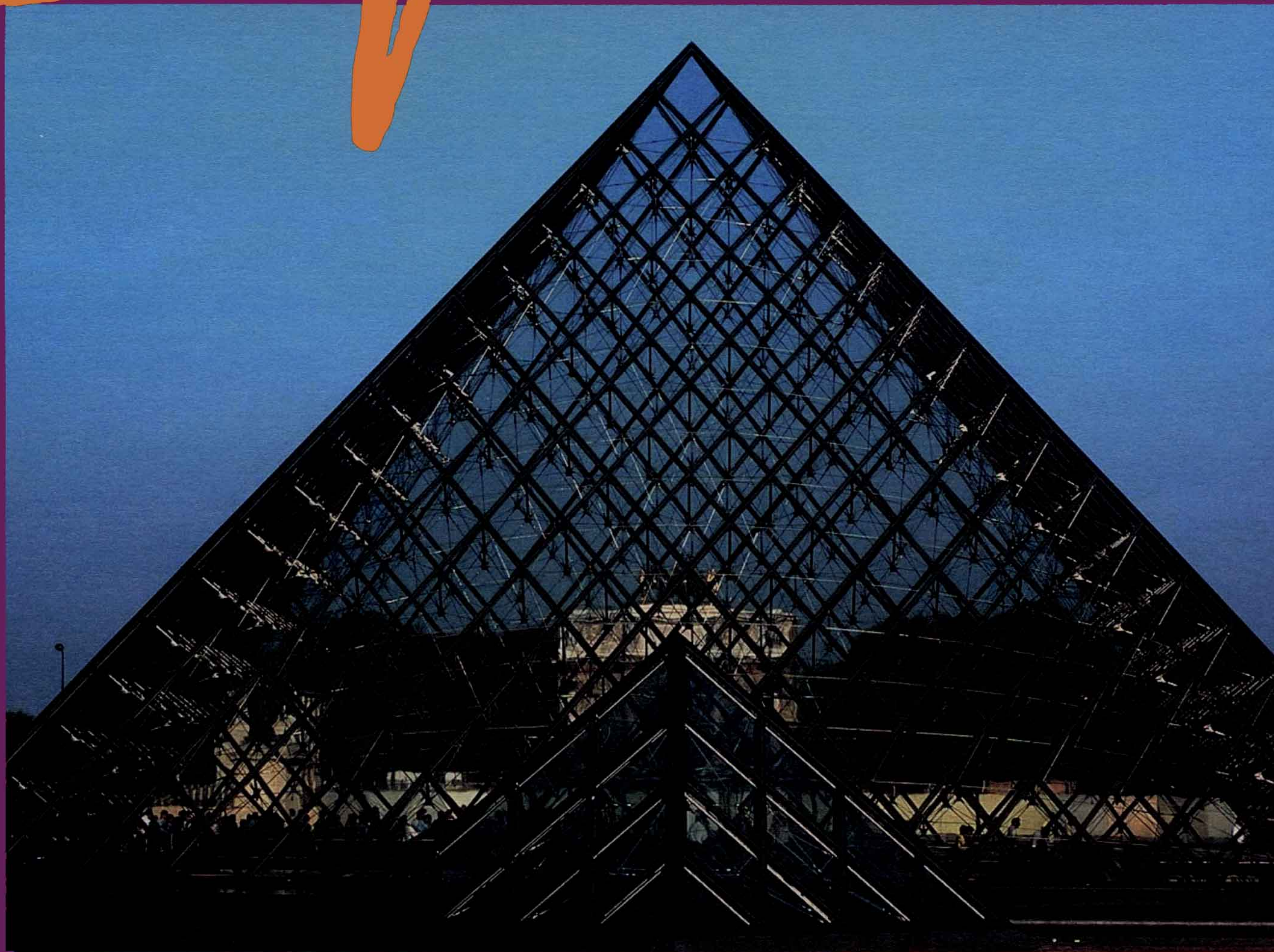


Math Explorers



MATH & CHEMISTRY

Chemistry Has the Solutions!
Nightingale Brings Relief
CRYSTALS SHAPE UP !!

Math Explorer

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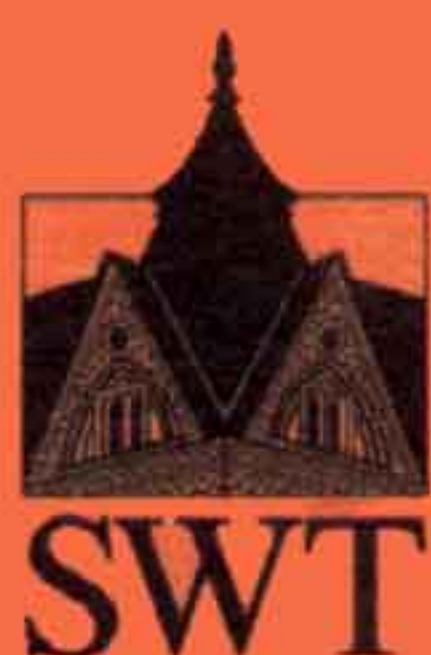
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Florence Nightingale



Hiroko K. Warshauer

Florence Nightingale is best remembered as a “ministering angel” for her dedicated work as a nurse during the Crimean War in the mid 1800’s. Born in 1820 to English parents, she was named after the Italian city of Florence where she was born. Most women of her era were encouraged to prepare for marriage, but Florence begged her parents, “to let her study mathematics instead of doing worsted work and practicing quadrilles.” [1] Her father, who loved mathematics and had communicated this love to his daughter, eventually gave her permission to study mathematics formally. Among Florence’s tutors was the famous English mathematician, James Sylvester.

