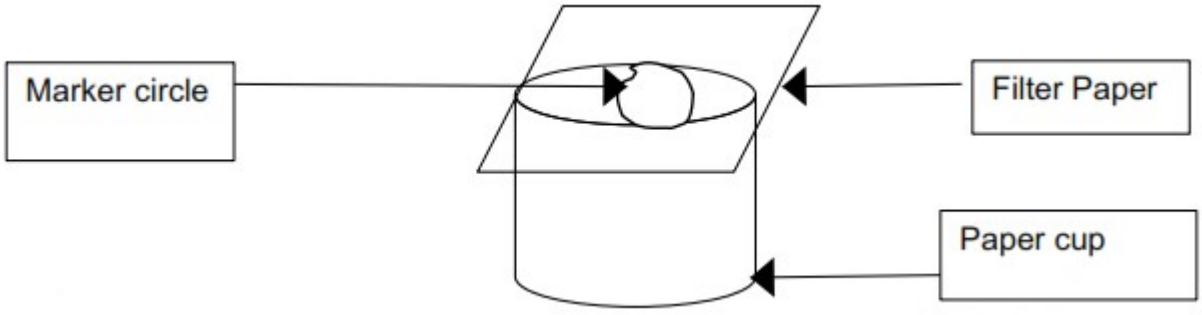
The ink inside of a water-based, washable marker pen is a mixture of pigments (colors). The mixture of pigments can be separated with a process known as *paper chromatography*.*Chroma* means color and *graph* means a picture. You will create a "color picture" of all the pigments after they are separated. In this experiement, you will draw a circle on a coffee filter. You will then dissolve the ink in a solvent, such as water. The water will spread out on the filter, but carry the dissolved pigments at different rates.When the water evaporates, the pigment is left behind and you will see several different lines. Leonardo da Vinci had to have knowledge of what pigments to mix in order to create certain colors in his paintings. Learn what pigment colors are mixed to create colored markers.

Materials

White coffee filters
Non-permanent magic markers (assorted colors and black)
Water
Pipette (dropper)
Paper cup

Procedure

1. Choose a black marker and make a circle in the middle of the paper.
2. Place the paper on top of the cup.



3. Predict or make a hypothesis about what colors you think you will see. Explain why you thought you were going to get the results predicted by your hypothesis. Writeyour hypothesis and explanation on the next page.
4. Take a pipette and place one drop of water in the middle of the circle. The drop should not touch the lines of the circle.
5. Observe what happens and draw a picture of your observations on the next page.
6. Repeat steps 1-5, but instead of a circle, draw your own design. Make sure the drop of water does not touch the lines.
7. Choose another color marker and repeat steps 1-5.
8. What are your conclusions about the ink in each marker you tested? Record your answer on the next page.

For more information about pigments and colors see: http://www.webexhibits.org/pigments/intro/making.html

Paper Chromatography Worksheet

Your Hypothesis:

_____

_____

_____

Your Observations:

The Results:

What are your conclusions about the ink in each marker you tested?

_____

_____

_____

Investigation: Paper Chromatography

Name:
Class/Period:

Background: Chromatography is a technique used for separating components within mixtures in order to analyze, identify, quantify, or purify the mixture or components.

Vocabulary:

element:

compound:

mixture:

component:

solvent:

solute:

Chromatography is used by: **pharmaceutical companies** to determine the amounts of each chemical found in new products, **hospitals** to detect drug or alcohol levels in a patient's blood stream, **law enforcement agencies** to compare samples found at a crime scene to samples from suspects, **environmental agencies** to determine the level of pollutants in the water supply, and **manufacturing plants** to purify a chemical needed to make a product.

- There are different types of chromatography: liquid chromatography, gas chromatography, paper chromatography, and thin-layer chromatography.
- All use the same principle. Chromatography separates the components that make up a mixture by their attractions to the "stationary" and "mobile" phases in the experiment.
    - "stationary" means = _____

  The "stationary" phase holds the mixture. The filter paper is the stationary phase in this experiment.
    - "mobile" means = _____

  The "mobile" phase passes through the mixture in the stationary phase, solubilizes the components, and moves them along at their individual rates. The alcohol is the solvent that dissolves the components that make up the ink, turning it into a solute.

- In paper chromatography, the filter paper holds the components (molecules that make up the ink) until the solvent (alcohol) dissolves them and carries them up the filter paper. The solvent travels up the filter paper by capillary action (the movement of liquid within the spaces of a porous material due to the forces of adhesion, cohesion, and surface tension).
- The separation of components depends on their solubility with the solvent and their attraction to the solvent and filter paper. The more soluble the mixture, the more it will move up the filter paper.
- Since each component has its own solubility with the solvent, each component that makes up the ink will travel up the filter paper at its own rate.
- Once components are separated from one another, they can be analyzed.

Purpose: To introduce the student to the principles and terminology of chromatography and demonstrate the separation of the dyes in Sharpie Pens with paper chromatography.

Pre-lab Questions:

Short answers will be judged on following directions, effort, and quality.

1. What is chromatography?

2. What is an example of a use for chromatography?

3. What is a mixture?

4. How does chromatography separate the components of a mixture?

5. How do the isopropanol solutions move up the filter paper?

6. What safety precautions should be taken with isopropanol?

7. Which % solution do you think will separate the dyes the best?

Materials:

5 beakers (250 mL or jars)
5 covers (petri dishes or plastic wrap)
distilled water (H_20)
isopropanol (91% - 100%, preferably 100%)
50 mL graduated cylinder
Pipettes(droppers)
Colored pencils
5 strips of filter paper (5 cm x 8 cm)
Black, blue, green, & red permanent Sharpie pens
Ruler
Tape
Scissors
Pencil

Safety: goggles, lab apron, poison, fumes, sharp objects

Isopropanol (rubbing alcohol)-is an antiseptic in lower concentrations and an irritant in high concentrations. SAFETY GOGGLES REQUIRED AT ALL TIMES! If it gets on your skin, wash with water. If it gets into your eyes, you will need to have your eyes flushed with water in an eye bath or eyewash station. Let the teacher know immediately!!!

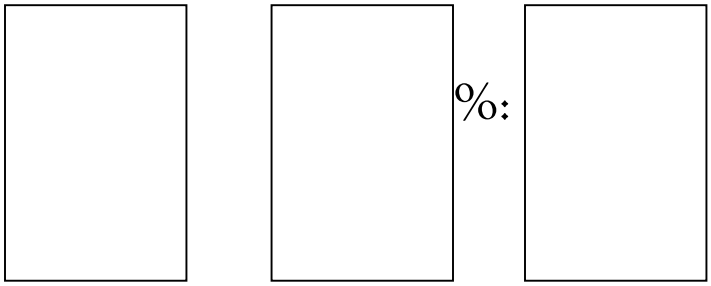
Procedure:

1. Label the beakers with the following: 0%, 50%, and 100%.
2. Prepare the 5 isopropanol solutions:
    - 0 mL isopropanol + 15 mL distilled water = 15 mL…pour into beaker labeled 0%
    - 7.5 mL isopropanol + 7.5 mL distilled water = 15 mL…pour into beaker labeled 50%
    - 15 mL isopropanol + 0 mL distilled water = 15 mL…pour into beaker labeled 100%
3. Immediately cover each beaker with a lid as you make them to prevent the isopropanol from evaporating.
4. Using the pencil and the ruler, lightly draw a horizontal line one cm above the bottom edge of each of the 5 filter paper strips. This is the starting line.
5. Use the Sharpies to put spots on the starting line, separating each spot as much as possible.
    - For best results, gently touch the tip of the pen to the paper, let it dry and spot it again on top of the first spot a few times.
    - Keep the spots small and space them out as much as possible so that the colors will not run together as they separate.
6. Remove the covers and place the filter strips in the beakers so that the bottom of the strip is in the alcohol solution. **Make sure the solution does not come above the starting line.** You may need to use the tape to keep the filter strips upright and from sliding down into the solutions as they get wet.
7. Cover your beakers and start keeping time now for your observations.
8. Let the strips develop. Watch the solution move up the strip, note the color(s). (Some of the colors may not move in some of the solutions.)
9. Remove the strips as they stop moving pigments or reach the top and let them dry on a paper towel.
10. Dispose of the isopropanol solutions down the drain with water.

