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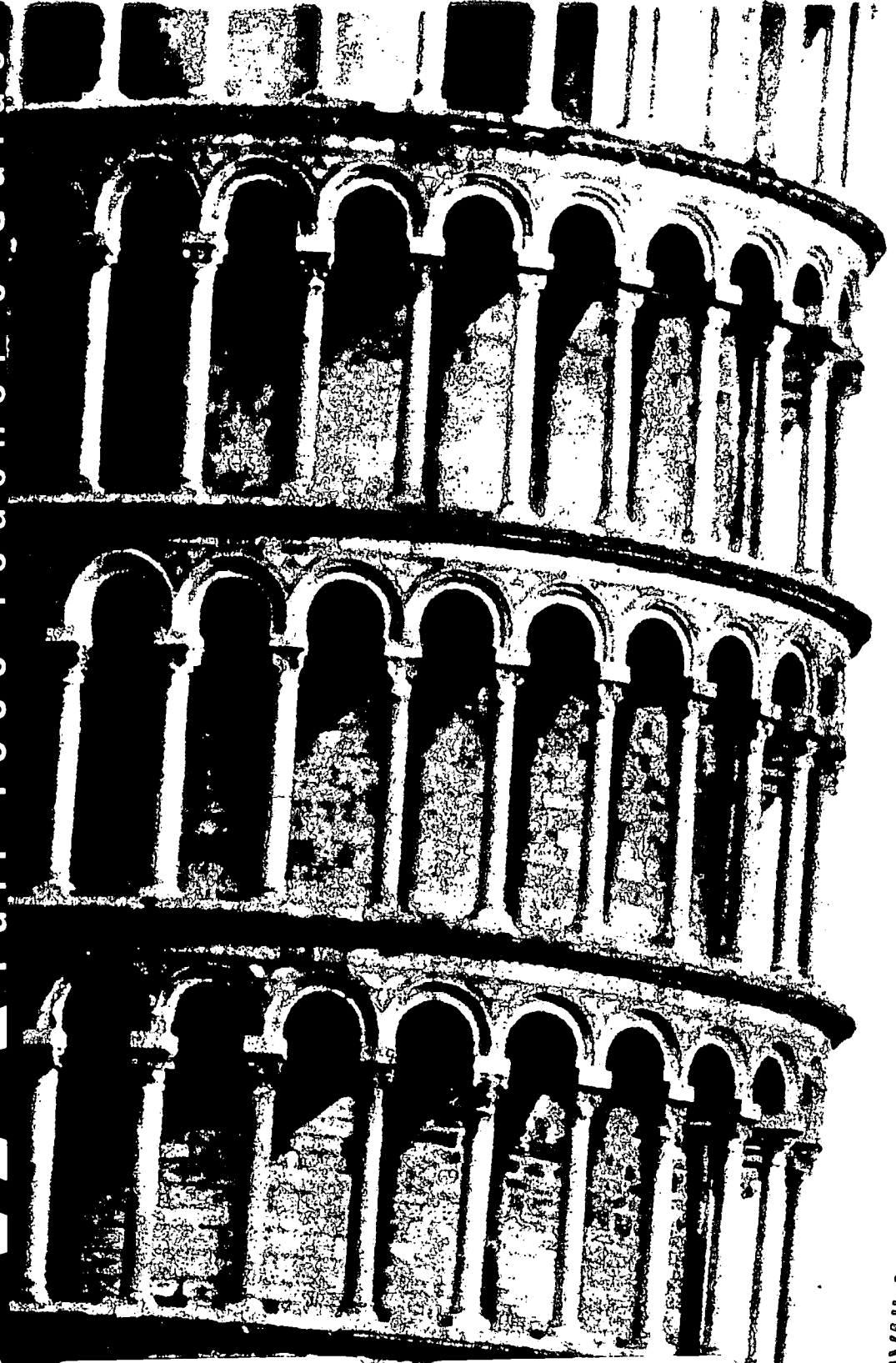
ABSTRACT

This teacher's guide complements five programs that aired on the Public Broadcasting System (PBS) in the fall of 1999. Programs include: (1) "Fall of the Leaning Tower"; (2) "Everest: The Mystery of Mallory and Irvine"; (3) "Time Travel, Decoding Nazi Secrets"; (3) "Voyage of Doom"; and (5) "Barely Breathing". It provides activity set-ups related to the programs and what to do before and after watching the programs. Activity sheets, answers for the activity sheets, and additional resources are also included. (ASK)

NOVA Fall 1999 Teacher's Guide



Fall of the Leaning Tower

As an educator, you deal with the future on a daily basis. More than that – you deal with it on a first-name basis. Every Lisa and Michael and Maria and Tyrone is a representative of future generations to be touched and inspired by your gift for teaching.

I understand how important you are to the future. Because at Northwestern Mutual Life, the future is our business, too: every day, we're helping people make personal and financial plans that will serve them well throughout their lives.

From one future-watcher to another, it is a pleasure to present you with the fall issue of the NOVA Teacher's Guide. I think you'll find this season's offerings to be rich with stimulating material for your classroom. And as proud sponsors of this award-winning educational television series, everyone here at Northwestern Mutual Life thanks you for your dedication to shaping the future.

James D. Ericson
President and Chief Executive Officer

Northwestern Mutual Life
The Quiet Company

At CNET, we support science education as a fundamental building block of a technology-driven future. For 25 years, NOVA has the opened the door on the world of science with unparalleled television programming that inspires learning and exploration. We applaud NOVA's effort to extend that spirit into the classroom where discovery begins.

CNET is pleased to bring you the Fall 1999 NOVA Teachers' Guide. The Guide is packed with information and activities to help you bring the wonders of science to your students. As masters of bringing science to life, NOVA and teachers make a great team.

As a proud sponsor of NOVA, CNET wishes all of you a successful school year.

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Broadcast Time Change

NOVA will now be broadcast at 9:00 p.m. EST (previously at 8:00 p.m. EST). NOVA is usually broadcast on Tuesday nights; check your local listings to confirm broadcast dates and times.

Contents & Broadcast Schedule

page		Earth & Space Science	General Science	Life Science	Physical Science	Social Studies	NOVA Activity
2	**NOVA in the Classroom** Find out what's new on NOVA Online and how NOVA is being used in classrooms nationwide.						
4	**Fall of the Leaning Tower*** Week of October 5		●		●	●	
	Everest: The Mystery of Mallory and Irvine* Week of October 6 (Special Wednesday 8 p.m Broadcast)		●			●	
8	**Time Travel*** Week of October 12				●		
	The Killer's Trail* Week of October 19			●			
	Island of the Spirits* Week of November 2			●			
12	**Decoding Nazi Secrets*** Week of November 9 (2-Hour Broadcast)		●			●	
18	**Voyage of Doom*** Week of November 23		●			●	
22	**Barely Breathing*** Week of November 30			●		●	
	Cracking the Ice Age (R)* Week of December 14	●					
	Electric Heart* Week of December 21			●			
	Avalanche (R)* Week of December 28				●		
26	**NOVA Video Catalog**						
36	**Ordering Guides and Transcripts**						

Because of schedule changes and space constraints, some NOVA programs do not have lessons.

* one-year off-air taping rights

(R) indicates a repeat program from a previous NOVA season.

Lesson within this guide

Lesson online at: www.pbs.org/nova/teachers/teachersguide.html

NOVA in the Classroom

Visit Us at NOVA Online!

Find content for each new fall program
NOVA Online brings you Web sites to accompany all of the new fall programs. See Resources in each lesson for details or visit our Web site at: **www.pbs.org/nova/**

Follow Shackleton's Antarctic Odyssey

www.pbs.org/nova/shackleton/
Bring your classroom along for the next NOVA/PBS Online Adventure, which will follow in the footsteps of Antarctic explorer Ernest Shackleton's infamous 1914 polar journey. The adventure will follow team members as they step ashore at Elephant Island, retrace Shackleton's ocean journey, and explore the rocky and treacherous terrain of South Georgia. The site will look at Antarctic exploration, history, science, wildlife, and more through daily dispatches, QuickTime VRs, games, articles, and interviews. Classroom Resources will include lesson plans, a place for students to create their own field reports, and related resources. The adventure begins in October. To receive more information, sign up for the teacher's listserve at: **www.pbs.org/nova/teachers/listsubscribe.html**

NOVA Online's Teachers Site www.pbs.org/nova/teachers/

Sign Up for Weekly Updates
Would you like to know what's coming up on NOVA each week, both on television and the Web site? Join our mailing list and find out. Each week we'll send you a reminder of the date and title of the following week's broadcast, and what you'll find online to help you integrate the Web into your curriculum. And we'll keep you abreast of any special programs or online adventures we're planning.

Lesson Ideas
In this section, you'll find ideas from your colleagues and lesson plans from this teacher's guide to help you integrate current and past NOVA programs and NOVA Online Web sites into your curriculum.

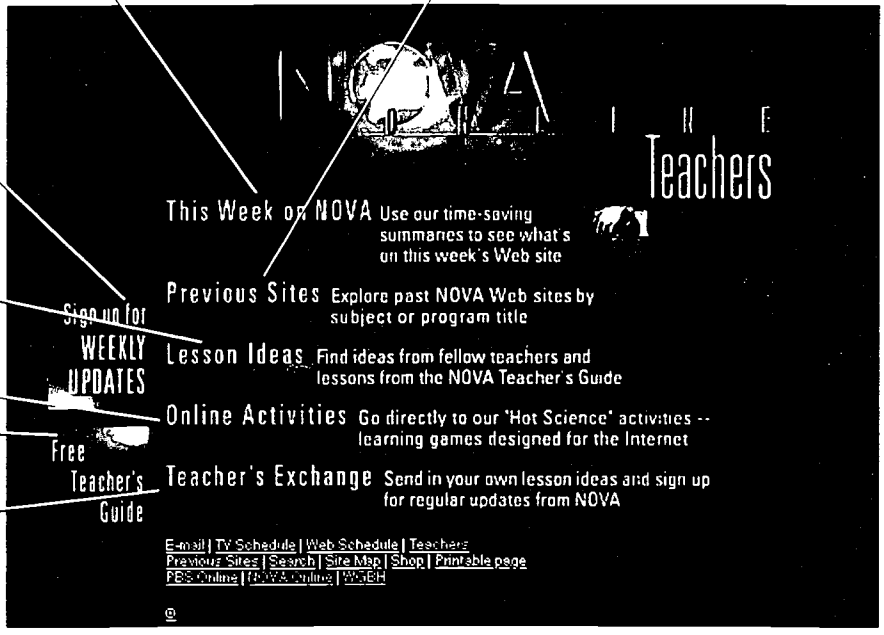
Online Activities
Click here to go to our activities designed especially for the Internet.

Teacher's Guide
Sign up to receive your free teacher's guide by mail.

Teacher's Exchange
Here you can swap ideas with other teachers about how you use NOVA.

This Week on NOVA
This section features a listing of the science articles, features, and activities on the Web site that accompany the most recent NOVA program. Brief descriptions and grade-level designations are provided for everything on the site.

Previous Sites
This section provides access by program title or subject area to Web content for previous NOVA programs.



Featured Teacher

Melting the Iceman

Don Frazier wants his students to bring the Iceman back to life.

The Iceman, believed to have lived in the Italian Alps more than 5,000 years ago, was found in 1991 with items such as a bead with rawhide strings and a cape of grass. He is featured in NOVA's Iceman and Return of the Iceman programs.

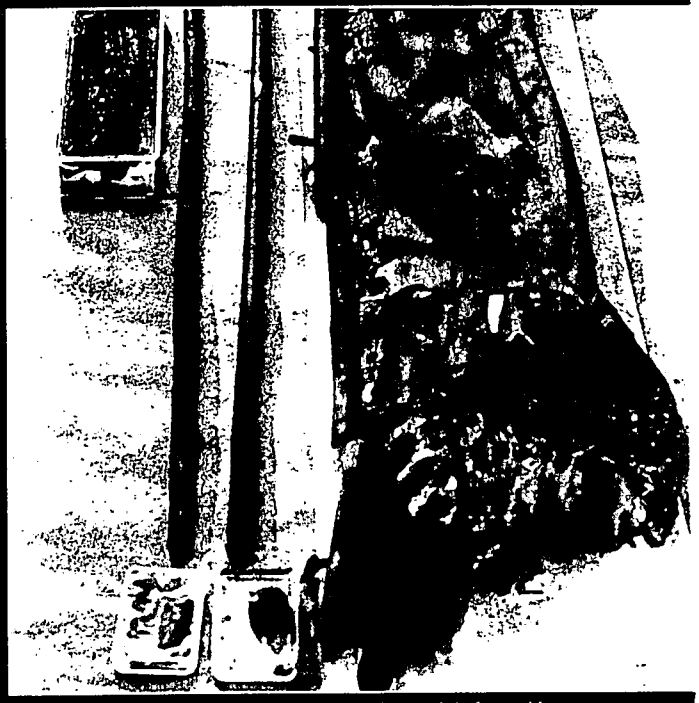
Frazier, a social studies teacher at Montpelier High School in Vermont, uses the original program in his unit on ancient history. His students first review branches of anthropology and then research information about the Iceman. After being assigned to groups, students watch the program, each taking notes on different aspects of the Iceman and his archaeological recovery.

Following the program, students pair up and create a scenario in which one plays the Iceman who has returned to life, and the other plays a reporter who interviews the Iceman. Students develop a short story explaining how the Iceman is brought to life and create a list of 10 questions for the Iceman to answer. When done, they act out their interview in front of the class.

Questions cover what the Iceman's society might have been like in Neolithic times, the way the Iceman might have made his living, and what it might have been like to live back then, such as what the Iceman might have done for fun and even what dating might have been like.

Throughout the unit, Frazier tries to address as many learning styles, or multiple intelligences, as possible. (Harvard University's Howard Gardner has proposed the following intelligences: linguistic, logical-mathematical, musical, spatial, bodily kinesthetic, interpersonal, intrapersonal, and naturalist). For example, students express linguistic intelligence through writing the short story, bodily kinesthetic intelligence through acting out the interview, and interpersonal intelligence through teamwork.

Frazier, who has been teaching for five years, also has students think critically, considering such issues as how the Iceman would react to life if he were alive now and what connections exist between people today and people of the Iceman's age 5,000 years ago.



A leather quiver, two unfinished arrows, and materials for making arrows were among the artifacts found with the Iceman's body.

The Iceman program offers interdisciplinary lesson connections as well, Frazier says, particularly in science, where connections could be made to electron microscopy and DNA analysis.

Frazier's lesson can be found on NOVA Online's Teacher's Exchange at: **www.pbs.org/wgbh/nova/teachers/ideas/icemummies.html**

Become a NOVA Featured Teacher

We'd like to hear from YOU! Tell us how you're using a NOVA program or NOVA Online in your classroom.

Send your comments to:
www.pbs.org/nova/teachers/teacherex.html
and we'll post them in our Lesson Ideas section.
Or send your ideas to:

Karen Hartley
WGBH
125 Western Avenue
Boston, MA 02134

If we choose to feature your classroom in our *NOVA Teacher's Guide*, we'll send you and your students six free NOVA videos or two Classroom Field Trip kits of your choice.

