It's a Gas!

Math & Science of the Blimp

Teachers Guide

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It's a Gas! Math & Science of the Blimp

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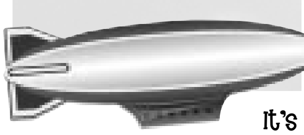

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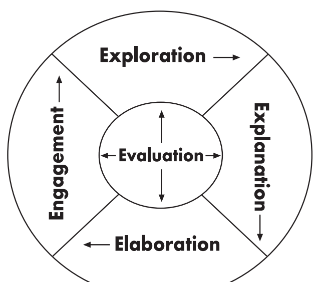
Credits

This project is designed for the 7th- through 9th- grade classroom. It consists of 11 instructional television programs, 12 lesson plans, classroom activities, computer activities and a Web site. Our goal is to help students learn quicker, in more depth and with better retention.

The Learning Cycle

The **It's a Gas** materials use the Learning Cycle as the instructional model for the lesson plans. The Learning Cycle rests on constructivism as its theoretical foundation. "Constructivism is a dynamic and interactive model of how humans learn" (Bybee, 1997, p. 176). A constructivist perspective assumes students must be actively involved in their learning and concepts are not transmitted from teacher to student but constructed by the student. In the early 1960s, Robert Karplus and his colleagues proposed and used an instructional model based on the work of Piaget. This model would eventually be called the Learning Cycle (Atkin & Karplus, 1962). Numerous studies have shown that the Learning Cycle as a model of instruction is far superior to transmission models in which students are passive receivers of knowledge from their teacher (Bybee, 1997). As an instructional model, the Learning Cycle provides the active learning experiences recommended by the National Science Education Standards (National Research Council, 1996).

The Learning Cycle used in this curriculum follows Bybee's (1997) five steps of Engagement, Exploration, Explanation, Elaboration and Evaluation. As in any cycle, there's really no end to the process. After elaboration ends, the engagement of the next learning cycle begins. In fact, the elaboration of one Learning Cycle could be thought of as the pre-assessment that occurs in the engagement of the next lesson. Evaluation is not the last step. Evaluation occurs in all four parts of the Learning Cycle. The description of each part of the learning cycle draws extensively from W. S. Smith's work.



A. Engagement

Engagement is a phase during which the teacher is on center stage. The teacher poses the problem, pre-assesses the students, helps students make connections and informs students about where they are heading.

The purpose of Engagement is to:

- focus students' attention on the topic at hand.
- pre-assess what students already know about the topic at hand.
- inform the students about the lesson's objective(s), so they'll know — at least in general terms — where they're heading.
- remind students of what they already know that they will need to apply to learning the topic at hand. One of the best ways a teacher can establish a context for the lesson is to ask students questions to refresh their memory.
- pose a problem for the students to explore in the next phase of the learning cycle.

Evaluation of Engagement: Evaluation's role in Engagement revolves around the pre-assessment. Find out what the students already know about the topic at hand. Frequently teachers pre-assess students in the Elaboration of a previous lesson

B. Exploration

Now the students take center stage as they collect data to solve the problem. The teacher tries to pique the students' curiosity, making sure the students collect and organize the data needed to solve the problem. The students need to be active. This is one of the hands-on parts of math and science. The purpose of Exploration is to have students collect data that they can use to solve the problem that was posed.

Evaluation of Exploration: In this portion of the Learning Cycle the evaluation should primarily focus on process, i.e., on the students' data collection rather than the product of the students' data collection. Teachers ask themselves questions such as the following:

- how well are the students collecting data?
- are they accurate?
- are they carrying out the procedures correctly?
- can they translate a written or spoken problem into a form whereby they can collect data to solve the problem?
- how do they record the data?
- is it in a logical form or is it haphazard?

C. Explanation

In this phase, students report what they did and try to figure out the answer to the problem that was presented. The teacher also introduces new words, phrases or sentences to label what the students have already figured out.

The purpose of Explanation is to:

- have students use the data they've collected to solve the problem that had been posed.
- present vocabulary words or phrases to label what the students have learned.

Evaluation of Explanation: Since the students are on center stage trying to figure out what's going on, Evaluation here focuses on the process the students are using. Remembering that the teacher's purpose is to help students think for themselves, the Evaluation at this point focuses on that – how well can students use the information they've collected, and synthesize that with what they already know to come up with new ideas?

Notice that so far we have passed through three of the Learning Cycle's stages: Engagement, Exploration and Explanation. To this point we have been acting like a discovery or inquiry teacher – that is, a teacher who focuses on students learning things for themselves. We now are going to shift gears to some extent in Elaboration.

D. Elaboration

The teacher gives students new information that extends what they have been learning in the earlier parts of the Learning Cycle. In **It' a Gas: Math & Science of the Blimp** project, this information is usually presented in the second half of each video and on the CD-ROM. At this stage the teacher also poses problems that students solve by applying what they have learned. The problems include both examples and non-examples.

Evaluation of Elaboration: The Evaluation that occurs during Elaboration is what teachers usually think of as Evaluation. Sometimes teachers equate Evaluation with "the test at the end of the chapter." When teachers have the students do the application problems as part of Elaboration, these application problems are "the test."

E. Final Assessment

Most of the final assessment is done in the Elaboration phase. The students are preparing products to be shared with the teacher and class. However, since paper-and-pencil tests can provide an efficient means of testing many students, test questions are provided for those who wish to use them.

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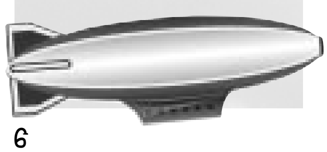


It's a Gas!

Math & Science of the Blimp

Lesson 1
Introduction to Blimps

Author: Dr. Kathie Owens, The University of Akron
Target Audience: 7th, 8th and 9th grades

Introduction to Blimps

Lesson overview

Key Objective:

Make and describe a timeline of at least 20 significant events in lighter-than-air flying.

Key Standard Addressed:

Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.

Procedure

Suggested time frame for this lesson is two class periods.

1. Make a class list of what students already know and what they want to learn about lighter-than-air flight and craft.
2. Show the video **It's a Gas #1: The History of Blimps**
3. Have your students draw a lighter-than-air craft and label its components. They should explain their drawing in two to three sentences. See Appendix A: Blimp Vocabulary.
4. Students will use the **It's a Gas** CD-ROM or the Web at pbs4549.org/blimp to access the lighter-than-air timeline. They should pick ten events and then explain in two to three sentences why they consider them significant.
5. Display their drawings and timelines and have students orally explain them.

Tools/Resources

- **It's a Gas #1: The History of Blimps**
- CD-ROM or Computer with Internet access
- VCR and TV
- Drawing paper
- Markers

Assessment

Students will write in their journals after each activity. You should revisit the "What I want to learn" list at the conclusion of the lesson to insure all their questions are answered.

Learning Objectives

The students will:

1. Make and describe a timeline of at least 20 significant events in lighter-than-air flying.
2. Draw and label a diagram of a lighter-than-air craft using at least six key terms.

Curriculum and Proficiency Standards Addressed

The students will:

1. Recognize that scientific knowledge and explanations have changed over time, almost always building on earlier knowledge.

Technology Objectives

The students will:

1. Use keyboards and other common input and output devices efficiently and effectively.
2. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
3. Use technology resources for solving problems and making informed decisions.

How technology is integrated into this lesson

The students will:

1. Analyze information relative to the characteristics of technology and apply in a practical setting.
2. Analyze the relationships among technologies and explore the connections between technology and other fields of study.

Video Synopsis

This program sets up the basis for studying blimps by exploring their history. For a contest, Trista and Abby decide to do a video presentation about blimps. They interview the president of the Lighter-Than-Air Society to find out about the background of blimps. (**Disclaimer**: The contest mentioned in this series does not exist. Please don't call to ask about it.)

CD-ROM Activity

(Also available on the web at pbs4549.org/blimp)
The history of lighter-than-air craft is presented using dates, data and pictures.

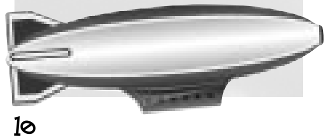
Lesson Overview

Unlike the science and mathematics lessons in this curriculum, this lesson is not written with inquiry-based methodologies. Key events in lighter-than-air flight and key terms are presented to form a context for the investigations students will conduct in subsequent lessons. Since the vocabulary will be used repeatedly through subsequent lessons, a thorough understanding is not expected at the end of this lesson. Vocabulary is provided as teachers' background information for the whole curriculum.

Learning Strategies:

Opener: Introduce the lesson and the curriculum unit by determining students' familiarity with lighter-than-air flight and craft. For example, use questions and pictures to determine what students know about the structure and operation of hot air balloons and blimps. Make a class list of what students already know and what they want to learn about lighter-than-air flight and craft. Show the video footage of historic and modern lighter-than-air craft. Return to the list and ask the class to add other items to the "Want to learn" column.

Introduction to Blimps



Evaluation of Opener: Students will write a journal entry explaining what they learned.

Possible Prompt: Write a paragraph explaining what you observed about lighter-than-air flight and crafts in the video. Include any questions you might have or information you would like to learn in this unit.

Body of the Lesson:

Watch **It's a Gas #1: The History of Blimps**

Activity One: Provide the students with drawing materials, paper and Appendix A: Blimp Vocabulary. Ask the students to draw lighter-than-air craft and to explain their drawing in two to three sentences. Require that at least six of the terms are included among the labels of the drawing and/or are included in the description.

Activity Two: Provide the students with the "lighter-than-air timeline" accessible from the CD-ROM or online at pbs4549.org/blimp. Ask students to pick ten events that they consider significant, construct a timeline of these events, and explain in two to three sentences why they picked these events to include on their timeline.

Evaluation of Lesson Body:

Activity One: Determine student's grade based on the following guidelines:

- At least six of the terms are included as labels in the drawing and/or explanation.
- Terms are used correctly in both the drawing and the explanation.

Activity Two: Determine student's grade based on the following guidelines:

- Timeline incorporates at least 20 key events.
- Events are arranged in a meaningful, logical and accurate sequence.
- Explanation clearly articulates the student's rationale for choice of events.

Closure:

Ask students to display their drawings and timelines. Invite students to explain orally their drawings and/or timelines. Revisit their "What I want to learn" list to insure all their questions have been addressed. The discussion should bring out that lighter-than-air craft have changed over time, with recent designs built on earlier knowledge.

Final Assessment:

Students will write a journal entry explaining what they learned.

Prompt:

Write a paragraph explaining what you have learned about lighter-than-air craft and events related to these craft.

Tools/Resources

It's a Gas #1: The History of Blimps
List of vocabulary related to lighter-than-air craft and blimps
Drawing tools and paper
CD-ROM or Internet site at pbs4549.org/blimp

NOTE: Appendix B: **It's a Gas** vocabulary has been provided but is NOT meant to be presented to the students in this lesson. The list is included as background for teachers using the curriculum unit.

Classroom Management

This is a two-day lesson
Allow 1 day for the opener and beginning the body.
Allow 1 day for completing the body and the closure.

Appendix A: Blimp Vocabulary

Air scoops: Directs air from the propellers into the ballonets. This is how the pilots can fill the ballonets with air while in flight. When the engines are not running, electric fans move air through the air scoops into the ballonets.

Ballonet: An air-filled bladder inside the envelope of a blimp used to regulate the gas pressure and maintain the envelope shape.

Blimp: A term coined in 1915. The term most likely originated when Lieutenant A. D. Cunningham of the English Royal Naval Air Service flipped his thumb on a lighter-than-air craft and was rewarded with an odd noise that echoed off the taut fabric. Cunningham imitated this sound by uttering “Blimp!”

Engines: Two engines on the blimp provide the thrust necessary to move foward. They are located on either side of the gondola.

Envelope: The gasbag of a blimp holds the lifting gas, forms an external barrier to the elements and serves an important role in maintaining the blimp’s shape. It also has fittings for attaching the fins, control car and other structural components. The envelope is usually made of a high-strength fabric combined with a sufficiently impermeable barrier coating or film to minimize loss of the buoyant gas it contains.

Flight control surfaces: Stiff, movable parts mounted at the rear of the blimp. They consist of the rudder and elevators. The **rudder** is used to steer the blimp to the starboard or port directions (right or left). The **elevators** are used to control the angle of ascent or descent (up or down) of the blimp. The pilot operates the flight control surfaces as he/she flies the blimp.

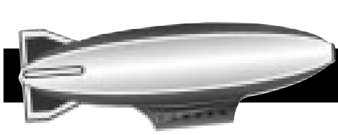
Gondola: A term used to describe the external pod on a blimp that house the passengers and pilot.

Helium valve: A valve on the envelope that can be used to vent helium should its pressure exceed the maximum safe limit. The valve can be opened manually or automatically.

Landing gear: A wheel that helps steady the blimp during landing. The blimp rests on the wheel while it is on the ground.

Nose cone battens: Supports that radiate from the front tip of the blimp. They stiffen the front of the blimp so that it is not damaged when it is hooked to the mooring mast. They also give the nose an aerodynamic shape and prevent it from pushing in as the blimp travels forward.

Railing: A bar wrapped around the gondola that allows the ground crew to hold on to the blimp during takeoff and landing.



Blimp Vocabulary (expanded for teacher use)

Airship: The generic term for any dirigible or powered lighter-than-air vehicle, including blimps and zeppelins.

Air scoops: Direct air from the propellers into the ballonets. This is how the pilots fill the ballonets with air while in flight. When the engines are not running, electric fans move air through the air scoops into the ballonets.

Air valves: The pilots must be able to vent air from the ballonets as well as add it. This is accomplished by air valves that are located on each ballonet. There are four valves, two fore and two aft.

Ballast: A weight carried aboard a lighter-than-air vehicle to offset the buoyancy of its lifting gas. Gas balloons commonly use sand, while blimps often carry metal shot in small canvas bags. Water has been the traditional ballast in rigid airships. Ballast is often expendable, as it is any weight that can be jettisoned from the vehicle. Ballast may be dropped by an airship to compensate for lost lifting gas or to ascend more quickly.

Balloon: An un-powered lighter-than-air vehicle. Balloons can derive their buoyancy from the confinement of hot air, hydrogen, helium, ammonia or other gas. Balloons can be free (un-tethered and free to drift with the wind) or tethered to the ground (sometimes called captive or kite balloons).

Ballonet: An air-filled bladder inside the envelope of a pressure airship used to regulate the gas pressure and maintain the envelope shape.

Blimp: A term coined in 1915 as a friendly synonym for a pressure airship. The word is said to have mimicked the sound made when a man snapped his thumb on the airship's gas-filled envelope. The term most likely originated with Lieutenant A. D. Cunningham of the Royal Naval Air Service. He flipped his thumb on a gasbag and was rewarded with an odd noise that echoed off the taut fabric. Cunningham imitated this sound by uttering, "Blimp!" It is believed that is how the word came into common usage.

Buoyancy: The ability to float when an object displaces a fluid medium greater than its own weight. Buoyancy can be controlled by the use of ballast.

Catenary curtain: A fabric curtain and metal cable structure inside the envelope of a pressure or semi-rigid airship to which an external gondola or control car is attached. A catenary curtain spreads the load across a large part of the envelope to minimize distortions and stretching of the gasbag. Its shape is not a true catenary in the mathematical sense, but it is similar in shape to an inverted rope suspended by its ends.

Dirigible: A word that describes any steerable or directable airship, including blimps (pressure airships), semi-rigid airships and zeppelins (rigid airships). The term is often used to describe only rigid airships, but it applies to both. Dirigible is a synonym for airship.

Duralumin: Originally the trade name of a lightweight but strong alloy of aluminum mixed with smaller amounts of copper, magnesium, manganese, iron and silicon. High strength with little weight made the metal a preferred choice for building the structure of rigid airships.

Dynamic lift: The vertical movement of an airship created by aerodynamic forces acting on the shape of the vehicle, as opposed to static lift, which is generated by the buoyancy of a lighter-than-air lifting gas.

Engines: Two engines on the blimp provide the thrust necessary to move ahead. They are located on either side of the gondola.

Envelope: The gasbag of a blimp or semi-rigid airship. Unlike a rigid airship gas cell, an envelope forms an external barrier to the elements, and when pressurized, serves an integral role in maintaining the airship's shape. It also has fittings for attaching the fins, control car and other structural components. The envelope is usually made of a high-strength fabric combined with a sufficiently impermeable barrier coating or film to minimize loss of the buoyant gas it contains. Formerly made of rubberized cotton, envelopes today are constructed mainly of synthetic materials with their seams cemented, glued or sealed.

Equilibrium: A condition of relative balance in which the forces of lift and gravity are equal.

Flight control surfaces: Stiff, movable parts mounted at the rear of the blimp. They consist of the rudder and elevators. The rudder is used to steer the blimp to the starboard or port directions (right or left). The elevators are used to control the angle of ascent or descent (pitch axis) of the blimp. The pilot operates the flight control surfaces as he/she flies the blimp.

Gas cell: On a rigid airship, the gas-impervious, balloon-like container of lifting gas housed within the rigid framework. These cells were built as light and gas-tight as possible, using a variety of fabrics and gas-barrier materials. They were held in place by wire and cord netting, and their volume could vary with atmospheric pressure. The framework and outer cover of a rigid airship maintained its shape, not the outward pressure exerted by its gas cells.

Gondola: A term used to describe the variously shaped external pods on an airship that house engines or control stations. The earliest airships had open-top, boat-shaped structures holding engines and crew. Later, these structures were enclosed, giving rise to the terms "control car" and "engine car" or simply "car."

Helium valve: A valve on the envelope that can be used to vent helium should its pressure exceed the maximum safe limit. The valve can be opened manually or automatically.

Heavier Than Air (HTA): The branch of aeronautics that includes flight vehicles that require air passing over an airfoil (e.g., a wing) to generate aerodynamic lift. Such vehicles include airplanes, gliders, helicopters and kites, either piloted or unpiloted.

Lighter Than Air (LTA): The branch of aeronautics that includes flight vehicles that depend upon buoyancy from the displacement of air for their lift. Such vehicles include balloons and dirigibles of all types, piloted or unpiloted.

Landing gear: A wheel that helps steady the blimp during landing. The blimp rests on the wheel while it is on the ground.

Non-rigid airship: Another term for a pressure airship.

Nose cone battens: Supports that radiate from the front tip of the blimp. They stiffen the front of the blimp so that it is not damaged when it is moored to the mooring mast. They also give the nose an aerodynamic shape and prevent it from pushing in as the blimp travels forward. In addition to the battens, the mooring hooks are located in the nose of the blimp.

Pressure airship: A term used to describe an airship whose shape is dependent on the gas inside its envelope having a higher pressure than is found in the atmosphere outside. With no lifting gas in its envelope, a pressure airship is only an empty bag on the ground with its control car, fins and hardware fittings the only rigid structures. Also called a "non-rigid airship."

Pressure height: The altitude at which an airship can no longer contain its lifting gas due to its greater pressure compared to the surrounding atmosphere. At this altitude, the airship's spring-loaded automatic valves open to relieve the pressure or else the gas cell or envelope will burst.

Railing: A bar wrapped around the gondola that allows the ground crew to hold on to the blimp during takeoff and landing.

Rigid airship: An airship whose shape is maintained by an internal framework and whose lifting gas is contained by a separate gas cell or cells within that structure. The external fabric covering on a rigid airship is not completely gas-tight, but it does protect the more delicate gas cells and other interior components from wind and weather and provides a degree of streamlining. Even the metal skeleton of a "rigid" airship must flex somewhat under loads or else it would break.

Semi-rigid airship: An airship with a rigid keel but whose envelope is maintained by gas pressure. The keel at the bottom of the envelope is used as a support for control car, engines, ballast and sometimes tail surfaces.

Static lift: The vertical force exerted on an airship created solely by the buoyancy of its lighter-than-air lifting gas, unlike dynamic lift, which is generated by aerodynamic forces acting on the shape of the vehicle.

Streamlined: Having a smooth, aerodynamically efficient shape offering minimal wind resistance; a classic example is the elongated teardrop shape.

Zeppelin: The often generic term for any rigid airship, derived from the name of its inventor and promoter, Ferdinand Graf von Zeppelin (1838-1917). The first aircraft of this type flew in 1900 near Friedrichshafen, Germany.

It's a Gas!

Math & Science of the Blimp

Lesson 2
Measurement/Scientific Notation

Measurement/Scientific Notation Quick Tour

Author: Andrea Stamp, Hubbard Exempted Village Schools
Target Audience: 8th or 9th grade math

Lesson Overview

Key Objective:

Students will apply accurate measurement skills and convert numbers to and from scientific notation.

Key Standards Addressed:

1. Select appropriate units and tools for measuring given items.
2. Use scientific notation.

Procedure

Suggested time frame for this lesson is five class periods.

1. Hold a classroom discussion about the best measurement tool to use and which unit of measure is best to determine the size of a blimp.
2. Use Appendix A: Discussion Questions to guide viewing of the video **It's a Gas #2**: **Measurement** and then go over the questions after viewing.
3. Small groups, using the sizes from Appendix B and string, will measure out one dimension of the blimp, Wingfoot Lake Hangar or Akron Airdock. It takes four groups for each structure, two lengths and two widths. Once they have their string measured, the four groups lay out their string to create an outline of the object.
4. Students will share the method they used to measure and lay out their part of the model, especially any holes or overlaps in the outline.
5. Use the Estimation game on the Web at pbs4549.org/blimp or the **It's a Gas** CD-ROM to determine how many lighter-than-air craft will fit into the Akron Airdock.
6. Complete Appendix B converting all feet measurements into inches, yards and miles. Since the numbers will get very large this is the place to introduce scientific notation for large and small numbers.
7. Students should do the computer activity on the Web or CD-ROM to practice matching scientific notation.
8. Use Appendices C and D to assess understanding of conversion and scientific notation.

Tools/Resources

It's a Gas #2: Measurement
CD-ROM or computer with Internet access
VCR and TV
Handouts
Calculators
Rulers
Tape measures
String/twine
Trundle wheel

Assessment

See Appendix G for Answer Keys and activity assessment rubric. Test questions are included in Appendices E and F.

It's a Gas! Math & Science of the Blimp

Measurement/Scientific Notation

Learning Objectives

The students will:

1. Apply accurate measurement skills when given dimensions of a blimp
2. Convert to another unit within English units (inches, feet, yards, miles) when given a measurement in one unit.
3. Convert large and small numbers from scientific notation to standard notation and vice versa.

Curriculum and Proficiency Standards Addressed

The students will:

1. Select appropriate units and tools for measuring given items (ex. length of math book, distance from here to mall).
2. Use appropriate levels of precision when calculating with measurements.
3. Use scientific notation to express large numbers and numbers less than 1.

How Technology is Integrated in this Lesson

The students will:

1. Use technology tools to process data and report results.
2. Use technology resources for solving problems and making informed decisions.
3. Use calculators to do conversions from one unit to another.

Video Synopsis

Abby and Trista discover how big the blimp looks up close. They interview an engineer and find out how they measure the blimp, how numbers are kept manageable using scientific notation, and why people need to know English as well as metric measurements.

CD-ROM Activities

(Also available on the web at pbs4549.org/blimp)

1. Estimation: In this activity, students will try to estimate how many blimps will fit into the Akron Airdock.
2. Students will match scientific notation to its corresponding standard number.
3. Students will place three scientific notation numbers in the proper order.

Learning Strategies

A. Engagement

1. Students will have a classroom discussion about the best measurement tool to use when measuring a blimp – ruler, yardstick, trundle wheel, tape measure. What would you use? Why?
2. Students will discuss which unit of measure is best to measure the blimp – inch, foot, yard or mile. To what measure should you round? How is precision affected when rounding to nearest inch versus nearest $\frac{1}{16}$?
3. Watch the instructional television program, **It's a Gas #2: Measurement**. Use Appendix A for discussion questions after watching the video.

Vocabulary

Conversion: changing from one unit of measurement to another

Scientific Notation: a way to express very large or very small numbers using a one-place decimal times a power of ten

Inch – $\frac{1}{12}$ of a foot　　Yard – 3 feet　　Mile – 5280 feet

Evaluation of the Engagement

Use Appendix A for discussion questions after watching the video. Also ask what things students learned from the video that they did not know about the blimp. How do students think that the blimp would compare in size to everyday items, such as a school bus or a car?

B. Exploration

1. Students will be split into small groups and be given the measure of one side of either the Wingfoot Lake Hangar or Akron Airdock. (There are four sides – two lengths and two widths – for each of the three items allowing for 12 groups. If this creates too many groups, you could just do the Hangar.) See Appendix B for the measurements. If space is an issue, you can use a scale of 1 foot = 10 feet to develop a model of each item instead of a life-size replica.
2. Each group should use string or twine and whatever measurement tool it chooses to measure out portion exactly. On a nice day that is not too windy, each group will bring its measured portion outside where a complete outline of the hangar and airdock can be put together. The outline of the blimp can be put together inside the Hangar and Airdock and stakes can be used to represent more than one blimp so that students can determine how many blimps could fit in each facility.
3. Students will discuss and share the method they used to lay out their part of the model, especially any holes or overlaps in the outline
4. What went right/wrong? How should the outline be adjusted? The whole class should work as a team to fix any problems.

Evaluation of Exploration

See Appendix G for rubric.

When the task is completed students will analyze the results. Do all sides of the hangar meet – does each taped part match up so that the outline is complete? Outcomes to be assessed:

1. Students chose best tool and unit to use for situation.
2. Students used correct measurement techniques.
3. Students measured accurately.

C. Explanation

Estimation

1. Students will play the Estimation game on the Web at pbs4549.org/blimp or CD-ROM to determine how many lighter-than-air craft will fit into the Akron Airdock.
2. Using Appendix B: The Wingfoot Hangar Vs. the Akron Airdock, students should compare their answers to what they learned from the computer activity. They can also estimate how many of the different craft featured on the computer activity will fit in the Wingfoot Lake Hangar.

Evaluation of Explanation

Students will write a paragraph explaining how they came up with their estimate and how they could improve their estimates.

D. Elaboration

Conversions and Scientific Notation

Activity #1: Inches

Problem to be posed:

Students should do the part of Appendix B converting all feet measurements to inches.

Procedure

1. Students must know there are 12 inches in a foot.
2. Students should devise a way to convert feet to inches (multiply feet by 12). Students should be able to evaluate this answer for reasonableness. Does this answer make sense?
3. Since the numbers will get very large this is the place to introduce scientific notation.
4. Students should be taught to move the decimal point so that there is only one non-zero number in front of the decimal point. The number of places the decimal moved becomes the exponent on the second part of the problem, or the 10. Large numbers always have positive exponents. Example: $1200000 = 1.2 \times 10^6$

Activity #2: Miles

Problem to be posed:

Complete Appendix B converting all feet measurements into yards and then into miles.

Procedure

1. Students should be grouped into pairs.
2. Students need to know how many feet are in a mile (5280) and how many feet are in a yard (3).
3. Students should be able to devise a method to convert yards to miles. Again they should be able to test for reasonableness.
4. When all groups of students have attained the right answer, it is time to demonstrate scientific notation for small numbers. Procedure is same as explained above except small numbers have a negative exponent. Example: $.0034 = 3.4 \times 10^{-3}$.
5. Students should do CD-ROM or Web activity on scientific notation.

Evaluation of Elaboration

1. Appendix C: Conversions
2. Appendix D: Scientific Notation

Final Assessment

Paper and pencil test using Pre- and Post-Test questions. See Appendices E and F.

Tools/Resources

It's a Gas #2: Measurement
CD-ROM or computer with Internet access
TV with VCR
Handouts
Calculators
Rulers
Tape measures
String/twine
Trundle wheel

Classroom Management

This lesson takes five class periods
Engagement activity: three class periods (one for video and preliminary discussions and two for string outlines and CD-ROM estimation).
At least two class periods for Problem-Posing Activities.

Student Groupings

Whole class discussions
Activities should be done in groups of two or three
Evaluation is done independently

Appendix A: Discussion Questions for Measurement

1. Why is it called a blimp?

2. Name the home base of the blimp in Akron.

3. What would cause you to choose a specific unit of measure over another such as inch instead of foot?

4. Why would you use scientific notation?

5. How many feet are in a mile?

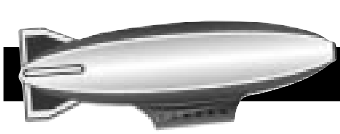
6. How many yards are in a mile?

7. How much does a blimp weigh?

8. How long is the blimp compared to a football field?

9. How fast does a blimp travel?

10. How high does a blimp usually fly?



Appendix B: Wingfoot Lake Hanger Vs. Akron Airdock

Estimate how many blimps will fit inside each structure.

Blimp Dimensions	inches	yards	feet
Length: 192 feet			
Width: 55 feet			
Height: 60 feet			

Wingfoot Lake Hangar
Length: 400 feet
Width: 100 feet
Height: 90 feet

Akron Airdock
Length: 1,175 Feet
Width: 325 feet
Height: 211 feet

Your Estimates:

__________ blimps will fit in the Wingfoot Lake Hangar

__________ blimps will fit in the Akron Airdock

Explain how you made your estimate:

Answer the following questions after doing the computer exercise:

1. How many blimps actually will fit in the Airdock?

Explain in paragraph form how you make an estimate. What kind of information do you need to make an estimate? Explain.

1. A football field is 100 yards long.
   a. How many inches is this?

   b. How many feet is this?

   c. How many miles is this?

2. A marathon is 26 miles.
   a. How many feet is this?

   b. How many inches is this?

   c. How many yards is this?

