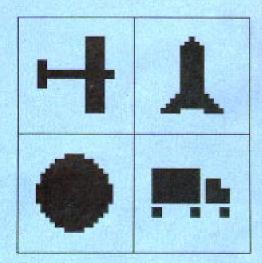
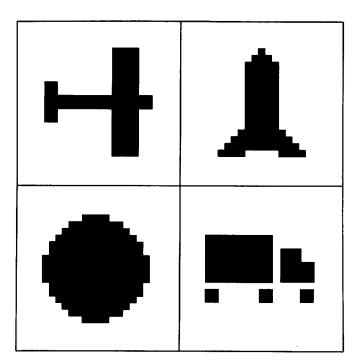
Texas Instruments TI-99 Computer Family



TI LOGO



TI LOGO



This Solid State $Software^{\mathsf{TM}}$ Command Module is designed to be used with the Texas Instruments computer. Its preprogrammed solid-state memory expands the power, versatility, and capability of your computer.

Copyright © 1981 Texas Instruments Incorporated Command Module program and data base contents copyright © 1981 Texas Instruments Incorporated. See important warranty information at back of book.

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Quick Reference

Note that the key sequences required to access special functions depend on the type of computer console you have.

	1				
<i>TI-99/4</i>	<u>TI-99/4A</u>				
AID (SHIFT A)	AID (FCTN 7)	Causes the computer to pause			
BACK (SHIFT Z)	BACK (FCTN 9)	 Leaves the Save and Recall Modes and returns the computer to the mode it was in. Stops a procedure. Leaves the Edit Mode, MAKESHAPE and MAKECHAR. 			
BEGIN (SHIFT W)	BEGIN (FCTN 5)	Moves the cursor to the beginning of the line in the Edit Mode.			
CLEAR (SHIFT C)	CLEAR (FCTN 4)	 Clears the MAKESHAPE and MAKECHAR grids. Erases what is above and to the right of the cursor in the Edit Mode. 			
DELETE (SHIFT F)	DELETE (FCTN 1)	 Erases what is above the cursor. Moves a line up one line if the cursor is at the end of the line in the Edit Mode. 			
ERASE (SHIFT T)	ERASE (FCTN 3)	 Erases what is one space to the left of the cursor. Moves a line up one line if the cursor is under the first character of a line in the Edit Mode. 			
PROC'D (SHIFT V)	PROC'D (FCTN 6)	Moves the cursor to the end of the line in the Edit Mode.			
† (SHIFT E)	(FCTN E)	 Moves the cursor up one line in the Edit Mode. Blackens a square on the MAKESHAPE and MAKECHAR grids as the cursor moves up one square. 			
(SHIFT S)	(FCTN S)	 Moves the cursor left one space in the Edit Mode. Blackens a square on the MAKESHAPE and MAKECHAR grids as the cursor moves left one square. 			
→ (SHIFT D)	→ (FCTN D)	 Moves the cursor right one space in the Edit Mode. Blackens a square on the MAKESHAPE and MAKECHAR grids as the cursor moves right one square. 			

<u>TI-99/4</u>	<u>TI-99/4A</u>	
↓ (SHIFT X)	(FCTN X)	 Moves the cursor down one line in the Edit Mode. Blackens a square on the MAKESHAPE and MAKECHAR grids as the cursor moves down one square.
SPACE	SPACE	 Leaves a blank space in the type in the Sprite and Turtle Modes. Reviews file names in the Save and Recall Modes.
[(SHIFT 4)	[(FCTN R)	Types a left bracket
] (SHIFT 5)] (FCTN T)	Types a right bracket
QUIT (SHIFT Q)	QUIT (FCTN =)	Stops TI LOGO and returns to the master title screen.

SETTING UP

Before using your TI LOGO Command Module, be sure:

- The Texas Instruments Memory Expansion unit ¹ is correctly attached and turned on.
- The appropriate accessory is attached to your computer system for saving and recalling your work. To save or recall your work on a diskette, attach the TI Disk Memory System¹. To save or recall your work on cassette tape, attach a cassette recorder¹. For getting printed copies of procedures, attach the TI Thermal Printer. See *Chapter 6* for more information on saving your work.

WARNING

If you are using the Disk Memory System with the computer, follow these steps for powering up:

- 1. First turn on the disk controller and disk drive(s).
- 2. Next turn on the Memory Expansion unit.
- 3. Then turn on the computer console and any other devices that are attached to your system.

If the above power-up steps are not followed in order, the computer cannot access you disk system. In this case, the console must be turned off and the Disk Memory System, Memory Expansion unit, and console turned back on in the correct order.

¹ sold separately

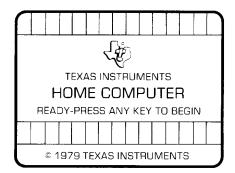
USING THE SOLID STATE SOFTWARE™ MODULE

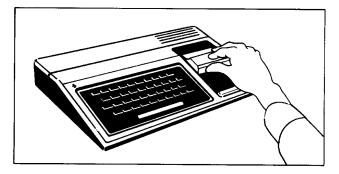
The Texas Instruments computer is a strong and rugged machine. It is made for easy use and care. You should give the computer the same good care and respect you would give a television set, record player, radio, or any other piece of electronic equipment:

- Keep snacks and beverages away from the console and keyboard.
- Don't hammer on the keyboard or place heavy objects on it.
- Don't touch the module contacts. These are deep in the module to keep them from being soiled or damaged.

An automatic reset feature is built into the computer. When a module is inserted into the console, the computer returns to the master title screen. All data or program material that is stored in the computer's memory is erased.

Note: Be sure the module is free of static electricity before putting it into the computer (see page 86).





- 1. While the master title screen is displayed, slide the module into the slot on the console, and slide the diskette into the slot on Disk Drive 1.
- 2. Press the number next to TI LOGO. The title sequence appears. The small black flashing symbol (_) you see in the upper left corner of the screen is called a *cursor*. This symbol tells you that the computer is ready to listen to your instructions.
- 3. Remove the diskette and put it back into the paper envelope. Be sure *not* to put the diskette on top of the disk drive as this may damage the diskette.

(*Note*: To remove the module, *first* return the computer to the master title screen by typing BYE and pressing **ENTER**. *Then*, remove the module from the slot. If you have any problem putting in the module, or if it is accidentally removed from the slot while in use, please see "In Case of Difficulty" on page 86.)

1. You and the Computer: an Adventure

Before starting *Chapter 1*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

This book is your guide to an adventure — learning to program with TI LOGO. Even if you have never worked with a computer before, you can use this book to teach yourself, your family, and your friends how to use and enjoy your computer.

Computers are all around us. We watch computerized scoreboards at sports events. We even see computers in the classrooms. Almost everything we eat, wear, and use has been handled by computer-operated machines.

What is computer programming? Nothing mysterious! Programming is just talking with a computer. You tell the computer what to do and when to do it. To program your computer you need to learn two things: the language your computer understands and how to talk to it.

1.1. Language

Language is very important. With language we can say what we need, where we want to go, or just "what's happening".

1.1.1. Dialect and Jargon

Every country has its own language. We speak English, people from Japan speak Japanese, and people living in France speak French. Each language has dialects (different pronunciations and grammar within the same language) and jargon (words that have special meaning to a group of people). Where a person lives determines the language he or she speaks and the dialect of that language. A child from New York sounds very different from a Texan child, even though both children live in the United States and speak English.

Jargon is usually developed by a group to serve a need. The different ways people greet each other is an example of jargon. "Howdy", "hi", "hello", "give me five", "hi y'all", and "what's happenin" all mean about the same thing.

1.1.2. Talking to the Computer

Talking to a computer is like talking to a friend. You must find a language, dialect, and jargon that both of you understand. Just as there are many different languages for people, there are many computer languages. We are going to learn the language called TI LOGO. You will find that the computer understands many of the words you use now. But in some cases, you will need to learn some new words or a new jargon. After you learn these words, you will be able to teach or program the computer to do many exciting things.

1.2. The Keyboard

Now, how do you talk to the computer? Look at the computer keyboard. You'll see the letters of the alphabet, numbers, punctuation marks, and other special symbols. Many of these you've seen before on typewriter keyboards. Everything you need to use to talk to the computer is right there on the keyboard. You "type" your instructions, and the computer "hears" them. It's as easy as that!

1.2.1. Letters

To type a letter of the alphabet, you must find it on the keyboard. Find each letter of your name and type it. Don't worry about capital letters because you can only type capitals with TI LOGO.

When the letters reach the edge of the screen, the cursor (the flashing _) automatically moves down to the next line. You don't have to stop typing. The computer understands if part of a word is on one line and the rest of it is on the next line.

1.2.2. Spacing

When you write a sentence, you always leave a space between words. The TI LOGO language doesn't always need a space between words. You need to watch carefully to learn when a space is needed and when it isn't.

1.2.3. SPACE BAR

Look at the keyboard. There is a key you can press to leave an empty space. It is the long bar at the bottom of the keyboard. A space is made each time you press the bar. Type your first name again, then a space, and then your last name.

Practice some more by typing the names of your friends, parents, pets, or any words that you want.

1.2.4. Numbers

Now, try typing some numbers. The number keys are on the top row of the keyboard. With these keys, you can now type your address, age, and telephone number.

1.2.5. Special Keys

Notice that some keys have two symbols on them. Look at the number 1 key. An exclamation point (!) is above the 1. How can you type the exclamation point?

Look at the keyboard. You see a key called **SHIFT**. Hold down **SHIFT** and, at the same time, press the key with 1 and ! on it. Use two hands to do this. The ! appears on the screen.

Experiment with the **SHIFT** key and other keys. Some keys use the **SHIFT** key for a function other than typing in a letter, number, or symbol. These special functions are discussed in the manual later.

Have fun typing and learning where the keys are on the keyboard.

1.2.6. **ERASE**

Have you pressed **ERASE** yet? Press it now and see what happens. The cursor (_) moves one space to-the left. Pressing **ERASE** also erases whatever was there before. Now you can type in the same spot again. The cursor moves one space to the left every time you press **ERASE**. To move the cursor three spaces to the left and erase three characters, press **ERASE** three times.

1.2.7. ENTER

Remember, we said everything you need to talk to your computer is on the keyboard. You "type", and the computer "hears". It's easy to understand how you "type". But how does the computer "hear"? Look at the right side of the keyboard. You see a key called **ENTER**. This is the key that tells the computer to hear and do what you type. After you type something you want the computer to do, you must press the **ENTER** key. If you forget to press the **ENTER** key, the computer does not "hear" you. It does not do what you want.

1.2.8. CLEARSCREEN

Is your screen full of words, numbers, and letters? Would you like to start over with a clear screen? That's easy! Type CLEARSCREEN. Make sure it is one long word with no space between the letters. Then you must tell the computer to do what you have typed. To do this, press the **ENTER** key. Remember, the **ENTER** key is on the right side of the keyboard.

1.3. About This Book

This book should help you learn the language of TI LOGO. There are many examples in the book. Try them all and experiment with other examples of your own.

1.3.1. Left Column

As you read the book, notice the words typed in the left column in capital letters. These words are called *commands* and are there to help you. If you don't remember exactly what to type to get the computer to do what you want, look in this column. Find the command that you need and type it carefully. Be sure to watch the spacing, symbols, letters, and numbers.

1.3.2. Pressing ENTER

Starting in *Chapter 2*, you need to press the **ENTER** key very often. The book will occasionally tell you to press the **ENTER** key. Usually, you need to remember to press the **ENTER** key after each command. If you forget, the computer won't "hear" and do what you tell it.

1.3.3. Short Forms

The computer understands some short forms for commands. For example, the short form for CLEARSCREEN is CS. The list of short forms is in *Appendix A*. The commands in the left column do not use any short forms. You can type the full command or the short form.

1.3.4. Organization

The first chapter of this book introduces the computer and the keyboard. Experiment with the keys until you feel ready to go on. In *Chapter 2* you learn to create interesting designs. You use a triangle (\triangle), called a Turtle, to draw and erase lines. *Chapters 3* and 4 introduce sprites, shapes, and tiles. For example, you give a sprite *commands* that make it look like a red plane "flying" around the screen. Next, in *Chapter 5*, you learn how to teach the computer to do a list of commands. This list is called a *procedure*.

After learning how to teach the computer, *Chapter 6* tells you how to save and recall your work. In *Chapters 7* and 8 you make the procedures longer by putting *subprocedures* together. *Chapter 9* shows you how to use TI LOGO as a calculator to do basic mathematical operations.

When you finish learning about the keyboard, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on. Let's start drawing in the "Turtle Way" or, as we call it in this book, the Turtle Mode.

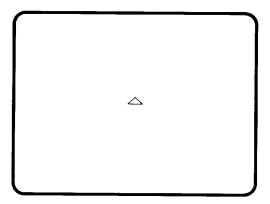
2. Turtle Mode

Before starting *Chapter 2*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

Let's play a game. Suppose you are standing in the middle of a circle of friends. You are facing north. If your friends tell you to go forward 10 steps, what happens? Now a friend tells you to turn right. Would you move or still be standing in the same spot? You'd be in the same spot but facing a different friend or direction. You'd be facing east now. Next, someone tells you to go back 20. Don't turn around, just move back 20 steps.

TELL TURTLE

Now, instead of a friend telling you what to do, let's tell a turtle what to do. Type TELL TURTLE and press **ENTER**. The following screen appears:



The triangle (Δ) is called a *Turtle*. It's in the middle of the screen, a place called HOME. It is ready to listen and do whatever you tell it.

The cursor (_) appears in the bottom fourth of the screen. After you enter a line, the cursor returns to the beginning of the next line. If it's the last line on the screen, the cursor moves up to the top line again. Although there are six lines for typing, you can only see four lines of typing at a time. The computer erases any more than that to make room for the designs you create with the Turtle.



Now think of the screen as a compass: the top is north, the right is east, the bottom is south, and the left is west. You can tell which way the Turtle is heading by looking at the top point of the triangle. (*Note*: The Turtle always faces north after you type TELL TURTLE and press the **ENTER** key.)

FORWARD 10

Let's look at the screen again. The top point of the Turtle faces north, just like you did in the game. It's easy to tell the Turtle the same directions your friends told you. (Remember to press the **ENTER** key after you type a command.) Type FORWARD 10 and press **ENTER**. The Turtle leaves a line 10 steps long as it moves 10 steps north.

RIGHT 90 BACK 30

Next, type RIGHT 90 and press **ENTER**. Like you, the Turtle turns to face east but stays in the same place. Type BACK 30, and press **ENTER**. The Turtle keeps facing east but moves backwards. As it moves back 30 steps, the Turtle draws a line 30 steps long.

2.1. FORWARD, BACK, RIGHT, and LEFT

You can tell the Turtle four commands: FORWARD, BACK, RIGHT, and LEFT. If you type just one of these commands, the Turtle doesn't know how much, so it doesn't move. Each command needs an amount or a number. FORWARD or BACK, and a number, cause the Turtle to move from one place to another and draw lines. RIGHT or LEFT, and a number, tell the Turtle how much to turn.

2.2. TELL ME MORE

If you type FORWARD, BACK, RIGHT, or LEFT, and press **ENTER** without telling the Turtle how much, the computer reminds you to complete the command. TELL ME MORE appears on the screen. To continue, retype the command with a number. Then press **ENTER** and watch the Turtle draw a line or turn.

2.3. TELL ME HOW TO...

If you make a typing mistake and press the ENTER key, the computer gives you a message — TELL ME HOW TO.... Look at the line you just typed and find your mistake. Then, retype the command correctly and press the **ENTER** key.

Now try giving the Turtle some FORWARD, BACK, RIGHT, and LEFT commands of your own.