Florence’s parents also opposed her decision to become a nurse, but eventually allowed her to attend a nursing school in Germany. As a nurse, Florence and 38 other women were recruited to go to Scutari in Turkey and attend to the sick and wounded British soldiers who were fighting against the Russian army in the Crimean War. With the poor health care provided to the injured soldiers and the unsanitary conditions of the hospitals, Florence saw that nearly 50% of the soldiers were dying not from injuries but from diseases such as dysentery and cholera. The military administrators did not want Florence to report such shocking statistics, as they would reflect poorly on them. With the documented data and information she gathered however, Florence gave evidence of the miserable conditions and provided reasons for health care reforms in Scutari. Eventually, Florence prompted the reviewing of health care conditions in England as well.

Florence helped “to promote the idea that social phenomena could be objectively measured and subjected to mathematical analysis. Her work with medical statistics was so impressive that she was elected (in 1858) to membership in the Statistical Society of England. One of the pioneers in the graphic method of presentation of data, she invented colorful polar-area diagrams, also known as pie graphs, to dramatize data.” [1]

References:

[1] Lipsey, Sally Irene. “Mathematical Education in the Life of Florence Nightingale.” Newsletter of the Association for Women in Mathematics, Vol. 23, Number 4 (July-August 1993), 11-12

1. How many ways can you get exactly 50 cents using only pennies and nickels? Using pennies, nickels and dimes?

2. An isosceles triangle has perimeter 30, and one of the sides has length 8. What are the lengths of the other two sides? Can you find more than one answer?

3. Mr. Fibonacci counted the students in his class and concluded that there must be at least 3 students with birthdays in the same month. What is the fewest possible number of students in his class?



4. How many integers between 1 and 100 are divisible by 5 or 6, or both?

5. Next year, Jenni will be exactly half her sister Sarah's age. The year after that, Sarah will be half the age of their father. Jenni's father is 40. How old is Jenni now?



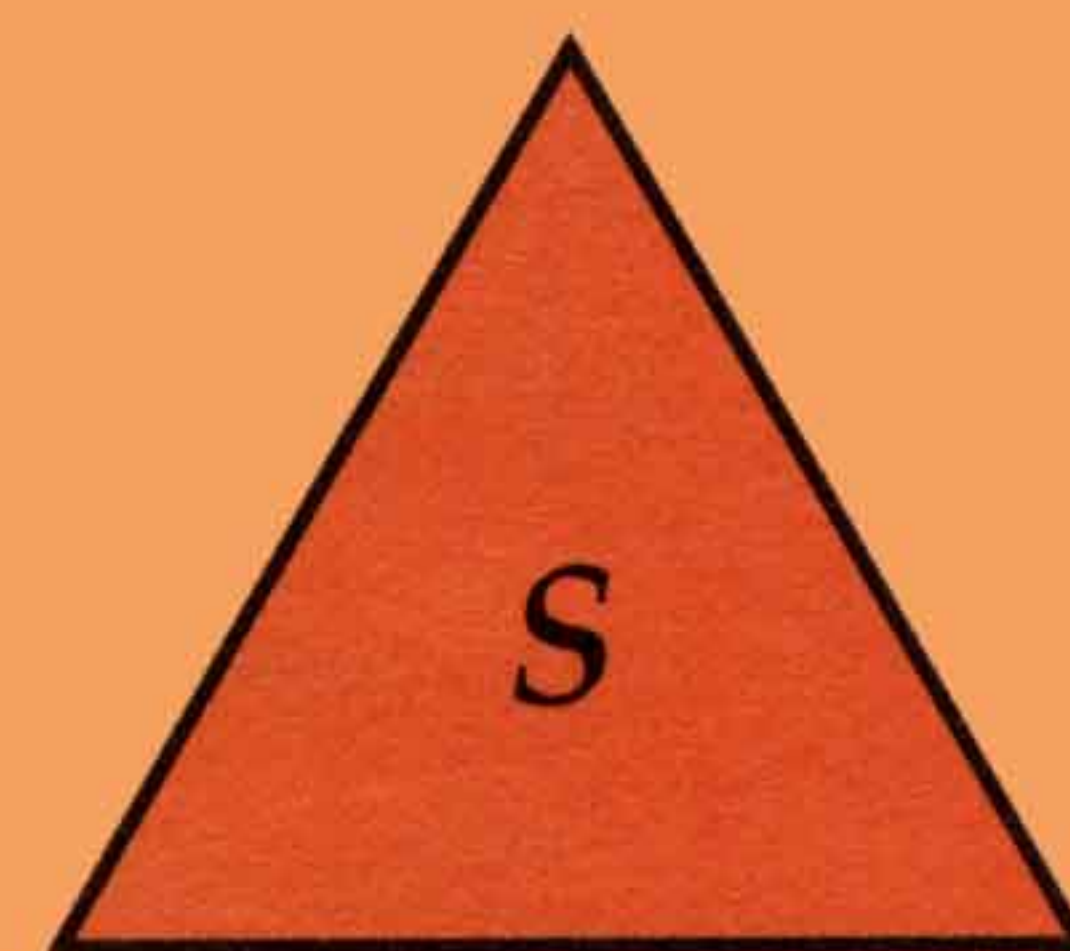
6. How many milliliters of water should be mixed with 5 milliliters of 80% antifreeze to reduce the concentration to 40%?