Fall of the Leaning Tower

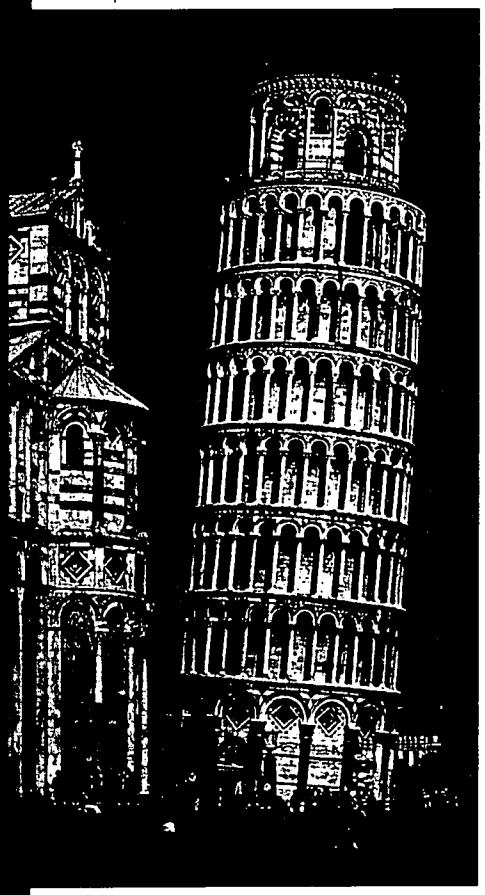
Airs the week of October 5 • www.pbs.org/nova/pisa/

Program Contents

NOVA investigates the 800-year battle between the leaning Tower of Pisa and the engineers struggling to keep it upright.

The program:

- **examines how the top of the 14,000-ton (12,700 metric tons) medieval tower has come to lean 16 feet (5 meters) off center.**
- **reveals how engineering experts offered varying solutions to prevent the tower's collapse.**
- **describes how the tower reacts to sunlight, rain, and vibrations.**
- **reviews the politics surrounding repairing the tower's lean.**
- **illustrates how extensive monitoring detects slight vibrations and movements.**
- **reveals how the tower was built on wet sand that compressed unevenly.**
- **portrays working models that predict what may happen if the tower is subjected to human interventions like propping and soil extraction.**
- **shows how many generations have tried and failed to compensate for the tower's lean.**



Before Watching

1. To give students an appreciation of the tower's weight, ask them to work in pairs to compare its weight (14,000 tons) to something familiar to them. For example, if an average midsize car weighs 1.75 tons (3,500 pounds), then how many cars would be needed to equal the tower's weight? 14 tons ÷ 1.75 tons = 8 cars.

2. Ask students to sketch three ideas illustrating how they might straighten the tower. As they watch, have students keep notes on reasons for the tower's lean and measures taken to prevent or correct it.

The Tower of Pisa has been closed to the public since January 1990. Experts hope the lean can be corrected enough so that the tower can be reopened by the year 2000.

After Watching

1. Return to students' sketches. How close were their ideas to ideas presented in the program? Compare students' ideas to those in the program and discuss the advantages and disadvantages of each.

2. Discuss attempts that have been made to straighten the tower and rate each in terms of effectiveness. Have students vote on which corrective measure they think should be pursued further.

Activity Setup

Objective

To experiment with different soil structures and the ability of each to carry a specific load.

Materials for each group

- copies of the *Hold It Up* activity sheet on page 6
- bucket each of dirt, sand, and gravel
- clear container big enough to hold a brick
- brick
- ruler with centimeter scale

Materials for teacher

- coffee can or coring device

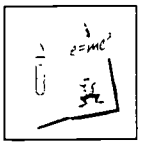
Procedure

1. Begin by discussing the nature of soil. *(See Activity Answer* on page 7 for background information.)
2. Following the discussion, take a core sample of soil from the schoolyard or other area. Study the sample and have students describe the soil's content layers.
3. Organize students into groups and distribute a copy of the *Hold It Up* activity sheet. The activity's goal is to mix the soil sample that will best support a brick on end.
4. As a class, have students decide what the experiment's parameters will be, such as whether to define a depth for the soil sample, whether all soil types must be used, and whether the materials list should be expanded to include additional soil types or other items.
5. Have students record and illustrate their sample makeup in journals.
6. Once all groups have finished, have each group stand the brick upright in the center of its soil sample. Let the bricks stand overnight. The next day, have students measure the indentations left by the bricks.
7. As a class, discuss the depth of each groups' brick indentation. Then have students try another mix, repeat the experiment, and measure again. Discuss the new results, comparing similarities and differences to the original soil samples.
8. As an *extension,* have students lay the brick on its side in the same soil mixture they used to lay the brick on end, or have students test the brick both ways after saturating the mixture with water. Are the indentations the same? If not, what accounts for the differences?

Standards Connection

The activity found on page 6 aligns with the following "National Science Education Standards."

Grades 5-8



Science Standard A:
Science as Inquiry

Abilities necessary to do scientific inquiry

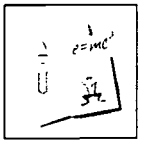
- Design and conduct a scientific investigation.
- Use appropriate tools and techniques to gather, analyze, and interpret data.
- Develop descriptions, explanations, predictions, and models using evidence.
- Think critically and logically to make the relationships between evidence and explanations.
- Recognize and analyze alternative explanations and predictions.
- Communicate scientific procedures and explanations.

Science Standard D:
Earth and Space Science

Structure of the earth system

- Soil consists of weathered rocks and decomposed organic material from dead plants, animals, and bacteria. Soils are often found in layers, with each having a different chemical composition and character.

Grades 9-12



Science Standard A:
Science as Inquiry

Abilities necessary to do scientific inquiry

- Design and conduct scientific investigations.
- Formulate and revise scientific explanations and models using logic and evidence.
- Recognize and analyze alternative explanations and models.
- Communicate and defend a scientific argument.

Hold It Up

NOVA Activity I **Fall of the Leaning Tower**

The Tower of Pisa is leaning because it was built on highly unstable ground right above an old river bed. What kind of soil is best to build on? Make your own soil mixture and see how well it supports a brick on end.

Procedure

1. Your goal is to mix a soil sample that will best support a brick standing on end. Using your materials, work with your group to make a mix you think will leave the least indentation from the brick.
2. Record and illustrate your final soil sample makeup in your journal.
3. Once your mix is done, *gently* stand the brick upright in the center of your soil sample. *Try not to push the brick down into the soil.*
4. Let your brick stand overnight. The following day, *gently* remove the brick and measure the indentation that has been left. Record the depth.
5. Based on the results of your first sample, mix a second sample that you think will better support the brick. Let stand overnight again and measure results.

Questions

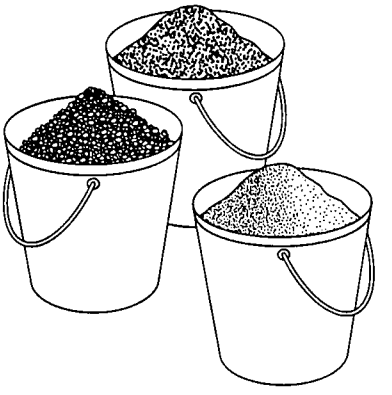
Write your answers on a separate sheet of paper.

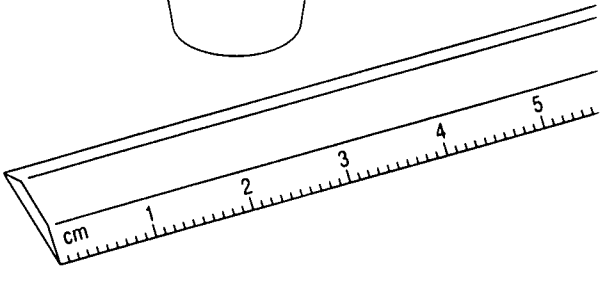
1. What did you learn?
2. How were your first and second soil samples different? Explain the reasoning behind any changes you made.
3. If you were to repeat the experiment once more, how would you change your soil mixture?
4. What other variables might affect a soil's effectiveness in holding up a building?
5. Based on what you learned, where might be a good place to build a new high rise in your town?

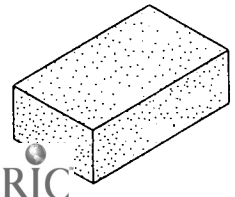
Think About It

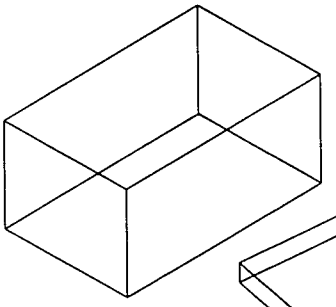
As you design your mix, consider:

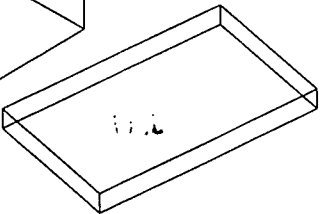
- **each type of soil.** Look individually at each type. Is it fine or coarse? How big are the particles that make it up? Describe and record the characteristics of each type.
- **how the different types of soil might work together.** How will the soil types change when you mix them together? Experiment mixing small amounts and see how the soil characteristics change. Record your results.
- **your mixing options.** Do you want to layer the soils, or mix them all up? Or do you want a layer on the bottom, a mix, and a layer on the top? Consider which combination might make the strongest foundation for your brick and why.











Activity Answer

Students' results will vary. Compare the soil makeup of the group whose brick left the least indentation to those of the other groups. In which ways are they alike? How do they differ? What might students infer from this?

Soil is made up of inorganic and organic particles. Inorganic particles include rocks and minerals, such as clay, silt, sand, gravel, and stone. Organic particles may include decomposed plants and animals and living plant roots.

The structure of soil is determined by the arrangement of particles, which account for the pore space within the soil that may be filled with air or water. The nature of soil is determined by the parent rock from which it came, the climate that has weathered it, the vegetation it contains, the topography where it lies, and the time it has had to mature. The U.S. Department of Agriculture, which maps and collects soil data, has cataloged more than 50,000 different varieties of soil in the United States.

Civil engineers specializing in soil mechanics determine whether a soil substrate is suitable to build upon, and if not, what measures need to be taken to make it safe. Civil engineers work with structures such as buildings, highways, dams, and bridges.

Resources

Article

Heiniger, Paolo. "The Leaning Tower of Pisa." Scientific American (December 1995): 62–67.
Describes how the tower has been leaning since first built, specifies the layers of soil beneath the monument, and discusses how modern technology is being used to keep the tower standing. The author is a member of the committee working to save the tower.

Web Sites

NOVA Online — Fall of the Leaning Tower
www.pbs.org/nova/pisa/
Includes a 360-degree QuickTime panorama of Pisa's famed Field of Miracles, an update on the recent soil-extraction method that slightly restored the tower's position, a look at the restoration of other monuments worldwide, and an interactive game that recreates some of the experiments Galileo conducted while in Pisa.

The Leaning Tower
www.cisiau.unipi.it/~pierotti/Torre/index-en.html
Provides the history of the tower and its construction. This site is available in both English and Italian.

The Leaning Tower of Pisa
www.endex.com/gf/buildings/ltpisa/ltpisa.html
Includes facts and figures about the tower, its history, architecture, construction details, and proposals to save the tower. This site also has press listings for current news events.

Soil Science Education Home Page
ltpwww.gsfc.nasa.gov/globe/index.htm
Contains information about how much soil there is on Earth, what soil looks like, what soil does, how soil has played a role in criminal cases, and a listing of ideas for science fair projects. This site accepts questions about soil at: globe@ltpmail.gsfc.nasa.gov.

United States Geological Survey: Learning Web
www.usgs.gov/education/
Provides background information on geologic hazards and mapping. This site also links to Ask-a-Geologist where students can send earth science questions to USGS scientists.

Time Travel

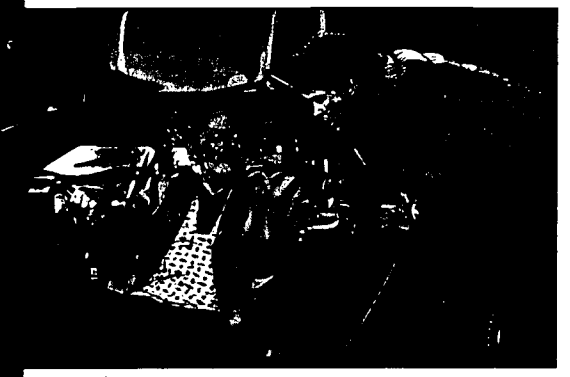
Airs the week of October 12 • www.pbs.org/nova/time/

Program Contents

NOVA examines the feasibility of time travel.

The program:

- **challenges early theories that time travel might be possible using a black hole.**
- **describes how wormholes, predicted by Einstein's theories, might provide a shortcut through time and space.**
- **shows how modern jet travel and atomic clocks have been used to prove Einstein's theory of special relativity.**
- **presents the views of such scientists as Carl Sagan, Stephen Hawking, and Kip Thorne.**
- **examines the consequences of the grandfather paradox and shows how laws of physics might prevent time travelers from changing the past, thereby affecting the future.**
- **presents a controversial experiment that claims to have sent a signal faster than the speed of light.**
- **introduces reasoning that the laws of relativity prevent a time traveler using a wormhole time machine from going back to a time before the machine was built.**
- **concludes with scientists disagreeing about the feasibility of time travel.**



Time travel has long been a popular film topic. In this 1985 film, *Back to the Future*, Christopher Lloyd's Doc Brown invents time travel, sending Michael J. Fox's Marty McFly back in time.

Before Watching

1. Have students define time. You may want to use the following quotes from the program to start your discussion: "Einstein said time is that which is indicated by a clock. I think I know what a clock is, therefore I think I know what time is." (Joe Hafele); "Time is the thing out there that flows and I go with the flow." (Kip Thorne); "Time is nature's way to keep everything from happening at once." (John Wheeler)

After Watching

1. Have students debate this quote from physicist Stephen Hawking: "Time travel might be possible, but if that's the case why haven't we been overrun by tourists from the future?"

2. Discuss with students how popular media portrays time travel in science fiction literature and movies, such as *Back to the Future, Terminator I and II, Contact,* and *Star Trek.* Why do students think time travel is such an appealing subject?

Activity Setup

Objective
To help students better understand the nature of time.

Materials for each student:
- copy of the *Measuring Time* activity sheet on page 10
- stopwatch

Materials for teacher
- stopwatch

Procedure
Have students do each of the activities outlined on the *Measuring Time* activity sheet.

How Long Have You Lived?
Students will plot their ages, and the ages of others, on a timeline and calculate what percent of their total life each person has lived (based on average life expectancies). Have students compare the percent of male and female time living at younger versus older ages on their timelines. What do they notice about the percents?

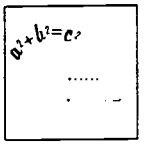
How Long Is a Minute?
Students will use a stopwatch to see how long other people think one minute is. You may want to have students do this activity themselves before and after they do the experiment with others to see whether their own perception of time changes.

Time Paradox
First discuss the implications of the grandfather paradox with students. Then have students develop their own scenarios where they go back in time and change something and have them list the many ways they think their change might affect a future timeline.

Standards Connection

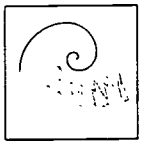
The activities found on page 10 align with the following "Curriculum and Evaluation Standards for School Mathematics."

Grades 5-8



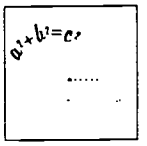
Mathematics Standard 3:
Mathematics as Reasoning

Mathematics Standard 7:
Computation and Estimation



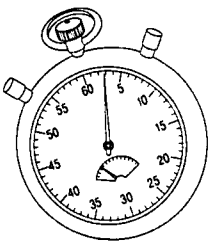
Mathematics Standard 8:
Patterns and Functions

Grades 9-12



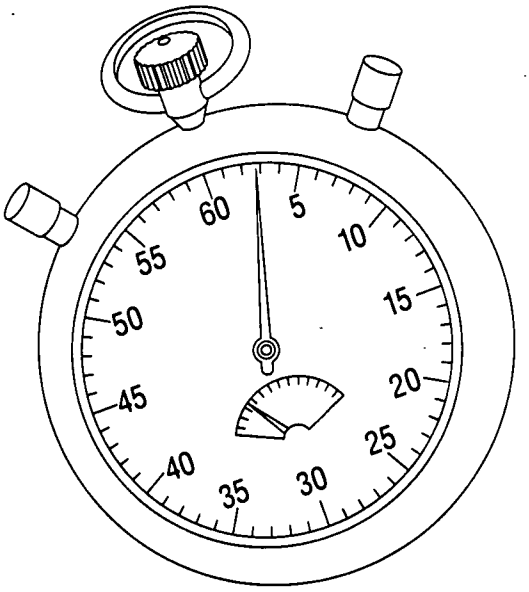
Mathematics Standard 3:
Mathematics as Reasoning

Measuring Time



NOVA Activity I **Time Travel**

What is time anyways? What amount of time have you lived? Does time mean the same thing for everybody? If you traveled back in time and changed something, how might your change affect the future? Make the time to do these activities and find out.