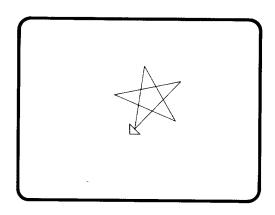
CLEARSCREEN

You've probably drawn several lines with the Turtle, and you might want to erase them. To do this, simply type CLEARSCREEN and then press the ENTER key. (You can also type CS, a short form for the command CLEARSCREEN.) All the lines the Turtle has drawn and everything you've typed are erased. The Turtle moves to the center of the screen (HOME) and is ready to draw again.

Now you're ready to experiment with some designs. Type these commands, just as you see them here. Be sure to press ENTER after each command. Then watch what the Turtle does!

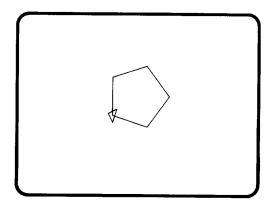
CLEARSCREEN
FORWARD 50
RIGHT 1 44
FORWARD 50

Design 1 — Star



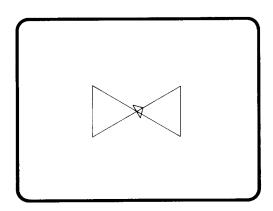
CLEARSCREEN
FORWARD 50
RIGHT 72
FORWARD 50
RIGHT 72
FORWARD 50
RIGHT 72
FORWARD 50
RIGHT 72
FORWARD 50

Design 2 — Pentagon



CLEARSCREEN
RIGHT 60
FORWARD 50
RIGHT 1 20
FORWARD 50
RIGHT 1 20
FORWARD 1 00
LEFT 1 20
FORWARD 50
LEFT 1 20
FORWARD 50

Design 3 — Butterfly



Now, try making your own design with the Turtle. It's a good idea to keep a journal of the exciting drawings and designs you make. Be sure to write down carefully the order of the commands. That way, they can be drawn again quickly and easily. To make a design, draw a picture on paper *without* picking up your pencil. Then, with the commands FORWARD, BACK, RIGHT, and LEFT, tell the Turtle to draw that same design.

2.4. OUT OF INK

When the computer gives you the message OUT OF INK, the Turtle cannot draw any more. Clear the screen, and give the Turtle new commands.

To send the Turtle HOME when you are in the middle of a drawing, type HOME and press **ENTER**. The Turtle takes the shortest path HOME without drawing a line and faces north again.

2.5. HIDETURTLE and SHOWTURTLE

If you don't want to see the Turtle in a drawing, type HIDETURTLE and press **ENTER**. Although the Turtle becomes invisible, you can still give it commands. You see the lines it draws, but not the Turtle. When you want to see the Turtle again, type SHOWTURTLE, and press **ENTER**.

Let's try drawing with the Turtle another way. When you are writing with a pen, you can only see what you write when the pen and the ink are on the paper. When the pen is up off the paper, it makes no marks. You can draw with the Turtle the same way you write with a pen.

2.6. PENUP and PENDOWN

You already know how to use FORWARD, BACK, RIGHT, and LEFT. What if you want to move the Turtle somewhere on the screen without drawing a line?

PENUP FORWARD 50

Type PENUP and press **ENTER**. Then type FORWARD 50 and press **ENTER**. The Turtle moves where you tell it, but it doesn't leave a path. Now you can start drawing a picture at someplace other than HOME. Just let PENUP be your first command, move the Turtle to the starting point, type PENDOWN, and start your drawing. (When you type TELL TURTLE, the pen is always down. To change that, you have to give the Turtle the correct commands.)

2.7. PENERASE

If you make a mistake, you can turn the Turtle into an eraser by typing PENERASE. Tell the Turtle to take the same path that it took before, and it erases that line. You must type PENDOWN and press **ENTER** when you're ready to draw with the Turtle again.

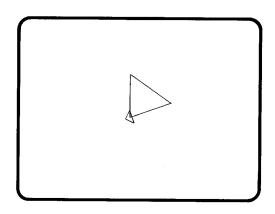
2.8. PENREVERSE

The Turtle can do another interesting thing. When it crosses or covers a line it has drawn, it can erase that part of the line. At the same time, it draws a line where one hasn't been drawn before. This is done by typing PENREVERSE. When you want to draw normally with the Turtle again, type PENDOWN.

These four functions of the Turtle, PENUP, PENDOWN, PENERASE, and PENREVERSE are called the *state of the pen*. Let's try a design with each state of the pen.

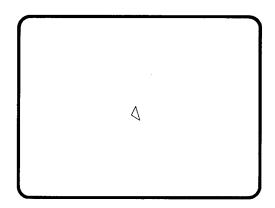
CLEARSCREEN
PENDOWN
FORWARD 50
RIGHT 120
FORWARD 50
RIGHT 120
FORWARD 50

First clear the screen. Remember to press the $\mbox{{\it ENTER}}$ key after you type each command.



CLEARSCREEN
PENUP
FORWARD 50
RIGHT 1 20
FORWARD 50
RIGHT 1 20
FORWARD 50

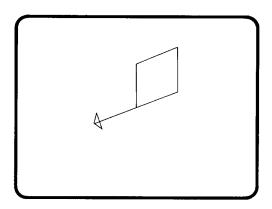
Now look what happens when you type the same commands with the PENUP.



Remember, the Turtle does not leave any lines until you type PENDOWN again.

PENDOWN CLEARSCREEN Put the pen back down and clear the screen. Let's draw a kite using PENUP, PENDOWN, and PENERASE. Watch carefully to see what each state of the pen does.

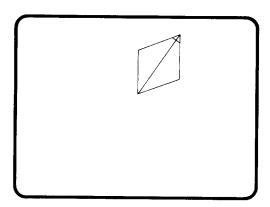
FORWARD 50 RIGHT 60 FORWARD 50 RIGHT 1 20 FORWARD 50 RIGHT 60 FORWARD 80 Let's make the kite by drawing a diamond shape first.



PENERASE BACK 30

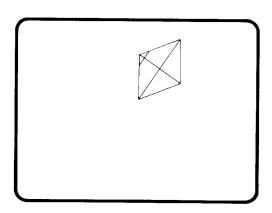
PENDOWN RIGHT 150 FORWARD 85 The last FORWARD command doesn't look like it should be part of the kite. Erase part of the line by typing PENERASE and the BACK command.

The Turtle won't draw again until we put the pen down. Do this. Now, let's draw one of the crossbars on the kite.



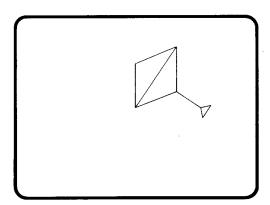
One line is still missing from the kite. Can you figure out how to draw the other crossbar?

PENUP RIGHT 150 FORWARD 50 RIGHT 120 PENDOWN FORWARD 50 You only want one line. Type PENUP and move the Turtle where you want it. Next, type PENDOWN, and point the Turtle in the correct direction. Then draw your line.



If you make a mistake, you can erase it by typing PENERASE and telling the Turtle to draw over the line.

PENREVERSE BACK 100 Let's try PENREVERSE on your kite design. Type PENREVERSE and BACK 100. The crossbar is erased and a line 50 steps long goes beyond the kite.



So far we've given the Turtle commands to draw straight lines. It can also draw curved lines. Let's play the game again to see how the Turtle can do this.

Face north and take one small step forward. Now, turn to the right just a little, and take another small step forward. Keep turning a little and taking one small step until you turn all the way around and face north again. Now tell the Turtle to do the same.

CLEARSCREEN
FORWARD 8
RIGHT 20
FORWARD 8
RIGHT 20
FORWARD 8
RIGHT 20
FORWARD 8
RIGHT 20

First clear the screen. Then tell the Turtle to go FORWARD 8 steps and turn RIGHT 20. Keep giving the Turtle these two commands until you see a curved line. If you continue telling the Turtle to go FORWARD 8 RIGHT 20 until a circle is drawn, will it be a large or small circle?

It's easy to tell the Turtle how to draw a different sized circle. Just change the number after the FORWARD and RIGHT commands. Or, tell the Turtle to draw a circle to the left with the LEFT command.

NOTURTLE

Remember to keep a journal of the drawings and designs you make. When you finish drawing in the Turtle mode, type NOTURTLE. The Turtle (\triangle) disappears. All your drawings and designs also disappear.

When you finish drawing with the Turtle, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

3. Sprites and Shapes

Before starting *Chapter 3*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

What is a sprite? It's an invisible thing you can talk to. You must tell a sprite about itself before you can use it.

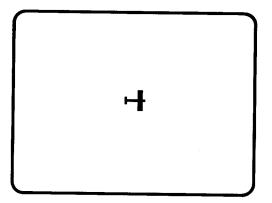
Let's pick a shape, such as a plane. There are many ways you can describe a plane: its shape, its color, where it is and how fast it goes. Just think, if it had no color and no shape, you wouldn't be able to see it.

A sprite also needs color and shape to be seen. Let's give a sprite the shape of the plane we have been talking about.

TELL SPRITE 1
CARRY : PLANE
SETCOLOR : BLACK

HOME

Type the four commands in the left column just as you see them. Remember to press the ENTER key after you type each command. A black plane then appears in the center of the screen, HOME. As it is for the Turtle, the middle of the screen is also HOME for a sprite.



3.1. : Dots

Did you notice the ":" in front of plane and black? They are called dots. Dots tell the computer to do or carry the value of the name that follows the dots. To type: (dots), press the **SHIFT** key and the key with : on it. *Always* type one empty space *before* the dots. *Never* type an empty space *after* the dots. Also, *never* type dots in front of a number.

3.2. TELL ME HOW TO ...

If you make a mistake, you can press **ERASE** *before* you press the **ENTER** key to backspace and erase the mistake. If you make a mistake and press the **ENTER** key, the computer gives you the message — TELL ME HOW TO.... Look at the line you just typed and find your error. Then, retype the command correctly.

3.3. Shapes and Colors

The computer knows five shapes. You can change the shape of a sprite by telling it to carry a different shape. Just type CARRY: and the name of one of these five shapes:

Shape	Design
PLANE	H
TRUCK	M t
ROCKET	1
BALL	•
BOX	

Next, let's change the color of the sprite on the screen. The computer knows 16 colors. To change the color, type the command SETCOLOR: and the name of one of these colors:

Color	Color	Color
BLUE	RUST	OLIVE
SKY	ORANGE	PURPLE
RED	YELLOW	GRAY
CYAN	LEMON	WHITE
	BLUE SKY RED	BLUE RUST SKY ORANGE RED YELLOW

CARRY : TRUCK Here's how to make a green truck appear on the screen. SETCOLOR : GREEN

CARRY: BOX Next, change the truck to a box. And make the box yellow.

SETCOLOR : YELLOW

CARRY : PLANE SETCOLOR : BLUE HOME Let's think about our plane again. We said it can also be described by how fast or slow it goes. Wouldn't it be fun if we could give the plane speed? Make the plane any color you want and put it at HOME.

3.4. SETSPEED and Wrapping

The command SETSPEED gives a sprite speed. SETSPEED also needs a number. A sprite can have any speed from -127 through 127. You can make your plane go very fast (SETSPEED 127) or very slow (SETSPEED 1). Or, you can change the speed and make the plane go in the opposite direction (SETSPEED -72).

SETSPEED 85

Give your plane a speed of 85 by typing SETSPEED 85 and pressing **ENTER**. The plane starts moving. When the plane reaches the top of the screen, it disappears. Then, almost immediately it reappears at the bottom of the screen. What does that tell you about the surface of the screen?

The screen is shaped like a rectangular box. Let's say you want to wrap that box for a gift. You wrap the paper around it, and then you wrap the ribbon around the box. With your ribbon, you start in the middle of the box and go over the top edge. You come back around the bottom of the box and to the middle again. Just as you wrap ribbon around the box, the plane wraps around the screen. This is called *wrapping*.

SETSPEED 0 SETSPEED 110 SETSPEED -110 Give the plane a speed of 0. It stops moving. Now give it a fast speed by typing SETSPEED 110 and pressing ENTER. Then send the plane in the opposite direction by setting the speed to - 110. (*Note*: To type the minus symbol in front of 110, press the SHIFT key and the key with - on it.)

3.5. SS DOESN'T LIKE...AS INPUT

If you try to set the speed to more than 127 or less than -127, the computer gives you a message SS DOESN'T LIKE...AS INPUT. SS is the short form for the command SETSPEED. Simply type the command again with a number from -127 through 127.



Let's look at the compass again. The center of the compass is the same as HOME on the screen. There are numbers all around the compass. Each number stands for a degree. Notice that there are 360 degrees in a circle. Therefore, there are 180 degrees in half of a circle. Have you ever done a "180" on a skateboard? Or, maybe a "360"!

3.6. SETHEADING

You can set the heading or direction of a sprite with the command SETHEADING. The command SETHEADING needs the number of degrees (from 0 through 360) in which you want the sprite to head. The names of the directions, north, south, east, and west, can also be used with SETHEADING. When you use the names, : must be typed in front of the name.

CARRY : ROCKET
SETCOLOR : GREEN
SETSPEED 0
HOME
SETHEADING 0
SETSPEED 60
SETHEADING 90

HOME FREEZE THAW Put a green rocket with no speed at HOME. Looking at the rocket, you can't see which direction it is heading. You need to set it. To set the heading straight up, or north, type SETHEADING 0 or SETHEADING:NORTH. Now give the rocket speed. It goes straight up and wraps around the bottom of the screen. Look at the compass again. Because the rocket is going straight up, the heading is 0 degrees. What number of degrees or name would you use to make the rocket go straight right? That's correct, SETHEADING 90 or SETHEADING:EAST.

If you want the sprite to start from HOME again, type HOME. It jumps HOME but keeps moving with the same speed and heading. If you want to stop or freeze the sprite while it is moving, type FREEZE. It won't move again until you tell it to. Are you ready for it to go? Type THAW and the sprite, with the speed it had before, starts moving again.

3.7. Talking to More Than One Sprite

All this time, you have been talking to Sprite 1. It has carried many different shapes and has had many different colors. It has also traveled all over the screen.

TELL SPRITE 2 CARRY :BALL SETCOLOR :BLUE HOME Now you are ready to talk to Sprite 2. Again, you need to tell Sprite 2 about itself. Make Sprite 2 a blue ball, and send it HOME.

There, at HOME, is Sprite 2. It's blue and shaped like a ball. You can give Sprite 2 all the commands you gave Sprite 1. You can even make it look exactly like Sprite 1!

Try changing the shape and color of Sprite 2. Also give it different speeds, directions, and headings.

TELL SPRITE 1
CARRY :TRUCK
SETCOLOR :PURPLE
SETSPEED 5

Now, let's go back and talk to Sprite 1. How can you do that? You need to get Sprite 1's attention again by calling it by its number. Type the commands you see in the left column.

Remember, you are now talking to Sprite 1. Whenever you want to talk to a new or different sprite, you need to get its attention. You do this by typing TELL SPRITE and then its number. And, if it's a sprite you haven't talked to before, you need to tell the sprite about itself.

You can talk to 32 sprites. Experiment by talking to as many as you would like. The first sprite has the number 0 and the last sprite has the number 31. Because there are only 32 sprites, you cannot talk to a sprite larger than 31. If you type TELL SPRITE 60, the computer takes that number and figures out which of the sprites 60 would be. It subtracts 32 from the number until it gets to a number from 0 through 31. Sprite 60 would be Sprite 28. It is easier to remember which sprite you are talking to if you use the numbers 0 through 31 with the TELL SPRITE command.

When you talk to a new sprite, all of the sprites you left behind keep the last shape, color, speed, and heading you gave them.