7. Find the 100th term of the sequence 1, 2, 4, 7, 11, ...

8. Today is Wednesday. What day of the week will it be 100 days from today?

9. On test 1, with 20 questions, Julie got 80%. On test 2, with 25 questions, Julie also got 80%. On which test did Julie miss more questions?

Ingenuity: R and S are equilateral triangles. The area of R is 1 square inch. The perimeter of S is 3 times the perimeter of R. What is the area of S?



THE IMPORTANCE OF PERCENTS IN CHEMISTRY

by Carol Lipsey Hersh

The calculation of percents is useful in a variety of situations. If your teacher hands back a math test in which you got 25 problems correct out of 25 total problems, your teacher may write 100% (great job!) on the top of the test. If the test was rather hard and you got 20 answers correct out of 25, your teacher might write 80% (good try!). Per cent means "out of one hundred". The fraction:

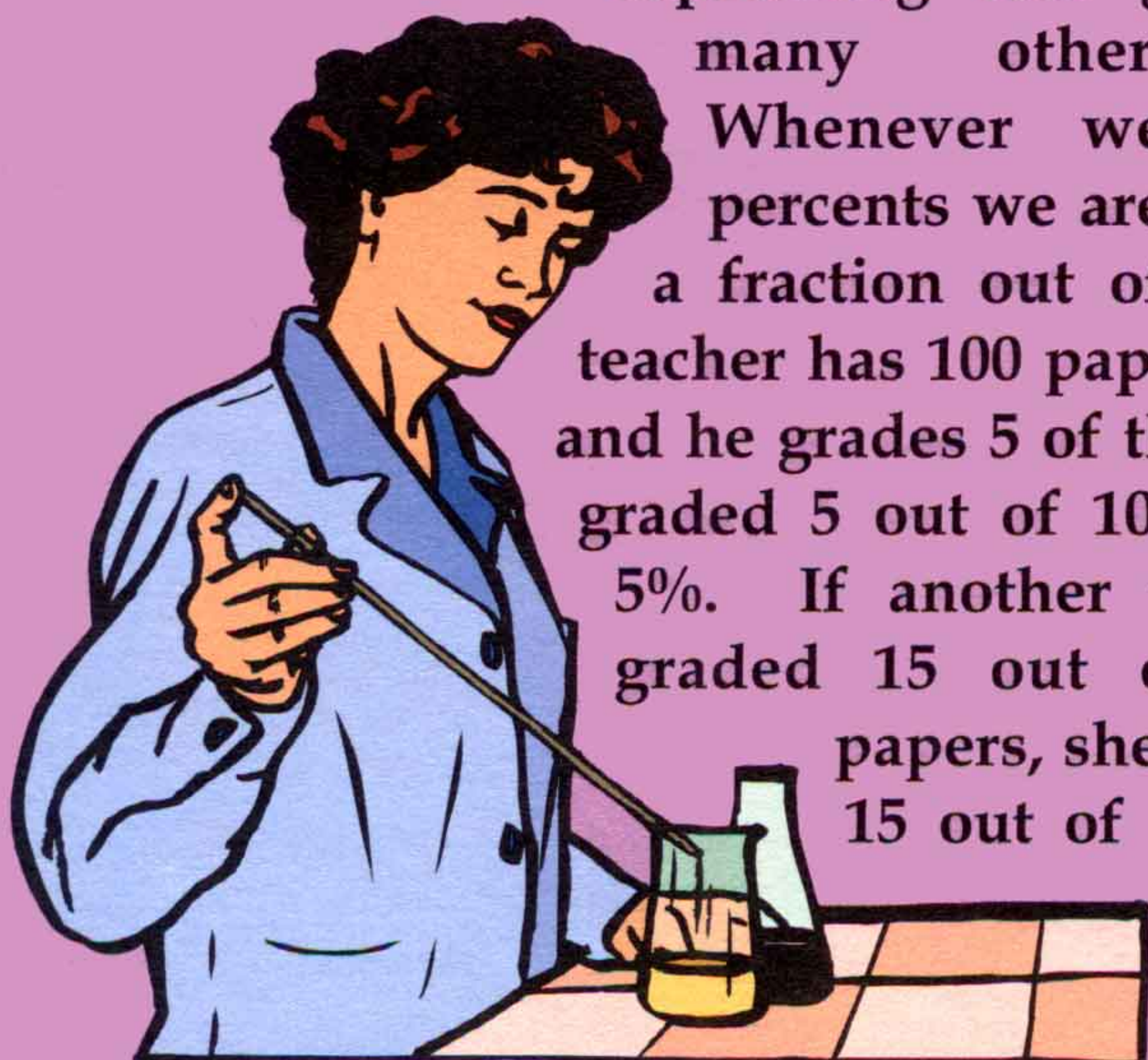
$$\frac{25 \text{ problems correct}}{25 \text{ total problems}}$$

is equivalent to, and can be converted to, 100 correct out of 100 (100/100) or 100%. The fraction:

$$\frac{20 \text{ problems correct}}{25 \text{ total problems}}$$

is equivalent to 80/100 or 80%.