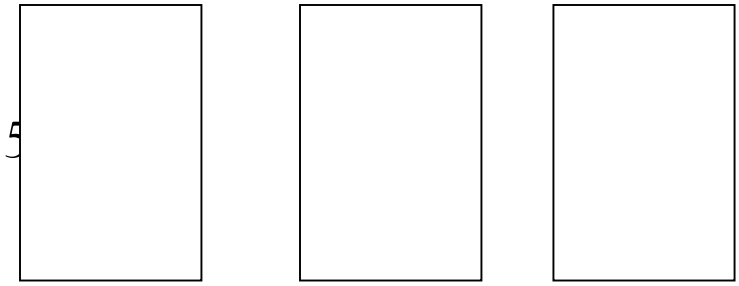
During Experiment Lab Questions:

Use colored pencils to show what you observe.

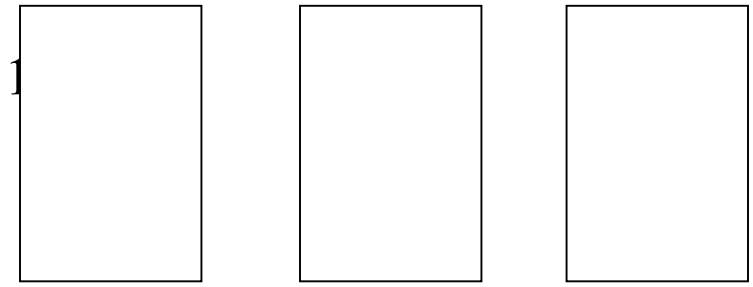
After one minute: Tape your samples here.



After 5 minutes:



After 15 minutes:



Post-lab Questions:

Short answers will be judged upon following directions, effort,and quality.

1. What color does each pen dye contain? (This question: list only)

Red= Green= Blue= Black=

2. Why does some of the black dye not move?

3. In the red pen, why does the yellow color move farther than the red color when the concentration of isopropanol is higher?

4. Are the blue colors in the blue and green pens the same?

How about the yellow colors in the red and green pens?

How do you know?

5. To perform an experiment in class, your teacher tells you to label some test tubes with a Sharpie. You will then put the test tubes in a water bath,then in a 50% isopropanol bath.Which color Sharpie should you use to label the test tubes and why? (Remember, if the label comes off in the bath, you may mix up your samples.)

Experiment adapted from Protein Chemistry Laboratory, Texas A&M University
(peer.tamu.edu/podium.../Paper%20Chromatography%20Handout.doc)

Build a Model Wing

Background

Though da Vinci lived 200 years before Bernoulli's Principle was discovered, he was already designing ways to fly. The engineering design of the wing of an airplane applies to Bernoulli's Principle. Bernoulli noted that a fast moving stream of a fluid has a lower pressure than slower moving fluid that surrounds it.

Purpose

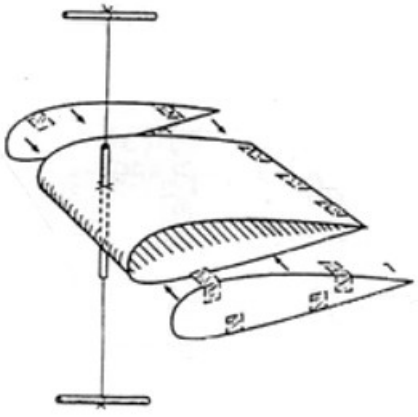
In this activity you will build a model of an airplane wing that takes advantage of this principle to provide lift.

Materials

8.5 x 11" sheet of paper
Two airfoil shapes (see next page)
Ruler
Paper punch
Tape
Sharpened pencil
60 cm piece of string
One 15 cm straw
Two 7.5 cm straws
Scissors

Procedure

1. Fold one sheet of paper in half, but do not crease the fold.
2. Tape the long opened edge of paper with three small pieces of tape to keep it closed. This taped side will be known as your "trailing edge" while the folded side will be known as the "leading edge."
3. With the pencil, mark an x on the centerline of the paper about one inch from the edge of the leading edge.
4. Punch a hole through both the top and bottom of the paper at the "x." Be careful not to crease the paper at the fold.
5. Place the 15 cm straw through the hole you punched. Use tape, if necessary, to hold the straw in place.
6. Tie one end of the string to the middle of a 7.5 cm straw.
7. Pass the other end of the string through the 15 cm straw, which is attached to the paper.
8. Pull the string through and tie it to the middle of the other 7.5 cm straw. The 7.5 cm straws will be your handles.
9. Cut out the two airfoil models (see bottom of next page) and tape the shapes to the open ends if the wing. The flat edge of the shapes should be on the bottom of the wing (see illustration).



10. Taking the 7.5 cm straw handles, one in each hand, draw the string tight and position it so that the line is perpendicular to the floor. Make sure the flatter surface of the wing faces down.
11. With your hand out in front of you, make a quick sweeping motion through the air. Be sure that the leading edge of the wing is in front.

Conclusions

What did your "wing" do when you swept it through the air?

_____

_____

What caused the wing to move this way?