By now you should have many sprites on the screen. FREEZE them all so that you can see them. When you are ready, type THAW, and they'll move again.

When you typed FREEZE, all the sprites stopped. And when you typed THAW, all of them moved again. If only one sprite is on the screen, you can FREEZE and THAW it. Or, you can FREEZE and THAW all the sprites that are on the screen.

TELL :ALL
CARRY :BOX
SETCOLOR :OLIVE
SETSPEED 75

To get the attention of all 32 sprites, type TELL :ALL. Now it's easy to make all of the sprites look the same. Give them the same shape, color, and speed.

There's one thing that is different about the sprites. What is it? The heading. There should be many sprites on the screen that look exactly the same, except they are going in different directions.

SETHEADING 220 HOME

How can you get all of the sprites to go in the same direction? That's right. Give them all the same heading. To start them together and from the same place, give them the same heading, and send them all HOME.

Now it looks like there is only one sprite. But you know that they are all there, grouped together. How can 32 sprites group together?

Let's pretend you have eleven cards that are numbered from zero through ten. Put them in counting order. The card that has the 0 on it would be on the top. And the card with the number 10 on it would be on the bottom. If you stack them in a neat pile, can you see card number seven? Or card number nine? No, you can only see the top card. But you know the other cards are under the 0 card.

Sprites stack up the same way. Sprite 0 is on the top of the stack, and Sprite 31 is on the bottom. Try this example to help you understand.

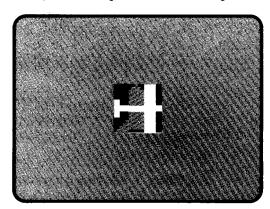
TELL :ALL
CARRY :BOX
SETCOLOR :BLACK
SETSPEED 0
HOME

Make all 32 sprites look the same — a black box with no speed at home.

TELL SPRITE 0
CARRY : PLANE
SETCOLOR : WHITE

Now tell Sprite 0 to carry the shape of the plane and set the color to white. You can see the shape of the plane on top of the box shape.

TELL SPRITE 1 CARRY : ROCKET SETCOLOR : GRAY Now tell Sprite 1 to be a gray rocket. Will it cover up part of the plane? No, because Sprite 1 is behind Sprite 0.



[Correction: The background color of the screen should be white, and not gray.]

TELL SPRITE 2 CARRY :BALL SETCOLOR :YELLOW

TELL SPRITE 0 CARRY :BOX

FORWARD 50

BACK 100

Now, tell Sprite 2 to carry a yellow ball. You can see the ball behind the plane and the rocket. You can see all of the plane because it is the first shape. But what happens when you make Sprite 0 carry a large shape? The largest shape is the box. Try it and see.

As you told it to, Sprite 0 changes its shape. You did not change its color from the last time you talked to it (a white plane). Because the white box is so big, it covers up the shapes of all the other sprites. But you know they are still under there. Want to check?

Move Sprite 0 forward. There, at HOME, is the gray rocket (Sprite 1), the yellow ball (Sprite 2), and the white boxes (Sprites 3 to 31)!

Like the Turtle in Chapter 1, you can give a sprite the commands FORWARD, BACK, RIGHT, and LEFT. Remember that these commands need a number after them to tell the sprite "how much" to move or turn.

Move Sprite 0 back 100 steps. Look where the box is now.

You can change the direction a sprite is pointing with the commands RIGHT and LEFT. If the sprite is not moving, you won't be able to see the change.

SETSPEED 60 LEFT 115 Let's give the box a speed. And, when you are ready, change the direction the box is going. The number you type after the RIGHT or LEFT command adds to the current heading of the sprite, and changes its direction.

3.8. To Whom Are You Talking?

3.8.1. WHO

It's important to remember to which sprite you are talking. But if you forget, the computer can help you. There is a word that tells you to what sprite you are talking. WHO tells you exactly what you typed after the TELL command. For example, let's say the last sprite you talked to was Sprite 16 with the command TELL SPRITE 16. Typing WHO would cause the phrase TELL ME WHAT TO DO WITH SPRITE 16 to appear on the screen.

3.8.2. PRINT

When the message TELL ME WHAT TO DO WITH... appears on the screen, the computer is asking you to tell it what to do with the answer. Using the command PRINT in front of WHO tells the computer to print the information on the screen. If Sprite 18 were the last Sprite you talked to, typing PRINT WHO would cause Sprite 18 to be printed on the screen.

3.8.3. NUMBEROF WHO

NUMBEROF WHO tells you the number of the sprite to whom you are talking. Type NUMBEROF WHO and the computer prints TELL ME WHAT TO DO WITH and a number. The number at the end of the message is the sprite that was given the last command. We'll call that sprite the active sprite. Typing PRINT NUMBEROF WHO tells the computer to print the number of the active sprite.

What does the computer tell you if your last TELL command was TELL :ALL? PRINT WHO prints the list of sprites. Because a list of sprites cannot have just one number, PRINT NUMBEROF WHO gives a meaningless number.

3.8.4. State of the Sprite

The features you give a sprite are called the *state of the sprite*. If you forget a certain state of a sprite, the computer can help you remember it. SHAPE, COLOR, SPEED, and HEADING tell you about the active sprite. When you type PRINT with one of these words, the computer prints the number of the shape, color, speed, or heading of the active sprite.

Any of the thirty-two sprites can carry any shape. So far, we've been using the five shapes the computer already knows — plane, truck, rocket, ball, and box. It would be fun to design your own shapes!

3.9. Making New Shapes

MAKESHAPE 1 First, let's look at the shapes the computer knows. Type

MAKESHAPE 1 and press **ENTER**. The color of the screen changes from cyan to green. A grid 16 squares wide and 16 squares high appears in the left corner. The plane design is on the grid. When you see the plane shape on the screen, you only see the squares that have been colored black. The rest of the grid disappears because it has no

design on it.

MAKESHAPE 2 When you are ready to look at another shape, press **BACK**. The

computer returns to the Sprite Mode and the screen turns cyan, or blue again. Type MAKESHAPE 2, and the green screen appears with the truck shape on the grid. Look at the other three shapes. Remember to press **BACK** each time to go back to the Sprite Mode.

MAKESHAPE 21 Now, let's try making a new shape. You can use any shape number

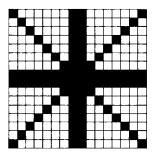
from 0 through 25. Let's use number 21. Be sure you are in the Sprite Mode (press **BACK** if your screen is green). Then type MAKESHAPE 21 and press **ENTER**. The screen turns green and an

empty grid appears.

The black cursor is in the upper left corner. In order to draw a shape, you need to move the cursor around the grid. Look at keys **E**, **S**, **D**, and **X**. Arrows are above each of those letters. Each arrow points in a different direction. Move the cursor around by pressing one key at a time. The cursor wraps around the grid, just like sprites wrap around the screen.

The cursor hasn't turned any of the squares black. This means you do not have a design yet. Press the **SHIFT** key with one hand and an arrow key with the other. The square that the cursor leaves turns black. Now move the cursor *without* pressing the **SHIFT** key. That square does not turn black. To clear the grid and start over, press **CLEAR**.

Try making the grid on your screen look like this:



When you finish, press BACK to go back to the Sprite Mode.

Remember, the shape you designed is number 21. Let's see what the star shape looks like on the screen.

TELL SPRITE 29

CARRY 21

SETCOLOR : RED

HOME

Tell a sprite to carry the shape. Remember, there are no: (dots) before the number 21. The star shape also needs a color to be seen. Then put it at HOME. This sprite, carrying your design, can have speed. You can also move it forward, back, right, and left and change its heading and color.

TELL : ALL CARRY 21

SETCOLOR : RED

HOME

You can even have all 32 sprites carry your design!

You can make a new shape whenever you want. Type MAKESHAPE and a number from 0 through 25. If you pick a number that already has a shape (Shapes 1, 2, 3, 4, and 5), that shape appears on the grid. You can change that design by pressing the arrow keys, or you can clear the design on the grid by pressing **CLEAR**. Or, you can press **BACK** and pick a different number for your shape.

You can make 26 shapes giving your design a shape number from 0 through 25. You cannot make a shape larger than 25. If you type MAKESHAPE 29, the computer takes that number and figures out which of the shapes 29 would be. It subtracts 26 from the number until it gets to a number from 0 through 25. Shape 29 would actually be shape 3. It will be easier to remember which shape you use if you use a number from 0 through 25 with the MAKESHAPE command.

All your designs are erased when you turn the computer off. If you think you might want to use any of your shapes again, be sure to draw them in your journal or save them (see *Chapter 6*).

Did you change any of the five designs the computer knows? If you did, the changes are erased when you turn the computer off. Then the original shapes are there the next time you use TI LOGO.

3.10. Background Color

Would you like to change the color of the screen? It has always been cyan (light blue) or green when making a shape.

COLORBACKGROUND: ORANGE

You can change the background to any of the 16 colors the computer knows (see $Appendix\ D$). The special command for this change is COLORBACKGROUND. Type COLORBACKGROUND, space, dots, the color, and then press **ENTER**.

What happens if the color of the background is the same as one of the sprites? You don't see the sprite any more, but it's still there. Change the background color or the color of the sprite to see it.

Experiment with the 32 sprites. Give them different shapes and colors. And change the background color of the screen. *Note*: The screen is always cyan when you turn on the computer.

When you finish experimenting with the sprites, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

4. Tiles and Characters

Before starting *Chapter 4*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

4.1. MAKECHAR

All of the letters, numbers, and symbols you see on the screen are called characters. The computer knows 96 characters. Each character is a design. Just as you are able to see the plane, truck, rocket, ball, and box shapes when you type MAKESHAPE, you can also see the designs of each of the characters. The command for this is MAKECHAR. Whenever you type MAKECHAR, you also need to type the code number for the character you want to see.

Here are the code numbers for many of the character designs the computer knows. (Code numbers 0 through 31 are the characters you see on the master title screen.)

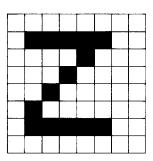
Group 1		Group 2		Group 3		Group 4	
Code	Character	Code	Character	Code	Character	Code	Character
Numbe	er	Number		Number		Number	
32	(space)	40	(48	0	56	8
33	!	41)	49	1	57	9
34	"	42	*	50	2	58	:
35	#	43	+	51	3	59	;
36	\$	44	,	52	4	60	<
37	%	45	-	53	5	61	=
38	&	46		54	6	62	>
39	•	47	1	55	7	63	?

Group 5		Group 6		Group 7		Group 8	
Code	Character	Code	Character	Code	Character	Code	Character
Number		Number		Number		Number	
64	@	72	H	80	P	88	X
65	A	73	I	81	Q	89	Y
66	В	74	J	82	R	90	${f Z}$
67	\mathbf{C}	75	K	83	S	91	[
68	D	76	L	84	${f T}$	92	\
69	${f E}$	77	M	85	U	93]
70	\mathbf{F}	78	N	86	V	94	^
71	G	79	0	87	W	95	_

All of the characters on the keyboard have a code number. The computer knows that number 43 is the code number for the plus sign (+) and that number 77 is the code number for the letter M. Let's look at a few of the character designs.

MAKECHAR 90

Type MAKECHAR 90 and press the **ENTER** key. A green grid appears in the upper left corner. It is smaller than the grid in MAKESHAPE. It is 8 squares high and 8 squares wide. The shape of the letter Z appears on the grid.



Now let's look at a number. Press **BACK** to return the computer to the cyan screen.

MAKECHAR 53

Look at the chart. The number 5 has the code number 53. Type MAKECHAR 53 and press **ENTER** to see the design for the number 5.

Return to the cyan screen by pressing **BACK**. Look at the chart again and find the code number for the symbol *.

MAKECHAR 42

Type the command, and see the design. Look at many of the character designs. Remember to press **BACK** to go back to the Sprite Mode each time.

There is space in the computer for 256 tiles on which you can put designs. Just as a sprite carries a shape, a tile carries a design. You can make all 256 tiles carry any character designs you want!

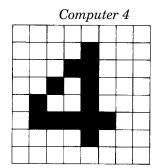
The computer already knows the character designs for tiles 32 through 95. Those are the letters, symbols, and numbers on the keyboard. You can change these characters if you want.

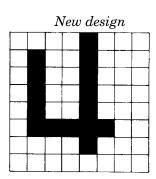
MAKECHAR 52

Let's change the way the number 4 looks. First type a row of 4's so that you know the computer design. Then put the grid with the number 4 on the screen.

Use the arrow keys, \neg , \uparrow , and \downarrow , to draw on the grid. The arrow keys work as they did in MAKESHAPE. To fill in a square, hold down the **SHIFT** key and an arrow key at the same time. To leave squares blank, press the arrow keys without pressing the **SHIFT** key. You can clear a grid by pressing **CLEAR**.

Make the computer's 4 look like the 4 on the right. To do this you need to move the arrow keys both with and without the SHIFT key.





Look! All the 4's on the screen have changed into the new shape. This new shape for the character 4 appears until you either redesign the 4 or type BYE and press **ENTER**. When you turn the computer on the next time, the original computer shape for the character 4 appears.

Experiment with changing the design of any of the characters. You can create some very interesting letters and numbers.

4.2. PRINTCHAR

Remember that the tiles 32 through 95 carry the characters on the keyboard. You can tell the computer to print any character on a tile. The command for that is PRINTCHAR and a number.

PRINTCHAR 81	Let's find out what character is on tile 81. You can look it up in the
	character chart, but let's have the computer tell us. Type the
	command PRINTCHAR 81, and press ENTER. The letter Q appears
	on the screen.

PRINTCHAR 200	For the numbers between 05 and 055 which do not have been head
FRINICIAN 200	For the numbers between 95 and 255, which do not have keyboard
	designs on them, a blank space appears on the screen. Later, this
	chapter teaches you how to create your own designs on these tiles.

4.3. PUTTILE

The command PUTTILE allows you to put a character anywhere on the screen. You must give it special directions for it to appear. Let's learn how to do that.

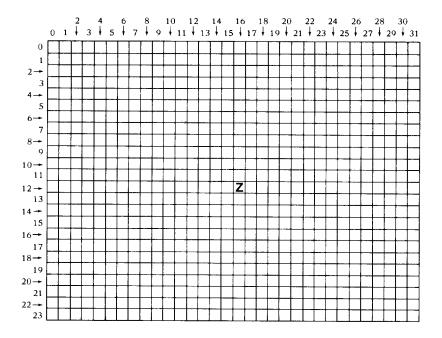
Think of your television screen as a large grid. There are 32 columns and 24 rows. Columns go up and down and rows go across. (*Note*: On some screens you may not see the first and last columns.)

Each column has a number from 0 through 31. Pick the column, 16, in the middle. Now look at the rows. Each has a number from 0 through 23. Pick the row, 12, in the middle. Next, we need to decide which character we want to put at the square where column 16 and row 12 meet.

Look at the character chart. The PUTTILE command needs the code number of the character. Let's pick the character Z with the code number 90. We can now put the character Z at the point where column 16 and row 12 meet. A "Z" then appears in the middle of the screen.

PUTTILE 90 16 12

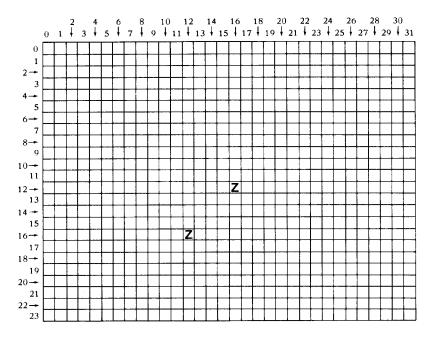
Type the command PUTTILE, a space, the character code number (90), a space, the column number (16), a space, and the row number (12). Then press **ENTER**.