3. _____ feet = 48 inches

4. _____ inches = 6 feet

5. _____ feet = 5 miles

6. _____ miles = 10,560 feet

7. _____ feet = 9 yards

8. _____ yards = 12 feet

9. _____ feet = 72 inches

10. _____ inches = 12 feet

11. _____ inches = 5 yards

Convert to scientific notation

1. 23,450,000

2. 1,300

3. 0.92

4. 4.385

5. 0.00006609

Convert to decimal notation

6. 6×10^{3}

7. 8.543×10^{-5}

8. 1.35×10^{3}

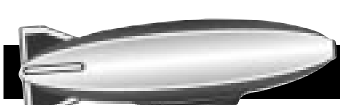
9. 7.8923×10^{-1}

10. 8×10^{-8}

1. What tool and unit of measure would you use to measure the width of this room?

2. 8 feet = _______ inches

3. The earth is 9.3×10^6 miles from the sun. How many feet is this? (Write your answer in decimal notation.)

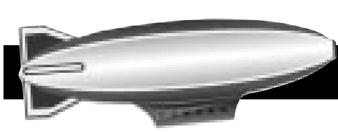


Appendix F: Post-Test

1. What tool and unit of measure would you use to measure the width of your math book?

2. 15,840 feet = ____miles

3. The moon is about 2.39×10^5 miles from earth. How many feet is this? (Answer in decimal notation.)



Appendix A: Discussion Questions

1. The sound it makes when you flip your thumb against the outside fabric
2. Wingfoot Lake Hangar
3. To keep the numbers manageable
4. For really big or really small numbers
5. 5,280
6. 1,760
7. 6,000 pounds deflated, 200 pounds inflated
8. 60 yards long
9. 35 miles per hour
10. 1,000 feet but can go up to 5,000 feet

Appendix B: Wingfoot Lake Hangar Vs. Akron Airdock

Blimp	feet	inches	yards	miles
	192	2,304	64	.036
	55	660	18.3	.010
	60	720	20	.011
Wingfoot Lake Hangar				
	400	4,800	133.3	.076
	100	1,200	33.3	.019
	90	1,080	30	.017
Akron Airdock				
	1,175	14,100	391.7	.223
	325	3,900	108.3	.062
	211	2,532	70.3	.040

_2_ blimps will fit in the Wingfoot Lake Hangar
_30_ blimps will fit in the Akron Airdock

Rubric for String outlines

Over the top

1. All parts of outline come together with no gaps or overlaps.
2. Everything is measured to a minimum of one foot accuracy.
3. Teamwork issues were always resolved cooperatively. Each person did his/her part and all ideas were honored.

Acceptable

1. There are no gaps or overlaps of more than one foot.
2. Everything is measured to a minimum of three foot accuracy.
3. Teamwork was evident. Most ideas and efforts were accepted.

Inadequate

1. There are large gaps or overlaps.
2. Lack of accuracy is over three feet.
3. Team failed to work cooperatively.

Appendix C: Conversions

1. a. 3,600
   b. 300
   c. .019
2. a. 137,280
   b. 1,647,360
   c. 45,760
3. 4
4. 72
5. 26,400
6. 2
7. 27
8. 4
9. 6
10. 144
11. 180

Appendix D: Scientific Notation

1. 2.345×10^{8}
2. 1.3×10^{3}
3. 9.2×10^{-1}
4. $4.385 \times 10^{\circ}$
5. 6.609×10^{-5}
6. 6600
7. .00008543
8. 1350
9. .78923
10. .00000008

Appendix E: Pre-Test

1. Tape measure and feet
2. 96
3. 49,104,000,000

Appendix F: Post-Test

1. Ruler and inches
2. 3
3. 1,261,920,000

It's a Gas!

Math & Science of the Blimp

Lesson 3
Ratio and Proportion

Author: Maria Mastromatteo, PBS 45 & 49, Kent, Ohio
Target Audience: 7th, 8th and 9th grade math

Ratio and Proportion

Lesson overview

Objective:

Students will do activities that demonstrate how ratio and proportion are useful in everyday life.

Standard Addressed:

Solve problems involving real numbers, including ratio, proportion and percent and explain solutions.

Procedure

Suggested time frame for this lesson is four class periods.

1. Using the worksheet, Enlarging a Drawing, larger graph paper, large blank paper, squares, markers, etc. students will make this same blimp, only larger. They will display their drawing and explain how they enlarged it.
2. Watch the video **It's a Gas #3: Ratio and Proportion**.
3. Using the worksheet, *T*he Blimp at the Super Bowl, students will use proportion to determine how much it costs to send the blimp to the Super Bowl. Because there are multiple ways that the problem can be solved it would be good for students to explain the different ways that they used for finding a solution.
4. Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to practice finding ratios and proportions.
5. On a sunny day, find a flagpole outside. It is the students' job to find out how tall the flagpole is. Have the students give their solutions to the problem – explaining both what their solution is and how they got it. Expect to see a variety of solutions and a variety of answers. Hopefully, someone will use proportion. If not, this is a time when the uses of ratio and proportion can be pointed out.

   The proportion would be:

$$\frac{\text{Height of the flagpole (x)}}{\text{Shadow of the flagpole}} = \frac{\text{Height of the person}}{\text{Shadow of the person}}$$

Tools/Resources

- **It's a Gas #3: Ratio and Proportion**
- CD-ROM or computer with Internet access
- VCR and TV
- Calculators
- Tape
- Markers

Assessment

Test questions and answer keys are included in Appendix D.
See Appendix E for activity assessment rubrics and answer keys.

Ratio and Proportion

Learning Objectives

The students will:

1. Enlarge a picture placed on a grid using a method of their choosing and explain their procedure.
2. Compute the missing measure using proportion when given three measures in the proportion.
3. Compute the height of a flagpole using proportion when given the height of a person and his shadow and the length of the shadow of a flagpole.

Curriculum and Proficiency Standards Addressed

The students will:

1. Use models and pictures to relate concepts of ratio, proportion and percent.
2. Estimate, compute and solve problems involving real numbers, including ratio, proportion and percent and explain solutions.
3. Use variables to create and solve equations.
4. Use symbolic algebra to represent and explain mathematical relationships
5. Model and solve problem situations involving direct and inverse variation.
6. Convert measures expressed in a given unit to other units in the same measurement system using proportional reasoning and a reference table when appropriate.
7. Use proportional reasoning and apply indirect measurement techniques, including right triangle trigonometry and properties of similar triangles, to solve problems involving measurements and rates (Grades 8-10)
8. Select an instrument and measure accurately to a specified level of precision.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Use keyboards and other common input and output devices efficiently and effectively.
2. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
3. Use technology resources for solving problems and making informed decisions.

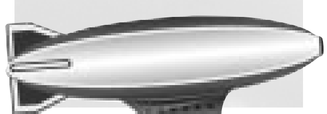
Video Synopsis

Trista and Abby figure out how to use ratio and proportion to determine the dimensions of the blimp. They interview an engineer to find out how ratios and proportions are important in designing, building and flying the blimp.

CD-ROM Activity

(Also available on the web at pbs4549.org/blimp)

Students determine how large dirigibles are by using proportion.



Learning strategies

A. Engagement

Appendix A: Enlarging a Drawing

1. Students will be put into groups of two or three.
2. Groups will be given a drawing of a blimp on graph paper.
3. Their task is to make this same blimp, only larger.
4. They will be provided with a worksheet, larger graph paper, large blank paper, squares, markers or other material the students might request.
5. Groups will make a decision as to how they will enlarge the model. (They can then decorate and name their blimp.)
6. When the task is completed, students will display their drawing and explain how they enlarged it.

Evaluation of Engagement:

See Appendix E for rubric.

B. Exploration

Watch the video **It's a Gas #3: Ratio and Proportion**

Appendix B: The Blimp at the Super Bowl

1. Introduce the scenario to the students.

   Scenario

   You work at the Goodyear hangar and are in charge of booking the blimp to go to various events across the nation. You call the general manager of the Miami Dolphins and offer to have the blimp available at the Super Bowl in Miami. The blimp is currently in the hangar in Akron. Your task is to figure out how much it will cost to take the blimp to Miami and then back to Akron.
2. Break the students into groups of two or three.
3. Pass out the worksheets and explain the task. Explain that there are many ways to solve this problem, but they need to show their work and to show at least two times where they used proportion to find a solution.
4. Compare answers at the end. It is okay if students come up with slightly different answers because they have rounded at different places.
5. Because there are multiple ways that the problem can be solved it would be good for students to explain the different strategies they used for finding a solution.

Evaluation of Exploration:

See Appendix E for answer key and rubric.

C. Explanation

1. Students will report their findings to the class.
2. Students can tell what difficulties they had and any questions they still have.
3. Students will need further practice using proportions. The teacher can go to the Blimp CD ROM, the Web at pbs4549.org/blimp, do work from the textbook or go online to http://www.algebrahelp.com/lessons/proportionbasics/pgw.htm.
4. The vocabulary words should be discussed after the CD-ROM has been used. (See Appendix C for vocabulary.)

Evaluation of Explanation:

Use Appendix E rubric to evaluate the work of the students.

D. Elaboration

Task 1: How Tall is the Flagpole?

1. Find a flagpole outside. Make sure you have a sunny day so that students can see their shadows.
2. Tell the students it is their job to find how tall the flagpole is. Have the students determine what unit of measure they should use. Give them a tape measure and tell them you'll supply other material if they need it (and if you have it) and let them attack the problem. (Have meter sticks, tape and other material available.)
3. After giving them some time, the students should give their solutions to the problem — explaining both what their solution is and how they got it. Expect to see a variety of solutions and a variety of answers. For instance, if the flagpole is short, students might get on shoulders and drop the tape measure to find the height. They might tie a rope to the part that raises the flag and then take the rope down and measure it. Estimation is also a possibility. Discuss the legitimacy of alternative solutions.
4. Hopefully, someone will use proportion. If not, this is a time when the uses of ratio and proportion can be pointed out.
5. The proportion would be:

$$\frac{\text{Height of the flagpole (x)}}{\text{Shadow of the flagpole}} = \frac{\text{Height of the person}}{\text{Shadow of the person}}$$

6. Point out that there are other ways to write this proportion.

Evaluation of Elaboration:

Use Appendix E rubric to evaluate student work in groups.

E. Final Assessment

- Student evaluation of each classroom activity.
- Paper and pencil assessment using the Pre- and Post-Test problems. (See Appendix D.)

Tools/Resources

- **It's a Gas #3: Ratio and Proportion**
- CD-ROM or a computer with Internet access
- VCR and TV
- Calculators
- Tape
- Markers

Classroom Management

Suggested time frame for this lesson is four class periods.

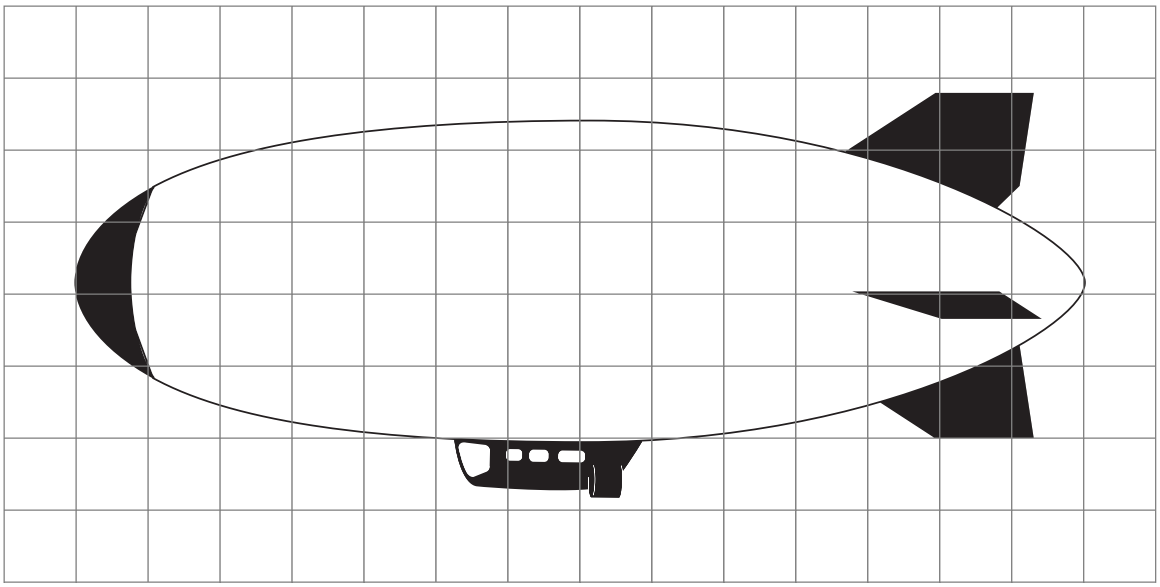
- No safety issues are involved other than traditional classroom rules.
- **Enlarging a Drawing**: One class period for work and a second period for analysis of work for the class.
- **The Blimp at the Super Bowl**: Some prior work needs to be done with proportion. This activity should take one class period. This should take one period to complete and part of another period for the students to analyze.
- **How High is the Flagpole:** This activity takes one class period.

Student Groupings

All activities with the exception of the Pre- and Post-Test worksheets should be done with groups of two or three so that students can share ideas and give/get mutual help.

Below you have a diagram of a blimp imposed on graph paper. Your job is to make the airship larger. You must keep the correct proportion. You may use:

- Larger graph paper
- Squares of paper
- A ruler or tape measure
- Markers (to decorate the blimp you make)



Appendix B: The Blimp at the Super Bowl

You work at the Goodyear Blimp Hangar and are in charge of booking the blimp to go to various events across the nation. You call the general manager of the Miami Dolphins and offer to have the blimp available at the Super Bowl in Miami. The blimp is currently in the hangar in Akron. Your task is to figure out how much it will cost to take the blimp to Miami and then back to Akron. You will also be flying for eight hours the day of the game.

You must show your work and use proportion to solve this problem. These are the facts you need to solve the problem:

- It takes ten gallons of aviation fuel to run the blimp one hour. Fuel is $1.50 per gallon.
- The speed of the blimp averages 35 miles per hour.
- The blimp travels ten hours per day to get to its location.
- Four pilots accompany the blimp and are paid an average of $50 per hour.
- Sixteen traveling ground crew accompany the blimp. They work eight hours per day and are paid an average of $35 per hour.
- Miami is 1,213 miles from Akron.
- Lodging is $100 per night for a room for two people. The trip will take four days each way and one day at the Super Bowl. This means six nights lodgings
- Food is $40 per day per person.
- The blimp will be up for eight hours on Super Bowl day.

I'll give you a clue! Here's a similar problem: If a car travels 60 miles per hour and has to travel six hours, the ratio of the distance to the time is 60 to 1. The proportion would be:

$$\frac{\text{Distance}}{\text{Time}} = \frac{\text{Distance}}{\text{Time}} \qquad \frac{60 \text{ miles}}{1 \text{ hour}} = \frac{X \text{ miles}}{6 \text{ hours}}$$

You would multiply the means and the extremes to get the total number of miles so...1 x X = 60 x 6 or X = 360 miles.

Be sure to show all work. Be sure to include labels. You must show at least two instances in which you used proportion.

Cost of fuel ________

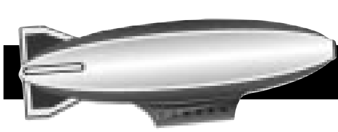
Cost of pilots ________

Cost of crew ________

Cost of room ________

Cost of food ________

Total Cost ________



Ratio: Comparing two numbers

Proportion: A statement of equality between two ratios.

Means: In the proportion 1/6=2/12, the means are the inner two numbers, the 6 and the 2.

Extremes: In the proportion 1/6=2/12, the extremes are the outer two numbers, the 1 and the 12.

Equal: Having the same value.

Estimate: An approximate value made by making a "rough" calculation.

Inch: A unit of measure equal to 1/12 of a foot.

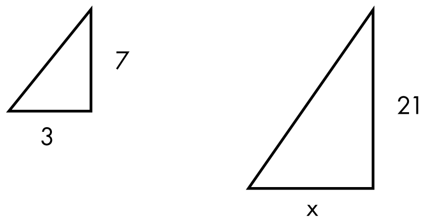
Measure: To determine a distance using a tool.

Variable: A symbol whose value changes.

Variability: The spread in a series of data points or numbers. (The range from the lowest to the highest.)

Pre-Test Question:

1. The triangles below are similar. What is the length of the base of the large triangle?



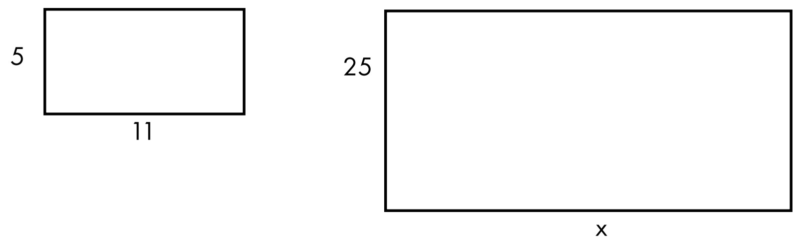
   a. 14
   b. 30
   c. 9
   d. 6

2. Three out of five students in Jenny's school bring their lunch to school. There are 150 students in the school. How many of them bring their lunch? Show the proportion and solve the problem.

3. Mark gets 27 miles for each gallon of gas he uses. How many gallons will he need to go 500 miles?

   Show two ways you can solve this problem:

1. The rectangles below are proportional. What is the length of the missing side?



a. 55
b. 5
c. 75
d. 50

2. Three out of seven people prefer bottled water to cola. Out of the 210 people in Don's school, how many prefer bottled water? Show your proportion and solve the problem.

3. John is going to the Ohio State football game. It takes him one hour to travel 65 miles. How long will it take him if Columbus is 180 miles away?

Show two ways you can solve this problem:

Answer Key for Appendix B: Blimp at the Super Bowl

Hours that the blimp will be flying:

- Distance is 1,213
- Flies at 35 miles/hour
- 1213 ÷ 35 = 35 hours (34.65 hours)
- Eight hours of flying time at the Super Bowl
- 35 hours to get there plus 35 hours to get home plus 8 hours in the air = 78 hours
- Total flight time is 78 hours

To find the cost of fuel:

- Ten gallons of fuel to fly one hour
- Fuel costs $1.50/gallon
- Ten gallons times $1.50/gallon = $15/ hour for fuel
- 78 hours times $15 = $1,170

To find the cost of pilots:

- $50/hour
- 78 hours
- Four pilots
- 50 x 78 x 4 = $15,600

To find the cost of the crew:

- $35/hour
- 78 hours
- 16 crew
- 35 x 78 x 16 = $43,680

To find the cost of lodging:

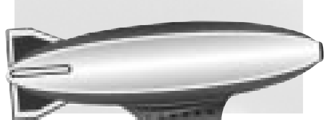
- Blimp flies ten hours per day
- It takes 35 hours one way
- It takes four days to get there, four to return and one day at the Super Bowl = nine days
- $100 for a room for two
- 20 people ÷ 2 = 10 rooms
- 10 rooms x 8 nights x $100 per room = $8,000

To find the cost of food:

- $40 per day per person
- 20 people
- Nine days
- 40 x 20 x 9 = $7,200

Fuel	**$ 1,170**
Pilots	**$15,600**
Crew	**$43,680**
Room	**$ 8,000**
Food	**$ 7,200**
TOTAL	**$75,650**

There are many ways to solve these problems. All parts could use proportion to solve. Students should show at least two examples where they have used proportion.



Rubric for Student Work Groups

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Comprehension	Student is able to accurately answer almost all questions posed by classmates about the topic.	Student is able to accurately answer most questions posed by classmates about the topic.	Student is able to accurately answer a few questions posed by classmates about the topic.	Student is unable to accurately answer questions posed by classmates about the topic.
Collaboration with peers	Almost always listens to, shares with and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with and supports the efforts of others in the group but sometimes is not a good team member.	Rarely listens to, shares with and supports the efforts of others in the group. Often is not a good team member.

Rubric for Math Problems

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Math	Math steps and solutions 90-100% correct	Math steps and solutions 85-89% correct	Math steps and solutions 75-84% correct	Math steps and solutions 75% correct
Explanation	Written out and explained completely	Written out completely but explanation needs improvement	The written work and explanation need work.	Difficult to understand.
Proportion use	At least two proportions are used in the explanation.	One proportion is used in the explanation.	No proportion is used but there is evidence of proportional reasoning.	No proportions are used in explanation.

Appendix D: Pre-Test Answer Key

1. c. 9
2. 90 students
3. 18.5 gallons

Appendix D: Post-Test Answer Key

1. a. 55
2. 90 prefer bottled water
3. 2.8 hrs.

It's a Gas!

Math & Science of the Blimp

Lesson 4
Surface Area

Author: Carol Snyder, Lisbon Exempted Village Schools
Target Audience: 8th and 9th grade math

Surface Area

Lesson overview

Key Objective:

Students will calculate the surface area of three-dimensional objects.

Key Standard Addressed:

Use formulas to find surface area for specified three-dimensional objects accurate to a specified level of precision.

Procedure

Suggested time frame for this lesson is five class periods.

1. Give your students oblong balloons to inflate and cover with paper. Use the paper to determine what two three-dimensional shapes compose the shape of the balloon. See Appendix A: Activity # 1 Worksheet.
2. Watch the video **It's a Gas #4: Surface Area and Volume**.
3. Go over Appendix B: Vocabulary.
4. Each group will be given a rolled oats can and a cone shape. Their task is to measure each object. The teacher may need to suggest cutting and flattening out the 3-D shape to make a 2-D recognizable shape to calculate area.
5. Students should then calculate the area of the top and bottom of the can. See Appendix D: Activity # 2 Worksheet.
6. Guide a student discussion about determining the width of the rectangle if it were still in a cylinder shape. Students should recognize the width is actually the circumference of the cylinder.
7. Students then calculate the area of the rectangle using their measured rolled oats can.
8. Guide a student discussion about determining the total surface area of the cone. Students can calculate the area of the circle, flatten the cone to form a semi-circle and use the formula to find the area of a semi-circle.
9. Students calculate total surface area and record their findings on the worksheet.
10. Students can use the activity on the CD-ROM or Web site to figure out the surface area of three blimps.
11. As homework, students will construct a sculpture using a three-dimensional cylinder and cone shapes, calculate the total surface and present their findings to the class in a verbal presentation.
12. Students will write a story of how surface area could be used in other areas of life.

Tools/Resources

It's a Gas #4: Surface Area and Volume
CD-ROM or computer with Internet access
VCR and TV
Handouts
Calculators
Oblong balloons
Glue and tape
Paper-mache
Newspaper
Tape measure
Tempera paint and brushes

Assessment

Student worksheets, essays, and testing data are used to assess student understanding.

Learning Objectives

The students will:

1. Recognize the importance of making accurate measurement.
2. Identify which three dimensional shapes such as cylinders and cones are used when given a three dimensional object consisting of more than one basic shape.
3. Be able to calculate the surface area by using a formula when given the dimensions of a three-dimensional object.

Curriculum and Proficiency Standards Addressed

The students will:

1. Use formulas to estimate, compute and solve problems involving real numbers.
2. Use formulas to find surface area for specified three-dimensional objects accurate to a specified level of precision.
3. Use algebraic representations, such as tables, graphs, expressions, functions and inequalities, to model and solve problem situations.
4. Formulate a problem or mathematical model in response to specific need or situation, determine information required to solve the problem, choose method for obtaining information and set limits for acceptable solution.
5. Write clearly and coherently about mathematical thinking and ideas.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in This Lesson

The students will:

1. Use technology tools to process data and report results.
2. Select appropriate technology resources to solve problems and support learning.

Video Synopsis

After a short history lesson, Abby and Trista interview an engineer to find out how to determine the surface area and volume of irregular shapes like the blimp. They discover how to break the object down into known geometric shapes and use formulas to figure things out.

CD-ROM Activities

(Also available on the Web at pbs4549.org/blimp)

Students select cones and cylinders that fit the size of the blimp in order to figure out its surface area and volume.

Learning Strategies

A. Engagement

1. Students should work in groups of two or three.
2. Students will be given oblong balloons to inflate as a simulation of the blimp shape.
3. Their task is to cover the balloon with paper to determine what two three-dimensional shapes compose the shape of the balloon.

4. They will be provided with construction paper, scissors and glue or tape.
5. Groups will decide what shape and sizes of paper were needed to cover the balloon by answering the questions found in Appendix A: Activity # 1 worksheet.
6. Watch the instructional television program, **It's a Gas #4: Surface Area and Volume**.

Evaluation of Engagement:

Use Appendix E: Answer Key.

B. Exploration

1. Go over Appendix B: Vocabulary.
2. Students should work in groups of two or three.
3. Each group will be given a rolled oats can to represent a cylinder and a cone shape made from a semi-circle.
4. Their task is to measure each object to explore a method to determine the surface area of each object.
5. The teacher will suggest cutting and flattening out the 3-D shape to make a 2-D recognizable shape to calculate area.
6. Needed to complete this activity are a tape measure and scissors.
7. Each group will attempt to come up with the formulas necessary to calculate the total surface area of both objects.
    - Formulas must be displayed on paper with a written explanation as to how surface area might be calculated.
    - Each group also gives an oral explanation to the teacher.

Evaluation of Exploration:

Use Appendix E: Assessment Rubric to assess student understanding.

C. Explanation

1. Students will be guided by the teacher using the rolled oats container and the cone used in the Exploration phase.
2. The teacher will begin by having students share their findings from yesterday's activity.
3. The teacher then reviews the concept of surface area by reviewing the vocabulary work sheet.
4. The teacher holds up the end pieces that have been cut from the ends of the rolled oats can and asks:
    - What shape is the top and bottom of the cylinder?
    - How would you calculate the area of the top and bottom of the cylinder?
5. Students calculate the area of top and bottom of the can and record their answers on Appendix D: Activity # 2 Worksheet.
6. The teacher holds up the rolled oats can so it re-forms a cylinder shape and asks what shape it is. Note: both ends have been cut out and cut down the middle during the Exploration phase.
7. The teacher then flattens the rolled oats can and asks the students what shape the cylinder is.
8. The teacher asks students how to find the area of a rectangle.
9. The teacher asks students how they would determine the length of the rectangle.
10. The teacher asks students how they would determine the width of the rectangle if it were still in a cylinder shape.
    - Students should be able to recognize the width is actually the circumference when in the cylinder shape.
    - Students should discover they would need to use the circumference of the circle to calculate the width.
11. Students then calculate the area of the rectangle using their measured rolled oats can. Students record their information on worksheet.
12. The teacher holds up the cone shape used in Exploration and asks how would students would calculate the area of the base of this cone.
13. Students calculate the area of the circle. Students record information on worksheet.
14. The teacher holds up cone again and flattens it to form a semi-circle and asks:
    - What shape is the body of this cone?
    - What formula would you use to find the area of a semi-circle?

15. Students calculate the area of the semi-circle and record information on worksheet.
16. The teacher then leads students in a discussion to discover how to determine the total surface area. Students calculate total surface area and record the data on worksheet.
17. Needed for this activity are rulers, tape measure, scissors, worksheet #2, and the rolled oats can and cone shape used in the Exploration phase.

Evaluation of Explanation:
Answer key for Appendix C: Activity #2 Worksheet.

Students can use the activity on the CD-ROM or Web site to figure out the surface area of three blimps. They drag and drop a cone and cylinder onto a blimp to find the best combination then use the data shown to figure out the surface area.

D. Elaboration

Part A: Individualized sculpture project:
1. Students will construct a sculpture using three-dimensional cylinder and cone shapes.
2. Students may use whatever materials are available to them to construct their sculpture.
3. After the sculpture is completed, students will calculate the total surface area of the sculpture and present their findings to the class in a verbal presentation.

Part B:
1. The teacher guides students to discuss how surface area might be used in other areas of life.
2. Students write a story of how surface area could be used in other areas of life.
   Example: Someone working for the city parks district is in charge of painting all of the trash containers in the park. He needs to be able to calculate surface area to be able to calculate how much paint he will need to buy.

Evaluation of Elaboration:
1. After students have completed the project they will present it to the class with a written as well as an oral explanation as to how they determined the total surface area of their sculpture.
2. Use Appendix E: Assessment Rubric to evaluate understanding.

E. Final Assessment

Paper and pencil test using the Pre- and Post-Test questions.

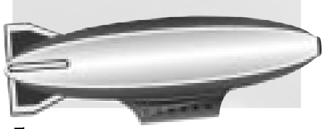
Tools/Resources

It's a Gas # 4: Surface Area and Volume
CD-ROM or computer with Internet access
VCR and TV
Handouts
Calculators
Oblong balloons
Glue and tape
Paper-mache
Newspaper
Tape measure
Tempera paint and brushes

Classroom Management

- One class period to inflate oblong balloon and discover what size and shape construction paper is needed to cover balloon and complete worksheet number one.
- One class period to watch video and discuss the importance of surface area and possible formulas to use to calculate the surface area of the rolled oats can and cone.
- One class period to complete worksheet number two with guided instruction from the teacher.
- Take-home project will take one week to complete.
- Two to three class periods for classroom presentations.

Student Groupings



Whole class discussions
Activities should be done in groups of two or three

Appendix A: Activity #1 Worksheet

Name ____________________

Directions: Answer the following questions after you have inflated your "blimp."

1. The "blimp" is composed of what three-dimensional shapes?

2. What three-dimensional shape would you use to cover the ends of your "blimp"?

3. What two-dimensional shape does this form when you open up the paper?

4. What procedure can you create to find the surface area of this shape?

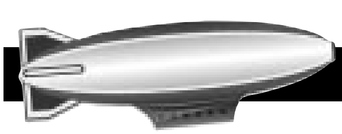
5. Look at the main body of the "blimp." What is this three-dimensional shape?

6. What three-dimensional shape would you use to cover this part of the "blimp"?

7. If you could not open your shape up to measure the width of the paper, how could you calculate the width?

8. Draw a sketch of what your three-dimensional shapes look like opened up into two-dimensional shapes.

9. Summarize the procedure you would use to find the surface area of the entire "blimp."



Appendix B: Vocabulary:

Area: The number of square units needed to cover a surface enclosed by a geometric figure.

Circular Cone: A shape in space that has a circular base and one vertex.

Circular Cylinder: A cylinder with two bases that are parallel, congruent circular regions.

Diameter: The distance across a circle through its center.

Height: The length of the altitude of a triangle or a quadrilateral.

Measure: To determine a distance using a tool.

Proportion: A statement of equality of two or more ratios.

Radius: The distance from the center of a circle to any point on the circle.

Ratio: A comparison of two numbers by division.

Surface Area: The sum of the areas of all the faces of a three-dimensional figure.

Variable: A symbol, usually a letter, used to represent a number in mathematical expressions or sentences.