_____

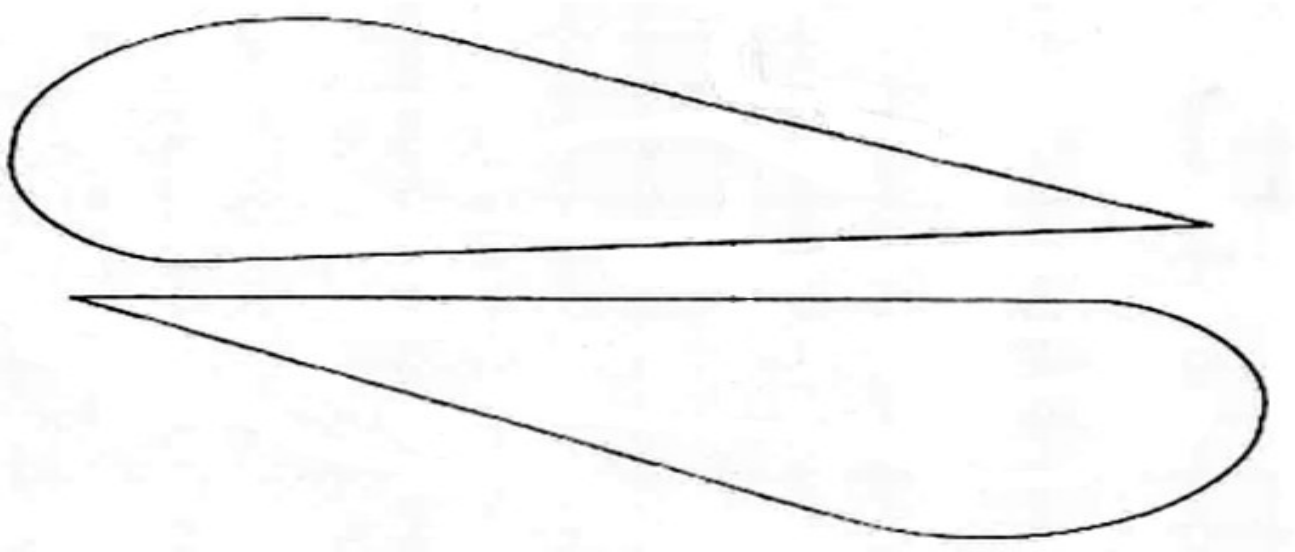
_____

How did the shape of the wing affect the lift?

_____

_____

For more information about lift and drag on an airplane wing and da Vinci's designs visit:
http://www.youtube.com/watch?v=yUpVrMaBKCQ
http://www.allstar.fiu.edu/aero/experiment1.htm



The Great Paper Airplane Challenge

Background

Have you ever noticed that some paper airplanes seem to fly better than others? They seem to have more lift and can stay in the air longer. Lift is a force that holds an airplane in the air. The creation of lift is relatively simple. All you have to do is to cause a flow of air to turn. Aerodynamic shapes such as airfoils can do this, but so will a flat edge if it is inclined to the flow of air. However, most lift on an airplane is due to the airfoil design of the wings. When air is turned, its velocity changes. The velocity of the air is related to its pressure. The faster the air moves, the lower its pressure on an object. The Swiss scientist Daniel Bernoulli developed this principle in the 1700's. Today we call it Bernoulli's Principle.

Lift can also be explained using Sir Isaac Newton's Third Law of Motion, which states that every action has an equal and opposite reaction. As the flow of air is deflected downward, its force causes an upward (aerodynamic) force on the airfoil called lift. The mathematics and design needed to ensure that a plane has the needed lift is quite complex. There are a number of incorrect theories about what causes lift on an airplane. Unfortunately, many of these theories are found in textbooks and on websites. The following website explains lift and has links to discuss the various correct and incorrect theories about what causes lift. It is suggested that you review this website before beginning this challenge.
http://www.grc.nasa.gov/WWW/K-12/airplane/lift1.html

Challenge

You and your team will design a paper airplane that demonstrates excellent lift capacity. The magnitude of your lift can be calculated with the following Lift Quotient equation:

$$\text{Lift Quotient} = \frac{\text{Mass of Airplane}}{\text{Time in Air (seconds)}}$$

This formula will be used to compare the lift capacity of all of the paper airplane designs in your class. The team with the highest Lift Quotient will receive bonus points on this activity.

You should keep in mind the following factors that affect lift when designing and flying your airplane.

- Design of the plane: mass, shape, and geometry of the wing
- Motion: velocity of the air and how the object is inclined to the flow

Procedure

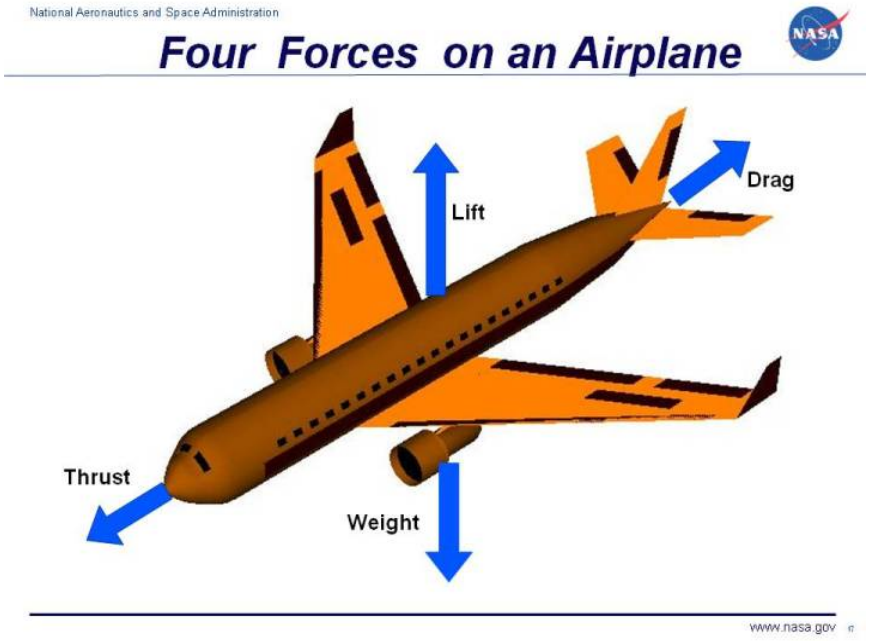
1. Go to the following website and do both experiments to learn about airflow around an airfoil.http://www.grc.nasa.gov/WWW/K-12/airplane/wrong1.html. Afterward, summarize how the design of the airfoil and its inclination affect the velocity of the air above and below the airfoil.

_____

_____

The Great Paper Airplane Challenge

2. Examine the diagram below to learn about the forces acting on an airplane.



Explain the difference between the forces of lift and weight and thrust and drag.

_____

_____

_____

3.Design and test your paper airplane using the following materials.

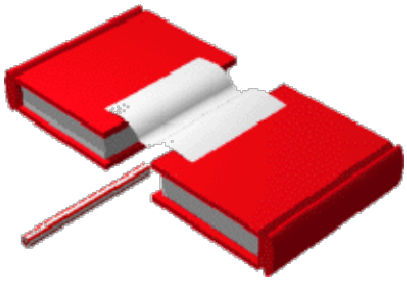
- Regular paper
- Paper clips
- Glue
- Tape
- Scissors
- Markers
- Balances
- Metric rulers
- Timers

Hypothesis:

Why is lift created when the flow of air turns?

Bernoulli's Principle—in 3 parts

#1: Bernoulli's Principle Investigation



Materials:

- 2 thick books, binders, or bricks, etc…
- 1 sheet of notebook paper
- 1 straw

Investigation: Place the two books or folders parallel to each other on a table and approximately 3" apart. Then, place the sheet of paper over the gap between the books, with the edges of the paper resting on the inside edges of the books. Using the straw, blow underneath the paper as hard as possible. The paper will be pushed down in the middle toward the table.

Explanation: The increase in air speed underneath the paper causes a decrease in pressure. The higher pressure on the top of the paper thus pushes the paper down toward the table.

#2: Bernoulli's Swinging Hose

Materials:

- 1 long vacuum cleaner hose (or other similar hose at least 1" in diameter).
- 1 small bucket filled with paper bits from a paper hole punch (or similar sized small pieces of paper).