Percents provide a very convenient way of expressing test grades and many other values. Whenever we calculate percents we are expressing a fraction out of 100. If a teacher has 100 papers to grade and he grades 5 of them, he has graded 5 out of 100 (5/100) or 5%. If another teacher has graded 15 out of her 100 papers, she has graded 15 out of 100 (15/100) or 15%.

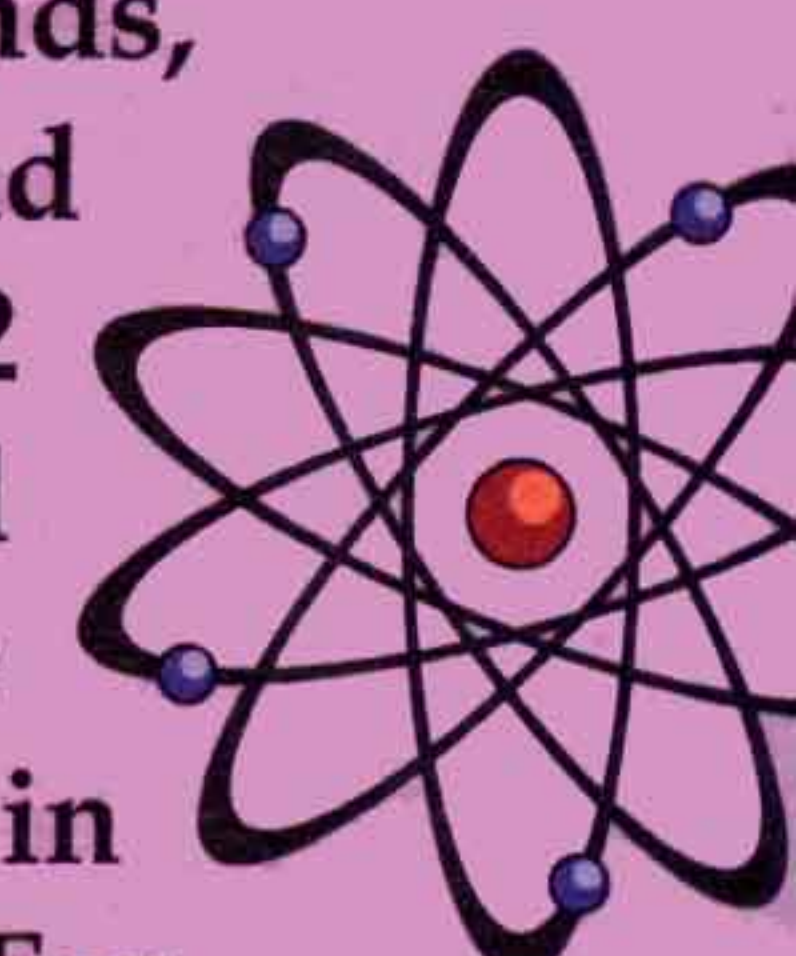
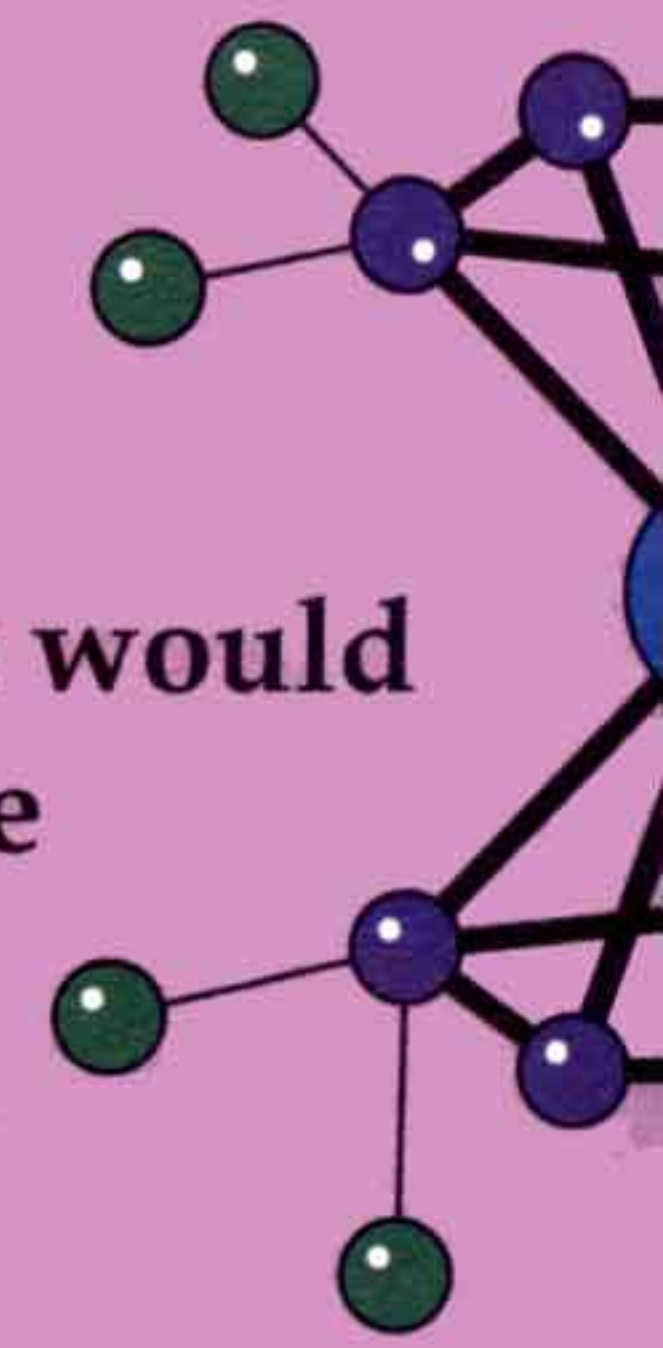