How Long Have You Lived?

If you are 11, what percent of your life have you lived? What about if you are 40? Or 70? Or 90? Plot the ages of your friends, brothers, sisters, cousins, aunts, uncles, parents, grandparents, and great grandparents and then — using the average expectancy — figure out what percent of their lives they have lived. According to the U.S. Census Bureau, the average female born today is expected to live to 80 and the average male born today to 73.

How Long Is a Minute?

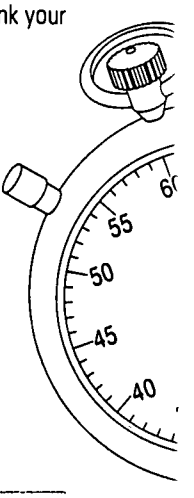
How long is a minute? Well, that might depend on who you ask. Try this activity and see if a minute means the same to everyone:

- Get a stopwatch.
- Choose people of different ages and genders and ask them to tell you when a minute is up after you start the stopwatch.
- Record each person's name, age, and gender and how long each person thought a minute was.
- Once you have recorded all your data, look for any patterns that might explain why some people think a minute is more or less than an actual minute.

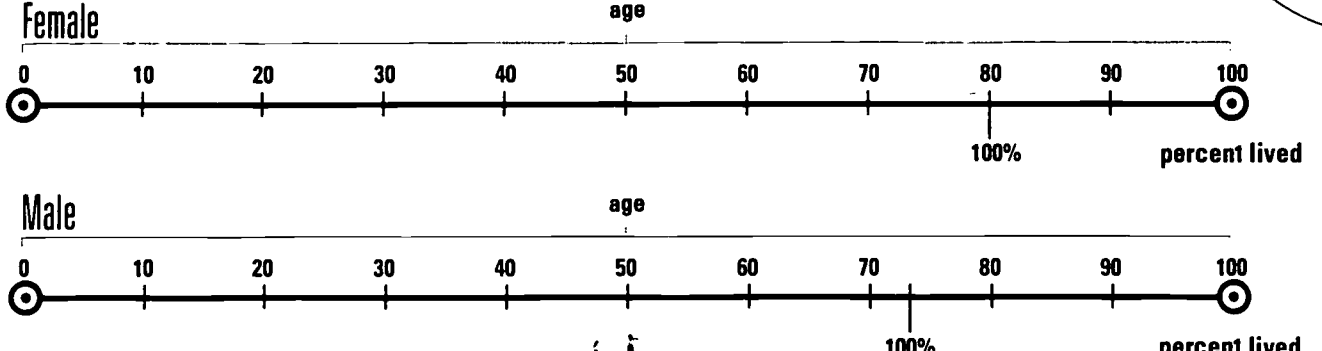
Time Paradox

One of the complications with time travel is an idea known as the grandfather paradox. Stated simply, it says that if you traveled to the past and accidentally killed your grandfather before your parents are conceived, there would be no way for you to be born. Therefore, you would not exist to travel back in time in the first place. So how could you have killed your grandfather?

Develop your own scenario where you go back in time and change something. List the many ways you think your change might affect a future timeline.



Average Life Expectancy



Activity Answer

How Long Have You Lived?

Percents will differ for males and females. In the examples given:

males living until 73-year life expectancy	females living until 80-year life expectancy
(current age) ÷ (life expectancy) = (percent of life lived) **i.e.** 11 year old male ÷ 73 = .15 (15%)	
11 years old = 15 percent 40 years old = 55 percent 70 years old = 96 percent 90 years old = 123 percent	11 years old = 14 percent 40 years old = 50 percent 70 years old = 88 percent 90 years old = 113 percent

How Long Is a Minute?

Students may be surprised to find a wide variability in how long people think a minute is. Encourage students to look for correlations in age, gender, and other variables.

Time Paradox

Students may think that smaller changes, such as taking something like a book, may not have as big of an impact as stopping someone from being assassinated. But this can be misleading. The book removed by the time traveler may have been the inspiration for a modern invention that greatly affected society, or the precursor to a new line of scientific thought. Just the presence of an observer can affect the timeline, such as the time traveler who, by just being in a certain place, causes an accident in which someone dies or otherwise changes the course of her life.

Resources

Books

Hawking, Stephen W. "A Brief History of Time: From the Big Bang to Black Holes."
New York: Bantam Books, 1988.
Describes what we know of the universe and includes discussions on space and time and the direction of time.

Nahin, Paul J. Time Machines: "Time Travel in Physics, Metaphysics, and Science Fiction."
New York: Springer-Verlag, 1999.
Explores time and space, time travel, and some of the paradoxes involved in time travel. The author examines the science and science fiction of many popular ideas.

Sagan, Carl. "Contact."
New York: Simon and Schuster, 1985.
This is a fictional account of looking for evidence of life other than on Earth and describes the physics involved in making such a journey.

Web Sites

NOVA Online — Time Travel
www.pbs.org/nova/time/
Includes text and audio from Carl Sagan about subjects ranging from wormholes to the nature of time, an excerpt from a book by an author who claims time travel is possible, a dictionary of words and concepts scientists use when discussing time travel, and an interactive game that encourages players to "think like Einstein."

Everything You Always Wanted to Know About Time Travel
epunix.biols.susx.ac.uk/Home/John_Gribbin/Time_Travel.html
Provides background information on time and the universe and the possibility of time travel.

Time Travel: Fact or Fiction?
math.ucr.edu/home/baez/physics/time_travel.html
Describes the problems and paradoxes of time travel.

Decoding Nazi Secrets

Airs the week of November 9 • www.pbs.org/nova/decoding/

Program Contents

NOVA tells the story of how the Allies are able to crack codes produced by Enigma, a supposedly impenetrable German cipher machine, and thereby influence the course of WWII.

The program:

- **describes how Enigma can produce more configurations for any particular message than there are grains of sand on Earth.**
- **tells how the British government secretly invited men and women of all ages and abilities — including Egyptologists, anthropologists, paleontologists, mathematicians, and crossword puzzle enthusiasts — to unravel the Enigma cipher at Station X, a mansion 50 miles (80 kilometers) north of London.**
- **relates the patience, team effort, and absolute secrecy needed to accomplish the task.**
- **explains how codebreakers at Station X recognized the role that human error played in helping to break the code.**
- **describes how the work at Station X gave Allied commanders essential information to attack the enemy effectively and reroute military personnel to avoid German attack.**

Before Watching

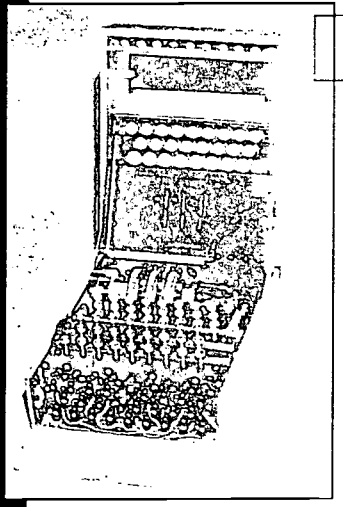
1. Discuss the meanings of codes and ciphers using the information to the right.

2. To help students understand the use of passwords in their current lives — for such things as locker locks, cell phones, ATMs, and computers — have them do the *Password Protection* activity on page 16. Discuss what students consider when choosing a password. To complete the activity, create small groups and follow the instructions on the activity sheet. Compare student answers to the master lists in *Activity Answer* on page 17.

3. Have students discuss the kinds of people they would choose if they were recruiting codebreakers. As they watch, have students record the kind of members asked to join the Station X team and the characteristics they possessed.

Codes and Ciphers

Codes and ciphers have specific meanings in the world of military intelligence. *Codes* are symbols, letters, or letter groups which represent whole words or concepts. For example, a U.S. Navy code, KE3, represents: "This unit is being harassed by gas." The relationship between a code and its meaning is unchanging for the life of the code. *Ciphers* are messages in which letters or symbols replace real letters. Encrypting a cipher is done one letter at a time using a cipher code.



After Watching

1. Discuss with students the kind of qualities necessary for a team to work as effectively as the one at Station X. Did students see any of the characteristics they chose before watching? Did the codebreakers include any characteristics students had not considered?

The Enigma cipher machine contained three code wheels. A letter typed into the machine would be converted to some other letter; then the entire mechanism would rotate.

Activity Setup

Objective

To allow students to experience how ciphers can conceal and protect information.

Materials for each student

- copy of *Operation Decode* activity sheets on pages 14–15
- scissors
- paper brad

Procedure

Part I

On the board copy the cipher and alphabet from the *Operation Decode* activity sheet so that the class can decode together.

Distribute materials and follow the instructions on the activity sheet. Before deciphering, discuss possible strategies to break this cipher. Tell students the message is from Winston Churchill to the members of Station X. If students experience difficulty, use the key in *Activity Answer* on page 17 to provide the letters for the word SOMETHING.

Students may work individually or in teams. Encourage them to share discoveries with the class, and as they decipher, print letters over each word in both the cryptogram and alphabet.

List all successful strategies students use to help decipher.

Part II

Follow the directions on the activity sheet. (Point out that the cipher is what they will write on the outside rim.)

When students determine their own setup configurations, tell them the first number can be any number from 1 to 26, but the second should be no greater than 5 (as moving the disk becomes a problem).

Standards Connection

The activity found on pages 14–15 aligns with the following "National Science Education Standards."

Grades 5-8

Science Standard G: History and Nature of Science

Science as a human endeavor

- Women and men of various social and ethnic backgrounds — and with diverse interests, talents, qualities, and motivations — engage in the activities of science, engineering, and related fields such as the health professions. Some scientists work in teams, and some work alone, but all communicate extensively with others.
- Science requires different abilities, depending on such factors as the field of study and type of inquiry. Science is very much a human endeavor, and the work of science relies on basic human qualities, such as reasoning, insight, energy, skill, and creativity — as well as on scientific habits of mind, such as intellectual honesty, tolerance of ambiguity, skepticism, and openness to new ideas.

Grades 9-12

Science Standard G: History and Nature of Science

Science as a human endeavor

- Individuals and teams have contributed and will continue to contribute to the scientific enterprise. Doing science or engineering can be as simple as an individual conducting field studies or as complex as hundreds of people working on a major scientific question or technological problem. Pursuing science as a career or as a hobby can be both fascinating and intellectually rewarding.

Part 1

Operation Decode

NOVA Activity | **Decoding Nazi Secrets**

You have been chosen by the British Secret Service to be a member of Station X, the highly secret organization set up to decode German messages during WWII. To prove you are up to the job, decode this cipher sent to you from your leader, Winston Churchill.

Procedure

(1) Decode this cipher. As you discover what each cipher letter represents, **print it over the actual letter** in the following alphabet.

cipher:																									
actual:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

Lx law bxpwnkwgiwky gl Ylgljxc V,

Gy mxe icxo law Cgfjy agzw jczgpwp Uxtgcp gcp gkw lakwglwcjcq gtt xh Wekxuw. Mxek bxeclkm gcp law oxktp cwwp mxek awtu! J agzw baxywc mxe nwbgeyw mxe agzw law hjcwyl sjcpy lx yxtzw law oxktp'y sxyl pjhhjbetl uefftw — WCJQSG. Mxe seyl oxki dejbitm gcp jc ywbkwl awkw gl Ylgljxc V ecljt mxe nkwgi law bjuawk.

Rxttm qxxp tebi!

Yjk Ojcylxc Baekbajtt

Part 2

Operation Decode

NOVA Activity I **Decoding Nazi Secrets**

Procedure

In *Part I*, you broke a simple cipher. Now try creating a more complex cipher.

① Cut out the NOVA Decoder Ring and NOVA Cipher Code Ring on this page and the window marked INDEX.

② Neatly copy the decoded letters from the alphabet in *Part I* into the outside spaces of the Decoder Ring. For example, you would write cipher **Y** over the actual letter **S** and cipher **X** over the actual letter **O**. When you finish, encrypt this simple message.

simple cipher: _____

actual: L O O S E L I P S S I N K S H I P S

③ You are now going to put this simple message into a complex cipher. To do this you need the Cipher Code Ring. Place the Cipher Code Ring over the Decoder Ring and attach at the center with a paper brad. Note that a number is visible through the window marked INDEX.

④ Cipher codes require setup configurations and today's configuration is 3/1. Set the index number to the first number **3**. If you are encrypting *LOOSE LIPS SINK SHIPS*, the first actual letter **L** becomes cipher letter **C**.

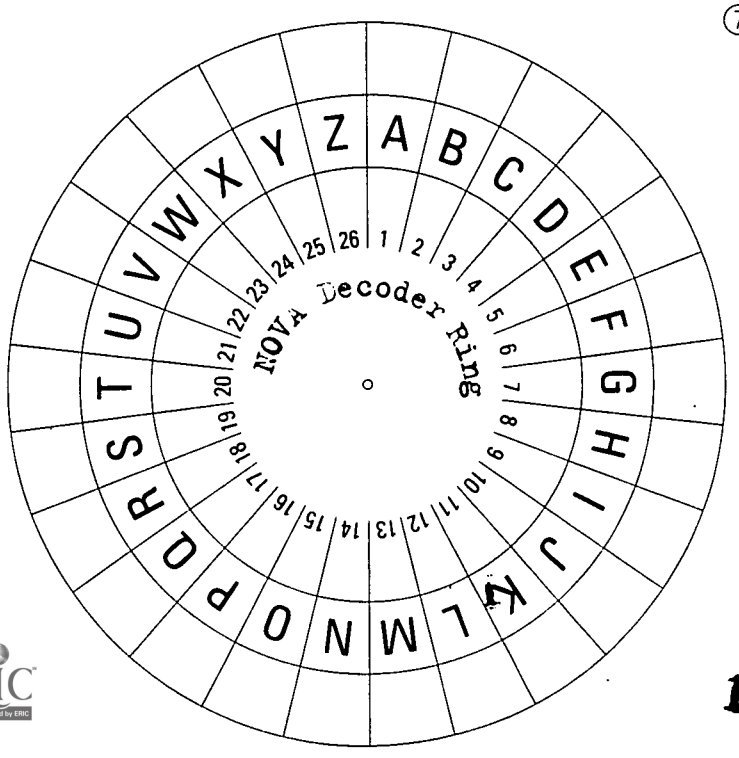
⑤ The second number of your setup configuration, **1**, tells you to increase the number in the index window by one before encrypting the next letter. Rotate the ring one space clockwise. Be sure that the lines of the two rings line up. The encrypted letter above **O** is now **K**. For the third letter, rotate again 1 space until the index window reads **5** and the encrypted letter for **O** is **Y**. Continue to rotate and encrypt to put this simple message into a complex cipher.

