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Sierra On-Line, Inc., Corvallis, California 97331

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ENCYCLOPEDIA ACTIONARY TOGRAPHY



ISLAND OF DOCTOR BEAD

ENCYCLOALMANACTIONARYOGRAPHY



## SIX YEAR CALENDAR

1993

JANUARY	FEBRUARY	MARCH	APRIL
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What is an EncycloAlmanacTionaryOgraphy? Well, it's a combination of an encyclopedia, an almanac, a dictionary, and a bibliography, and it's yours free just for playing this game.

The goal of the EncycloAlmanacTionaryOgraphy is to present a variety of topics in one concise, easy-to-read and easy-to-find source. You may just find yourself carrying this manual around with you for your research projects. However, it's especially beneficial for learning more about the puzzles in the game.

There are three main SECTIONS to the EncycloAlmanacTionaryOgraphy.

In SECTION ONE, you'll find all the necessary information about playing the game (i.e., learning the Icon Bar, saving your game, setting difficulty levels from Easy to Standard to Expert, operating your Hint Watch, and scoring). There's also a free Chart of the Cerebral Hemisphere (needed for solving your first puzzle of the game).

In SECTION TWO, you'll find related background information on many of the puzzles in your game. This section is designed to help you get started on your own research projects. For example, under the heading *You Might Look it Up (on Dr. Braun's Bookshelf)*, you can find answers to questions like these: Is Zambezi a river or a country? On which continent is Belize? And where is Mt. Kilimanjaro anyway? In a band, is an English horn a brass or woodwind instrument? In what system of your body are phalanges found? Are yaks generally found in high mountain regions?

In SECTION THREE, you'll find a Glossary of Terms, a Bibliography, and an index to your EncycloAlmanacTionaryOgraphy. You'll also find some additional useful reference charts. Things you might like to look up in this section are as follows: Who was Gregor Mendel and what did he discover? (You can find this in your Glossary.) Who wrote *Who's Afraid of Virginia Woolf?* (This is found in your Bibliography.) Is AU the abbreviation for gold? (You can look it up in your Periodic Table of the Elements.)

These are just some of the uses we've come up with for the EncycloAlmanacTionaryOgraphy. We're sure you will come up with other uses. The world needs good, dedicated lab assistants such as yourself! Good luck in all your endeavors!

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## SECTION ONE

SOME NOTES  
ON GAME PLAY

### THE ISLAND OF DR. BRAIN

In the *Island of Dr. Brain*, you'll need to apply yourself in many different ways. Although no experience is required, you'll need to use your thinking skills in at least some of the following subject areas: math, science, foreign language, music, and art history. Your persistence in these areas will help you win the game.

#### Hint Calls

When you begin the game, Dr. Brain gives you a hint watch (with one hint call left). If you get stuck trying to solve a puzzle, press the hint watch button from the top of your puzzle bar (for more details, see *How the Puzzle Box Works*).

In some puzzles a hint call will buy a solution to part of the puzzle. If a hint call buys a solution, several hint calls (if you have them) will buy more solutions.

In other puzzles a hint call will buy a strategy (think about 'em) hint about

solving the puzzle. If a hint call buys this kind of hint, you can press the hint call button repeatedly without using more hint calls.

The more hint calls you have left over at the end of the game, the higher your score will be. Therefore, use your hint calls wisely.

#### Difficulty Level

There are three difficulty levels in the *Island of Dr. Brain*. You can set the difficulty level to Novice, Standard, or Expert at any time. The higher the difficulty level, the more points you will earn for solving the puzzles and the more your brain will ache.

If you replay one of the puzzles in the *Island of Dr. Brain*, you will discover that it requires a new and different solution. Therefore, you may receive one additional point for up to three replays of any puzzle. In some puzzles, such as the Coconut Tree Word Search, you can receive even more additional points.

#### How the Puzzle Box Works

Most puzzles come up in a puzzle box. Each puzzle box has three buttons as follows:

**Hint Call Button:** Pressing the **Hint Call Button** gets you more help (hints) with the puzzle if you have any hint call charges left. For more information on hint calls, see the previous section entitled *Hint Calls*.

**Exit:** Pressing the **Exit** button closes the puzzle box. If you are unable to complete the puzzle or want to quit the game and do something else, pressing the **Exit** button will allow you to leave the puzzle and come back to it later.

**Question Mark:** Pressing the **Question Mark Button** tells you about the puzzle — what you need to do, how to use the controls, and what kind of help your hint calls will supply.



## THE DR. BRAIN ICON BAR

At the top of the game screen is an Icon Bar. Each icon represents an activity you can perform in the game. The icons in Dr. Brain are as follows:



### From Left to Right:

**Look:** Looks like an eye. Choose **Look** when you want a description of something you see on the screen.

**Do:** Looks like a hand. Choose **Do** when you want to take an action on something on the screen.

**Item:** Looks like a picture frame. When you select an inventory **Item**, it will show in the frame.

**Inventory:** Looks like a beach bag. Choose **Inventory** when you want to see what items you have picked up, or to use one of your items. For more information on **Inventory**, see your *Sierra Game Manual*.

**Go Back:** Looks like an arrow pointing back the way you came. Choose **Go Back** when you want to leave the room you are in now and go back to the previous room you came from.

**Controls:** Looks like a slider bar on a control panel. Choose **Controls** when you want to change the volume or difficulty level of the game, or when you want to save, restore, restart or quit the game.

**Help:** Looks like a question mark. When you choose **Help** you will be able to get information by moving the question mark cursor on the other icons in the Icon Bar.

**Dr. Brain:** Click **Dr. Brain** to get a description of the island locale you currently occupy.

For more information on how icons work, see your *Sierra Game Manual*.

## THE ACHIEVEMENT BOARD

To examine your progress and score in the game, consult the Achievement Board. You carry the Achievement Board around with you in your inventory. You may examine the Achievement Board at any time. Simply move the mouse cursor to the top of the screen and select the Inventory icon. Now you'll see the Achievement Board icon. Look at the Achievement Board at any time to find out your current score and discover which skills you've mastered.

As you complete puzzles in the *Island of Dr. Brain*, each category of your Achievement Board will have a bronze, silver, or gold placard affixed to it. If a placard is affixed to the Achievement Board in one of the categories, this means you've solved one of the puzzles for that skill area. A bronze placard is awarded for Novice Level players, a silver placard for Standard Level players, and a gold placard for Experts.

## NAVIGATING THE CEREBRAL HEMISPHERE

In order to get to the Island, you need to tell Dr. Brain's pilot where to go. To help you in this task, fourteen important landmarks are indicated on the following chart of the Cerebral Hemisphere.



### Chart of the Cerebral Hemisphere



		North/South distance from Castle	East/West distance from Castle
Y	Cerebellum Rock	83 deg. S	53 deg. W
4	Cerebral Aqueduct	60 deg. S	64 deg. E
7	Corpus Callosum Mountains	23 deg. N	102 deg. E
8	Frontal Lobe Islands	23 deg. S	206 deg. E
9	Harbor Vitae	63 deg. N	60 deg. W
+	Hypothalamus Sea	45 deg. S	47 deg. E
V	Isle of Thalamus	29 deg. S	30 deg. E
◇	Lake Pituitary	103 deg. S	151 deg. E
△	Lund of Medulla Oblongata	65 deg. S	25 deg. W
△	Olfactory Lagoon	72 deg. S	177 deg. E
+	Pons Island	104 deg. S	66 deg. E
+	Sea of Cortex	41 deg. N	53 deg. E
+	Ventricle Bay	14 deg. S	92 deg. E

## Now What?

On Easy Level, the imaginary north-south line (Longitude) measuring at 0 degrees and the imaginary east-west line (Latitude) measuring at 0 degrees intersects at the castle. For example, suppose you need to instruct Dr. Brain's pilot to go to Ventricle Bay. Since Ventricle Bay is 14 degrees South and 92 degrees East of the castle, use the parallel rulers to line off these two locations.

Begin by marking the latitude location. (When you move the parallel rulers, notice how the degrees of latitude in the upper left-hand corner of the screen automatically increase South as you move down and North as you move up.) Move the parallel rulers cursor down to 14 degrees South and select it by pressing your mouse button or ENTER key.

Now mark the longitude location. (When you move the parallel rulers, notice how the degrees of latitude in the upper left-hand corner of the screen automatically increase West as you move left and East as you move right.) Move the parallel rulers right to 92 degrees East and select it by pressing your mouse button or ENTER key.

If you do this correctly, you'll land on the beach of the island and begin the game. If you miss, just try again. With a little practice, you'll become an experienced navigator in no time!

### As a Matter of Fact...

Latitude and longitude lines are an important feature of most maps and charts. They can be very useful. Latitude and Longitude refer to imaginary lines that navigators and map makers use. The imaginary lines that go from East to West around the Cerebral Hemisphere are called lines of latitude. Imaginary lines that run from North to South are lines of longitude. Longitude



and latitude lines are measured in degrees, beginning with 0 degrees. The lines above the imaginary latitude 0 degree line are called north latitude. Those lines below are called south latitude. The lines to the left of the imaginary longitude 0 degree line are called west longitude. Those lines to the right are called east longitude. On most maps, these numbers are printed along the borders. When used together, these lines can be used to locate any point on the Cerebral Hemisphere and on Earth as well.

### Things to Do...

If you enjoyed this puzzle, try it again on the Intermediate or Expert level. On these levels, you'll discover the castle is no longer at a 0,0 degree intersection. Therefore, you'll have to calculate an offset. For example, suppose the castle is at 10 degrees North and 10 degrees East. This time to get to Ventricle Bay, instruct the pilot to travel to 4 degrees South and 102 degrees East.

You might also like to check out the map of Earth and the United States in the section entitled *You Might Look it Up (On Dr. Brain's Bookshelf)*.

### Related Terms...

Lines of Latitude   Lines of Longitude   World Map



## SECTION TWO

SOME THINGS TO DO  
WITH THE PUZZLES

### USING YOUR POLYOMINOES

#### Now What?

If you enjoyed playing the cave entrance puzzle on the beach, perhaps you'd like to try creating your own set of game pieces. These shapes are called polyominoes. If you'd like to create your own set of polyominoes, you could just copy the following page of polyominoes on a copy machine and then cut out the shapes with a pair of scissors. Alternatively, if you have some graph paper you could create these shapes yourself. To do this, study the shapes on the following page carefully. Notice how each shape is made of units or squares? Using your pen, draw lines around the squares on your graph paper to make each polyomino shape. Then use your scissors to cut them out. Congratulations! You've created your first set of polyominoes. If you'd like some ideas on what to do with your polyominoes, take a look at the following section entitled *Things to Do*.

#### As a Matter of Fact...

Polyominoes ("poly" means many) are a large set of shapes formed by joining together identical squares, making special subsets according to the number of squares involved. A one-



square shape is called a monomino. A two-square shape is called a domino. A three-square shape is called a tromino, a four-square, tetromino; a five-square, pentomino, and so on. Take a look at the names of these specific pieces in the examples on the following page.

### Things to Do...

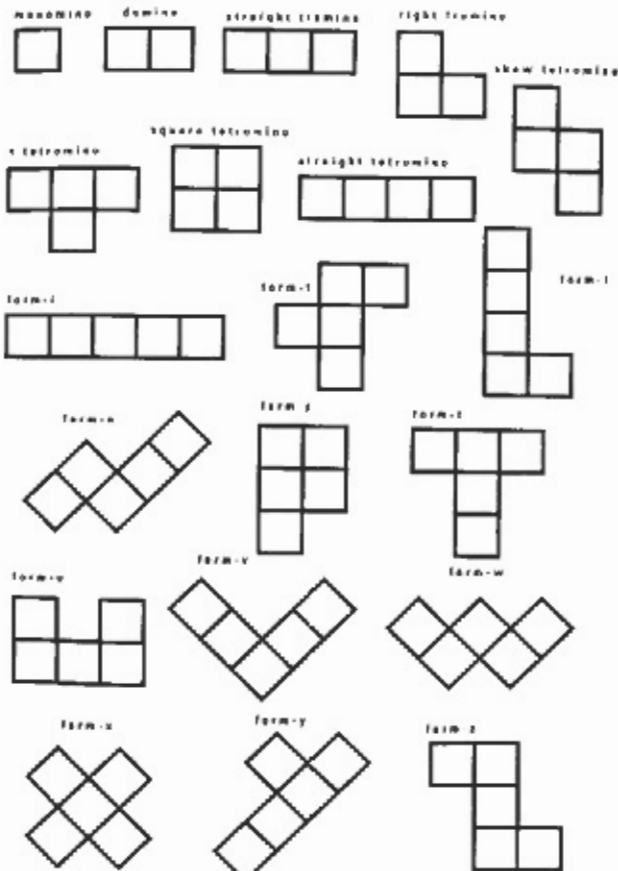
The whole point of polyominoes is to form different shapes with them. Once you've created your own set of polyomino shapes, you can experiment with them in a variety of ways. Here are a few ideas to get you started. See if you can form some of the following:

1. Arrange all the pieces to form the largest possible solid shape you can think of. How about the smallest?
2. What is the largest frame you can create with the pieces? And the smallest?
3. Use the pieces to create different-sized people, animals, boats, cars, airplanes, and other interesting objects.
4. Use the pieces to form different-sized rectangles, squares, and triangles.
5. Notice how some of the shapes resemble letters of the alphabet? (I, V, P, U, T, W, X, Y, Z, F, L, and N.) See if you can combine the pieces to create larger-sized letters. Can you create numbers as well?
6. Use the pieces to form four or five unique and interesting patterns.

### Related Terms...

Polyominoes

### POLYOMINOES



## MAKE YOUR OWN MAGIC SQUARE

### Now What?

The magic square you'll play in the *Island of Dr. Brain* is actually a variation of traditional magic squares. In traditional magic squares, all rows, columns, and diagonals add up to one magic number. Historically, the first magic square of this type was supposed to have been painted on the back of a tortoise shell and was presented to Emperor Yu around 2200 B.C. In the middle ages, people believed magic squares would protect them against the plague. And in 1514, Albrecht Dürer painted a magic square into his painting entitled, "Melancholia." His magic square looked like this.

16	3	2	13
5	10	11	8
9	6	7	12
4	15	14	1

Notice that the year he painted this work (1514) is in the bottom row. Can you figure out what his magic number is?

### As a Matter of Fact...

Creating your own 3X3 magic square is a fun and easy task. In fact, if you'd like to make your own magic square, just follow these three steps

1. Choose your first two numbers. (These can be any numbers which aren't in the ratio 1:2 or 2:1. For example, 1, 3; 1, 4; and 5, 2; 6, 2, etc.)

2. Choose a third, larger number. (This number may not be less than 5, but must be greater than the sum of the first two numbers. So if your first two numbers are 3 and 5, your third number must be 9 or larger because  $3+5=8$ .)

3. Place these numbers in the magic square grid. (You'll need to perform a special calculation for the diagonal numbers.)

Let's try making a magic square together. For our example, we'll use the numbers 3, 4 and 8. The largest number (8) goes in the center square.

	8	

Next, fill in one diagonal at a time. The numbers in your first diagonal are the sum and difference of the first and third numbers. In our example,  $8 + 3 = 11$  and  $8 - 3 = 5$ .

11		
	8	
		5

The numbers in your second set of diagonals are the sum and difference of the second and third numbers. In our example,  $8 + 4 = 12$  and  $8 - 4 = 4$ .

11		12
	8	
4		5

Add up the diagonals to determine your magic number. In our example, the magic number is 24. Fill in the rest of the square so all rows, columns, and diagonals add up to the magic number.

11	1	12	24
9	8	7	24
4	15	5	24
24	24	24	24

Congratulations! You've completed your first magic square

### Things To Do...

Now that you've created a solution to a 3x3 magic square, create a blank 3x3 grid, leaving only your magic number around the edges. Then ask a friend to complete it.

### Related Terms...

Albrecht Dürer

Magic Number

## DR. BRAIN'S SARCOPHAGUS

### Now What?

The whole point of the Sarcophagus lock is to give you practice with number series. If you learn to look for patterns in number sequences, you will greatly enhance your problem-solving skills. Some patterns on the sarcophagus lock are as follows:

odd and even numbers:

1	3	5	7	9
2	4	6	8	10

adding five:

5	10	15	20	25
---	----	----	----	----

Multiplying a number by itself, such as  $2 * 2 * 2 * 2 * 2$ :

2	4	8	16	32
---	---	---	----	----

Fibonacci sequence:

1	1	2	3	5
---	---	---	---	---

### As a Matter of Fact...

Here's an Ancient Chinese Secret: Did you know that the sum of consecutive odd numbers always produces a square number? For example:

$1 + 3 + 5 + 7 + 9 + 11 = 36$  (There are 6 consecutive odd numbers in this sequence.)

Count the odd numbers in this sequence and you will get 6. Six consecutive odd numbers add up to 36. Therefore, the square root of 36 is 6. Here's another example:

$1 + 3 + 5 + 7 + 9 + 11 + 13 = 49$  (There are 7 consecutive odd numbers in this sequence.)

Count the odd numbers in this sequence and you will get 7. Seven consecutive odd numbers add up to 49. Therefore, the square root of 49 is 7.

### Who was Fibonacci?

The famous Italian mathematician Leonardo da Pisa (also called Fibonacci, which means son of Bonacci) created this sequence of numbers. He was a brilliant mathematician and would publicly display his amazing problem-solving skills to famous emperors and mathematicians of his day. He lived during the time when the famous Leaning Tower was being constructed, but died in the year 1230 before the tower was finished. In the year 1202, he published a book entitled *Liber Abaci*, which provided a foundation throughout Europe for future development in arithmetic and algebra.

### What are Fibonacci Numbers?

Fibonacci numbers are cool. The Fibonacci sequence is found by finding the sum of two consecutive terms to give the next term. For example,  $1 + 1 = 2$ ,  $1 + 2 = 3$ ,  $2 + 3 = 5$ , etc. Therefore the first seven numbers of the sequence look like this:

1    1    2    3    5    8    13    ...

### Things To Do...

Memorize the multiplication table in the reference section of your EncycloAlmanacTionaryOgraphy.

Come up with number sequences of your own.

Complete the following Fibonacci sequence:

1    \_    \_    \_    \_    \_    \_    \_    \_    \_    610

### Related Topics...

Fibonacci    Number Patterns

## THE ANCIENT BRAHMIN TOWER OF HANOI

### Now What?

If you play all three levels of the Tower of Hanoi puzzle, you may notice that each level requires significantly more moves than the previous level. This is because the number of moves are increasing exponentially. Imagine if you were given the task of sorting 64 disks. To solve the puzzle, it would require approximately 18,446,744,073,710,000,000 moves. Now if you were quick and could move each disk a second at a time, you would be able to complete the task in about 584,542,046,090.6 years! This is approximately 129.89 times the life of the earth and 30 times the life of our universe. Fortunately, Dr. Brain doesn't expect you to use anything like 64 disks to complete his version of the puzzle.

### As a Matter of Fact...

There's an ancient Brahmin tale that goes something like this. Life in the universe is defined in terms of the time it will take a group of monks (working continuously) to move a set of 64 gold disks, all of different diameters, from one pole to another. There are specific rules about how the transfer should be done, which you will discover when you play this puzzle. These rules make the project far from trivial and also a very "long-term" project, to put it mildly.

### Things to Do...

Why not try building your own Tower of Hanoi using more disks? (If you have good wood-working skills you might want to give it as a gift to one of your friends or family members.)