Appendix C: Activity #2 Worksheet

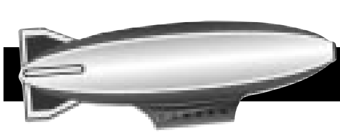
Name ____

Formulas: Circumference $C=\pi D$	**Circle $A=\pi R^2$**
Rectangle $A=LW$	**Surface area of cone SA=Area of the base + $\frac{1}{2}(\pi R^2)$**

Part of cylinder	**Formula**	**Substitute Values in Formula**	**Answers**
Top	$A = \pi R^2$	$A = 3.14 \times$ ____	A = ______ in^2
Bottom	$A = \pi R^2$	$A = 3.14 \times$ ____	A = ______ in^2
Cylinder Body	$A = H \times \pi D$	A= ____ $\times 3.14 \times$ ____	A = ______ in^2
		Total Surface Area	SA = ______ in^2

Part of cone	**Formula**	**Substitute Values in Formula**	**Answers**
Base of cone	$A = \pi R^2$	$A = 3.14 \times$ ____	A = ______ in^2
Body of cone	$A = \frac{1}{2}(\pi R^2)$	A = ½ (3.14 × ____)	A = ______ in^2
		Total Surface Area	SA = ______ in^2

Total SA of cylinder	**Total SA of cone**	**Total SA**
________________ in^2	________________ in^2	________________ in^2



1. Given the formula: Area = πr^2 or $\pi \cdot r \cdot r$
   With a radius of 2.25m, the area will be:

2. Given the formula: Area = Length × Width
   With a width of 25 centimeters and a length of 30 centimeters, the area will be:

3. Given the formula: Circumference = πd
   With a diameter of 20 centimeters, the circumference will be:

Appendix D: Post-Test

1. Given the formula: Area = πr^2 or $\pi \cdot r \cdot r$
   With a radius of 3.25m, the area will be:

2. Given the formula: Area = Length × Width
   With a width of 30 centimeters and a length of 50 centimeters, the area will be:

3. Given the formula: Circumference = πd
   With a diameter of 30 centimeters, the circumference will be:

Appendix A: Activity #1 Worksheet (Answer Key)

1. The "blimp" is composed of what two basic geometric shapes?
   cone   cylinder

2. What shape piece of paper would you use to cover the end pieces?
   cone

3. What shape does this form when you flatten the paper out?
   semi-circle

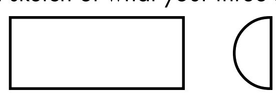
4. What procedure can you create to find the surface area of this shape?
   Answers will vary. Should say something about finding the area of one half of a circle.

5. Look at the main body of "blimp." What is this basic shape?
   cylinder

6. What shape paper would you use to cover this part of the "blimp"?
   rectangle

7. How is the width of the paper related to the shape of balloon?
   The width is actually the circumference around the balloon

8. Draw a sketch of what your three-dimensional shapes look like flattened out on your desk.



9. Summarize the procedure you would use to find the surface area of the entire "blimp."
   Answers will vary.

Assessment Rubric

CATEGORY	Proficient	Acceptable	Unacceptable
Measurement	Shows complete understanding.	Shows substantial understanding.	Shows some understanding.
Explanation	Detailed and clear.	Clear.	Difficult to understand.
Calculations	Uses appropriate formulas and data analysis.	Uses some formulas and data analysis.	Uses no formulas and data analysis.
Technology	Correctly collects and displays data.	Collects and displays some data.	Does not collect and display data.
Mathematical Terminology and Notation	Correct terminology and notation are always used.	Correct terminology and notation are usually used.	There is little use or a lot of inappropriate use of terminology and notation.

Appendix D: Activity #2 Worksheet (Answer Key)

Formulas: Circumference $C=\pi D$	**Circle $A=\pi R^2$**
Rectangle $A=LW$	**Surface area of cone SA=Area of the base + ½ (πR^2)**

Answers will vary depending on size of rolled oats can.

Part of cylinder	**Formula**	**Substitute Values in Formula**	**Answers**
Top	$A = \pi R^2$	A = 3.14 × _____	A = ______ in^2
Bottom	$A = \pi R^2$	A = 3.14 × _____	A = ______ in^2
Cylinder Body	$A = H \times \pi D$	A= _____ × 3.14 × _____	A = ______ in^2
		Total Surface Area	SA = ______ in^2

Answers will vary depending on size of cone.

Part of cone	**Formula**	**Substitute Values in Formula**	**Answers**
Base of cone	$A = \pi R^2$	A = 3.14 × ____	A = ______ in^2
Body of cone	$A = ½ (\pi R^2)$	A = ½ (3.14 × ____)	A = ______ in^2
		Total Surface Area	SA = ______ in^2

Total SA of cylinder	**Total SA of cone**	**Total SA**
98.91 in^2	Answers will vary	Answers will vary

It's a Gas!

Math & Science of the Blimp

Lesson 5
Volume

Author: Erik Essig, Canton City Schools
Target Audience: 8th and 9th grade science or math

Volume

Lesson overview

Key Objective:

Apply different methods to determine volume.

Key Standard Addressed:

Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts dealing with volume.

Procedure

Suggested time frame for this lesson is four class periods.

1. Have students inflate balloons of various shapes and sizes and pose the following question: "How can we find the volume of an object?" Then, show the class the objects they will be working with and ask, "What is the volume of each of these objects?"
2. Administer the Pre-Test. (See Appendix A: Pre-Test)
3. Watch the video **It's a Gas #4: Surface Area and Volume**
4. Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp using cones and cylinders to measure the blimp.
5. Provide students with a set of three to five three-dimensional objects. Pose the problem of finding volume of shapes that are regular (spheres, rectangular prisms) and geometric but unusual (cylinders and the blimp). Explain that the method demonstrated on the video is one of many ways to determine volume. Discuss with students their ideas about volume, what it is, how it is determined, what data they might need to determine volume, and how that data will be recorded and used.
6. Have students collect data from each object and use the data to determine the volume of each object.
7. Have students report both their procedures for finding volume and the volume of each object. As the students are reporting their results and discussing any discrepancies and observations they have made, the teacher should record student vocabulary on the board/overhead.
8. Vocabulary building: Rather than giving definitions, ask clarifying questions. Look for terms that are inappropriate or naïve usage. Encourage students to use terms such as length, width, surface area and volume correctly.
9. Explain that there are many approaches to finding the volume of a blimp. Have students develop their own procedure to measure a blimp. Plan for students to create scale models or diagrams of the blimp to use in their work. Have graph paper, glue and scissors available.
10. Use Appendix B: Post-Test to evaluate students.

Tools/Resources

It's a Gas #4: Surface Area and Volume
CD-ROM or computer with Internet access
VCR and TV
String
Tape measures and meter sticks
Various three-dimensional objects e.g. round cake pan, cereal box, food can
Volumetric beaker
Graduated cylinder
Pan or electric balance
Calculator

Assessment

Teacher observation and paper and pencil testing is used to gauge student understanding.

Learning Objectives

The students will:

1. Develop a definition for volume.
2. Define how volume is determined.
3. Ascertain what data they need to determine volume.
4. Apply different methods to determine volume.

Curriculum and Proficiency Standards Addressed

The students will:

1. Construct, interpret and apply physical and conceptual models that represent or explain systems, objects, events or concepts.
2. Draw logical conclusions based on scientific knowledge and evidence from investigations.
3. Analyze alternative scientific explanations and predictions and recognize that there may be more than one good way to interpret a given set of data.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Integrate conceptual knowledge of technology systems in determining practical applications for learning and technical problem-solving.
2. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.
3. Select, access and use appropriate electronic resources for a defined information need.

Video Synopsis

After a short history lesson, Abby and Trista interview an engineer to find out how to determine the surface area and volume of irregular shapes like the blimp. They discover how to break the object down into known geometric shapes and use formulas to figure things out.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)

Students drag and drop cones and cylinders onto the shape of the blimp and then do the math to determine the surface area and volume.

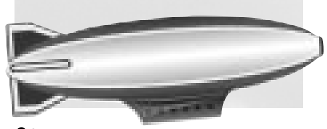
Learning Strategies

A. Engagement

The Blimp Inflates

Have students inflate balloons of various shapes and sizes. Explain to the students that they will be learning about volume and different techniques for determining volume of an object. Present the following problems:

- "How can we find the volume of an object?" Show the class the objects they will be working with and ask, "What is the volume of each of these objects?"



Evaluation of Engagement

Administer the Pre-Test at this time. (See Appendix A: Pre-Test)

B. Exploration

Collecting Data and Finding Volume

View **It's a Gas #4: Surface Area and Volume**.

Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp using cones and cylinders to measure the blimp.

Provide students with a set of three to five three-dimensional objects. Found objects or commercially available sets can be used. It would be helpful to have a blimp-shaped object in the set. Examples might include a box, a circular cake pan, balloons, cans, etc. Pose the problem of finding volume of shapes that are regular (spheres, rectangular prisms) and geometric but unusual (cylinders and the blimp).

Procedure

1. Provide each team of students with metric rulers, tape measures, volumetric flasks/cylinders, calculators and the set of objects.
2. Assign tasks to each team member. A team member may be required to take on more than one task depending upon the configuration of each team:
    a. Technician I uses the metric ruler and tape measure to make linear measurements;
    b. Technician II uses the volumetric beakers/cylinders and or overflow cans to measure displaced volume;
    c. Data/Process Recorder records specific procedures used in the exploration, sets up data table and records specific data about each object provided by Tech I and II;
    d. Equipment Manager obtains and returns all materials used in the exploration;
    e. Research Coordinator/Task Master/Time Keeper keeps the group on time and on task to complete the data collection.
3. Explain that the method demonstrated on the video is one of many ways to determine volume. Discuss with students their ideas about volume, what it is, how it is determined, what data they might need to determine volume and how that data will be recorded and used.
4. Have students collect data from each object and use the data to determine the volume of each object.

Below are a variety of methods for determining the volume of an object. **These methods provided for teacher reference only:**

- **Volumetric Measures (Liquid Contents) -** The easiest method of determining volume would be to fill the object with a liquid such as water, pour off the water into a measuring vessel and read liquid volume. This requires that the object of interest is capable of being filled and is sturdy enough to contain the liquid volume. Pringle's cans, orange juice or milk cartons, plastic soda bottles or plastic eggs with holes drilled in one end should suffice.
- **Volumetric Measures (Liquid Displacement)** - Any container that has volume gradations can be used to determine the volume of a three-dimensional object using the following technique:
    a) Partially fill the container with water, taking note of the volume present;
    b) Fully submerge the object and record the new volume;
    c) Subtract the initial volume from the final volume and you will have the volume of the object.
- **Volumetric Measures** (See Appendix D: Construction of an Overflow Can) - This technique requires either the purchase of an overflow can from a supply house, or the construction of an overflow can out of a two-liter soda bottle and a soda straw:
    a) Fill the overflow can until water flows from its spout;
    b) After the spout has stopped dripping, place a graduated cylinder or beaker under the spout;
    c) Submerge the object in the overflow can, capturing the water that overflows from the spout;
    d) The volume of the object is equal to the volume of the displaced water captured from the can.

- **Cubes and Rectangles Indirect Measurements (length × width × height or lhw)** - Students will need rulers and tape measures for making indirect measurements. Objects that are regular geometric shapes require a straight edged ruler. In this technique, determine the three dimensions and find their product. The formula above or (l)(h)(w) only works for regular squares or rectangles.
- **Cylinders Indirect Measurements ($\frac{4}{3}\pi r^2 h$)** - Students must understand the concepts of radii, exponentiation and multiplying with fractions. Students who find multi-variant formulae daunting may have trouble with this equation and may need extra time and support to work with it. Using a cylindrical object such as a Pringle's can, have students find the radius and the height. Substitute the values for the variables and solve the equation. Students could then verify their calculations via a direct measure of the fluid volume the can would contain using one of the direct measures above or by simply filling the can with water and measuring the contents.
- **Three-Dimensional Ellipsoids ($\frac{4}{3}\pi \cdot \frac{L}{2} \cdot \frac{H}{2} \cdot \frac{W}{2}$)** - This equation is used for approximating the volume of objects whose shapes resemble the blimps. It assumes that the shape is the same at both ends and not tapered at one end as with the blimp. Students should be able to multiply using fractions and have experience simplifying equations. Students who find multi-variant formulae daunting may have trouble with this equation and may need extra time and support to work with it. Measure the length, height and width of the ellipsoid. Set all three measurements over two and find the product of the three fractions. Multiply by $\frac{4}{3}\pi$. If the object is sufficiently sturdy enough, students may be able to verify their results directly using one of the direct methods above.
- **Mass-Density Calculations (mass per unit volume)** - Students using this equation must have prior experience using a balance, understand the concept of density and be able to cross-product methods of solving equivalent fractions problems. This method may require a separate teaching day or two to familiarize students with the approach. The teacher will likely have to provide the unit volume densities of the object in use.

Evaluation of Exploration

The teacher should engage in concurrent assessment of procedures, processes and techniques for data collection using the following rubric:

CATEGORY	4	3	2	1
Data Collection	Using appropriate tools, measurements are accurate and computations are accurate.	Using appropriate tools, measures are accurate but some computations are inaccurate.	Using appropriate tools, some measures are inacccurate and some computations are inaccurate.	Using an inappropriate measurement tool. Inaccuracies in computation and measurement.
Data Table	Data in the table is well organized, accurate and easy to read.	Data in the table is organized, accurate and easy to read.	Data in the table is accurate and easy to read.	Data in the table is not accurate and/ or cannot be read.

C. Explanation

Seminar and Vocabulary Building

During the seminar phase of the lesson, have students report both their procedures for finding volume and the volume of each object. Remind the class that they should be looking for patterns and similarities in the procedures used by each group as well as within the volume data that each group has collected about the objects.

Be alert to groups that come up with different volumes for identical objects. Ask the students to come up with explanations for these discrepancies. Ask the students to clarify their explanations and justify, if they can, why one method of finding volume may be more accurate or appropriate than another.

As the students are reporting their results and discussing any discrepancies and observations they have made, the teacher should record student vocabulary on the board/overhead. This will be used in the next phase.

Vocabulary Building

Begin to look for terms that are inappropriate or naïve in usage. Encourage students to use terms such as length, width, surface area and volume correctly. Rather than giving definitions, ask clarifying questions about what they mean when they say an object has a certain volume. Ask if the volume of regular objects in any way different from the volume of unusual or irregular objects and if it is, why they think so.

Evaluation of Explanation

The teacher should use the rubric below for appropriate use of terms and demonstration of different methods of determining volume:

CATEGORY	4	3	2	1
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Vocabulary	Uses vocabulary appropriate for the audience. Extends audience vocabulary by defining words that might be new to most of the audience.	Uses vocabulary appropriate for the audience. Includes one to two words that might be new to most of the audience, but does not define them.	Uses vocabulary appropriate for the audience. Does not include any vocabulary that might be new to the audience.	Uses several (five or more) words or phrases that are not understood by the audience.

D. Elaboration

New Information and New Problems to Solve

1. Present the students with a new task to solve, "Finding the Volume of the Blimp."
2. Explain to the students that there are many approaches that may be used to find the volume of the blimp. What you are interested in is how they would measure or calculate the volume.
3. Provide time and materials necessary for the students to work out their own procedure for measuring the volume of the blimp.
4. Plan for students to create scale models or diagrams of the blimp to use in their work. You may want to provide graph paper, glue and scissors for this part of the lesson.

Evaluation of Elaboration

Ask students to exchange their models and procedures with one other group to obtain a peer check of their work before presenting their approach to the rest of the class.

E. Final Assessment

Use Appendix B: Post-Test to evaluate students.

Tools and Resources

It's a Gas #4: Surface and Volume Video
CD-ROM or a computer with Internet access
TV and VCR
Observation log/lab book
String
Tape measures and meter sticks
Various three-dimensional objects to include
- Sphere
- Cube
- Rectangular prism
- Cylinder

Volumetric beaker
Graduated cylinder
Pan or electric balance
Calculator

Classroom Management

Suggested time frame for this lesson is four class periods
One class period each for The Blimp Inflates, Pre-Test, and viewing the video.
One class period to collect data and find volume.
Two class periods for seminar, vocabulary building and new problems to solve.

Student Groupings

All activities should be done in groups of five.

Appendix A: Volume Pre-Test Questions

1. What description would you use for the concept of volume?
    a. The distance between telephone poles.
    b. The surface contained on a tabletop.
    c. The space occupied by a cereal box.

2. What units of measure should be attached to a volume measurement?
    a. Meters
    b. Square meters
    c. Cubic meters

3. How would you calculate the volume of a cube or a rectangular prism?
    a. Find the product of length and width.
    b. Find the product of length, width and height.
    c. Divide the mass by the product of length, width and height.

4. How would you find the volume of a balloon?
    a. Look up the formula for volume of a sphere.
    b. Sink the balloon in water and measure the displacement of water that takes place.
    c. Measure how much air is used to inflate the balloon.

Do you know what volume is? Write a definition.

Explain how to find the volume of some object.

Appendix B: Volume Post-Test Questions

1. Which of the following is a description of volume?
    a. The distance or separation between two objects.
    b. The surface contained within a set of lines.
    c. The amount of space occupied by a three-dimensional shape.

2. Of the following units, which would be applied to a measurement of volume?
    a. m
    b. m^2
    c. m^3

3. Which of the following formulae is used for finding the volume of a cube?
    a. l x w
    b. l x w x h
    c. m/(l x w x h)

4. Which of the following descriptions explains how to find the volume of an object?
    a. Determine the overall shape and apply the appropriate formula.
    b. Submerge the object in water and record the amount of overflow.
    c. Fill the object with a known volume of a liquid or gas.
    d. All of the above

Can you give a definition of volume?

Can you explain two ways to find the volume of some object?

Pre-Test Questions (Answer Key)

1. What description would you use for the concept of volume?
   c. The space occupied by a cereal box.

2. What units of measure should be attached to a volume measurement?
   c. Cubic meters

3. How would you calculate the volume of a cube or a rectangular prism?
   b. Find the product of length, width and height.

4. How would you find the volume of a balloon?
   b. Sink the balloon in water and measure the displacement of water that takes place.

Do you know what volume is?
   Students should equate volume with the space an object occupies.

Can you explain how to find the volume of some object?
   For regular shapes you can use mathematical formulae. For irregular shapes, you either submerge and measure liquid displacement or measure the amount of liquid or gas that is used to fill the object.

Post-Test Questions (Answer Key)

1. Which of the following is a description of volume?
   c. The amount of space occupied by a three-dimensional shape.

2. Of the following units, which would be applied to a measurement of volume?
   c. m3

3. Which of the following formulae is used for finding the volume of a cube?
   b. l x w x h

4. Which of the following descriptions explains how to find the volume of an object?
   d. all of the above

Can you give a definition of volume?
   Students should equate volume with the space an object occupies.

Can you explain two ways to find the volume of some object?
   For regular shapes you can use mathematical formulae. For irregular shapes, you either submerge and measure liquid displacement or measure the amount of liquid or gas that is used to fill the object.

Appendix D: Construction of an overflow Can

1. Take the top off of a 2L clear plastic soda bottle.
2. Use a paper punch to make a hole in the side ¾ to 1 inch from the top edge.
3. Cut off a 1" length of a plastic soda straw.
4. Insert the straw section into the hole about half its length.
5. Apply a generous amount of rubber cement around the straw on the inside of the soda bottle.
6. Carefully pull the straw out until there is only a small part of it intruding into the bottle.
7. Tip the straw slightly downward to encourage it to drain.
8. Once the cement has set, you fill the bottle until it starts to overflow through the straw.
9. Once the straw stops dripping, you can place a graduated cylinder or beaker under the straw spout, submerge objects, and catch and measure the overflow.

That's all there is to it. If you have a budget, you may also purchase overflow cans from the various science equipment supply houses.

It's a Gas!

Math & Science of the Blimp

Lesson 6
Structure of Matter

Structure of Matter Quick Tour

Author: Dan Rooney, Canton City Schools
Target Audience: 8th and 9th grade science

Key Lesson Overview

Students will utilize data from the periodic table to draw atomic models and identify elements that could be used in lighter-than-air craft.

Key Standard Addressed

Investigate various standard classification systems.

Procedure

Suggested time frame for this lesson is five class periods.

1. Watch **It's a Gas #5: Structure of Matter**
2. Discuss the nature of matter and its properties.
3. Have the students watch an ice cube melt and lead a discussion on what they observe, specifically about liquids, solids, and gasses.
4. Students apply the information presented thus far by responding to statements on Appendix A: Structure of Matter.
5. Students explore and process data from the periodic table using Appendices B, C and D.
6. Students take a pencil and paper test to determine understanding. See Appendix E: Summary Questions.
7. Small groups compose short essays that discuss similarity in atomic structure, patterns in atomic models, reactivity and families of atoms. See Appendix F: Periodic Chart Essays.
8. Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to view the makeup and weight of different gases.
9. Students respond to two prompts on why properties of atoms are important to blimp technology. See Appendix G: Which Gas is Best?
10. A paper and pencil test will be given to gauge student understanding. (See Appendix H: Structure of Matter Test)

Tools/Resources

- **It's a Gas #5: Structure of Matter**
- CD-ROM or a computer with Internet access
- VCR and TV
- Periodic table

Assessment

Student discussions, observations, written materials and pencil and paper tests will be used to assess student success. Answer keys are included as Appendix I.

Learner Objectives

The students will:

1. Identify data in the periodic table such as atomic number, mass number, group number and the period.
2. Utilize data from the periodic table to draw atomic models, and apply the mass number to identify elements that could be used in lighter-than-air craft.
3. Be able to utilize atomic models to make predictions about an element's reactivity. These predictions are made by making observations on the number of electrons in the outer orbits of an atom (valence shell).
4. Be able to apply the concepts to explain why blimps use helium rather than hydrogen.

Curriculum and Proficiency Standards Addressed

The students will:

1. Relate uses, properties, and chemical processes (reactions) of matter to the behavior and/or arrangements of small particles, which compose matter.
2. Investigate various standard classification systems.
3. Translate information from one form to another.
4. Summarize the data in several meaningful ways when given a set of data on an event or phenomenon.
5. Investigate composition and level of organization of objects and organizations.
6. Investigate models and theories that help explain the interactions of compounds in systems.
7. Demonstrate understanding that equal volumes of different substances often have different masses.
8. Use graphs, tables and charts to study physical phenomena and infer relationships.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Use keyboards and other common input and output devices efficiently and effectively.
2. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
3. Use technology resources for solving problems and making informed decisions.

Video Synopsis

Abby and Trista try to figure out why helium is used to fill the blimp. Abby demonstrates how an ice cream sundae can be used to model the building blocks of matter. They interview a college professor to find out why some gases are lighter than others.

After the interview, they decide to find out what gases have been used for lighter-than-air craft. In the interview at the Lighter-Than-Air Society they discover that coal gas (hot air), methane, hydrogen and helium have all been used to create lift.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)
Students are presented with a giant bell jar with a scale inside. The bell jar contains a vacuum. They place containers of 1,000 cubic feet of different gases on the scale to determine their weight. The gases weighed are air, oxygen, nitrogen, helium and hydrogen.

Learning strategies

A. Engagement

After watching **It's a Gas #5: Structure of Matter**, guide the students in a discussion about the nature of matter and its properties. Reflect on the characteristics of common substances that are found in our daily lives. Students will brainstorm properties of some objects presented to them. These properties can be divided into chemical and physical properties. While sorting out these properties reinforce the following concepts:

- Solids have definite volume, definite size and shape and do not take the shape of their container.
- Liquids have a definite volume, no definite shape and take the shape of their container.
- Gases have no definite volume, no definite shape and take the shape of their container.

Watching Ice Melt

Following the discussion, students will examine an ice cube over a period of time. The instructor will guide a discussion based on the following:

- What state or phase is the ice in? (at first, solid)
- How can you tell that it is in the solid state? (definite shape and size)
- How can you change the ice into a liquid? (increase temperature)
- How will you be able to tell the when the ice is a liquid? (no definite shape)
- How can you change the liquid back into a solid? (lower the temperature)
- How can the liquid be changed into a gas? (increase the temperature above 212º F or 100º C)
- How can you tell the liquid is a gas? (water vapor gas is not visible, water will disappear)
- Does gas have a definite size or shape? (no)
- How can you change a gas into a liquid? (lower the temperature)

Evaluation of Engagement

After watching the video and doing the melting ice cube activity students will answer the questions in Appendix A: Structure of Matter.

B. Exploration

Students will explore and process data from the periodic table.

1. Identify data on the periodic table such as atomic number, mass number, group number and the period. The periodic table will be used in this section along with worksheets to look up information.
2. Utilize the data listed above and apply it through construction of atomic models. Students will process the data from the worksheets constructing these atomic models (see Appendix B: Processing Periodic Table Data). Students will construct atomic models from four different families of elements. These families are Nobel Gases, Halogens, Alkali Metals and Alkaline Earth Metals. Students will construct these atomic models on a worksheet organized with these categories (see Appendix C: Atomic Model Activity).
3. Students will identify families of the periodic table by producing a color key on periodic table worksheet (see Appendix D: Periodic Table Families).

Evaluation of Exploration

A paper and pencil test will be used to judge student understanding (see Appendix E: Summary Questions).

C. Explanation:

In small groups, students will cooperatively write short essays that answer the questions in Appendix F: Periodic Chart Essays.

Evaluation of Explanation

See Appendix G for answer key. The following rubric can also be used:

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Comprehension	Student is able to accurately answer almost all questions posed by classmates about the topic.	Student is able to accurately answer most questions posed by classmates about the topic.	Student is able to accurately answer a few questions posed by classmates about the topic.	Student is unable to accurately answer questions posed by classmates about the topic.
Collaboration with peers	Almost always listens to, shares with and supports the efforts of others in the group. Tries to keep people working well together.	Usually listens to, shares with and supports the efforts of others in the group. Does not cause "waves" in the group.	Often listens to, shares with and supports the efforts of others in the group but sometimes is not a good team member.	Rarely listens to, shares with and supports the efforts of others in the group. Often is not a good team member.

D. Elaboration

Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to view the makeup and weigh different gasses. Using electron configurations and element families, they should demonstrate why helium rather than hydrogen is used in the blimp.

Evaluation of Elaboration:

Students will respond to two prompts on why properties of atoms are important to blimp technology. They will be expected to incorporate concepts from previous sections into their essay in support of their conclusions. See Appendix G: Which Gas is Best?

E. Final Assessment

A paper and pencil test will be given to gauge student understanding. See Appendix H: Structure of Matter Test.

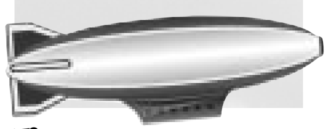
Tools/Resources

Periodic table
It's a Gas #5: Structure of Matter video
CD-ROM or a computer with Internet access
TV & VCR

Classroom Management

Suggested time frame for this lesson is five class periods.

- One period for instruction video & classroom Pre-Test activity.
- One period for periodic table processing activities.
- One period for drawing atomic models.
- One period for learning how to identify elements reactivity, CD-ROM interactive programs to reinforce activities.
- One period for evaluation.



There are several elements, including helium, present in some natural gas wells. The manufacturing process can extract the helium because each element in natural gas freezes at a different temperature. Helium has the lowest freezing temperature.

The following statements explain how helium is purified:

1. The natural gas is refrigerated to bring about a change in each element's form.

2. Once all the other elements have been frozen the pure helium is drawn off and put into tanks.

Based on your observations of a melting ice cube, use the terms solid, liquid and gas to rewrite the above statements.

Appendix B: Processing Periodic Table Data

Name ________________________

Key terms

1. Atomic number:

2. Mass number:

3. Group number:

4. Period:

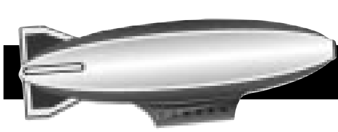
5. Protons:

6. Neutrons:

7. Electrons:

Use your periodic table to fill in the table

Element	Atomic Number	Mass Number	Group Number	Period	Protons	Neutrons	Electrons
Oxygen (O)							
Sulfur (S)							
Fluorine (F)							
Chlorine (Cl)							
Neon (Ne)							
Argon (Ar)							
Lithium (Li)							
Sodium (Na)							
Magnesium (Mg)							
Calcium (Ca)							



Name ____

Lithium (Li)	Magnesium (Mg)
Neon (Ne)	Fluorine (F)

Sodium (Na)	Chlorine (Cl)
Argon (Ar)	Calcium (Ca)

Name ____

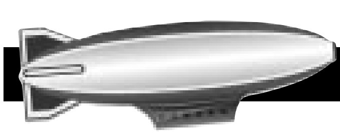
12 Mg 24.31	← Atomic number ← Chemical symbol ← Atomic weight

Ia																	0
1 H 1.008	IIa											IIIa	IVa	Va	VIa	VIIa	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.00	8 O 15.99	9 F 18.99	10 Ne 20.18
11 Na 22.99	12 Mg 24.31	IIIb	IVb	Vb	VIb	VIIb	⊢——	VIII	——⊣	Ib	IIb	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.6	22 Ti 47.9	23 V 50.94	24 Cr 51.99	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 99	44 Ru 101.97	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57-71 see below	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89-103 see below	104 Rf 261	105 Db 262	106 Sg 263												

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 147	62 Sm 150.35	63 Eu 151.96	64 Gd 157.24	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
89 Ac 227	90 Th 232.04	91 Pa 231	92 U 238.03	93 Np 237	94 Pu 242	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 249	99 Es 254	100 Fm 253	101 Md 256	102 No 254	103 Lr 257

Produce a color key for the following families:

- ☐ - Alkali Metals – Li, Na, K, Rb, Cs, Fr
- ☐ - Alkaline Earth Metals – Be, Mg, Ca, Sr, Ba, Ra
- ☐ - Oxygen Family – O, S, Se
- ☐ - Halogen Family - F, Cl, Br, I
- ☐ - Noble Gas Family - He, Ne, Ar, Kr, Xe, Rn



Appendix E: Summary Questions

Name ____

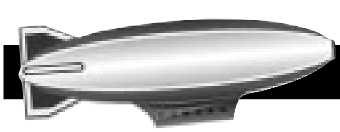
1. Analyze the electron configuration for the models of sodium (Na) and lithium (Li). How are they similar?

2. Analyze the electron configurations for the models of chlorine (Cl) and fluorine (F). How are they similar?

3. Compare models of calcium (Ca) and magnesium (Mg). Also, compare argon (Ar) with neon (Ne). How are these models similar?

4. The models of the elements in the above questions are in the same family of elements. How can the information be used as a tool in science?

5. How are atomic models in the same family of elements similar?



Appendix F: Periodic Chart Essays

Write short essays in response to the following questions:

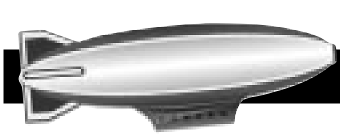
1. When analyzing the atomic models from the same family explain the similarity in atomic structure.

2. When analyzing atomic models from reactive families (e.g., halogen family) and unreactive families (e.g. noble gases) explain the patterns in the arrangement of the elements in the atomic models.

3. Explain why one atom is more reactive than another atom.

4. Explain how atomic structure is involved with reactivity.

5. Why do atoms of the same family behave similarly?

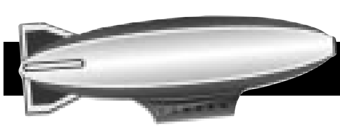


Appendix G: Which Gas is Best?