The order that you type these three numbers in is important. The computer understands that the *first* number is the character code number. It also knows that the *second* number is the column and the *third* number is the row.

PUTTILE 90 12 16

Change the order of the numbers in the PUTTILE command and see where the Z appears. It's now at the point where column 12 and row 16 meet.



PUTTILE 55 2 22 PUTTILE 55 30 2 PUTTILE 55 30 22 PUTTILE 55 2 2 Now you are ready to experiment with the PUTTILE command. Can you put a 7 in each of the four corners? Use the commands to help you. (*Note*: If there is already a character in the space where you put a 7, it will be replaced by the 7.)

Clear the screen, so that we can try something different with tiles. You design a new character the same way you change the keyboard characters. Type MAKECHAR and a number from 96 through 255. A grid that is 8 squares wide and 8 squares long appears in the upper left corner, and the screen turns green.

MAKECHAR 100

Let's make a solid character on tile 100. Type the command for this. Use the arrow keys and the **SHIFT** key to color in all of the grid. Press **BACK** when you finish the design.

PRINTCHAR 100

Look at the new design by typing the command PRINTCHAR 100 and pressing **ENTER**. A little black box appears on the screen.

4.4. REPEAT

Let's repeat the new character all the way across the screen. This creates a long, solid black line. The command for this is REPEAT.

REPEAT is a command that needs two pieces of information or inputs:

- a number telling how many times the instructions are to be repeated, and
- a list of instructions (which are inside brackets []).

REPEAT 30 [PRINTCHAR 100]

The command for a long black line going across the screen is REPEAT 30 [PRINTCHAR 100]. Type this and watch the line draw, from the left to the right, across the screen. (*Note*: To type the symbol [, press **SHIFT** and 4. To type the symbol], press **SHIFT** and 5.)

REPEAT 15 [PRINTCHAR 100]

You can make the line shorter or longer by changing the number of times the command is repeated. Try making the solid line only go halfway across the screen.

4.5. Coloring Tiles

All tiles have two colors. Think about the grid with the number 4 on it. The 4 is black and the background of the grid is green. When **BACK** is pressed, the black 4 appears on the screen. But where is the green background? It's always clear if no other color is given to the background. (*Note*: It looks cyan because the color of the screen, cyan, can be seen through the clear background of the tile.) The two colors of a tile are the foreground and the background. Let's change the foreground color of the character code number 35, the symbol #.

PUTTILE 35 16 12 TELL TILE 35 SETCOLOR :RED

Let's put the # in the middle of the screen. A black # appears with the clear background. Now, give tile 35 the color red. The foreground is red and the background is still clear. *Chapter 8* teaches you how to change the background color of a character. For now, experiment with changing the foreground color of a character.

Looking at the chart again, you see that characters are listed in groups of eight. Each group has eight characters in it. The group that a character is in is important. You can change the color of a group of characters by telling one character in the group to change color. All eight characters in a group have the same color.

Let's see what this looks like. First clear the screen, and then type the following short poem. Remember, you can backspace and correct any mistakes by pressing **ERASE**. *Do not press* **ENTER** *after each line*.

```
I LIKE THE COMPUTER----A,B,C:
JUST LIKE IT LIKES ME--E,F,G.
WE ALWAYS WORK TOGETHER-1,2,3:
OH! WHAT FUN IT CAN BE--X,Y,Z!
```

When you finish typing the whole poem, press the **ENTER** key. Because your poem isn't a command, the computer returns the message TELL ME HOW TO I. Don't worry about this message. Now we're going to tell the computer what to do with the poem.

The letters H, I, J, K, L, M, N, and O are in group 6. If you change the color of any letters in that group, all eight letters change to the same color. Let's pick the letter H with the code number 72.

TELL TILE 72

The command for setting the color of a group of characters is TELL TILE and the code number. Since we've picked the letter H (with code number 72) to represent group 6, type the command with that number.

SETCOLOR : BLUE

Now let's make all eight letters in that group blue. Type the same SETCOLOR command you used for the sprites. All the H, I, J, K, L, M, N, and O's in your poem turn blue.

TELL TILE 68
SETCOLOR :PURPLE
TELL TILE 35
SETCOLOR :YELLOW
TELL TILE 44
SETCOLOR :GREEN
TELL TILE 55
SETCOLOR :RED
TELL TILE 58
SETCOLOR :ORANGE
TELL TILE 83
SETCOLOR :GRAY
TELL TILE 88

SETCOLOR : WHITE

Let's pick another group (5) and a letter (D) with a code number (68) to represent that group. Make this group of characters purple. Using the same commands, change the color of the characters in the other six groups. You can pick your own colors and code numbers, or you can use the ones in the left column. (See the Color Chart in *Appendix B*.) To turn all of the characters, symbols, and numbers black again, set the color of one character from each group to black.

When you finish experimenting with tiles and shapes, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

5. Teaching Mode

Before starting *Chapter 5*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

Each time you tell the computer to do something, it looks through all the things it's been taught. And, if it doesn't find what you tell it, it prints a message like TELL ME MORE or TELL ME HOW TO.... It's asking you to teach it to do something new.

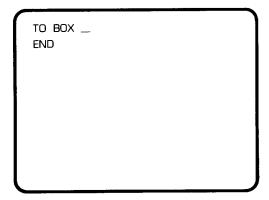
5.1. Primitives and Procedures

The things the computer already knows are called *primitives*. All the commands, the characters on the keyboard, and the five shapes for sprites are primitives. What you teach the computer is called a *procedure*. A procedure is made up of commands. It can have many commands and be a long procedure. Or, it can be short and have only a few commands. (*Note*: To help you recognize a procedure, the name of the procedure appears in capital letters in the manual.)

Suppose that you have drawn a box with the Turtle. Let's call it BOX. Type BOX and press **ENTER**. The computer gives you the message TELL ME HOW TO BOX. You know what BOX is supposed to look like, but the computer doesn't. So, let's teach the computer how to BOX.

5.2. Procedures with the Turtle

You teach the computer a procedure by typing TO and the name of the procedure. Type TO BOX. The screen turns green and a red cursor appears at the end of the first line. Your screen should look like this:



Notice that END appears automatically as the last command of the procedure. END tells the computer that the procedure is complete. If you accidentally erase END, be sure to type it again. *You must always have END as the last command in a procedure*.

Now teach the computer how to draw a box.

FORWARD 50
RIGHT 90
FORWARD 50
RIGHT 90
FORWARD 50
RIGHT 90
FORWARD 50
RIGHT 90
END
TELL TURTLE
BOX

Press **ENTER** and the cursor moves to the beginning of a new line. Carefully, type the commands in the left column. To start each command on a new line, press **ENTER** after you type each command. Since you don't want to type another command after the last RIGHT 90 command, don't press **ENTER**. Then END is the last command in the procedure. If you make a typing error, press **ERASE** before pressing **ENTER** to backspace. Then type the command again.

When you finish, press **BACK**. The screen turns cyan again. Now, the computer knows how to BOX, but it hasn't done it yet. Type the commands TELL TURTLE and the name of your procedure. Watch the Turtle follow the commands listed in the procedure BOX.

The computer knows how to draw a box because you have taught it how. If you want the computer to draw your box again, type BOX and press **ENTER**. The second box is drawn over the first box. To see a procedure with no other drawings on the screen, type CLEARSCREEN and press **ENTER**. All of the drawings disappear. The Turtle returns HOME and faces north. Type the name of the procedure and press **ENTER**.

Let's make one of the designs in Chapter 2 into a procedure.

TO STAR
FORWARD 50
RIGHT 144
END
CLEARSCREEN
STAR

Type TO and the name of the procedure, and press **ENTER**. Then, press **ENTER** again and carefully type all of the commands. Remember to press **ENTER** after each command except the one before END. When you finish, press **BACK**. Then clear the screen and type the name of this procedure.

Sometimes the procedures you write may not draw the design you want. That means there is a *bug* in the procedure. It's easy to write procedures that have bugs. Let's learn how to fix a bug.

First draw a house with the procedure BOX as the main part of the house. Write a procedure for the roof. Call it TRIANGLE.

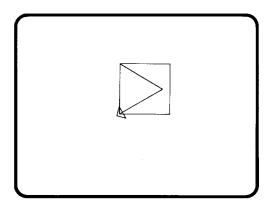
TO TRIANGLE FORWARD 50 RIGHT 120 FORWARD 50 RIGHT 120 FORWARD 50 END

Type TO TRIANGLE and press **ENTER**. A triangle has three sides. Type the commands to make a triangle. Remember to press **ENTER** after each command except the one before END. Press **BACK** when you finish.

Now we can build a house with the procedures BOX and TRIANGLE.

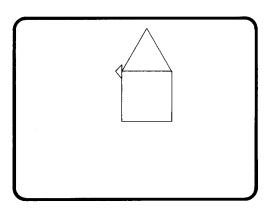
CLEARSCREEN BOX TRIANGLE

Clear the screen, type BOX and press **ENTER**. The Turtle draws the main part of the house. When the Turtle is finished drawing the procedure BOX, type TRIANGLE and press **ENTER**. The Turtle draws the triangle, but look what happened. The roof of the house is inside the house! That's a bug! We need to fix it. Can you find where the bug is in the procedure?



After the Turtle draws the box, it draws the triangle. There's the bug! The Turtle needs to move to the top of the box and turn to the right before it starts drawing the triangle.

CLEARSCREEN BOX FORWARD 50 RIGHT 30 TRIANGLE Clear the screen again. Type BOX and press **ENTER**. Now type the command that moves the Turtle to the top of the box. And, type the command that turns the Turtle to the right. Now, the Turtle is in the correct position to start the TRIANGLE procedure. Type TRIANGLE and press **ENTER**. The roof is on top of the house and the bug is fixed.



5.3. Edit Mode

When you write a procedure, you are in the Edit Mode. There are special keys to help you. The chart below explains what each key does.

PRESS	FUNCTION
BEGIN	Moves the cursor to the end of the line
PROC'D	Moves the cursor to the beginning of the line
†	Moves the cursor up one line
←	Moves the cursor one space to the left
→	Moves the cursor one space to the right
1	Moves the cursor down one line
ENTER	Creates a blank row between the line the cursor is on and the next line <i>if</i> the cursor is
	at the end of a line
ERASE	■ Moves the entire line up one line <i>if</i> the cursor is under the first character of a
	line
	■ Erases the character or space one space to the left of the cursor
DELETE	■ Erases the character or space above the cursor
	■ Moves the next line up to that line <i>if</i> the cursor is at the end of the line
CLEAR	Erases the character or space above the cursor and everything to the right of the cursor
BACK	Leaves the Edit Mode and returns the computer to the mode it was in

As you type a letter in the Edit Mode, the cursor moves one space to the right. It may look a little confusing at first. Experiment with the keys to see what each one does. Type a procedure name, and press **ENTER**. Try erasing a line (press **CLEAR** when the cursor is at the beginning of a line) and then typing it again. Or, erase a letter (press **DELETE** when the cursor is under a letter), and then type it back in the correct place.

The more you practice and learn what each key does, the easier it is to write and take bugs out of procedures.

5.4. TELL ME HOW TO...AT LEVEL...LINE...OF...

If the computer doesn't understand a line in a procedure, the message TELL ME HOW TO... AT LEVEL... LINE... OF... appears on the screen. TELL ME HOW TO... tells you what the bug is. AT LEVEL... tells you how many times you have tried to run this procedure before getting this message. LINE... shows you the line in the procedure that the bug is on. And OF... names the procedure. With this information, it is easy to find your bug and fix it. Type TO and the name of the procedure. Then make the changes.

NOTURTLE

Before we write a procedure for the sprites and one for the tiles, we need to leave the Turtle Mode. Type NOTURTLE and press **ENTER**.

5.5. Procedures with Sprites

When you write a procedure in the Sprite Mode, you need to give a sprite, or a list of sprites, color, shape, heading, and speed. Let's make this procedure move a red ball along a square path. Call it SQUARE.

TO SQUARE TELL SPRITE 1 CARRY : BALL SETCOLOR : RED HOME SETSPEED 10 WAIT 30 RIGHT 90 WAIT 30 RIGHT 90 WAIT 30 RIGHT 90 WAIT 30 RIGHT 90 SETSPEED 0 END SOUARE

Type the commands in the column. Remember, there are special keys to help you correct any typing mistakes. When you finish, press **BACK**. Then type the name of your procedure and press **ENTER**. If there's a bug, look at the procedure, and then fix it.

In the SQUARE procedure, the ball follows the path of a square. But it doesn't draw a line like the Turtle does. Do you understand what the WAIT command does? Sprite 1 has a speed of 10. It continually moves at that speed. When it is told to turn right, it does so, keeping the same speed. WAIT tells the sprite to wait 30/60 (one-half) of a second before it does the next command (a right turn). What happens if the WAIT commands are not included in this procedure?

Then Sprite 1 moves and turns at the same time making it difficult to see the sprite follow the path of a square. How could you make Sprite 1 follow the path of a larger square? If the sprite waits a longer length of time before turning, the square path is larger. With the special keys in the Edit Mode, try changing the WAIT commands to 40, 50, or 100.

REPEAT 10 [SQUARE]

Can you use the REPEAT command to tell the ball to follow the square path ten times? Remember, REPEAT needs a number with what the computer is supposed to repeat inside the brackets.

TO VANISH
TELL :ALL
CARRY 0
SETCOLOR 0
SETSPEED 0
SETHEADING 0

Now we're ready to write a procedure for the Tile Mode. But first we need to write a procedure to make the sprite disappear. You want to tell all to set the shape, color, speed, and heading to 0. Call the procedure VANISH.

SETHEADING END VANISH

Now type VANISH, press **ENTER**, and the sprites disappear. You can use the VANISH procedure whenever you want all of the sprites to disappear.

5.6. A Procedure with Tiles

For a procedure with a tile, let's use the tile we made in *Chapter 4* where we put a solid box on Tile 100. Type MAKECHAR 100 to check it. If the character is not all colored in, use the arrow keys to do so. Remember, press both the **SHIFT** key and an arrow key to blacken a square. Press **BACK** when all the squares are colored black. The procedure we are going to write causes the tile to make a long black line.

TO LINE
REPEAT 30
[PRINTCHAR 100]
END
CLEARSCREEN
LINE

Start the procedure by typing TO LINE and pressing **ENTER**. Now teach the computer to repeat and print Character 100 30 times. Tell the computer you have finished teaching it by pressing **BACK**. Now, type the name of the procedure to see the black line.

LINE LINE LINE LINE REPEAT 5 [LINE]

Let's make an extra thick black line by repeating the LINE procedure five times. Type LINE, space, LINE, space, LINE, space, LINE, space, LINE, and then press **ENTER**. That took quite a bit of typing to get the thick line. Let's use the REPEAT command with the LINE procedure. Experiment and see if you can repeat the line so many times that the top half of the screen is black.

5.7. A Procedure with COLORBACKGROUND

Let's try another easy procedure. The command COLORBACKGROUND changes the color of the screen. When given a color, the background stays that color until it is changed with the COLORBACKGROUND command. (*Note*: It doesn't matter what color the screen is when you turn off the computer.)

COLORBACKGROUND : RED COLORBACKGROUND : WHITE COLORBACKGROUND : CYAN Change the background to red and then to white. To return the screen to its normal color, type the same command to change the background color to cyan. Do this. Let's write a procedure that does this for you. Call it BLINK.