Investigation: This experiment will help to dramatically demonstrate Bernoulli's Principle to your students, but be forewarned—it can make quite a mess! Place the bucket of paper scraps on the floor, with one end of the hose in the bucket. Keeping the one end of the hose in the bucket, swing the other end rapidly over your head like a lasso. (Watch out for low hanging light fixtures!) The paper will come shooting out the top of the hose!

Explanation: When swinging the hose over your head, the increased air speed at that end of the hose results in a corresponding decrease in air pressure. This results in the higher air pressure at the other end of the hose (the end in the bucket of paper scraps) pushing the paper through the hose and out the swinging end!

#3: Bernoulli's Spool and Cardboard

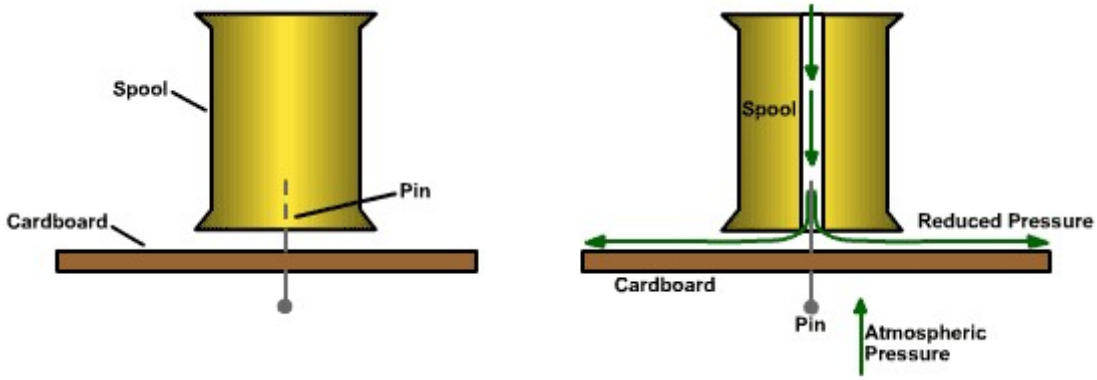
Materials:
thread spool
cardboard, 7 cm by 7 cm, lightweight but firm
pin
science journal

Investigation:

1. Cut a piece of cardboard (from the back of a notebook) so that it measures 7 cm by 7 cm.
2. Stick a pin through the center of the cardboard.
3. Place the spool over the pin so that the pin goes into the hole in the spool.
4. Hold the cardboard against the spool vertically. Blow firmly through the hole in the top of the spool and observe what happens to the cardboard.
5. Release your hand from underneath the cardboard.
6. Record your observations in the science journal.

Explain why the cardboard did not fall once you removed your hand.

What's Happening?
As you blow through the top of the spool, a jet of air moves horizontally from the hole at the bottom of the spool and spreads out over the surface of the cardboard. As the air moves rapidly out of the bottom, it lowers the pressure between the cardboard and the spool. The higher pressure from the surrounding air pushes up against the bottom of the cardboard and demonstrates how the lift (pressure force) overcomes the weight (force of gravity) of the cardboard.



Teacher Explanation:

As you blow through the top of the spool, a jet of air moves horizontally from the hole at the bottom of the spool, spreads out over the surface of the cardboard, and lowers the pressure between the cardboard and the spool. The higher pressure from the surrounding air pushes up against the bottom of the cardboard and "lifts" the cardboard.

The NASA "Why?" Files have become the NASA SCIence Files™. http://scifiles.larc.nasa.gov/.

Be a Master Artist

Background

Artists in the Renaissance primarily used charcoal and oil-based paints. Leonardo da Vinci created the *Mona Lisa*with oil-based paints. Today, there are many options open to artists, such as watercolors and acrylic paints.

Materials

Finger-paint paper
Oil paints
Acrylic paints
Basin of water

Procedure

Mix the acrylic paint and oil paint in water. Swish around. For some more fun, float some of the finger-paint paper in the basin with paints. Pull it out and admire your abstract artwork.

Conclusions

What is the difference between acrylic paint and oil paint?

_____

_____

_____

What do you observe? How do the acrylic and oil paints interact?

_____

_____

_____

Explain the science behind your observation.

_____

_____

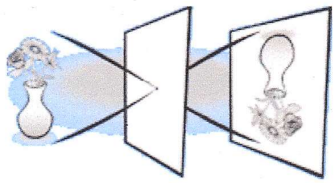
_____

Name:

Building Your Own Pinhole Camera Using a Pringles® Can

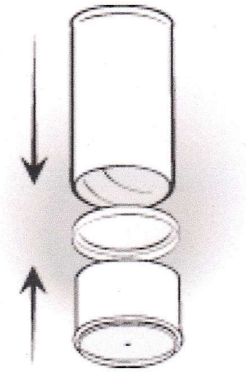
http://www.exploratorium.edu/science_explorer/pringles_pinhole.html

Before modern cameras and photographs were invented (more than a thousand years ago), people used a device called a *camera obscura,* which is Latin for "darkened room" to look at images. The first camera obscuras were small rooms that were completely dark except for a tiny hole in a wall that let in a dot of sunlight. People in the room saw an image of the trees and sky on the wall opposite the hole-and were amazed when the image disappeared at sunset!



Materials:

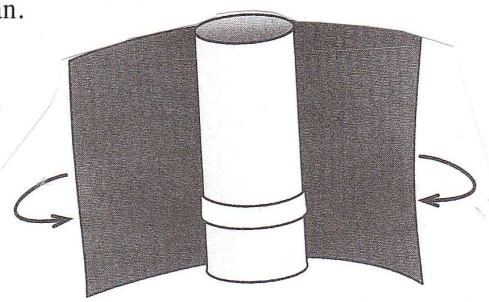
- empty Pringles® chip can
- marker
- ruler
- X-Acto knife or utility knife (ask a grown-up to help you cut)
- thumbtack or pushpin
- masking tape
- aluminum foil
- scissors (if you want)
- bright sunny day

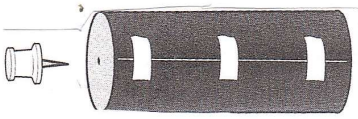


1. Take the plastic lid off the Pringles® can and wipe out the inside. (Save the lid!)
2. Draw a line with the marker all the way around the can, about 2 inches up from the bottom. Have a grown-up cut along that line so the tube is in two pieces. The shorter bottom piece has a metal end.

We're going to use the plastic lid as a screen. If your lid is clear, you may need to apply a piece of wax paper, white tissue paper, or vellum to the lid to act as a translucent screen.

3. Put the plastic lid onto the shorter piece. Put the longer piece back on top. Tape all the pieces together.
4. To keep light out of the tube, use a piece of aluminum foil that's about 1foot long or black construction paper. Tape one end of the foil to the tube. Wrap the foil all the way around the tube twice, then tape the loose edge of the foil closed. If you have extra foil at the top, just tuck it neatly inside the tube.
5. With the thumbtack, make a hole in the center of the metal end of the can.





The Home Scientists in the Graff family improved their Pringles® Pinhole by using a foam soda can holder as an eyepiece. It made the inside of the tube dark, and was easier to use for people who wear glasses.

Now, go outside on a sunny day. Close one eye and hold the tube up to your other eye. You want the inside of the tube to be as dark as possible-so cup your hands around the opening of the tube if you need to. Look around your yard through the tube. The lid makes a screen that shows you upside-down color pictures!