Write a short essay in response to the following statements:

1. Using electron configurations and element families, why is helium rather than hydrogen used in the blimp?

2. Why are properties of atoms important to blimp technology?

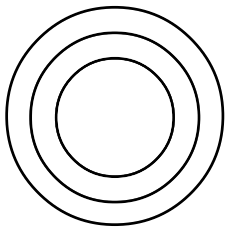


Appendix H: Structure of Matter Final Test

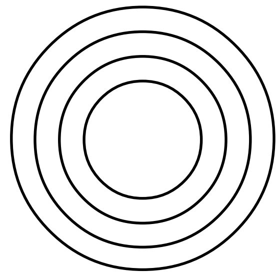
Name ____

1. Construct the atomic models for chorine (Cl) and bromine (Br).

   a) Chlorine Model

   b) Bromine Model

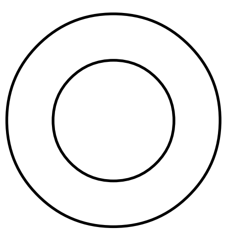
   

   c) How are these atomic models similar?

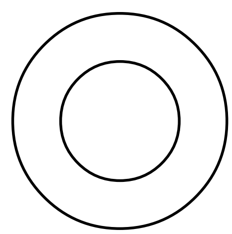
   d) What properties (reactivity) do these elements contain due to the electron configuration?

2. Construct the atomic models for fluorine (F) and neon (Ne).

   a) Fluorine Model

   b) Neon Model

   c) How are these models different?

   d) The properties (reactivity) for these elements are different. Explain why those properties are different in terms of electron configuration.

Appendix 1: Structure of Matter Pre-Test

Name ____

True or False: Place a “T” in the blank if the statement is true and “F” if the statement is false.

_____ 1. Hydrogen gas is used in the Goodyear Blimp.

_____ 2. The reactivity of elements is based on the size and charge of the nucleus.

_____ 3. Protons contain a positive charge.

_____ 4. Neutrons are negative.

_____ 5. The atomic number is used to determine the number of orbits that contain electrons.

_____ 6. The periods are horizontal rows on the periodic table.

_____ 7. Protons and electrons repel each other.

_____ 8. The group number is used to determine the number of electrons on the outer orbit.

_____ 9. Metals are found on the bottom of the periodic table while non-metals are near the top.

_____ 10. The elements in the halogen family are reactive.

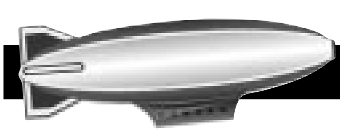
_____ 11. The noble gas family of elements is reactive.

_____ 12. Atomic models are arranged in a similar manner to the solar system.

_____ 13. Helium is chemically very reactive.

_____ 14. Different elements contain the same number of electrons.

_____ 15. Patterns of neutrons are used to determine the reactivity.



Appendix I: Structure of Matter Post-Test

Name ____

True or False: Place a "T" in the blank if the statement is true and "F" if the statement is false.

_____ 1. Patterns of neutrons are used to determine the reactivity.

_____ 2. Neutrons are negative.

_____ 3. Helium is chemically very reactive.

_____ 4. Hydrogen gas is used in the Goodyear Blimp.

_____ 5. Protons contain a positive charge.

_____ 6. Different elements contain the same number of electrons.

_____ 7. The reactivity of elements is based on the size and charge of the nucleus.

_____ 8. The atomic number is used to determine the number of orbits that contain electrons.

_____ 9. Atomic models are arranged in a similar manner to the solar system.

_____ 10. The elements in the halogen family are reactive.

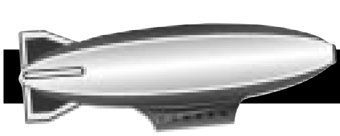
_____ 11. Protons and electrons repel each other.

_____ 12. The periods are horizontal rows on the periodic table.

_____ 13. The group number is used to determine the number of electrons on the outer orbit.

_____ 14. The noble gas family of elements is reactive.

_____ 15. Metals are found on the bottom of the periodic table while non-metals are near the top.



Appendix A: Answer Key

1. The natural gas is refrigerated to bring about a change in each element's form.
   The natural gas is refrigerated to change the elements from a gas to a liquid and then to a solid.
2. Once all the other elements have been frozen, the pure helium is drawn off and put into tanks.
   Once all the other elements have been frozen solid, the pure helium is the only gas left so it can be drawn off and put into tanks.

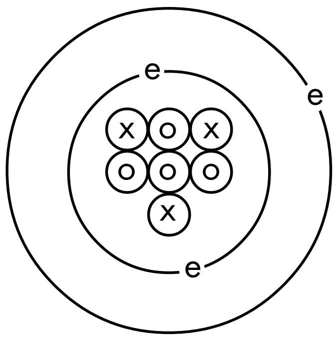
Appendix B: Answer Key

1. **Atomic number:** Refers to the number of protons and electrons in an atom.
2. **Mass number:** Refers to the number of particles in the nucleus (sum of protons and neutrons).
3. **Group number:** The number located on the top of the group of elements. The roman numerals refer to the number of electrons on the outer orbit of the atom. This number refers to the reactivity of the element.
4. **Period:** The horizontal rows on the periodic table that indicate the number of orbits (or levels) of electrons that surround the nucleus.
5. **Protons:** The positive particles found in the nucleus of an atom.
6. **Neutrons:** Particles that are found in the nucleus and have no charge.
7. **Electrons:** These particles are negative and are very small in comparison to protons and neutrons. These particles revolve around the nucleus at very high speeds.

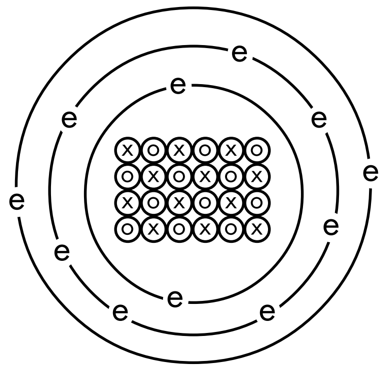
Element	Atomic Number	Mass Number	Group Number	Period	Protons	Neutrons	Electrons
Oxygen (O)	8	16	6	2	8	8	8
Sulfur (S)	16	32	6	3	16	16	16
Fluorine (F)	9	19	7	2	9	10	9
Chlorine (Cl)	17	35	7	3	17	18	17
Neon (Ne)	10	20	8	2	10	10	10
Argon (Ar)	18	40	8	3	18	22	18
Lithium (Li)	3	7	1	2	3	4	3
Sodium (Na)	11	23	1	3	11	12	11
Magnesium (Mg)	12	24	2	3	12	12	12
Calcium (Ca)	20	40	2	20	20	20	20

Appendix C: Answer Key

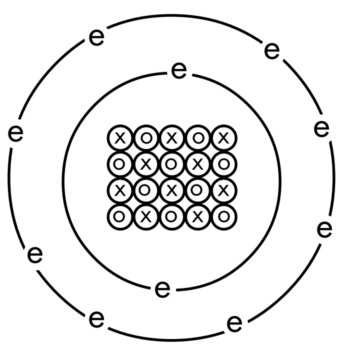
Lithium (Li)



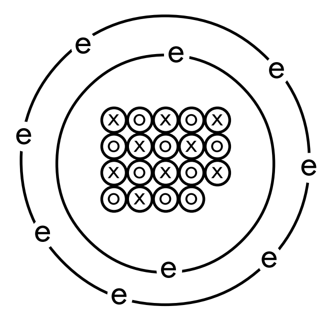
Magnesium (Mg)



Neon (Ne)

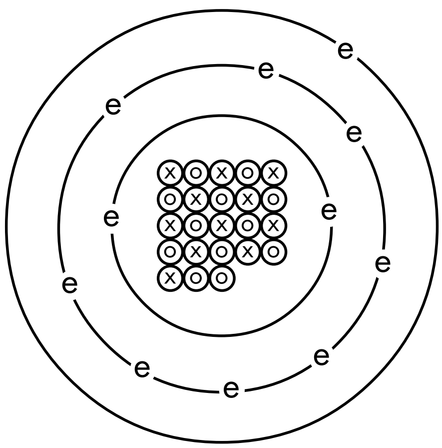


Fluorine (F)

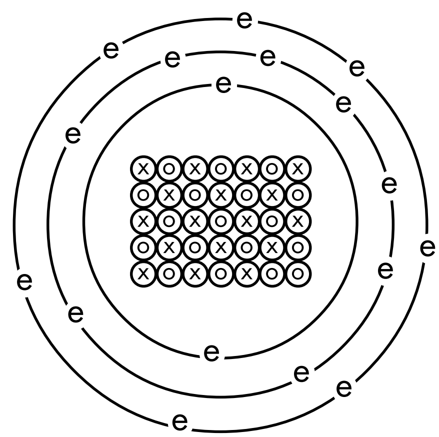


Structure of Matter

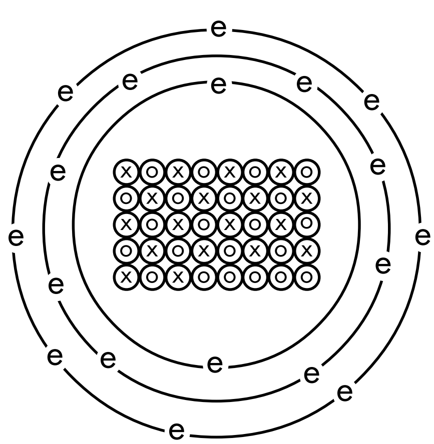
Sodium (Na)



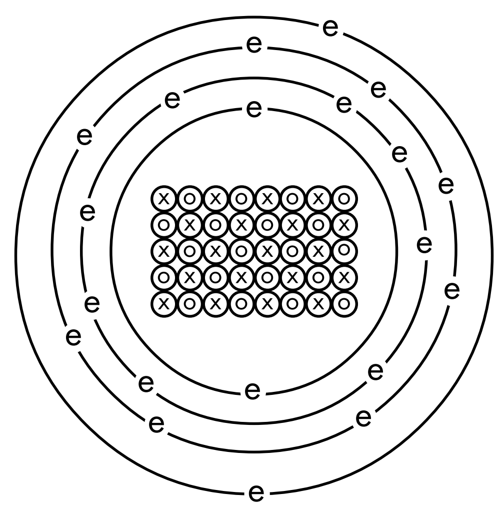
Chlorine (Cl)



Argon (Ar)



Calcium (Ca)



Appendix D: Periodic Table Families

12 Mg 24.31	← Atomic number ← Chemical symbol ← Atomic weight

Ia Alkali Metals	IIa Alkaline Earth Metals	IIIb	IVb	Vb	VIb	VIIb	VIII	VIII	VIII	Ib	IIb	IIIa	IVa	Va	VIa Oxygen Family	VIIa Halogen Family	0 Noble Gas Family
1 H 1.008																	2 He 4.00
3 Li 6.94	4 Be 9.01											5 B 10.81	6 C 12.01	7 N 14.00	8 O 15.99	9 F 18.99	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.6	22 Ti 47.9	23 V 50.94	24 Cr 51.99	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.71	29 Cu 63.54	30 Zn 65.37	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.91	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc 99	44 Ru 101.97	45 Rh 102.91	46 Pd 106.4	47 Ag 107.87	48 Cd 112.40	49 In 114.82	50 Sn 118.69	51 Sb 121.75	52 Te 127.60	53 I 126.90	54 Xe 131.30
55 Cs 132.91	56 Ba 137.34	57-71 see below	72 Hf 178.49	73 Ta 180.95	74 W 183.85	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.09	79 Au 196.97	80 Hg 200.59	81 Tl 204.37	82 Pb 207.19	83 Bi 208.98	84 Po 209	85 At 210	86 Rn 222
87 Fr 223	88 Ra 226	89-103 see below	104 Rf 261	105 Db 262	106 Sg 263												

57 La 138.91	58 Ce 140.12	59 Pr 140.91	60 Nd 144.24	61 Pm 147	62 Sm 150.35	63 Eu 151.96	64 Gd 157.24	65 Tb 158.92	66 Dy 162.50	67 Ho 164.93	68 Er 167.26	69 Tm 168.93	70 Yb 173.04	71 Lu 174.97
89 Ac 227	90 Th 232.04	91 Pa 231	92 U 238.03	93 Np 237	94 Pu 242	95 Am 243	96 Cm 247	97 Bk 247	98 Cf 249	99 Es 254	100 Fm 253	101 Md 256	102 No 254	103 Lr 257

Produce a color key for the following families:

- Alkali Metals – Li, Na, K, Rb, Cs, Fr
- Alkaline Earth Metals – Be, Mg, Ca, Sr, Ba, Ra
- Oxygen Family – O, S, Se
- Halogen Family - F, Cl, Br, I
- Noble Gas Family - He, Ne, Ar, Kr, Xe, Rn

Appendix E: Answer Key

1. Analyze the electron configuration for the models of sodium (Na) and lithium (Li). How are they similar?
   Both have an electron on the outer orbit.

2. Analyze the electron configurations for the models of chlorine (Cl) and fluorine (F). How are they similar?
   Both have seven electrons on the outer orbit.

3. Compare models of calcium (Ca) and magnesium (Mg). Also, compare argon (Ar) with neon (Ne). How are these models similar?
   Ca/Mg both have two electrons on the outer orbit and form +2 charges.
   Ar/Ne contain two electrons on the outer orbit and do not gain or lose electrons. Therefore they are neutral.

4. The models of the elements in the above questions are in the same family of elements. How can the information be used as a tool in science?
   Elements in the same verticle column contain the same number of electrons in the outer orbit. Therefore, these elements have the same charge. One can make predictions about an element's charges in forms based on what group it is in.

5. How are atomic models in the same family of elements similar?
   Atomic models in the same family contain the same number of electrons in the outer orbit.

Appendix F: Answer Key

1. When analyzing the atomic models from the same family explain the similarity in atomic structure?
   They all have the same number of electrons on the outer orbits.

2. When analyzing atomic models from reactive families (e.g. halogen family) and un-reactive families (e.g. noble gases) explain the patterns in the arrangement of the elements in the atomic models?
   The un-reactive elements contain full outer electron orbits. That is, they have eight electrons on the outer orbit, except helium which only has two electrons on its outer orbits. On the other hand, reactive metals that contain one or two electrons on the outer orbit like the alkali metals lose electrons to form positive charges. The halogen reactive non-metals contain seven electrons and they have a strong tendency to gain one electron to form a negative charge.

3. Explain why one atom is more reactive than another atom.
   An atom with seven electrons on the outer orbit is more reactive than an atom with five or six electrons. It's easier to gain one electron to fill the orbit than to gain two or three electrons. An atom with one electron on its outer orbit is more reactive than an atom with two or three electrons on its outer orbits. It's easier to lose one electron than to lose two or three electrons. Atoms that have eight electrons on the outer orbit are unreactive. They have no desire to gain or lose electrons.

4. Explain how atomic structure is involved with reactivity.
   The outer electron orbits are responsible for the elements' reactivity. Atoms either need to gain or lose electrons to have an outer orbit that is filled to its capacity or has eight electrons.

5. Why do atoms of the same family behave similarly?
   Atoms of the same family have the same number of electrons on the outer orbits. They either lose electrons (form positive charges), gain electrons (form negative charges, or have the right amount of electrons which is eight. (Exception of helium which has two, but the single orbit is filled to its capacity).

Appendix G: Answer Key

1. Using electron configurations and element families, why is helium rather than hydrogen used in the blimp?

   Helium is used in the blimp rather than hydrogen because helium is unreactive. Hydrogen has only one electron on its outer orbit and is very reactive. Helium has two electrons on its outer orbit and the single orbit has a capacity to hold only two electrons. Helium has no desire to gain or lose electrons and is unreactive.

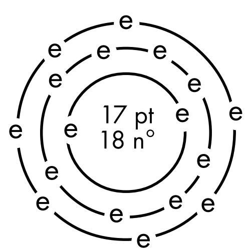
2. Why are properties of atoms important to blimp technology?

   For blimp technology, properties are very important because one needs to use elements that contain the least mass or weight, which enhance lifting capacity. Elements that are least reactive are important due to safety.

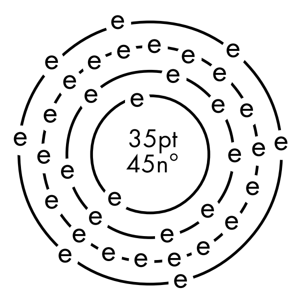
Appendix H: Answer Key

1. Construct the atomic models for chorine (Cl) and bromine (Br).

   a) Chlorine Model



   b) Bromine Model



   e) How are these atomic models similar?

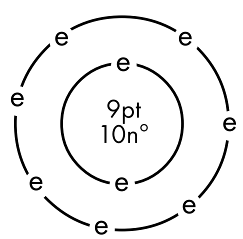
   Both have seven electrons on the outer orbits.

   f) What properties (reactivity) do these elements contain due to the electron configuration?

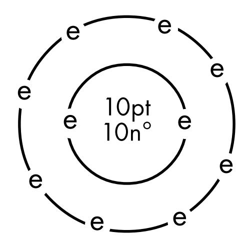
   Form –one charge by gaining one electron on the outer orbit.

2. Construct the atomic models for fluorine (F) and neon (Ne).

   a) Fluorine Model



   b) Neon Model



   c) How are these models different?

   Fluorine has seven electrons on the outer orbit, neon has eight electons on the outer orbit (filled to capacity). Fluorine forms a –1 charge, neon is unreactive.

   d) The properties (reactivity) for these elements are different. Explain why those properties are different in terms of electron configuration.

   Fluorine is one electron short of filling to its capacity. Neon has eight electrons in outer orbit; it is filled to its capacity.

Appendix I: Pre-Test Answer Key

F I. Hydrogen gas is used in the Goodyear Blimp.
F 2. The reactivity of elements is based on the size and charge of the nucleus.
T 3. Protons contain a positive charge.
F 4. Neutrons are negative.
F 5. The atomic number is used to determine the number of orbits that contain electrons.
T 6. The periods are horizontal rows on the periodic table.
F 7. Protons and electrons repel each other.
T 8. The group number is used to determine the number of electrons on the outer orbit.
F 9. Metals are found on the bottom of the periodic table while non-metals are near the top.
T 10. The elements in the halogen family are reactive.
F 11. The noble gas family of elements is reactive.
T 12. Atomic models are arranged in a similar manner to the solar system.
F 13. Helium is chemically very reactive.
F 14. Different elements contain the same number of electrons.
F 15. Patterns of neutrons are used to determine the reactivity.

Post-Test Answer Key

F 1. Patterns of neutrons are used to determine the reactivity.
F 2. Neutrons are negative.
F 3. Helium is chemicallyvery reactive.
F 4. Hydrogen gas is used in the Goodyear Blimp.
T 5. Protons contain a positive charge.
F 6. Different elements contain the same number of electrons.
F 7. The reactivity of elements is based on the size and charge of the nucleus.
F 8. The atomic number is used to determine the number of orbits that contain electrons.
T 9. Atomic models are arranged in a similar manner to the solar system.
T 10. The elements in the halogen family are reactive.
F 11. Protons and electrons repel each other.
T 12. The periods are horizontal rows on the periodic table.
T 13. The group number is used to determine the number of electrons on the outer orbit.
F 14. The noble gas family of elements is reactive.
F 15. Metals are found on the bottom of the periodic table while non-metals are near the top.

It's a Gas!

Math & Science of the Blimp

Lesson 7
Gas Laws

Author: Wendy Meek, Sebring Local Schools
Target Audience: 8th or 9th grade science

Key Objective

Students will determine how air pressure and temperature affect a gas within a container.

Key Standard Addressed

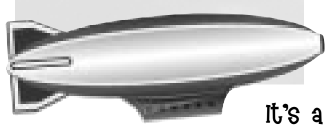
Use mathematical models to predict natural phenomena.

Procedure

Suggested time frame for this lesson is five class periods.

Construction of scientific apparatus is required for this lesson. See page 98 for instructions.

1. Discuss questions dealing with gas pressure. Appendix A: Engagement Questions.
2. View **It's a Gas #6: Gas Laws** and the segment of **It's a Gas #10: Weather** describing the effect of temperature and atmospheric pressure on the blimp.
3. Students record their observations on Appendix B: Data Sheets for items 4-9:
4. Students place a partially blown up a balloon under a heat lamp and then in a cold-water bath so it expands and contracts.
5. The teacher places a metal cylinder with a rubber stopper inserted over a heat source. The students will observe the stopper pop out of the can after several minutes.
6. Using a large glass jar containing an elastic balloon, compare the pressure before any air is pumped into the container and then after.
7. Students put water and Alka Seltzer in a plastic film canister and snap on the lid. Students will observe the lid pop off the canister.
8. Inflate the elastic balloon within the large glass jar and then add air to the jar so students will observe the balloon getting smaller.
9. Open the valve to the jar and let the air out. Students will observe the balloon get larger. **Point out that the elastic balloon models what happens to the helium gas within the blimp as it changes altitude. The jar represents the atmosphere around the helium.**
10. Lead a discussion about the observations recorded on the data sheet and infer the cause of each observation. See Appendix G: Answer Key.
11. Using the jar containing the non-elastic inflatable containing some air, increase and decrease the amount of air in the jar to demonstrate that it does not affect the non-elastic inflatable. **Point out that the non-elastic inflatable represents what happens to the envelope of the blimp as it changes altitude**.
12. Lead a discussion of the role of the ballonets in maintaining constant pressure within the blimp. As the blimp ascends, air pressure decreases and helium volume tries to increase against the non-elastic walls. As the pressure inside increases, the pilot releases air from the ballonets, decreasing the number of particles contained inside the envelope, which decreases the pressure inside. The process is reversed when the blimp descends.
13. Demonstrate how to write formulas that show direct and indirect relationships.
14. Students complete the Appendix C: Equations Worksheet in which they relate their findings to the operation of the blimp.
15. Students use the CD-ROM activity to practice maintaining blimp inflation by controlling air in the ballonets.
16. Students complete Appendix D: Math Problems Worksheet and Appendix E: Word Problem, using formulas to solve problems.
17. Students take a written exam. See Appendix F: Final Test.



Tools/Resources

It's a Gas #6: Gas Laws and **It's a Gas #10: Weather**
CD-ROM or computer with Internet access
VCR and TV
String
Tape measures and meter sticks
Various three-dimensional objects
Volumetric beaker
Graduated cylinder
Pan or electric balance
Calculator
Gas Laws apparatus (teacher construction required)
Bicycle tire pump with pressure gauge

Assessment

See Appendix G for worksheet and testing answer keys

Learning Objectives

The students will:

1. Explain that heating a gas causes the particles to move faster and hit the walls with more force (microscopic) causing:
   a. An increase in the pressure within a fixed container (macroscopic).
   b. An increase in the volume of an elastic container (macroscopic).
2. Describe the result of differences in gas pressure on either side of a container's walls:
   a. If the pressure on either side of the container is the same, there will be no change.
   b. If the internal gas pressure is less than the outside gas pressure, the container's volume will decrease until its internal pressure rises to the outside pressure.
   c. If the internal gas pressure is greater than the outside gas pressure, an elastic container will expand (increase in volume) until its internal pressure lowers to that of the outside pressure.
   d. If the internal gas pressure is greater than the strength of a rigid container's walls plus the outside pressure, then the container will explode to reduce the pressure.
3. Mathematically express the relationship among: number of particles and pressure, pressure and volume, number of particles and volume, pressure and temperature, volume and temperature.

Curriculum and Proficiency Standards Addressed

The students will:

1. Relate uses and properties of matter to the small particles that compose it.
2. Conceptually describe the effect of forces on an object.
3. Design a physical model and conduct an investigation to formulate scientific principles.
4. Identify dependent and independent variables.
5. Draw valid conclusions based on evidence from investigations.
6. Distinguish between observation and inference.
7. Use mathematical models to predict natural phenomenon.
8. Round the results of calculator operations to the proper number of significant figures.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
2. Use technology resources for solving problems and making informed decisions.

Video Synopsis

Trista and Abby try to figure out what the ballonets (pronounced bal - o – naze) do inside the blimp. They interview a blimp pilot and discover they are used to overcome the effects of pressure and heat (gas laws) on the blimp.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)

Given a control board with instrument readings, students must control the blimp's air ballonets to maintain proper inflation.

Learning strategies

A. Engagement

Distribute a paper lunch sack to each student and have them tear a piece of paper into seven strips. As you ask a series of questions, the students write the answers on a paper slip and deposit it into the paper sack. After answering all the questions, the class discusses them and the correct responses are written on the board. When all questions have been discussed, the teacher erases the board and allows the students to make corrections to their responses in the paper sack. (Putting the answer in the sack is designed to prevent students from copying the correct answers from the board onto their paper slips.) See Appendix A: Engagement Questions.

Show **It's a Gas #6: Gas Laws** and a segment of **It's a Gas #10: Weather** (segment discusses how temperature and atmospheric pressure affect the blimp). After the videos, explain that students are going to investigate how changing certain conditions in the atmosphere would affect the blimp envelope if it had no ballonets. Review the conditions that can change for gases (volume, temperature, number of particles, pressure).

Evaluation of Engagement

Collect paper slips and check for understanding using Appendix G: Answer Key.

B. Exploration

Construction of a gas law experiment

Materials needed

- Two 1 gallon or larger glass bottles with metal screw on lids (school kitchen staff)
- Four tire valve stems (automotive supply store)
- Drill and drill bit the same diameter as valve stems (shop teacher or custodian)
- Clear packing tape
- Medium to large party balloons
- Non-elastic inflatable such as a beach ball, toy punching bag, whoopee cushion (toy section in department store)
- Silicone seal (hardware store)
- Bicycle tire pump with pressure gauge (department store)
- Optional: vacuum pump

Assembly

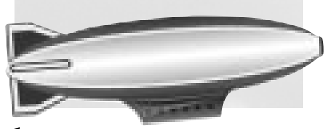
Drill two holes in the lid of each bottle (one hole placed in the center) and insert valve stems into each hole. To the center valve stem of one lid attach a party balloon and to the center valve stem of the second lid attach the non-elastic inflatable. Use the silicone to seal the lids onto the jars and allow it to dry overnight. Wrap the sides of the bottle with the clear packaging tape to prevent flying pieces if for any reason the bottle were to break.

Experiment and Demonstration Activities

After each activity students should record their findings on the Appendix B: Data Sheet. They should identify the independent variable, the dependent variable, whether each variable increased or decreased, and whether the two variables have a direct or indirect relationship.

Student Experiment

1. Partially blow up a balloon and then place it under a heat lamp. After the heat expands the balloon, place it in a cold-water bath so it contracts. This shows changes in the circumference of a balloon that is heated and cooled.



Answer for Data Sheet B

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
1 Balloon heated	Temp	Increase	Volume	Increase	Direct
Cause: When the balloon was placed under the heat source it got larger, so increasing temperature causes an increase in the volume of the gas. Temperature and volume are directly related. This is because increasing temperature of a gas causes the molecules to move faster, hit the walls harder and push out the elastic walls.					
1 Balloon cooled	Temp	Decrease	Volume	Decrease	Direct
Cause: When the balloon was placed in the cool water it got smaller, so decreasing temperature decreases the volume of a gas. Temperature and volume are directly related. Decreasing the temperature slows them down so that they do not hit the walls as hard and then the molecules on the outside push the walls in.					

Teacher Demonstration

2. Set up a ring and ring stand over a Bunsen burner. Place wire gauze on the ring and light the burner. Set a metal cylinder with a rubber stopper inserted into its open end onto the gauze. The students will observe the stopper pop out of the can after several minutes. Use tongs to handle the hot cylinder.

   Answer for Data Sheet B

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
2 Metal Container	Temp	Increase	Pressure	Increase	Direct
Cause: When the metal canister was heated, the stopper popped out. This is because increasing temperature increases the pressure of a fixed container. The pressure increased until the force inside the canister was great enough to overcome the force of friction between the stopper and the walls of the cylinder. Temperature and pressure are directly related because increasing temperature makes the gas molecules move faster and hit the walls with more force. This force is pressure.					

3. Pick up the bottle containing the elastic balloon. With the elastic balloon deflated, attach the air pump to the off-center valve and show students that the pressure gauge reads zero. Pump air into the bottle and show students that the pressure gauge now reads 10-15 psi. Release the air from the bottle.

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
3 Bottle with Elastic Balloon	Number of molecules	Increase	Pressure	Increase	Direct
Cause: When more air molecules were pumped into the bottle, the pressure inside the bottle increased, as shown by the gauge. The number of gas molecules and the pressure of a gas are directly related. More gas molecules result in more collisions with the walls and that increases the force on the walls.					

Student Experiment

4. To reinforce the concept in #3, put water and Alka Seltzer in a plastic film canister and snap on the lid. Students will observe the lid pop off the vial.

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
4 Plastic Film Canister	Number of molecules	Increase	Pressure	Increase	Direct
Cause: When more gas molecules were created by the reaction between the water and Alka Seltzer, the pressure inside the vial increased and popped off the lid. The number of gas molecules and the pressure of a gas are directly related. More gas molecules result in more collisions with the walls and that increases the force on the walls.					

Teacher Demonstration

5. Inflate the elastic balloon within the bottle using the air pump. Leave the balloon inflated.

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
5 Bottle with Elastic Balloon	Number of molecules	Increase	Pressure	Increase	Direct
Cause: When air was pumped into the balloon, the balloon got bigger. There is a direct relationship between the number of gas molecules and the volume of a gas. This is because more gas molecules result in more collisions with the walls and more force and that pushes out the balloon's elastic walls.					

6. Attach the pump to the off-center valve and add air to the bottle containing the inflated elastic balloon. Students will observe the balloon get smaller.

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
6 Bottle with Elastic Balloon	Number of molecules	Increase	Volume	Increase	Direct
Cause: When air was pumped into the bottle, the inflated balloon inside the bottle got smaller. There is an indirect relationship between pressure and volume of a gas. More gas molecules outside result in more pressure and that squeezes the molecules in the balloon closer together until they have a pressure equal to that of the outside.					

7. Open the valve to the bottle and let the air out of the bottle. Students will observe the balloon get larger. **Point out that the elastic balloon models what happens to the helium gas within the blimp envelope when conditions change.**

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
7 Bottle with Elastic Balloon	Pressure	Increase	Volume	Decrease	Indirect
Cause: When the air was released the balloon got bigger again. There is an indirect relationship between pressure and volume of a gas. When the air in the bottle was released, that decreased the pressure outside the balloon so as the molecules inside the balloon collided with each other they were able to spread apart until their pressure decreased to the outside pressure.					

Lead a discussion about the observations recorded on their data sheet and determine the cause of each observation.

Now pull out the bottle containing the non-elastic inflatable containing some air; increase and decrease the amount of air in the bottle (off-center valve) to see the effect of the atmosphere on the blimp envelope. **Point out that the non-elastic balloon represents what happens to the envelope of the blimp when conditions change**.

Lead a discussion of the role of the ballonets in maintaining constant pressure within the blimp. As the blimp ascends air pressure decreases, helium volume tries to increase against the non-elastic walls. As the pressure inside increases the pilot releases air from the ballonets, decreasing the number of particles contained inside the envelope, which decreases the pressure inside. The process is reversed when the blimp descends.