If a shirt is on sale for 10% off, the price would be reduced by \$10 dollars if it were originally \$100 dollars, or by \$5 dollars if it were originally \$50, or by \$2.50 if it originally cost \$25.

$$2.50 / 25 = 5 / 50 = 10 / 100 = 10\%$$

Scientists find percent a very useful tool for expressing certain values in chemistry. Chemists frequently prepare products or carry out reactions in solutions in which one or more substances are dissolved in a liquid. The amount of the substance dissolved can be described using percent. If 10 grams of sugar were dissolved in 100 milliliters of water, we would say that we have a 10% (weight/volume) solution. Contact lens wearers must wash their lenses with saline that is a 0.9% salt solution, that is, 0.9 grams of salt dissolved in 100 milliliters of water. The composition of products that we buy is sometimes given in percents. For example, many products that are used to keep skin free of pimples contain a chemical called salicylic acid. One such product has 0.5% salicylic acid (0.5 grams in 100 milliliters of solution).

Elements are the basic building blocks of all chemicals. Some examples of elements are carbon, found in graphite and diamonds, hydrogen, used as fuel for rockets, and oxygen, found in air. Of the 112 known elements, some are natural and some are man-made. All of the naturally occurring elements come in multiple forms called isotopes. For example, there are two different isotopes of the element copper, copper-63 and copper-65. The



atoms of these two isotopes have many of the same properties, but differ in their mass. Careful determinations of the relative amounts of the different isotopes have been made for many elements, and are expressed as percents. In a sample of copper, 69% is copper-63 and 31% is copper-65. In any sample of copper taken from anywhere in the world, the relative amounts of the two copper isotopes will be the same. Out of any sample of 100 atoms of carbon, therefore, 69 will be copper-63 and 31 will be copper-65.

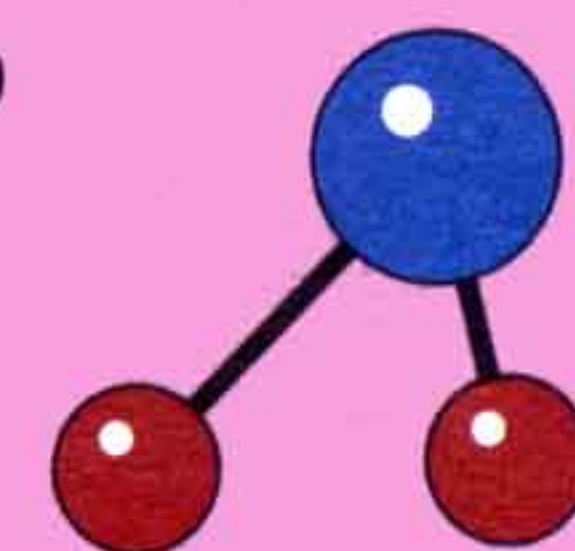
Most chemicals, including medicines, plastics, and fuels, are classified as compounds. A compound consists of one or more elements joined together. When chemists discover a new compound, they want to find out what the composition of the compound is. Eventually the chemist will want to write a formula stating the types and numbers of atoms present. One clue about the compound that chemists can determine readily is the masses of the elements present in the compound. From the masses of the elements, the chemist will often calculate a percent composition which can be used to describe the compound. The percent composition indicates how much of the total mass of the compound is contributed by each element. For example a water molecule consists of two atoms of hydrogen and one atom of oxygen. Hydrogen has a mass of 1.01 atomic mass units and oxygen has a mass of 16.00 atomic mass units. The total mass of a water molecule is 18.02 atomic mass units. Oxygen contributes 16.00 out of the 18.02 atomic mass units; as a percent it is

$$\frac{16.00}{18.02} = \frac{88.79}{100} = 88.79\%$$

Hydrogen contributes 2.02 out of the 18.02 atomic mass units, so it contributes

$$\frac{2.02}{18.02} = \frac{11.21}{100} = 11.21\%$$

percent of the total mass.



Chemicals are made by chemical reactions. From the amounts of starting materials that are used, a chemist can calculate how much product could possibly be obtained. Because chemical reactions don't always give complete conversion of starting materials to products and because some material can be lost when chemicals are transferred from one container to another, it is rare that all of the possible amount of product will be obtained. In order to determine how well the reaction went, a chemist will calculate a percent yield. This is a way of comparing the amount of product actually obtained to the amount of product that could be obtained under ideal circumstances. For example, suppose a student was synthesizing ibuprofen (the active ingredient in Motrin and Advil) and collected 80 grams when the maximum possible amount was 100 grams. The percent yield is:

$$\frac{80 \text{ grams}}{100 \text{ grams}} = 80\%$$

If 24 grams of ibuprofen is the maximum possible amount and 12 grams of product are obtained, the percent yield is $12/24 = 50/100$ or 50%.