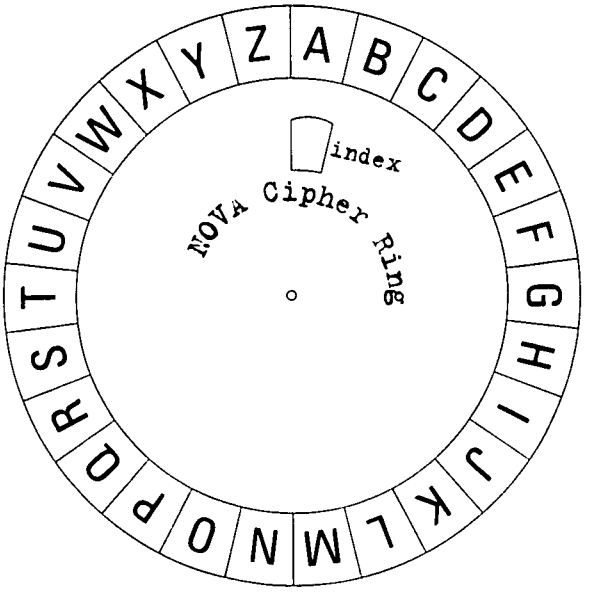
complex cipher: C K Y _____

actual: L O O S E L I P S S I N K S H I P S

⑥ Look at your cipher. Can you use any of your earlier strategies to decode this? Why?

⑦ Send a message to a friend using cipher code. Remember your partner must know the setup configuration in order to decode your message.

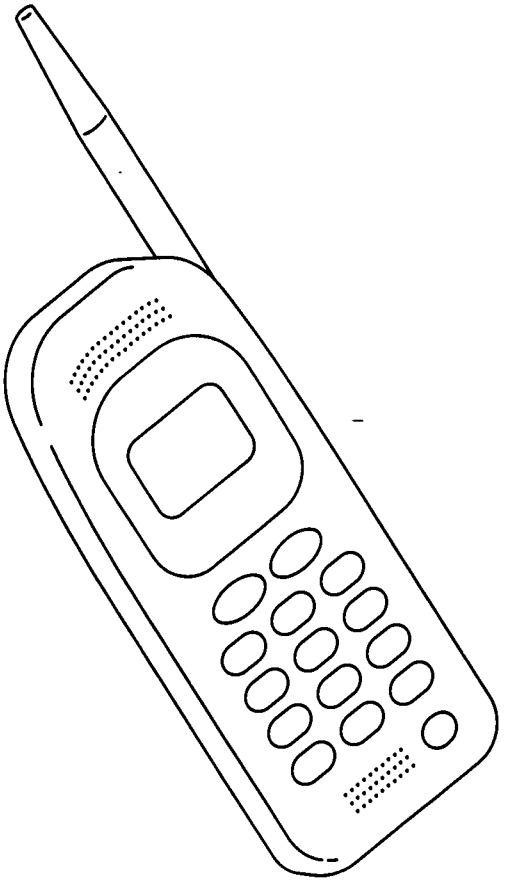




Password Protection

NOVA Activity I **Decoding Nazi Secrets**

When choosing a password, many people choose something that is easy to remember. But how secure are these kinds of passwords? Do this activity and find out.



Procedure

① Read these three biographies. For each, write a list of possible four- to eight-letter passwords they might use for their cell phones, computers, or ATM machines.

a) Miss Elisia Valdrez is a retired grade one teacher.

b) Michael Thomas is a high school football coach.

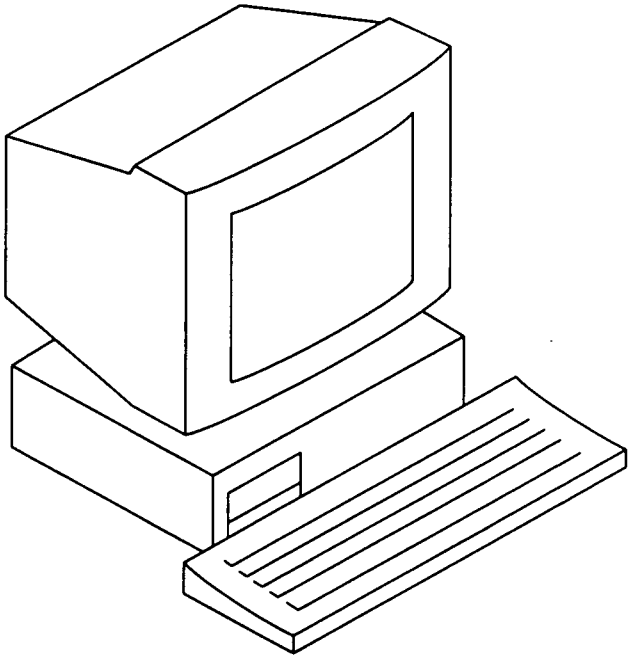
c) Ling loves mathematics and dates Ken. Her two cats are Samantha and Tigger.

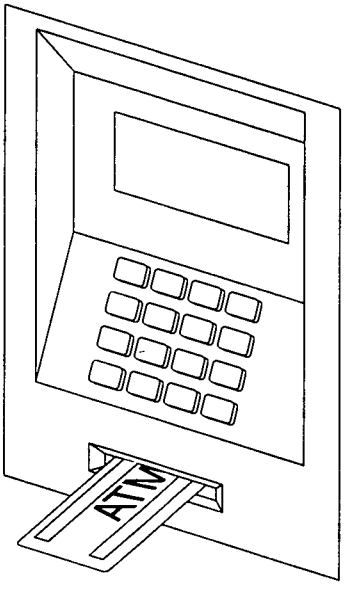
Questions

Write your answers on a separate sheet of paper.

① What kind of passwords are easy to remember but hard to guess?

② List any of your current passwords. Do you feel your current passwords are: (a) relatively secure, (b) somewhat at risk, or (c) should be changed ASAP!? If you think they should be changed, why?





Activity Answer

Password Protection

People choose passwords they can easily remember. These master lists include some words that may appear on students' lists:

a) *Miss Elisia Valdrez:* RECESS, TEACHER, CHALK, BOOK, MISST, RETURN, SCHOOL, GRADE1, ABCDEFG

b) *Michael Thomas:* COACH, HIKE, SCRIMAGE, PIGSKIN, HUDDLE, FUMBLE, PUNT, TACKLE, SUPRBOWL

c) *Ling:* TIGGER, TIGSAM, ALGEBRA, CALCULUS, KITTIES, TWOCATS, MATHWHIZ, SANDT, ILUVKEN

Good passwords are unrelated single syllable words that form a password students can visualize and remember. (PIZZACOLA, FOOTBOOK)

Operation Decode

Some possible strategies to break this cipher code include looking at spaces, punctuation, and double letters. Single letters are probably the letters A or I, the only single letter words. Students may list as many two-letter groups they can think of and then see whether they seem to fit anywhere (i.e. as, an, if, is, in, of, so, to). They may also first figure out the greeting and signature lines. The process includes trial-and-error substitution while looking for the sense of the message. The correct cipher code alphabet and decoded cipher follow.

cipher:	G	N	B	P	W	H	Q	A	J	R	I	T	S	C	X	U	D	K	Y	L	E	Z	O	V	M	F
actual:	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z

To the codebreakers at Station X,
As you know the Nazis have invaded Poland and are threatening all of Europe. Your country and the world need your help! I have chosen you because you have the finest minds to solve the world's most difficult puzzle — ENIGMA. You must work quickly and in secret here at Station X until you break the cipher.
Jolly good luck!
Sir Winston Churchill

By itself, the NOVA Decoder Ring can encrypt and decode simple ciphers, but as the students demonstrated, these ciphers are not highly secure. The same letters always substitute for each other.

simple cipher:	T	X	X	Y	W		T	J	U	Y		Y	J	C	I		Y	A	J	U	Y				
actual:	L	O	O	S	E		L	I	P	S		S	I	N	K		S	H	I	P	S				

But a complex cipher is more secure because it requires more strategies to crack it. The cipher letters used to represent actual text change after each letter is encrypted.

complex cipher:	C	K	Y	V	I		Y	D	M	B		P	E	G	M		A	V	F	A	T				
actual:	L	O	O	S	E		L	I	P	S		S	I	N	K		S	H	I	P	S				

Resources

Books

Hinsley, F.H., and Alan Stripp, editors. "Codebreakers: The Inside Story of Bletchley Park."
New York: Oxford University Press, 1994.
Provides a compilation of accounts by many of the leading codebreakers at Bletchley Park.

Kahn, David. "Seizing the Enigma: The Race to Break the German U-Boat Codes, 1939–1943."
Boston: Houghton Mifflin Company, 1991.
Examines the history of the cracking of the naval Enigma and its impact on the U-boat war in the Atlantic.

Web Sites

NOVA Online — Decoding Nazi Secrets
www.pbs.org/nova/decoding/
Includes an article describing how the Enigma machine works, insights into the minds of the Engima codebreakers, a feature on how encryption affects people on the World Wide Web today, and an interactive game that allows students to encode their own messages, e-mail them to a friend, and then have the messages decoded.

Bletchley Park
www.cranfield.ac.uk/ccc/bpark/morebpark.htm
Describes the work at Bletchley Park, contains links to other sites with information on Bletchley Park including a "virtual Enigma" to type personal coded messages (Java-enabled browser required).

Voyage of Doom

Airs the week of November 23 • www.pbs.org/nova/lasalle/

Program Contents

NOVA follows a team of archaeologists that excavates the wreck of *La Belle* in Texas' Matagorda Bay. In 1685 French explorer Rene Robert Cavalier, Sieur de La Salle, sailed the ship from his native France to establish a colony at the mouth of the Mississippi River.

The program:

- **recounts La Salle's career as an explorer and describes his four-ship expedition to the New World.**
- **describes the problem of excavating in silty water.**
- **shows steel cofferdam construction and removal of most of the water inside.**
- **reviews the use of a *stadia* — a telescopic instrument used to measure distances — to map the site and its artifacts.**
- **shows artifacts found, including wooden containers, rope, pewter and ceramic items, and weapons carried in the ship's hold.**
- **examines a human skeleton and illustrates forensic techniques used to determine age and gender and reconstruct facial features.**
- **speculates how the ship sank and La Salle's final attempts to locate and claim the mouth of the Mississippi River.**

Before Watching

1. Have students locate France on a world map or globe (preferrably one with tradewinds or currents) and trace the possible route La Salle might have taken to reach the southern United States. Have students calculate the trip's distance and estimate how long it might have taken to make the journey.

2. As students watch, have them note the different kinds of artifacts discovered on *La Belle*. Have students classify each artifact as household goods, defense item, exploration item, or other.

The Matagorda Bay cofferdam was constructed by sinking pilings into the seabed, building a double wall around the excavation area, filling the space between the walls with sand, and pumping water out of the inner cavity.

After Watching

1. Discuss with students La Salle's various attempts to locate the Mississippi River. What tools did La Salle use for navigation? What might today's explorers use? What did La Salle and his crew undergo to try and reach their final destination? What current-day explorers can students think of that have gone to similar lengths? What might motivate these explorers?

2. Have students debate whether funds should be spent on excavating and restoring a historical ship such as *La Belle* that contains no conventional treasure, such as gold or gems.

Activity Setup

Objective

To design and construct a simple cofferdam and consider the advantages and disadvantages of modeling.

Materials for each group:

- copies of the *Build a Cofferdam* activity sheet on page 20
- scissors
- 1-gallon (4-liter) milk jug, with the top third cut off, leaving about 6 inches (15 centimeters) in height
- 101-fluid ounce (3-liter) soda bottle, top and bottom cut off so that the remaining cylinder is 6 inches (15 cm) high
- 68-fluid ounce (2-liter) soda bottle, top and bottom cut off so that the remaining cylinder is 6 inches (15 cm) high
- soup ladle or other device to remove water
- pair of forceps or tongs
- sand
- water
- small objects such as marbles, dimes, and pennies

Procedure

1. Once students have seen the program, discuss the principles of how the cofferdam kept most of the water from re-entering the site once it was pumped out.
2. Assign students to groups and distribute the *Build a Cofferdam* activity sheet. Lay out one set of the supplies. Have students talk through the requirements listed on their activity sheet and consider whether they would like any additional materials added to the existing list.
3. Before students begin building, have each group design its cofferdam on paper.
4. Once you have checked their designs and helped students problem solve any major obstacles, distribute materials to each group and have students execute their design. Have students keep a record of their progress.
5. Once the cofferdam is built, have students recover their artifacts, map where the artifacts were in relation to each other, and describe and record each artifact in their journal.
6. Have a class discussion about how well each cofferdam worked and what students might do differently if they were to build it again.
7. To complete the lesson, have students assess their model in terms of how accurately they portrayed a full-scale cofferdam. What does the model show that would be useful for engineers? What does the model not take into account?

Standards Connection

The activity found on page 20 aligns with the following "National Science Education Standards."

Grades 5-8

Science Standard E:
Science and Technology

Abilities of technological design

- Implement a proposed design. Students should organize materials and other resources, plan their work, make good use of group collaboration where appropriate, choose suitable tools and techniques, and work with appropriate measurement methods to ensure adequate accuracy.

Understandings about science and technology

- Science and technology are reciprocal Technology is essential to science, because it provides instruments and techniques that enable observations of objects and phenomena that are otherwise unobservable due to factors such as quantity, distance, location, size, and speed. Technology also provides tools for investigations, inquiry, and analysis.

Grades 9-12

Science Standard E:
Science and Technology

Abilities of technological design

- Implement a proposed solution. A variety of skills can be needed in proposing a solution depending on the type of technology that is involved. The construction of artifacts can require the skills of cutting, shaping, treating, and joining common materials — such as wood, metal, plastics, and textiles.

Build a Cofferdam

NOVA Activity | **Voyage of Doom**

To construct a cofferdam you need to sink pilings into the seabed, build a double wall around an area, fill the space between the walls with sand, and pump water out of the inner cavity. Do you think you can build a cofferdam model that keeps water out of an enclosed area? Work with your group and see.

Procedure

① Look at the materials your teacher has laid out and consider the *Cofferdam Requirements* listed.

② After you have talked about the requirements, think about whether you would like to add anything to the materials shown.

③ Build your cofferdam.

Questions

Write your answers on a separate sheet of paper.

① What was the most difficult part of building a cofferdam? What might you do differently next time to solve any problems you had?