Hold your hand below the tube and move it very slowly upward. Your hand is moving up, but you'll see its shadow move down the screen!

What's Going On?

How does a hole in the bottom of a Pringles® can make a picture of the world?

The hole doesn't make the picture. The image of the world is always there. All the hole does is make it possible for you to see it.

Suppose you point your Pringles® Pinhole camera at a brightly lit bouquet of flowers. Light reflects off the red rose, the blue iris, the white daisy, and the green leaves. If you hold a piece of white paper near the bouquet, some of that reflected light will shine on the paper, but it won't look like anything.

That's because light bouncing off the red rose ends up overlapping with light bouncing off the blue iris, the white daisy, and the green leaves. There are many images of the bouquet on the paper, but they overlap with one another, and the colors all blend together, making a jumble of light.

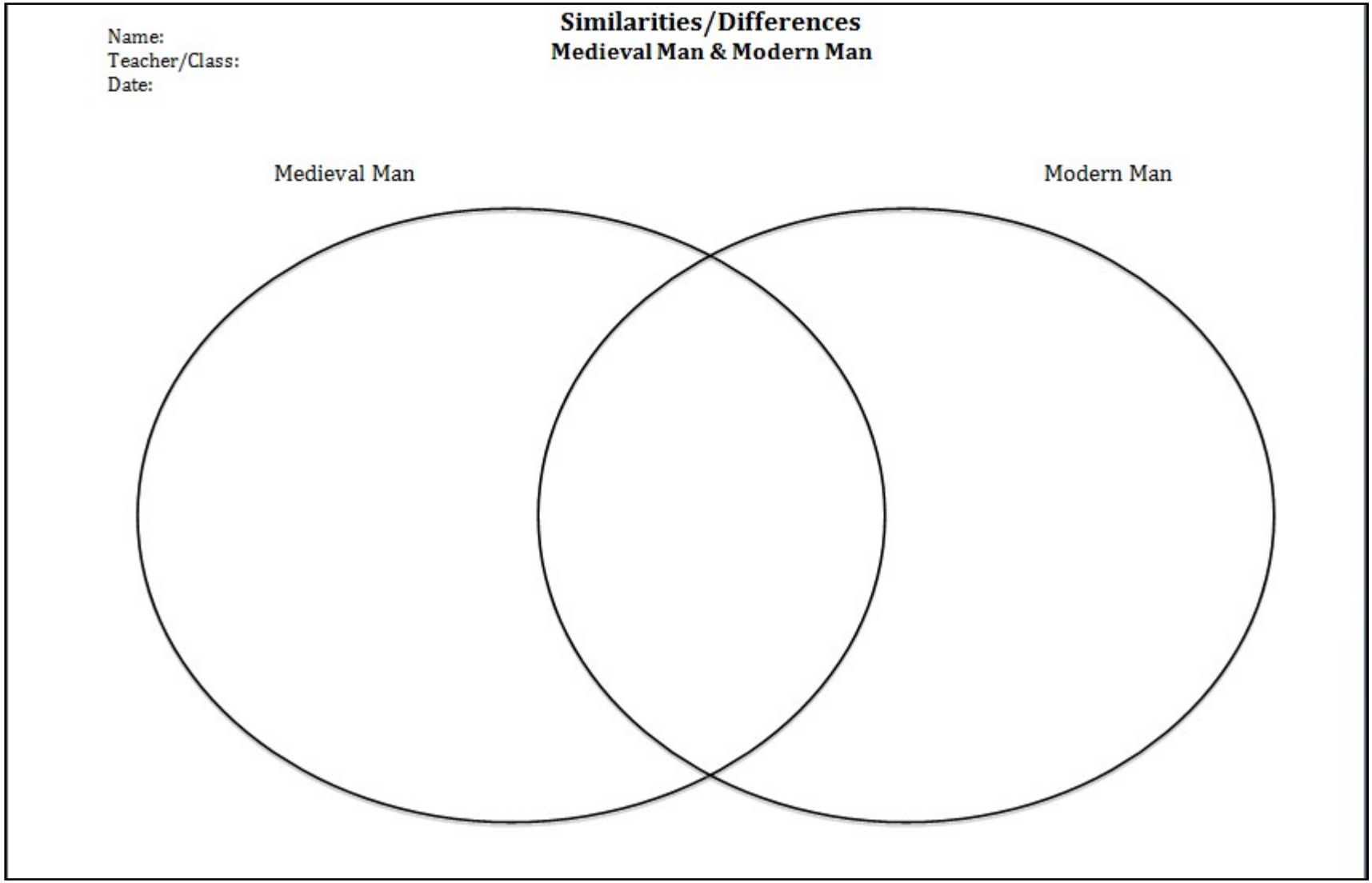
The hole isolates a small part of the light, sorting a single image from the jumble. Only a few of the light rays reflecting off each point on the rose are traveling in a direction that will let them pass through the hole. The same is true for light bouncing off all the other flowers in the bouquet. On the other side of the hole, these light rays reveal an image of the bouquet.

Extension Questions?

1. Try making different sized pinholes; pin, pencil point, the point of a pair of scissors. How does the size of the pinhole affect the image formed?

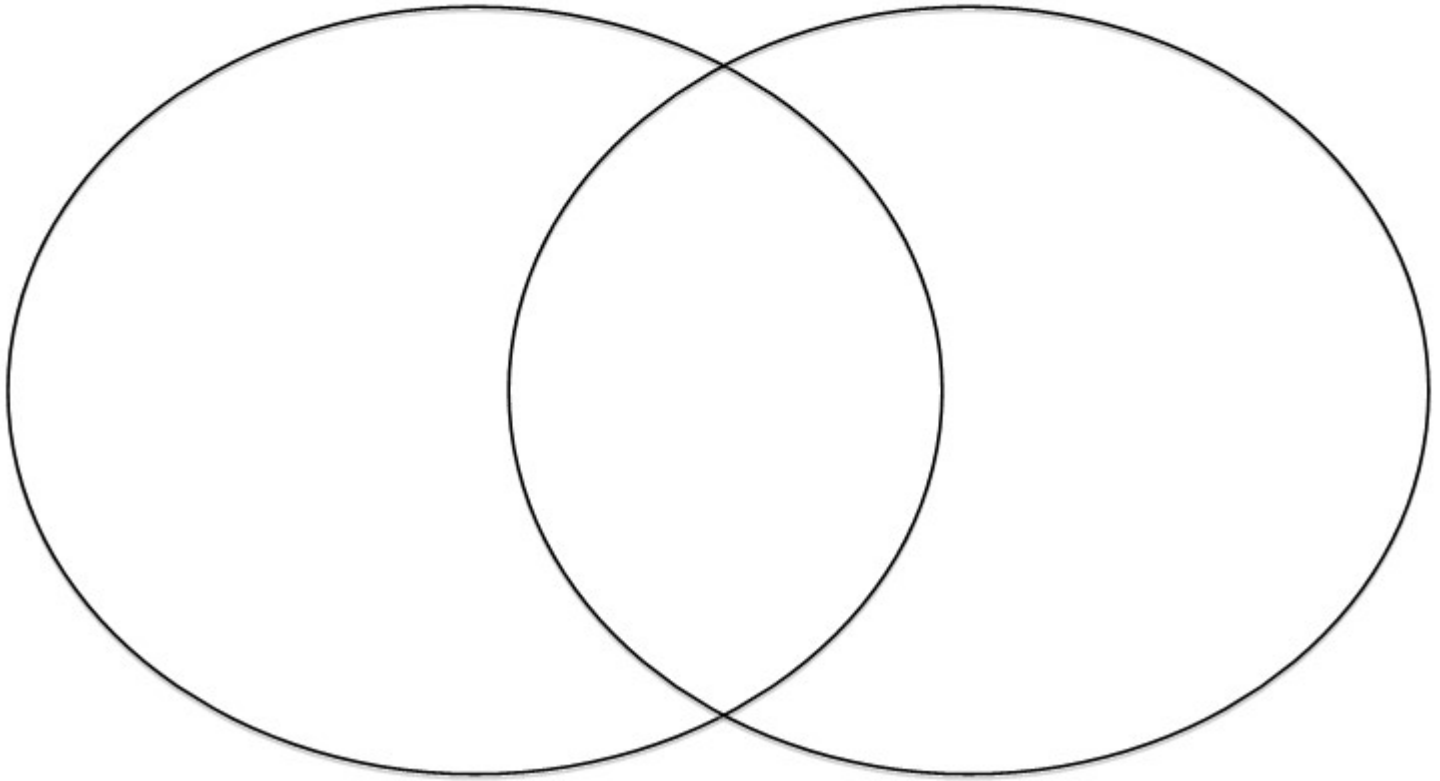
2. What factors can affect the image formed by the pinhole camera?