Chemists use calculation of percents in determining the composition of solutions and compounds, expressing the relative amounts of the various isotopes of an element, and in describing the success of a reaction. But chemistry is only one of many fields in which percents are important.

Carol Lipsey Hersh teaches chemistry and science research at Great Neck South High School in New York. Inspired by her mother, a math teacher, she has always enjoyed math.

Puzzle Page

Math Explorers:

We want to print your work! Send us original math games, puzzles, problems, and activities. If we print them, we'll send you and your math teacher free *Math Explorer* pens.

Word Search

Forwards or backwards, up, slanted, or down.

Where can the words in this puzzle be found?

STATISTICS

PERCENT

CHEMISTRY

CRYSTAL

ISOTOPE

COMPOUND

HYDROGEN

MOLECULES

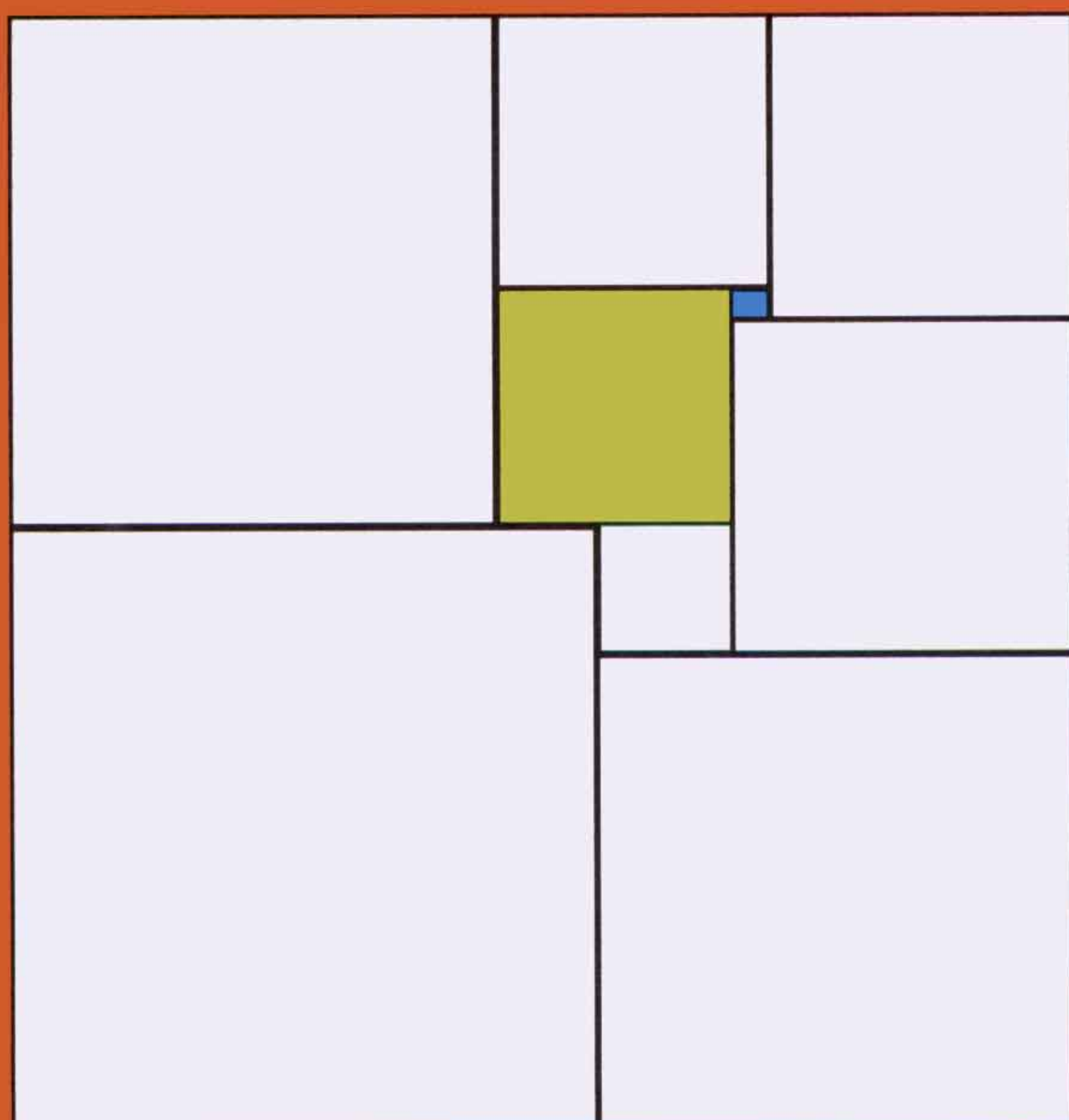
ATOM

POLYHEDRA

R	P	S	C	I	T	S	I	T	A	T	S	H	Y
T	S	P	R	I	O	R	Y	P	I	O	Q	D	I
C	O	T	O	T	A	C	T	S	Y	I	T	M	S
P	M	Q	S	I	Y	T	D	C	M	D	C	T	O
E	L	Y	U	C	H	E	M	I	S	T	R	Y	T
R	R	E	M	C	T	Y	U	T	D	H	Y	P	O
C	S	A	T	O	P	I	D	D	N	P	S	O	P
E	T	Y	U	O	U	M	T	R	U	E	T	I	E
N	M	T	T	I	M	C	Y	L	O	P	A	O	I
T	C	O	M	O	E	T	O	L	P	G	L	Y	E
Y	S	I	T	T	I	Y	C	O	M	E	E	I	T
I	L	A	R	D	E	H	Y	L	O	P	L	N	T
L	C	O	C	L	O	M	Y	C	C	R	O	E	M
O	A	A	O	R	M	O	L	E	C	U	L	E	S

A total of 30 quarts of milk was in 3 cans. 4 quarts were poured from the first can into the second; then 2 quarts from the second can to the third; and finally 3 quarts from the third can to the first. After this each can had the same amount of milk. How many quarts of milk were in each can at the beginning?