### Related Terms...

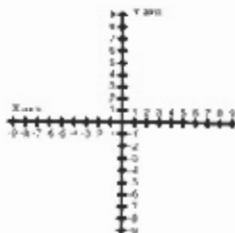
Brahmin    Tower of Hanoi

## DR. BRAIN'S MICROSCOPE

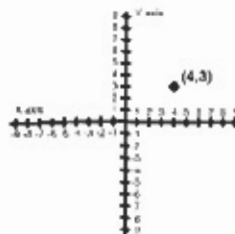
Dr. Brain's microscope is actually a graph. Graphs are pictures of functions. In fact, you're using functions to categorize microscopic life on Dr. Brain's microscope. In general, a function describes the way one quantity depends on another or the way one quantity varies with another. For example, a line can represent a linear function where for each X value, there is a subsequent Y value. Plotting all these relationships forms the line. Some graphs of functions illustrate how pressure is a function of temperature, others show how population is a function of time, and so on. You can experiment with many different kinds of functions on Dr. Brain's microscope.

### As a Matter of Fact...

The lines formed on a graph are composed of many points on a plane called coordinates. Points plotted from left to right create lines on or parallel to the X axis of the graph. Points plotted from top to bottom create lines on or parallel to the Y axis of the graph. Here's a graph showing the X and Y axes.



When all the parallel lines are drawn on the graph, they form a rectangular grid on the entire plane. This grid allows us to coordinate each point on the plane. Thus, each point on a graph is represented like this (X, Y). These are called X and Y coordinates. The system of representing X and Y coordinates is called the cartesian coordinate system.



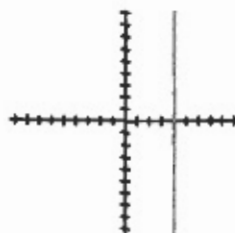
Cartesian coordinates are always represented in an (X, Y) order. This is called an ordered pair. So if we have an X value of 4 and a Y value of 3, we would plot this point as the ordered pair (4, 3). Here's what the point would look like on the graph. We describe this plotted point by stating it is drawn three above the X axis and four to the right of the Y axis in cartesian space.

On Dr. Brain's microscope, there are three kinds of functions that you can experiment with. These are simple functions, linear functions, and polynomial functions.

### The Simple Functions:

The simple functions in cartesian space are  $X = ?$  and  $Y = ?$ . These functions state that for all values of their neighboring axis, their value is fixed. For example, given the equation  $X = 4$ ; we know that regardless of all Y values, X will still be 4.

$X = 4$  looks like this:

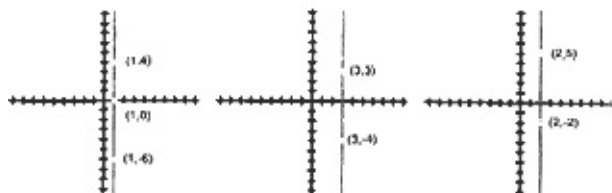


Therefore, as you change the X value, the line moves 1 space to the left or right. Increasing the X value moves the line to the right and decreasing the X value moves the line to the left.

$X = 1$   
looks like this:

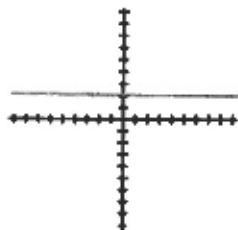
$X = 3$   
looks like this:

$X = 2$   
looks like this:



A fixed Y axis, such as  $Y = 2$ , is a line drawn through the Y axis at 2. Regardless of all X values, Y will still be 2.

$Y = 2$  looks like this:

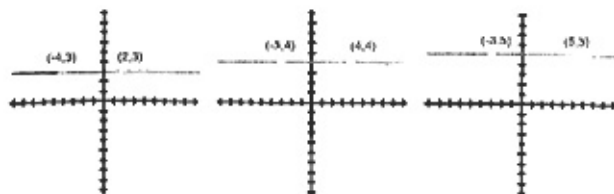


As you change the Y value, the line moves 1 space up or down. Increasing the Y value moves the line up and decreasing the Y value moves the line down.

$Y = 3$   
looks like this:

$Y = 4$   
looks like this:

$Y = 5$   
looks like this:



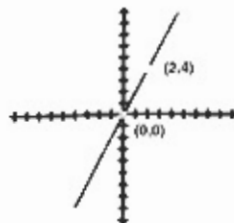
### Linear Functions:

Linear functions are a little more complicated. These functions deal with ratios or slopes between X and Y. The slope of a line is the amount of change in Y over the amount of change in X. As the X multiplier (the number in the function that multiplies X) increases, the slope of a line becomes steeper (approaching a vertical line). As the Y multiplier increases, the slope of a line becomes flatter (approaching a horizontal line).

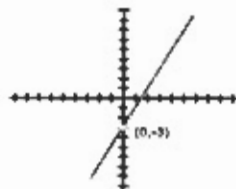
The function  $Y = 2X$  has a ratio of two to one. This means that every time X increases, Y increases twice as much. Every time X decreases, Y decreases twice as much. We calculate the slope of a line by taking the X multiplier (the number in the function that multiplies X) and dividing it by the Y multiplier. For example, the slope of  $Y = 2X$  is 2, because  $2 \div 1 = 2$ .

Let's draw some more functions together. To do this, we find two points that satisfy the function and connect them with a straight line. Suppose  $X = 0$ . In  $Y = 2X$ , this gives us  $Y = 2 \cdot 0$  which equals 0. Therefore, when  $X = 0$ ,  $Y = 0$ . We write this ordered pair like this  $(0, 0)$ . Suppose  $X = 2$ , then  $Y = 2 \cdot 2$  which equals 4. This ordered pair is  $(2, 4)$ . We plot these two ordered pairs on the graph and then draw a line through them.

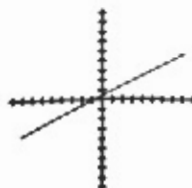
Therefore, graphing the function  $Y = 2X$  looks like this:



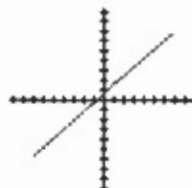
Graphing the function  $Y = 2X + 3$  looks like this:



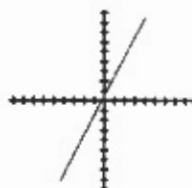
$2Y = X + 1$   
looks like this:



$2Y = 2X + 1$   
looks like this:



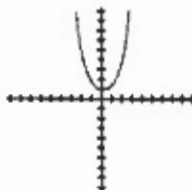
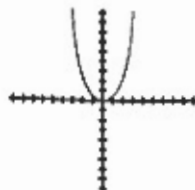
$Y = 2X + 1$   
looks like this:



### Polynomial Functions:

Polynomials are functions where  $Y$  is evaluated to some combination of powers of  $X$ . We use the base function  $aY = bX^2 + cX + d$  where  $a$ ,  $b$ ,  $c$ , and  $d$  are integer multipliers of  $X$  and  $Y$ . This type of function creates a curved line known as a parabola. As the  $Y$  multiplier increases, the parabola widens. As the  $X^2$  multiplier increases, the parabola narrows. As the  $X$  multiplier increases or decreases, the parabola moves left or right. As the  $d$  value increases or decreases, the parabola moves up or down. Examples:

$$1Y = 1X^2 + 0X + 0 \quad 2Y = 1X^2 + 0X + 0 \quad 2Y = 2X^2 + 2X + 2$$



## DR. BRAIN'S ELEVATOR

### Now What?

The gear and chain system used to move the elevator in the gear puzzle is called a chain drive. You may recognize the chain drive from an old friend of yours... the bicycle! To help us talk about chain drives, let's define a few words with your bicycle as an example.

First, we'll call the gear which your pedals are attached to the input gear. The gear on the rear wheel of your bicycle is called the output gear. In the gear puzzle, the input gear is peddled by the robot rat, while the output gear actually moves the elevator.

The simplified elevator in the puzzle has a counterweight which weighs just about the same as the elevator itself. To see how the elevator works, imagine trying to lift a bucket with several 2-liter bottles of soda up to your treehouse. You could throw a rope over a tree branch, tie the bucket of soda on one end of the rope and then tie a bucket of water on the other end. Then when you lift the bucket of soda, the bucket of water would move downward (which the bucket of water wants to do!). This helps you lift the bucket of soda; in fact, instead of lifting the weight of the sodas, now you are lifting the weight of the soda minus the weight of the water.

For this "treehouse elevator", the bucket of water is a "counterweight". The elevator and its counterweight work the same way, since the counterweight reduces the weight the robot rat needs to lift. In the gear puzzle, Dr. Brain made the counterweight weigh just a bit more than the elevator to make things hard for you. This way, the robot rat has to lift the counterweight in order to lower the elevator.

The chain drive in the puzzle works just like the one on your bicycle. Think about how you use the gears on your bicycle; if you need to climb a hill, you choose a large output gear on the rear wheel. In the puzzle, the robot rat is not lifting himself up a hill

like a bicycle rider, but he still needs to lift a weight (the counterweight). Thus, the rat will need a large output gear to enable him to lift the counterweight and lower the elevator.

If you'd like to know more about how a chain drive actually helps a robot rat lift a weight or a bicycle rider travel quickly on flat surfaces, see the next section entitled *As a Matter of Fact...*

### As a Matter of Fact...

First, let's define a few phrases which will help us understand how a chain drive works. There are two kinds of force which a chain drive uses: turning force and push-pull force. A turning force can turn things like wheels and gears; you generate a turning force on the input gear of your bicycle when you pedal it. Engineers call a turning force "torque" or "moment". A push-pull force is just what it sounds like: a force which pushes or pulls things. You generate a push-pull force when you push your bicycle up a hill that is too steep to ride up. Another important phrase is "rotational speed", which is just a fancy way of saying how fast a gear or wheel spins around.

A chain drive can be thought of as a machine which changes turning force and rotational speed. For example, when you ride your bicycle, a large output gear on the rear wheel generates more turning force at the rear wheel which can help you climb a hill. The tradeoff is that the rotational speed of the output gear is reduced, and so your bicycle moves slowly. On the other hand if a small output gear is used you must push hard on the pedals since the small gear does not generate as much turning force as a large gear. But as you know, a small output gear can make your bicycle go FAST! Your bicycle moves faster because the small output gear has a high rotational speed compared to a large output gear.





To help explain the change in speed that a chain drive produces, imagine watching the chain drive on your bicycle as it works. Pretend you can see the chain drive in slow motion, and that one link in the chain is painted red so that you can watch as it moves around the gears. The red link starts on the top between the two gears, and moves towards the large input gear (the one you pedal). Then the red link touches the top of the input gear, moves around to the bottom of the input gear, leaves the input gear and travels to the output gear on the rear wheel of your bike. After the link touches the bottom of the small output gear, it must travel only a short ways before it leaves the top of the output gear. Thus, the small gear must turn several times for each time the large gear turns just to keep up! This is why small output gears make your bike go faster: they make your rear wheel spin fast. A large output gear does not need to turn as much to keep up with the input gear, and so your bike will not move as quickly.

A chain drive also can change the turning force at the rear wheel of your bike, but this is harder to explain. First of all, remember that turning force turns things like gears and bolts. Now imagine you are using a wrench to turn a bolt. Your hand and arm are actually pushing or pulling on the wrench, but the bolt is turning. The wrench helps you create a turning force on the bolt with only the push-pull force your hand and arm provides. The longer the

wrench, the more turning force you can deliver to the bolt; this is why a longer wrench can help you turn a rusty, stubborn bolt. An engineer might call the wrench a "moment arm" (remember that a fancy name for turning force is "moment"). Notice that this change of push-pull force to turning force can also work in the other direction. For example, if the bolt were being turned by some turning force like an engine, then the wrench would push against your hand and arm.



To help see how a chain drive changes turning forces, imagine each tooth on the input gear of your bicycle as a wrench, so that

the gear is nothing more than a group of wrenches. As the chain drive works, each wrench (gear tooth) attaches to a chain link as the link touches the top of the gear. The gear turns and the wrench (gear tooth) releases the link when it reaches the bottom of the gear.

Now imagine you are pedaling the bicycle. Your feet provide turning force to the input gear. The turning force you produce is converted by the imaginary wrenches (the gear) to a push-pull force on the chain itself. The chain then "carries" this push-pull force to the output gear. The chain delivers push-pull force to the output gear, just like your hand delivers push-pull force to a wrench. And like the wrench you push with your hand, the output gear converts the push-pull force carried by the chain to a turning force at the rear wheel. If the output gear is smaller than the input gear, less turning force is delivered to the rear wheel than you produced at the input gear. This is okay though; remember that the output gear is also turning faster! If you were to change to a larger output gear, it's like using a longer wrench to turn a bolt: more turning force is created at the rear wheel. An engineer would say that a large output gear provides a larger "moment arm" than a small output gear.



### Things to Do...

If you found this explanation of chain drives interesting, you should look for physics classes that your school provides. Physics classes can help you to understand how machines work; for example, a pulley system could make the robot rat's job even easier.

### Related Terms...

Mechanical Advantage Pulleys Push-Pull Force Rotational Speed

## MEASURING DR. BRAIN'S COUNTERWEIGHT



**Tip-O-Meter:** This display shows the funnel hose leading into the three sections of the counterweight below. On easy level, as you fill a container with a specified liquid, you'll notice the funnel hose will shift to the appropriate section to be filled. On expert level, take care filling each section of the counterweight because if you fill the left or right sections unevenly, the liquid will spill out of the counterweight. This is shown on the Tip O Meter.

**Pour Spouts:** There are three different liquids in Dr. Brain's fountain: W = Water, M = Mercury, and A = Alcohol.

**Dispense Counter:** There are a limited number of dispenses for each kind of liquid. This display indicates how many pours are left for each dispenser. Depending on the container you select, a pour spout will dispense a cup, quart, or gallon.

**Containers:** There are three containers: gallon, quart, and cup.

**Funnel Hose:** After filling a container, pour it into this funnel opening. The funnel is attached to a long hose which leads to one of the three sections in the counterweight below.

**Weight Displays:** The three weight displays correspond to the three sections of the counterweight. When you first start the puzzle, each display will show you the total amount of weight needed in each section of the counterweight to complete the puzzle.

### As a matter of Fact...

Since you are given the weight of a cup of each kind of liquid, you can calculate how much a quart and gallon of each liquid weighs yourself.

First of all, there are four cups in a quart and sixteen cups in a gallon. Therefore, to get the weight of a quart, take the weight of each cup and multiply it by 4. And to get the weight of a gallon, take the weight of each cup and multiply it by 16.

Let's calculate the weights of a quart and gallon of water together. A cup of water weighs 8 ounces. Therefore, a quart weighs 4 (cups) X 8 (ounces in a cup) which equals 32 (ounces in a quart). Since a pound weighs 16 ounces, a quart of water weighs 2 pounds because  $32 \text{ (ounces in a quart)} \div 16 \text{ (ounces in a pound)} = 2 \text{ (pounds)}$ . Since there are four quarts in a gallon, a gallon of water weighs 2 (pounds in a quart) X 4 (quarts in a gallon) or 8 pounds. You could also calculate this in ounces by multiplying 8 (ounces in a cup) X 16 (cups in a gallon) to get 128 ounces.

On easy level, you can figure out which of the containers you'll use. First, subtract the weight of the heaviest container first. For example, suppose the counterweight total for water was 10 pounds. Subtract the weight of one gallon (or 8 pounds) from the total weight,  $10 - 8$  and you're left with 2 pounds. Therefore, fill up a gallon of water and pour it into the funnel hose. Your weight display for water will now equal 2 pounds. Now look at your dispense counter beside the water pour spout. Compare it to the weight value on the weight display for water. If your dispense counter is 1, then fill up a quart (since a quart of water weighs 2 pounds) and pour it into the funnel hose. However, if your dispense counter is 4, you have two choices. You could fill up a quart (since a quart of water weighs 2 pounds) or you could fill up four cups (since 4 cups of water also equals 2 pounds) and pour them into the funnel hose.

### Related Terms...

Cup   Mercury   Quart   Water   Gallon   Alcohol

## THE VOLCANO STACK COMPUTER (VSC) CONSOLE

### Now What?

The Volcano Stack Computer's (VSC) sole function is to ensure that too much pressure doesn't build up inside Dr. Brain's volcano (thereby causing a pressure overload). Unfortunately, when you crossed over to the mountain top in the middle of the game, the VSC short-circuited and such a condition occurred. Thus, repairing the VSC will involve three basic steps as follows:

- 1) Determine which computer chip is the problem.
- 2) Use the Integrated Scanner (IS) for further chip analysis, and
- 3) Use the Circuit Programmer (CP) for programming a replacement chip.



For detailed procedure information, see the sections entitled *At the VSC Console*, *At the Integrated Scanner (IS)*, and *At the Circuit Programmer (CP)*.

It takes a creative mind, persistence and perseverance, and good organizational skills to succeed in designing the Volcano Stack Computer (VSC) chip from the logic gates and tools provided. To ensure your success, you may wish to follow a good Experimental Plan. Many successful Project Engineers often follow such a plan. An example Experimental Plan Checklist is provided for you in Table 1.

**Table 1** *An Experimental Plan Checklist*

<b>Objective</b>	Repair the VSC Console before the volcano explodes.
<b>Preparation</b>	Learn the following logic gates: OR, NOR, AND, NAND, X-OR, X-NOR and NOT (INVERTER). Study the example completed circuit in Figure 2.
<b>Instruments</b>	Become familiar with VSC Console operation as well as IS and CP functions.
<b>Setup</b>	Use your best educated "guess" to determine the

logic gates you'll use. Make a list of your predictions and your expected results. Compare them to your final results.

<b>Conditions</b>	Remember this safety precaution: <b>WARNING!</b> Unsuccessful repair of the VSC will result in dire consequences.
<b>Operation</b>	Before ever installing a new chip in the VSC console, perform a comparison test in the IS.
<b>Personnel</b>	Often Project Engineers can delegate these tasks to other qualified personnel. However, since you're Dr. Brain's only lab assistant, you'll need to perform this task yourself.
<b>Conclusion</b>	Have you met your original objective? (Is the VSC repaired?) If not, examine the following criteria: your prediction, your results, accuracy of your work, and analysis of the example circuit.

### At the VSC Console

To repair the VSC, begin with the following:

1. Determine which chip is damaged. Look for smoke or sparks.
2. Carefully remove the damaged chip using the Hand cursor.

### At the Integrated Scanner (IS)

The three functions of the Integrated Scanner (IS) are as follows: to analyze and test computer chips for damage, to display the logic of the chip's programming, and to compare other computer chips' logic for analysis.

To use the IS, perform the following:

1. Place damaged chip in chip holder.
2. Press the Test button.
3. Study the logic of the damaged chip.

## At the Circuit Programmer (CP)

The Circuit Programmer (CP) is used to program a blank chip with logic structures you create from logic gates. If you're not familiar with a logic gate, place it in the Test area to see a display of its logic on a truth table.

To use the CP, perform the following:

1. Select a logic gate.
2. Place this logic gate in the Test area (to determine its logic).
3. Compare the logic of the logic gate in the Test area to the logic of the damaged chip in the Integrated Scanner.
4. If the logic of the logic gate in the Test area doesn't match the logic of the damaged chip in the Integrated Scanner, select another logic gate and place it in the test area.
5. Repeat Steps 3 and 4 until a correct logic gate is found.
6. Once the correct gate is found, remove it from the Test box and place it in the Logic Gate Construction area.
- [NOTE: Standard and Expert Players will place two or more logic gates to complete the programming of the chip.]
7. Press the Program button to program the new chip.
8. Remove the new chip from the Circuit Programmer chip holder.
9. Place the new chip in the chip holder of the Integrated Scanner.
10. Press the Test button of the Integrated Scanner (to perform the comparison test).
11. If your chip passes the comparison test, place it in the Volcano Stack Control Panel.