TO BLINK

COLORBACKGROUND : RED COLORBACKGROUND : WHITE COLORBACKGROUND : CYAN

END

Type TO BLINK and press **ENTER**. Type the statements just as you see them in the left column. Check each line before you press **ENTER**. Remember, if you make a mistake, press **ERASE** before you press **ENTER** to backspace and erase it. If you have already entered the line, use the arrow keys to move the cursor to the beginning of the line that the mistake is on. Press **CLEAR** to clear the line. Then retype it correctly. When you finish teaching the computer, press **BACK**.

BLINK BLINK

Type the name of the procedure, BLINK, and press **ENTER**. Your screen turns red, white, and cyan. It goes so quickly that it is difficult to see each color. Type BLINK again and watch closely.

How can we slow down the blinking? If a pause happens with each color, then we can see each color longer. We need to change the BLINK procedure to include a pause after each color.

TO BLINK

COLORBACKGROUND : RED WAIT 60

COLORBACKGROUND :WHITE

WAITS 60 COLORBACKGROUND :BLUE

COLORBACKGROUND :BLUI WAIT 60 END

END BLINK Type TO BLINK and press **ENTER**. Now add a WAIT command after each color. You can have it wait for one second (WAIT 60) or any length of time you want. Your procedure should now look like the one in the column.

Next, press **BACK**. The screen returns to the cyan color. Type the name of the procedure and press **ENTER**. You can easily see each color now!

5.8. A Place for Comments — After;

It's easy to forget what a procedure does. Think about the STAR procedure. Is it a five- or six-pointed star? You could name the procedure FIVEPOINTEDSTAR, but that's a lot of typing. Instead you can use the symbol; to help you. After typing; you can type as much information about the procedure as you want. The computer pays no attention to what follows the; symbol. For example, you could type STAR; 5 POINTS AND POINTING NORTH. The "5 points and pointing north" helps you remember what the STAR procedure does.

[Correction: Comments cannot be placed after the ; in the title of a procedure. However, ; can be used after any command following the title line.]

You can use; after any command. It's a good idea to use it after a FORWARD or BACK command. For example, in the BOX procedure you would type FORWARD 50; MAKES BIG BOX USE 25 FOR SMALL BOX. Now you know exactly what command needs to be changed to make the box smaller.

Experiment with the procedures you've taught the computer. Or, write new ones for the Turtle, the sprites, and the tiles. If you are in the Sprite Mode and want to go to the Turtle Mode, use the VANISH procedure to erase the sprites on the screen. If you are in the Turtle Mode and type NOTURTLE, the computer returns to the Sprite Mode.

The computer saves a procedure until you type BYE and press **ENTER**. There are three other ways you can save procedures for later use. We'll learn about these in *Chapter 6*.

When you finish experimenting with teaching the computer, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

6. Saving and Recalling Your Work

Before starting *Chapter 6*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

The computer can remember four different things:

- any procedures you've taught it,
- any shapes you've designed,
- any tiles you've designed, and
- any names you've made using CALL. (*Chapter 7* explains CALL.)

6.1. Saving Your Work

The computer can only remember four things while it is turned on. When it is turned off, the computer forgets, or erases, everything except the primitives. To use a shape, a tile, or a procedure at a later time, you have to save it. There are four ways you can store or save work done in TI LOGO:

- write your work in a journal,
- save your work on a cassette tape,
- save your work on a diskette, or
- have the TI Thermal Printer² print your procedures.

² sold separately

6.1.1. Saving Your Work in a Journal

As said in earlier chapters, it's always a good idea to copy your work in a journal. This makes it easy to check over your procedures for bugs or changes you might want to make.

There is an easy way to see a procedure if you've forgotten to write it down. You can type PO (print out) and the name of the procedure, and press **ENTER**. The computer then prints the procedure on the screen so that you can copy it in your journal. You can do this for each procedure you've taught the computer during this session. But what if you've forgotten the name of a procedure?

Type PP (print procedure) and press **ENTER**. The computer prints the names of all of the procedures you've taught it during this session. Then, for each procedure you want to copy in your journal, type PO and the name of the procedure, and press **ENTER**.

You can see all the primitives and everything you've taught the computer during this session. Type PA (print all) and press **ENTER**.

6.1.2. Saving Your Work on Cassette Tape, Diskette, or the Thermal Printer

To save your work on cassette tape, diskette, or the Thermal Printer, be sure the cassette recorder, disk drive, or Thermal Printer is attached to the Personal Computer and turned on. (See the *User's Reference Guide* or product owner's manual for details.)

Next, to see the names of the procedures, type PP and press **ENTER**. Now, decide which procedures you want to save. If you want to save all of them, you are ready to continue. If there are some procedures you don't want to save, you have to erase them before you save the others. The command for erasing a procedure is ERASE and the name of the procedure. For example, if you have a procedure named SUPER, you would type ERASE SUPER and press **ENTER**. Do this for each procedure you want to erase.

You may have also designed some shapes and tiles during this session with TI LOGO and want to save some of them. To erase a shape you don't want to save, type MAKESHAPE and the number, and then press **ENTER**. Next, press **CLEAR** to clear the grid, and then press **BACK** to return to the mode you were in. The shape is now erased. Use the MAKECHAR command, and repeat the same steps to erase tiles.

After you decide what you want to save and erase everything else, type SAVE and press **ENTER**. The computer is now in the Save Mode. The Save selection list appears on the screen.

SAVE

PRESS FOR

- 1 PROCEDURES
- 2 SHAPES AND TILES
- 3 BOTH 1 AND 2

PRESS 'BACK' FOR TI LOGO

The computer is now in the Save Mode. You can stop saving your work any time the message PRESS 'BACK' FOR TI LOGO is on the screen. If you press **BACK**, the computer returns to the mode it was in.

When the Save selection list is on the screen, press the number next to what you want to save. The Device selection list appears next.

DEVICE

PRESS FOR

- 1 CASSETTE
- 2 DISKETTE
- 3 THERMAL PRINTER

PRESS 'BACK' FOR TI LOGO

6.1.2.1. Saving on Cassette Tape

You can save procedures, shapes and tiles, or both on a cassette tape by pressing **1** when the Device selection list is on the screen. Be sure a tape is in the recorder. If you use the same cassette tape that has other TI LOGO work recorded on it, the new procedures, shapes, and tiles replace the previous work. Be sure to label the cassette tape if you want to keep that work and recall it at another time. Then, follow the instructions that appear on the screen.

When you finish saving your work on a cassette tape, the computer automatically returns to the mode it was in before you started saving your work.

6.1.2.2. Saving on Diskette

You can save procedures, shapes and tiles, or both on a diskette by pressing $\mathbf{2}$ when the Device selection list is on the screen. Before you save work for the first time on a diskette, the diskette must be initialized with the Disk Manager *Solid State Software* $^{\text{TM}}$ Command Module 3 . The work diskette included in this package is already initialized. To save your work on the diskette, put the work diskette in Disk Drive 1.

³ sold separately

After pressing **2** the following screen appears.

TYPE FILE NAME, PRESS 'ENTER'
OR
PRESS
'SPACE' TO REVIEW FILE NAMES
OR
'BACK' FOR TI LOGO
SAVINGNAME: _______

The space on the diskette where you save your work is called a *file*. You need to give the file a name *each* time you save procedures, shapes and tiles, or both. When NAME: ______ is on the screen, type a file name up to eight characters long. Try to pick a name that is easy to remember. If you make a typing mistake press **ERASE**, before pressing **ENTER**, to backspace and erase the mistake or mistakes. Then type the name correctly and press **ENTER**.

Be careful not to use the same file name twice. If you do, the new file erases and replaces the old file. If you can't remember the file names you've used, press the **SPACE BAR**. If there are any files on the diskette in the selected category, the computer prints the name alphabetically after NAME: ______ each time the **SPACE BAR** is pressed. To replace a file with a new file of the same file name, press **ENTER** when the file name appears in NAME: ______ . If you don't want to replace a file and are finished reviewing the file names, press 'BACK' for TI LOGO. (*Note*: After you press the **SPACE BAR** you cannot type a new file name. You can only replace a file. To save a new file, repeat the steps under "Saving Your Work on Cassette, Tape, Diskette, or the Thermal Printer".)

It's a good idea to write down the name of your file or files in your journal. It helps if you write down what category (procedures, shapes and tiles, or both) the file name is for. You can only recall your procedures, shapes and tiles, or both by selecting the correct category and typing the name that the work is filed under.

When you finish saving your work on a diskette, the computer returns to the mode it was in when you typed SAVE.

6.1.2.3. Saving with the TI Thermal Printer

You can print procedures with the TI Thermal Printer by pressing **3** when the Device selection list is on the screen. The TI Thermal Printer prints procedures only. When the computer finishes printing all the procedures you have written during this session with TI LOGO, the computer returns to the mode it was in.

6.2. Recalling Your Work

The command to put the procedures, shapes, tiles, and names back into the computer is RECALL. Type RECALL and press **ENTER**. The following Recall selection list appears.

RECALL

PRESS FOR

- 1 PROCEDURES
- 2 SHAPES AND TILES
- 3 BOTH 1 AND 2

PRESS 'BACK' FOR TI LOGO

The computer is now in the Recall Mode. You can stop recalling your work any time the message PRESS 'BACK' FOR TI LOGO is on the screen. If you press **BACK**, the computer returns to the mode you were in.

Looking at the Recall selection list on the screen, press the number next to what you want to recall. The Device selection list appears next.

DEVICE
PRESS FOR
1 CASSETTE
2 DISKETTE
PRESS 'BACK' FOR TI LOGO

Note: You can recall work only from the device it was saved on. For example, you cannot recall work saved on a diskette with the cassette recorder.

6.2.1. Recalling from Cassette Tape

You can recall procedures, shapes and tiles, or both from a cassette tape by pressing 1 when the Device selection list is on the screen. Be sure the correct tape, with your work on it is in the recorder. Then follow the instructions that appear on the screen.

When you finish recalling your work from the cassette tape, the computer returns to the mode it was in.

6.2.2. Recalling from Diskette

You can recall procedures, shapes and tiles, or both from a diskette by pressing **2** when the Device selection list is on the screen. Be sure the diskette, with your work on it, is in Disk Drive 1. The following screen appears.

You need to know two things about a file to recall it by typing in the file name when NAME: _____ is on the screen. First, the category the file was saved under must appear after RECALLING-. And second, the *same* file name that the work was saved under must be used. Type the file name when NAME: _____ is on the screen. If you make a typing mistake, press **ERASE** before pressing **ENTER** to backspace and erase the mistake. Then type the name of the file and press **ENTER**.

If you type and enter a name that is not a name on the diskette or does not appear in the category, the computer gives you a message. DID NOT SAVE (OR RECALL) appears on the screen. Press 'BACK' for TI LOGO and repeat the steps under "Recalling from Diskette", using a correct file name or selecting the correct category.

If you forget the file name, the computer can help you remember it. When NAME: _____ is on the screen, press the **SPACE BAR** at the bottom of the keyboard. The name of the first file appears on the screen. All files are saved in alphabetical order and appear in that order when the **SPACE BAR** is pressed. When you reach the file you want to recall, press **ENTER**.

Note: The computer only prints the names of the files in the group you told it to recall. For example, if you selected 1 to recall procedures when the Recall selection list was on the display, pressing the **SPACE BAR** causes the computer to print, alphabetically, only the names of the files saved under procedures. It does not print the file names for shapes and tiles or both.

If you decide not to recall any work when NAME: _____ is on the screen, press **BACK** to return to TI LOGO.

When you finish recalling your work from a diskette, the computer returns to the mode it was in.

7. More Fun with Sprites

Before starting *Chapter 7*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

This chapter explains writing procedures in the Sprite Mode. Sometimes, sprites that we don't want may be on the screen. You could type, each time you need them, the commands that cause a sprite to disappear. But it is easier, and takes less typing, if we use a procedure. The VANISH procedure in *Chapter 5* is just what we need.

TO VANISH
TELL :ALL
CARRY 0
SETCOLOR :CLEAR
SETSPEED 0
SETHEADING 0
END

Type TO VANISH and press **ENTER**. Then type the commands that tell all the sprites to carry no shape, have no color or speed, and have a heading of 0.

Now let's play "The Name Game". Tell a friend to "Say your name". If your friend is Ned, and he answers "Ned", you could tell him that he gave you the wrong answer. You mean that your friend should say the words "your name". Now, tell him to "Say your name", again. This time Ned answers "your name". You then say to him, "Hi, your name! I thought your name was Ned". Your friend is probably confused now. He doesn't know what you want him to say. The computer gets confused the same way. You need to tell the computer whether you want it to understand the words ("your name") or the value or meaning of the words your name (Ned).

You already know that dots (:) is the symbol which makes the computer understand the value of a word. When you use dots with the SETCOLOR command, you tell the computer to do the value of the word following the dots, or give the sprite the color.

The symbol for telling the computer to understand something as a word or a series of words is ", called quote. As with dots, you type a space before the quote but no space after it.

Let's use the commands PRINT and CALL to help show the difference between : and ". PRINT tells the computer to print something on the screen rather than just store it. CALL tells the computer to give a value to something. Try these examples.

PRINT "YOURNAME Type the command just like it is without a space between the two

words YOUR and NAME. Then press **ENTER**. The computer prints YOURNAME. It prints exactly what follows the " *to the next blank*

space.

PRINT : YOURNAME Now type the same command with dots in place of the quote, and

press ENTER. The computer gives you a message :YOURNAME

HAS NO VALUE.

CALL "NED "YOURNAME You can give it a value by telling the computer to call Ned PRINT : YOURNAME YOURNAME Type CALL "NED "YOURNAME and press ENTER

YOURNAME. Type CALL "NED "YOURNAME, and press **ENTER**. The computer understands that the value of YOURNAME is now NED. Now tell the computer to PRINT:YOURNAME. The computer prints NED. Try this with your own name. Remember, you use "when you want the computer to store letters exactly as you type them (like a quote from a book). And you use: when you want the

computer to figure out the value or meaning of something.

7.1. YOURNUMBER

Every sprite knows its number. When you type TELL SPRITE 1, Sprite 1 knows you are talking to it. Let's play a game.

Pretend you are with 32 friends. Give each friend a number from 0 through 31. Now tell your friend who is number five to call out his number and your friend who is number 26 to call out her number. Let's make the game more interesting by telling your friend to "clap your hands your number of times". Friend number 0 doesn't clap at all, while friend number 31 claps 31 times. Now tell your friends to "jump your number times 3". Friend number 6 jumps 6 times 3, or 18, times.

TELL 3
CARRY YOURNUMBER
SETCOLOR YOURNUMBER
HOME

You can play this same game with the sprites. Tell Sprite 3 to carry YOURNUMBER of shape and YOURNUMBER of color. (*Note*: You can simply type TELL and a number from 0 through 31. The computer understands that you are talking to a sprite. You can also use a number with the SETCOLOR command. Look in *Appendix D* to see the number for each color.)

As listed in *Appendices B* and *C*, the number 3 is both the ball shape and the color blue. What happens if you use 0? Try it. The sprite disappears because there is no shape on Sprite 0 (unless you've designed a special one for it), and clear is color number 0.

Just like the number game with your friends, you can use YOURNUMBER with a mathematical operation. The symbols for the four operations are listed in the following chart.

Operation Symbol addition + subtraction - multiplication division /

TELL 7
CARRY YOURNUMBER - 6
SETCOLOR YOURNUMBER - 6
HOME

Try giving a sprite its number and subtracting 6 from YOURNUMBER. Also, you can mix the operations and have a sprite CARRY YOURNUMBER / 2 and SETCOLOR YOURNUMBER * 2.

TELL :ALL CARRY 0

SETCOLOR : CLEAR

Now clear all the sprites off the screen. You can use the word clear with the SETCOLOR command or the number 0.