A rectangle is divided into 9 squares as shown below. The lengths of the sides of the 2 colored squares are 7 inches and 1 inch respectively. What is the perimeter of the rectangle?



If 642 digits are used in numbering the pages of a book (beginning with 1,2,3...), how many pages does the book have?

Bulletin Board

swtMathworks First Annual Star Award Recipient

Governor Rick Perry recognized **swtMathworks** as one of five exemplary programs in Texas (out of 88 nominees) with the First Annual Star Award from the Texas Higher Education Coordinating Board, for Closing the Gaps by Moving Every Texan Forward. Kudos to Mathworks!

Siemens-Westinghouse competition winners

SWT Honors Math Camp students Charles Hallford, Rebecca Williams, and Cynthia Chi competed and finished 4th nationally in the Siemens-Westinghouse Science and Technology Competition. Their project was entitled *The Generalization of the deBruijn Edge Sums*, and their advisor was Daniela Ferrero, Asst. Professor of Mathematics at SWT. They received \$30,000 in scholarships!



Thanks Intel!

Intel announced a \$40,000 grant to support **swtMathworks** programs this coming summer! This includes student and teacher scholarships. In addition, Intel will make presentations to math camp students about Math and Technology in Industry.

Math Riddle

What did the acorn say when it grew up?
Geometry

Nightingale (cont'd)

For more information read:
Michalowicz, Karen Dee. "Florence Nightingale, The First Woman Statistician."
Newsletter of Women & Mathematics Education, Fall 2001

<http://www.spartacus.schoolnet.co.uk/Renightingale.htm>

Note: Sally Lipsey, author of the main reference for this article, is former President of Women and Mathematics Education and is also the mother of Carol Lipsey Hersh, author of this issue's main article on Chemistry and Mathematics.

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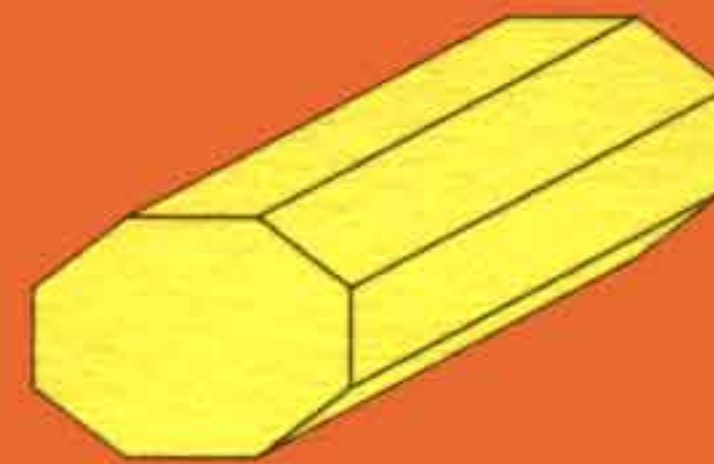
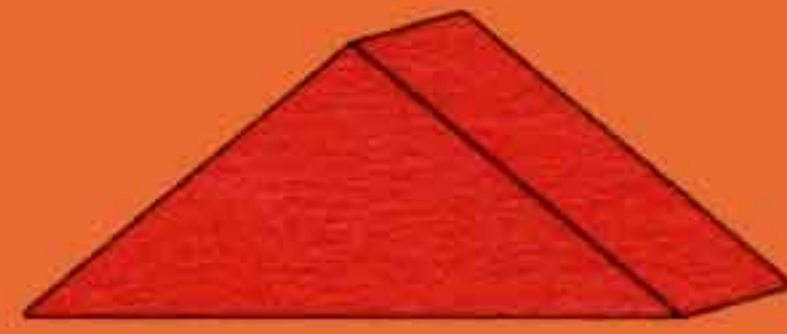
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Crystals: Naturally occurring polyhedra

A soccer ball, the Pyramids of Egypt, a six-sided die, and table salt all have something in common. They are all examples of a polyhedron. A **polyhedron** (the plural is polyhedra) is a three-dimensional solid whose faces are all polygons.