Congratulations! You've successfully repaired the VSC.

## As a Matter of Fact...

Computers contain components called logic gates that are linked together to perform electronic calculations. In fact, logic gates are used in transistor logic units as well as logic chips. They are different from resistors, capacitors, and inductors in that they do not react to continuous voltages, but rather, respond to discrete voltage ranges. The purpose of a logic gate is to put out a response based upon a combination of its inputs.

Logic gates have two outputs: voltage (1) or no voltage (0). This output is dependent on the combination of two inputs: voltage (1) or no voltage (0). For instance, with an AND gate, both inputs must have voltage input in order to have a voltage output. In the truth tables and Karnaugh maps, voltage is indicated by a 1 and no voltage is indicated by a 0. When you repair the Volcano Stack Computer (VSC), you're experimenting with different kinds of logic gates.

If you're unfamiliar with logic gates, consult Figure 1. You may also wish to study an accurate, working, completed logic gate construction for the VSC. Figure 2 gives an example.

**NOT (INVERTER) gate** - The output of a NOT gate is a 1 if the input is a 0, and a 0 if the input is a 1.



**AND gate** - The output of an AND gate is a 1 if and only if all inputs are 1's.



**OR gate** - The output of an OR gate is a 1 if one or more of the inputs is a 1.



**X-OR gate** - The output of an X-OR gate is a 1 if one and only one of the inputs is a 1.



**NAND gate** - The output of a NAND gate is a 0 if both inputs are 1's.



**NOR gate** - The output of a NOR gate is a 1 if both inputs are 0's.



**X-NOR gate** - The output of an X-NOR gate is a 1 if both inputs are identical (either both 1's or 0's).



**Figure 1** *Becoming Familiar with Logic Gates*

## Easy Level

Let's look at a couple of example logic gates and examine their truth tables together. First, let's examine an OR gate. Sending all possible combinations of input (A and B) through the OR gate, the output is 1 if one or more of the inputs is a 1.

(Inputs)

B	A	Output
0	0	0
0	1	1
1	0	1
1	1	1



Learn the pattern in each of these rows for an OR gate.

For our second example, we will use an AND gate. Sending all possible combination of inputs (A and B) through the AND gate, the output is a 1 only if both inputs are 1.

(Inputs)

B	A	Output
0	0	0
0	1	0
1	0	0
1	1	1



Learn the pattern in each of these rows for an AND gate.

You can learn the different truth tables for each logic gate using the tester on the Circuit Programmer of the Volcano Stack Computer puzzle.

## Standard Level

If we increase the number of inputs and gates used to program the volcano chip, it affects both the size of the corresponding truth table and the output. For our example, let's examine the following truth table.

(Inputs)

C	B	A	Output
0	0	0	0
0	0	1	0
0	1	0	0
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Look for a repeating pattern in each of the rows.

Notice that there are now eight rows in our truth table. First, we look for a consistent pattern in each of the rows of the truth table Output column. The first three rows are all 0's and the last five rows are all 1's. Comparing these to each of our logic gates, we see that no single logic gate will give us the desired output. Therefore, we have a new problem: how do we put two gates together to get the desired result?

Well, we begin by selecting a gate, then testing two of the inputs, such as A and B, or A and C, or B and C. We chart our results in a temporary column, T. (As you experiment with the volcano stack computer, you may wish to write this step down. However, as you become familiar with the logic gates, you will be doing this step in your head.)

Let's test inputs A and B using an AND gate. We get the following:

(Inputs)

B	A	T
0	0	0
0	1	0
1	0	0
1	1	1
0	0	0
0	1	0
1	0	0
1	1	1



Look for a repeating pattern in each of the rows

Now we compare our temporary column, T, to our other input column C using another gate. In this case, let's try an OR gate. We get the following:

(Inputs)

C	T	Output
0	0	0
0	0	0
0	0	0
0	1	1
1	0	1
1	0	1
1	0	1
1	1	1



Compare your Output column to the original Output

Since our output column matches the original output column, we see that the use of an OR gate with inputs A and B connected to an AND gate with input C will give the desired result. Therefore, our solution uses a combination of both the AND and OR gates as follows:

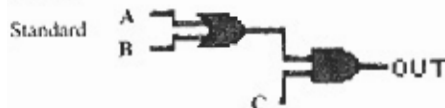


Figure 2 Example of Completed Circuit

You may experiment with these kinds of structures in the Standard and Expert level of the Volcano Stack Computer.

#### Related Terms...

Capacitor      Resistor      Truth table      Karnaugh map

## DR. BRAIN'S LANGUAGE GARDEN — CHOOSING JUST THE RIGHT WORD

### Now What?

Using just the right word is important in writing. In fact, one of the best ways to improve your reading and writing skills is to improve your vocabulary. There are many things you can do to improve your vocabulary. Here are three important steps to take.

**Use a dictionary** - If you're unsure what a word means, look it up in the dictionary rather than guess its meaning. When you do, look at all the meanings listed, not just the first one. This will give you the complete definition and expand your vocabulary at the same time. Also, check the pronunciation of the words you look up. It is much easier to remember the definition of a word if you know how to pronounce it.

**Use a thesaurus** - A thesaurus can be a great help for improving your vocabulary. Next time you're feeling creative, rather than settle for just any word to describe something, use your thesaurus to find a synonym for that word. A really great thesaurus is Roger's University Thesaurus. Instead of organizing words alphabetically, it groups words according to the ideas they express. You will learn much from this source.

### Learn unfamiliar words as they're used in

**context** - Each word you read depends on the other words in the sentence to make sense. These words make up the context of a word. Next time you read an unfamiliar word, examine the words surrounding it to see if you can determine its meaning before looking it up in the dictionary.



### As a Matter of Fact...

**Here is a list of some commonly misspelled words.** To help you pronounce and spell the words in the following list, they are divided into syllables. This list is also useful for those writing assignments when you aren't sure where to divide a word at the end of a line. However, never leave a single letter on a line by itself i.e., a-fraid.

ab-bre-viate	ac-count	ad-ver-tise (-ment)	ad-ic-hol
a-board	ac-cu-rate	ad-ver-tis-ing	a-like
a-bout	ac-cus-tom (-ed)	a-fraid	a-live
a-bove	ac-be	af-ter	al-ley
ab-sence	a-chieve (-ment)	af-ter-noon	al-low-ance
ab-sent	a-cre	af-ter-ward	all right
ab-so-lute (-ly)	a-cross	a-gain	al-most
a-bun-dance	ac-tu-al	a-against	al-read-y
ac-cel-er-ate	a-dapt	a-gree (-ment)	al-though
ac-ci-dent	ad-di-tion (-al)	a-gree-able	al-to-geth-er
ac-ci-den-tal (-ly)	ad-dress	ah	a-lu-mi-num
ac-com-pa-ny	ad-e-quate	aid	al-ways
ac-com-plice	ad-just (-ment)	air-y	am-a-ble
ac-com-plish	ad-mire	aisle	am-bu-lance
ac-cord-ing	ad-ven-ture	a-larm	a-mend-ment

u-mong	ar-ti-cle	be-fore	cab-bage	cir-cum-stance	con-scious	de-ci-ded	di-vi-sion
u-mount	ar-ti-fi-cial	be-gun	caf-e-ter-i-a	cit-i-zen	con-sec-ra-tive	de-ci-sion	doc-tor
un-a-lyze	n-sleep	beg-gar	cal-en-dar	civ-i-li-za-tion	con-spi-tu-Con	dec-la-ra-tion	doesn't
un-cient	as-sas-sin	be-gin-ning	can-paign	class-matex	con-tin-ue	dec-o-rate	dol-lar
an-gel	as-sign (-ment)	be-have	ca-nal	class-room	con-tin-u-ous	de-fense	dor-mi-to-ry
an-ger	as-sis-tance	be-hav-ior	can-coled	cli-mate	con-trol	def-i-nite (-ly)	doubt
an-gie	as-so-ci-ate	be-ing	can-di-date	climb	con-tro-ver-sy	def-i-ni-tion	dough
an-gry	as-so-ci-a-tion	be-lief	can-dle	clos-et	con-ve-nience	de-li-cious	du-al
an-i-mal	as-sume	be-lieve	can-i-ster	cloth-ing	con-vince	de-pen-dent	dup-li-cate
an-ni-ver-sa-ry	ath-lete	be-long	can-non	coach	cool-ly	de-pot	ea-ger (-ly)
an-nounce	ath-let-ic	be-neath	can-not	co-coa	co-op-er-ate	de-scribe	ec-cu-ni-my
an-noy-ance	at-tach	ben-e-fit (-ed)	ca-noe	co-coon	cor-po-ra-tion	de-scrip-tion	edge
an-nu-al	at-tack (-ed)	be-tween	can't	col-fee	cor-re-spond	de-serve	e-di-tion
a-non-y-mous	at-tempt	bi-cy-cle	can-yon	col-lar	cough	de-sign	ef-fi-ci-en-cy
an-oth-er	at-ten-dance	bis-cuit	ca-pac-i-ty	col-lege	couldn't	de-sir-a-ble	eight
an-swer	at-ten-tion	black-board	cap-tain	col-u-mel	coun-ter	de-sir-a-ble	eight
ant-arc-tic	at-ti-tude	blan-ket	car-bu-re-tor	col-or	coun-ter-fet	de-spair	ei-ther
an-tic-i-pate	at-tor-ney	bliz-zard	card-board	co-los-sal	coun-try	des-ert	e-lab-o-rate
an-ti-ri	at-trac-tive	both-er	car-reer	col-umn	coun-ty	de-ter-i-o-rate	e-lec-tric-i-ty
an-xious	au-di-ence	bot-tle	care-ful	com-e-dy	cour-age	de-ter-mine	el-e-phant
an-y-bod-y	Au-gust	hot-tom	care-less	com-ing	cou-ra-geous	de-vel-op	el-i-gi-ble
an-y-how	au-thor	hough	car-pen-ter	com-mer-cial	court	de-vel-op-ment	el-ipse
an-y-one	au-thor-i-ty	bought	car-riage	com-mis-sion	cour-te-ous	de-vice	em-bar-rass
an-y-thing	au-to-mo-bile	bounce	car-rot	com-mit	cour-te-ous	de-vice	e-mer-gen-cy
an-y-way	au-tumn	bound-a-ry	cash-ier	com-mit-ment	cous-in	di-a-mond	em-pha-size
any-where	a-vail-a-ble	break-fast	cas-sa-rok	com-mit-ted	cou-cr-age	di-a-phragm	em-plo-ye
a-part-ment	av-e-nue	breast	cas-u-al-ty	com-mit-tee	co-zz	di-a-ry	em-ploy-ment
a-piece	av-er-age	breath (n.)	cat-a-log	com-mu-ni-cate	crack-cr	dic-tio-na-ry	en-close
a-pol-o-gize	aw-ful (-ly)	breath (v.)	ca-tus-tro-phic	com-mu-ni-ty	crank-y	diff-fer-ence	en-cou-rage
ap-par-ent (-ly)	awk-ward	breeze	catch-cr	com-pun-y	crawl	diff-fer-ent	en-gi-neer
ap-peal	bag-gage	bridge	cat-cr-pil-lar	com-par-i-son	creed-i-tor	diff-fi-cul-ty	e-nor-mous
ap-pear-ance	bak-ing	brief	cat-sup	com-pe-ti-tion	eried	din-ling	e-nough
ap-pe-tite	bal-ance	bright	ceil-ing	com-pe-ti-tive (-ly)	crit-i-cize	di-plo-ma	en-ter-tain
ap-pi-ance	bal-loon	bril-liant	cel-c-bra-tion	com-plain	cru-el	di-rector	en-thu-si-as-tic
ap-pi-ca-tion	bal-lot	broth-er	cem-e-ter-y	com-plete (-ly)	crumb	dis-a-gree-a-ble	en-tire-ly
ap-point-ment	ban-nam	brought	cem-sus	com-plex-ion	crum-ble	dis-ap-peal	en-trance
ap-pre-ci-ate	ban-dage	bruise	cen-tu-ry	com-pro-mise	cup-board	dis-ap-point	en-ve-lop (v)
ap-proach	bank-rupt	hub-ble	cer-tain	com-ceive	cu-ri-o-si-ty	dis-ap-prove	en-ve-lop (n)
ap-pro-ri-ate	bar-ber	buck-et	cer-tain (-ly)	con-cern-ing	cu-ri-ous	dis-as-trous	en-vi-ron-ment
ap-pro-val	bar-gain	buck-de	cer-ti-fi-cate	con-cern	cur-rent	dis-ci-pline	e-quip-ment
ap-prox-i-mate	bar-rel	bud-get	chal-lenge	con-cen-sion	cus-tom	dis-cov-er	e-quipped
ar-chi-tect	buse-ment	build-ing	cham-pi-on	con-crete	cus-tom-er	dis-cuss	e-quis-a-lent
arc-tic	bus-is	bul-le-tin	change-a-ble	con-demn	cyl-in-der	dis-cus-sion	es-cape
aren't	bus-ket	buoy-ant	char-ac-ter (-is-tic)	con-dition	dai-ly	dis-ease	es-pe-cial-ly
ar-gu-ment	but-te-ry	bur-y	chief	con-di-tion	dair-y	dis-sat-is-fied	es-sen-tial
a-rith-me-tic	beau-ti-ful	bur-glar	chil-dren	con-fer-ence	damp-age	dis-tin-guish	es-tab-lish
a-round	beau-ty	bur-y	chim-ney	con-fi-dence	damp-ger (-ous)	dis-tri-bute	ev-ery
a-rouse	be-cause	bus-i-ness	choc-a-late	con-fi-dence	thugh-ter	di-vide	ev-i-dence
ar-range (-ment)	be-come	bus-y	choice	con-nect	dead	di-vine	ex-ag-ger-ate
ar-rival	be-com-ing	but-ton	cho-ru	con-science	de-ceive	di-vi-si-ble	ex-ceed

ex-cel-lent	freight	hes-i-tate	in-tel-li-gence	liv-ing	nei-ther	per-sis-tent	quies-cent
ex-cept	friend (-ly)	his-to-ry	in-ten-tion	loaves	nick-el	per-son-al (-ly)	raise
ex-cep-tion-al (-ly)	fright-en	hoarse	in-ter-est-ed	lone-li-ness	niece	per-son-nel	re-al-ize
ex-cite	ful-fill	holi-day	in-ter-est-ing	loose	nine-teen	per-spi-ra-tion	re-al-ly
ex-er-cise	fun-da-men-tal	hon-or	in-ter-fer-e	lose (r)	nine-teenth	per-suade	re-cvipe
ex-haust (-ed)	fur-ther	hop-ing	in-ter-pret	low-ing	nine-ty	phase	re-ceive
ex-hi-bi-tion	fur-ther-more	hop-ping	in-ter-rupt	lov-a-ble	nois-y	phy-si-cian	re-ceived
ex-is-tence	gad-get	hor-ri-ble	in-ter-view	love-ly	no-tice-a-ble	piece	rev-i-pe
ex-pect	gauge	hos-pli-tal	in-ves-ti-gate	ma-chin-er-y	nu-cle-ar	pitch-er	rev-og-nize
ex-pen-sive	gen-er-al-ly	hu-mor-ous	in-vi-ta-tion	mag-a-zine	nu-sance	planned	rev-om-mend
ex-per-i-ence	gen-er-ous	hur-ried-ly	ir-ri-gate	mag-nif-i-cent	o-bi-ect	plan-teau	reign
ex-plain	ge-nius	hy-drau-lic	is-land	main-tain	o-bey	play-wright	re-lieve
ex-pla-na-tion	gen-tle	hy-giene	issue	ma-jor-i-ty	ob-sta-cle	pleas-ure	re-li-gious
ex-pres-sion	gen-u-ine	hymn	jeal-ous (-y)	mak-ing	oc-ca-sion	pleas-ure	re-mem-ber
ex-ten-sion	ge-og-ra-phy	i-ci-cle	jew-el-ry	man-u-al	oc-ca-sion-al (-ly)	pneu-mo-nia	re-pe-tition
ex-tinct	ghet-to	i-den-ti-cal	jour-nal	man-u-fac-ture	oc-cur	pol-i-ti-cian	rep-re-sen-ta-tive
ex-tror-din-ar-y	ghost	il-leg-i-ble	jour-ney	mar-riage	oc-curred	pos-si-ble	res-er-voir
ex-treme (-ly)	gnaw	il-lit-e-rate	judg-ment	mu-tu-ri-al	of-fense	pos-si-ble	re-sis-tance
fa-cil-i-ties	gov-ern-ment	il-lus-trate	jur-y	math-e-ma-tics	of-fi-cial	pre-ced-ent (-ly)	re-spect-ful-ly
fa-mil-i-ar	gov-er-nor	im-ag-i-nar-y	kitch-en	max-i-mum	of-fen	pre-cede	re-spon-si-bil-i-ty
fam-i-ly	grad-u-a-tion	im-ag-i-na-tive	knave	may-or	o-mis-sion	pre-cious	re-sus-cit-ant
fa-mous	gram-mar	im-ag-ine	knave	mean-t	o-mit-ting	pre-cious	re-view
fas-ci-ate	grate-ful	im-i-ta-tion	knives	mean-sure	o-per-ate	pre-cise (-ly)	rhyme
fash-ion	grease	im-me-di-ate (-ly)	knock	med-i-cine	o-pin-ion	pre-ci-sion	rhythm
fa-tigue (d)	grief	im-mense	knowl-edge	med-i-um	op-po-nent	prefer-a-ble	ri-dic-u-lous
fau-cet	gro-cer-y	im-mi-grant	knuck-les	mex-sage	op-po-rtu-ni-ty	prefer-ered	route
fa-vor-ite	grudge	im-mor-tal	la-bel	mille-age	op-po-site	prej-u-dice	safe-ty
fea-lure	grue-some	im-pa-tient	lab-o-ra-to-ry	min-i-a-ture	or-di-nar-i-ly	pre-pur-a-tion	sal-ad
fed-er-ar-y	guar-an-tee	im-por-tance	la-dies	min-i-mum	orig-i-nal	pres-ence	sal-u-ry
fed-er-al	guard	im-pos-si-ble	lan-guage	min-ute	out-ra-geous	pre-vi-ous	sand-wich
fer-tile	guard-i-an	im-prove-ment	laugh	mir-ror	pack-age	prim-i-tive	sat-is-fac-to-ry
field	guess	in-con-ve-nience	laun-dry	mis-er	paid	prin-ci-pal	Sat-ur-day
fi-erce	guid-ance	in-cred-i-ble	law-yer	mis-er-er-lan-e-ous	pam-phlet	prin-ci-pal	scene
fi-er-y	guide	in-dec-i-ent-ly	league	mis-er-a-ble	para-dise	prison-er	sec-er-y
ff-ty	guilt-y	in-de-pen-dence	lec-ture	mis-sile	par-a-graph	privi-leges	sched-ule
fi-nal-ly	gym-na-si-um	in-de-pen-dent	le-gal	mis-spell	par-al-lel	prob-a-bly	science
fi-nan-cial (-ly)	ham-mer	in-di-vid-u-al	leg-i-tle	mis-ture	par-a-lyze	pro-ceedure	sci-ences
fol-i-age	hand-ker-chief	in-dus-tri-al	leg-i-sla-ture	mis-ture	par-a-lyze	pro-ceed	scream
for-ci-ble	han-dle (d)	in-fe-ri-or	lei-sure	mon-o-to-nous	par-tial	pro-ceed	screen
for-eign	hand-some	in-fi-nite	length	mon-u-ment	par-tic-i-pant	prom-i-nent	season
for-feit	hap-haz-ard	in-flam-ma-ble	li-a-ble	mont-guery	par-ti-ci-pate	pro-nounce	sec-er-tary
for-mal (-ly)	hap-pen	in-flu-en-tial	li-brar-y	mus-tain	par-ti-cu-lar (-ly)	pro-nun-ci-a-tion	sen-si-ble
for-mer (-ly)	hap-pi-ness	in-i-tial	li-cense	mus-cle	pas-time	pro-tein	sen-tence
forth	ha-rass	in-i-ti-a-tion	li-cen-sed	mus-cle	pas-ture	psy-cho-l-ogy	sep-a-rate
for-tu-nate	hast-i-ly	in-no-cence	light-ning	mus-cle	pas-ture	pure	sev-er-al
for-ty	hav-ing	in-no-cent	lik-able	mus-cle	pas-ture	quar-ter	sher-iff
for-ward	haz-ard-ous	in-stal-la-tion	like-ly	nat-u-ral (-ly)	pe-cu-niar	ques-tion-naire	shin-ling
foun-tain	head-ache	in-stance	li-quit	neg-es-sar-y	per-haps	qui-et	sim-i-lar
fourth	height	in-stead	lis-ten	neg-o-ti-ate	per-ma-nent	quite	since
frag-ile	hem-or-rhage	in-sur-ance	lit-er-a-ture	weigh-bar (-hood)	per-pen-dic-u-lar		