7.2. EACH

Sometimes it's fun to talk to a group or a list of sprites. To do this, put the list inside brackets. If you type TELL [1 2 3 4], you are now talking to Sprites 1, 2, 3, and 4. Be sure there is a space between numbers and no comma after each number. If you tell this list of sprites to CARRY YOURNUMBER, each sprite would carry the same shape. The command CARRY YOURNUMBER tells the computer to do YOURNUMBER only once. The command EACH causes the computer to do something to each sprite in the list. So, if you type EACH [CARRY YOURNUMBER], each sprite in the list carries its number of shape. Then, each sprite would carry a different shape. You can also use EACH with SETCOLOR, SETSPEED, and SETHEADING. But, *only* use EACH when you talk to a list of sprites *and* use YOURNUMBER. Be sure to put brackets around the command you want each sprite to do. Let's try an exciting procedure, called SHOW, with EACH and YOURNUMBER.

TO START
TELL :ALL
CARRY :BALL
SETCOLOR :RED
SETSPEED 0
HOME
END
START

Before we start the SHOW, we need to make sure that only the ball shape is on the screen and all the sprites are at HOME. We'll write a procedure for that called START. Type the commands for the START procedure. When you finish and you have looked over the procedure for bugs, press BACK. Now type START and press ENTER. All 32 sprites carry a red ball and are at HOME. Now we're ready to write the SHOW procedure.

TO SHOW
HOME
EACH [SETHEADING
YOURNUMBER * 13]
SETSPEED 20
WAIT 90
SHOW
END
SHOW
END
SHOW
EDIT SHOW

Type TO SHOW and the commands that are in the column. Notice the name of the procedure is in the procedure. This tells the computer to repeat the procedure until you press **BACK** to stop it. After checking the procedure for typing errors, press **BACK**. Type SHOW, press **ENTER**, and enjoy the show.

EDIT SHOW
EACH [SETCOLOR
YOURNUMBER]

While SHOW is on the screen, you can't type any commands. To stop SHOW, press BACK. Wouldn't the SHOW look great if we could make the balls different colors? You can. Type EDIT SHOW and put EACH [SETCOLOR YOURNUMBER] *after* the command EACH [SETHEADING YOURNUMBER * 13]. (If you need help, see *Chapter 4*.) Press **BACK** after you add this line. Then type SHOW and press **ENTER**.

Experiment with changing the procedure by designing a new shape for the sprites to carry. (The new shape would take the place of the ball shape in the START procedure.)

7.3. CALL

There's a command that lets you talk to a group of sprites without listing all the numbers of each sprite each time. It's named CALL. Let's use CALL to design some trees. You can CALL Sprites 1, 2, 3, and 4 the tops and Sprites 5, 6, 7, and 8 the trunks. Then, when you want to talk to Sprites 1, 2, 3, and 4, you can just use the word tops. And when you want to talk to Sprites 5, 6, 7, and 8, you can type trunks. Let's try it.

VANISH

Use the VANISH procedure (see *Chapter 5*) to clear the screen. Or, clear the screen by telling all the Sprites to carry shape 0, the clear color, and 0 speed.

CALL [1 2 3 4] "TOPS CALL [5 6 7 8] "TRUNKS

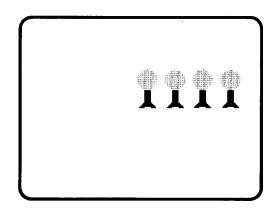
Now type the CALL commands in the column. The quote in front of tops and trunks signals the computer that the words that follow are a name. Now when you talk to the tops, you talk to Sprites 1, 2, 3, and 4. And when you talk to the trunks, you talk to Sprites 5, 6, 7, and 8. Let's make each top and trunk into a tree. Then, we can put four trees in a row and have them change colors like real trees do when the seasons change.

TELL : TOPS CARRY : BALL SETCOLOR : GREEN HOME SETHEADING 0 FORWARD 14 SETHEADING 90 EACH [FORWARD YOURNUMBER * 25] TELL :TRUNKS CARRY : ROCKET SETCOLOR : BLACK HOME SETHEADING 90 EACH [FORWARD (YOURNUMBER - 4) * 25] Type the commands in the column. The commands after TELL :TOPS put the tree tops in a line. Because the numbers of the sprites carrying the trunks are larger than the numbers of the sprites carrying the tops, the tree tops cover up part of the tree trunks. The commands after TELL :TRUNKS put the tree trunks below and behind the tree tops. (*Note*: Parentheses go around YOURNUMBER - 4 in the command EACH [FORWARD (YOURNUMBER - 4) * 25]. This tells the computer to do YOURNUMBER - 4 before it multiplies by 25.)

TELL :TOPS
SETCOLOR :OLIVE
WAIT 50
SETCOLOR :GREEN
WAIT 50
SETCOLOR :ORANGE
WAIT 50
SETCOLOR :GRAY

TO SEASONS

END SEASONS Now that the trees are ready, let's write a procedure named SEASONS. Type TO SEASONS and press **ENTER**. Since we only want the tree tops to change color, the second line of the procedure is TELL:TOPS. The WAIT command lets you see each season. You can slow down the season changes or speed them up by changing the amount of the WAIT command.



SEASONS REPEAT 10 [SEASONS] When you finish typing SEASONS, check over the procedure for bugs. Then, press **BACK** to return to the Sprite Mode. Clear the screen (CS), if you want. Then, type SEASONS and press **ENTER**. Make the trees go through several SEASONS using the REPEAT command. Or, type the name of the procedure as a command in the procedure. It goes before the END command. This causes the procedure to repeat itself until **BACK** is pressed to stop it.

7.4. Set X-Coordinate and Y-Coordinate

VANISH

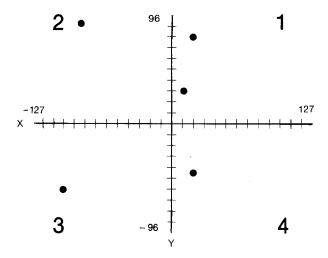
Use VANISH to clear the screen. Or, clear the screen by telling all the Sprites to carry shape 0, the clear color, and 0 speed.

TELL [1 2 3 4] CARRY :BOX SETCOLOR :BLACK

HOME

Can you stack four black boxes one above the other on the screen? First, list the sprites, give them a shape and color, and put them at HOME. Let's leave Sprite 1 at HOME and make it the last sprite in the stack. Can you move the other three sprites? You could use the FORWARD command, but you don't know the heading of the sprites. Try moving Sprite 2 FORWARD 20. It probably isn't above the other sprites. Move it back by typing HOME or BACK 20.

There's an easy way to put a sprite at a specific point on the screen. It's done by setting the *x-coordinate* and *y-coordinate*. Every point on the screen can be reached by a pair of numbers. This pair of numbers is made up of the *x-coordinate* and the *y-coordinate*. Look at the graph. The point where the *x-coordinate* is 0 and *y-coordinate* is 0 is the center of the screen. It's the same place as HOME.



Can you find the point where the x-coordinate is 10 and the y-coordinate is 30? Starting on the x line and at 0, count 10 points to the right. Draw an imaginary line up from the 10 on the x line. Now, starting at 0 on the y line, count up 30 points. Draw an imaginary line to the right from the 30 on the y line. A dot is at the point where these two lines meet. This dot is at the pair of coordinates 10 30. Always write the x-coordinate first and the y-coordinate second. Notice that there are four parts or *quadrants* on the graph. Let's look at each one closer.

Look at the first quadrant. It is the upper-right part of the graph. The x-coordinates and y-coordinates, or all the points in this quadrant, are positive numbers. If a point is at 20 (x-coordinate) and 80 (y-coordinate), you know that it is in this quadrant.

Now look at the second quadrant, which is the upper-left part of the graph. Something is different about the x-coordinates in this quadrant. The x-coordinates are negative numbers. The y-coordinates are still positive numbers. Find - 85 90. A dot is at that point.

The third quadrant is the lower-left part of the graph. All the x-coordinates and y-coordinates are negative numbers. A dot is at -100 (-60).

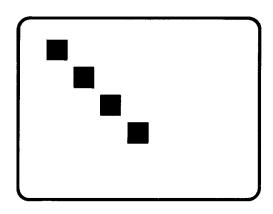
The lower-right part of the graph is the fourth quadrant. The x-coordinates are positive numbers and the y-coordinates are negative numbers. Can you find 20 (- 45)? A dot is at that point.

Because the screen is a rectangle, there are more x-coordinate points than there are y-coordinate points. You can set the x-coordinate to a positive or negative number from 0 through 127. The y-coordinates can be set to a positive or negative number from 0 through 96. The command for setting the x-coordinate is SX. The command for setting the y-coordinate is SY. You can set both the x-coordinate and y-coordinate at the same time with the command SXY. Remember, the first number is always the x-coordinate and the second number is the y-coordinate.

Now let's get back to those boxes we want to stack on top of each other. It is simple to stack them with the SX, SY, and SXY commands.

TELL 2 SY 20 TELL 3 SY 40 TELL 4 SY 60 By changing only the y-coordinate of each box, you can stack the four boxes one on top of the other. Leaving Sprite 1 at HOME causes it to be on the bottom of the stack.

TELL 2 SX 20 TELL 3 SX 40 TELL 4 SX 60 If you change the x-coordinate, you can spread the boxes apart so that they look like stairs.



TELL 2
SXY -20 20
TELL 3
SXY -40 40
TELL 4
SXY -60 60

TELL [5 6 7]
CARRY :BOX
SETCOLOR :BLUE
TELL 5
SXY 20 (-20)
TELL 6
SXY 40 (-40)
TELL 7
SXY 60 (-60)

Can you figure out a shorter way to make the stairs? You can set the x-coordinate and y-coordinate using the SXY command. Let's make the stairs go the other way using SXY.

Can you add three more steps to the bottom of the stairs? To do this you have to give three new sprites shape and color. Then set each x-coordinate and y-coordinate. (*Note*: You need to type parentheses around all negative y-coordinates. If you forget, the computer gives you the message TELL ME MORE.)

Putting sprites at certain points on the screen is easy with SX, SY, and SXY. You don't need to know the heading of a sprite like you do with the FORWARD and BACK commands.

7.5. XCOR and YCOR

If you forget the x-coordinate and y-coordinate of a sprite or the Turtle, XCOR and YCOR can help you remember. First, get the attention of the sprite by typing TELL SPRITE and the number of the sprite. Or, type TELL TURTLE to get the attention of the Turtle. Then press **ENTER**. For the x-coordinate, type XCOR and press **ENTER**. The computer returns the message TELL ME WHAT TO DO WITH and the number of the x-coordinate. For example, look at Sprite 7. Type XCOR and press **ENTER**. The computer prints TELL ME WHAT TO DO WITH 60. Now type YCOR and press **ENTER**. The computer returns TELL ME WHAT TO DO WITH -60. If you tell the computer to PRINT XCOR, it prints 60.

For fun, check the XCOR and YCOR of the other sprites on the screen.

7.6. DOT

In the Turtle Mode, the command DOT lets you put a dot anywhere on the screen. The DOT command needs two numbers. The first number is the x-coordinate and the second number is the y-coordinate.

TELL TURTLE DOT 37 68 NOTURTLE

Type TELL TURTLE. Put a dot in the first quadrant using the DOT command. Now put a dot in the three other quadrants. Remember to type parentheses around the negative y-coordinate. When you are finished putting dots on the screen, type NOTURTLE to return to the Sprite Mode.

7.7. BEEP and NOBEEP

Another primitive in TI LOGO gives sound. The command to turn on the sound is BEEP. The command to turn off the sound is NOBEEP. You can write procedures that make a truck beep, a bug beep, or a cannon fire. Or, you can use the beep to send messages in Morse Code. Let's send an SOS.

TO DOTS
BEEP
WAIT 5
NOBEEP
END
TO DASHES
BEEP
WAIT 20
NOBEEP
END

The Morse Code is made up of short beeps, called dots, and long beeps, called dashes. The BEEP command turns on the sound. The WAIT command determines how long the sound will be on. So, the length of the WAIT command sets up the dot and the dash code. Type the commands for the DOTS and DASHES procedures.

7.8. Subprocedures

A Morse Code message is made by putting dots and dashes together. Let's put the procedures DOTS and DASHES together to write a procedure called SOS. DOTS and DASHES then become *subprocedures* of SOS. It's a good idea to put subprocedures together to make one large procedure. It makes it easier to find bugs.

TO S DOTS WAIT 10 DOTS WAIT 10 DOTS WAIT 30 END	Let's put three DOTS procedures together to make the Morse Code for the letter S. Call this procedure S. The WAIT 10 command separates the three DOTS. The WAIT 30 command signals the end of one letter and the beginning of the next one.
TO O DASHES WAIT 10 DASHES WAIT 10 DASHES WAIT 30 END	Now put three DASHES procedures together to make the Morse Code for the letter O. Call this procedure O.
TO SOS S O S END	We're ready to make S and O subprocedures of the SOS procedure. Type TO SOS, and subprocedure S, O, and S again.

Now try sending an SOS many times using the REPEAT command. Or, type SOS as a command before the END command in the procedure. To stop sending an SOS, press **BACK**. If you stop the procedure with the beep sound on, type NOBEEP and press **ENTER** to turn off the sound.

When you finish experimenting with teaching the computer and saving your procedures, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

8. More Advanced Procedures

Before starting *Chapter 8*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

8.1. REPEAT in a Procedure

We've been using the REPEAT command to repeat a procedure. But REPEAT can also be used as a command in a procedure. When REPEAT is used this way, the procedure does the same steps, but there are fewer lines in the procedure. This means there is also less typing. Let's compare a procedure that uses REPEAT and one that does not.

```
TO HEXAGON
                         TO HEXAGON
FORWARD 40
                         REPEAT 6 [FORWARD 40 RIGHT 60]
RIGHT 60
FORWARD 40
RIGHT 60
END
```

Count the FORWARD and RIGHT commands in the procedure on the left. There are six each. Since a hexagon is a six-sided figure, we need to tell the computer to repeat the FORWARD and RIGHT commands six times. In the procedure on the right, the FORWARD and RIGHT commands are now listed for the computer to repeat. Brackets must be typed around the list.

To teach the Turtle to draw a square, how many times would you repeat the list of FORWARD and RIGHT commands? If you said four times, you are correct. (*Note*: The Turtle doesn't have to draw a design to the right. You can also use the LEFT command.)

Remember the STAR and SQUARE procedures in Chapter 2?

8.2. A Variable in a Procedure

You can use a box procedure as a subprocedure in many large procedures. Let's use a house as an example. You can use one large box for the main body, two small boxes for windows, and another box for the chimney. Each box has four 90 degree angles, but the length of the sides would be different. That means we would need to write three different procedures for three different sized boxes. It would be easier if we could write one procedure for a box and then change the length of the sides. We can.

TO	SQU	JAR	Ε	Ν
FOR	WAF	2D	:1	1
RIG	HT	90		
FOR	RWAF	2D	:1	1
RIG	HT	90		
FOR	RWAF	2D	:1	1
RIG	HT	90		
FOR	WAF	2D	:1	1
RIG	HT	90		
ENI)			
CLE	ARS	CR	ΕĒ	ΞN
COL	T 7 T T	, ,	Λ	

Type TO SQUARE and press **ENTER**. Because we want to be able to change the length of the side, call it N. Type a space after SQUARE. Then type N, and press **ENTER**. Next type the commands that are in the column. In this procedure, N takes the place of a number. N is called a *variable*. :N means the value of the number. FORWARD :N tells the Turtle to move the number of steps you make N. Each time you use SQUARE N, you have to tell the computer what number is to replace N. Let's try it.

CLEARSCREEN SQUARE 50 SQUARE 10

Clear the screen, and then type SQUARE 50. The length of each side of the square is 50. The variable N is replaced by 50. Now make a small box with 10 replacing the variable.