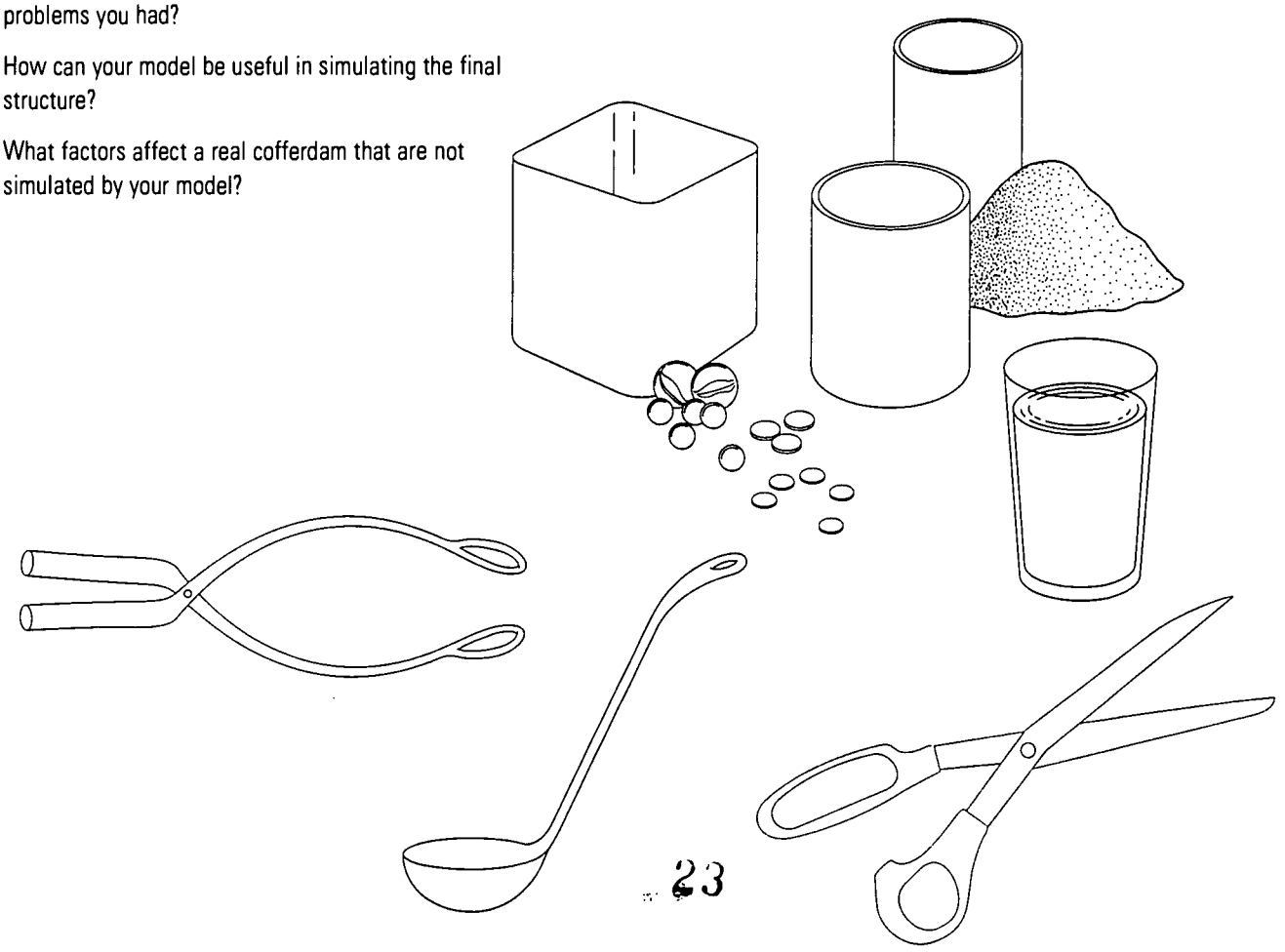
② How can your model be useful in simulating the final structure?

③ What factors affect a real cofferdam that are not simulated by your model?

Cofferdam Requirements

Your goal is to build a cofferdam that successfully keeps water out of the interior. It needs to meet the following requirements:

- The water must be at equilibrium when you start, that is, at the same level inside and outside of the cofferdam.
- You must find a way to extract the water.
- Most of the water must stay out of the interior once it has been removed.



Activity Answer

To construct a cofferdam out of the materials provided:

① Pour sand in the milk jug to a depth of about 2 inches (5 centimeters).

② Push three or four small objects into the middle of the container of sand. Pour water in to a depth of about 4 inches (10 centimeters).

③ Push the 101-fluid ounce (3-liter) bottle cylinder into the sand until it reaches the bottom of the milk jug. This simulates the outer wall of the cofferdam.

④ Place the 68-fluid ounce (2-liter) bottle cylinder inside the larger cylinder and push it into the sand. This simulates the inner wall.

⑤ Fill the space between the cylinder walls with sand. Make sure the water level inside and outside the cofferdam is equal. Use the ladle to empty the water from inside the smaller cylinder. (Some water is likely to leak back in and will need to be pumped back out as with the cofferdam seen in the program.) Use forceps or tongs to recover the artifacts.

Some similarities between the model and the final structure include the sand, water, and objects to recover. Some factors not modeled include water pressure outside the dam, testing for the most suitable diameter between the cofferdam walls, the most suitable materials needed to build the structure, and the effect of tides, rain, and storms. While many factors are not simulated, the model is still useful to brainstorm and problem solve potential pitfalls in building a cofferdam and pumping out water.

Cofferdams have many uses, including in the construction of bridges, piers, building foundations, sewer or water lines, and pumping stations; or to permit repairs to the substructure of a bridge or pier.

Resources

Organization

Texas Historical Commission
The Texas Historical Commission sponsored the excavation of the La Salle shipwreck. For more information, call (512) 463-6100.

Books

Foster, William C., editor. "The La Salle Expedition to Texas: The Journal of Henri Joutel, 1684–1687." Austin: Texas State Historical Association, 1998.
Describes Henri Joutel's account of the historic journey with La Salle, written from detailed notes taken during the voyage.

Weddle, Robert S. "La Salle, the Mississippi, and the Gulf." College Station, Texas: Texas A&M University Press, 1987.
Provides several first-hand accounts by people affected by La Salle's voyage.

Article

Roberts, David. "Sieur de la Salle's Fateful Landfall." Smithsonian (April 1997): 41–52.
Presents La Salle's fateful journey to the Mississippi River and the recent excavation of La Belle.

Web Sites

NOVA Online — Voyage of Doom
www.pbs.org/nova/lasalle/
Includes an illustrated inventory of some of the more than 900,000 artifacts found on La Salle's ship *La Belle*, a look by underwater archeologist Toni Carrell at everything one can learn from the hull, and more. Note: Following the broadcast, the Texas Historical Commission will break the seals on a two-handled wooden box that has rested unopened in an aquarium in Texas ever since it was uncovered on the wreck on *La Belle*. Log on to find out the date and time.

Conservation Research Laboratory
nautarch.tamu.edu/napcrl.htm
Describes several nautical archaeology projects the CRL is working on, including a conservation report on the La Salle shipwreck.

Texas Historical Commission La Salle Shipwreck Project
www.thc.state.tx.us/belle/index.html
Presents an online photo album of the excavation of *La Belle*, and the history of La Salle's exploration. Journeys, a online newsletter for teachers, offers activities, articles, and resources to help bring the life and times of La Salle to the classroom.

Barely Breathing

Airs the week of November 30 • www.pbs.org/nova/smoking/

Program Contents

NOVA chronicles the life of Pamela Laffin, a 29-year-old who describes how smoking cigarettes destroyed her life.

The program:

- **examines Laffin's smoking history, which began at age 10 after seeing an actor in the movie *Grease* appear to gain instant popularity after smoking her first cigarette.**
- **compares the anatomy of a healthy and an emphysemic lung.**
- **states facts about the health and economic impacts of cigarette smoking.**
- **conveys the power of addiction and the denial of health effects of smoking through Laffin's refusal to quit smoking during two pregnancies, while suffering chronic bronchitis, after a week-long asthma attack, and during the onset of emphysema.**
- **shows cigarette advertisements targeted toward young people.**
- **follows Laffin through her medical history that culminates in a failed lung transplant.**
- **shows the impact of Laffin's deteriorating condition on her children.**

Before Watching

1. Ask students to calculate these problems. Pamela smoked a pack a day for 11 years between ages 10 and 21. How many packs of cigarettes did she smoke? (4,015) How many cigarettes, assuming 20 cigarettes per pack? (80,300) How much money would a pack-a-day smoker spend in 11 years on smoking, assuming a constant of $3.35 per pack? ($13,450.25)

2. Have students consider different kinds of cigarette advertising. When and where did students last see a cigarette ad? Bring in some print ads for students to analyze. Who do the ads target? What message do they convey?

The proper functioning of a healthy lung (left) depends on the elasticity of tiny air sacs. Continual exposure to smoke damages the air sacs in a lung and causes them to enlarge and lose their resiliency (right), making it very difficult to exhale.

After Watching

1. Ask students what impressed them most about the program. What was the most powerful anti-smoking fact, photo, or statement made? How did this fact affect them?

2. Discuss with students the concepts of addiction and denial. What role did both play in Pamela's smoking? Have students consider how either addiction and/or denial might have played a role in their lives.

Activity Setup

Objective

To design and carry out a qualitative study to understand what teen-agers think will prevent teen smoking.

Materials for each group

- copies of *What Do You Think?* activity sheet on page 24
- paper and pens

Procedure

1. Before beginning the activity, discuss with students the difference between qualitative and quantitative research. (See *Activity Answer* on page 25 for more information.)
2. Distribute the *What Do You Think?* activity sheet and follow the procedure with students. As a class, decide how many students each group will interview.
3. Create a chart to display the variety of participants students select. Discuss the diversity of this sample and whether this collective list will help students answer the original question.
4. Before students conduct their interviews, ask a team to try out their questions with a classmate. Challenge students to record the participant's answers as closely as possible. When the interview is completed, ask a few students to write on the board the participant's answer to the third question. If there is variance between the student recorders, talk about that variance and how it might have occurred. Allow students to revise their list of questions before their first interview.
5. Assist groups while they code their observations, look for patterns in the participants' responses, and develop hypotheses. Challenge students to come up with other plausible explanations for their observations.
6. Invite students to create a class-wide table that can help them look for patterns among all of their codes and participants' responses, and to develop hypotheses based on the class-wide observations. Discuss why various research teams may have arrived at different conclusions.
7. As an *extension*, have students come up with an anti-smoking campaign based on their research results.

Standards Connection

The activity found on page 24 aligns with the following "National Science Education Standards."

Grades 5-8

Science Standard F: Science in Personal and Social Perspectives

Personal health

- The use of tobacco increases the risk of illness. Students should understand the influence of short-term social and psychological factors that lead to tobacco use, and the possible long-term detrimental effects of smoking and chewing tobacco.

Science Standard G: History and Nature of Science

Nature of science

- It is part of scientific inquiry to evaluate the results of scientific investigations, experiments, observations, theoretical models, and the explanations proposed by other scientists. Evaluation includes reviewing the experimental procedures, examining the evidence, identifying faulty reasoning, pointing out statements that go beyond the evidence, and suggesting alternative explanations for the same observations.

Grades 9-12

Science Standard F: Science in Personal and Social Perspectives

Personal and community health

- Personal choice concerning fitness and health involves multiple factors. Personal goals, peer and social pressures, ethnic and religious beliefs, and understanding of biological consequences can all influence decisions about health practices.

Science Standard G: History and Nature of Science

Science as a human endeavor

- Scientists are influenced by societal, cultural, and personal beliefs and ways of viewing the world. Science is not separate from society but rather science is a part of society.

What Do You Think?

NOVA Activity | **Barely Breathing**

You have been hired to develop a public service campaign to prevent teen smoking. But before you develop anything, you need find out what message will work best. Follow these steps to design and deliver a qualitative study that will inform your campaign.

Procedure

① You will work in groups to examine this research question: **What do teen-agers think will prevent teen smoking?**

Conduct your study in a separate journal.

A. Select your participants. Choose the "type" of teen-agers you want to interview (age, gender, amount smoked, age at which they began smoking, non-smokers).

B. Develop interview questions. Create a list of at least 10 open-ended questions (for example, questions that cannot be answered by a simple yes or no) to elicit what participants think will prevent teen smoking.

C. Collect the information. Arrange and conduct the interviews. Remind participants they are free to *not* participate and to *end* their participation *at any time*. Promise anonymity. Write what you hear and observe during the interview.

D. Analyze the information. Code each participant's response with a word or phrase that you think best reflects the idea. Write this in the margin near the response. Then, create tables, diagrams, and/or conceptual maps to help identify patterns in your codes. (See Table 1.)

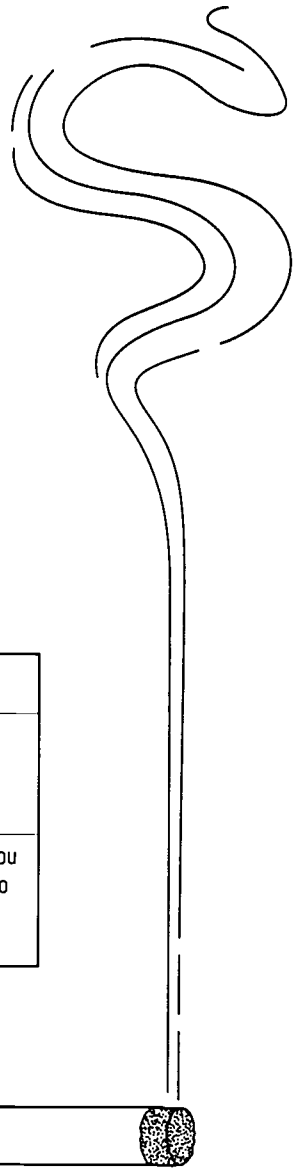
Questions

Write your answers on a separate sheet of paper.

① Look for patterns. What are your conclusions based on any patterns? If patterns don't emerge, what might that mean?

② Pool your information with that of your classmates. What patterns do you interpret from the class's observations? How do your participants' ideas compare with others?

③ How would you answer this question: What do some students at your school think will stop teen smoking?



Code	Participant 1	Participant 2
Denial	"Teens think they're immortal. Charcoal lungs, and emphysema won't do diddly."	"There's no risk with smoking if you think you can live forever."
Might Work	"Dissecting a smoker's lung, and designing experiments to measure the effects of smoking might work."	"What would work for me is if you paid me a thousand bucks not to smoke over the next 3 years."

Table 1. An example for how to organize and reduce information to help identify patterns.

Activity Answer

There are two major kinds of research: quantitative and qualitative. *Quantitative researchers* try to use measures which are objective and information that is countable. Quantitative research asks such questions as: Who smokes more, girls or boys? What is the school's smoking policy? How many students, at different grades, know the policy and support it? What is the lung capacity of different students?

Qualitative researchers, on the other hand, have a different orientation. They ask more open-ended questions. Their answers cannot be analyzed by numbers alone. Instead, these researchers seek people's stories, explanations, and observed behaviors. They then look for patterns among the participants' words and behaviors. They are interested in developing new theories and not in proving or disproving what they think may be the answer to their questions. They try to understand people's meaning, and are cautious about generalizing their interpretations beyond their participants' responses. They ask such questions as: Why do smokers think they started smoking? How do smokers under 16 try to quit? Why do smokers refuse to quit even when debilitated by smoking illnesses?

While there are no previously known answers to the research question students are carrying out, there are some understandings about good qualitative research. First, there can be a variety of approaches to answering this research question. There may be many interview questions and protocols that can elicit teens' elaborated ideas. Similarly, there can often be more than one legitimate code for a passage, as well as multiple interpretations of the observations.

This does not imply, however, that anything goes. For example, some interview questions are better than others at getting past abbreviated responses. In some cases, researchers may unknowingly influence those being studied. Some strategies are better than others for coding narratives and organizing them into categories. And not all interpretations of the observations are equal, especially if the interpretations cannot be supported by the observations, or if the researchers select observations to fit their preexisting theory.

Resources

Organization

American Cancer Society
This health organization is active in research, education, advocacy, and service to eliminate cancer and sponsors the Great American Smokeout. For more information call (800) ACS-2345 or look on the World Wide Web at: www.cancer.org/smokeout/

Article

Smolowe, Jill. "Sorry, Pardner."
Time (June 30, 1997): 24-31.
Reviews the agreement in which tobacco companies concede that smoking cigarettes is harmful and outlines major efforts by state attorney generals and public health officials to cut smoking among youth.

Web Sites

NOVA Online — Barely Breathing
www.pbs.org/nova/smoking/
Paints a picture of the suffering inflicted by smoking, takes a look at those at the cutting edge of developing new procedures to alleviate the disease, and probes the science of addiction.

Surgeon General's Report for Kids about Smoking
www.cdc.gov/nccdphp/osh/sgr4kids/sgrmenu.htm
Presents SGR4Kids, an online magazine sponsored by the Centers for Disease Control, which includes information about kids and smoking, facts about tobacco and second-hand smoke, and advertising campaigns. Includes a list of 10 steps for a smoke-free world.

Video Catalog

Save 25% on orders of 10 videos or more!

*plus shipping & handling

These videos have been categorized by their primary content strand; many programs are interdisciplinary. You may want to scan several categories for videos of interest.