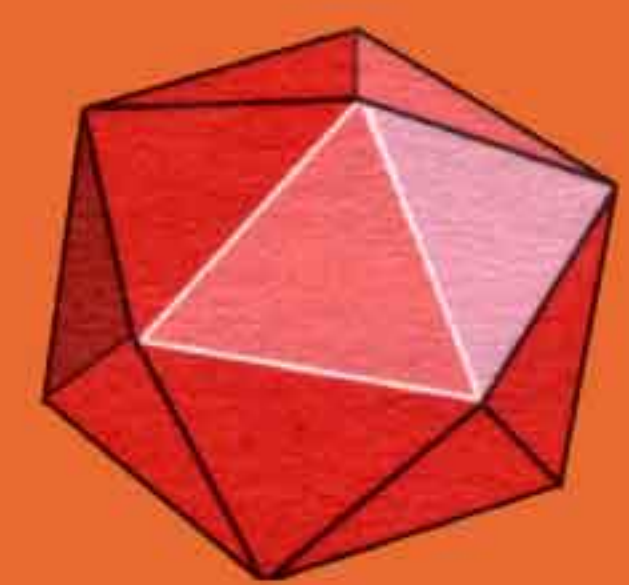
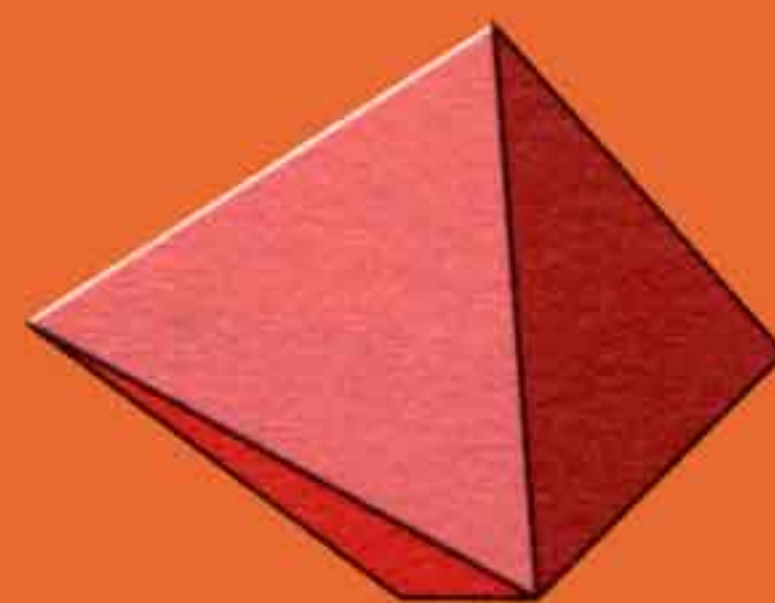
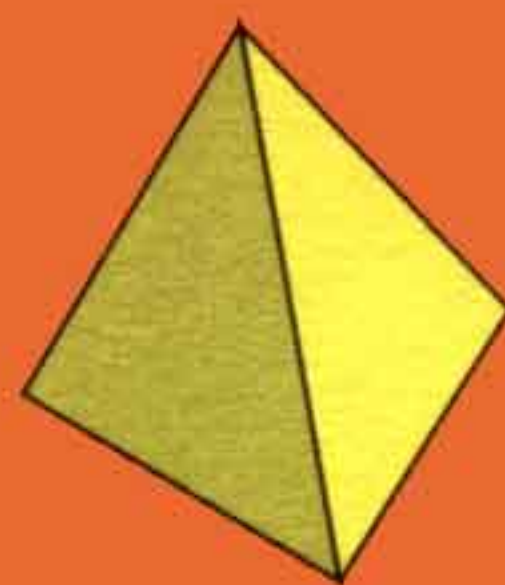


A **regular polyhedron** is a polyhedron whose faces are all regular polygons.



A **regular polygon** is a polygon with all its sides of equal length and all its interior angles of equal measure. There are only five regular polyhedra. Named after the famous Greek philosopher Plato (~400 BC), the five Platonic Solids are the cube, tetrahedron, octahedron, dodecahedron, and the icosahedron.

Except for the cube, notice that each of the remaining four shapes has a prefix before “hedron”. Each prefix has a meaning. For example, tetra means four in Greek. Can you determine what the other prefixes mean? Look at the Platonic Solids below and you may see why those prefixes were chosen for the polyhedra. Observe the regular polygons that make up the faces of the Platonic Solids.



Crystals are examples of polyhedra that occur in nature. **Crystals** are solid materials in which the atoms are arranged in symmetrical patterns. The combination of one or more kinds of atoms is the basic building block of a crystal, and is called the unit cell. The unit cells are arranged in geometric shapes which when stacked in any direction, form the crystal. Table salt or sodium chloride, is made up of crystals in the form of cubes. In the quartz crystal, each silicon atom is surrounded by a tetrahedron of oxygen atoms. Chrome alum crystals are in the form of octahedra. Crystallographers, or those who study crystals, classify crystals by looking at their geometric shapes. In 1985, a new form of crystalline carbon called the 60-carbon buckminsterfullerene, nicknamed Buckyballs was discovered. Though not a regular polyhedron, it is in the shape of a truncated icosahedron and resembles a soccer ball.

References: <http://mathforum.org/alejandre/applet.polyhedra.html>

The Joy of Mathematics Discovering Mathematics All Around You, Theoni Pappas

Chemistry is an important branch of the sciences that studies the nature of matter. It also uses mathematics as a tool for investigation. We hope you enjoy our discussion of the mathematics behind percents and polyhedra in this issue of *Math Explorer*. Good luck with the challenging puzzles and intriguing problems! Write to us with any interesting math problems or solutions to the puzzles. We look forward to hearing from you!

If you'd like to attend the Junior Math Camp this summer, don't forget to request your application soon.

Sincerely,

Hiroko K. Warshauer