Evaluation of Exploration

Appendix G: Answer Key for Data Sheets

C. Explanation

Explain to students that a **direct variation** means that as one variable increases the resulting variable increases also. For example, the longer the faucet is open, the more water goes in a closed sink. **Indirect variation** means that if one variable increases, the resulting variable decreases. For example, the longer time a cup of coffee sits, the colder it gets (until it hits room temperature).

Demonstrate how to write formulas that show direct and indirect relationships:

Direct $\frac{X1}{X2} = \frac{Y1}{Y2}$ Indirect $\frac{X1}{X2} = \frac{Y2}{Y1}$

Use the temperature and volume relationship as an example: $\frac{T1}{T2} = \frac{V1}{V2}$

Ask students to complete Appendix C: Equations Worksheet in which they relate their findings to the operation of the blimp.

Evaluation of Explanation

Appendix G: Answers to Formulas Worksheet

D. Elaboration

Students use the CD-ROM activity to practice skill at maintaining blimp inflation by reading an instrument panel and controlling the amount of air in the ballonets. Ask students who have completed the flight successfully to assist those having difficulty.

Students complete Appendix D: Math Problems Worksheet, which asks students to use the formulas developed in the Explanation phase to solve math problems.

Students complete Appendix: E: Word Problem Worksheet which asks the students to use the formulas developed in the explanation phase to solve word problems.

Suggestion: write the correct answers to the worksheets on the board so students know they are solving correctly; stress to students they need to write down the letter equation, the equation with the numbers, and show how they cross multiply to find the unknown; since you are giving them the answer you are grading the solution and not the answer!

Evaluation of Elaboration

Appendix G: Answer Key for Worksheets #1 and #2

E. Final Evaluation:

Appendix F: Final Test

Tools/Resources

It's a Gas #6: Gas Laws and a segment of **It's a Gas #10: Weather**
TV and VCR
CD-ROM or computer with Internet access
Paper lunch bags (1 per student)
Ring stand with ring
Wire gauze
Bunsen burner
Metal canister with opening that will fit available rubber stopper
Vial used for packaging of camera film
Alka Seltzer tablets
Two one gallon or larger glass bottles with metal screw-on lids
Four tire valve stems
Drill and drill bit the same diameter as valve stems
Clear packing tape
Medium to large party balloons
Whoopie cushion or small beach ball
Silicone seal
Bicycle tire pump with pressure gauge

Classroom Management

Suggested time frame for this lesson is 5 class periods,

- Students answer, discuss, and correct questions, show It's a Gas – 1 class period
- Experiment and Demonstration Activities – 1 class period
- Discussion about formulas for direct and indirect relationships, and students complete Explanation Worksheet - 1 class period
- Students complete Worksheet # 1 and Worksheet #2 and do the CD-ROM activity – 1 class period
- Final Test – 1 class period

Student Groupings

Whole group discussions
Small group experiments
Worksheets are done individually

Appendix A: Engagement Questions and Answer Key

1. Name and describe what all gases are made of.
    - Usually molecules
    - Noble gases are made of individual atoms

2. Describe how gas particles move and act.
    - Move about freely (independent of each other)
    - Move rapidly compared with liquids and solids
    - Have large spaces between them
    - Collide with their surroundings

3. Why does the balloon get bigger when I add more air to it? (Teacher blows up a balloon.)
    - Adding more air molecules
    - More molecules= more collisions with walls
    - Collisions with walls causes elastic walls to push outward

4. What do we call the force that results from air molecules colliding with surfaces?
    - Air pressure
    - Atmospheric pressure

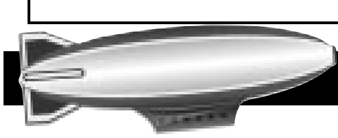
5. Why doesn't the air pressure on the **outside** of the balloon keep the walls from pushing out?
    - The air pressure inside the balloon is greater than pressure outside the balloon
    - There are more particles/volume inside the balloon

6. What would happen to a balloon if an equal density of air were added both inside and outside the balloon?
    - The balloon size will not change
    - Pressure inside and pressure outside will remain balanced
    - Equal numbers of particles/space means same number of collisions with balloon walls

7. What would happen to a glass bottle if I continuously pumped air into it?
    - Explode
    - More molecules means more collisions and more pressure
    - When (inside pressure) > (strength of walls +outside pressure) the walls will break
    - The walls break along weakest points
    - The pressure from the molecules pushes the pieces of glass outward

Appendix B: Data sheet

Activity	Independent Variable		Dependent Variable		Relationship Type
	Name	Change	Name	Change	Direct or Indirect
1 Balloon heated					
Cause:					
1 Balloon cooled					
Cause:					
2 Metal Container					
Cause:					
3 Bottle with Elastic Balloon					
Cause:					
4 Plastic Film Canister					
Cause:					
5 Bottle with Elastic Balloon					
Cause:					
6 Bottle with Elastic Balloon					
Cause:					
7 Bottle with Elastic Balloon					
Cause:					



Appendix C: Equations Worksheet

1. Now that you know how to set up equations for pairs of conditions that are directly related and indirectly related, write equations for the five pairs of conditions for which you determined the relationship and explain what they mean (five equations total). The variables you will be using are T for temperature, V for volume, P for pressure and n for the number of particles.

2. A. What happens to atmospheric pressure as the blimp rises in altitude?

   B. Provide the two reasons why this is so.
      a.

      b.

   C. Which two of your equations from #1 would you use to show these changes?

3. A. As the blimp rises in altitude, what effect does the change in atmospheric pressure have on the helium within the blimp?

   B. Which of your equations from #1 show these changes?

   C. Why could this be a problem for the blimp envelope?

4. A. Name the part of the blimp that normally solves the problem in #3.

   B. Explain how it solves the problem.

   C. Which equation from #1 shows these changes?

5. A. Once the corrective action in #4 has been completely exhausted, the blimp is said to be at its pressure height. Explain the result if the blimp continues to rise in altitude or if the sun's rays are particularly strong and no corrective action is taken.

   B. What is the last-resort corrective action used to maintain proper inflation of the blimp?

6. Explain the series of changes that takes place first outside and then inside the blimp as the blimp descends in altitude. (eight steps total).

Appendix D: Math Problems Worksheet

In each of the following problems you are given the original conditions of a gas. Then you are given a change in one of the original conditions and asked to solve for the change in the second condition. First decide which of the equations developed in class would apply and write down the equation using letters. Rewrite the equation with the given numbers and solve for the unknown condition. Round your answers to the correct number of significant digits. Label your answers with units.

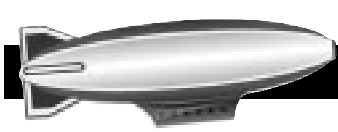
1. Original Conditions:	Pressure= 3.5 atm	No. of Particles= 7,400,000 particles
New conditions:	Pressure= 5.0 atm	No. of Particles= ?

2. Original Conditions:	Pressure= 10.3 atm	Temperature= 273 K
New Conditions:	Pressure= 5.9 atm	Temperature= ?

3. Original Conditions:	Temperature= 163 Kelvin	Volume= 5.7 L
New Conditions:	Temperature= 279 Kelvin	Volume= ?

4. Original Conditions:	Volume= 38 L	Pressure= 90.0 kPa
New Conditions:	Volume= 19 L	Pressure= ?

5. Original Conditions:	Amount of Gas= 100 million particles	Volume= 2008L
New Conditions:	Amount of Gas= 75 million particles	Volume=?



Appendix E: Word Problem Worksheet

Directions: Write the equation that applies using letters. Rewrite the equation with the given numbers. Solve for the unknown condition. Round the answer to the nearest whole number. Label your answers.

1. A gas is confined in a cylinder with a movable piston at one end. When the volume of the cylinder is 760 cm^3 the pressure of the gas is 125.0 kPa. If the piston moves down and reduces the volume to 450.0 cm^3, what is the new pressure within the cylinder?

2. An automobile tire has a pressure of 210.0 kPa at 293 K. What will be the tire pressure after driving, if the tire temperature rises to 308 K?

3. A balloon will burst at a volume of 2.0 dm^3. The original volume is 0.75 dm^3 when the temperature is 294 K. At what temperature will it burst?

4. The gas inside a tire exerts a pressure of 35 pounds per square inch (psi). How much more air must be pumped into the tire to produce a pressure of 70 psi?

5. A welder uses oxygen in his torch. At the beginning of the work day the internal gas pressure is 2250 psi. At the end of the day the pressure is 225 psi. What fraction of the original gas molecules remains at the end of the day? What fraction was used?

6. If your lungs exhale 1×10^{22} air particles when your normal breath is 500 mL, how many air particles would be exhaled during your largest breath of 4000mL?

Appendix F: Final Test

1. Most gases are made up of molecules. Describe four of their properties when they are in the gas state.

2. What else can a gas be made of besides molecules? Give examples of such a gas.

3. Explain the cause of gas pressure.

4. How does air pressure change as the altitude **increases**? Provide TWO reasons for this.

5. If more gas molecules are added to an **elastic** container, what other condition changes? Does it increase or decrease? EXPLAIN the cause of this.

6. If more gas molecules are added to a **fixed** container, what other condition changes? Does it increase or decrease? EXPLAIN the cause of this.

7. What is the effect of heating a **fixed** container of a gas? EXPLAIN.

8. What is the effect of heating an **elastic** container of gas? EXPLAIN.

9. If the pressure on the outside of a gas container **increases**, what other condition will change? Will it increase or decrease? EXPLAIN why this occurs.

10. If the volume of a container is **decreased** (such as moving a piston down a cylinder), what other condition will change for the gas? Will it increase or decrease? EXPLAIN why this occurs.

11. If the pressure inside of a glass or metal container continuously **increases**, what will happen? EXPLAIN.

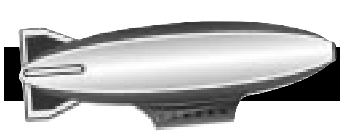
12. What will be the end result if the inside pressure of a blimp continuously **increases**?

13. What two changes can cause the inside pressure of the blimp to **increase**?

14. Explain the effect on the blimp if the outside pressure continuously **decreased**, and there was no method to correct the situation.

15. Explain the effect on the blimp if the outside pressure on the blimp continuously **increased** and there was no method to correct the situation.

16. Explain the method used by the blimp to correct the situation in #14. Then explain how it corrects the situation in #15. What is the end result of both these corrections?



17. Explain what the blimp will do if it is at a high altitude, the sun's rays are intense and the normal corrective action has been exhausted.

18. Explain why a balloon attached to a flask of boiling water gets larger and then goes into the flask when the flask is cooled.

19. Explain step by step what causes:

    a. The lid to pop off a vial containing water and Alka Seltzer

    b. The stopper to pop off a heated metal canister

20. How can a balloon be made to pop when LESS air is added than what the balloon normally requires to pop?

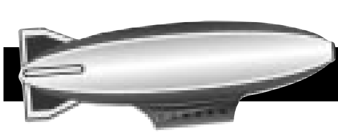
21. Original Conditions: pressure = 3.0 atm number of particles= 475,000,000
    New Conditions: pressure= 42.3 atm number of particles= ?

22. Original Conditions temperature= 60. K volume= 109 L
    New Conditions: temperature= 32 K volume= ?

23. You are scuba diving. At a depth of 66 ft., you are at a pressure of 3.0 atm. The volume of your lungs is 10.0 L. Your scuba gauge indicates that your supply is low so to conserve air you hold your breath as you surface to 1.0 atm. Using a calculation, find the new volume of the air in your lungs.

    What will happen to your lungs since you are holding the air in?

24. At normal atmospheric pressure of 1.0 atm, water boils at 373 K. At what temperature would water boil if you took it to an altitude where the pressure dropped to 0.5 atm?



Appendix B: Data Sheets Answer Key

<table>
<tr><th rowspan="2">Activity</th><th colspan="2">Independent Variable</th><th colspan="2">Dependent Variable</th><th>Relationship Type</th></tr>
<tr><th>Name</th><th>Change</th><th>Name</th><th>Change</th><th>Direct or Indirect</th></tr>
<tr><td>1 Balloon heated</td><td>Temp</td><td>Increase</td><td>Volume</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When the balloon was placed under the heat source it got larger, so increasing temperature causes an increase in the volume of the gas. Temperature and volume are directly related. This is because increasing temperature of a gas causes the molecules to move faster, hit the walls harder and push out the elastic walls.</td></tr>
<tr><td>1 Balloon cooled</td><td>Temp</td><td>Decrease</td><td>Volume</td><td>Decrease</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When the balloon was placed in the cool water it got smaller, so decreasing temperature decreases the volume of a gas. Temperature and volume are directly related. Decreasing the temperature slows them down so that they do not hit the walls as hard and then the molecules on the outside push the walls in.</td></tr>
<tr><td>2 Metal Container</td><td>Temp</td><td>Increase</td><td>Pressure</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When the metal canister was heated the stopper popped out. This was because increasing temperature increases the pressure of a fixed container. The pressure increased until the force inside the canister was great enough to overcome the force of friction between the stopper and the walls of the cylinder. Temperature and pressure are directly related because increasing temperature makes the gas molecules move faster and hit the walls with more force. This force is pressure.</td></tr>
<tr><td>3 Bottle with Elastic Balloon</td><td>Number of molecules</td><td>Increase</td><td>Pressure</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When more air molecules were pumped into the bottle, the pressure inside the bottle increased, as shown by the gauge. The number of gas molecules and the pressure of a gas are directly related. More gas molecules result in more collisions with the walls and that increases the force on the walls.</td></tr>
<tr><td>4 Plastic Film Canister</td><td>Number of molecules</td><td>Increase</td><td>Pressure</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When more gas molecules were created by the reaction between the water and Alka Seltzer, the pressure inside the vial increased and popped off the lid. The number of gas molecules and the pressure of a gas are directly related. More gas molecules result in more collisions with the walls and that increases the force on the walls.</td></tr>
<tr><td>5 Bottle with Elastic Balloon</td><td>Number of molecules</td><td>Increase</td><td>Pressure</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When air was pumped into the balloon, the balloon got bigger. There is a direct relationship between the number of gas molecules and the volume of a gas. This is because more gas molecules result in more collisions with the walls and more force and that pushes out the balloon’s elastic walls.</td></tr>
<tr><td>6 Bottle with Elastic Balloon</td><td>Number of molecules</td><td>Increase</td><td>Volume</td><td>Increase</td><td>Direct</td></tr>
<tr><td colspan="6">Cause: When air was pumped into the bottle, the inflated balloon inside the bottle got smaller. There is an indirect relationship between pressure and volume of a gas. More gas molecules outside result in more pressure and that squeezes the molecules in the balloon closer together until they have a pressure equal to that of the outside.</td></tr>
<tr><td>7 Bottle with Elastic Balloon</td><td>Pressure</td><td>Increase</td><td>Volume</td><td>Decrease</td><td>Indirect</td></tr>
<tr><td colspan="6">Cause: When the air was released, the balloon got bigger again. There is an indirect relationship between pressure and volume of a gas. When the air in the bottle was released, that decreased the pressure outside the balloon so as the molecules inside the balloon collided with each other they were able to spread apart until their pressure decreased to the outside pressure.</td></tr>
</table>

Appendix C: Equations Worksheet Answers Key

1. Showing direct and indirect relationships.
   - **a.** $\frac{P1}{P2} = \frac{T1}{T2}$ means as pressure increases (or decreases), temperature increases or decreases (direct variation)
   - **b.** $\frac{n1}{n2} = \frac{P1}{P2}$ means as the number of particles increases, the pressure increases (direct)
   - **c.** $\frac{n1}{n2} = \frac{V1}{V2}$ means as the number of particles increases, the volume increases (direct)
   - **d.** $\frac{T1}{T2} = \frac{V1}{V2}$ means as the temperature increases, the volume increases (direct)
   - **e.** $\frac{V1}{V2} = \frac{P2}{P1}$ means as the volume increases, the pressure decreases (indirect)

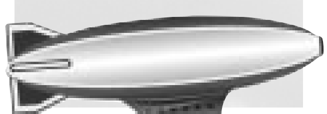
2. A. Atmospheric pressure decreases with increasing altitude.
   B. There is less gravity as you get farther from Earth so there are fewer particles in air. There is less conduction of heat from the earth's surface so it is colder.
   C. a. and b.

3. A. As the blimp rises and the atmospheric pressure decreases, the volume of helium will increase (expand)
   B. e.
   C. If the volume of helium is trying to increase but can't because the walls are not elastic, then the pressure inside the blimp will increase and the envelope may tear.

4. A. Ballonets are air bags inside the blimp envelope
   B. Ballonets release air to the atmosphere; there are fewer gas molecules inside the envelope; pressure inside the envelope decreases proportional to the decrease in the outside pressure
   C. b.

5. A. A continued rise in altitude will make the helium volume continue to try to expand against the rigid walls and increase internal pressure; greenhouse heating from the sun will make the helium move faster than the outside air and increase the internal pressure; either or both can cause the envelope to tear.
   B. Vent helium from the envelope to the atmosphere

6. a. More air molecules and a higher air temperature
   b. Increase in outside air pressure
   c. More pushing by atmosphere on the external walls of the envelope
   d. Decrease in the volume of helium inside the blimp while at the same time increase in amount of air into ballonets (pumped in from outside atmosphere)
   e. Increase in the number of gas molecules inside the blimp and increase in the inside gas pressure
   f. No "caving in" or wrinkling of the blimp envelope



Appendix D: Math Problems Worksheet Answer Key

1. 10,571,428.6 particles
2. 156.4 K
3. 9.8 L
4. 180 kPa
5. 1506 L

Appendix E: Word Problems Worksheet Answer Key

1. 211 kPa
2. 221 kPa
3. 784 K
4. 2x more air
5. 1/10 remains, 9/10 was used
6. 8 x 10^22 particles

Appendix F: Final Test Answer Key

1. Move fast, independently, have wide spaces between them, collide with surfaces
2. Atoms; examples are helium, argon, neon
3. Molecules collide with surfaces
4. Air pressure decreases as altitude increases because the number of particles decreases as you get farther from the earth's surface and the temperature decreases as you get farther from earth's surface
5. The volume increases; there are more collisions with the inside walls which push out the walls
6. Pressure increases; more collisions with the walls and the walls can't push out
7. Pressure increases and it may explode; molecules move faster and hit the walls harder
8. Volume increases; molecules move faster and hit the walls harder; walls push out
9. Volume decreases; outside pressure squeezes the molecules closer together
10. Pressure increases; molecules in a smaller space so they hit the walls more
11. It will explode; the force on the walls becomes stronger than the walls + the outside pressure; container's walls break along weak points; pressure of gas pushes the pieces out in all directions
12. It will tear.
13. Increase the amount of gas or increase the temperature of the gas
14. It would tear; gas volume tries to increase and pushes on the walls
15. It would wrinkle and cave in.
16. The outside pressure decreases when the blimp ascends. Ballonets release air to decrease the number of particles, which in turn decreases pressure. The outside pressure increases when the blimp descends. Ballonets take in air to increase the number of particles and thus increase pressure. The end result is that the balance between the pressure outside and inside the blimp envelope stays the same.
17. Let out helium to decrease pressure inside.
18. Boiling water creates steam, which is water vapor. The number of gas molecules are increasing and so the volume of the balloon increases. When the flask is cooled, the steam condenses back into liquid water. This deceases the number of air particles inside the flask. The molecules in the air outside the flask have greater pressure and push the balloon inside the flask.
19. A chemical reaction between the water and Alka Seltzer produces a gas. The number of gas particles increases, which increases the pressure. The cap pops when the pressure inside is greater than the pressure outside.
20. Heat it or decrease the outside air pressure by going up a mountain or pumping air out of the room.
21. $\frac{P1}{P2} = \frac{N1}{N2} \qquad \frac{3.0}{42.3} = \frac{475,000,000}{X} \qquad X = \frac{(475,000,000)(42.3)}{3.0}$

    $X = 6,697,500,000$

22. $\frac{T1}{T2} = \frac{V1}{V2}$ $\frac{60.}{32} = \frac{109}{X}$ $X = \frac{(109)(32)}{60.} = 58$ L

23. $\frac{P1}{P2} = \frac{V2}{V1}$ $\frac{3}{1} = \frac{X}{10}$ X= (3)(10) = 30 L (Your lungs will explode)

24. $\frac{P1}{P2} = \frac{T1}{T2}$ $\frac{1.0}{.5} = \frac{373}{X}$ X= (373) (.5) = 200 K

It's a Gas!

Math & Science of the Blimp

Lesson 8
Buoyancy

Buoyancy Quick Tour

Author: Stephen Panak, Warren City Schools

Target Audience: 7th, 8th and 9th grade Science

Key Objective

Students will relate buoyancy to density and use this knowledge to explain why a blimp floats, and how the volume of helium in the blimp relates to the amount of weight it can lift.

Key Standard Addressed

Explain that equal volumes of different substances usually have different masses.

Procedure

Suggested time frame for this lesson is five class periods.

1. Students will use two density spheres of equal mass but unequal volume (since one is hollow) and hypothesize if one is heavier. First students will estimate by just holding them and then they will use a scale after spheres have been placed in containers so they can't see which is larger. Finally, the students are challenged to predict if either sphere will float. Their predictions are then tested.
2. Watch the video **It's a Gas #7: Buoyancy**
3. Using Appendix A: Density & Buoyancy, students will experiment with density samples to predict what floats.
4. After the data sheets are completed, you should demonstrate which objects float in water and then hold a discussion about how buoyancy relates to density.
5. Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to determine how big a blimp must be to lift its own weight.
6. Each group will attempt to determine how much a helium balloon will lift by computing its density.
7. Using Appendix B: Archimedes' Principle, students should determine the buoyant force of a cube in water.
8. Final Assessment is an essay on how buoyancy relates to a hot air balloon, blimp, submarine or in the animal kingdom.

Tools/Resources

- **It's a Gas #7: Buoyancy**
- CD-ROM or computer with Internet access
- VCR and TV
- Calculators
- Scales
- Rulers
- Density spheres
- Density samples (cubes)

Assessment

Student worksheets, essays and testing data are used to assess student understanding. You will need to adapt the worksheets to the buoyancy and density examples available in your own classroom.

It's a Gas! Math & Science of the Blimp

Buoyancy

Learning Objectives

The students will:

1. Determine density of solid samples.
2. Identify an unknown substance using the calculated density.
3. Relate buoyancy to density and predict what objects will float in water and give reasons why or why not.
4. Extrapolate this knowledge to explain why a blimp floats and how the volume of helium in the blimp relates to the amount of weight it can lift.

Learning Outcomes

The students will:

1. Select appropriate tools to measure mass and volume.
2. Use formulas to determine volume.
3. Interpret data by looking for patterns and relationships, draw and justify conclusions and answer related questions.
4. Explain that equal volumes of different substances usually have different masses.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Apply a research process model to conduct research and meet information needs.
2. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
3. Use technology resources for solving problems and making informed decisions.

Video Synopsis

Trista and Abby talk with their science teacher about buoyancy. Archimedes Principle is demonstrated and related to how it makes the blimp lighter than air.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)

The computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp asks students to determine how big the envelope on a blimp must be to lift its own weight.

Learning Strategies

A. Engagement

Why Things Float

To do this part of the lesson, you need to have density spheres, which can be purchased from one of the suppliers listed on page 122.

A number of demonstrations are possible. I use density spheres consisting of two spheres of equal mass but unequal volume. They are made of stainless steel and the larger one is hollow. First the spheres are given to one person with a request to determine if one is heavier. A couple of students can try this. Then students are asked to make the determination without being able to see the spheres. The best way to accomplish this is to use identical cups or beakers to hold the spheres, and the student then holds the cups/beakers. This prevents the students from knowing which the sphere is larger. The spheres are weighed with a scale to determine that the mass is identical. Finally, the students are challenged to predict if either sphere will float. Their predictions are then tested.

Evaluation of Engagement:

Write a paragraph explaining what they observed about the two spheres, specifically why one sphere floated and the other did not.

Give one point for accurate description of the activity.
Give one point for accurate explanation of density's influence on buoyancy.

B. Exploration:

Watch **It's a Gas #7: Bouyancy**.

Forming Rules to Determine What Floats

Using Appendix A: Density & Buoyancy, students will work in groups of three to four to form rules about what floats. Each group will obtain some density samples and predict whether they will float. Once predictions are made, they will test the samples to see what floats. Students will find that some plastic floats and some doesn't. Some wood doesn't float, but most does. Students will then attempt to come up with some rules to determine whether something floats.

Make sure you have sufficient density samples and number each with an indelible magic marker. The best set of samples will include metals, plastics and wood, and you should try to obtain plastics and woods that both float and sink. See the materials list on page 124 for suppliers.

The objective of the lesson should be reviewed with the students, and then they should have about 30 minutes to examine the samples and complete the data sheets. Time at the end of class should be reserved to review the proposed rules to determine when something will float.

Density Determines Whether Something Floats

To speed up the process, each group should assign one person to each of the tasks, i.e., to determine mass and volume and to compute the density. The group should compute the density of a number of samples and identify the substance in the sample. They should predict which samples float by using computed density and compare these results with the predictions from Phase 1. (It is easiest to find the volume of regular shaped items, like cans or boxes. This makes finding the density easier.)

Each student is responsible for a complete sheet at the end of the lesson. It should take about 30 minutes to complete the data sheet.

Evaluation of Exploration:
The teacher should monitor the work of the students for completeness and accuracy. Listen to the discussion within the groups for evidence of understanding. When the tasks are completed, the accuracy of student work is checked. No answer key is provided since the variables will be different in each classroom. The following rubric can be used:

CATEGORY	4	3	2	1
Scientific Concepts	Explanation shows complete understanding of the scientific concepts used to solve the problem(s).	Explanation shows substantial understanding of the scientific concepts used to solve the problem(s).	Explanation shows some understanding of the scientific concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Data Table	Data in the table is well organized, accurate and easy to read.	Data in the table is organized, accurate and easy to read.	Data in the table is accurate and easy to read.	Data in the table is not accurate and/ or cannot be read.

C. Explanation

Once the groups have finished their data sheets, results are shared with the class and corrections are made as necessary. After the data sheets are completed, you should demonstrate which objects float in water and then hold a discussion about how buoyancy relates to density.

You can also hold a class discussion about density, buoyancy and their uses in flight (hot air balloons and blimps), sea vessels (boats and submarines) and nature (hot air rises, ocean animals). Students should be given some class time to write a journal entry.

Evaluation of Explanation:
Write a paragraph.

Describe buoyancy and explain density's influence on buoyancy.

The following rubric should be used to evaluate writing:

CATEGORY	4	3	2	1
Quality of Information	Information clearly relates to the main topic. It includes several supporting details and/or examples.	Information clearly relates to the main topic. It provides 1-2 supporting details and/or examples.	Information clearly relates to the main topic. No details and/or examples are given.	Information has little or nothing to do with the main topic.
Organization	Information is very organized with well-constructed paragraphs.	Information is organized with well-constructed paragraphs.	Information is organized, but paragraphs are not well-constructed.	The information appears to be disorganized.

D. Elaboration

Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to determine how big the envelope on a blimp must be to lift its useable weight. Using a graph, students will be asked to determine the difference between the static lift (the total amount of weight the volume of gas can lift) and the useable lift (the difference between static lift and the empty weight of the blimp). Students should develop a graph with the data they collect showing the useful load on the X axis and the volume of the blimp on the Y axis.

Activity #1: Why does a helium balloon float and how much can it carry?
Each group will attempt to determine how much a helium balloon will lift by computing its density. Each group will verify its answer experimentally.

Activity #2: Archimedes' Principle
To do this part of the lesson, you need to have Archimedes blocks which can be purchased from one of the suppliers listed on page 124. Using Appendix B: Archimedes' Principle, students should determine the buoyant force of a cube in water. The Archimedes blocks are available from a number of supply houses.

Evaluation of Elaboration:

The teacher should monitor the work of the students for completeness and accuracy. Listen to the discussion within the groups for evidence of understanding. When the tasks are completed, the accuracy of student work is checked. No answer key is provided since the variables will be different in each classroom.

E. Final Assessment

Students will write an essay on the buoyancy topic of their choice.

a. Hot air balloon
b. Blimp
c. Submarines
d. The animal kingdom

Management Guide

This is a five class period lesson

Engagement with spheres and watching video – 1 class period
Exploration with density and buoyancy – 1 class period
Explanation with classroom discussion and computer activity – 1 class period
Elaboration with one or both activities – 1 class period
Final assessment – 1 class period

Tools/Resources

- **It's a Gas #7: Buoyancy**
- Scales
- Rulers
- Density spheres
- Density samples (cubes)
    - Wood, including Lignum Vitae, the wood that does not float
    - Metals
    - Plastics
    - Also include some density cylinders to show alternative methods of determining volume (measure water displacement)
- VCR and TV
- CD-ROM or computer with Internet access
- Calculators

Science Suppliers:

Educational Innovations, Inc.
362 Main Avenue
Norwalk, CT 06851
www.teachersource.com
Density Samples, Density Spheres

Ward's Natural Science
PO Box 92912
Rochester, NY 14692-9012
www.wardsci.com
Various Density Demonstrations. Archimedes Blocks

Carolina Biological Supply Company
2700 York Road
Burlington, NC 27215-3398
www.carolina.com
Various Density Products and Kits

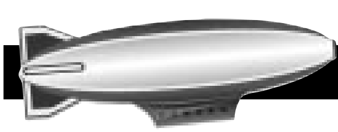
Name: ______________________________

Density = Mass/Volume = g/cm3

Examine each of the numbered samples. Complete the table below. First predict whether it will float. Once you have guessed on all the samples, drop each into a 1000 mL beaker of water to see if it floats. Finally, try to determine what the material in the sample is.

Sample Number	Will it Float?	Does it Float?	What is the sample?
1	Yes/No	Yes/No	
2	Yes/No	Yes/No	
3	Yes/No	Yes/No	
4	Yes/No	Yes/No	
5	Yes/No	Yes/No	
6	Yes/No	Yes/No	
7	Yes/No	Yes/No	
8	Yes/No	Yes/No	
9	Yes/No	Yes/No	
10	Yes/No	Yes/No	

Write some observations you made to help determine what will float.



Examine each of the numbered samples. Complete the table. First, use a scale to determine the mass of each sample. Second, using a meter stick, determine the volume of each sample. Then, using the mass and volume, compute the density. Finally, using your computed density and the data table at the bottom of this sheet, determine what each sample is.

Sample Number	**Mass (g)**	**Volume (cm3)**	**Density (g/cm3)**	**What is the sample?**
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

Create a graph with Microsoft Excel. Arrange the samples in order of increasing density. Annotate your chart to show which samples float in water.

Write a new rule to determine whether something floats.