WGBH BOSTON VIDEO

Earth & Space Science

Adrift on the Gulf Stream

Explore the Stream's importance to ocean life, climate and human history. Writer Bill MacLeish travels its full course, sailing on top of it, under it and viewing its mighty swirl via satellites in space. *Educational use only.* 1 hr. **WG1606* $19.95**

Buried in Ash

Learn what life was like ten million years ago when an enormous volcanic eruption buried much of what is now Nebraska in up to ten feet of ash, preserving countless skeletons of prehistoric big game animals. 1 hr. **WG2117* $19.95**

Chasing El Niño

Lethal ice storms, droughts, floods and devastation—what in the world is going on here? Through spectacular film footage, groundbreaking research, expert interviews and colorful diagrams, *NOVA* explores the myths, reveals the devastation, explains the fascinating facts and provides a new climate for understanding the ultimate weather machine. 1 hr. **WG2512 $19.95**

Countdown to the Invisible Universe

Infrared telescopes unveil the outer regions of space. 1 hr. **WG1401 $19.95**

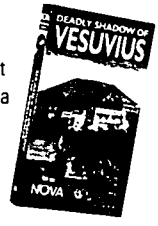
Cracking the Ice Age

Could the Himalayas be the cause of one of the planet's most dramatic climactic changes—the ice age? Take a trek to Tibet with a renegade band of researchers bent on proving this controversial concept. *Educational use only.* 1 hr. **WG2320* $19.95**

Danger in the Jet Stream

Climb aboard and experience the exhilaration—and the terror—of trying to fly a balloon around the world. 1 hr. **WG2419* $19.95**

Deadly Shadow of Vesuvius



Scientists believe it's only a matter of time before Italy's Vesuvius erupts... again. Find out how science can help predict when Vesuvius will change from dormant to destructive. Take a historic tour of Pompeii and see the astonishing power of nature—including footage from recent eruptions in other parts of the world. 1 hr. **WG2515 $19.95**

Dinosaur Hunt Boxed Set

Of all the creatures that ever walked the earth, none captures the human imagination like the dinosaur. See scientists offer important clues to the mystery of the evolution of life. 3-video set includes *Curse of T. rex, Case of the Flying Dinosaur* and *T. rex Exposed.* 3 hrs. **WG737 $39.95**

CC NOVA videos are closed-captioned for the hearing impaired

• signifies generic packaging

† public performance rights are not included

- **Curse of T. rex**
  An unusual battle is brewing: Who gets to keep "Sue," a magnificent million-dollar T. rex that turned up on a South Dakota ranch? Everyone wants a piece of her, from the tribal council to the fossil dealers to the scientists. Head out west and join the investigation in this tale of fossil crime and punishment. 1 hr. **WG2408 $19.95**

- **Case of the Flying Dinosaur**
  Explore the link between dinosaurs and birds, and tune in to the fierce debate—about whether dinosaurs are truly extinct—that continues to captivate no matter how you choose to draw the family tree. 1 hr. **WG1805 $19.95**

- **T. rex Exposed**
  Go on a suspenseful dig in Montana, where a crew is carefully uncovering one of the most complete Tyrannosaurus rex specimens ever found. 1 hr. **WG1806 $19.95**

Dinosaurs of the Gobi

NOVA accompanies an American Museum of Natural History expedition to the Gobi Desert. The trip relives the exploits of the Museum's dashing explorer of the 1920s, Roy Chapman Andrews—said to be the real-life model for Indiana Jones. *Educational use only.* 1 hr. **WGW2102* $19.95**

The Doomsday Asteroid

Join the hunt to scan the skies and earth for evidence that giant rocks from outer space have struck before and will strike again. *Educational use only.* 1 hr. **WGD2212* $19.95**

Earthquake

Will the earth send us a warning signal before the next "big one" strikes? Predicting earthquakes is risky business, but *Earthquake* shows how today's advanced technology helps geologists interpret nature's rumblings. 1 hr. **WG1715 $19.95**

Everest—The Death Zone

Now available on DVD!

Climb all the way from Base Camp, through the Khumbu Icefall, up the precipitous Lhotse Face, into the Death Zone and on to the very pinnacle of the earth at 29,028 feet. Wind, cold, extreme dehydration and blinding solar radiation add to the misery. You'll witness first-hand why rational people can make astonishingly poor, and sometimes fatal, decisions on the world's highest peak. Narrated by Jodie Foster. From David Breashears, the Emmy® award-winning producer of the IMAX film. 1 hr. **WG2506 $19.95**

Now available on DVD! The stunning views from the top of Mount Everest are even more breathtaking in the DVD format. 1 hr. **WG800 $19.95**

NEW! Everest: The Mystery of Mallory and Irvine

George Mallory and Andrew Irvine came within 1,000 feet of reaching the peak of Mt. Everest in 1924, twenty-five years before the historic ascent of Sir Edmund Hillary and Tenzing Norgay. The recent discovery of Mallory's frozen body has reignited debate over what caused their demise. This 1986 film, produced by renowned climbers David Breashears and Andrew Harvard, investigates this classic mountaineering riddle and includes rare interviews with Hillary as well as two survivors of the Mallory expedition. 1 hr. **WG830 $19.95**
Available October 1999.

Flood!

Relive one of the greatest flood disasters—the Mississippi River in the summer of 1993—and explore the problem of taming the mightiest river. 1 hr. **WG2307 $19.95**

Hawaii Born of Fire

Behold the fiery moonscapes and lush rain forests surrounding Hawaii's active volcanoes. *Educational use only.* 1 hr. **WGH2211 $19.95**

Hunt for Alien Worlds

All eyes are on the heavens in search of planets around other stars, probably the best hope for showing that we may not be alone in the universe. *NOVA* covers an effort that is turning up more and more new worlds. *Educational use only.* 1 hr. **WG2407* $19.95**

Ice Mummies Boxed Set

Witness fascinating accounts of cutting-edge science and archaeology delving into the mysteries of frozen human remains. 3-video set includes *Frozen in Heaven, Siberian Ice Maiden* and *Return of the Iceman.* 3 hrs. **WG2525 $49.95**

- **Frozen in Heaven**
  This is the bizarre and fascinating story of the remains of Inca culture, frozen for posterity high in the mountains of the Andes. 1 hr. **WG2516 $19.95**

- **Siberian Ice Maiden**
  Mummified and then frozen by freak climactic conditions 2,400 years ago, the Siberian Ice Lady is believed to have been a shamaness of the lost Pazyryk culture. Her body has now been restored, and is providing new clues as to the role and power of women in the nomadic peoples of ancient Siberia. 1 hr. **WG2517 $19.95**

- **Return of the Iceman**
  Cutting-edge science and archaeology is reconstructing the life and culture of the Iceman—the five thousand year-old frozen corpse found buried in the ice of the Alps. 1 hr. **WG2518 $19.95**

Iceman

NOVA covers the international efforts to unlock the secrets behind the mummified body of a man who lived over 5,000 years ago, discovered in the Alps by two German hikers. *Educational use only.* 1 hr. **WG1916* $19.95**

In Search of Human Origins Boxed Set

The award-winning exploration of the beginnings and expansion of the human race. 3-video set includes *The Story of Lucy, Surviving in Africa* and *The Creative Revolution.* 3 hrs. **WGW2111 $49.95**

- **The Story of Lucy**
  Discover the missing link between humans and apes. 1 hr. **WGW2106 $19.95**

- **Surviving in Africa**
  Witness a living experiment to understand how early humans thrived. 1 hr. **WGW2107 $19.95**

- **The Creative Revolution**
  Examine the world-wide expansion and evolution of the human race. 1 hr. **WGW2108 $19.95**

NEW! Island of the Spirits

Mystical, magical and marvelous, Japan's northernmost island, Hokkaido, is filled with steaming lakes, fairy tale forests and wildlife as varied and unique as its terrain. Dazzling photography captures a year in the life of its rare inhabitants. *Educational use only.* 1 hr. **WG2614 $19.95**
Available November 1999.

Journey to the Sacred Sea

Travel to Lake Baikal, the world's oldest and deepest lake. Watch *NOVA* chart its dramatically changing environment over the course of four seasons. *Educational use only.* 1 hr. **WG2119* $19.95**

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Lost at Sea: The Search for Longitude

Navigation in the 1700s was both unpredictable and deadly... until one man solved the mystery. Richard Dreyfuss narrates the riveting story of a humble, ingenious country carpenter, John Harrison, who discovered that the secret to navigation lay not just in the stars but in the mastering of time. Climb aboard an authentic tall ship and go back in time to see history—and the quest for longitude—unfold. 1 hr. **WG2511 $19.95**

Lost City of Arabia

The secrets of Ubar, ancient city of mystery from the Arabian Nights which vanished in the shifting desert sands, are revealed as archaeology and space-age intelligence team up. *Educational Use Only.* 1 hr. **WG2312* $19.95**

Mammoths of the Ice Age

Watch scientists piece together a picture of the life our ancestors shared with the woolly mammoth. *Educational use only.* 1 hr. **WG2201* $19.95**

Mysterious Mummies of China

Perfectly preserved 3,000-year-old mummies have been unearthed in a remote Chinese desert, but they have long, blonde hair and blue eyes. New evidence of the lost civilization of the Tocharians along the Silk Road offers more clues to this mystery from the past. 1 hr. **WG2502 $19.95**

The Mystery of Space Set

Travel into space to uncover the mysteries and wonders of our galaxy. 3-video set includes *Death of a Star, Eclipse of the Century* and *Rescue Mission in Space.* 3 hrs. **WG162 $49.95**

- **Death of a Star**
  Witness one of the most spectacular events since creation—the supernova. 1 hr. **WG1411 $19.95**
- **Eclipse of the Century**
  The race to view and study celestial splendor. 1 hr. **WG1910 $19.95**
- **Rescue Mission in Space**
  Witness the dramatic space repair of the Hubble Telescope and view the stunning images of space that it now produces. 1 hr. **WG2118 $19.95**

Natural Disasters Boxed Set

Natural disasters strike with little or no warning—making them uniquely frightening and fascinating. Still, scientists continue to search for ways to guard us against nature's fury. 3-video set includes *The Day the Earth Shook, Tornado!,* and *In the Path of a Killer Volcano.* 3 hrs. **WG165 $49.95**

- **The Day the Earth Shook**
  Does a devastating earthquake lurk beneath Los Angeles? Have we learned any lessons from the past? Watch terrifying scenes from Kobe, Japan, and Northridge, California—and find out how new warning and rescue technology could protect us if it's put into place in time. 1 hr. **WG2302 $19.95**
- **Tornado!**
  Travel with "stormchasers" as they view the awesome power of tornadoes sweeping across the land and seek to understand how they are created. 1 hr. **WG1217 $19.95**
- **In the Path of a Killer Volcano**
  The Philippines' Mount Pinatubo is about to blow big. Is there enough time to evacuate the hundreds of thousands in its raging path? Stay with the scientists who remain behind—and see some astonishing footage of the world's largest volcanic eruption in 80 years. 1 hr. **WG2005 $19.95**

Nature's Fury Boxed Set

Witness the awesome power of nature and then travel with the "stormchasers" into danger in an effort to better understand and predict these extraordinary cataclysms.

3-video set includes *Hurricane!, Lightning!* and *Killer Quake!* 3 hrs. **WG027 $49.95**

- **Hurricane!**
  Witness nature's fury as hurricanes Camille and Gilbert crash onto the Gulf coast. 1 hr. **WG1616 $19.95**
- **Lightning!**
  Join an adventurous investigation into the source of lightning, nature's most dazzling and dangerous display, and take a front seat for nature's electrifying light show set to music. 1 hr. **WGA2213 $19.95**
- **Killer Quake!**
  Relive the L.A. earthquake, and preview what it portends for California's future. 1 hr. **WG2116 $19.95**

Nomads of the Rainforest

Visit the unique tribe of the Waironi Indians in eastern Ecuador. 1 hr. **WG1112 $19.95**

Search for the Lost Cave People

Discover a lost civilization that inhabited caves high on the isolated cliffs of Southern Mexico nearly 1,000 years ago. The tantalizing clues, including graphic evidence of ritual child sacrifice and a sophisticated writing system, shed new light on this mysterious people, the Zoqui, who may have been precursors of the Mayans. 1 hr. **WG2507 $19.95**

NEW! Space Explorers Boxed Set

Step on the moon. Float in space. Explore the final frontier. *NOVA* assembles three of its most acclaimed space adventures to create this special four-hour set. Explore three of America's most historic space missions: *To The Moon, Terror in Space* and *Rescue Mission in Space.* 4 hrs. on 3 cassettes. **WG667 $49.95**

- **To the Moon**
  The mission was impossible. The odds were astronomical. The results were spectacular. *NOVA* shares the fascinating inside story behind "one giant leap for mankind." This expanded two-hour special shares vivid recollections of Apollo astronauts Gene Cernan and Frank Borman, and introduces you to legendary Flight Director Gene Kranz and other unsung heroes. Rare interviews and amazing footage captures America's full-thrust effort to be the first to the moon. 2 hrs. **WG2610 $19.95**
- **Terror in Space**

  Moscow, we have a problem. In 1997, the Mir space station was an orbiting disaster that nearly took the lives of several Russian and American astronauts. Through candid interviews and spectacular previously unreleased footage, *NOVA* exposes what really happened. Experience the computer failures, power outages, fires and crashes that made the Mir link-up one of the most dangerous missions in NASA history. 1 hr. **WG2513 $19.95**
- **Rescue Mission in Space**
  Witness the dramatic space repair of the Hubble Telescope and view the stunning images of space that it now produces. 1 hr. **WG2118 $19.95**

Three Men and a Balloon

For a few diehard daredevils, it was "the last great challenge in aviation:" to fly a balloon non-stop around the world—simply because it's never been done before. Follow one of the foremost teams in a hair-raising race against time, technology, and hot competition. 1 hr. **WG2313 $19.95**

NEW! Time Travel

The Terminator and *Dr. Who* aren't the only ones fascinated with time travel. Inspired by Carl Sagan's novel *Contact*, scientist Kip Thorne has postulated how time travel might be possible. Take a wonderfully head-spinning trip with Thorne and other top scientists, like Stephen Hawking, and see how science has created a theoretical time machine that may someday make time travel a reality. *Educational use only.* 1 hr. **WG2612* $19.95** *Available November 1999.*

NEW! To the Moon

The mission was impossible. The odds were astronomical. The results were spectacular. NOVA shares the fascinating inside story behind "one giant leap for mankind." This expanded two-hour special shares vivid recollections of Apollo astronauts Gene Cernan and Frank Borman, and introduces you to legendary Flight Director Gene Kranz and other unsung heroes. Rare interviews and amazing footage captures America's full-thrust effort to be the first to the moon. 2 hrs. **WG2610 $19.95**

Treasures of the Sunken City

It's an undersea adventure in Cleopatra's erstwhile capital: Alexandria, Egypt, where marine archaeologists are frantically salvaging mysterious stone ruins from the harbor floor. 1 hr. **WG2417 $19.95**

The Tribe That Time Forgot

NOVA travels deep into the Amazon wilderness in search of a mysterious tribe that dismembered and partially ate three prospectors in 1976. Locating the group, *NOVA* lives with them for three months, gaining insight into the customs and beliefs of a people whose lifestyle has not changed for centuries. *Educational use only.* 1 hr. **WG2115* $19.95**

Venus Unveiled

Travel with the spacecraft Magellan as it flies by Venus to reveal the planet's true face, one of the most bizarre places in the solar system. *Educational use only.* 1 hr. **WGV2210* $19.95**

NEW! Volcanoes of the Deep

The pitch-black, near-freezing water nearly 8,000 feet below the ocean surface is the last place you'd suspect life to flourish. But here, in one of the most hellish environments on Earth, sea life thrives on mammoth superheated volcanic chimneys. Is the key to life's origins locked inside their fiery cores? Join a team of explorers on a daring undersea expedition to raise these mysterious undersea volcanoes. 1 hr. **WG2609 $19.95**

NEW! Voyage of Doom

The recent discovery of *Belle*, part of the fleet of fanatical French explorer Robert La Salle, has been called the most important shipwreck find in North America. Lying mud-covered and remarkably preserved on the bottom of a Texas bay, *Belle's* final resting place was unfortunate for La Salle, but incredible for historians and archaeologists. Join the unprecedented excavation effort as *NOVA* reveals *Belle's* vivid history, incredible artifacts and mysterious details. 1 hr. **WG2616 $19.95** *Available December 1999.*

Wanted: Butch and Sundance

Forensic sleuth, Clyde Snow, and a posse of experts travel to Bolivia in search of the remains of Butch Cassidy and the Sundance Kid. They find that Hollywood and legend got a few things wrong. *Educational use only.* 1 hr. **WGW702* $19.95**

Warnings From the Ice

Could the earth as we know it be about to drown? Huge ice sheets in Antarctica may be in the process of collapse, triggering a catastrophic rise in sea level that will inundate the most populous regions of the world. Battle extreme weather conditions in Antarctica with *NOVA* scientists as they gather data that will reveal new insight into the nature of global climate change. 1 hr. **WG2508 $19.95**

Warriors of the Amazon

See a rare glimpse of life today for the Yanomami, who live in a remote and inhospitable part of the Amazon rain forest. 1 hr. **WG2309 $19.95**

General Science

Anastasia Dead or Alive?