sin-cere (-ly)  
ski-ing  
sleigh  
sol-dier  
sou-ve-nir  
spa-ghet-ti  
spe-ci-fic  
sphere  
sprin-kle  
squeeze  
squirl-rel  
stat-ue  
stat-ue  
stom-ach  
stopped  
straight  
strength  
stretched  
stud-y-ing  
sub-tle  
suc-ceed  
suc-cess  
suf-fi-cient  
sum-ma-rize  
sup-ple-ment  
sup-pose  
sure-ly  
sur-prise

syl-la-ble  
sym-pa-thy  
symp-tom  
tar-iff  
tech-nique  
tem-per-a-ture  
tem-po-ra-ry  
ter-ri-ble  
ter-ri-to-ry  
thank-ful  
the-ater  
their  
there  
there-for-ward  
thief  
thor-ough (-ly)  
though  
through-out  
tired  
to-bac-co  
to-gether  
to-mor-row  
tongue  
touch  
tour-na-ment  
to-ward  
trag-e-dy  
trea-sur-er  
tried

tries  
tru-ly  
Tues-day  
typ-i-cal  
un-con-scious  
un-for-tu-nate (-ly)  
u-nique  
uni-ver-sal-ty  
un-u-sual-ty  
un-til  
us-a-ble  
use-ful  
us-ing  
usu-al (-ly)  
u-ten-sil  
va-ca-tion  
va-cuum  
valu-a-ble  
va-ri-ety  
var-i-ous  
veg-e-ta-ble  
ve-hi-cle  
very  
vi-ci-ni-ty  
view  
vil-lain  
vi-lence  
vi-si-ble  
vi-si-tor

voice  
vol-ume  
vol-un-tary  
vol-un-teer  
wan-der  
weath-er  
Wed-nes-day  
weigh  
weird  
wel-come  
wel-fare  
whole  
where  
wheth-er  
which  
whole  
whose  
width  
wom-en  
worth-while  
wreck-age  
writ-ing  
writ-ten  
yet-low

## KNOW WHEN TO USE THE RIGHT WORD

**a, an** - *A* is used before words which begin with a consonant sound; *an* is used before words which begin with a vowel sound. *A* pile, *a* dog, *a* history test, *an* aunt, *an* elevator, *an* honor.

**accept, except** - The verb *accept* means "to receive." "Your mother would never *accept* that answer." The preposition *except* means "with the exception of." "All of the boys *except* Josh would do it." The verb *except* means "to exclude." "In the main dining hall, smoking is *excepted*. Therefore, please refrain from smoking."

**affect, effect** - *Affect* is always a verb; it means "to influence." "The raise *affected* us." *Affect* also means "to pretend or imitate." "Bruce *affected* a Scottish accent flawlessly." *Effect* can be a verb, but it is most often used as a noun. As a verb, *effect* means "to produce or make happen." "When will doctors *effect* a cure for the common cold?" As a noun, *effect* means "result." "Your insults had no *effect* on Alice."

**allow, aloud** - The verb *allowed* means "permitted" or "let happen." "We weren't *allowed* to shout 'fire!' in the theater." *Aloud* is an adverb which means "in a normal voice." "Please do not read *aloud* in the library."

**allusion, illusion** - An *allusion* is a brief reference or mention of a famous person, place, thing, or idea. "She made an *allusion* to Shakespeare's 'Merchant of Venice'." An *illusion* is a false impression or idea. "It was an optical *illusion*."

**a lot, alot, allot** - *A lot* is colloquial when used for "many" or "much." "She was an okay substitute, but she accused us of talking *a lot*." *Alot* is a misspelling. *Allot* means "to apportion or give by some plan." "The judge *allotted* motel rooms for each member of the jury."

**already, all ready** - *Already* means "previously." "My little boy reads *already*." *All ready* means "completely ready." "After brushing his teeth for an hour, Andy was *all ready* for the dentist."

**alright, all right** - *Alright* is the incorrect spelling of *all right*. *All right* means "correct." "Her answers to the test questions were *all right*."

**altogether, all together** - *Altogether* means "completely." "This is *altogether* too much fun." *All together* means "in a group." "The holiday season is special because our family is *all together*."

**among, between** - *Among* is used when speaking of more than two persons or things. "As the three boys lay in the hospital bedchamber furiously with poison oak, one said, 'I think there's a fungus *among* us.'" *Between* is used when speaking of only two. "One of the others scoffed, 'Can't you tell the difference *between* a fungus and a rash?'"

**amount, number** - *Amount* refers to things which can be weighed or measured, but not counted. "Although she lost a large *amount* of blood, she survived the accident." *Number* refers to countable persons or things. "A *number* of humans."

**unt, aunt** - *Unt* is an insect. "John collected *unts* for his ant farm." *Aunt* is a relative. "Aunt Faina will stay with us for three weeks."



**ascend, ascent** - *Ascend* is "the act of rising." "The plane's *ascent* to thirty-thousand feet went as scheduled." *Ascent* is "agreement." "The mayor's *ascent* with the city council's plan to build a new city hall was sound."

**bare, bear** - *Bare* means "to be naked." "Without any leaves, the tree looked *bare*." A *bear* is a large, furry animal. "He ran from the *bear*." The verb *bear* means "to put up with" or "to carry." "Daryl could not *bear* being teased by Frances."

**base, bass** - *Base* is the foundation or the lower part of something. "The *base* of the pedestal was made of marble." *Bass* is a deep sound or tone. "The best player in that band was their *bass* player." *Bass* (rhymes with mass) is also a fish. "In the fishing tournament, he caught a nine-pound *bass*."

**be, bee** - *Be* is the verb. "Will you *be* coming to the party?" *Bee* is the insect. "When she sniffed the flower, a *bee* stung her on the nose."

**beat, beet** - *Beat* means "to strike, to defeat." "He *beat* in the drums all day long." A *beet* is the vegetable. "Grandma had a recipe for sugar *beets*."

**berth, birth** - *Berth* is a space or compartment. "She rode in one of the *berths* on the train." *Birth* is the process of being born. "She also gave *birth* on the train."

**beside, besides** - *Beside* means "by the side of." "She always sits *beside* the window." *Besides* (as an adverb) means "more." "Besides, your breath stinks." *Besides* (as a preposition) means "except." "Besides you and me, who else knows about it?"

**billed, build** - *Billed* means either "to be given a bill" or "to have a beak." "That female flamingo is beautifully *billed*." The verb *build* means "to construct." "When are they going to *build* your new house?"

**blew, blue** - *Blew* is the past tense of blow. "Those strong winds *blew* the smog right out of our city, clear into the next state." *Blue* is the color. "Her favorite color is *blue*."

**boar, bore** - *Boar* is a wild pig. "The natives barbecued the wild *boar* for dinner." *Bore* means "to tire with dullness" or "to make a hole by drilling." "His lecture was so *boring*, we all fell asleep."

**board, bored** - A *board* is a piece of wood. "Are you going to use this *board* in your new project?" *Bored* can mean "to make a hole by drilling" or "to become weary or tired of something." "This metal panel needs three more holes *bored* into it."

**brake, break** - A *brake* is a device used to stop a vehicle. "Hit the *brakes* or we'll all die!" *Break* means "to split, crack, or destroy." "Step on a crack, *break* your mother's back."

**bring, take** - *Bring* means "to come (here) with." "Bring me some meat between two slices of bread," said the Earl of Sandwich. "Take" means "to go (there) with." "Don't forget to *take* your sunglasses with you to the beach."

**by, buy** - *By* means "near or through." "We can swim in the river *by* your house." *Buy* is a verb meaning "to purchase." "If you aren't going to *buy* the magazines, then don't read them."

**can, may** - *Can* means "to be able." "Can you shut up?" *May* means "to have permission." "May I eat one of your cookies?"

**cannon, canon** - A *cannon* is a big gun. "They fired the *cannon* on the Fourth of July." A *canon* is a rule or law made by an authority in a church or organization. "The *canons* of our club forbid that kind of behavior."

**canvass, canvas** - *Canvass* is a heavy cloth. "He painted on the *canvas*." *Canvass* means "to go among the people asking them for votes or opinions." "After *canvassing* the people in front of the mall, John concluded that no one knew who they wanted to be the next president."

**capital, capital** - *Capital* is used only when talking about "the building in which the state or national legislative assemblies, are spelled *capital*."

**cell, sell** - *Cell* means "a small room" or "a small unit of life which makes up all plants and animals." "An amoeba is a one-celled animal." *Sell* means "to give up for a price." "Are you *selling* your piano?"

**cent, sent, scent** - *Cent* is a coin. "I won't give you one more *cent* for that empty bar." *Sent* is the past tense of "to send." "She was *sent* to bed without any supper." *Scent* is an odor or smell. "The bloodhound had again picked up the *scent* of the escaped convict just beyond the river."

**chord, cord** - *Chord* is used to mean "the sound when three or more musical tones are played at the same time," as a piano *chord*. "Have you learned to play *chords* on the piano?" A *cord* is a string, rope, or wire. "Don't let the puppy chew on the lamp *cord*."

**chose, choose** - *Chose* is the past tense of *choose*. "Please *choose* where you'd like to eat." "She *chose* an expensive restaurant."

**course, course** - *Course* means "rough or crude." "That sandpaper is too *course* for the surface of this table." *Course* means "a path or direction taken"; *course* also means "a class or series of studies." "What *courses* are you taking this semester?"

**complement, compliment** - *Complement* means "completes or goes with." "These illustrations will *complement* the story nicely." *Compliment* means to express admiration or praise. "My *compliments* to the chef."

**continual, continuous** - *Continual* means "frequently repeated." "He finished the game in spite of *continual* interruptions." *Continuous* means "without interruption." "They held hands on the beach listening to the *continuous* roar of the waves."

**council, counsel, consul** - *Council* means "a deliberative assembly of persons." "Our city *council* is incompetent." *Counsel* (noun) means "advice" or "attorney." "The *counsel* for the defense was a famous attorney." *Counsel* (verb) means "to give advice." "She will *counsel* him about career goals." *Consul* means "an officer in the foreign service." "Isn't that the distinguished Russian *consul*?"

**creak, creek** - *Creak* is a squeaking sound. "Oil that *creaky* chair!" *Creek* is a stream. "They swam in the *creek*."

**cymbal, symbol** - A *cymbal* is a metal instrument shaped like a plate. "Rob can really play that *cymbal* loudly." A *symbol* is something that stands



for or represents another thing or idea. "The lion is a *symbol* of courage."

**dear, deer** - *Dear* means "loved or valued." "Do be a *deer* and bring your grandma her medication," she said. "Deer are animals. "We saw three *deer* on our vacation to Yosemite National Park."

**desert, dessert** - A *desert* is a barren wilderness. "Let's visit the *desert* on our next vacation." *Desert* also means "to abandon." "Please don't *desert* me tonight," she said sympathetically. "Dessert as food served at the end of a meal. "We're having apple pie for *dessert* tonight."

**die, dye** - *Die* (dying) means "to stop living." "Live by the sword, *die* by the sword." *Dye* (dyeing) is used to change the color of something. "For everyone's surprise, Lorelei *died* her hair blue."

**faint, feign, feint** - *Faint* means "to be feeble, without strength." "It was so hot at the airport, no wonder grandma *fainted*!" *Feign* means "to pretend or make up." "The kidnapper *feigned* a broken wing to lure the housecat away from its nest." *Feint* means "a move or activity which is pretended or false." "Stuart won the fencing match when he made a *feint* to the right before striking to the left."

**farther, further** - *Farther* refers to distance. "She ran *farther* than I did." *Further* means "to a greater extent or degree." "There's no need to discuss the issue *further*."

**fewer, less** - *Fewer* refers to a measurable number. "He has *fewer* friends than I." *Less* refers to little bulk quantity. "He also has *less* talent than you."

**fur, fur** - *Fur* refers to a type of evergreen tree; *fur* is animal hair. "Let's get a Douglas *fur* tree for Christmas next year." "She had the nerve to wear a mink *fur* coat to our party!"

**flair, flare** - *Flair* means "a natural talent." "She had a *flair* for painting." *Flare* means "to light up quickly or burst out." "It was John's nature to let his temper *flare*."

**for, fore, four** - *For* means "because" or "directed to." "What did you hit me *for*?" *Fore* means "earlier" or "the front." "Because she had a strong *forehand*, she won the tennis match." *Four* is the number 4. "He ate *four* candy bars."

**good, well** - *Good* is an adjective. "She did a *good* job." *Well* is nearly always an adverb. "The car runs *well*."

**hare, hair** - *Hare* refers to an animal similar to a rabbit. "Have you read Aesop's 'The Tortoise and the *Hare*'?" *Hair* refers to the growth covering the head and body of animals and human beings. "When are you going to get a *haircut*?"

**heal, heel** - *Heal* means "to mend or restore to health." "The doctor said her knee would not *heal* for two months." *Heel* is the back part of a human foot. "You may have won the race, but I was on your *heel* the whole way."

**hear, here** - *You hear* with your ears. "Did you *hear* what I said?" *Here* is the opposite of there and means "nearly." "Come over *here*."

**heard, herd** - *Heard* is the past tense of *hear*. "Yeah, I *heard* what you said." *Herd* is a large group of animals. "We saw a *herd* of wild elephants on our visit to Africa."

**heir, air** - *Heir* is a person who inherits something. "I'm naming you *heir* to my estate." *Air* is the stuff we breathe. "The *air* is so polluted in this town that it makes my eyes burn."

**hole, whole** - A *hole* is a cavity or hollow place. "The rabbit jumped across the field and into a *hole* on the other side." *Whole* means "entire or complete." "Tell us the *whole* truth this time."

**immigrate, emigrate** - *Immigrate* means "to come into a new country or area." "Many Irish people *immigrated* into the United States in the nineteenth century." *Emigrate* means "to go out of one country to live in another." "The Pilgrims *emigrated* from England in search of freedom."

**its, it's** - *It's* is the contraction of "it is." "It's a cold day outside." *Its* is the possessive form of *it*. "Why is that monkey chewing on *its* paw?"

**kernel, colonel** - A *kernel* is a seed or core. "All the popcorn *kernels* popped that time." A *colonel* is a military officer. "The enlisted men saluted the *colonel*."

**knew, new** - *Knew* is the past tense of *know*. "I *knew* you were spying on us." *New* means "recent or modern." "When will your *new* house be built?"

**know, no** - *Know* means "to understand or to realize." "I *know* what you mean." *No* means "the opposite of yes." "No, we can't afford to go to Hawaii this Christmas."

**later, litter** - *Later* means "after a period of time." "I'll clean the house *later*." *Latter* refers to the second of two things mentioned. "When given the choice between a large dinner and a large dessert, I prefer the *latter*." If more than two things are mentioned, use *last*.

**lay, lie** - *Lay* (laid, laid, laying) means "to put or place" and is a transitive verb (takes an object). "He *lay* the book on the table." "He *laid* it there yesterday." "He has *laid* it there." "He has been *laying* brick." *Lie* (lay, lain, lying) means "to rest" and is an intransitive verb (never has an object). "She *lies* down every day." "She *lay* down yesterday." "She has *lain* down." "She has been *lying* down."

**lead, led** - *Lead* is the present tense of the verb meaning "to guide." "John can *lead* you up the path." The past tense of the verb is *led*. "We *led* them to that store." When the words are pronounced the same, then *lead* is the metal. "This thing weighs a ton! Is it made out of *lead*?"

**leave, let** - *Leave* means "to depart." "She must *leave* now." *Let* means "to permit." "Let her go."

**like, as** - *Like* is a preposition meaning "similar to." "She looks *like* her father." *As* is a conjunction meaning "such as." "The project went *as* he had hoped."

**lose, lose, loss** - *Loose* means "to release, to loosen, to set free." "Bill had a *loose* tooth." *Lose* means "to be deprived of, to fail to keep." "If we play a good game, we won't *lose*." *Loss* means "something lost." "When he left our company, it was a real *loss*."

**made, maid** - *Made* is the past tense of *make* which means "to create."

"Who made this delicious cake?" A *maid* is a female servant; *maid* is also used to describe an unmarried girl or young woman. "The *maid* will start in two weeks."

**mail, male** - *Mail* refers to letters or packages handled by the postal service. "Our one-million dollar check came in the *mail* today." *Male* refers to the masculine sex. "Is your cat *male* or female?"

**main, mane** - *Main* refers to the principal or most important part or point. "The *main* thing is that you are happy." *Mane* is the long hair growing from the top or sides of the neck of certain animals such as a lion or horse. "The lion's *mane* was beautiful."

**meat, meet** - *Meat* is food or flesh. "I thought vegetarians don't eat *meat*." *Meet* means "to come together at a particular place." "I'll *meet* you after school."

**metal, meddle, merial, mettle** - *Metal* is an element like iron or gold. "Is gold the most expensive *metal*?" *Meddle* means "to interfere." "I wouldn't have been caught if you kids didn't *meddle* in my affairs." *Merial* is an upward. "He won a second-place *medal* at the track meet." *Mettle* is a noun, refers to a quality of character. "Do you have the *mettle* to join our club?"

**miner, minor** - A *miner* digs in the ground for valuable ore. "Your great grandfather was a gold *miner*." A *minor* is a person who is not legally an adult. "No *minors* were admitted into the theater." A *minor* problem is one of no great importance.

**moral, morale** - *Moral* relates to what is right or wrong. "What kind of *moral* values do kids have these days anyway?" *Morale* refers to a person's attitude or mental condition. "Your quitting wouldn't be good for the *morale* of our team."

**morning, mourning** - *Morning* refers to the first part of the day before noon. "I'll meet you for breakfast tomorrow *morning*." *Mourning* means "showing sorrow." "The widow was *mourning* the death of her husband."

**oar, or, ore** - An *oar* is a paddle used in rowing or steering a boat. "If we can't get the boat motor started, we'll have to use our *oars* to get back to shore." *Or* is a conjunction indicating choice. "Do you want chocolate or vanilla?" *Ore* refers to a mineral made up of several different kinds of material, as in iron *ore*. "After digging all day, we found a rich deposit of iron *ore*."