Experiment with the SQUARE N procedure. Try drawing a house. Use PENUP to put the Turtle where you want the windows and chimney drawn. Type PENDOWN to get the Turtle ready to draw lines again. Then tell the Turtle what size square to draw. You can even use the DOT command to make a doorknob on the door.

When you use a variable in the name of a procedure, you *must* type the variable *after* you are in the Edit Mode. Type TO, the name of the procedure, and then press **ENTER**. Next, type a space and then the variable. A variable can be a letter, like the N in the SQUARE N procedure. Or, it can be a word. You could have called the procedure SQUARE LENGTH. Remember to use dots (:) *in front of the variable* in the statements following the name of the procedure. Dots tells the computer to do the value of the variable.

TO SQUARE N
REPEAT 4
[FORWARD :N RIGHT 90]
END

The REPEAT command can also be used with a variable. Can you write the SQUARE N procedure using REPEAT?

8.3. Foreground and Background Tile Colors

In *Chapter 4* we said that a tile has two colors. The first color is the foreground or color of the character. The second color is the background of the tile. To change the foreground and background colors of a tile, the colors must appear in a list after the SETCOLOR command. For the colors to be in a list, the numbers, and not the words, for the colors must be used.

The screen is covered with blank tiles. Let's use the blank character (code number 32) to make one pattern cover the screen.

TELL TILE 32 SETCOLOR [15 4]

Type the commands in the column. The screen turns blue because the background color is number 4. The foreground color is number 15, white. However, there is not a design on the foreground of the tile, so you can't see it. Let's make a design with MAKECHAR.

MAKECHAR 32

Type MAKECHAR 32 and press **ENTER**. Using the arrow keys with and without the SHIFT key, draw a design on the grid. Look! As you draw it, the design appears on all of the blank tiles on the screen. Press **BACK** when you finish your design.

MAKECHAR 32 SETCOLOR [1 0] To erase the design on the screen, type MAKECHAR 32 and press **ENTER**. Then press **CLEAR** to erase the grid. The design disappears. To turn the screen cyan, type the new SETCOLOR command. (*Note*: TELL TILE works the same as TELL SPRITE. You must get the attention of the one you want to do something. If you haven't talked to a different tile, you don't need to use the TELL TILE command again.)

Let's make a rainbow by setting the foreground and background colors of some of the tiles.

TO SETUP
TELL TURTLE
PENUP
LEFT 90
FORWARD 50
RIGHT 90
BACK 20
PENDOWN
END

First, write a procedure to move the Turtle to the left side of the screen. Call this procedure SETUP. To move the Turtle without drawing a line, use PENUP. Type the commands for SETUP.

TO UP FORWARD 80 RIGHT 55 FORWARD 12 END TO DOWN BACK 12 LEFT 55 BACK 80 END	We want the rainbow to go on an angle. We have to give the Turtle the commands that cause it to draw a thick line, or ray, going up. It also needs the commands that get the Turtle ready to draw the next thick line. The first procedure is called UP and the second is called DOWN. The procedures UP and DOWN are opposite of each other.
TO OVER RIGHT 90 FORWARD 8 LEFT 90 END	Next, we need to tell the Turtle how far over to draw the next ray. Call that procedure OVER.
TO ARCH UP DOWN OVER END	It's taken three procedures to tell the Turtle how large and the angle on which each color of the rainbow is to be drawn. Let's make these three procedures subprocedures of ARCH. Now when we tell each tile what color to be, ARCH tells the Turtle how to draw that ray of the rainbow.
TO RAINBOW SETUP SETCOLOR [6 6] ARCH SETCOLOR [8 8] ARCH SETCOLOR [10 10] ARCH SETCOLOR [3 3] ARCH	Type TO RAINBOW and press ENTER . The procedure SETUP puts the Turtle in the correct place to start drawing the rainbow. Since the rainbow has solid colored rays, both the foreground and the background colors are the same. (<i>Note</i> : The numbers of the colors must be used when the colors are in a list.) Color number 6 makes the first ray red. Typing ARCH next makes the Turtle draw the first ray of the rainbow. Continue typing the commands in RAINBOW. When you finish, check over the procedure for typing mistakes, and
SETCOLOR [4 4] ARCH SETCOLOR [13 13] END	then press BACK.

The foreground and background colors of the Turtle can be different. Using the SETCOLOR command, give the Turtle two different colors inside the brackets. Then move the Turtle around the screen. As the Turtle draws, the background color of the tile is one color and the line is another color. To make the Turtle draw a black line on a clear background again, use the command SETCOLOR [1 0].

Now type RAINBOW, press ENTER, and watch the Turtle draw. Try

changing the colors of the rainbow. Or, add more rays to it.

RAINBOW

8.4. TEST, IFT, IFF

When you write procedures, you may want one sprite to do one thing at certain times and a different thing at other times.

Let's think of a situation when this might happen. Pretend it's Saturday. What would you like to do? Let's plan a picnic at the park. But what if it rains? We can go to a movie instead. The plan for Saturday is: if it's sunny, we go on a picnic; if it's not sunny, we go to a movie.

Let's write this situation using TI LOGO commands. Call it TO SATURDAY. We have a condition that we want to test. The condition is a sunny day (TEST SUNNY DAY). If it's true that it's a sunny day, we go on a picnic (IFT PICNIC). If it's false and it's not a sunny day, we go to a movie (IFF MOVIE).

We can test the following situation with TEST, IFT (if true), and IFF (if false). A rocket is going north at a slow speed. A plane is flying east, also at a slow speed. If it's true that the y-coordinate of the rocket is greater than 80, the rocket and plane explode. If it's false that the y-coordinate of the rocket is not greater than 80, the computer retests the situation.

TO HIT
TELL SPRITE 2
TEST YCOR > 80
IFT EXPLODE
IFF HIT
END

TO FLIGHT
TELL SPRITE 3
CARRY :PLANE
SETCOLOR :BLUE
SETHEADING :EAST
SETSPEED 30
SX 0
SY 80
TELL SPRITE 2
CARRY : ROCKET
SETCOLOR : BLACK
HOME
SETHEADING 0
SETSPEED 10
END

The HIT procedure states the situation in TI LOGO. It has two subprocedures. One tells the computer what to do if the test is true (EXPLODE). The other tells the computer what to do if the test is false (HIT). Type the commands in HIT.

The procedure FLIGHT gives Sprite 2 and 3 the features of the plane and the rocket. Type TO FLIGHT and the commands that follow.

TO EXPLODE
TELL SPRITE 2
SETCOLOR : CLEAR
TELL SPRITE 3
CARRY 10
SETCOLOR : RED
SETHEADING 180
SETSPEED 5
WAIT 220
SETCOLOR : CLEAR

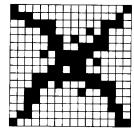
Next, the procedure EXPLODE needs to be defined. If the y-coordinate of the rocket is greater than 80, Sprite 2 (the rocket) hits Sprite 3 (the plane), and disappears by turning clear. Then, Sprite 3 looks like the pieces of the crash and slowly falls to the ground. When it gets to the ground, it disappears by turning clear. Type the commands in the procedure EXPLODE.

END

MAKESHAPE 10

After typing the commands for EXPLODE, type MAKESHAPE 10 and press **ENTER**. With **SHIFT** and the arrow keys design shape 10 to look like the pieces of the crash. When you finish, press **BACK**.

MAKESHAPE 10



TO TARGET FLIGHT HIT END

We can type FLIGHT, which puts the sprites on the screen, and then type HIT that tests the situation. But, it is easier to make the two procedures part of another procedure. Call the main procedure TARGET. Type TO TARGET, and the subprocedures FLIGHT and HIT. When you finish typing the procedure TARGET, press **BACK**.

TARGET

Now type TARGET and see what happens.

If the situation is true, and the y-coordinate of Sprite 2 is greater than 80, the rocket hits the plane, and the pieces fall to the ground. Test the situation again by typing TARGET. Or, try creating other situations and testing them. You can have more than one TEST in a situation. You can also create a situation that doesn't need both IFT and IFF. The procedure LAZY8, which you'll learn next, uses only IFF.

8.5. IF...THEN...ELSE

A situation like TARGET can also be written using IF...THEN...ELSE. IF does the same as TEST, THEN replaces IFT, and ELSE replaces IFF.

When the commands TEST, IFT, and IFF are used, each command goes on a different line. When IF...THEN...ELSE is used, the command goes on the same line. Compare the two different ways to test the HIT procedure.

```
TEST IFT IFF IF...THEN...ELSE

TO HIT TO HIT

TELL SPRITE 2 TELL SPRITE 2

TEST YCOR > 80 IF YCOR > 80 THEN EXPLODE ELSE HIT

IFT EXPLODE END

IFF HIT

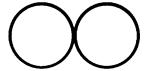
END
```

Because TI LOGO understands both ways of testing a situation, you can use either one.

8.6. Recursion

8.6.1. Recursion with the Turtle

Have you ever drawn a design like this?



It looks like a sideways eight. You can tell the Turtle to draw a design like the one above. Call it LAZY8.

TO LAZY8	
FORWARD 4	
RIGHT 10	
TEST HEADING =	0
IFF LAZY8	
FORWARD 4	
LEFT 10	
END	

Type TO LAZY8 and press **ENTER**. Be sure *not* to type a space between LAZY and the number 8. Next, type the FORWARD and RIGHT commands. TEST checks the heading of the Turtle. If it's not 0 or north, the Turtle continues to draw the LAZY8. When the Turtle finishes the circle on the right side of the LAZY 8, the heading is 0. Giving the turtle the FORWARD and LEFT commands changes the heading of Turtle. Since it's no longer 0, the Turtle draws the circle on the left side of the LAZY8.

LAZY8

When you finish typing the commands in LAZY8, press **BACK**. Then type LAZY8 and watch the Turtle draw the design.

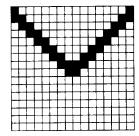
The idea of using a procedure as a subprocedure of itself is called *recursion*. The procedure can repeat itself until the TEST is complete. Or, a procedure can have *tail-end recursion*. Tail-end recursion occurs when the procedure appears as a subprocedure before the END command. The next procedure, FLAP, shows tail-end recursion.

8.6.2. Recursion with Sprites

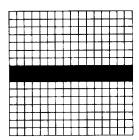
We can design three shapes for a bird in flight, and then write a procedure that tells the wings to flap over and over again. The flapping of the wings is an example of tail-end recursion with sprites.

With **SHIFT** and the arrow keys, make shapes 6, 7, and 8 look like the designs below.

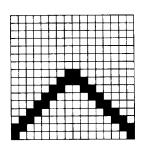
MAKESHAPE 6



MAKESHAPE 7



MAKESHAPE 8



TO FLAP CARRY 6 WAIT 10 CARRY 7 WAIT 10 CARRY 8 WAIT 10 FLAP END

TO BIRD
TELL SPRITE 1
SETCOLOR : RED
SETSPEED 5
SETHEADING 45
FLAP
END

Type the commands in FLAP to tell a sprite to carry one shape and then another. This makes the bird look like it's flapping its wing.

Now type the commands in the procedure BIRD. Making FLAP a subprocedure of the BIRD procedure causes tail-end recursion. The wing of the bird keeps flapping until you press **BACK** to stop the flapping.

Try designing other shapes that you can put together in a procedure.

When you finish experimenting with teaching the computer and saving your procedures, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit. Or, if you're ready to go on, leave the module in and the system turned on, and go on to the next chapter.

9. TI LOGO as a Calculator

Before starting *Chapter 9*, be sure to follow the steps in SETTING UP. Then put the TI LOGO Command Module in the slot on the console. Press any key to see the selection list. Then, press the number that appears next to TI LOGO. TI LOGO is now ready. The computer is in the Sprite, or Command, Mode.

TI LOGO can help you in another way. You can use it as a calculator.

Some calculators have many keys and can do many different computations. With TI LOGO, you can add, subtract, multiply, and divide. The computer has a limit on the largest positive number you can use. That number is 32,767. It also has a limit on the smallest negative number, -32,768. If you give it a problem that goes over the limits, the answer is incorrect. Now let's try each of these functions.

The symbol for addition is +. Find it on the keyboard. Let's add 27 and 56. Type 27, the plus sign (+), and 56. You don't need to put a space between the numbers and the plus sign. Then press **ENTER**.

The computer returns the message TELL ME WHAT TO DO WITH 83. It did the addition but didn't know what to do with the answer. The PRINT command tells the computer to print just the answer. Type PRINT 27 + 56 and press **ENTER**. The computer prints the answer (83).

The symbols for the four functions, "less than", and "greater than" are below.

SYMBOL/PRESS	ACTION
+	add
-	subtract
*	multiply
/	divide
<	less than
>	greater than

Can you subtract 29 from 437 and have the computer print only the answer? Type PRINT 437, the minus sign (-), and 29. Then press **ENTER**. Your answer is 408.

Now multiply 36 by 18. Type PRINT 36, times sign (*), and 18. Press **ENTER** and 648 appears on the screen.

When you divide with TI LOGO, the computer does not print the remainder. It prints the answer as a whole number. Divide 7 by 2. Type PRINT 7, division sign (/), and 2. The answer, 3, prints on the screen without the remainder.

The computer solves a problem with more than one operation in it in a specific order. It starts at the beginning or left side of the problem and does any problems that are in parentheses first. Returning to the beginning of the problem, the multiplication and division operations are done next, followed by addition and subtraction.

Let's look at an example:

$$62 + 10/2 + 3 \times 24 - (17 - 8) = 62 + 10/2 + 3 \times 24 - 9$$

= $62 + 5 + 72 - 9$
= 130

The computer does the operation in parentheses first (17 - 8), then the division (10/2) and multiplication (3×24) , and then all of the addition and subtraction problems.

The computer can also tell if one number is greater than or less than another. The sign for greater than is > . Type 561 > 49. The computer returns the message TELL ME WHAT TO DO WITH TRUE. It tells you the statement was true. Again, the PRINT command tells the computer what to do with the answer. You can check to see if a number is less than another by using the symbol <. Type PRINT 69 < 28. The computer tells you that is FALSE. Suppose that you want to know if the answer to 47 + 35 is less than the answer to 74 - 16. Ask the computer. Type PRINT 47 + 35 < 87 - 16 and press **ENTER**. The computer prints TRUE.

Try adding a column of numbers — or find out if the sum of your parents' ages is less than the sum of your friend's parents' ages!

TI LOGO can do another interesting thing. It can give you a random number from 0 through 9. Type RANDOM and the computer gives you the message TELL ME WHAT TO DO WITH (a number). Use the PRINT command (PRINT RANDOM) and the computer prints the random number. Try guessing the number before the computer prints it. Or, figure out all the addition or multiplication factors of the number. Or, let the computer decide who goes first in a game — the player who guesses the random number or the number closest to it, goes first. Can you think of other ways you can use a random number from 0 through 9?

When you finish using TI LOGO as a calculator, type BYE and press **ENTER**. If you are also finished using the computer for this session, remove the TI LOGO Command Module. Then, turn off the console and Memory Expansion unit.

10. Appendix A. COMMANDS with SHORT FORMS

The following chart lists primitives and their short forms. Since the computer understands both forms, you can use either the full word for the primitive or the short form.