3. How can your pinhole camera be used to observe a solar eclipse?


Similarities/Differences
Medieval Man & Modern Man
Name:
Teacher/Class:
Date:
Medieval Man
Modern Man

Name:
Teacher/Class:
Date:

Similarities/Differences
Plant & Animal Cells



Name:
Class:
Date:

Breakfast Density

How do the mass, volume, and density of breakfast cerealcompare?

Materials:

- 1 sandwich bag of marbles, all marbles are the same size
- 1 sandwich bag of cheese puffs(all puffs the same size as the marbles AND the bag must be the same size)
- 3 or more additional sandwich bags
- 3 types of cereal
- Balance
- Graduated Cylinders

Procedure:

1. Lift the bag of marbles and the bag of cheese puffs.
    a. How are they alike?

    b. How are they different?

    c. Explain why they have different masses.

2. Measure 100mL of each cereal into plastic bags.

3. In Data Table 1, list the cereal starting with the one you think has the highest density and ending with the one you think has the lowest density.

4. Use the balance to find the mass of each cereal. Record the mass on Data Table 1.

DATA TABLE 1

Name of Cereal	Volume (mL)	Mass (g)	Density (D=M/V)	Density Ranking(1 is less, 4 is most)

5. Use a calculator to determine the density of each cereal. Density is the mass per unit of volume (Density = Mass/Volume). Record this in the chart, and then rank the densities.

6. If all the cereals have the same volume, why don't they all have the same mass?

7. Now measure 25 g of each cereal, and measure the volume using a graduated cylinder. Calculate the density of the uncrushed cereal. Record all of this in the Data Table 2.

8. Why do some cereals take up more space than others?

9. What claim can you make if the mass of a cereal stays the same, but the volume changes by crushing the cereal?

10. Place the 25 g of cereal into a freezer zipper bag, and crush it. After crushing it, use a creased sheet of paper to put it back into the graduated cylinder to measure the volume. Calculate the density of each crushed cereal and record all of the data in Table 2.

DATA TABLE 2

UNCRUSHED CEREAL					CRUSHED CEREAL		
Name of Cereal	Mass (g)	Volume (mL)	Density (D=M/V)	Density Ranking (1 is least, 5 is most)	Volume (mL)	Density (D=M/V)	Density Ranking (1 is least, 5 is most)

Analysis:

1. In your own words, what is volume?

2. In your own words, what is density?

3. Write a conclusion that explains what happens if the mass of a substance stays the same, but the volume decreases.

How to Create a Golden Rectangle with Fibonacci Numbers

Student:

How to Create a Golden Rectangle With Fibonacci Numbers (Video)
By Jimmy Chang, eHow Presenter

http://www.ehow.com/video_12237950_create-golden-rectangle-fibonacci-numbers.html

Step 1: Write several Fibonacci series numbers:

_____, _____, _____, _____, _____,
_____, _____, _____, _____.

Step 2: The first number that you should have written is "0", the point of origin. This is a point that you will start your drawing; draw a point (dot) near the center of the graph paper.

Step 3: The second number you should have written should be "1". Using the point of origin, start and draw a square that is 1 unit X 1 unit.

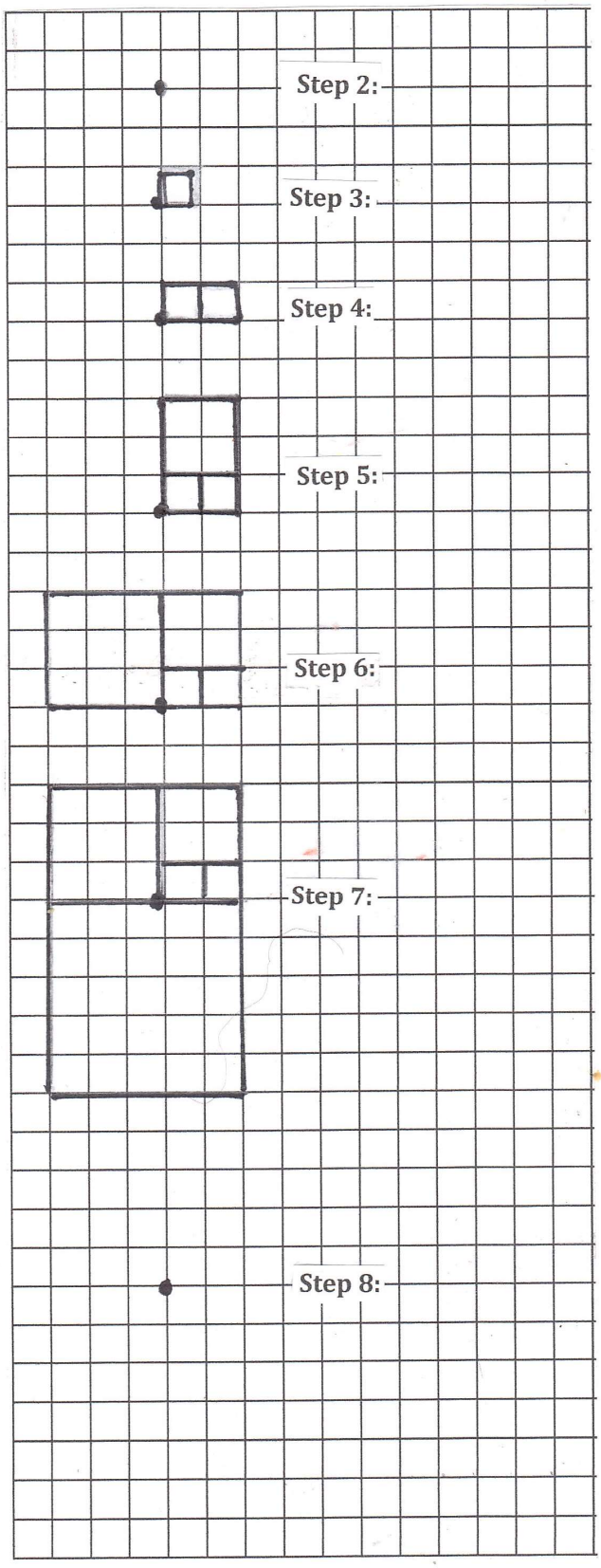
Step 4: The third number you should have written is "1" (add the first number and the second number to give you the third number. (0+1=1)). Draw another square that is 1 unit X 1 unit connected to the first square.