Table of Densities (g/cm3)

Substance	**Density**	**Substance**	**Density**
Aluminum		Water	
Bronze		Gasoline	
Brass		Zinc, cast	
Copper, pure		Red Oak	
Steel, cold drawn		Iron, pure	

Complete the table above using the Internet. Use a search engine to look for "densities."
Here's a good site: http://www.mcelwee.net/html/densities_of_various_materials.html

Appendix B: Archimedes' Principle

Name: ____

1. Get one of the Archimedes blocks and a spring scale. Determine the mass and the volume of the block and write it down here. Compute the density.

2. What is the density of water? How does the density of the block compare to the density of water?

3. How far will the block sink into the water? Try it to confirm your hypothesis.

4. Add 25 grams of mass to the block. Add in increments of 25 grams. Repeat these steps to complete the table below.

Mass of block (g)	Block density (g/cm3)	Percentage of block below water
25		
50		
75		
100		

5. Add mass to the block so the total mass is 105 grams. Lower the block into the water using the spring scale. What is the mass of the block once it is submerged?

   How much water does the block displace? What is the mass of the water that is displaced? (Hint: you need to use the density of water to figure this out.)

Repeat the procedure to complete the table below.

Mass of block (g)	Water displaced (ml)	Mass when submerged (g)
105		
110		
125		

6. What is the buoyant force of water in each case?

7. In which direction does this force act?

8. What is the force the buoyant force acts against?

9. Submerge the 125-gram block in a beaker of salt water. What is the mass when submerged?

10. What is the volume of salt water displaced?

11. What is the mass of the salt water that is displaced?

12. What is the density of the salt water?

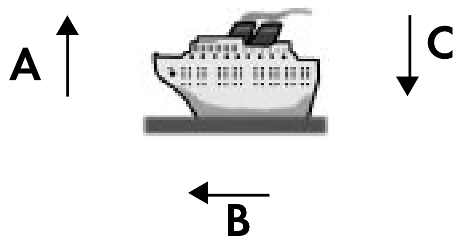
13. Write down Archimedes’ Principle.

14. Write down the principle of flotation.

Appendix C: Buoyancy Pre-Test

1. The property of floating on the surface of a fluid is:
    a. Boat
    b. Gravity
    c. Buoyancy
    d. Floatation

2. A stone sinks in water while a ping pong ball floats on water because
    a. The stone is heavier than the ping pong ball
    b. The ping pong ball is made of plastic, the stone is not
    c. The ping pong ball is less dense than the stone
    d. None of the above



3. Which arrow above best describes the direction of the buoyant force?
    a. A
    b. B
    c. C
    d. None of the above

Material	Mass (g)	Density (g/cm^3)
Plastic	100	1.06
Concrete	400	2.7
Steel	300	2.7

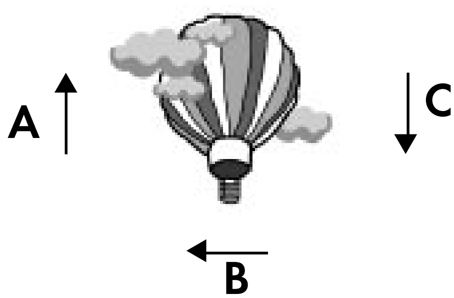
Use the table above to answer the following question:

4. Which material above will float on water?
    a. Plastic
    b. Concrete
    c. Steel
    d. None of the above

Appendix C: Buoyancy Post-Test

1. The property of floating on the surface of a fluid is:
a. Archimedes' Principle
b. Beach Ball
c. Life Raft
d. Buoyancy

2. A helium balloon floats because
a. The air is heavier than the balloon
b. The helium is under pressure
c. Helium is less dense than the air
d. None of the above



3. Which arrow above best describes the direction of the buoyant force?
a. A
b. B
c. C
d. None of the above

Material	Mass (g)	Density (g/cm^3)
Plastic	100	1.06
Concrete	400	2.7
Oil	1000	.90
Aluminum	300	2.7

Use the table above to answer the following question:

4. Which material above will float on water?
a. Plastic
b. Concrete
c. Steel
d. None of the above

Appendix D: Answers: Buoyancy Pre-Test and Post-Test

Buoyancy Pre-Test

1. c. Buoyancy
2. c. The ping pong ball is less dense than the stone.
3. a. A
4. d. None of the above

Buoyancy Post-Test

1. d. Buoyancy
2. c. Helium is less dense than the air
3. a. A
4. d. Oil

It's a Gas!

Math & Science of the Blimp

Lesson 9
Motion and Forces

Author: Tim McBride, Sandy Valley Local Schools
Target audience: 7th, 8th, and 9th grade science

Key Objective

Given distance and time, students will determine the speed of an object.

Key Standard Addressed

Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.

Procedure

Suggested time frame for this lesson is four class periods.

1. Have one student walk around the room, one run, one remains motionless and another release the air from an inflated balloon. Lead a discussion about motion, reference point, what is fast and slow, how do we measure motion, how was the motion from the balloon different and what motion would be faster/slower than the blimp?
2. Watch **It's a Gas #8: Motion and Forces**.
3. Students will create a list where speed can be measured and categorize the list by which will be easy, moderate and hard to measure. (Appendix A: Measuring Speed 1)
4. Students pick one situation from each of the three columns and measure the rate of motion. (Appendix B: Measuring Speed 2)
5. Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to compare the speed of the blimp to other objects in motion.
6. Students will determine which items are faster or slower than the blimp.
7. Have students determine the rate of motion and produce a graph for each situation.
8. Students will write definitions in their own words. (Appendix C: Vocabulary)
9. Introduce measuring acceleration by lining up students one meter apart as another student moves past them walking for two seconds, skipping for two seconds and running for two seconds. The student closest to the moving student at each two-second interval will raise her or his hand. Discuss what they just measured.
10. Students will determine which object will hit the ground first: one in free fall or one in projectile motion. (Appendix D: Acceleration Experiment)
11. Students will take a paper and pencil test. (Appendix E: Motion and Forces Test)

Tools/Resources

It's a Gas #8: Motion and Forces
CD-ROM or computer with Internet access
VCR and TV
Things to measure
Stopwatch
Meter sticks
Tape measure
Calculator

Assessment

See Appendix F for graph assessment rubric, worksheet and test answer keys.

Learning objectives

The students will:

1. Determine the speed of an object when given distance and time.
2. Graph the speed of an object when Given changes in distance as a function of time.
3. Determine which objects are faster when given the maximum speed of the Goodyear Blimp.
4. Determine the acceleration of the student when given a change in speed for a fellow student.
5. Determine its speed and acceleration when given a projectile.

Curriculum and Proficiency standards Addressed:

The students will:

1. Choose the appropriate tools and instruments to complete scientific investigations.
2. Use graphs, tables and charts to study physical phenomena and infer mathematical relationships between variables.
3. Read, construct and interpret data in various forms produced by self and others in both written and oral form.
4. Draw logical conclusions based on scientific knowledge and evidence from investigations.
5. Evaluate the effectiveness of a product design or solution.
6. Describe how the change in the position (motion) of an object is always judged and described in comparison to a reference point.
7. Explain that motion describes the change in position of an object (characterized by a speed and direction) as time changes.
8. Demonstrate that motion is a measurable quantity that depends on the observer's frame of reference and describe the object's motion in terms of position, velocity, acceleration and time.
9. Explain the change in motion (acceleration) of an object.

Technology objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Apply a research process model to conduct research and meet information needs.
2. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.

Video synopsis

Abby and Trista decide they need to know how a blimp moves forward and how it is maneuvered. They interview a blimp pilot and he explains how the shape of the blimp helps it maneuver. He also tells them that he must compensate for drag, or friction, whenever he flies the blimp.

CD-ROM Activity:

(Also available on the Web at pbs4549.org/blimp)

Watch the simulated video from the blimp to determine which objects move slower or faster than the blimp. Also determine the speed of objects by measuring the time the object takes to cover a certain distance (how the air patrol catches speeders).

Learning strategies

A. Engagement

Students' knowledge of motion will be assessed after a demonstration. Four students will be needed. One will walk around the room, one will run around the room, one will remain motionless and the fourth student will release the air from an inflated balloon.

Pose the following for discussion:

1. What is motion?
2. What is the reference point?
3. Compare the motion examples in the demo.
4. Give other examples of motion.
5. What is fast?
6. What is slow?
7. How do we measure motion?
8. How was the motion from the balloon different from the others?
9. What types of motion would be faster/slower than the blimp?

Watch **It's a Gas #8: Motion and Forces**.

Evaluation of Engagement:

As a class students will create a list of situations where speed can be measured. Students should then categorize their list into which measurements will be easy, moderate and hard to make. (See Appendix A: Measuring Speed 1)

B. Exploration

Use the computer activity on the **It's a Gas** CD-ROM or on the Web at pbs4549.org/blimp to compare the speed of the blimp to other objects in motion.

Put students into groups of two or three. Students will pick one situation from each of the three columns on Appendix A and measure the rate of motion. Students will need to determine what materials will be needed to make accurate measurements. Five measurements for each situation should make for reliable conclusions. (See Appendix B: Measuring Speed 2)

Evaluation of Exploration:

Students will compare the rate of speed for the blimp and determine which items were faster and which were slower than the blimp.

C. Explanation

Students demonstrate how they accurately measured the speed of their chosen items. Students graph the rate of speed for each of the three items they measured (see Appendix F: Answer Key for graph rubric).

Vocabulary is introduced at this time: reference point, speed, velocity and acceleration (see Appendix C: Vocabulary).

Evaluation of Explanation:

Have students determine the rate of motion for various situations. Students will graph the motion for each situation. Students can write vocabulary definitions in their own words to insure understanding.

D. Elaboration

Introduce students to measuring acceleration with the following demonstration. Have a row of students line up one meter apart from each other. A designated student will walk past the row for two seconds, then skip for two seconds, and then run for two seconds. The student in the row closest to the moving student at each interval will raise her or his hand. Students will be asked what they just measured. (They can measure speed or velocity for each two-second interval.)

Next, students will determine the velocity and acceleration of a free falling object vs. a projectile object. Explain that acceleration due to gravity is 9.8 m/s2. Drop two 100g weights from the same height. This demonstration shows that each hits the floor at the same time.

Once this is established, the students will create an experiment to determine which object would hit the ground first: a ball in free fall or one in projectile motion. For example, flicking a penny off of a desk while dropping a penny from the same height. If available, have students use a photogate to obtain accurate velocity data.

Evaluation of Elaboration:
Evaluate the experiment designed by the various teams (see Appendix D: Experiment).

E. Final Assessment:

Students will take a paper and pencil test (see Appendix E: Motion and Forces Test).

Tools/Resources

It's a Gas #8: Motion and Forces
CD-ROM or computer with Internet access
VCR and TV
Stopwatch
Meter sticks
Tape measure
Calculator

Classroom Management

Suggested time frme for this lesson is four class periods.
Watch **It's a Gas #8: Motion and Forces**, and Measuring Speed worksheet – 1 class period
Measuring Speed 2 worksheet, using the computer activity, and graphing – 1 class period
Definitions worksheet, speed demonstration and Experiment worksheet – 1 class period
Motion and Forces Test – 1 class period

Student Groupings

Whole class discussions
Experiment in groups
Worksheets individually

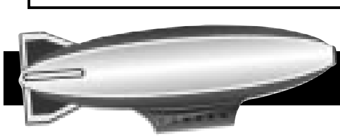
Appendix A: Measuring speed 1

List situations where you can measure speed:

1.
2.
3.
4.
5.
6.
7.
8.
9.
10.

Now categorize each situation as easy, moderate or hard to measure.

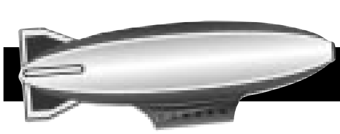
Easy Both distance and time can be easily and accurately measured.	**Moderate** One of the measurements may be difficult to measure accurately	**Hard** Both measurements may be difficult. For instance, an object may move in a circle, indefinite path or move rapidly.
Example: student walking	Example: water moving through a hose	Example: sound moving across a field



Directions: Chose one situation from each column (easy, medium, hard) from the worksheet Measuring Speed 1. List what type of tools you will need to determine speed in each situation. Run five tests of each situation to determine a reliable speed. Compare your results to the speed of the blimp. Which are faster and which are slower than the blimp? (Note: both speeds need to be in the same unit of measure to make comparisons.)

Easy Both distance and time can be easily and accurately measured.	**Moderate** One of the measurements may be difficult to measure accurately	**Hard** Both measurements may be difficult. For instance, an object may move in a circle, indefinite path or move rapidly.
Situation:	Situation:	Situation:
Measurement Tools:	Measurement Tools:	Measurement Tools:
Distance:	Distance:	Distance:
Time:	Time:	Time:
Speed:	Speed:	Speed:
Speed of the blimp: 35 mph	Speed of the blimp: 35 mph	Speed of the blimp: 35 mph
Compare the speed in your situation to the speed of the blimp.	Compare the speed in your situation to the speed of the blimp.	Compare the speed in your situation to the speed of the blimp.

Graph the rate of speed for each of the three items you've measured.



Reference Point: A place or object used for comparison to determine if an object is in motion.

Speed: The distance an object travels in a unit of time.
Speed = distance / time.

Velocity: Speed in a given direction.

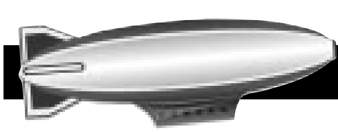
Acceleration: The rate at which velocity changes.
Acceleration = speed or velocity / time.

Use your own words to write new definitions.

Reference Point:

Speed:

Velocity:



Appendix D: Acceleration Experiment

Which object will hit the ground first: an object in free fall or an identical object in projectile motion?

Hypothesis:

Experiment:

Create an experiment to determine which object will hit the ground first. Example: flick a penny off of a desk while dropping a penny from the same height. Things to consider when setting up your experiment:

1. Does the projectile move only horizontally before dropping due to gravity?
2. Is the other object dropped from the same height as the maximum height of the projectile?
3. Are both objects the same size and mass?
4. Is data easy to gather? If it's too hard to get accurate measurements, the experiment won't be very successful.

Analysis

The projectile object must not be thrown vertically. Why?

Why did both objects have to have the same size, shape and mass?

What condition would be necessary for both objects to fall at the same rate?

List four ways in which the blimp accelerates.

What is the formula for measuring acceleration?

How close were the measurements? Within 10%, 20%, 50% of each other?

Did the results prove your hypothesis? Explain.

1. A change in position with respect to a reference point is ______________________________.

2. If a car travels 25 km in 30 minutes, you can determine its ______________________________.

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's

   ____.

4. Using S.I. Units, what is the speed of a car moving 25 km in 30 minutes?

5. How far will a vehicle travel if its average speed is 40 km/hr and it travels for three hours?

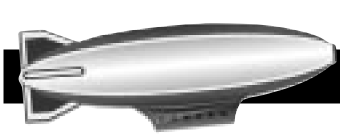
6. What is the acceleration of a dragster going from 0km/hr to 75 km/hr in five seconds?

7. An object moving at a speed of 3 m/s increases its speed to 8 m/s over a three second time period. What was its rate of acceleration?

8. Explain why a flat piece of paper dropped from a height of two meters will not accelerate at the same rate as a sheet of paper crumpled into a ball.

9. A tennis player hits a tennis ball horizontally so that the ball hits ten meters away. At exactly the same time another tennis player drops a ball from exactly the same height. Explain which ball hits the ground first.

10. What is the difference between speed and velocity? How are they similar?



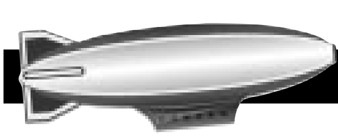
Appendix F: Pre-Test

1. A change in position with respect to a reference point is?

2. What is the speed of a car moving 30 km in 15 minutes?

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's

____ .



Appendix F: Post-Test

1. What is the speed of a truck moving 40 km in 30 minutes?

2. A change in position with respect to a reference point is?

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's

____ .

Appendix B: Grading Graphs

Total of eight points: One point for each item listed below:

Time - X axis
Distance - Y axis
Unit - labeled
Uniformity marked (each square worth the same distance and time)
Appropriately marked so that the graph takes up most the page instead of jammed in a corner
Points are accurately positioned on the graph
Points are connected with a line
Lines are identified as to which situation they represent

Appendix D: Experiment Answer Key

Hypothesis:

A projectile will hit the ground at the same time as an identical object dropped straight down.

Analysis:

The projectile object must not be thrown vertically. Why?

Example: Any increase in verticality will cause inaccurate results. A tennis ball thrown with an arc will not hit the floor the same time as one that is dropped.

Why did both objects have to have the same size, shape and mass?

Example: Air resistance will keep objects with a greater surface area from falling as fast as objects with a smaller surface area. Air resistance acts against gravity to slow down the object's velocity.

What condition would be necessary for both objects to fall at the same rate?

Example: Objects are in a vacuum, no air resistance.

List four ways in which the blimp accelerates.

Example: Increases speed, decreases speed, change in direction while changing altitude.

What is the formula for measuring acceleration?

(Final velocity - Initial velocity)/ time

How close were the measurements? Within 10%, 20%, 50% of each other?

Answers will vary.

Did the results prove your hypothesis? Explain.

Answers will vary.

Appendix E: Motion and Forces Test

1. A change in position with respect to a reference point is __________.

   motion

2. If a car travels 25km in 30 minutes, you can determine its ___________.

   speed

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's _____________.

   acceleration

4. Using S.I. Units, what is the speed of a car moving 25 km in 30 minutes?

   50 km/hr

5. How far will a vehicle travel if its average speed is 40 km/hr and it travels for three hours?

   120 km

6. What is the acceleration of a dragster going from 0 km/hr to 75 km/hr in five seconds?

   15 km/hr/second

7. An object moving at a speed at 3m/s increases its speed to 8 m/s over a three second time period. What was its rate of acceleration?

   8m/s - 3 m/s = 5 m/s / 3 sec = 1.67 m/s2

8. Explain why a flat piece of paper dropped from a height of two meters will not accelerate at the same rate as a sheet of paper crumpled into a ball.

   A flat sheet of paper has more surface area for air resistance to affect its rate of fall.

9. A tennis player hits a tennis ball horizontally so that the ball hits ten meters away. At exactly the same time another tennis player drops a ball from exactly the same height. Explain which ball hits the ground first.

   The two balls should hit the ground simultaneously.

10. What is the difference between speed and velocity? How are they similar?

    Speed is equal to the distance covered in a given time while velocity is speed in a given direction.

Appendix F: Pre-Test Answer Key

1. A change in position with respect to a reference point is?
   Motion

2. What is the speed of a car moving 30 km in 15 minutes?
   120km/hr

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's ______________.
   acceleration

Post-Test Answer Key

1. What is the speed of a truck moving 40 km in 30 minutes?
   120 km/hr

2. A change in position with respect to a reference point is?
   Motion

3. If you divide the increase in an object's speed by the time it takes for that increase, you are measuring the object's __________________.
   acceleration

It's a Gas!

Math & Science of the Blimp

Lesson 10
Mapping and Navigation

Mapping and Navigation

Authors: Dale and Jane Morckel, West Branch Local Schools
Target Audience: 8th grade science, math, social studies

Lesson overview

Key Objective:

Students will be able to identify and illustrate the typical physical characteristics of the 22 physiographic regions of the United States.

Key Standard Addressed:

Use models to analyze the size and shape of Earth, its surfaces and its interior (e.g., globes topographic maps, satellite images).

Procedure

Suggested time frame for this lesson is 12 class periods.

1. Watch the instructional television program **It's a Gas #9: Mapping and Navigation**.
2. Research the latitude and longitude and elevation of Cleveland, Ohio, on the Web and plot the latitude, longitude and elevation on the map provided. To gain a better understanding of what map data represents, students can use the CD-ROM or Web activity to see the difference between terrain structures on a topographic map.
3. Divide the class into groups and randomly assign three physiographic regions to each group. They will identify three locations in each physiographic region and plot the locations' latitude, longitude and elevation on a map.
4. The students will share their data with the other groups and record the information onto their maps.
5. After reviewing the altitude parameters of the blimp, each group will plot a course from Akron to one of the identified locations. They must travel through at least three different physiographic land regions. The students must plot the shortest route and explain why their route is possible.
6. Each group will use the map scale and a ruler to calculate the number of miles the blimp will travel and calculate the gallons of fuel needed to complete the trip.
7. Each student will construct a travel brochure showing the physiographic features that occur along the course of their blimp excursion

Tools/Resources

- **It's a Gas #9: Maps and Navigation**
- CD-ROM or computer with Internet access
- VCR and TV
- Handouts
- Calculators
- Rulers
- Maps
- Pencil

Assessment

Assessment rubrics are provided as Appendices E, F and G.
Test questions and answer keys are included in Appendix H.

Learning Objectives

The students will:

1. Be able to identify and illustrate the typical physical characteristics of the 21 physiographic regions of the United States.
2. Identify three locations in each of three physiographic regions when given a physiographic map and information about each physiographic region.
3. Chart a location's latitude, longitude and elevation.
4. Chart the most direct course from one location to another.
5. Use a map scale to calculate the number of miles the blimp will travel on the chosen course.
6. Calculate the gallons of fuel needed to complete the trip when given the average fuel consumption of the blimp.
7. Use aerial views to construct a travel brochure of the physiographic regions on the course of the blimp excursion.

Curriculum and Proficiency Standards Addressed:

The students will:

1. Evaluate stages of product development and technological design (e.g. identify a problem, create a solution, evaluated the solution) using criteria relevant to the purpose.
2. Read, construct and interpret data in various forms (e.g. tables, charts, graphs, diagrams, symbols) produced by self and others in both written and oral form.
3. Apply mathematical knowledge and skills routinely used in other content areas and practical situations.
4. Collect, organize, display and interpret data for a specific purpose or need.
5. Specify locations and plot ordered pairs on a coordinate plane.
6. Use proportional reasoning to solve problems involving measurements and rates.
7. Use models to analyze the size and shape of Earth, its surfaces and its interior (e.g., globes topographic maps, satellite images).

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in the Lesson

The students will:

1. Develop search strategies, retrieve information in a variety of formats and evaluate the quality and appropriate use of Internet resources.
2. Select, access and use appropriate electronic resources for a defined information need.
3. Use productivity tools to produce creative works, to prepare publications and to construct technology-enhanced models.
4. Communicate information technologically and incorporate principles of design into the creation of messages and communication products.

Physiographic maps and other data can be found on the Internet

Students should go to pbs4549.org/blimp for a listing of sites that give the information necessary to complete this activity.

Video synopsis

Trista and Abby try to determine if a blimp has altitude limitations and if this would keep it from going to cities located in the mountains. They interview a blimp pilot and he tells them how maps and other tools are used to determine where they can fly the blimp.

CD-ROM Activities

(Also available on the Web at pbs4549.org/blimp)

Students can change the size of a mountain, ravine, and plateau in a side view and watch how the item changes on a flat topographic map.

Learning strategies

A. Engagement:

After watching the instructional television program **It's a Gas #9: Mapping and Navigation**, students will be put into groups of two or three. Their task will be to research the latitude and longitude and elevation of Cleveland, Ohio on given web sites or by using a variety of resources. They will be provided with a map to plot the latitude and longitude of Cleveland. Next to the plotted point students will record the elevation. (see Appendices A, B and C — Physiographic Region and Maps).

Evaluation of Engagement:

When the task is completed, students will display their maps and the teacher will inspect to see if students completed the task correctly.

B. Exploration:

The class should be divided into groups of three for these activities. Each group will randomly draw the names of three physiographic regions (Example: Great Plains, Southern Rocky Mountains, and Allegheny Plateau). They will identify three locations in three physiographic regions and plot the locations' latitude and longitude on the map (see Appendix D: Coordinate Worksheet).

To gain a better understanding of what map data represents, students can use the CD-ROM or Web activity to see the difference between terrain structures on a topographic map.

Groups will be given web sites to obtain elevation data. Their task will be to record the elevation of each identified location next to the plotted point. Students will share their data with the other groups and each group will record the data from all the groups.

For the purpose of this excerise, studenta should use 5,000 feet as the maximum height that the blimp can fly.

The group will plot a course from Akron to one of the identified locations (Teacher approved: The course plotted must cover at least three different physiographic land regions). The students must plot the shortest route that allows the blimp to stay below 5,000 feet. Then the student must give an adequate and relevant explanation why the shortest route is possible, or if not, describe the next shortest route and why it would be a possible one.

Evaluation of Exploration:
When the task is completed, use the lesson plan rubric to evaluate the work of the students (see Appendix E: Rubric).

C. Explanation

Once the students have plotted their course, the groups will explain how they plotted their course. They will discuss if their course is the most direct route, if it is possible at all. Teacher reviews altitude limitations of the blimp with regards to staying under 5,000 feet.

Evaluation of Explanation:
When the task is completed, use the lesson plan rubric to evaluate the work of the students (see Appendix E: Rubric).

D. Elaboration

Distribute Appendix F: Mapping a Route.

How Many Miles?
Each group will use the map scale and a ruler to calculate the number of miles the blimp will travel on the chosen course. The students should report their solutions to the problem, explaining what their solution is and how they got it to the rest of the class.

Teachers can check students' answers with the information on this Web site:
http://mac.usgs.gov/mac/isb/pubs/booklets/elvadist/elvadist.html.

How Much Gas?
Given the average fuel consumption of the blimp each group of students will calculate the gallons of fuel needed to complete the trip. The students should report their solutions to the problem, explaining what their solution is and how they got it to the rest of the class (see Appendix F).

Hopefully, someone will use the formula for finding fuel consumption. If not, this is the time when the formula for finding the fuel consumption should be given to the students. Amount of fuel needed = Distance ÷ Miles per Gallon.

Travel Brochure
Each group of students will be assigned a computer and use the Internet to find aerial views and text of the physiographic regions they will cross on their trip. Having found aerial views and text of the locations, students will construct a travel brochure along the course of their blimp excursion. Using the computer, the students will construct a colorful travel brochure using pictures and text. Students should go to pbs4549.org/blimp for a listing of appropriate sites.

Evaluation of Elaboration:
How Many Miles?
When students have completed the worksheet, each individual will write a paragraph explaining the answer and the solution.

When the task is completed, use this Web site to evaluate the work of the students:
http://mac.usgs.gov/mac/isb/pubs/booklets/elvadist/elvadist.html.

How Much Gas?
When students have completed the worksheet, each individual will write a paragraph explaining the answer they got and how they solved the problem. When the task is completed, use a calculator to evaluate the work of the students.

E. Final Assessment

When the Travel Brochure task is complete, evaluate the work of the students (see Appendix G).

Tools/Resources

It's a Gas #9: Mapping and Navigation
CD-ROM or computer with Internet access
VCR and TV
Handouts
Calculators
Rulers
Maps
Pencil

Classroom Management

Suggested time frame for this lsson is 12 class periods..
Engagement: one class period
Exploration: three to four class periods
Explanation: three class periods
Elaboration:
  Activity #1: one-half of a class period
  Activity #2: one class period
  Activity #3: three to four class periods

Student Groupings

Whole class discussions.
Activities should be done with groups of two or three.
Writing paragraphs for Appendix G: Mapping a Route should be done independently.

Appendix A: Physiographic Regions of the U.S.

1. **Superior Upland:** Glaciated plain, old worn down mountain ranges, igneous and metamorphic rocks.

2. **Continental Shelf:** Flooded part of the continent, shallow water area, near shore, made of sedimentary rocks.

3. **Coastal Plain:** Flat lowland, relatively young sedimentary rocks, near ocean in elevation.

4. **Piedmont:** Flat to gently rolling land, slightly higher in elevation than the coastal plain, made of old igneous and metamorphic rocks.

5. **Appalachian Mountains:** Old, worn down fold mountains.

6. **Appalachian Plateaus:** Plateaus made of sedimentary rock layers. Streams have cut deep valleys into these plateaus producing hilly areas in S.E. Ohio, W. Va., Pa., Ky. and Tenn.

7. **Saint Lawrence Valley:** Rolling lowlands near the Saint Lawrence River.

8. **Adirondack Mountains:** Dome mountains of igneous and metamorphic rocks. Mountains are nearly 5,000 feet high.

9. **Interior Low Plateaus:** Low plateaus made of sedimentary rocks.

10. **Central Lowlands:** Low, flat areas made of old sedimentary rocks.

11. **Great Plains:** Interior plain made of sedimentary rocks, mostly cretaceous age chalk and limestone deposited when the area was a shallow sea.

12. **Ozark Plateau:** High, hilly area made of sedimentary rocks.

13. **Ouachita Mountains:** Old, worn down fold mountains.

14. **Southern Rocky Mountains:** Young complex mountains, made mostly of igneous rocks, (some volcanoes).

15. **Wyoming Basin:** High plains and plateaus made of sedimentary rock surrounded by high mountains.

16. **Middle Rocky Mountains:** Young fault block mountains and volcanic mountains.

17. **Northern Rocky Mountains:** Young mountains formed mainly by compression (folds and reverse faults).

18. **Columbia Plateau:** High plateau formed by huge lava flows.