Investigate the massacre of Tsar Nicholas and his family, and evaluate whether or not modern science has resolved the mystery surrounding Princess Anastasia. 1 hr. **WGA2209 $19.95**

NEW! Battle Alert in the Gulf

With rare access to American submarines, cruisers, destroyers, helicopters, aircraft carriers and their personnel, *NOVA* reveals the complex inner workings of American military forces as they prepare to retaliate against Iraq for its recent violation of UN sanctions. Land an FA-18 "Hornet" on the USS Stennis. Pinpoint enemy targets with high-tech weaponry. And discover why—despite our advanced fighting power—American forces could be vulnerable to future attacks in the Persian Gulf. 1 hr. **WG2608 $19.95**

Behind the Scenes with King Kong in Special Effects

Welcome to the wild world of special effects, where anything can happen! *NOVA* takes you behind the scenes as effects experts bring a legend to life in this exclusive look at how King Kong was created for the Oscar®-nominated IMAX film *Special Effects.* 33 min. **WG093 $12.95**

The Bermuda Triangle

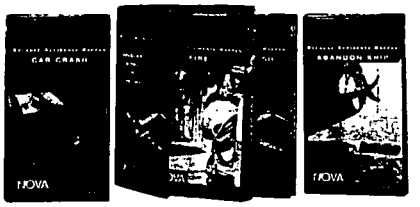
Join this investigation of the mysterious watery graveyard in the Atlantic. 1 hr. **WGW264 $19.95**

Dr. Spock The Baby Doc

Witness an absorbing view of one of this century's most influential Americans and his profound impact on changing ideas about child care. *Educational use only.* 1 hr. **WG2308* $19.95**

NEW! ESCAPE! Because Accidents Happen Boxed Set

In the air, at sea, on the road, or in your home, you must be prepared to escape! Accidents happen every day, but thanks to technology's ever-increasing sophistication, fewer accidents than ever result in the loss of life. In this four-part series, *NOVA* goes behind the sensational headlines to examine the fascinating science of "survival engineering." 4 hrs. **WG260 $49.95**



* signifies generic packaging

- **Fire**
  NOVA reveals the historic evolution of firefighting and fire prevention by revealing how today's sophisticated arsenal of weapons battle flames from subways to skyscrapers. Rare fire footage, dramatic re-creations and expert insights reveal fascinating details about everything from the Great Fire of London of 1666 to the invention of automatic sprinklers to tomorrow's futuristic firefighting tools. 1 hr. **WG2604 $19.95**

- **Car Crash**
  Automobile safety has progressed slowly and at the expense of millions of lives. Vivid footage shares the story of our dangerous love affair with the automobile, from early "motorized coffins" that disintegrated on impact to the "smart" protection found in today's vehicles. Discover the fascinating evolution of auto design, and learn how science and technology are vastly improving the survivability of auto accidents. 1 hr. **WG2605 $19.95**

- **Plane Crash**
  There will always be aircraft accidents. The goal is finding ways to make them survivable. *NOVA* reveals the fascinating evolution of aircraft and passenger safety—from the invention of the parachute to the aerial peril of early dogfights, to today's ultra-modern safety systems. 1 hr. **WG2606 $19.95**

- **Abandon Ship**
  It's taken centuries of deadly accidents to reach today's technological advancements and maritime regulations. *NOVA* offers breathtaking footage, survivor interviews and expert commentary for this remarkable look at the historic evolution of maritime safety. 1 hr. **WG2607 $19.95**

The Great Wildlife Heist

NOVA goes undercover with a US government sting that breaks an international parrot smuggling ring, landing some surprising suspects. *Educational use only.* 1 hr. **WG2111* $19.95**

In Search of the First Language

NOVA explores the common threads that link the more than 5,000 languages of Earth, including a controversial theory that claims to reconstruct words from a time when only a handful of languages were spoken, recalling the biblical story of the Tower of Babel. *Educational use only.* 1 hr. **WG2120* $19.95**

The KGB, the Computer and Me

NOVA follows computer sleuth Clifford Stoll as he tracks down a data thief through a maze of military and research computers. 1 hr. **WG1710* $19.95**

NEW! The Killer's Trail

Did Dr. Sam Sheppard kill his wife? With the help of advanced technology, *NOVA* re-examines the 1954 murder of Marilyn Sheppard and the subsequent trials of her husband. With a detailed reconstruction of the Sheppard house, access to little-known evidence, plus insights from noted experts, America's most intriguing unsolved murder reveals fascinating new clues... and surprising new suspects. 1 hr. **WG2613 $19.95** *Available November 1999.*

NEW! A Man, A Plan, A Canal, Panama

Explore the mind-boggling construction of the Panama Canal through historic film footage, rare archival photographs and insightful narration from author David McCullough. Get an unprecedented look at the people behind the Canal's deadly 30-year construction and witness its amazing present-day operation. 1 hr. **WG1415 $19.95**

Mysterious Crash of Flight 201

Join in the investigation of a mysterious jetliner crash in Panama. 1 hr. **WGW707 $19.95**

Nazi Designers of Death

The discovery of top-secret Nazi files reopens a painful chapter in history, revealing the careful planning behind the Nazi death camps. *Educational use only.* 1 hr. **WG2205* $19.95**

NEW! The Perfect Pearl

NOVA takes a deep look inside the pearl's precious world and reveals how these wonders of nature are fast becoming wonders of science. Trace the pearl's fascinating history and see how modern pearl cultivators are coping with complex natural, technological and environmental obstacles. 1 hr. **WG2507N $19.95**

The Science of Crime Boxed Set

Serial criminals wield a particular brand of terror. Fortunately for us, scientific sleuths are on their trail. 3-video set includes *The Bombing of America, Mind of a Serial Killer* and *Hunt for the Serial Arsonist.* 3 hrs. **WG164 $49.95**

- **The Bombing of America**
  Follow investigators using the latest forensic techniques and psychological insights to crack such notorious cases as the World Trade Center and the Unabomber—as well as many lesser-known tragic incidents. 1 hr. **WG2310 $19.95**

- **Mind of a Serial Killer**
  Follow the FBI's psychological detectives as they race against time to penetrate the mind of a serial killer—and stop him from striking again. 1 hr. **WG1912 $19.95**

- **Hunt for the Serial Arsonist**
  Trail along with fire sleuths as they discover the mysterious source of a series of L.A. store fires, and capture a surprising suspect filmed by *NOVA.* 1 hr. **WGA2214 $19.95**

Secrets of Making Money

Learn the secrets of counterfeiting—made easier by today's technology—and find out what the Feds are doing to fight back: a new look for US currency, with layers of security features to keep counterfeiters at bay. 1 hr. **WG2314* $19.95**

Secrets of the Psychics

Are some of us born with mysterious powers—able to move objects at will, read a person's thoughts, even cure physical ailments with the power of the mind? Follow master magician James Randi as he uncovers the secrets about psychics. 1 hr. **WGW703 $19.95**

The Shape of Things

Marvel at the endlessly inventive patterns of natural objects like crystals, honeycombs, seashells, eggs and seeds through photomicroscopy, computer animation and time-lapse photography. 1 hr. **WG1206* $19.95**

Submarines, Secrets and Spies

If you thought the Cold War was scary then, look back now. Through candid interviews with Soviet and US military personnel, shocking underwater footage, and recently de-classified film and documents, *NOVA* lifts the veil on deadly, mysterious submarine accidents and high-risk spy missions. 1 hr. **WG2602 $19.95**

Terror in the Minefields

Investigate the terror and tragedy of Cambodia's deadly legacy of minefields. 1 hr. **WG2301 $19.95**

Titanic's Lost Sister

Titanic's sister ship is surrounded by mystery. Search for the wreck of the *Britannic* and explore the clues as to how it sank. Four years after the *Titanic* went down, the *Britannic* sank in just one hour, despite an overhaul to meet post-*Titanic* standards. 1 hr. **WG2402 $19.95**

Vikings in America

Five hundred years before Columbus, the Vikings reached North America. Who were the people they met here? What happened when their two worlds collided? Archaeologists are now revealing an extraordinary story of tragedy and triumph. *Educational use only.* 1 hr. **WG2202* $19.95**

War Machines of Tomorrow

Take a look back at the war technology employed in the Gulf War, "Desert Storm," and preview the military machines of the future. 1 hr. **WG2305 $19.95**

UFOs Set

Is there life out in the universe? Are there aliens hovering above or even mixing among us? Our fascination with this fundamental question never ends. 2-video set includes *Kidnapped by UFOs* and *UFOs: Are We Alone?*. 2 hrs. **WG082 $29.95**

- **Kidnapped by UFOs**
  Delve into this remarkable phenomenon, hear eyewitness accounts and learn what lies behind the incredible claims of UFO abductions. 1 hr. **WG2306 $19.95**
- **UFOs: Are We Alone?**
  Using rare UFO footage, *NOVA* investigates the claims of sightings. 1 hr. **WGW262 $19.95**

Life Science

All-American Bear

Share a year in the life of the North American black bear—mating, playing, foraging for food and hibernating. 1 hr. **WG1520* $19.95**

Animal Hospital

Go behind the scenes for this offbeat, sometimes humorous, sometimes sad portrait of pets, their owners and their vets. From racehorses under the knife for cancer, to Manhattan hounds on Prozac, you'll view the mini-dramas that unfold everyday in homes, zoos and veterinary hospitals. 1 hr. **WG2504 $19.95**

Animal Imposters

A gnarled twig. A stretch of sand. A shadow. Suddenly they twitch—or lunge—and you realize you've been taken in by a cleverly disguised animal. 1 hr. **WG909* $19.95**

NEW! Barely Breathing

Smoking cigarettes has given Pam Laffin the attention she desired—just not the right kind of attention. At 29, Laffin has emphysema, one barely functional lung and a lifetime of regret. *NOVA* offers a "breathtaking" look at emphysema through her tragic experience and introduces the doctors whose groundbreaking research could significantly reduce the number of Americans—500,000—who currently die each year from smoking-related illness. *Educational use only.* 1 hr. **WG2617 $19.95**
Available December 1999.

The Brain Eater

Highly infectious and incurable, "mad cow disease" has claimed the lives of nearly a million cattle in Britain. Scientists race to determine whether a variant of the disease spells a deadly epidemic for humans. *Educational use only.* 1 hr. **WG2505* $19.95**

Brain Transplant

NOVA follows a remarkable, little-known medical detective story, leading from an inexplicable paralysis among drug abusers, to a bad batch of synthetic heroin, to a research breakthrough in understanding Parkinson's Disease, to the prospect of curing brain diseases with fetal implants. *Educational use only.* 1 hr. **WG1918* $19.95**

Can Buildings Make You Sick?

Join the quest to uncover baffling cases of bad air found in offices, schools, homes and even hospitals! *Educational use only.* 1 hr. **WG2217* $19.95**

City of Coral

Dive into the beauty and wonder of a Caribbean coral reef. 1 hr. **WG1006* $19.95**

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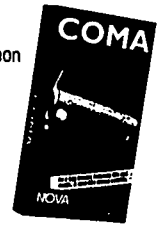

In a gripping real-life drama, *NOVA* follows famous neurosurgeon Jam Ghajar as he struggles to save a young boy with massive head trauma, using simple but crucial techniques that are dangerously absent from most hospitals across the country. 1 hr. **WG2411 $19.95**

Creatures of the Sea Set

Experience the undersea beauty of the Pacific Ocean. 2-video set includes *Treasures of the Great Barrier Reef* and *Kingdom of the Seahorse*. 2 hrs. **WG738 $29.95**

- **Treasures of the Great Barrier Reef**
  Swim through a day in the life of Australia's greatest natural wonder, and view the undersea world's brilliant colors and extraordinary inhabitants. 1 hr. **WG2215 $19.95**
- **Kingdom of the Seahorse**
  Discover this remarkable fish whose male becomes pregnant and gives birth. Tour the magical and complex world of the seahorse—from an underwater enclave in Australia to a village in the Philippines dependent on the seahorse for survival. 1 hr. **WG2410 $19.95**

Cut to the Heart

Can a radical form of surgery from the jungles of Brazil save desperately ill heart-disease patients? Watch this cutting-edge procedure in action—and listen to the stories of those whose lives it has renewed. 1 hr. **WG2409 $19.95**

Ebola: The Plague Fighters

The Ebola virus and its devastating impact is profiled as *NOVA* travels behind the quarantine line to observe the scientists battling to contain this most deadly of viruses. 1 hr. **WG2304 $19.95**

NEW! Electric Heart

Brilliant surgeons Michael DeBakey, Robert Jarvik and Denton Cooley are the founding fathers of the artificial heart. Their ego-driven battle to create the first operational implant device has pitted them against each other as well as the medical establishment. Discover how three decades of research, success and failure challenged the limits—and potential—of the human body. *Educational use only.* 1hr. **WG2618 $19.95**
Available January 2000.

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Haunted Cry of a Long Gone Bird

NOVA explores the legacy of the great auk, a magnificent flightless bird that was hunted to extinction over a century ago. *Educational use only.* 1 hr. **WG2113* $19.95**

Life's First Feelings

Look close-up with researchers to understand babies' emotional responses, clues about developing personality traits and how parents help with socialization. 1 hr. **WG9304* $19.95**

Little Creatures Who Run the World

Peer close-up into the worlds of the most amazing ants and understand why some believe ants are the most successful life form on earth. 1 hr. **WG2203 $19.95**

MD: The Making of a Doctor

Check up on seven aspiring doctors as they undergo the exhilarating and rigorous years of medical training. 2 hrs. **WG2207 $19.95**

Mystery of the Animal Pathfinders

Travel to bird feeding grounds in Brazil, bat caves in Mexico and eel habitats in Maine to understand the mystery of animal migration. 1 hr. **WGW710* $19.95**

Night Creatures of the Kalahari

When the sun sets over southern Africa, the grasslands' strangest and most secretive residents sneak out from their lairs. Witness some veldt vignettes that few have ever seen in this mysterious world where the zebra grazes by day and the aardvark wanders at night—along with bush babies, meerkats, striped polecats, brown hyenas, flying termites, and many more rarely seen exotic creatures. 1 hr. **WG2501 $19.95**

The Private Lives of Dolphins

Discover the deep-sea drama of life for the ocean's most charming and sophisticated mammals. 1 hr. **WG1917* $19.95**

Rescuing Baby Whales

Join the dramatic rescue of young, stranded pilot whales, and learn what is behind this puzzling phenomenon. 1 hr. **WG1908* $19.95**

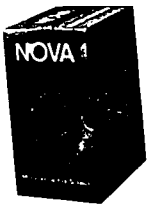
Shark Attack!