Step 5: The fourth number should be "2" (add the second number and third number to give you the fourth number-*the two previous numbers.* (1+1=2)). Draw a square that is 2 units X 2 units connected to the first two squares.

Step 6: The fifth number should be "3" (the two previous numbers to give you the fifth number. (1+2=3)). Draw a square that is 3 units X 3 units connected to the previous squares.

Step 7: The sixth number should be "5" (the previous two numbers. (2+3=5)). Draw a square that is 5 units X 5 units connected to the previous squares.

Step 8: Continue with the seventh number in the pattern. (You run out of room on this sheet).



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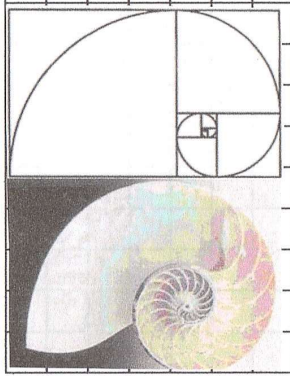


Visualizing the Fibonacci Series:
Teacher Instructions

For this activity, some preparation is required to make the puzzles the students will assemble.

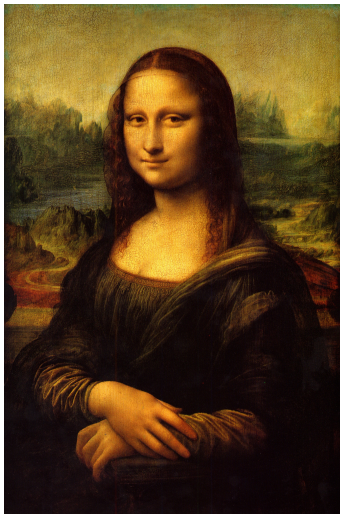
1. Print out as many Mona Lisa puzzle images as needed.

2. As guided by the lines on the image, cut the Mona Lisa into rectangles. Then cut the smallest rectangle in half, making two squares of equal size. Discard the extra scrap paper.

3. On the blank backside of the rectangles and two squares, write the first eight values of the Fibonacci Series (1, 1, 2, 3, 5, 8, 13, 21), beginning with the small squares. Each small square will both have a 1 on it, the next biggest rectangle will have a 2 on it, the next biggest rectangle will have a 3 on it, and so on.

4. Place the puzzle pieces in a Ziploc bag. Students will construct the puzzle with the Visualizing the Fibonacci Series activity sheet.

Visualizing the Fibonacci Series



You broke into the Louvre Art Museum in Paris and cut up the *Mona Lisa*in order to ship it out of the country. Since you just destroyed a priceless treasure belonging to all of humanity, you'd better learn something. Put the *Mona Lisa* back togetherwith the square puzzle pieces. When you have reconstructed it, turn the pieces over to reveal the numbers.

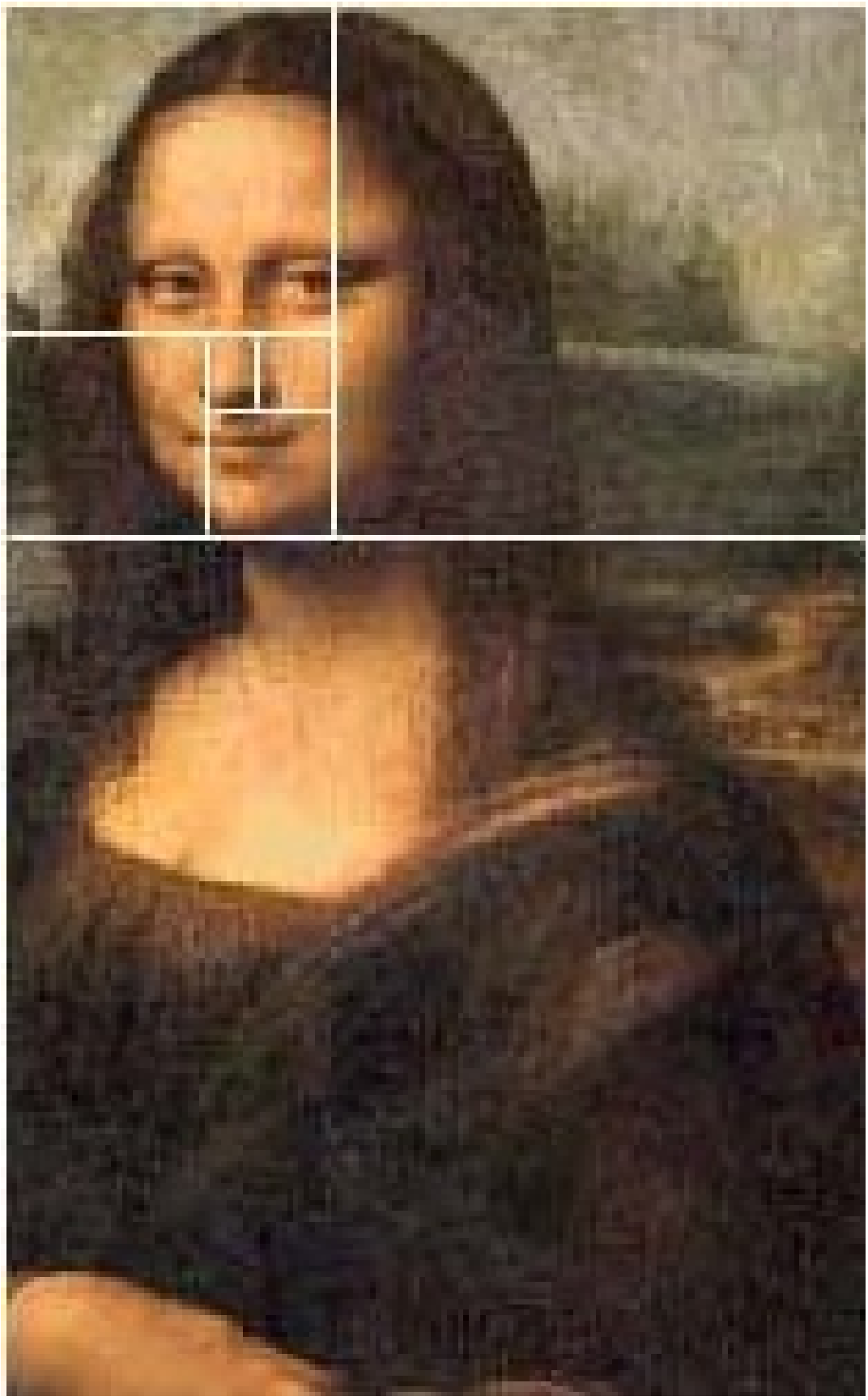
1. Write the numbers found on the back of the squares, in increasing order, in the spaces below. There are more spaces than you have numbers. Can you guess what numbers come next?