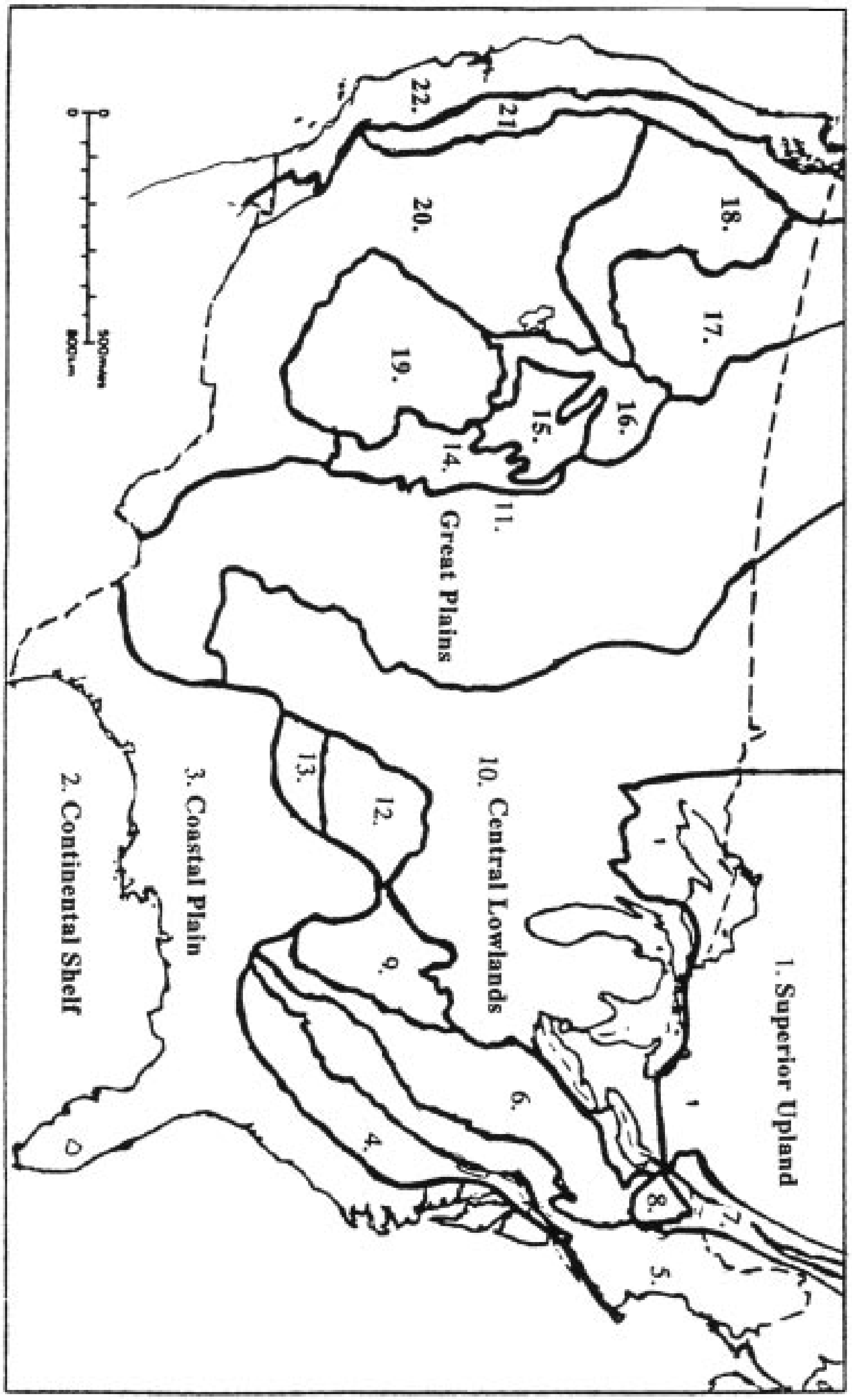
19. **Colorado Plateau:** High plateau made of sedimentary rocks. Cut by deep canyons.

20. **Basin and Range:** Many parallel mountain ranges separated by wide desert basins. Tension in the crust formed basins.

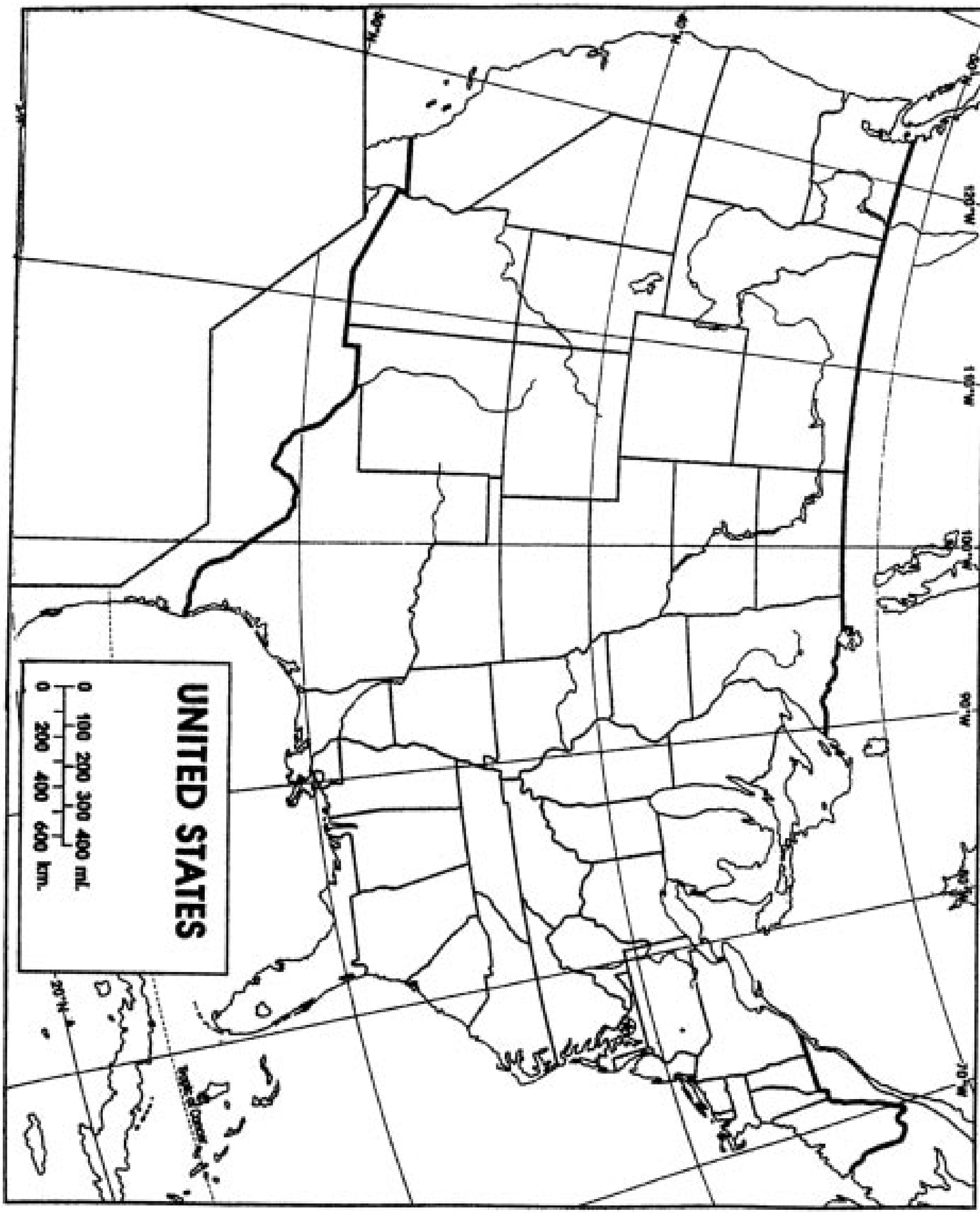
21. **Sierra Nevada, Cascade Ranges:** Sierras are high mountains made of igneous rocks (granite) and Cascades are volcanoes.

22. **Coast Ranges and Valleys:** Young, low mountains of various types along the coast. Large central valley.

Appendix B: Physiographic Map



(Map from U.S. Geological Survey)


UNITED STATES
0 100 200 300 400 mi.
0 200 400 600 km.
120°W
110°W
100°W
90°W
80°W
70°W
20°N
Tropic of Cancer

Latitude, Longitude and Elevation Chart

Name of Physiographic Region

1. ______________________________

A. Location Name ________ Latitude ________ Longitude ________ Elevation ________

B. Location Name ________ Latitude ________ Longitude ________ Elevation ________

C. Location Name ________ Latitude ________ Longitude ________ Elevation ________

2. ______________________________

D. Location Name ________ Latitude ________ Longitude ________ Elevation ________

E. Location Name ________ Latitude ________ Longitude ________ Elevation ________

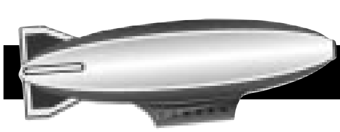
F. Location Name ________ Latitude ________ Longitude ________ Elevation ________

3. ______________________________

G. Location Name ________ Latitude ________ Longitude ________ Elevation ________

H. Location Name ________ Latitude ________ Longitude ________ Elevation ________

I. Location Name ________ Latitude ________ Longitude ________ Elevation ________



Appendix E: Rubric for Exploration

Total Possible Points	Your Points	
9	_________	Correctly plotted latitudes and longitudes on U.S. map (one point for each correct latitude and longitude plotted)
9	_________	Correct elevations written next to plotted points. (one point for each correct elevation.)
2	_________	Visually present the shortest route the group plotted on its map.
12	_________	Adequate and relevant explanation describing shortest route. (Identify physiographic regions, physical features, states and large cities.) Maximum three points for each item: 3 - excellent 2 - good 1 - average 0 - poor
5	_________	Adequate and relevant explanation why the shortest route is possible. Or adequate and relevant explanation describing the next shortest route and why it would be a possible one.
5	_________	Neatness
42	_________	Total earned

How Many Miles?

Directions: Using the map scale and a ruler, calculate the number of miles the blimp will travel on the chosen course.

_______ Miles

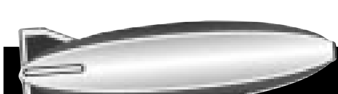
Explain how you got your answer

How Much Gas?

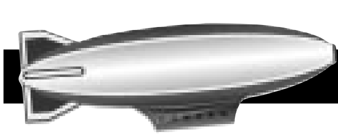
The blimp uses 3.5 gallons of fuel per mile. Calculate the number of gallons of fuel needed to complete the trip.

______ Gallons

Explain how you got your answer.



Total Possible Points	Your Points	
10	__________	Photographs of aerial views of each physiographaic region crossed (minimum of five photographs). 1 point per photograph 1 point per label
20	__________	Text describing the major landforms shown in each photograph. Landforms identified and prominent features described. 4 points per text: facts accurate and exceptional, above average, well done 2 points per text: average 1 point per text: below average
5	__________	Attractiveness/Organization
35	__________	Total



Appendix H: Pre-Test Questions

1. Given the elevation of these four locations, which would the blimp be unable to reach?
    A. New Orleans, Louisiana – eight feet
    B. New York City, New York – 410 feet
    C. Lincoln, Nebraska – 1,189 feet
    D. Leadville, Colorado – 10,430 feet

2. On a trip from Akron, Ohio, to Orlando, Florida, what highlands would you cross?
    A. Ozark Plateau and Appalachian Mountains
    B. Colorado Plateau and Cascade Range
    C. Allegheny Plateau and Appalachian Mountains
    D. Columbia Plateau and Sierra Nevada Mountains

3. You are taking a trip from Cleveland, Ohio, to Cincinnati, Ohio. On the 250-mile trip from Cleveland to Cincinnati, a car averaged 32 miles per gallon. How many gallons of gas would it have taken to complete the trip?

Read the next problem and then answer the question below.

The blimp travels from point A to point B and flies 250 miles. The ground crew travels in a semi and a bus. They travel between point A and point B but go 375 miles.

4. List three things that might account for the ground crew traveling farther.
    A.

    B.

    C.

5. List all the resources you can think of to help find the answer.

Appendix H: Post-Test Questions

1. Given the elevations of these four locations, which would the blimp be able to reach?
   A. Yellowstone Lake, Wyoming – 7,731 feet
   B. Madison, Wisconsin – 863 feet
   C. Independence Pass, Colorado – 12,094 feet
   D. Tahoe City, California – 6,260 feet

2. On a trip from Akron, Ohio, to Orlando, Florida, what lowlands would you cross?
   A. Great Plains and Coastal Plain
   B. Basin and Range
   C. Ozark Plateau and Canadian Shield
   D. Piedmont and Coastal Plain

3. On the 416-mile trip from Youngstown, Ohio, to New York City, the blimp used 82 gallons of fuel. What was the average fuel usage per mile?

Read the next problem and then answer the question below.

The ground crew for the blimp travels in a semi and a bus. They travel between point A and point B and go 475 miles. The blimp travels from point A to point B and flies 350 miles.

4. List three things that might account for the ground crew traveling farther.
   A.

   B.

   C.

5. List all the resources you can think of to help find the answer.

Pre-Test Questions - Answer Key

1. Given the elevation of these four locations, which would the blimp be unable to reach?
   D. Leadville, Colorado

2. On a trip from Akron, Ohio, to Orlando, Florida, what highlands would you cross?
   C. Allegheny Plateau and Appalachian Mountains

3. You are taking a trip from Cleveland, Ohio, to Cincinnati, Ohio. On the 250-mile trip from Cleveland to Cincinnati, a car averaged 32 miles per gallon. How many gallons of gas will it have taken to complete the trip?
   250 miles divided by 32miles / gallon = 7.81 gallons

Read the next problem and then answer the questions below.

The blimp travels from point A to point B and flies 250 miles. The ground crew travels in a semi and a bus. They travel between point A and point B but go 375 miles.

4. List three things that might account for the blimp crew traveling a shorter distance.
   Large bodies of water, winding roads and deep canyons are not obstacles for aircraft. The blimp is able to fly on a straight line course that wheeled vehicles cannot.

5. List all the resources you can think of to help find the answer.
   Atlas, auto club, aviation charts, State and National Geological Survey, Internet map sites and road maps.

Post-Test Questions - Answer Key

1. Given the elevations of these four locations, which would the blimp be able to reach?
   B. Madison, Wisconsin

2. On a trip from Akron, Ohio, to Orlando, Florida, what lowlands would you cross?
   D. Piedmont and Coastal Plain

3. On the 416-mile trip from Youngstown, Ohio, to New York City, the blimp used 82 gallons of fuel. What was the average fuel usage per mile?
   416 miles divided by 82 miles = 5.07 miles / gallon

Read the next problem and then answer the questions below.

The ground crew for the blimp travels in a semi and a bus. They travel between point A and point B and go 475 miles. The blimp travels from point A to point B and flies 350 miles.

4. List three things that might account for the ground crew traveling farther.
   A. Large bodies of water, swamps, marshes
   B. Mountains, winding roads
   C. Deep canyons (other reasonable answers possible)

5. List all the resources you can think of to help find the answer.
   Atlas, auto club, aviation charts, State and National Geological Survey,Internet map sites and road maps.

It's a Gas!

Math & Science of the Blimp

Lesson 11
Weather

Author: Jim Clay, Maplewood Local Schools
Target Audience: 7th and 8th Grade Science

Weather

Key Objective

Students will explore how the relationship between temperature, barometric pressure and air movement are used to predict the weather.

Key Standard Addressed

Read a weather map to interpret local, regional and national weather.

Procedure

Suggested time frame for this lesson is five class periods.

1. Students will use Appendix A to construct a paper spiral, develop a hypothesis, answer questions and demonstrate how a heat source causes the spiral to turn.
2. Watch the instructional video, **It's a Gas # 10: Weather**
3. Using Appendix B: Measuring Surface Temperatures as a guide, students will place thermometers around the school grounds, take temperature readings and record their results.
4. Using Appendix F: Convection Current Box as a construction guide, students will observe how air moves in the atmosphere.
5. As students report to the class about their experiments, a teacher-guided discussion should bring out the following points: The sun drives all wind patterns. Dark surfaces absorb more energy from sunlight than light surfaces causing irregular heating of the earth's atmosphere. Cold or dense air is pulled to the earth's surface and warm or less dense air tends to rise.
6. Explain how areas of high pressure usually mean sunny, fair skies and low pressure can mean cloudy, stormy weather. Discuss high and low pressure systems prior to handing out Appendix D: Weather Patterns.
7. Have students write short essays addressing how temperature and low- and high-pressure systems affect the flight of the blimp. They should also describe what weather conditions make it impossible to fly the blimp.
8. Use additional weather maps found on the CD-ROM or on the Internet at pbs4549.org/blimp to study how high- and low-pressure areas affect the weather.

Tools/Resources

It's a Gas #10: Weather

CD-ROM or computer with Internet access
VCR and TV
Handouts
Rulers
Aquarium
Spool of thread
Thermometers
Wax paper
Matches
Ice
Heat source

Assessment

Student discussions, observations, and written materials will be used to assess student success. Answer keys are included as Appendix I.

Learning Objectives

The students will:

1. Explain what happens when air is heated or cooled.
2. Explain how the temperature of air affects winds.
3. Explain how air and changes in air pressure cause winds.
4. Interpret local weather by reading a weather map.

Curriculum and Proficiency Standards Addressed

The students will:

1. Collect, organize, display and interpret data for a specific purpose or need.
2. Read, construct and interpret data in various forms (e.g. tables, charts, graphs, diagrams, symbols) produced by self and others in both written and oral form.
3. Determine how weather observations and measurements are combined to produce weather maps and that data for a specific location at one point in time can be displayed in a station model.
4. Read a weather map to interpret local, regional and national weather.
5. Apply mathematical knowledge and skills routinely in other content areas and practical situations.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Select appropriate technology resources to solve problems and support learning.
2. Use productivity tools to produce creative works, to prepare publications and to construct technology-enhanced models.

Video Synopsis

Abby and Trista find out what happens when lightning strikes the blimp. They interview a blimp pilot to find out how weather affects the blimp. He tells them that temperature and thermals affect the blimp and that wind and rain figure into the decision of when the blimp can fly.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)
Three days' worth of weather maps are available on the CD-ROM or on the Web site. Students will be able to see how high- and low-pressure areas change over time.

Learning strategies

A. Engagement

Appendix A: How Does Hot Air Behave?

Divide the class up into pairs. Each group will construct a paper spiral, develop a hypothesis, answer questions and demonstrate their spiral.

Hold a discussion about how their spiral experiment relates to the blimp (the movement of the blimp could be affected by warm air). Pose the problem: What accounts for differences in air temperatures? What is the effect on the weather of warm and cold air?

Watch the instructional video, **It's a Gas # 10: Weather**.

Evaluation of Engagement:

Use the Appendix A: How Does Hot Air Behave? Answer Key to assess student understanding.

B. Exploration

Have groups of students do one of the activities and report their findings.

Appendix B: Measuring Surface Temperatures

Explain that they need to find out where temperature differences might occur on the school property and hand out Appendix B: Measuring Surface Temperatures Worksheet. Students will place thermometers around the school, take temperature readings and record their results.

Each area, depending on the surface reflectivity and color, will have different readings even though they are done at the same time. During the follow-up discussion, the areas of the school grounds should be related to larger areas such as manmade shopping malls, housing developments, cities and naturally occurring parts of the earth such as large bodies of water, forests, deserts etc.

Appendix C: Convection Current Box

The students will observe how wind moves in the atmosphere by constructing a convection current box. Convection current is heat transfer from or to something that can flow, like air. This movement of the air sets up what we call "convection" when part of it is heated. Use Appendix C: Convection Current Box to construct the experiment.

The air in the warm end of the aquarium will expand and rise. The cool air at the other end of the aquarium will contract and sink. The cool air will flow in to replace the rising warm air. A circulating wind will develop in the aquarium. The smoke enables you to see the movement of the air. This is convection current.

Evaluation of Exploration:

Use Appendix F: Answer Key to assess student understanding.

C. Explanation

Students will report to the class what they found in their experiments.

A teacher-guided discussion should bring out the following points:

- The sun drives all wind patterns. Remember this basic principle: warm air rises and cool air falls.
- Energy from the sun causes uneven heating of the land and sea surfaces.
- Air moves from areas of high atmospheric pressure (cooler air) to areas of low pressure (warmer air), trying to equalize the density of air molecules. This movement is the wind.
- The greater the difference in air pressure, the greater the winds will be.

- On a sunny day, warm air rising from land heated by the sun flows toward the cooler water when the air sinks. The cooler air then rushes in toward land again to replace the warm air that is rising. This cycle continues as long as the daytime heating continues from the sun. Since air moves inland from the water, the wind is called a sea breeze. At night, the opposite cycle occurs. Land cools quicker than water; the air over the warmer water rises, making it flow toward cooler land where the air sinks. This reverse cycle of wind blowing out to sea is called a land breeze.
- Heat rising is called a thermal and causes the blimp to ride like a roller coaster. Explain that cold or condensed air is pulled to the earth's surface and warm or less dense air tends to rise.
- Some surfaces of the earth get hotter than others. Surfaces with darker areas are hotter. Dark surfaces absorb more energy from sunlight than light surfaces. Students should have discovered that the earth receives the most radiant energy when the sun's rays are more direct and that the dark surfaces absorb more radiant energy from the sun.
- Convection current is heat transfer from or to something that can flow. Anything that flows is called a fluid. Fluids can transfer heat by convection. This movement of the air, when part of it is heated, sets up what we call "convection."
- As air warms its molecules spread out. When there's some space between them, the molecules become less dense. This means the warm air weighs less for the amount of space it is taking up.
- Gravity pulls down cooler air because it weighs more for the amount of space it takes up. It forces the warm air up. Some of the cooler air at the bottom becomes warmer and some of the warm air at the top cools. This cool air sinks and pushes up the warm air. This constant switching is called a natural convection current.

Prior to handing out Appendix D: Weather Patterns discuss high- and low-pressure systems with the students.

- Areas of high pressure usually mean sunny, fair skies; low pressure can mean cloudy, stormy weather.
- The density of the air determines air pressure, i.e. warmer air is less dense or heavy than colder air because warm air expands and its molecules move farther apart.
- Warm air therefore exerts less pressure on the ground, creating a low-pressure region in which air is rising, cooling and condensing into clouds that can bring rain or snow.
- Cool air is denser and will sink, pulling more air behind it that will also sink, increasing pressure and temperature due to compression. In this region of high pressure, as air sinks and warms, water evaporates leaving fair skies.

Evaluation of Explanation:

Distribute a copy of Appendix D: Weather Patterns Worksheet. Have students answer the questions that accompany the map.

D. Elaboration

Have students write a short essay addressing these questions:

1. Explain how temperature affects the flight of the blimp.
2. What do pilots of the blimp need to know about low- and high-pressure systems?
3. What weather conditions do you think make it impossible to fly the blimp?

Evaluation of Elaboration:
In scoring responses to these questions, ascertain the students' understanding of the causes of high and low pressure, the differences in these pressure systems and the weather likely to accompany these pressure systems.

CATEGORY	Excellent	Good	Satisfactory	Needs Improvement
Content	Shows a full understanding of the topic.	Shows a good understanding of the topic.	Shows a good understanding of parts of the topic.	Does not seem to understand the topic very well.
Comprehension	Student is able to accurately answer almost all questions about the topic.	Student is able to accurately answer most questions about the topic.	Student is able to accurately answer a few questions about the topic.	Student is unable to accurately answer questions about the topic.

E. Final Assessment

Additional weather maps are available on the CD-ROM or on the Internet at pbs4549.org/blimp. Use these maps to study how high- and low-pressure areas affect the weather.

Tools/Resources

It's a Gas #10: Weather
CD-ROM or computer with Internet access
VCR and TV
Handouts
Rulers
Spool of thread
Heat source
Ice cubes
Aquarium
Wax paper
Thermometers
Matches

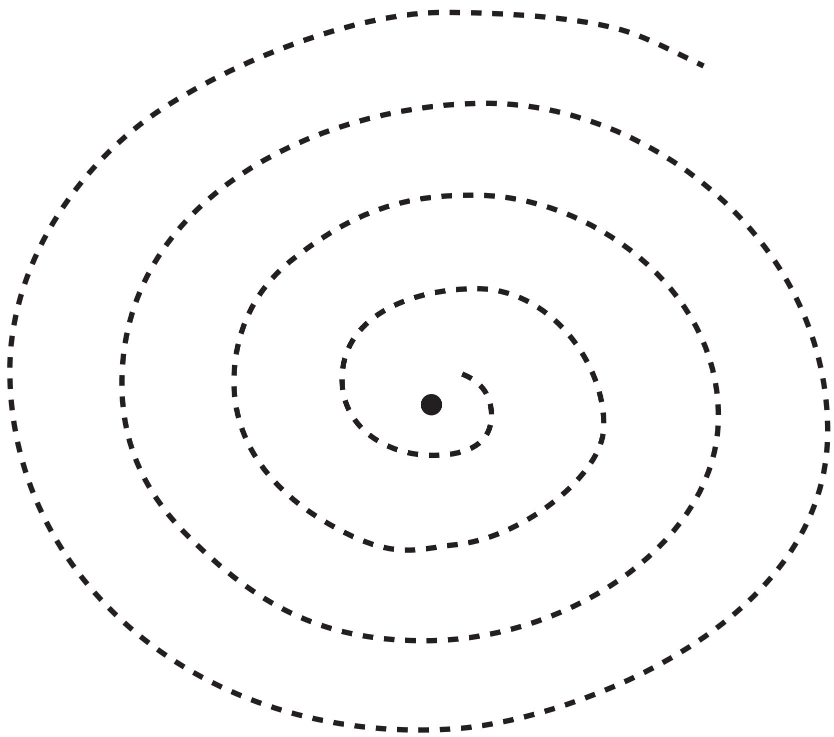
Classroom Management

Suggested Time Frame for this lesson is five to six class periods.
Pre-test spiral paper experiment and viewing of instructional video: 1 class period
Measuring Surface Temperatures and Convection Current Box: 1-2 class periods
Class discussion and Weather Map worksheet: 1 class period
Essays: 1 class period
Weather map interpretation: 1 class period

Student Groupings

Whole class discussions
Activities should be done with groups of two or three

Appendix A: How Does Hot Air Behave?



Materials:

Three-inch paper circle cut into a spiral
10-inch piece of thread
Heat source (40-watt light bulb); use caution around hot objects!

Procedure

1. CUT OUT the paper spiral along the dotted black lines.
2. PUNCH a hole through the center of the spiral.
3. THREAD a piece of string through the hole in the center.
4. TIE the piece of string at one end.
5. USE the string to hang the wind spiral over a heat source.
6. Remove the spiral form the heat source.

Before you run the experiment:

A. What will happen to the spiral when placed over a heat source?

Hypothesis:

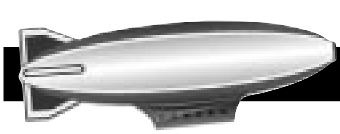
Experiment:

B. Illustrate and describe your observation.

Analysis:

C. How do you account for what happened in this experiment?

D. Did your findings support your hypothesis? Explain.



Appendix B: Measuring Surface Temperatures Worksheet

Materials you will need:

Thermometers
Meter sticks

Question: How does the sun heating up the earth affect our atmosphere?

Hypothesis:

Experiment:

1. Select sites to place thermometers that include grass, dirt, asphalt, light-colored stone or cement, and on the roof if possible. Each area should be at least ten meters square.
2. Place all of the thermometers ten cm above the ground.
3. Record the temperature from each of the sites at least three times during the day.
4. Answer the following questions:

Analysis:

A. What is producing the heat energy measured by the thermometers?

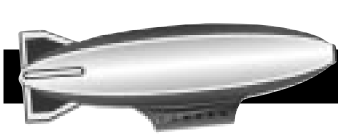
B. What surfaces create higher readings on the thermometers? Why?

C. What surfaces create lower temperatures on the thermometers? Why?

D. Did your findings support your hypothesis? Explain.

Application:

E. Hot and cold affect the flight of the blimp as it travels over the countryside and above the cities. From your temperature reading in the schoolyard, what surfaces would greatly affect the blimp in flight? Can you explain?



Appendix C: Convection Current Box

Materials needed:

Aquarium
Heat lamp and cord
Bowl of ice
Wax paper
Matches

Question: Will air move when different air temperatures are created at opposite ends of a box?

Hypothesis:

Experiment:

1. Set up the aquarium with the heat lamp shining down in one end and the bowl of ice at the other end.
2. To make clean smoke, roll some wax paper into a pencil sized tube. Use a match to light one end. After it burns for a few seconds blow the flame out but let it smolder, creating smoke. Caution: use safe practices when handling flame.
3. Hold the smoldering wax paper inside the aquarium next to the bowl of ice.
4. Answer the following questions:

A. Draw and label what you see happening to the smoke.

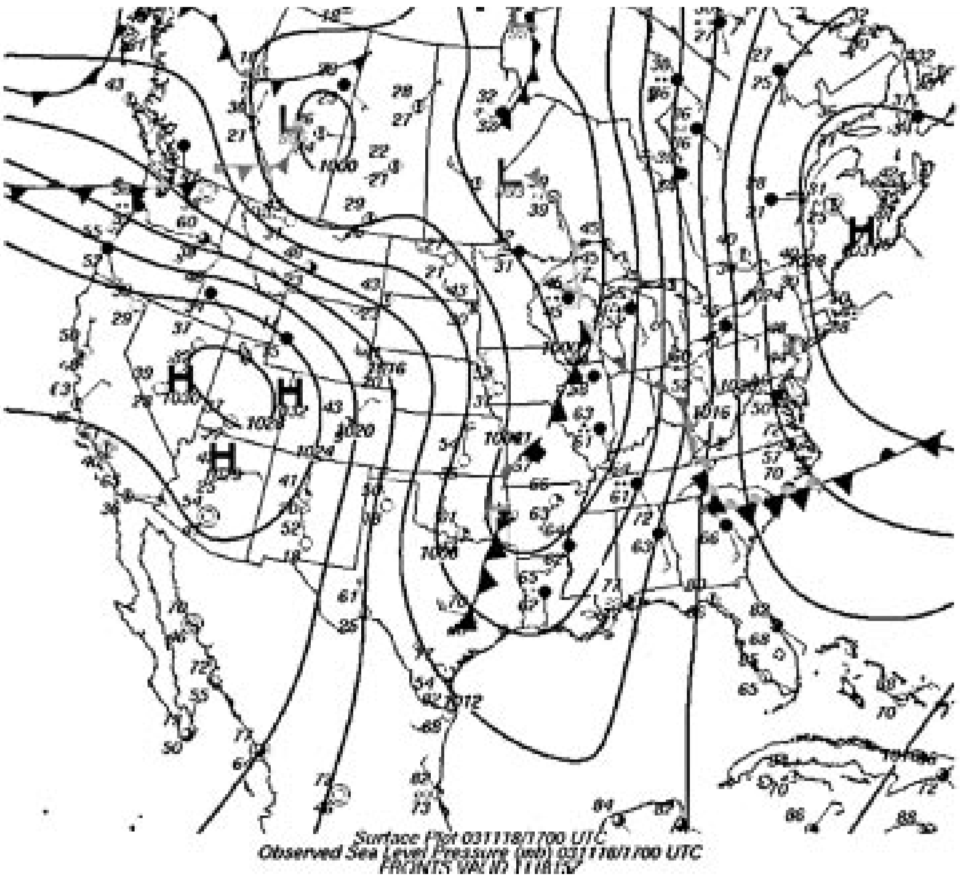
Analysis:

B. Explain what happens to the smoke.

Application:

C. How do your observations help explain wind patterns?

Appendix D: Weather Patterns Worksheet



A. Explain which areas might have more sunshine.

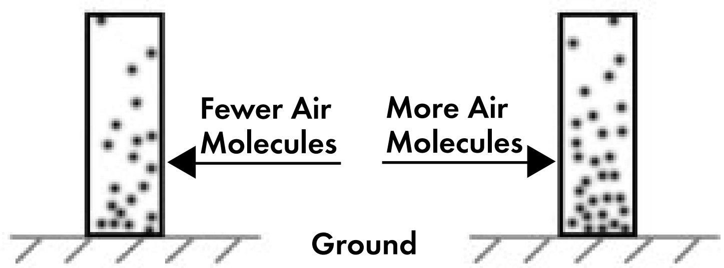
B. Explain what may be causing the low-pressure areas.