**pain, pane** - *Pain* is the feeling of being hurt. "She felt a sharp *pain* in her neck." *Pane* is a section or part of something, as in a framed section of glass in a window or door. "The baseball flew through one of our window *panes*."

**pair, pare, pear** - A *pair* is a couple (two). "Lori and Corey make a nice *pair*." *Pare* is a verb meaning "to peel." "Would you like to help mom *pare* some apples for her pie?" *Pear* is the fruit. "Eat a peach, eat a *pear*, and you won't despair."

**past, passed** - *Past* can be used as a noun, as an adjective, or as a preposition. "She had a dark and secret *past*." *Passed* is always a verb. "We just *passed* a police car on the freeway."

**peace, piece** - *Peace* means "harmony or freedom from war." "The police officer said his primary objective was to keep the *peace*." *Piece* is a part or fragment. "Would you like another *piece* of cake?"

**personal, personnel** - *Personal* means "private." "I can't tell you because it's too *personal*." *Personnel* are people working at a particular job. "All *personnel* will attend the safety meeting."

**plain, plane** - *Plain* means "an area of land which is flat or level." It also

means "clearly seen or clearly understood." "That's *plain* enough for anyone to understand." *Plane* means "flat, level, and even"; it is also a tool used to smooth the surface of wood. "He used a *plane* to make the board smooth."

**pore, pour, poor** - A *pore* is an opening in the skin. "That makeup will clog your *pores*." *Pour* means "a constant flow or stream." "She *poured* him a drink." *Poor* means "needy." "Are you going to give money to the *poor* this year?"

**principal, principle** - *Principal* (as an adjective) means "chief" or "main." "Her *principal* concern was to find a job that paid more money." *Principal* (as a noun) means "a chief official" or "a sum of money." "The school *principal* spoke to our class today about discipline." *Principle* means "fundamental truth." "It's the *principle* of the matter."

**quiet, quit, quite** - *Quiet* is the opposite of noisy. "It's too *quiet* in here." *Quit* means "to stop." "He *quit* his job." *Quite* means "completely or entirely." "That's not *quite* true!"

**raise, rays, raze** - *Raise* is a verb meaning "to lift or elevate." "Raise the bridge!" *Rays* are thin lines or beams, as in rays of sunlight. "Want to go to the beach and catch some *rays*?" *Raze* means "to tear down completely." "They plan to *raze* that old bank to build a parking lot."

**read, very, really** - Do not use *read* in place of the adverbs *very* or *really*. "The movie was about *real* life." "He was *very* smart." "Kathy is a *really* talented dancer."

**red, read** - *Red* is the color. "Red was her favorite color." *Read* is the verb meaning "to understand the meaning of written letters, words, and symbols." "Have you *read* John Grisham's 'The Firm'?"

**right, write, wright, rite** - *Right* means "correct or proper"; it also refers to anything which a person has a legal claim to, as in copyright. "It wouldn't be the *right* thing to do." *Write* means "to record in print." "Would you *write* this in *writing*?" *Wright* is a person who makes or builds something. "The shipwright works at the harbor entrance." *Rite* is a ritual or ceremonial act. "The priest read the prisoner his last *rites*."

**scene, seen** - *Scene* refers to the setting or location where something happens; it also may mean "sight or spectacle." "Don't make a *scene* in this restaurant." *Seen* is a form of the verb "see." "I've *seen* that movie at least a hundred times."

**seam, seem** - *Seam* is a line formed by connecting two pieces of material. "Her dress tore at the *seams*." *Seem* means "to appear to exist." "It just *seems* like this day will never end."

**sew, so, sow** - *Sew* is a verb meaning "to stitch." "She *sews* her own clothes." *So* is a conjunction meaning "in order that." "Speak directly into the microphone so we may hear you better." The verb *sow* means "to plant." "The farmer *sowed* cotton seeds last week."

**sight, cite, site** - *Sight* means "something that is seen." "After the fire, her house was quite a *sight*." *Cite* means "to quote or refer to." "The old actor *cited* a passage from Shakespeare." *Site* means "location or position." "This is a great *site* for camping."

**sit, set** - *Sit* means "to put the body in a seated position." "Will you please *sit* down?" *Set* means "to place." "Set the glass of milk on the counter."

**sole, soul** - *Sole* means "single, only one"; *sole* also refers to the bottom surface of a foot or shoe. "You run so much that you're going to wear out the *soles* of your shoes." *Soul* refers to the spiritual part of a person. "Grandma's

soul has gone to heaven."

**some, sum** - *Some* means "a certain unknown number or part." "*Some* thieves broke in and stole our television set last week." *Sum* means "an amount." "You still owe a *sum* of forty-five dollars."

**sure, soar** - *Sure* means "painful." "After yesterday's workout, are you *sure* today?" *To soar* means "to rise or fly high into the air." The bird *soared* over the tops of the buildings.

**stationary, stationery** - *Stationary* means "not movable." "Their mobile home was pretty *stationary* after they braced its wheels with wooden blocks." *Stationery* is the paper and envelopes used to write letters. "She wrote him a letter on perfumed *stationery*."

**steal, steel** - *Steal* means "to take something without permission." "Did *Jon* *steal* that new couch?" *Steel* is a metal. "Your head is as hard as *steel*."

**than, then** - *Than* is used in a comparison. "You know better *than* that." *Then* is an adverb expressing time. "*Then* we left."

**their, there, they're** - *Their* is a possessive pronoun, one which shows ownership. "It is *their* turn." *There* is a pronoun used to point out a location. "Let's go *there*." *They're* is the contraction of "they are." "*They're* leaving."

**throw, through** - *Throw* is the past tense of "throw." "He *threw* the ball." *Through* means "passing from one side of something to the other." "It went right *through* the window."

**to, at** - *To* should not be used in place of *at* in a sentence. "She is *at* (not *to*) home."

**to, too, two** - *To* is the preposition which can mean "in the direction of." "He came *to* class." (*To* also introduces the infinitive.) "He wanted *to* kiss her." *Too* is an adverb meaning "also." "Will you come to the party, *too*?" *Two* also means "more than." "I ate *too* much at the party." *Two* is the number. "Are the *two* of you coming to the party?"

**vain, vane, vein** - *Vain* means "worthless." It may also mean "thinking too highly of one's self; stuck-up." "She is *so vain*." *Vane* is a flat piece of material set up to show which way the wind blows. "The weather vane almost blew off the roof during the storm." *Vein* refers to a blood vessel or a mineral deposit. "She's so mean that she must have ice water flowing through her veins."

**vary, very** - *Vary* is a verb that means "to change." "The weather can *vary* from snow to sunshine in a single day." *Very* can be an adjective meaning "in the fullest sense" or "complete." "The movie was the *very* opposite of funny." *Very* can also be an adverb meaning "extremely." "The movie was *very* exciting."

**waist, waste** - *Waist* is the part of the body just above the hips. "No punching below the *waist*." The verb *waste* means "to wear away; decay." "If you don't eat something soon, the food will go to *waste*." The noun *waste* refers to material which is unused or useless. "Would you empty the *waste* paper basket?"

**wait, weight** - *Wait* means "to stay somewhere expecting something." "*Wait* in the lobby." *Weight* is the measure of heaviness. "What is the *weight* of a pound of gold?"

**ware, wear, where** - *Ware* means "a product which is sold." "The street

vender sold his *wares* on the corner." *Wear* means "to have on or to carry on one's body." "What are you *wearing* to the dance?" *Where* asks the question, "in what place?" or "in what situation?" "*Where* is Fresno anyway?"

**way, weigh** - *Way* means "path or route." "Do you know the *way* to San Jose?" *Weigh* means "to measure weight." "We'll have to *weigh* you on that big scale over there."

**weather, whether** - *Weather* refers to the condition of the atmosphere. "Hail in the summer is unusual *weather* indeed." *Whether* refers to a possibility. "I don't know *whether* we'll be able to go."

**week, weak** - A *week* is a period of 7 days. "I can finish that project in a *week*." *Weak* means "not strong." "She was too *weak* to lift it."

**which, witch** - *Which* is a pronoun used to refer to or point out a choice of two or more options. "The car *which* had burned out taillights caused this accident." *Witch* is "a woman that is credited with supernatural powers." "Have you seen 'The Witches of Eastwick'?"

**who, which, that** - *Who* is used to refer to people. "Who does he think he is?" *Which* refers to nonliving objects or to animals, *which* should never refer to people. "The house *which* has a big backyard is still for sale." *That* may refer to animals, people, or nonliving objects. "The letter *that* arrived yesterday contained a million dollar check."

**who, whom** - *Who* is used as the subject in a sentence. "Who did you meet there?" *Whom* is used as the object of a preposition or as a direct object. "About *whom* were you speaking?"

**who's, whose** - *Who's* is the contraction of who is. "He's the one *who's* always late." *Whose* is a possessive pronoun, one which shows ownership. "Whose sweater is this?"

**wood, would** - *Wood* is the stuff of which trees are made. "The *woods* are lovely, dark, and deep." — Robert Frost. "*Would* is a form of the verb 'will.'" "Would you go to the dance with me?"

**your, you're** - *Your* is a possessive pronoun, one which shows ownership. "Put on *your* shoes." *You're* is the contraction for "you are." "He looked in the mirror and said, 'I *you're* worth a million.'"



## DR. BRAIN'S SECRET CIPHERS

### Now What?

Sometimes you and your secret spy friends will need to pass notes that should not be read by anyone's prying eyes. Dr. Brain's cipher techniques can help you disguise your messages. Practice the following ciphers at Dr. Brain's Secret Cipher Bridge.

**Extra-Spaced Words** - The letters of the words are written in the same order, but extra spaces are placed between letters and taken out between words. Example (in code): Le t'sd oi! Solution: Let's do it!



**Backwards Words** - Each word in the sentence is spelled backwards. Example (in code): hənul yadot ta eno keole'o. Solution: Lunch today at one o'clock.

**Backwards Words and Sentences** - Each word in the sentence is spelled backwards and each word is in reverse order. Example (in code): !gniroh si ssale siht Solution: This class is boring!

**Phoney Letter in front:** Each word in the sentence has a fake first letter tacked on. Next, extra spaces are placed between letters or taken out between words. Example (in code): cme etime ube hind at hewsc hool Solution: Meet me behind the school.

**Phoney Letter in back:** Each word in the sentence has a fake last letter tacked on. Next, extra spaces are placed between letters or taken out between words. Example (in code): Do n'th for getu toebr ingi thee ea kee. Solution: Don't forget to bring the cake.

**Number Substitution:** Each letter in the alphabet is substituted with numbers. These are as follows:

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  
26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Example (in code): 24121422 267 8183 Solution: Come at six.

### As a Matter of Fact...

The use of codes and ciphers for secret communications is called Cryptography.

### Related Terms

Cipher	Plain text	Encipher	Decipher
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Table 2 *Some Important Foreign Words and Phrases - Easy*

English	German	French	Spanish
zero	null	zéro	cero
one	eins	un (m); une (f)	uno(m); una (f)*
two	zwei	deux	dos
three	drei	trois	tres
four	vier	quatre	cuatro
five	fünf	cinq	cinco
six	sechs	six	seis
seven	sieben	sept	siete
eight	acht	huit	ocho
nine	neun	neuf	nueve
ten	zehn	dix	diez
mother	mutter	mère	madre
father	vater	père	padre
son	sohn	fils	hijo
daughter	tochter	filie	hija
dog	hund	chien	perro
cat	katze	chat	gato
hand	hand	main	mano
hat	hut	chapeau	sombrero
hair	haar	cheveu	pelo
house	haus	maison	casa
street	straße	rue	calle
city	stadt	ciité	ciudad
school	schwarm	école	escuela
today	heute	aujourd'hui	hoy
yesterday	gestern	hier	yesterday
tomorrow	morgen	demain	mañana
good evening	guten abend	bon soir	buenas noches
hello	hallo	bonjour	hola
very well	schr gut	très bien	muy bien
marvelous	wunderbar	merveille	maravilloso
goodbye	auf wiedersehen	au revoir	adiós
my name	mein name	mon nom	mi nombre
understand?	verstehen sie?	comprenez?	¿comprende?
thank you	danke schön	merci	gracias
you're welcome	bitte	de rien	de nada
excuse me	verzeihung	pardon	perdón

Table 2 *Some Important Foreign Words and Phrases - Standard*

English	German	French	Spanish
island	insel	île	isla
doctor	arzt	médecin	médico
brain	gehirn	cerveau	cerebro
stop	anhalten	arrêter	parar
sunday	sonntag	dimanche	domingo
monday	montag	lundi	lunes
tuesday	dienstag	mardi	martes
wednesday	mittwoch	mercredi	miércoles
thursday	donnerstag	jeudi	jueves
friday	freitag	vendredi	viernes
saturday	sonnabend	samedi	sábado
dentist	zahnarzt	dentiste	dentista
sick	krank	malade	enfermo
pain	schmerz	douleur	dolor
left	links	gauche	izquierda
right	rechts	droit	derecha
please	bitte	s'il vous plaît	por favor
smart	geschrei	intelligent	inteligente
open	offen	ouvert	abierto
closed	geschlossen	fermé	cerrado
sad	traurig	triste	triste
happy	glücklich	heureux	feliz
pretty	hübsch	joli	bonito
ugly	häßlich	laide	feo
coffee	kaffee	du café	café
milk	milch	du lait	leche
water	wasser	eau	agua
bread	brrot	pain	pan
meat	fleisch	vande	carne
chicken	huhn	poulet	pollo
delicious	köstlich	délicieux	delicioso
fish	fisch	poisson	pescado
wait	ein moment	attendez	espere
again	nach einmal	encore	otra vez
now	jetzt	maintenant	ahora
later	später	plus tard	más tarde

\* Gender Note: In languages other than English, words can take on masculine and feminine genders.

Table 2 *Some Important Foreign Words and Phrases - Expert*

English	German	French	Spanish
January	Januar	janvier	enero
February	Februar	février	febrero
March	März	mars	marzo
April	April	avril	abril
May	Mai	mai	mayo
June	Juni	juin	junio
July	Juli	juillet	julio
August	August	août	agosto
September	September	septembre	septiembre
October	Oktober	octobre	octubre
November	November	novembre	noviembre
December	Dezember	décembre	diciembre
your name	Ihr Name	votre nom	su nombre
bathroom	bad/zimmer	salle de bains	cuarto de baño
kitchen	Küche	cuisine	cocina
what number?	welche Nummer?	quel numéro?	¿qué número?
how much?	wie viel?	combien?	¿cuánto?
not far	nicht weit	pas loin	no lejos
very expensive	sehr teuer	très cher	muy caro
less expensive	billiger	moins cher	menos caro
luggage	Gepäck	bagage	equipaje
market	Markt	marché	mercado
department store	Warenhaus	grand magasin	almacén
restaurant	Restaurant	restaurant	restaurante
smaller	kleiner	plus petit	más pequeño
larger	größer	plus grand	más grande
approximate	annähernd	approchant	aproximado
what is this?	was ist das?	qu'est-ce que c'est?	¿qué es esto?
the airport	der Flughafen	l'aéroport	el aeropuerto
bank	Bank	banque	banco
drugstore	Apotheke	pharmacie	farmacia
possible	möglich	possible	posible
slowly	langsam	doucement	despacio
quickly	schnell	accélérer	pronto
funny	spalig	amusant	chistoso

## Related Topics

Dr. Brain's Language Garden, Know When to Use the Right Word

## DR. BRAIN'S VOLCANO DOOR ANALYZER

### Now What?

The next time one of your competitive friends asks you what you're really made of, tell him or her the following! Human beings are made of the following chemical elements.

Oxygen	65%
Carbon	18%
Hydrogen	10%
Nitrogen	3%
Calcium	1.5%
Phosphorous	1%
trace elements*	1.5% = 100%

\*The trace elements include:

potassium	iron
silicon	chlorine
magnesium	sodium
sulfur	zinc

### As a Matter of Fact...

All substances are made up of tiny particles called molecules. Scientists can examine molecules only through the use of powerful microscopes. Molecules can be broken into even smaller particles called atoms. In 1869, Dmitri Mendeleev, a Russian chemist, tried to find a pattern that would explain how the elements are alike or different. He published the Periodic Table



of the Elements, which classified each element by their atomic number. Therefore, elements are substances composed of atoms having the same atomic number. You can find your own Periodic Table of the Elements in the reference section of your EncycloAlmanacTionaryOgraphy.

In Dr. Brain's hut door analyzer, you can find out the composition of many common items. For instance, you'll discover a tablet of aspirin is composed of molecules containing 9 atoms of carbon, 8 atoms of hydrogen, and 4 atoms of oxygen. Water is composed of molecules containing 2 atoms of hydrogen and 1 atom of oxygen. And a sea shell is composed of molecules containing 1 atom of calcium, 1 atom of carbon, and 3 atoms of oxygen.

### Things to do...

Look up the atomic numbers of carbon, calcium, hydrogen, and oxygen on your Periodic Table of the Elements.

Memorize ten of the elements on your Periodic Table of the Elements and their atomic weights.

### Related Terms...

atomic weight   element   Mendeleev, Dmitri

## DR. BRAIN'S ART GALLERY



Figure 3 Timeline of Artists in Dr. Brain's Gallery

### Now What?

The artists on display in Dr. Brain's art gallery are: Vincent Van Gogh, Wassily Kandinsky, Pablo Picasso, Georgia O'Keeffe, Salvador Dali, and Jackson Pollock. The timeline in Figure 3 shows these artists in relation to their period in art history.

### As a Matter of Fact...

**Vincent Van Gogh (1853-1890)** - Post-Impressionist. Vincent Van Gogh's works are perhaps better known generally than those of any other painter. Some of his works in Dr. Brain's gallery are the following:

- "The Night Cafe" 1888.
- "Sunflowers" 1888.
- "Fishing Boats on the Beach at Saintes-Maries" 1888.
- "Road with Cypress and Stars" 1890.
- Van Gogh's self portrait. 1887.

**Wassily Kandinsky (1866-1944)** - Abstract Expressionist. Wassily Kandinsky is generally regarded as the originator of abstract art. Some of his works in Dr. Brain's gallery are the following:

- "Storeys" 1929.
- "White Stroke" 1920.
- "Colorful Ensemble" 1938.
- "Gorge Improvisation" 1914.

**Pablo Picasso** (1881-1973) - Spanish painter, sculptor, graphic artist, and ceramist. Although very versatile in his style, some of his most significant works developed a technique called Cubism.

Pablo Picasso is considered the foremost figure in 20th century art. Some of his works in Dr. Brain's gallery are the following:

- "The Dream" 1932.
- "Girl Before a Mirror" 1932.
- "Woman's Head with Self Portrait" 1929.
- "Three Musicians" 1921.

**Georgia O'Keeffe** (1887-1985) - Famous American Painter. Painted organic, abstract forms in clear, strong colors. Some of her works in Dr. Brain's gallery are the following:

- "Jack in the Pulpit #2" 1930.
- "Red Puppy No. VI" 1928.
- "Petunia and Coleus" 1924.
- "Black Iris II" 1936.

**Salvador Dali** (1904-1989) - Surrealist. Salvador Dali became the leader of surrealism. Some of his works in Dr. Brain's gallery are the following:

- "The Three Sphinxes of Bikini" 1947.
- "The Dream" 1937.
- "Hallucinogenous Bullfighter" 1970.
- "Fifty Abstract Paintings in Which One Sees, at a Distance of Three Meters, Three Chinese-like Lenins, the Whole Forming the Face of a Royal Tiger" 1963.