___ , ___ , ___ . ___ . ___ , ___ , ___ , ___ , ___ , ___ , ___ , ___ , ___

2. Using a calculator, divide each number by the number before it. Start by dividing the second number by the first number, then the third number by the second number, and the fourth number by the third number, and so on. Write your answers in the spaces below.

___ , ___ , ___ . ___ . ___ ,___, ___, ___, ___, ___, ___, ___,

3. Do you have any idea what number this series could be approaching?



Articulations to the
Next Generation Science Standards
and
Common Core State Standards Connections

Next Generation Science Standards Articulations

This book asks questions that will help develop some content science literacy. It is articulated to the standards noted here. The questions should encourage children to ask more questions and seek more explanations.

MS-LS1: From Molecules to Organisms: Structures and Processes

1. In multi-cellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.
2. Animals engage in characteristic behaviors that increase the odds of reproduction.
3. Plants reproduce in a variety of ways, sometimes depending on animal behavior and specialized features for reproduction.

MS-LS2: Ecosystems: Interactions, Energy, and Dynamics

1. In any ecosystem, organisms and populations with similar requirements for food, water, oxygen, or other resources may compete with each other for limited resources, access to which consequently constrains their growth and reproduction.
2. Changes in biodiversity can influence humans' resources, such as food, energy, and medicines, as well as ecosystem services that humans rely on—for example, water purification and recycling.
3. Food webs are models that demonstrate how matter and energy are transferred between producers, consumers, and decomposers as the three groups interact within an ecosystem. Transfers of matter into and out of the physical environment occur at every level. Decomposers recycle nutrients from dead plant or animal matter back to the soil in terrestrial environments or to the water in aquatic environments. The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem.

MS-LS4: Biological Evolution: Unity and Diversity

1. Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

MS-ESS3: Earth and Human Activity

All human activity draws on both short and long-term consequences, positive as well as negative, for the health of people and the natural environment.

MS-PS1: Matter and Its Interactions

1. Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms.
2. In a liquid, the molecules are constantly in contact with others; in a gas, they are widely spaced except when they happen to collide. In a solid, atoms are closely spaced and may vibrate in position but do not change relative locations.
3. The changes of state that occur with variations in temperature or pressure can be described and predicted using these models of matter.
4. The term "heat" as used in everyday language refers both to thermal motion (the motion of atoms or molecules within a substance) and radiation (particularly infrared and light). In science, heat is used only for this second meaning; it refers to energy transferred when two objects or systems are at different temperatures.
5. Temperature is not a measure of energy; it is a measurement of molecular motion.The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present.

MS-PS2: Motion and Stability: Forces and Interactions

1. For any pair of interacting objects, the force exerted by the first object on the second object is equal in strength to the force that the second object exerts on the first, but in the opposite direction (Newton's third law).
2. Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both of the objects have large mass—e.g., Earth and the sun.
3. Forces that act at a distance (gravity, electricity, and magnetism) can be explained by fields that extend through space and can be mapped by their effect on a test object (a ball, a charged object, or a magnet, respectively).

MS-PS4: Waves and Their Applications in Technologies for Information Transfer

1. A sound wave needs a medium through which it is transmitted.
2. The path that light travels can be traced as straight lines, except at surfaces between different transparent materials (e.g., air and water, air, and glass) where the light path changes direction.

MS-ESS1: Earth's Place in the Universe

1. Patterns of the apparent motion of the sun, the moon, and stars in the sky can be observed, described, predicted, and explained with models.
2. The solar system consists of the sun and a collection of objects, including planets, their moons, and asteroids that are held in orbit round the sun by its gravitational pull on them.
3. Maps of ancient land and water patterns, based on investigations of rocks and fossils, make clear how Earth's plates have moved great distances, collided, and spread apart.
4. Weather and climate are influenced by interactions involving sunlight, the ocean, the atmosphere, ice, landforms, and living things. These interactions vary with latitude, altitude, and local and regional geography, all of which can affect oceanic and atmospheric flow patterns.

Science and Engineering Practices

1. Asking Questions and defining problems.
2. Planning and carrying out investigations

Articulations created by Joan Wagner, 2014.

Common Core State Standard Connections:

NGSS Cross-cutting Concepts for Middle School in Science:

RST.6-8.1	Cite specific textual evidence to support analysis of science and technical texts.
RST.6-8.2	Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
RST.6-8.3	Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
RST.6-8.7	Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, or graph).
RTS.6-8.8	Distinguish among facts, reasoned judgment based on research findings, and speculations in a text.
RST.6-8.9	Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading the text on the same topic.

NGSS Cross-cutting Concepts for Middle School Social Studies:

WHST.6-8.1	Write arugments focused on discipline-specific content.
WHST.6-8.2	Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes.
WHST.6-8.7	Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.
WHST.6-8.8	Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; quote or paraphrase the data and conclusions of others while avoiding plagiarism.
WHST.6-8.9	Draw evidence from informational texts to support analysis, reflection, and research.

NGSS Cross-cutting Concepts for Middle School Math:

6.RP.A.1	Understand the concept of a ratio and use mathematical language to describe a ratio relationship between two quantities.
6.RP.A.3	Use ratio and rate reasoning to solve real-world and mathematical problems.
7.EE.B.4	Use variables to represent quantities in a real-world or mathematical problem, and constructsimple equations and inequalities to solve problems by reasoning about quantities.
7.RP.A.2	Recognize and represent proportional relationships between quantities.
8.EE.A.3	Use numbers expressed in the form of a single digit times a whole number power of 10 to estimate very large or very small quantities, and to express how many times greater one isthan the other.

English Language Arts Standards>>History/Social Studies>>Gr. 6-8:

http://www.corestandards.org/ELA-Literacy/RH/6-8/ - CCSS.ELA-Literacy.RH.6-8.10

Key Ideas and Details:

CCSS.ELA-Literacy.RH.6-8.1

Cite specific textual evidence to support analysis of primary and secondary sources.

Craft and Structure:

CCSS.ELA-Literacy.RH.6-8.4

Determine the meaning of words and phrases as they are used in a text, including vocabulary specific to history/social studies.

CCSS.ELA-Literacy.RH.6-8.5

Describe how a text presents information (e.g., sequentially, comparatively, causally).

CCSS.ELA-Literacy.RH.6-8.6

Identify aspects of a text that reveal an author's point of view or purpose (e.g., loaded language, inclusion or avoidance of particular facts).

Integration of Knowledge and Ideas:

CCSS.ELA-Literacy.RH.6-8.8

Distinguish among fact, opinion, and reasoned judgment in a text.

CCSS.ELA-Literacy.RH.6-8.9

Analyze the relationship between a primary and secondary source on the same topic.

NGSS Cross-cutting Concepts for Middle School Language Arts

www.nextgenerationscience.org/

RI.8.8 Delineate and evaluate the argument and specific claims in a text, assessing whether the reasoning is sound and the evidence is relevant and sufficient; recognize when irrelevant evidence is introduced.

SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on Grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims & evidence, and add interest.

Articulations created by Joan Wagner, 2014.

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