C. Explain which areas might have more clouds.

D. Explain what may be causing the high-pressure areas.

E. How is the barometer reading different in areas of high pressure and in low pressure?

1. Pictured below are two imaginary columns of air molecules exerting pressure on the surfaces below them. The left column contains fewer molecules than the right column.



Explain which one is more likely to be found over a high-pressure system.

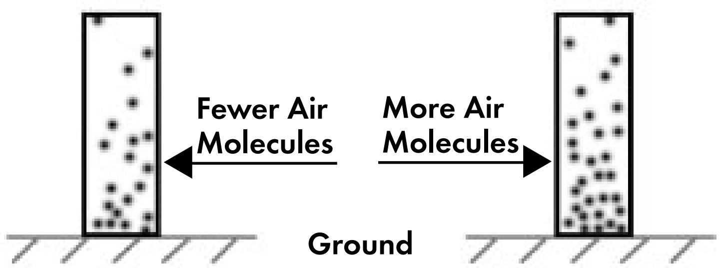
2. If a high-pressure system comes into our area, what type of weather we are most likely to encounter?
    a) Cold
    b) Dry
    c) Wet
    d) Wind

    Please explain your answer.

3. When the earth's surface is heated the tendency for the air molecules directly above it is to expand, making them less dense. This allows the air molecules to rise into the atmosphere. As air rises explain what happens to the water molecules found in the air near a body of water.
    a) They expand and explode.
    b) They cool and dry up.
    c) They cool and condense and then turn into a form of precipitation.
    d) Air pulled toward cooler land surface picks up moisture out of the air.

4. List at least three ways you are affected by atmospheric pressure in your everyday life.

1. Pictured below are two imaginary columns of air molecules exerting pressure on the surfaces below them. The right column contains more molecules than the left column.



Explain which one is more likely to be found over a low-pressure system.

2. If a high-pressure system comes into our area, what type of weather we are most likely to encounter?
   a) Cold
   b) Dry
   c) Wet
   d) Windy

   Please explain your answer.

3. When the earth's surface is cooled, the tendency for the air molecules directly above this area is to contract and make them denser. As air falls toward the cooler land, what happens to the water molecules found in the air near a body of water?
   a) They expand and explode.
   b) They cool and dry up.
   c) They cool and condense and then turn into a form of precipitation.
   d) Air pulled toward cooler land surface picks up moisture out of the air.

4. List at least three ways you are affected by atmospheric pressure in your everyday life.

Appendix A: How Does Hot Air Behave? (Answer Key)

A. What will happen to the spiral when placed over a heat source?
Hypothesis: The molecules in the air are heated by the heat source and start to expand, making them less dense. This causes them to rise into the atmosphere.

B. Illustrate and describe your observation.
Make a drawing showing this phenomenon.

Analysis:

D. How do you account for what happened?
Heated air rises. The energy from the air molecules pushes on the spiral, making it turn on the string.

D. Did your findings support your hypothesis? Explain.
Answers will vary.

Appendix B: Measuring Surface Temperatures Worksheet (Answer Key)

Question: How does the sun heating up the earth affect our atmosphere?
Hypothesis: The temperature will be hotter above surfaces that have a dark surface.

A. What is producing the heat energy measured by the thermometers?
The sun produces heat energy.

B. What surfaces create higher readings on the thermometers? Why?
Dark surfaces become hotter.
More radiant energy is absorbed into dark-colored surfaces.

C. What surfaces create lower temperatures on the thermometers? Why?
Lighter areas are not as hot.
Not as much radiant energy is absorbed into light-colored surfaces.

D. Did your findings support your hypothesis? Explain.
Answers will vary.

E. Hot and cold air affects the flight of the blimp as it travels over the countryside and above the cities. From your temperature readings in the schoolyard, what surfaces would greatly affect the blimp in flight? Can you explain?
Parking lots, plowed fields, etc.
Thermals or updrafts are caused by the uneven heating of the earth's surface due to the different colors of the earth surface.

Appendix C: Convection Current Box (Answer Key)

Question: Will air move when different air temperatures are created at opposite ends of a box?

Hypothesis: The air will go down on the cool side and rise on the hot side, causing the air to circulate.

B. Draw and label what you see happening to the smoke.

Analysis:

C. Explain what happens to the smoke.

Warm air rises because it is less dense.

Cool air sinks because it is denser.

Application:

D. How do your observations help explain wind patterns?

Wind is created when cool air moves in to replace rising warm air.

Wind is created when warm air moves over cool air.

Appendix D: Answer Key

A. Explain which area might have more sunshine.

Areas of high pressure in New England and the U.S. Southwest are having fair weather with sunshine.

B. Explain what may be causing the low-pressure areas.

Warm, rising air accompanies low pressure.

C. Explain which area might have more clouds.

Areas of low pressure will be cloudy.

D. Explain what may be causing the high-pressure areas.

Cool, sinking air will have high pressure.

E. How is the barometer reading different in areas of high pressure and in low pressure?

Millibars of pressure are greater in areas of high pressure.

Appendix E: Pre-Test Answer Key

1. Right (more air molecules)
2. High pressure brings (fair weather, little moisture)
3. D
4. Dress, comfort, etc. Any answer that shows how weather affects them.

Appendix E: Post-Test Answer Key

1. Left (fewer)
2. High pressure brings (fair weather, little moisture)
3. C
4. Any answer that deals with weather and touches their daily life.

Lesson 12
Design Technology

Authors: Joe Radza, Girard City Schools and Nadyne Stallsmith, Campbell City Schools
Target Audience: 7th, 8th, and 9th grade science and math

Lesson overview

Key Objective:
Students will design and construct a product model.

Key Standards Addressed:
Demonstrate an understanding of technology design and how to implement technological problem-solving procedures using appropriate tools and methods, analyzing risk, benefits and tradeoffs of using technology.

Procedure

Suggested time frame for this lesson is ten class periods.

1. Pose the following question: "What science and/or math ideas have we learned in the previous blimp lessons?" Have students make a list and then combine the lists on the chalkboard.
2. Watch the instructional television program **It's a Gas #11: Design Technology**.
3. Divide the class into groups and have each make a concept map showing the key science and math concepts associated with the blimp. Each group should present their findings to the class.
4. Have each group develop and display a timeline for lighter-than-air craft.
5. To get students started thinking about different uses of a blimp, use the drawing on the CD-ROM or Web site that shows what designers thought in 1923. To help students understand the relationship of the many parts of a blimp, students will use the Web activity to construct varying sizes of blimps.
6. Each student group will brainstorm new uses for a blimp and present ideas to the class.
7. The groups will choose one idea and do research to check its feasibility. They will make a presentation to support the development of the new use for a blimp.
8. Given a budget of $1,000,000 each group will design its new blimp according to Appendix C: Blimp Specifications Handout.
9. Each group will design and construct a three-dimensional diorama that shows a model blimp prototype successfully meeting the requirements of its new use. The team's written plan should accompany and support the diorama.

Tools/Resources

It's a Gas #11: Design Technology
CD-ROM or computer with Internet access
VCR and TV
Examples of timelines
Large boxes
Craft items
Scissors
Colored markers

Assessment

See Appendices A and F for activity assessment rubrics.
Test questions and answer keys are included in Appendix G.
Hold a technology fair. Invite local scientists, hot air balloon pilots, fixed wing pilots and science and math educators to judge student dioramas and written plans.

Learning Objectives

The students will:

1. Design and construct a timeline examining how technology has advanced through the contributions of different people at different times in history.
2. Investigate a new use for technology driven by the need to meet human needs and solve human problems.
3. Investigate a new use for technology that allows the students to identify a problem or need, propose designs and choose among alternative solutions for the problem.
4. Design and construct a model of a product taking into account scientific and mathematical concepts given two or more constraints.
5. Design and construct a model of a product evaluating the stages of product development and technological design (e.g. identify a problem, create a solution, evaluate the solution) using criteria relevant to the purpose.
6. Design and construct a model of a product that allows the students to recognize that a design must be continually assessed and the ideas of the design must be tested, adapted and refined.

Curriculum and Proficiency Standards Addressed

The students will:

1. Demonstrate an understanding of how scientific and mathematical knowledge is used to create and improve needed technologies to solve problems.
2. Demonstrate an understanding of how technologies are use to expand scientific knowledge.
3. Use the concepts of limitations and constraints to design a product to be used for a specific purpose.
4. Make decisions of which features to incorporate into their product given the various operating parameters of the product.
5. Demonstrate an understanding of technology design and how to implement technological problem-solving procedures using appropriate tools and methods, analyzing risk, benefits and tradeoffs of using technology.

Technology Objectives

The students will:

1. Use technology tools to process data and report results.
2. Synthesize information, evaluate and make decisions about technologies.
3. Apply technological knowledge in decision-making.
4. Identify, select and apply appropriate technology tools and resources to produce creative works and to construct technology-enhanced models.

How Technology is Integrated in this Lesson

The students will:

1. Analyze the relationships among technologies and explore the connections between technology and other fields of study.
2. Describe how design and invention have influenced technology throughout history.
3. Interpret and evaluate the influence of technology throughout history and predict its impact on the future.

Video Synopsis

Recapping the lessons they've learned throughout the series, Trista and Abby are featured in their video project, Dazzling Dirigibles.

CD-ROM Activity

(Also available on the Web at pbs4549.org/blimp)

To get students started thinking about different uses of a blimp, use the drawing on the CD-ROM or Web site that shows what designers thought in 1923.

Web site only: Students build a blimp based on the performance they need to accomplish a task, (e.g., advertising blimp, people mover or a heavy lifter). They choose the design parameters and as choices are made their design appears on an electronic drawing board.

Learning strategies

A. Engagement

This activity is designed to illustrate the connections between the science and math concepts that have been covered in the previous lessons. It is very important that this backbone of knowledge be in place in order for students to complete this unit.

1. The teacher needs to pose the following question to the class: "What science and/or math ideas have we learned in the previous blimp lessons?"
2. Students are to work individually for at least five minutes recording their ideas on paper.
3. The teacher then needs to conduct a class sharing session, calling on students to share the science and math ideas they recorded on their papers. The teacher should record all of the students' ideas. This shared list of blimp math and science ideas needs to be placed on display in the classroom for future reference.
4. After all ideas have been shared, the teacher can call on students for further explanation and/or clarification of the ideas that have been recorded.
5. The teacher needs to stress that blimp design, construction and flight is based on scientific and mathematical concepts.
6. Show **It's a Gas #11: Design Technology**.

Evaluation of Engagement:

1. Form student teams consisting of three or four students. The following jobs/roles may be assigned:
   - The Coach/Manager keeps the team on track toward meeting its goals.
   - The Recorder/Scribe is in charge of all writing done by the team.
   - The Supplier/Materials Handler is in charge of getting, taking care of and returning all materials needed by the team.
   - The Presenter/Director coordinates the team presentation of the final product.
2. The Challenge: Using knowledge gained from previous lessons, each student team will design and make a blimp science and math concept map that shows the key science and math ideas associated with the blimp. Each concept map should be structured with the main topic (Blimp Science and Math Ideas) in the center and the subtopics (Measurement, Structure of Matter, etc.) branching outward. Key details (science and math ideas) should complete the concept map as they spread outward from the subtopics.
3. Materials Needed: poster paper, rulers and colored markers
4. Information resources: Video #11, CD-ROM, Internet/library resources and work from previous blimp lessons.
5. After completing their concept maps, the students will present their work to the class. The teacher needs to monitor the student teams' presentations of their concept maps, making sure that they are including key facts. Check for any incorrect information.
6. Appendix A: Team Product Rubric may be used for evaluating the work of the student teams.

B. Exploration

Students need to understand how blimps have changed throughout history before they investigate possible new uses of blimp technology.

1. Form student teams consisting of three or four students. Assign job/roles listed in the Engagement activity.
2. The Challenge: Each student team needs to design and make a blimp timeline that shows the historic development of the blimp. This timeline may include the following information:
   a. A history of blimp designs and flight.
   b. A comparison of blimp designs and flight throughout history.
   c. A history of blimp scientific and mathematical research and application.
   d. Blimp successes and failures.
   e. Scientific discoveries that have led to a better blimp design and flight.
   f. A history of blimp inventors/designers.
3. Materials needed: poster paper, rulers and colored markers. Have examples of various timelines available for the students so that they can see good examples. Timelines can be found in history books and at various Internet Web sites.
4. Information resources: **It's a Gas**: Program 1, CD-ROM information, and Internet/library resources.
5. After completion, the student teams need to present their timelines to the class. Timelines can be placed on display in the classroom or hallway.

Optional idea: After teams have completed their individual blimp timelines, have the entire class work together to create the ultimate blimp timeline in the classroom. This can easily be done using sheets of paper, colored markers and a clothesline (with clothespins) to represent the line.

Evaluation of Exploration:

Monitor the development of the student teams' blimp timelines, making sure that they reflect correct historical development. Check and correct any misconceptions. Appendix A: Team Product Rubric may be used for the evaluation of the student teams' timelines.

C. Explanation

Students will investigate new uses for a blimp. They will also develop the design parameters required for a blimp. To get the creative juices flowing, have the students use the CD-ROM or Web site to check out the 1923 drawing of how designers thought dirigibles could be used.

1. Form student teams consisting of three or four students. Assign job/roles listed in the Engagement activity.
2. The First Challenge: Student teams need to brainstorm a list of possible new uses for the blimp, taking into account the needs of society today.
   - It is best to have the student teams develop their own lists of ideas. Encourage students to consider all areas including, but not limited to, space exploration, conservation, weather, entertainment, transportation, communication, mapping and national security.
   - Some possible new uses for the blimp could be lunar exploration, Martian exploration, mapping the land, sightseeing, weather forecasting, forestry, communication, tracking animal populations, and in some way ultimately improving the overall quality of life for people.
3. The student teams should share their brainstormed lists with the class by making an oral presentation or by posting their brainstormed lists in the classroom.
4. The teacher needs to explain to the students that they will assume the role of the engineer. The teacher needs to introduce the steps used by engineers when designing a product using **Appendix B: The Engineer's Approach to Solving Problems and Inventing a New Product**. These steps are suggested for use by student teams when designing their new blimps. The engineer:
   1. Works with his/her client to determine a need for a new product.
   2. Accepts his/her client's project and begins to plan.
   3. Determines an approach to solve the problem – develops several alternatives, evaluates each alternative as to cost, etc., and determines best alternative.
   4. Assembles all information and develops preliminary design.
   5. Develops final design calculations, drawing, etc.

    6. Publishes final plan and specifications for the project.
    7. Carries out plans.
    8. Field-tests the project.
    9. Revises, if necessary.
    10. Delivers final product to the client.

5. At this time the teacher needs to review the standard parts of the blimp with the students. These standard parts are described in Appendix C: Blimp Vocabulary.
6. The Second Challenge: The student teams will choose one of their ideas to investigate further. Each team needs to gather and record information that will support the development of their new use for a blimp. The teacher should encourage the student teams to explain why and how their new uses for the blimp will work. Teachers may ask their student teams the following design questions:
    a. Does current science and math knowledge support the team's new use of the blimp?
    b. What are the pros and cons of the new use for the blimp?
    c. What are the possible economic and environmental issues of the new use for the blimp?
    d. What is the feasibility of this new use for the blimp when comparedit to technologies that already meet that need?
    e. What changes, and/or adaptations, if any, would have to be made to the parts of the standard blimp?

Evaluation of Exploration:

1. Each student team will maintain a learning journal in which it records all information needed to design a new blimp. This information needs to include current science, math and technology knowledge and how it supports the invention of a new use for the blimp. The journal should also include the problems that need to be solved in order for the new blimp to function well. For example, a team that is trying to develop a blimp that could be used for lunar exploration would need to investigate and gather information about current ways the moon is explored, the characteristics of the lunar atmosphere and surface, and the changes that would have to be made to a blimp used on the earth so that is would function on the moon. The team-learning journal may include diagrams, written descriptions, scientific and mathematical facts, problems, solutions, alternatives, revisions and calculations.
2. After the research is finished, the teams will present their findings to the class and explain why the new use for the blimp may be possible. These presentations may include visual aids such as design diagrams, etc. The goal of the presentation is to show that current science, math and technology support the new use for the blimp. Teams need to consider the following **It's a Gas: Math & Science of the Blimp** concepts: measurement, ratio and proportion, surface area and volume, structure of matter, the gas laws, buoyancy, motion and forces, mapping and navigation, and meteorology.

    Encourage students to include the following items in their presentations:
    a. Information needed in order to design the new blimp.
    b. Blimp changes necessary in order to meet the challenges of the new use.
    c. Possible new blimp designs that will meet the challenges of the new use.
    d. The feasibility of using a blimp in this new way.
    e. Problems inherent in designing this new blimp.
3. Read team journals and check to see that correct and required information is being recorded. Challenge the teams to continue their research by writing thought-provoking questions in their journals that redirect them to find more information. The rubric shown in the Engagement section may be used to evaluate the teams' learning journals after all work is complete.
4. The student teams will use their learning journals in the Elaboration phase of this lesson.

D. Elaboration

The student teams will submit written plans for their new blimp designs. Each team will be given a budget of $1,000,000 to use to design its new blimp according to Appendix D: Blimp Specifications. The teacher will explain to the teams that they must stay within this design budget and encourage teams to make revisions or alterations to their original designs if necessary. The team's blimp design must include all the standard parts in order for it to work. (The amounts listed on the Blimp Specification Handout are estimates and not exact.)

1. Have the students continue to work in the same teams as in the previous section.
2. To help students understand the relationship of the many parts of a blimp, students can use the Web activity to construct varying sizes of blimps.
3. The First Challenge: Each student team will submit a plan of at least one page using Appendix E: Blimp Proposal. This written plan should explain the new use for the blimp in detail and also fall within the $1,000,000 budget. Any student team that uses different or additional parts for their blimp design is encouraged to investigate and report the cost of those parts. For example, if a team decides to use solar energy as a power source for its blimp, it may investigate the cost of solar panels.
4. The Second Challenge: Each student team will design and construct a three-dimensional diorama that shows a model blimp prototype successfully meeting the requirements of its new use. The team's written plan should accompany and support the diorama.
5. Team dioramas can be placed on display and presented by the student teams in a Blimp Technology Fair. The teams need to present their dioramas and accompanying written plans to an audience. This event can be held during the school day with other classes and school staff invited to be the audience for the team presentations. It can also be held after school for parents and community members.
6. Materials needed (a suggested list): large boxes, craft items, scissors, colored markers and blimp construction items brought from home by students (Safety caution! Be sure to address any safety problems concerning material brought by students from home for their diorama construction.)
7. Information resources: Previous blimp programs, CD-ROM or Web information, Internet/library resources and team journals.

Evaluation of Elaboration:

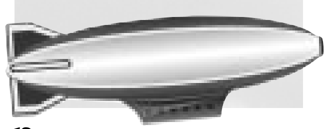
Appendix F: Blimp Diorama/Written Plan Rubric should serve as a design template. The teacher and the student teams should work together to create their own rubric appropriate for evaluating the blimp dioramas and written plan.

Optional Elaboration Activities:

1. Have students individually write summaries of what they learned about blimp science, math and design.
2. Have students investigate original blimp designers and their designs. Have students plan and make presentations about these blimp pioneers. Students could role-play these blimp pioneers and make presentations to the class.
3. Have students investigate the science and math involved in the design and operation of other vehicles (automobile, airplanes, etc.) and compare/contrast them to the science and math involved in blimp design and flight.

E. Final Evaluation

Hold a technology fair. Invite local scientists, hot air balloon pilots, fixed wing pilots and science and math educators to be judges. Since lighter-than-air expertise is not necessarily available in all communities, provide judges with all 11 programs, or at least programs 1 and 11, of **It's a Gas** for review.



Suggested Blimp and Invention Websites

Active as of July 2004.

Blimps:
http://www.howstuffworks.com/blimp.htm
http://www.goodyearblimp.com
http://www.wings.avkids.com/Book?Vehicles/beginner/blimps-01.html

Inventions:
http://www.invent.org
http://www.ideafinder.com/history/of_inventions.htm
http://www.edge.org/documents/Inventions.html

Tools/Resources

It's a Gas #11: Design Technology
TV and VCR
CD-ROM or computer with Internet access
Examples of timelines
Large boxes
Craft items
Scissors
Colored markers

Classroom Management

The time frame for all of the activities in this lesson is ten class periods. It should be noted that not all of the activities in this lesson are required. Teachers should feel free to choose the parts of this lesson that best meet the needs of their students and time constraints. The Engagement and Exploration activities are optional review activities. The Explanation and Elaboration activities must be done in sequence.

Pre-assessment: To be given the day before the lessons begin.
Engagement (Blimp Science and Math Concept Map): 1-2 class periods
Exploration (Blimp History Timelines): 1-2 class periods
Explanation (Blimp Design Investigation): 1-2 class periods
Elaboration (Blimp Model Activity): 2-3 class periods
Post-assessment: To be given the day after the lesson ends

Student Groupings

Activities in this lesson are designed to be done with the entire class acting as a cooperative team of learners and with small teams that consist of three to four students.

Appendix A: Team Product Rubric

Team understands the purpose and expected outcomes of the activity.

1 2 3 4 5 6

The team is able to complete the activity.

1 2 3 4 5 6

The team produces quality ideas, examples and information.

1 2 3 4 5 6

The team uses good writing skills (grammar, punctuation and spelling).

1 2 3 4 5 6

The team uses available resources to complete the final product.

1 2 3 4 5 6

Each member of the team carries out the duties of his/her role.

1 2 3 4 5 6

Key

1 = Minimal Evidence of Achievement
2 = Limited Evidence of Achievement
3 = Some Evidence of Achievement
4 = Adequate Evidence of Achievement
5 = Commendable Evidence of Achievement
6 = Exemplary Evidence of Achievement

Teacher/Student Comments:

Appendix B: The Engineer's Approach to Solving Problems and Inventing a New Product

The engineer:

1. Works with his/her client to determine a need for a new product.
2. Accepts his/her client's project and begins to plan.
3. Determines an approach to solve the problem – develops several alternatives, evaluates each alternative as to cost, etc. and determines best alternative.
4. Assembles all information and develops preliminary design.
5. Develops final design calculations, drawing, etc.
6. Publishes final plan and specifications for the project.
7. Carries out plans.
8. Field-tests the project.
9. Revises, if necessary.
10. Delivers final product to client.

Appendix C: Blimp Vocabulary

Unlike a balloon, a blimp has a shape and structure that enables it to fly and maneuver. The following parts allow it to do this:

The **envelope** is the large bag that holds the helium gas. The envelope is generally cigar-shaped, for aerodynamic purposes, and made of a durable, airtight, lightweight fabric (polyester composites) that is much like the fabric of a space suit. An envelope forms an external barrier to the elements and, when pressurized, serves an integral role in maintaining the airship's shape.

Nose Cone Battens are supports that radiate from the tip of the blimp. They stiffen the front of the blimp so that it is not damaged when it is moored to the mooring mast. They also give the nose an aerodynamic shape and prevent it from pushing in as the blimp travels forward. In addition to the battens, the mooring hooks are located in the nose of the blimp.

Ballonets are air-filled bags located inside the envelope. The blimp has two ballonets, one fore and one aft. They are inflated or deflated to keep the blimp's shape as the lifting gas expands and contracts

The two **catenary curtains** are located inside the envelope along the length of the blimp. They are made of fabric and sewn into the envelope, and suspension cables attach them to the gondola. The curtains help to support and shape the envelope and attach the gondola.

The **flight control surfaces** are stiff, movable parts of the blimp that are mounted to the tail. They consist of the rudder and elevators. The rudder is used to steer the blimp to the starboard or port directions (yaw axis). The elevators are used to control the angle of ascent or descent (pitch axis) of the blimp. The flight control surfaces are operated by the pilot as he/she flies the blimp.

The two **engines** on the blimp provide the thrust necessary to move ahead. The engines use gasoline fuel and are cooled by air. The engines can generate several hundred horsepower, depending upon the particular blimp. They are located on either side of the gondola.

The **air scoops** direct air from the propellers into the ballonets. This is how the pilots fill the ballonets with air while in flight. When the blimp is in the hanger and its engines are not running, electric fans move air into the ballonets.

The pilots must be able to vent air from the ballonets as well as add it. This is accomplished by **air valves** that are located on each ballonet. There are four valves – two fore, two aft.

Normally, blimp pilots do not have to add or remove helium from the envelope. However, there is a **helium valve** on the envelope that can be used to vent helium should the helium pressure exceed its maximum safe limit. The valve can be opened manually or automatically.

The **gondola** holds the passengers and crew. Some gondolas have specialized equipment, such as a camera, attached to them.

The **landing gear** is usually one wheel on the bottom of the gondola that helps steady the blimp during landing procedures.

A **railing** around the gondola allows the ground crew to hold on to the blimp during takeoff and landing.

Appendix D: Blimp Specifications

Your team has been given a budget of $1,000,000. Every blimp must have the standard parts package. From there, your team can pick and choose from the following basic technical data price list to design your blimp. In order for your airship to work, you must include a specification from each list. Equipment packages are sold for an additional cost depending on what you need your airship to do. The options that you choose should be directly related to the intended use for your blimp.

Standard Parts Package Includes

Cost: $100,000

- Nose cone battens
- Ballonets
- Catenary curtain
- Suspension cables
- Air scoops
- Air valves
- Helium valve
- Railing
- Landing gear
- Flight control surfaces
    - Rudder
    - Elevators

Power

Small ***Cost: $50,000***

- Engine=80 hp
- Cruise Speed=32 mph
- Max. Speed=55 mph

Medium ***Cost: $100,000***

- Engine=180 hp
- Cruise Speed=46 mph
- Max. Speed=63 mph

Large ***Cost: $150,000***

- Engine=210 hp
- Cruise Speed=53 mph
- Max. Speed=72 mph

Blimp Size

Small ***Cost: $125,000***

- Length=128 ft.
- Width=36 ft.
- Height=44 ft.

Medium ***Cost: $145,000***

- Length=165 ft.
- Width=46 ft.
- Height=55 ft.

Large ***Cost: $150,000***

- Length=192 ft.
- Width=50 ft.
- Height=60 ft.

Envelope

- Neoprene-impregnated polyester fabric, two-ply

Cost: $25,000

- Technologically advanced fabrics enhanced with UV protection

Cost: $30,000

Operating Altitude

- 750 ft.

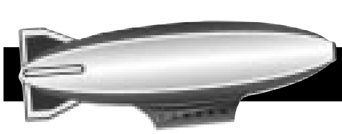
Cost: $10,000

- 1,000 ft.

Cost: $15,000

- 3,000 ft.

Cost: $25,000



Gondola

Small *Cost: $210,000*

- L=10 ft.
- H= 7 ft.
- W=5 ft.
- 3 plus pilot

Medium *Cost: $215,000*

- L=14 ft.
- H=9 ft.
- W=6 ft.
- 6 plus pilot

Large *Cost: $220,000*

- L=19 ft.
- H=11 ft.
- W=6 ft.
- 9 plus pilot

Extra Equipment Packages

- Scientific *Cost: $200,000*
- Security *Cost: $275,000*
- Transportation *Cost: $100,000*
- Advertisement *Cost: $250,000*

Fuel Tank Capacity

Small *Cost: $50,000*

- 74 gallons
- 4 gallons per hr. at 30 mph.

Medium *Cost: $100,000*

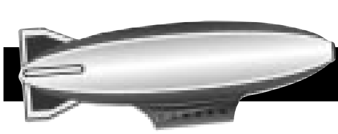
- 148 gallons
- 10 gallons per hr. at 35 mph.

Large *Cost: $150,000*

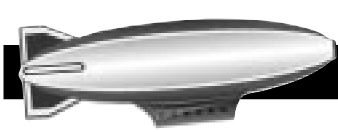
- 200 gallons
- 12 gallons per hr. at 45 mph.

Blimp Cost Analysis

Parts		Cost
1. Standard Parts Package		$100,000
2. Blimp Size	____________	____________________
3. Envelope	____________	____________________
4. Power	____________	____________________
5. Fuel Tank Capacity	____________	____________________
6. Gondola	____________	____________________
7. Operating Altitude	____________	____________________
8. Extra Equipment Package	____________	____________________
	Total Cost:	____________________



Team ____________________



Appendix F: Blimp Diorama/Written Plan Rubric

Grade A: Exemplary Achievement

Criteria:

1.
2.
3.
4.

Grade B: Commendable Achievement

Criteria:

1.
2.
3.
4.

Grade C+: Adequate Achievement

Criteria:

1.
2.
3.
4.

Grade C-: Some Evidence of Achievement

Criteria:

1.
2.
3.
4.

Grade D: Limited Evidence of Achievement

Criteria:

1.
2.
3.
4.

Grade F: Minimal Evidence of Achievement

1.
2.
3.
4.

Teacher/Student Comments:

Appendix G: Pre-Test: Design Technology

1. Mr. X, an engineer, was asked to design a new lunar vehicle for NASA. Is he able to design anything he wants? Why or why not?

2. Ms. Y, an engineer, has been hired to build a new kind of playground equipment. What factors would she have to take into consideration when designing this product?

3. You have been called upon to design a new and improved lawn mower. List the series of steps you would follow, using the engineering approach to solving problems.

Appendix G: Post Test: Design Technology

1. Ms. Y has been just hired to design and build a roller coaster for a popular theme park. Is she able to design anything she wants? Why or why not?

2. Mr. X, an engineer, was asked to design a new car for General Motors. What factors would he have to take into consideration when designing this product?

3. You have been called upon to design a new building. List the series of steps you would follow, using the engineering approach to solving problems as your guide.

1. **0 points** – No logical response given
   1 point – Student answers question with a yes or no
   2 points – Student writes explanation giving at least one idea.

   Example: 2-point response: No, designers are limited to cost, function, and use

2. **0 points** – No logical response given
   1 point – Gives one example
   2 points – Gives at least two examples

   Examples: 1point response – Names one of the following: cost, function, need, quality of life, scientific and/or mathematical knowledge
   2 point response - Names at least two of the above

3. **0 points** – No logical response given
   1 point – List one of the following steps:
   1. A need is determined (the engineer works with his/her client when determining a need).
   2. Determine plan to solve problem and meet the need (the engineer his/her client's project and determines plan to solve problem).
   3. Engineer determines approach to solve problem – develops several alternatives, evaluates each alternative as to cost, etc. and determines best alternative.
   4. Engineer assembles all information and develops preliminary design.
   5. Engineer develops final design calculations, drawing, etc.
   6. Engineer publishes final plan and specifications for the project.
   7. Engineer carries out plans.
   8. Engineer field-tests project.
   9. Engineer revises, if necessary.
   10. Engineer delivers final product to client.

   2 points – List at least two of the steps used by engineers to solve problems

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