**Jackson Pollock** (1912-1956) - Abstract Expressionist. His unique style and devotion to the act of painting, led to the term "Action Painting." Some of his works in Dr. Brain's gallery are the following:

- "Composition with Pouring II" 1943.
- "Overall Composition" 1938.
- "Convergence #10" 1952.
- "The Moon Woman Cuts the Circle" 1943.

## Related Terms...

Action Painting	Vincent Van Gogh	Abstract Expressionism
Cubism	Postimpressionism	Wassily Kandinsky
Pablo Picasso	Surrealism	Salvador Dali
Georgia O'Keeffe		

## DR. BRAIN'S MUSIC PUZZLE

Now what?

For those of you who know little about what to do with Dr. Brain's keyboard, but would like to try it out, here's a quick introduction.

## Keys on the keyboard

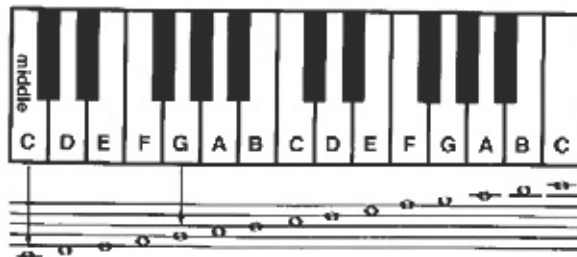
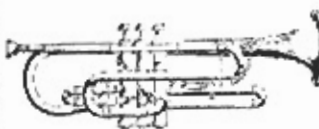


Figure 4 Keys on the Keyboard and Notes on the Staff

This puzzle is all about learning to play music. A good place to begin is by learning the notes. In music there are seven letter names—A B C D E F G. These seven letters are the names of the white keys. The next white key on the keyboard begins repeating the first note of this sequence. This sequence of keys is called an octave. There are also five black keys within each octave. These represent special kinds of notes called accidentals. Accidentals are also called sharp and flat notes. Flats and sharps are special kinds of notes which are one-half step between each of these seven notes. Flat notes are one half step lower in pitch, while sharp notes are one-half step higher in pitch according to key signatures. Figure 4 labels the notes on the keyboard for you and also shows their relationship to placement of the notes on the musical staff.



### The Musical Staff and Notation

In order to identify a particular pitch, notes are placed on a treble clef staff composed of 5 lines and 4 spaces. There are two helpful expressions to help you remember where notes are placed on the treble clef staff. One is an acronym, FACE. The other is a phrase,

Every Good Boy Does Fine (EGBDF). The notes in the 4 spaces are F A C E or FACE. The notes on the five lines are E G B D F or Every Good Boy Does Fine.

The staff is also divided into measures. To show the division between measures, music notation is marked with a Bar line. To indicate the end of a section, movement, or piece, music notation is

marked with a double bar. Therefore, depending on the duration of each note, a measure may contain from one to eight notes on Dr. Brain's staff. Tempo also affects the duration of a note. With a faster tempo, a four-count note will be shorter. With a slower tempo, a four-count note will be longer.

### The Duration of Notes and Rests

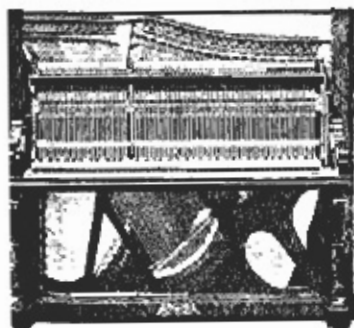


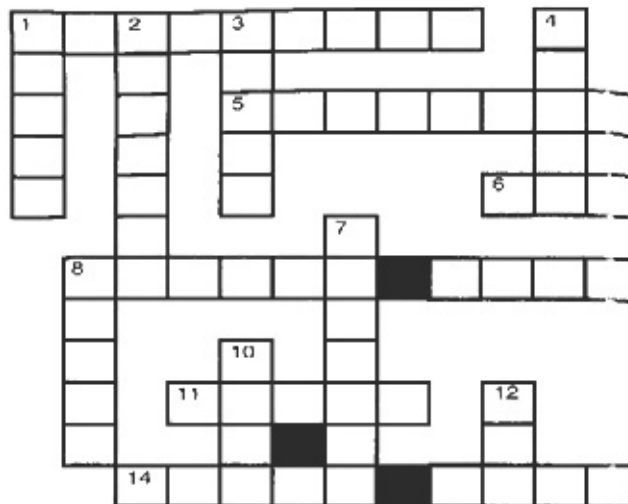
**Figure 5** *The Duration of Notes and Rests*

The duration of notes used in Dr. Brain's music puzzle is shown in Figure 5. Basically, there are four kinds of notes and rests in his music puzzle—whole, half, quarter, and eighth. Our examples will use 4/4 time. The bottom 4 shows that a quarter note is given one beat and the top 4 means that there will be 4 beats in each measure. Therefore, a whole note gets four counts, a half note gets two, and a quarter note gets one count. Eighth notes get one-half count in a measure and several in a row are counted as one and two and three and, etc.

### As a Matter of Fact...

See how many of the following music terms you can correctly identify in Dr. Brain's Music Crossword Puzzle. Definitions are found in your Glossary.





# ACROSS

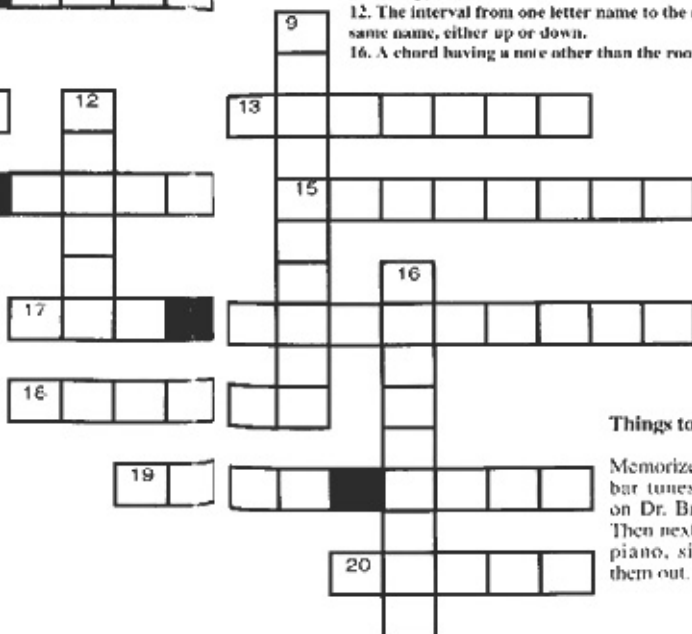
1. To change the key of a composition to one higher or lower.
5. A sign ( $\sharp$  or  $\flat$ ) not in the key signature.
6. A series of tones arranged in a sequential order of ascending and descending pitches.
8. A time signature (C) indicating 4/4 time.
11. Soft (*p*).
13. A sign ( $\cancel{\flat}$ ) which cancels a previous flat or sharp.
14. Twice the distance of a half step.
15. The differences in pitch between two sounds.
17. Flats or sharps placed after the clef sign to indicate which notes to play flat or sharp.
18. Smooth and connected.
19. The distance from one key to the next in either direction.
20. Loud (*f*).

# MUSICAL CROSSWORD PUZZLE

(answers on page 102)

## Down

1. A chord of three tones consisting of a root, third, and fifth.
2. Quick, lively.
3. A sign ( $\sharp$ ) which indicates a pitch one half step higher.
4. The keynote of a scale.
7. Slowly.
8. A combination of three or more tones.
9. Very soft (*pp*).
10. Lively, brisk.
12. The interval from one letter name to the next note of the same name, either up or down.
16. A chord having a note other than the root in the bass.



## Things to Do...

Memorize six of the four-bar tunes you've played on Dr. Brain's Keyboard. Then next time you're at a piano, sit down and try them out.

## YOU MIGHT LOOK IT UP (ON DR. BRAIN'S BOOKSHELF)

When you're sorting books on Dr. Brain's bookshelf, you will find the following pages come in handy for reference. Other sections you might like to check out are the Bibliography, the Glossary, and occasionally the other main sections of the EncycloAlmanacTionaryOgraphy.

### SOME INSTRUMENTS IN A BAND

**Brass** - You create music with these instruments by pinching your lips as you blow into the mouthpiece. The sounds vibrate down the tube of the instrument and become amplified.

cornet trumpet French horn bugle trombone tuba

**Percussion** - You create music with these instruments by shaking or beating them.

maracas bells gongs drums xylophone timpani

**Strings** - You create music with these instruments by vibrating their strings with your fingers or a bow.

violin cello viola guitar harp lute

**Woodwind** - You create musical notes with these instruments by blowing into them through a reed or across a mouth hole which makes the air inside vibrate.

flute oboe bassoon English horn saxophone  
clarinet piccolo

## SOME SYSTEMS IN THE BODY

Learning the systems of the body will come in handy. For a quick reference, consult Table 3 which contains a list of some systems in the body.

Table 3 *Some Systems in the Body*

Digestive	Circulatory	Respiratory	Nervous	Skeletal
stomach	heart	lungs	neurons	tarsals
intestine	veins	diaphragm	nerves	phalanges
mouth	arteries	alveoli	receptors	tibia
esophagus	blood	chest wall	effectors	femur
colon	plasma	pharynx	brain	carpal
liver	platelets	larynx	spinal chord	sacrum
salivary glands	capillaries	trachea	axon	pubis
pancreas	venules	cilia	dendrites	ulna
gall bladder	arterioles	branchi	synapse	

### OUTER SPACE

Space exploration is the investigation of physical conditions in space and on stars, planets, and natural satellites through the use of space probes or manned spacecraft. Figure 6 shows some of the things you'll see in outer space as well as listing some of the probes that have already been sent out for exploration.

Constellations	Moons	Planets	Probes	Stars
Delphinus	Phobos	Mercury	Luna	Sirius
Cetus	Deimos	Venus	Ranger	Polaris
Pegasus	Triton	Earth	Apollo	Betelgeuse
Aquarius	Nereid	Mars	Pioneer	Sun
Orion	Callisto	Jupiter	Mariner	Alpha Centauri
Percus	Europa	Saturn	Helios	Arcturus
Andromeda	Io	Uranus	Venera	Vega
Cassiopeia	Ganymede	Neptune	Voyager	Capella
Heracles	Titan	Pluto	Giotto	Altair
Ursa Major	Oberon		Galileo	Pollux
Cepheus	Charon			

Figure 6 *Things in Outer Space*

## GODS OF MANY CULTURES

Myths are traditional stories occurring in a timeless past and involving supernatural elements. In ancient cultures, myths were told to express and explain such serious concerns as the creation of the

universe and of humanity, the evolution of society, and the cycle of agricultural fertility. Gods often played a major role in mythology. Some of the Gods from around the world are found in Table 4.

Table 4 *Gods of Many Cultures*

	Sky God Ruler	Queen	Sun Light	Moon	War Storms Thunder	Sea Rivers Rain	Agriculture Fertility Earth	Love	Underworld Dead	Wisdom Knowledge Arts/Science	Crafts Invention	Culture Hero Schemer
<b>Egyptian</b>	Amon-Re	Hathor Isis	Amon-Re Horus	Thoth Hathor Isis	Mont	Osiris	Hathor Isis Osiris	Hathor	Anubis Osiris	Thoth Isis	Ptah	Osiris
<b>Sumerian/ Babylonian</b>	An Anu Marduk	Innini	Ishtar Shamash	Nanna Sin	Enlil Marduk Adad	Enlil Enki	Nanna Ishtar	Nanna Ishtar Tammuz	Ereshkigal	Nabu En	Ea	Ea
<b>Greece</b>	Zeus	Hera	Apollo	Artemis	Ares	Poseidon	Demeter Persephone Dionysus	Aphrodite Eros	Hades (Dis)	Athena Apollo	Hephaestus Athena	Prometheus Hermes
<b>Roman</b>	Jupiter (Jove)	Juno	Apollo	Diana	Mars	Neptune	Ceres Proserpine Bacchus	Venus Cupid	Pluto	Minerva	Vulcan Minerva	Mercury
<b>Norse</b>	Odin	Frigg	Baldur	--	Thor	Aegir Frey	Frey Freyja	Freyja Frigg	Hel	Odin Bragi Mimir	Volund Frigg	Loki
<b>Celtic</b>	Dagda	Dana	Lug	Branwen	Morrigan Macha Taranis	Manannan	Dana Macha Brigit	Branwen	Bran Urian	Lug Brigit Bran	Gothma Lug	--
<b>Chinese (Taoist/Buddhist)</b>	Yü-huang (Hao Hsiao-yeh)	T'ien Hou	Yü	Ch'ang yü (Hsiao-yü)	Huang-ti Kuan-ti Lei-kung	Long wang (dragon king) Yu-ch'ung	Sheng-mu (Hsiao-yüan-tsun) Kuan-yin	--	Yen-wang Ts'ün-kuang-wang	Wen ch'ang	Lu fan Huang-ti	Shen-nung Fu-hsi
<b>Indian (Vedic/Hindu)</b>	Indra Vishnu Shiva	Lakshmi Parvati (Sati)	Surya Mitra Savitara	Soma Yama	Indra Skanda Rudra	Vamana Parjanya	Parvati	Kama Krishna	Yama	Rudra Sarasvati	--	--
<b>West African (Akan/Ewe/Volta)</b>	Nyame Mahu Olorun	Asase Yaa	Lisa	--	Tano Nweso Schangbo	Nyanne Ayekpe Olokofo	Asase Yaa Mahu Odudua	--	--	Orunmila	Gun Ogun	Ananse Gum, Legba Eshe
<b>Mayan</b>	Hun-Ahpu	Ixchelucob	Hun-Ahpu Itzamna	--	Hurakan	Chim	Ixamal	--	Hunabau	Itzamna Kukulcan	Ixchelucob	Itzamna Kukulcan
<b>Aztec</b>	Totemecutli	Totemecihuatl	Tezcatlipoca	Meztl	Huitzilopochtli	Thak	Tzintecotl	Thacoltectl Coatlucue	Mictlantecutli	Quetzalcoatl	Quetzalcoatl	Quetzalcoatl

## TOPOGRAPHIC TALLY

Table 5 lists some of the major continents and countries around the world. In fact, see if you can locate some of these on your world map.

Table 5 *Topographic Tally*

### Major Continents and Countries

Africa	Asia	Europe	North America	South America
Morocco	China	Norway	Canada	Argentina
Tunisia	India	Sweden	U.S.A.	Chile
Algeria	Mongolia	Finland	Mexico	Brazil
Libya	Burma	Poland	Guatemala	Venezuela
Egypt	Laos	Germany	El Salvador	Colombia
Sudan	Vietnam	France	Cuba	Ecuador
Chad	Japan	Austria	Panama	Peru
Niger	North Korea	Spain	Nicaragua	Bolivia
Nigeria	South Korea	Switzerland	Honduras	Paraguay
Ghana	Philippines	Italy	Costa Rica	Uruguay
Ivory Coast	Cambodia	Portugal	Belize	
Zaire	Malaysia	Hungary		
Angola	Sri Lanka	Yugoslavia		
Zambia	Nepal	United Kingdom		
Uganda	Iran	Ireland		
Ethiopia	Iraq	Denmark		
Botswana	Afghanistan	Russia		
South Africa	Turkey	Bulgaria		
Zimbabwe	Lebanon	Czechoslovakia		
	Israel	Netherlands		
	Saudi Arabia			
	Thailand			

### Major Landmarks

Deserts	Lakes	Mountains	Rivers
Death Valley	Ontario	Acocagua	Amazon
Gobi	Caspian Sea	Everest	Danube
Great Basin	Superior	Kilimanjaro	Nile
Kalahari	Victoria	Matterhorn	Congo
Kara Kum	Aral Sea	Fuji	Ganges
Kyzyl Kum	Titicaca	McKinley	Hudson
Mojave	Huron	Rainier	Jordan
Negev	Michigan	Saint Helens	Mississippi

Table 5 *Topographic Tally (concluded)*

Deserts	Lakes	Mountains	Rivers
Sahara	Tanganyika	Shasta	Niger
Sahel	Baikal	Whitney	Potomac
Takli Makan	Nyasa	Olympus	Rhine
Thar	Albert	Vesuvius	Rio Grande
Atacama	Balkhash	Popocatepetl	St. Lawrence
Arabian	Bungweulu	Orizaba	Selne
	Chud	Kenya	Thames
	Erie	Logan	Volga
	Geneva	Catopavi	Yangtze
	Mead	Jungfrau	Zambezi
	Tahoe	Mamun Lou	
		Mamun Ken	
		Etna	

## LOCATING LANDMARKS ON THE CONTINENTS

Studying maps can help you learn of places all around the world. In Africa, look for these important landmarks: Nile River, Mt. Kilimanjaro, Victoria Falls, Cape of Good Hope, Great Rift Valley, Suez Canal, Sahara Desert, Congo River, and the Canary Islands.

In Antarctica are the Horlick Mountains, Whitmore Mountains, Filchner Ice Shelf, Berkner Island, Ross Sea, Prydz Bay, Ross Ice Shelf, and Mertz Glacier.

Discover Mt. Everest, Pamir Knot, Altai Mountains, Tigris River, Euphrates River, Taklimakan Desert, Gobi Desert, and the River Jordan in Asia.

In Australia, look for Botany Bay, Coral Sea, Darling River, Great Barrier Reef, Great Victoria Desert, Lake Eyre, Lake Torrens, Mount Kosciuszko, and Murray River.

In Europe, you'll find these landmarks: Volga River, Danube River, Rhine River, Dardanelles, English Channel, Alps, Baltic Sea, Bay of Biscay, and Aegean Sea.

In North America, see if you can find the Rocky Mountains, Death Valley, Everglades, Grand Canyon National Park, Great Lakes, Great Salt Lake, Klondike, Mississippi River, Niagara Falls, Painted Desert, Rio Grande, Yosemite National Park, and the Yukon River.

In South America are the following landmarks: Amazon River, Lake Titicaca, Andes Mountains, Cape Horn, Galapagos Islands, Angel Falls, Atacama Desert, Lake Maracaibo, and the Tropical Rain Forest.







## ANIMAL CLASSIFICATIONS

The animal kingdom is one of the largest groups of living things. To classify them, scientists divide them into categories. Six of these are fishes, amphibians, reptiles, birds, mammals, and insects. Table 6 shows some of these animals classified by their category.

Table 6 *Animal Classifications*

Fishes	Amphibians	Reptiles	Birds	Mammals	Insects
pike	frog	iguana	robin	tiger	ant
trout	toad	gecko	crow	rabbit	aphid
perch	salamander	gila monster	jay	cow	bee
carp	tailed frog	thorn devil	raven	armadillo	butterfly
catfish	tree frog	tortoise	eagle	camel	cicada
baos	spadefoot toad	turtle	ostrich	dog	cricket
marlin	spring peeper	crocodile	emu	whale	earwig
halibut	narrowmouth toad	snake	owl	rat	flea
seahorse	bullfrog	chameleon	duck	monkey	katydid
salmon	spotted salamander	alligator	goose	kangaroo	wasp
tuna	mudpuppy	tussock	vulture	bat	termite
turbot	nwt	lizard	moose	seal	silverfish
eel	caecilian	caiman	flamingo	rhinoceros	louse

## LEARNING THE ANIMAL KINGDOM

Did you know that many different kinds of animals have made their homes in different regions around the world? Next time you're traveling in new territory, see if you can find some of the following (from a safe distance of course).