Are sharks developing a taste for human flesh? A rash of shark attacks off Hawaii spurs a team of researchers to track the predators' elusive movements–and the scientists discover some surprising truths about the way sharks kill. 1 hr. **WG2316 $19.95**

NEW! Surviving AIDS

Journey with *NOVA* to the front lines of research and meet the remarkable people devoted to battling one of the fiercest enemies science has ever faced. Meet the scientists, physicians, and courageous patients whose cutting-edge experimentation and heroic acts will help achieve the ultimate goal: transforming every AIDS patient into a long-term survivor. 1 hr. **WG2603 $19.95**

Mystery of the Senses Boxed Set



Enjoy a celebration of the senses— a vivid blend of science and imagery. 5-video set includes *Hearing, Smell, Taste, Touch* and *Vision.* 5 hrs. **WG2214† $69.95**

- **Hearing**
  Visit the quietest place on earth, the music-rich Maori and a deaf woman regaining her hearing. 1 hr. **WG2209† $19.95**
- **Smell**
  Sample a huge spectrum of smells, from the world's largest perfumery to sweaty t-shirts. 1 hr. **WG2210† $19.95**
- **Taste**
  Savor the miracle of great cooking and eating. 1 hr. **WG2211† $19.95**
- **Touch**
  Discover how touching is a potent tonic. 1 hr. **WG2212† $19.95**
- **Vision**
  Explore how art and science enhance this, our most magical sense. 1 hr. **WG2213† $19.95**

The Wonder of Life Boxed Set

Hidden from the human eye, the wonder of life unfolds in, on and around us with startling beauty and unexpected drama. 4-video set includes *The Odyssey of Life Set (The Ultimate Journey, The Unknown World, The Photographer's Secrets)* and *The Miracle of Life.* 4 hrs. **WG177 $59.95**

- **The Odyssey of Life Set**
  Travel with the creator of *The Miracle of Life* into the mysterious and previously invisible world inside our bodies. The 3-video set includes *The Ultimate Journey, The Unknown World* and *The Photographer's Secrets.* 3 hrs. **WGB2317 $49.95**
- **The Miracle of Life**
  This Emmy® award-winning classic brings you along on an incredible microphotographic voyage through the human body as a new life begins, including the moment of conception. 1 hr. **WG001 $19.95**
  The Miracle of Life is now available on DVD for the first time! 1 hr. **WG799 $19.95**
- **The Ultimate Journey**
  Stunning microphotography by Lennart Nilsson shows how the developing human embryo reveals links to other species—reflecting a shared ancestry that harks back to the dawn of creation. 1 hr. **WG2317 $19.95**
- **The Unknown World**
  They're hiding in your closet. They're lurking in your bed. They're all over you—and now, thanks to the microphotography of Lennart Nilsson, you can catch these creepy crawlers in the act, magnified to monster size. 1 hr. **WG2318 $19.95**
- **The Photographer's Secrets**
  For the first time ever, Lennart Nilsson—the photographer who led us into the awe-inspiring world of the womb—reveals his secret state-of-the-art microphotographic techniques. 1 hr. **WG2319 $19.95**

Now available on DVD!

Secret of the Wild Child

NOVA profiles "Genie," a girl whose parents kept her imprisoned in near total isolation from infancy. Includes footage of Genie during her rehabilitation and probes how and when we learn the skills that make us "human." *Educational use only.* 1 hr. **WG2112* $19.95**

Siamese Twins

Witness the intricate plans and delicate operations that give independence to two young girls who were born joined at the pelvis. 1 hr. **WG2204* $19.95**

† public performance rights are not included

Stranger in the Mirror

NOVA explores the nature of human perception through the puzzling condition called visual agnosia, the inability to recognize faces and familiar objects, made famous in Oliver Sacks' book, *The Man Who Mistook His Wife for a Hat. Educational use only.* 1 hr. **WG709* $19.95**

NEW! The Truth About Impotence

Everyone's buzzing about the hot new pill for it. But when it comes to the condition itself, no one wants to talk about it—until now. *NOVA* offers a revealing look at erectile dysfunction: its causes, its life-shattering effects and the amazing progress science has made in treating it over the last 20 years. 1 hr. **WG2510 $19.95**

The Universe Within

Travel inside the human body, with microphotography and computer animation achieved by the creators of *The Miracle of Life.* Witness the miracle of pregnancy, the travels of a PB&J sandwich, and the amazing mechanism of movement. 1 hr. **WG2206 $19.95**
Also available, 90-min. educational version. **WG2206A $19.95**

What's New About Menopause

Examine new research and medical capabilities that stir up ethical controversies over the new ability to postpone menopause or bear children after "the change." 1 hr. **WG2114 $19.95**

Physical Science

Avalanche!

With no warning and in mere seconds, avalanches wipe out everything in their path, killing hundreds of people each year. See what risks scientists are taking to protect us. 1 hr. **WG2418N $19.95**

The Beast of Loch Ness

Is the Loch Ness Monster a hoax, an undiscovered species, or a shared illusion born of myth, mirage and wishful thinking? Join *NOVA* for an all-out investigation of the mystery as MIT-trained investigators scour the loch with sophisticated sonar, biologists and geologists explore whether a new species may still await discovery in Britain's largest lake, and the most famous photo of Nessie is put to the test. 1 hr. **WG2601 $19.95**

The Best Mind Since Einstein

NOVA profiles the late Richard Feynman—atomic bomb pioneer, Nobel prize-winning physicist, acclaimed teacher and all-around eccentric–who helped solve the mystery of the space shuttle Challenger explosion. *Educational use only.* 1 hr. **WGW708* $19.95**

Bomb Squad

A former IRA member reveals some of the organization's most chilling tactics as *NOVA* looks at the British Army's latest technological advances—in which science and ingenuity are the key to survival. 1 hr. **WG2413 $19.95**

Einstein Revealed

Journey into the life and thoughts of a genius—through interviews with "Einstein" (Andrew Sachs of *Fawlty Towers*), insight from experts, and some whimsical computer animation. 2 hrs. **WG2311 $19.95**

NEW! Fall of the Leaning Tower

Tilting at an amazingly dangerous angle, the Leaning Tower's problem is obvious—its solution isn't. See how science is attempting to save a medieval masterpiece with a high-risk rescue plan that may add centuries to the life of this architectural treasure. Discover centuries of eye-opening historical facts and curious restoration efforts as *NOVA* brings you inside a riveting battle to right history's wrongs. 1 hr. **WG2611 $19.95** *Available October 1999.*

Fast Cars

The exhilaration of speed meets the challenges of aerodynamic design as champion driver Bobby Rahal and a team of experts race to ready his custom car for the Indianapolis 500. 1 hr. **WG2208 $19.95**

Faster Than Sound

The international race to build an aircraft that could crack the sound barrier was fraught with danger, ambition, and intrigue. *NOVA* tells the real story of those who risked all to make aviation history—including Chuck Yeager, who on October 14, 1947 was the first pilot to fly faster than sound. 1 hr. **WG2412 $19.95**

Flying the Blimp

Revisit the giant airships that ruled the skies—before the Hindenburg disaster dashed their promise—and find out how latter-day blimp builders are resurrecting these romantic lighter-than-air machines. 1 hr. **WG1714 $19.95**

Kaboom!

Experience the ultimate chemical reaction—the explosion. With high speed photography and dramatic reconstructions, *NOVA* examines the history of explosives and their role in accidents, war and terrorism. 1 hr. **WG2401 $19.95**

The Light Stuff

Reliving a Greek myth takes an effort of mythic proportions, as *NOVA* reveals in its behind-the-scenes report of the recent human-powered flight across the Aegean Sea. *Educational use only.* 1 hr. **WGW711* $19.95**

Race to Catch a Buckyball

Learn about the chance discovery of an entirely new form of carbon—soccer-ball-shaped miraculous molecules called Buckyballs. *Educational use only.* 1 hr. **WG2216* $19.95**

Roller Coaster!

NOVA takes viewers on the ride of their lives as it explores the science of roller coasters, where physics and psychology meet. New rides of the future may take place entirely in the mind—with virtual reality. *Educational use only.* 1 hr. **WGW706* $19.95**

Secrets of Lost Empires Boxed Set

Uncover the secrets of ancient civilizations as *NOVA* journeys to five archaeological sites where teams of experts use traditional techniques to test their hypotheses. 5-video set includes *Colosseum, Inca, Obelisk, Stonehenge* and *Pyramid.* 5 hrs. **WG182 $69.95**

- **Colosseum**
  Try out two possible designs for the canopy that once covered the Colosseum—one of them borrowed from ancient ships. 1 hr. **WG2406 $19.95**
- **Inca**
  Explore the magnificent mountainside citadels—and marvel as villagers create a 150-foot suspension bridge using nothing but grass. 1 hr. **WG2404 $19.95**
- **Obelisk**
  Face the challenge of quarrying, chiseling, hauling, and mounting an obelisk—using stones, ropes, logs, and dirt. 1 hr. **WG2405 $19.95**
- **Stonehenge**
  Watch a band of experts move, raise, and cap a structure like the mysterious Stonehenge—armed with Stone Age tools. 1 hr. **WG2403 $19.95**
- **Pyramid**
  Join the race to erect an 18-foot stone pyramid in three weeks—while testing out some clever construction theories. 1 hr. **WG181 $19.95**

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Super Bridge
Take a look at "the bridge of the future" and play sidewalk supervisor on one of the world's most remarkable and risky bridge projects—the building of the elegant, cable-stayed Clark Bridge spanning the Mississippi at Alton, Illinois. 2 hrs. **WG2416 $19.95**

Supersonic Spies
The shocking details of the race for supersonic passenger travel are finally coming to light. The Soviets started years behind the Concorde, but their remarkably similar Soviet TU-144 (dubbed the "Konkordski") was in the air first. This true tale of Cold War espionage reveals what really happened at the 1973 Paris air show, a supersonic competition between the planes, when the Konkordski went down in a fatal, fiery explosion, which was never fully explained by either the French or the Soviets. 1 hr. **WG2503 $19.95**

This Old Pyramid
Join an Egyptologist as he reveals the secrets of the ancient pyramids and advises a stonemason from *This Old House* on how to build a new pyramid. 90 min. **WGW278 $19.95**

The Thrill of Flight Set
Take a rare opportunity to fly in some of the world's most fascinating airplanes. 3-video set includes *Aircraft Carrier!, Daredevils of the Sky* and *B-29 Frozen in Time*. 3 hrs. **WG163 $49.95**

- **Aircraft Carrier!**
  The grueling, yet suddenly thrilling life aboard the USS Independence. 1 hr. **WGW2110 $19.95**
- **Daredevils of the Sky**
  Strap in for a ride with America's greatest stunt pilots. Stunning in-air photography puts you in the pilot's seat with the US Aerobatic Team. 1 hr. **WGW2103 $19.95**
- **B-29 Frozen in Time**
  Join a grueling expedition to recover this rare plane from the North Pole after 50 years—a trip which tests team members in ways they never imagined. 1 hr. **WG2303 $19.95**

Top Gun Over Moscow
For half a century we feared them. Now, for the first time, meet the rugged pilots of the Russian Air Force—and take a close-up look at the heart-stopping maneuvers that still fill Western flyers with awe. 1 hr. **WG2315 $19.95**

Mathematics

Chip vs. the Chessmaster
NOVA explores what it took to prepare Deep Thought, a computer chess program, to take on world champion Gary Kasparov in 1989. *Educational use only.* 1 hr. **WG1803* $19.95**

Codebreakers
NOVA delves into the history of secret communications and the people who decipher them, probing the most celebrated of all cryptographic coups: the breaking of the World War II codes used by Japan and Germany. *Educational use only.* 1 hr. **WGW2101* $19.95**

NEW! Decoding Nazi Secrets
Historic, fascinating and filled with stunning revelations, *NOVA* presents the first fully detailed account of the greatest codebreaking coup of all time. Hear American and British codebreakers—as well as German codewriters—reveal long-held secrets for the first time. 2 hrs. **WG2615 $19.95** *Available December 1999.*

The Proof
Eureka! Follow Princeton math whiz Andrew Wiles, spent eight secluded years perfecting the proof of Fermat's Last Theorem, a famous enigma that had stumped experts for 300 years. Follow a fascinating tale of obsession, secrecy, brilliance–and one man's inspiring single-minded quest. *Educational use only.* 1 hr. **WG2414* $19.95**

NOVA Field Trips

Amazing Animals
Meet some extraordinary animals around the world—from bugs to bats and more. Includes *All-American Bear, Little Creatures Who Run the World* and *Mystery of the Animal Pathfinders.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG089 $49.95**

Creatures of the Sea
Dive deep for an underwater visit with the ocean's most fascinating creatures. Includes *Shark Attack!, Private Lives of Dolphins* and *Treasures of the Great Barrier Reef.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG091 $49.95**

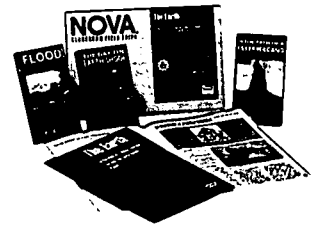
Dinosaurs
Join scientists in a dig for clues about the world of dinosaurs. Includes *Buried in Ash, Dinosaurs of the Gobi,* and *Mammoths of the Ice Age. T*eacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes. **WG094 $49.95**

The Discoverers
Take a close look at the century's great scientists and learn how they made their breakthrough discoveries. Includes *Einstein Revealed* (2 hrs.) and *Race to Catch a Buckyball.* Teacher's guide included. *Educational use only.* 3 hrs. on 2 cassettes. **WG106 $49.95**

Discovering Ancient Cultures
Science provides new clues about some of the world's most interesting ancient cultures. Includes *This Old Pyramid* (90 min.), *Vikings in America,* and *Warriors of the Amazon.* Teacher's guide included. *Educational use only.* 3.5 hrs. on 3 cassettes. **WG092 $49.95**

The Doctors
See how doctors operate behind the scenes. Grades 7 and up. Includes *MD: The Making of a Doctor* (2 hrs.) and *Ebola: The Plague Fighters.* Teacher's guide included. 3 hrs. on 2 cassettes. **WG104 $49.95**

The Earth
Take a close-up look at some of Earth's most spectacular phenomena. Includes *In the Path of a Killer Volcano, The Day the Earth Shook* and *Flood!.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG110 $49.95**



Exploring Space
View the universe from new perspectives. Includes *Countdown to the Invisible Universe, Death of a Star* and *Rescue Mission in Space.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG107 $49.95**

Fast Physics
Understand the thrill and power of motion. Includes *Roller Coaster!, Fast Cars* and *Daredevils of the Sky.* Teacher's guide included. *Educational use only.* 3 hrs. on 3 cassettes. **WG086 $49.95**

Flight

Feel the exuberance and the thrill of flight—in a classic plane, fast planes, and a balloon. Includes *Top Gun Over Moscow, Three Men and a Balloon* and *Aircraft Carrier!*. Teacher's guide included. 3 hrs. on 3 cassettes. **WG111 $49.95**

The Human Body

The intricate wonders of the human body are revealed in extraordinary visual detail. Includes *The Miracle of Life, The Universe Within* and *The Ultimate Journey.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG085 $49.95**

In Search of Human Origins

View the award-winning exploration of the beginnings and development of the human race. Includes *The Story of Lucy, Surviving in Africa* and *The Creative Revolution.* Teacher's guide included. 3 hrs. on 3 cassettes. **WG109 $49.95**

The Mysteries of the Mind

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