In the high mountain regions some animals include yaks, bighorn sheep, snow leopards, Himalayan ibexes, chinchillas, vicuñas, giant pandas, and Marco Polo sheep.

In the grasslands look for ostriches, giraffes, armadillos, zebras, gnus, pronghorns, kudus, blackbucks, hippopotamuses, kangaroos, prairie dogs, and elephants.

In the temperate forest, you'll find moose, wood frogs, otters, beavers, muskrats, raccoons, skunks, porcupines, opossums, woodchucks, chipmunks, white-tailed deer, snapping turtles, wild boars, koalas, echidnas, flying squirrels, and garter snakes.

In tropical forests, expect to see black howler monkeys, spider monkeys, coati, iguana, two-toed sloths, ocelots, tree boa constrictors, axis deer, chevroians, tapirs, gibbons, bongos, jaguars, leopards, and orangutans.

If you happen to be in the desert, you'll find dingoes, scorpions, camels, dromedaries, saigas, gila monsters, kit foxes, bobcats, coyotes, muledeer, pocket mice, kangaroo rats, cacomistles, sidewinders, and chuckwallas.

Put on your parka at the polar regions. Some of the animals you'll find in these ice-capped places are musk oxen, arctic hares, polar bears, emperor penguins, caribou, walrus, collared lemmings, and ermine.

When you're swimming in the ocean look for these aquatic creatures: octopuses, whales, manatees, sharks, copepods, starfishes, limpets, jellyfishes, and saltwater crocodiles.



## DR. BRAIN'S FAVORITE SONG WRITERS AND COMPOSERS

Look up Irving Berlin, George Cohan, Jerome Kern, Cole Porter, Richard Rodgers, Franz Schubert, and Paul Simon in your Glossary.

# SECTION THREE REFERENCE

## Glossary of General Terms

**Abstract expressionism** - Abstract expressionist artists shared a common outlook characterized by a spirit of revolt against tradition and a demand for spontaneous freedom of expression. One form of abstract expressionism is action painting.

**Accidental** - Music term meaning a sign (*#*, *b*) not in the key signature.

**Acronym** - Acronyms are words and abbreviations made up of the initials of other words. For example, BASIC stands for Beginners All-Purpose Symbolic Instruction Code, ROY G. BIV stands for the colors of the rainbow (Red, Orange, Yellow, Green, Blue, Indigo, and Violet), and FDIC stands for Federal Deposit Insured Corporation.

**Action painting** - A technique and style of painting made famous by Jackson Pollock. The artist using this style drips, dribbles, splashes, and pours paint over the canvas, which is often laid on the floor rather than placed upright.

**Adjective** - An adjective describes a noun or pronoun. For example, "She had *blue* hair. That elephant was *huge*."

**Adverb** - An adverb modifies a verb, an adjective, or another adverb. It tells when, how, where, why, how much, and how often. For example, "She talks *quietly*. (*Quietly* modifies the verb *talks*.) You're *really* funny. (*Really* modifies the adjective *funny*.)"

**Algae** - The slimy scum you see on the surface of a stagnant pond is blue-green algae. Blue-green algae were among the first forms of life to appear on Earth more than 3,000 years ago.

**Allegro** - Musical term meaning to play quickly and lively.

**Amoeba** - The amoeba is a single-celled animal called a protozoan. It lives in ponds and puddles. The amoeba moves by stretching out a part of its body known as a pseudopod, or "false foot."

**Alcohol** - One of the liquids you can measure in Dr. Brain's elevator puzzle.

**Amphibians** - Any of a class of cold-blooded vertebrates (such as frogs, toads, or newts) intermediate in many stages between fishes and reptiles, and having gilled aquatic larvae and air-breathing adults.

**Andante** - Musical term meaning play slowly.



## Glossary of General Terms

**Antonym** - A word that is opposite in meaning to another word. Hot and cold; dark and bright; etc.

**Applying** - The scientific thinking process by which we use knowledge.

**Archimedes** - Greek scientist who explained how levers and pulleys work and discovered how things float.

**Atomic Weight** - This is the weight of one atom of an element compared to the weight of an atom of carbon. You can discover the atomic weights of all known elements on the Periodic Table of the Elements (in your reference section of the EncycloAlmanacTionaryOgraphy).

**Berlin, Irving** - One of Dr. Brain's favorite song writers. Created such memorable hits as *Easter Parade*, *God Bless America*, *White Christmas*, *Alexander's Ragtime Band*, *All Alone*, *Blue Skies*, and *Always*.

**Brahmin** - A Hindu of the highest caste traditionally assigned to the priesthood.

**Brass** - Some of the most exciting sounds in music come from brass instruments. Some of the instruments in this group are the French horn, the trumpet, and the tuba.

**Capacitor** - A device for storing electrical charge.

**Categorizing** - The scientific thinking process that deals with patterns of groups and classes.

**Cerebral** - Of or relating to the brain or the intellect.

**Cerebellum** - A large dorsally projecting part of the brain concerned especially with the coordination of muscles and the maintenance of bodily equilibrium.

**Charts** - An outline map exhibiting something (as climatic or magnetic variations) in its geographical aspects; a map for the use of navigators.

**Chord** - A music term meaning a combination of three or more tones.

**Chromosome** - Chromosomes are in the nucleus of the cell. They carry genetic information and give a unique mixture of genetic material to each person. Chromosomes contain DNA which is the main carrier of genetic information in almost all living things.

**Cilia** - A minute short hairlike growth of a cell that is capable of lashing movement and serves to produce locomotion.

**Cipher** - A cipher converts plain text into a scrambled message by substituting another letter, number, or symbol for each letter of plain text or by mixing up the letters.

**Circuit** - The complete path of an electric current usually including the source of electric current.

**Circulatory system** - The system of blood, blood vessels, lymphatics, and heart concerned with the circulation of the blood and lymph.

**Coding** - To put in the form or symbols of a code forming a system of uncommunication; also, to specify the genetic code.

**Cohan, George M.** - One of Dr. Brain's favorite song writers. He wrote the following songs: *I'm a Yankee Doodle Dandy*, *Give My Regards to Broadway*, *You're a Grand Old Flag*, *Mary's a Grand Old Name*, *Harrigan*, and *Over There*.

**Common time** - A musical term denoted by a time signature (C) indicating 4/4 time.

**Communicating** - The scientific thinking process that conveys ideas through social interchanges.

## Glossary of General Terms

**Comparing** - The scientific thinking process that deals with concepts of similarities and differences.

**Conjunction** - A conjunction connects two individual words or groups of words. Some coordinate conjunctions are as follows: and, or, but, not, for, yet, and so.

**Contraction** - A contraction is a word that is shortened by the omission of one or more letters, often combining two words into one word, with the insertion of an apostrophe. For example, *do not* becomes *don't*, *would not* becomes *wouldn't*, and *who is* becomes *who's*.

**Constellation** - Groups of stars often forming recognizable forms and shapes.

**Cortex** - The outer layer of gray matter of the cerebrum and cerebellum of the brain.

**Cubism** - Movement in painting developed by Picasso and Braque in the early 1900s. It is recognized as one of the great turning points in Western art. Cubists broke down their subject so that rather than showing them from a single, fixed viewpoint, many different aspects of the same object could be seen simultaneously. Picasso's works in cubism were generally called Analytical Cubism because forms were analyzed into predominantly geometrical structures and color was extremely subdued.

**Cup** - A cup is 8 ounces. You can experiment with a cup in Dr. Brain's elevator.

**Cryptography** - Writing and understanding secret messages. A person who engages in this activity is known as a cryptographer.

**Dali, Salvador (1904-1989)** - Painter on display in Dr. Brain's Art Gallery. He became a leader of surrealism. With a precise style, he created nightmare effects in his works, such as in *The Persistence of Memory*.

**Da Vinci, Leonardo** - The great Italian artist and inventor designed many machines, including a parachute and a helicopter, which were never built in his time. Leonardo was well ahead of his time.

**Decipher** - Converting a scrambled message into intelligible language or plain text.

**Diagonal** - A straight line in an oblique direction.

**Digestion** - The process of making food absorbable by dissolving it and breaking it down into simpler chemical compounds.

**Dominant characters** - Factors that are transmitted or inherited from one generation to the next and are clearly visible.

**Domino** - A polyomino made of two units. See *polyominoes*.

**Duration** - A continuance of time or the time during which something exists or lasts.

**Dürer, Albrecht (1471-1528)** - Dürer was one of the most influential German painters, engravers, and theoreticians of all time. He created such works as "Passion of Christ," "Melancholia," and "Apocalypse." His many self-portraits reveal a self-awareness rare for his time. He produced some important altarpieces, many sensitive watercolors of wildlife and landscapes, several



## Glossary of General Terms

decorative projects, and treatises on human proportions, applied geometry, and fortifications.

**Easter Island** - Island in the South Pacific Ocean containing many unusual polynesian hieroglyphs and gigantic carved heads, some weighing over 50 tons!

**Egyptian** - A native or inhabitant of Egypt.

**Element** - A substance composed of atoms having the same atomic number. For more information on elements, see the Periodic Table of Elements in your reference section.

**Encipher** - Technique used by cryptographers to convert plain text into scrambled form.

**Encyclopedia/Maniac/Dictionary/Ography** - Dr. Brain's all-encompassing reference manual combining an encyclopedia, an almanac, a dictionary, a bibliography and game playing instructions.

**Ensure** - To make sure, certain, or safe; guarantee.

**Expressionism** - Term used to describe works of art and literature in which the representation of reality is distorted to communicate an artist's inner vision, transforming nature rather than imitating it.

**Fibonacci, Leonardo (1170-1240)** - Italian mathematician who invented the fibonacci sequence of numbers: 1, 1, 2, 3, 5, 8, 13, etc.

**Fine** - Musical term meaning *the end*.

**Flagellum** - A long hairlike locomotory organelle on the surface of a cell.

**Flat** - Musical term for a sign (*b*) which indicates a pitch one-half step lower.

**Forté** - Musical term meaning to play loudly (*f*).

**Gallon** - A gallon is 64 ounces or 16 cups. You can experiment with a gullion container in Dr. Brain's elevator.

**Gershwin, George** - One of Dr. Brain's favorite song writers. This famous American composer created songs such as *Swanee*, *I Got Rhythm*, *Love Walked In*, and *Embraceable You*.

**Gene** - The unit of heredity.

**Genetics** - The scientific study of heredity or chromosomal inheritance. The science arose in 1900, with the rediscovery of Gregor Mendel's work on traits that are inherited as if each were a separate, independent unit. Geneticists call the unit of inheritance the gene. Genes are located on the chromosomes in the nucleus, are passed on from generation to generation, and exert control over the characteristics of organisms.

**Greek** - A native or inhabitant of Greece.

**Half step** - A musical term meaning the distance from one key on the piano to the next in either direction.

**Hindu** - The dominant cultic religion of India emphasizing dharma with its resulting ritual and social observances and often mystical contemplation and ascetic practices.

**Hippopotomonstrosesquipedalian** - A word pertaining to a very long word.

**Homonym** - A word that is pronounced the same as another word, but has a different meaning and spelling. *Won* and *one*, *maize* and *maze*.

**Hydra** - A many-headed serpent or monster in Greek mythology, slain by Hercules, each head of which when cut off was replaced by two others. A small tubular microscopic lifeform having at one end a mouth surrounded by tentacles.

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**Hypothalamus** - Part of the posterior portion of the vertebrate forebrain, containing important centers of the autonomic nervous system and centers of emotion.

**Icon** - A pictorial representation for something else, i.e. the Icon Bar in the *Island of Dr. Brain* represents the notions a Player may make during the game.

**Inductor** - A coil which stores electrical current (such as a magnetic field) which also releases energy on the change of a current.

**Impressionism** - Late 19th century movement in art generally characterized by the attempt to depict transitory visual impressions, often painted directly from nature, and by the use of broken color to achieve brilliance and luminosity.

**Inferring** - The scientific thinking process that deals with principles concerning interactions.

**Interjection** - A word or phrase expressing strong emotion. For example, "All right! Good job! Congratulations!"

**Interval** - A musical term meaning the difference in pitch between two sounds.

**Inversion** - A musical term for a chord having a note other than the root in the bass.

**Kandinsky, Wassily (1866-1944)** - Russian abstract painter and theorist. He developed his ideas concerning the power of pure color and non-representational painting in Paris. He examined the psychological effects of color in such works as *Spiritual in Art* (1912). In the 1920's his style evolved from pure bursts of color to more precise geometric compositions.

**Karnaugh Map (K-Map)** - A reorganized truth table used to minimize the complexity of a logical structure.

**Kern, Jerome** - One of Dr. Brain's favorite song writers. Created hits such as *Bill, All the Things You Are, Make Believe, Ol' Man River, and Smoke Gets in Your Eyes*.

**Key signature** - A musical term for flats or sharps placed after the clef sign to indicate which notes in play flat or sharp.

**Kinetic energy** - Energy associated with motion.

**Kinetic theory** - Either of two theories in physics based on the fact that the minute particles of a substance are in vigorous motion.

**Kitchen sink** - The usual place where household dishes are washed.

**Legato** - A musical term meaning to play in a manner that is smooth and connected.

**Lines of Latitude** - The imaginary lines that go from east to west around the Earth.

**Lines of Longitude** - The imaginary lines that go from north to south around the Earth.

**Magic Number** - In magic square puzzles, the magic number is generally the number which all columns, rows, and diagonals equal.

**Magic square** - A square containing a number of integers arranged so that the sum of the numbers in each row, column, and diagonal is the same.

**Mass** - The property of a body that is a measure of its inertia, that is commonly taken as a measure of the amount of material it contains and causes it to have weight in a gravitational field, and that along with length and time constitutes one of the fundamental quantities on which all physical measurements are based.

## Glossary of General Terms

**Mass Spectrum** - An instrumental method for identifying the chemical constitution of a substance by means of the separation of gaseous ions according to their differing mass and charge.

**Mechanical Advantage** - The advantage gained by the use of a simple machine (lever, pulley, wheel and axle, inclined plane and wedge, and screw) in using force. Mechanical advantage is also the ratio of the force that performs the useful work of a machine to the force that is applied to the machine.

**Mendel, Gregor** - An Austrian Monk, who conducted experiments chiefly on garden peas. With his controlled pollination technique and a careful statistical analysis of his results, he produced the first accurate and scientific explanation for chromosomal inheritance or *genetics*. In his experiment with garden peas, he found that factors (which he termed hereditary characteristics) are transmitted from one generation to the next. Sometimes a given character did not show, but it was there nevertheless. For example, when red and white flowered peas were crossed, all the offspring bore red flowers. However, one-quarter of the red-flowered second generation had white flowers. The factor for white flowers had been there in the second generation plants, but it was "recessive" and had been masked by the "dominant" red flowers. The scientific community of his day was unprepared for so radical a view of heredity that it paid little heed to Mendel's results or theories. His findings, published in 1866, were therefore generally ignored. It wasn't until 1900, when three botanists, working independently in their own countries, confirmed Mendel's conclusions. As a result, Mendel died well before the scientific community acknowledged him as the "Father of Genetics."

**Mendeleev, Dmitri (1834-1907)** - Mendeleev is credited with formulating periodic law and the Periodic Table of the Elements. In so doing, he invented a system of classifying the elements that allowed him to predict properties of unknown elements. Since that time over 100 elements have been classified. Will you be the next to discover a new element?

**Mercury** - One of the elements on your Periodic Table of the Elements with an atomic weight of 200.59. This is a very heavy viscous liquid which you can experiment with in Dr. Brain's elevator.

**Michelangelo Buonarroti (1475-1564)** - Florentine sculptor, painter, architect, draftsman, and poet. He was one of the greatest figures of the Renaissance.

**Mythology** - The myths dealing with the gods, demigods, and legendary heroes of a particular people.

**Natural** - A musical term for a sign which cancels a previous flat or sharp.

**Navigate** - To operate or control the course of a boat or ship.

**Nervous System** - The bodily system that in vertebrates is made up of the brain and the spinal chord, nerves, ganglia, and parts of the receptor organs.

**Newton, Sir Isaac** - In 1666, Isaac Newton discovered that white light is really made up of a mixture of colors. In his darkened room, he placed a glass prism in a beam of



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sunlight streaming through a small hole in the wall and saw white light split into the colors of the rainbow: Red, Orange, Yellow, Green, Blue, Indigo, and Violet, or ROY G. BIV. He also proposed the daring idea that gravity is a universal force, keeping planets and moons in their orbits as well as causing things to fall to the ground. Newton also put forward the famous laws of motion and invented calculus.

**Noun** - A noun is a person, place, thing, or idea. Some examples are as follows: Uncle George, grandma, Lake Millerton, stream, Ford Taurus, wheels, Christmas, happiness.

**Number Patterns** - Look for patterns in numbers and you will greatly enhance your problem-solving skills. For example, 12, 0, -12, -24, -36, this pattern decreases by 12 each time.

**Observing** - The scientific thinking process from which fundamental patterns of the world are constructed.

**Octave** - A musical term for the interval from one letter name to the next note of the same name, either up or down.

**O'Keeffe, Georgia (1887-1986)** - An American painter whose works are marked by organic, abstract forms painted in clear, strong colors. O'Keeffe lived much of her life in New Mexico and frequently employed motifs from the Southwest in her paintings.

**Olfactory** - Of, relating to, or connected with the sense of smell.

**Ordering** - The scientific thinking process that deals with patterns of sequence and variation.

**Paramecium** - These one-celled cilia covered organisms have a permanent structure, an organelle, that functions in feeding. Some of them are among the most incredibly complex cells known.

**Parts of Speech** - There are eight different parts of speech: noun, pronoun, verb, adjective, adverb, preposition, conjunction, and interjection. For more information, you may wish to look up each in this glossary.

**Percussion** - Bells, gongs, drums. These instruments are beaten or shaken to make sound.

**Periodic Table** - An arrangement of the chemical elements based on the periodic law which states: the elements when arranged in the order of their atomic numbers show a periodic variation in most of their properties.

**Perseverance** - What you need to complete *the Island of Dr. Brain*. It's the continuation of something usually to an exceptional degree or beyond a desired point: steadfastness.

**Pianissimo** - A musical term meaning play very softly (*pp*).

**Piano** - A musical term meaning play softly (*p*).

**Picasso, Pablo (1881-1973)** - A Spanish painter, sculptor, graphic artist, and ceramist who worked in France. Leader of the School of Paris, he was remarkable for his technical virtuosity, incredible originality, and being prolific. In his later years, Picasso turned to creations of fantasy and comic invention. Working consistently in sculpture, ceramics, and the graphic arts, he continued to explore his personal vision until his death at 91.

**Pitch** - The property of a sound and especially a musical tone that is determined by the frequency of the waves producing it: highness or lowness of sound.

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**Pituitary Gland** - An endocrine gland located near the brain of vertebrates; known as the master gland because it secretes hormones that regulate the action of the other endocrine glands.

**Plain text** - In cryptics, plain text is the message to be written secretly.

**Planaria** - These free-living aquatic organisms, also known as flatworms, have distinct front and rear ends, as well as distinct upper and lower surfaces. Their bodies are composed of three well-formed tissue layers.

**Polar** - Of, or relating to, a geographical pole or the region around it.

**Pollock, Jackson (1912-1989)** - An American painter who was a pioneer of abstract expressionism. He was influenced by Picasso and surrealism in his attempt to express, rather than illustrate, feeling. Pollock developed an abstract art in which he vigorously drew or "dripped" complicated linear rhythms onto enormous canvases.



**Polyominoes** ("poly" means many) - This is a large set of shapes formed by joining together identical square units, making special subsets according to the number of units involved. Solomon Golomb (the great American mathematician) is credited with their invention, when he first introduced them to the Harvard Mathematics Club in 1953. Polyomino patterns are examples of combinatorial (or computational) geometry. This type of mathematics deals with the ways in which geometrical shapes can be combined. Combinatorial geometry seems to

have few general methods, and in it systematic rules have not replaced ingenuity as the key to discovery. Therefore, many of the design problems in practical engineering are combinatorial in nature, especially when standard components or shapes are to be fitted together in some optimal fashion.

**Pons** - A broad mass of nerve fibers on the ventral surface of the brain of man and on lower mammals at the anterior end of the medulla oblongata.

**Porter, Cole** - One of Dr. Brain's favorite song writers. He wrote such great hits as *Begin the Beguine*, *Night and Day*, *I've Got You Under My Skin*, *You're the Top*, and *Anything Goes*.

**Postimpressionism** - Term referring to the work of some late 19th-century painters, in particular: Georges Seurat (1859-1891), Paul Cézanne (1839-1906), Vincent Van Gogh (1853-1890), and Paul Gauguin (1843-1903). The ways in which Postimpressionist artists rejected the naturalism and preoccupation with pictorial effects used by impressionists varied greatly. Seurat concentrated on a scientific analysis of color. Cézanne was concerned with pictorial structure. Gauguin explored the symbolic use of color and line. And Van Gogh created a foundation for expressionism. A sound understanding of their individual styles and achievements is necessary if one is to fully comprehend twentieth-century art.

**Potential energy** - The energy that a piece of matter has because of its position or because of the arrangement of its parts.

**Prefix** - A word "part" added to the front of a word to enhance its meaning.

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**Preposition** - A word (or group of words) which shows how two words or ideas are related to each other. For example, about, around, because of, down, on, since, under, and upon.

**Probe** - A scientific vehicle that travels through space and sends information back to earth.

**Pronoun** - A pronoun is a word used in place of a noun. Some examples are as follows: (Personal Pronouns) I, you, he, she, it, we, you, and they; (Relative Pronouns) who, whose, whom, which, what, that; (Demonstrative Pronouns) this, that, these, those; (Intensive and Reflexive Pronouns) myself, himself, herself, yourself, themselves, ourselves; (Indefinite Pronouns) all, both, everything, nobody, and someone.

**Pronunciation** - The way a word is sounded or spoken.

**Pulleys** - A pulley is a simple machine which consists of a wheel over which a rope, belt, chain, or cable runs. See mechanical advantage.

**Push-pull force** - A push-pull force is just what it sounds like: a force which pushes or pulls things.

**Quart** - A quart is 32 ounces or 4 cups. You can experiment with a quart container in Dr. Brain's elevator.

**Recessive characters** - In genetics, these are factors that are transmitted or inherited from one generation to the next but are not always visible.

**Relating** - The scientific thinking process that deals with principles concerning interactions.

**Reptiles** - Scaly-skinned animals such as alligators, turtles, and snakes are called reptiles. Some reptiles live in water and some on land; most are found in warmer parts of the world. The ancestors of today's reptiles were the dinosaurs.

**Resistor** - A resistor reduces the amount of current flowing in a circuit.

**Respiratory System** - The lungs, the airways, the throat, and the nasal passage make up the respiratory system. The lungs absorb vital oxygen from the air.

**Rhythm** - A music term which refers to all the elements, such as accent, meter, and tempo that relate to forward movement. Also the instruments in the band supplying the rhythm (the rhythm section).

**Rodgers, Richard** - Famous American composer who created famous tunes (often in collaboration with other composers). One of Dr. Brain's favorite song writers. Some of his works include: *The Lady is a Tramp*, *Falling in Love With Love*, *People Will Say We're in Love*, *Some Enchanted Evening*, and *Hello, Young Lovers*.

**Roman** - Two thousand years ago a single government and way of life united most of western Europe, the Middle East, and the north coast of Africa called the Roman Empire. The Roman Empire was based on good organization and centralized control. Strong border defenses manned by the Roman army protected the empire, while a skilled civil service governed it. The empire reached its height of power in about A.D. 200 and then began to decline slowly.

**Rotational speed** - A fancy way of describing how a gear or wheel spins around.

**Scale** - A musical term for a scale of tones arranged in a sequential order of ascending and descending pitches.

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**Schubert, Franz Peter** - One of Dr. Brain's favorite song writers. This famous composer created such symphonies as *Ave Maria*, *Death and the Maiden*, *Serenade*, *the Trout*, and *Who is Sylvia?* to name a few.

**Shakespeare, William (1564-1616)** - Considered the greatest of all playwrights, this English dramatist and poet wrote such works as "The Rape of Lucrece" and "Hamlet."

**Sharp** - A musical term for a sign (#) which indicates a pitch one-half step higher.

**Simon, Paul** - One of Dr. Brain's favorite song writers. Some of the songs he wrote are as follows: *The Sounds of Silence*, *Homeward Bound*, *Mrs. Robinson*, *Bridge Over Troubled Water*, and *Loves Me Like a Rock*.

**Skeleton** - A rigid supportive framework (bones) of the body.

**Spectrum** - A series of images formed when a beam of radiant energy is subjected to dispersion and brought to focus so that the component waves are arranged in the order of their wavelengths (as when a beam of sunlight that is refracted and dispersed by a prism forms a display of colors).

**Strings** - The string section of a band is made up of instruments with the vibrating strings stretched across them to make music. The finer the string and shorter its length, the higher the note. Two string instruments are the violin and the cello.

**Suffix** - A word "part" added to the back of a word to enhance its meaning.

**Surrealism** - A movement in art and literature which flourished in the 1920s and 30s, characterized by a fascination with the bizarre, the incongruous, and the irrational. Andre Breton said its primary purpose was "to resolve the previously contradictory conditions of dream and reality into an absolute reality, a super-reality." The poet Lautreamont wrote, "Beautiful as the chance encounter of a sewing machine and an umbrella on an operating table."

**Synonym** - A word that has the same meaning as another word. *Hairy and furry*, *Angry and mad*.

**Temperate** - Having a moderate climate.

**Tempo** - The rate of speed of a musical piece or passage indicated by one of a series of directions, i.e. *largo*, *allegro*, *legato*.

**Tetramino** - A polyomino shape consisting of four units. See polyominoes.

**Teutonic** - Germanic.

**Thalamus** - Part of the rear portion of the vertebrate forebrain.

**Thesaurus** - A book of words and their synonyms.

**Tonic** - A music term meaning the keynote of a scale.

**Tower of Hanoi** - Ancient Brahmin puzzle using gold disks placed on three poles. You can see Dr. Brain's version of the Tower of Hanoi in the cave on the island.

**Transpose** - A musical term meaning to change the key of a composition to a higher or lower one.



**Treble Clef** - Shows the pitch at which to play the music.

**Triad** - A music term for a chord of three notes consisting of a root, third, and fifth.

**Trivial** - Commonplace, ordinary.

**Tromino** - A polyomino shape consisting of three units. See polyominoes.

**Truth table** - A listing of all possible states of a boolean function

**Van Gogh, Vincent (1853-1890)** - Dutch postimpressionist painter. The great majority of his works were produced in 29 months of frenzied activity interspersed with epileptic seizures, his cutting off his ear, and despair that finally ended in suicide. His story has been captured in the movie *Vincent and Theo* (available on videocassette)

**Ventricle** - A chamber of the heart which receives blood from a corresponding atrium and from which blood is forced into the arteries.

**Verb** - A verb is a word which expresses action or existence. For example, "He ran to the store, (action) They played basketball yesterday afternoon, (action) We were in the stands to watch, (existence)"

**Vivo** - A musical term meaning to play lively; briskly.

**Vocabulary** - A list or collection of words and phrases employed by a language, group, individual, work, or field of knowledge.

**Water** - One of the liquids in Dr. Brain's measurement puzzle. Water has a molecular structure of H<sub>2</sub>O.

**Whole step** - A music term meaning twice the distance of a half step.

**Woodwind** - Flutes, oboes, saxophones. Woodwind instruments are characterized by a cylindrical or conical tube of wood or metal usually ending in a slightly flared bell, that produces tones by the vibration of one or two reeds in the mouthpiece or by the passing of air over a mouth hole. These instruments usually also have finger holes or keys to allow the player to produce all the tones within the instrument's range.

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Ia	IIa	IIb	IVb	Vb	VIB	VIIb	VIII	
1 <b>H</b> Hydrogen 1.00794								
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.01218							
11 <b>Na</b> Sodium 22.98977	12 <b>Mg</b> Magnesium 24.305							
19 <b>K</b> Potassium 39.0983	20 <b>Ca</b> Calcium 40.08	21 <b>Sc</b> Scandium 44.9559	22 <b>Ti</b> Titanium 47.88	23 <b>V</b> Vanadium 50.9419	24 <b>Cr</b> Chromium 51.996	25 <b>Mn</b> Manganese 54.938	26 <b>Fe</b> Iron 55.847	27 <b>Co</b> Cobalt 58.9332
37 <b>Rb</b> Rubidium 85.4678	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.9059	40 <b>Zr</b> Zirconium 91.22	41 <b>Nb</b> Niobium 92.9064	42 <b>Mo</b> Molybdenum 95.94	43 <b>Tc</b> Technetium 98	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.905
55 <b>Cs</b> Cesium 132.9054	56 <b>Ba</b> Barium 137.33	57-71 Lanthanide Series	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.9479	74 <b>W</b> Tungsten 183.85	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.2	77 <b>Ir</b> Iridium 192.22
87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium 226.4254	89-103 Actinide Series	104 <b>Unq</b> Unnilquadium (261)	105 <b>Unp</b> Unnilpentium (262)	106 <b>Unh</b> Unnilhexium (263)	107 <b>Uns</b> Unnilseptium (264)		109 <b>Une</b> Unnilenne (266)

Lanthanide Series (Rare Earth Elements)	57 <b>La</b> Lanthanum 138.9055	58 <b>Ce</b> Cerium 140.12	59 <b>Pr</b> Praseodymium 140.9077	60 <b>Nd</b> Neodymium 144.24	61 <b>Pm</b> Promethium (145)	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.96
Actinide Series (Radioactive Rare Earth Elements)	89 <b>Ac</b> Actinium 227.0278	90 <b>Th</b> Thorium 232.0381	91 <b>Pa</b> Protactinium 231.0362	92 <b>U</b> Uranium 238.0289	93 <b>Np</b> Neptunium 237.0482	94 <b>Pu</b> Plutonium (244)	95 <b>Am</b> Americium (243)

Ib	IIb	IIIA	IVA	VA	VIA	VIIa	0
							2 <b>He</b> Helium 4.00260
		5 <b>B</b> Boron 10.81	6 <b>C</b> Carbon 12.011	7 <b>N</b> Nitrogen 14.0067	8 <b>O</b> Oxygen 15.9994	9 <b>F</b> Fluorine 18.998403	10 <b>Ne</b> Neon 20.179
		13 <b>Al</b> Aluminum 26.98154	14 <b>Si</b> Silicon 28.0859	15 <b>P</b> Phosphorus 30.97376	16 <b>S</b> Sulfur 32.06	17 <b>Cl</b> Chlorine 35.453	18 <b>Ar</b> Argon 39.948
28 <b>Ni</b> Nickel 58.69	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.38	31 <b>Ga</b> Gallium 69.72	32 <b>Ge</b> Germanium 72.64	33 <b>As</b> Arsenic 74.9216	34 <b>Se</b> Selenium 78.96	35 <b>Br</b> Bromine 79.904
46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.8682	48 <b>Cd</b> Cadmium 112.41	49 <b>In</b> Indium 114.82	50 <b>Sn</b> Tin 118.69	51 <b>Sb</b> Antimony 121.75	52 <b>Te</b> Tellurium 127.6	53 <b>I</b> Iodine 126.9045
78 <b>Pt</b> Platinum 195.08	79 <b>Au</b> Gold 196.9665	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.37	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.9804	84 <b>Po</b> Polonium (209)	85 <b>At</b> Astatine (210)
							86 <b>Rn</b> Radon (222)

## PERIODIC TABLE OF THE ELEMENTS

64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.9254	66 <b>Dy</b> Dysprosium 162.50	67 <b>Ho</b> Holmium 164.9304	68 <b>Er</b> Erbium 167.26	69 <b>Tm</b> Thulium 168.9342	70 <b>Yb</b> Ytterbium 173.04	71 <b>Lu</b> Lutetium 174.967
96 <b>Cm</b> Curium (247)	97 <b>Bk</b> Berkelium (247)	98 <b>Cf</b> Californium (251)	99 <b>Es</b> Einsteinium (252)	100 <b>Fm</b> Fermium (257)	101 <b>Md</b> Mendelevium (258)	102 <b>No</b> Nobelium (259)	103 <b>Lr</b> Lawrencium (260)

# SOME IMPORTANT INFORMATION

## TABLE OF TIME MEASURE

60 seconds = 1 minute  
60 minutes = 1 hour  
24 hours = 1 day  
7 days = 1 week  
30 days = 1 month  
12 months = 1 year  
365 days = 1 common year  
366 days = 1 leap year  
100 years = 1 century

## TABLE OF DRY MEASURE

2 pints (pt.) = 1 quart (qt.)  
4 quarts = 1 peck (pk.)  
4 pecks = 1 bushel (bu.)  
1 cord = 128 cu. ft.

## TABLE OF LIQUID MEASURE

4 gills (gi.) = 1 pint (pt.)  
2 pints = 1 quart (qt.)  
4 quarts = 1 gallon (gal.)  
12.5 gallons = 1 hogshead (hhd.)  
2 barrels = 1 hoghead (hhd.)

## TABLE OF PAPER MEASURE

24 sheets = 1 quire  
20 quires = 1 ream  
10 reams = 1 bale

## TABLE OF LINEAR MEASURE

12 inches = 1 foot  
3 feet = 1 yard  
16.5 feet (5.5 yds.) = 1 rod  
660 feet = 1 furlong  
5280 feet (1.32 mi.) = 1 mile

## TABLE OF CUBIC MEASURE

1728 cubic inches = 1 cubic foot  
27 cubic feet = 1 cubic yard  
128 cubic feet = 1 cord of wood  
24.75 cubic feet = 1 perch of stone

NOTE: A chord of wood is a pile 8 feet long, 4 feet wide and 4 feet high.  
A perch of stone or brick is 16.5 feet long, 1.5 ft. wide and 1 foot high.

## TABLE OF CIRCULAR MEASURE

60 seconds (") = 1 minute (')  
60 minutes = 1 degree  
360 degrees = 1 circumference

## TABLE OF APOTHECARIES' WEIGHT

20 grains (gr.) = 1 scruple  
3 scruples = 1 dram  
8 drams = 1 ounce  
12 ounces = 1 pound (lb.)

## TABLE OF TROY WEIGHT

24 grains (gr.) = 1 pennyweight (dwt.)  
20 pennyweights = 1 ounce (oz.)  
12 ounces = 1 pound (lb.)

## MISCELLANEOUS MEASURE

12 units = 1 dozen  
12 doz. = 1 gross  
12 gross = 1 great gross  
20 units = 1 score  
1 hand = 4 inches  
1 fathom = 6 feet  
1 knot = 1046 feet  
3 knots = 1 league  
1 bu. potatoes = 60 lbs.  
1 barrel flour = 196 lbs.  
1 cu. ft. of water = 7.48 liquid gals. and  
weighs 62.425 lbs.

Diameter of circle X 3.1416 = circumference

Diameter of circle squared X .7854 = area

Atmospheric pressure is 14.7 lbs. per sq. inch at sea level.  
1.5 cu. ft. of air weighs 1 lb.

## TABLE OF SURFACE MEASURE

144 sq. in. = 1 sq. ft.  
9 sq. ft. = 1 sq. yd.  
36.25 sq. yds. = 1 sq. rod  
160 sq. rods = 1 acre  
640 acres = 1 sq. mile  
An acre measures 208,710, each side  
A section of land is 1 sq. mile  
A quarter section is 160 acres.  
A township is 36 sq. miles.

## MULTIPLICATION TABLES

1	2	3	4	5	6	7	8	9	10	11	12
2	4	6	8	10	12	14	16	18	20	22	24
3	6	9	12	15	18	21	24	27	30	33	36
4	8	12	16	20	24	28	32	36	40	44	48
5	10	15	20	25	30	35	40	45	50	55	60
6	12	18	24	30	36	42	48	54	60	66	72
7	14	21	28	35	42	49	56	63	70	77	84
8	16	24	32	40	48	56	64	72	80	88	96
9	18	27	36	45	54	63	72	81	90	99	108
10	20	30	40	50	60	70	80	90	100	110	120
11	22	33	44	55	66	77	88	99	110	121	132
12	24	36	48	60	72	84	96	108	120	132	144

## CONVERSION TABLES

Meters Yards Inches  
1,000 1,093 39.37  
914 1,000 36.00

Centimeters Inches Feet  
100 39.4 .33  
2.54 1,000 1/12  
30.48 12.00 1.000

Kilometers Miles  
1,000 .621  
1,609 1,000

Grams Ounces Pounds  
1,000 .035 .002  
28.35 1,000 1/16  
453.59 16.00 1.000  
1,000.00 35.274 2.205

Kilograms Ounces Pounds  
1,000 35.274 2.205  
.028 1,000 1/16  
.454 16.000 1.000

Liters Pints Quarts Gals.  
1,000 2.113 1.057 .264  
.473 1.000 1/2 1/8  
.946 2.000 1.000 1/4  
3.785 8.000 4.000 1.000

## TABLE OF AVOIRDUPOIS WEIGHT

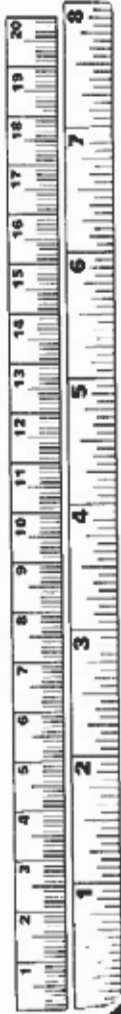
16 drams = 1 pound (lb.)  
16 ounces = 1 pound (lb.)  
100 pounds = 1 hundredweight (cwt.)  
2000 pounds = 1 ton  
2240 pounds = 1 long ton (L.T.)

## CONVERSION TABLES

LENGTH  
1 meter (m) = 100 cm = 1,000 mm  
1 millimeter (mm) = .001 m  
1 centimeter (cm) = .01 m  
1 decimeter (dm) = .1 m  
1 dekameter (dkm) = 10 m  
1 hectometer (hm) = 100 m  
1 kilometer (km) = 1,000 m

CAPACITY  
1 liter (l) = 100 cl = 1,000 ml  
1 milliliter (ml) = .001 l  
1 centiliter (cl) = .01 l  
1 deciliter (dl) = .1 l  
1 decaliter (da) = 10 l  
1 hectoliter (hl) = 100 l  
1 kiloliter (kl) = 1,000 l

WEIGHT  
1 gram (g) = 100 cg = 1,000 mg  
1 milligram (mg) = .001 g  
1 centigram (cg) = .01 g  
1 decigram (dg) = .1 g  
1 decagram (dag) = 10 g  
1 hectogram (hg) = 100 g  
1 kilogram (kg) = 1,000 g



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The *Island of Dr. Brain* was a collaborative design made possible only by the hard work from the

## BRAINSTORMERS

*"We play games with your future in mind."*

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