Primitives	Short Form	Primitives	Short Form
BACK	BK	PENREVERSE	PR
BACKGROUND	BG	PENUP	PU
BUTFIRST	BF	PRINTCHAR	PC
BUTLAST	BL	PUTTILE	PT
CHARNUM	CN	READCHAR	RC
CLEARSCREEN	CS	READLINE	RL
COLORBACKGROUND	CB	RIGHT	RT
FORWARD	FD	SENTENCE	SE
HIDETURTLE	HT	SETCOLOR	SC
LEFT	LT	SETHEADING	SH
MAKECHAR	MC	SETSPEED	SS
MAKESHAPE	MS	SHOWTURTLE	ST
OUTPUT	OP	TRACEBACK	TB
PENDOWN	PD	YOURNUMBER	YN
PENERASE	PE		

11. Appendix B. PRIMITIVES in TI LOGO

The following chart lists the TI LOGO primitives, explains each one, and gives an example of those that require more than a single-word input. The primitive is printed in bold type. If additional input is needed by a primitive, it is printed after the primitive.

BACK number

Moves the turtle or a sprite back the number of steps indicated.

Example: BACK 20

BACKGROUND

Names the screen.

Example: TELL BACKGROUND

SETCOLOR: GRAY

BEEP

Starts a tone.

BOTH condition 1 condition 2

Gives true if both conditions are true.

Example: TEST BOTH :X<:Y:Y>:Z

BUTFIRST [list]

Gives all but the first item of a list.

Example: PRINT BUTFIRST [1 2 3 4]

MAKE "X BUTFIRST [OR OF]

BUTFIRST "word

Gives all but the first character of a word.

Example: PRINT BUTFIRST "CANDY

BUTLAST [list]

Gives all but the last item of a list.

Example: MAKE "X BUTLAST [1 2 3]

PRINT BUTLAST [OF IT IS]

 ${\tt BUTLAST}~"word$

Gives all but the last character of a word.

Example: PRINT BUTLAST "SMILES

BYE

Leaves TI LOGO.

CALL thing "name

Gives a value to a name.

Example: CALL 7 "X

PRINT:X

CARRY number

Tells a sprite what shape to carry.

Example: CARRY 6

CARRY:word

Tells a sprite what shape to carry.

Example: CARRY :ROCKET

CHARNUM "character

Gives the number of the character.

Example: PRINT CHARNUM "7

CLEARSCREEN

Clears the typing and turtle lines off the screen.

COLOR

Gives the color number of the active sprite.

Example: PRINT COLOR

COLORBACKGROUND number

Changes the background screen to the color indicated.

Example: COLORBACKGROUND 10

COLORBACKGROUND:word

Changes the background screen to the color indicated.

Example: COLORBACKGROUND:ORANGE

CONTENTS

Prints the names of everything.

CONTINUE

Continues a procedure that has been paused.

DEFINE "procedure name [list]

Gives a procedure name to a list of commands.

Example: DEFINE "X [(N)(FORWARD :N RIGHT 90)]

TELL TURTLE

X 40

DIFFERENCE number number

Subtracts the second number from the first number and gives the answer.

Example: PRINT DIFFERENCE 10 6

DOT *x-coordinate y-coordinate*

Puts a dot at the point indicated in the Turtle Mode.

Example: DOT 45 45

EACH [list]

Applies a list of commands to a list of sprites.

Example: TELL:ALL

EACH [SETCOLOR YOURNUMBER]

EDIT

Enters the Edit Mode.

EDIT name of procedure

Allows editing of the named procedure.

EITHER condition 1 condition 2

Gives true if either of the two conditions is true.

Example: TEST EITHER :A=:B:B=0

ELSE

Action taken when result of IF is false.

Example: IF :A<15 THEN SETCOLOR 1 ELSE SETCOLOR 6

END

Signals the end of a procedure. *Note*: This must be the last command of every procedure.

ERASE name of procedure

Erases the named procedure.

FIRST [list]

Gives the first item of a list.

Example: CALL FIRST [5 2 8] "NUM

FIRST "word

Gives the first character of a word.

Example: CALL FIRST "RALPH "INITIAL

FORWARD number

Moves the Turtle or a sprite forward the number of steps indicated.

Example: FORWARD 35

FREEZE

Stops the motion of the sprites.

GO

Tells the procedure to go where the label is.

Example: 10: MAKE "X :X+1 IF :X<:Y GO "10

GREATER number number

Gives true if the first number is greater than second number. Gives false if the first number is not greater than the second number.

Example: PRINT GREATER 5 6

HEADING

Gives the heading of the active sprite.

Example: PRINT HEADING

HIDETURTLE

Makes the Turtle disappear.

HOME

Clears the screen and makes the Turtle go to the center of the screen and face north. Makes the active sprite go to the center of the screen.

IF relation

Looks at a relation and returns true or false.

Example: IF :RED = 6 THEN PRINT "GOOD

IFF action

Determines the action taken if the result of the TEST command is false.

Example: TEST XCOR > 30 IFF SETCOLOR :GREEN

IFT action

Determines the action taken if the result of the TEST command is true.

Example: TEST SHAPE=5
IFT SETHEADING 90
IFF SETHEADING 0

IS *number number*, "words, or "characters

Gives true if both numbers, words, or characters are equal. Gives false if both numbers, words, or characters are not equal.

Example: PRINT IS :RED 6

PRINT IS: ROCKET 10

LAST [list]

Gives the last item of a list.

Example: TELL LAST [13 1 5 2]

LAST "word

Gives the last character of a word.

Example: CALL LAST "XYZ

PRINT:Z

LEFT number

Turns the Turtle or a sprite left the number of degrees indicated.

Example: LEFT 120

LESS number number

Gives true if the first number is less than the second number. Gives false if the first number is not less than the second number.

Example: IF LESS :X 6 THAN SETHEADING 12

 ${\bf LOOKLIKE}\ number$

Tells a sprite what shape to look like.

Example: LOOKLIKE 5

LOOKLIKE: word

Tells a sprite what shape to look like.

Example: LOOKLIKE :TRUCK

MAKE "name thing

Gives a name to a value.

Example: MAKE "JOHN 20

MAKECHAR number

Provides a grid for designing a character on a tile.

Example: MAKECHAR 230

 ${\tt MAKESHAPE}\ number$

Provides a grid for designing a shape.

Example: MAKESHAPE 21

NOBEEP

Turns off the tone.

NOT

Looks at a relations and returns true or false.

Example: PRINT NOT : RED = 6

NOTURTLE

Leaves the Turtle Mode.

NUMBEROF shape, tile, heading, color, speed, who

Gives number of feature.

Example: PRINT NUMBEROF SPEED

OUTPUT anything

Causes a procedure to return a value to the level from which it was called.

Example: TO SQUARE N TO B

PRINT B OUTPUT :N * :N

END END

PENDOWN

Makes the Turtle's pen ready to draw a line.

PENERASE

Makes the Turtle's pen ready to erase a line.

PENREVERSE

Makes the Turtle's pen ready to draw a new line or erase a line if it crosses or covers a line it has already drawn.

PENUP

Makes the Turtle's pen ready to move without drawing a line.

PA

Prints all the primitives, procedures, and names.

PN

Prints all the names.

PO procedure name

Prints out procedure.

PP

Prints the names of the procedures the computer knows.

PRINT

Prints what follows and returns the cursor to the beginning of the next line.

Example: PRINT "HELLO

PRINTCHAR number

Prints the character that has that number.

Example: PRINTCHAR 45

PRODUCT number number

Multiplies the first number by the second number and gives the answer.

Example: PRINT PRODUCT 5 4

PUTTILE character number row number column number

Puts a character at the point where the row and column meet.

Example: PT 50 10 10

QUOTIENT number number

Divides the first number by the second number and gives the answer without the remainder.

Example: PRINT QUOTIENT 18 2

RANDOM

Gives a random number from 0 through 9.

Example: PRINT RANDOM

RC?

Returns true if a key has been pressed.

READCHAR

Waits for a key to be pressed and gives the key character.

READLINE

Waits for information, and gives information as a list.

Example: MAKE "X READLINE

RECALL

Enters the Recall Mode for recalling procedures, shapes, and tiles.

REPEAT number [list]

Repeats a list the number of times indicated.

Example: REPEAT 4 [FORWARD 20 RIGHT 90]

RIGHT number

Turns the Turtle or a sprite right the number of degrees indicated.

Example: RIGHT 80

RUN [list]

Makes the action in the list happen.

Example: MAKE "X [FORWARD 30 RIGHT 90]

RUN:X

SAVE

Enters the Save Mode for saving procedures, shapes, and tiles.

SENTENCE two inputs "word or [list]

Joins two inputs to make a list.

Example: CALL [YOU ARE] :X

CALL [MY FRIEND] :Y PRINT SENTENCE :X :Y

SETCOLOR number

Gives the active sprite or Turtle the specified color.

Example: SETCOLOR 10

SETCOLOR: word

Gives the active sprite or Turtle the specified color.

Example: SETCOLOR:WHITE

SETCOLOR [number number]

Gives a tile the foreground and background color indicated.

Example: TELL TILE 102

SETCOLOR [8 3]

 ${\bf SETHEADING}\ number$

Gives the active sprite the heading indicated.

Example: SETHEADING 290

SETSPEED number

Gives the active sprite or Turtle the speed indicated. The number must be from -127 through

127.

Example: SETSPEED 98

SHAPE

Gives the shape number of the active sprite.

Example: PRINT SHAPE

SHOWTURTLE

Makes the Turtle reappear after you use HIDETURTLE.

SPEED

Gives the speed of the active sprite.

Example: PRINT SPEED

SPRITE number

Names invisible object that does work.

Example: TELL SPRITE 3

STOP

Stops a procedure.

Example: IF SHAPE=5 STOP

SUM number number

Adds two numbers and gives the answer.

Example: PRINT SUM 3 4

SV number number

Gives the active sprite the x-velocity and y-velocity indicated.

Example: SV 10 10

 $SX\ number$

Gives the active sprite or Turtle the x-coordinate indicated.

Example: SX 50

SXV number

Gives the x-velocity to the active sprite.

Example: SXV 20

SXY number number

Gives the active sprite or Turtle the x-coordinate and y-coordinate indicated.

Example: SXY 50 (-20)

SY number

Gives the active sprite or Turtle the y-coordinate indicated.

Example: SY -30

SYV number

Gives the y-velocity to the active sprite.

Example: SYV 20

TELL [list]

Alerts a list of sprites.

Example: TELL [10 15 20]

 ${\it TELL}\ number$

Alerts sprite with that number.

Example: TELL 5

TELL word

Alerts the Turtle, sprite, tile, or background.

Example: TELL BACKGROUND

TELL:word

Alerts all the sprites named by "word.

Example: TELL:ALL

TEST operation

Reads true or false from the operation and determines the next step.

Example: TEST COLOR = 5

IFT SETCOLOR 5 IFF RIGHT 90

TEXT "procedure

Forms a list of the statements in a procedure.

Example: MAKE "X TEXT "B

PRINT:X

THAW

Starts the motion of the sprite or sprites after FREEZE.

THEN action

Determines the action taken after the IF command.

Example: IF :X = 5 THEN SETCOLOR 2

TILE

Defines a character with a number.

Example: TELL TILE 28

TO name

Defines a procedure.

TRACEBACK

Lists subprocedure if paused.

TURTLE

Name of the \triangle in the Turtle Mode.

Example: TELL TURTLE

TYPE "word, character, "symbol or [list]

Prints what follows without returning the cursor to the beginning of the next line.

Example: TYPE [HI JAN]

WAIT number

Pauses number times 1/60 of a second.

Example: WAIT 60

WHERE

Gives the x-coordinate and y-coordinate and heading of the Turtle.

Example: TELL TURTLE

SXY 20 30

SETHEADING 45 PRINT WHERE

WHO

Gives the number of the active sprite, Turtle, or tile.

Example: PRINT WHO

XCOR

Gives the x-coordinate of the active sprite or Turtle.

Example: PRINT XCOR

XVEL

Gives the x-velocity of the active sprite.

Example: SXV XVEL- 2

YCOR

Gives the y-coordinate of the active sprite or Turtle.

Example: PRINT YCOR

YOURNUMBER

Gives the number of the active sprite.

Example: TELL :ALL

EACH [SETCOLOR YOURNUMBER]

YVEL

Gives the y-velocity of the active sprite.

Example: SYV YVEL+16

12. Appendix C. SHAPE CHART

The following chart gives the number and shape of each of the five sprites defined by TI LOGO. When you tell a sprite or a list of sprites to CARRY a shape, dots (:) must be typed in front of the word. No dots (:) are typed if you use the number. You can use either the word or the number since the computer understands both.

Number	Shape	Design
1	PLANE	H
2	TRUCK	
3	ROCKET	1
4	BALL	•
5	BOX	

13. Appendix D. COLOR CHART

The following chart lists the 16 colors and their numbers. When you tell a sprite or a list of sprites to SETCOLOR, dots (:) must be typed in front of the word. No dots (:) are typed if you use the number. You can use either the word or the number since the computer understands both.

Color	Number	Color	Number
CLEAR	0	RUST	8
BLACK	1	ORANGE	9
GREEN	2	YELLOW	10
LIME	3	LEMON	11
BLUE	4	OLIVE	12
SKY	5	PURPLE	13
RED	6	GRAY	14
CYAN	7	WHITE	15

14. Appendix E. CODE NUMBER and CHARACTER CHART

The following charts give you the group and code number of each character, symbol, and number that the computer understands.

Group	p l	Grou	p 2	Grouj	p 3	Group	9 4
Code	Character	Code	Character	Code	Character	Code	Character
Number	er	Numb	er	Numb	er	Number	er
32	(space)	40	(48	0	56	8
33	!	41)	49	1	57	9
34	"	42	*	50	2	58	:
35	#	43	+	51	3	59	;
36	\$	44	,	52	4	60	<
37	%	45	-	53	5	61	=
38	&	46	•	54	6	62	>
39	1	47	1	55	7	63	?
Group	p 5	Grou	p 6	Group	p 7	Group	8
_	p 5 Character	Grou j <i>Code</i>		_	o 7 Character	Grou j <i>Code</i>	9 8 Character
_	Character	_	Character	_	Character	_	Character
Code	Character	Code	Character	Code	Character	Code	Character
Code Numb	Character er	Code Numb	Character er	Code Numb	Character er	Code Numb	Character er
Code Numbe 64	Character er @	Code Numb 72	Character er H	Code Numb 80	Character er P	Code Numbe 88	Character er X
Code Numbe 64 65	Character er @ A	Code Numb 72 73	Character er H I	Code Numb 80 81	Character er P Q	Code Numbe 88 89	Character er X Y
Code Numbe 64 65 66	Character er @ A B	Code Numb 72 73 74	Character er H I J	Code Numb 80 81 82	Character er P Q R	Code Numbe 88 89 90	Character er X Y
Code Number 64 65 66 67	Character er @ A B C D E	Code Numb 72 73 74 75	Character er H I J K L M	Code Number 80 81 82 83	Character er P Q R S T	Code Number 88 89 90 91	Character er X Y
Code Number 64 65 66 67 68	Character er @ A B C D	Code Numb 72 73 74 75 76	Character er H I J K L	Code Number 80 81 82 83 84	Character er P Q R S T	Code Number 88 89 90 91 92	Character er X Y
Code Number 64 65 66 67 68 69	Character er @ A B C D E	Code Numb 72 73 74 75 76	Character er H I J K L M	Code Number 80 81 82 83 84 85	Character er P Q R S T	Code Number 88 89 90 91 92 93	Character er X Y Z [\ \]

15. Appendix F. MESSAGES

The following is a list of messages the computer prints if it doesn't understand something you've told it. Each message is followed by a short explanation to help you correct a mistake or a bug.

15.1. GENERAL

Message Explanation

CAN'T Computer can't do what you told it to do.

DOESN'T LIKE AS INPUT Computer doesn't like a number, word, or list.

...HAS NO VALUE No value was given to something that needed a value.

NOTHING BEFORE THE... Computer needs a mathematical operation.

OUT OF SPACE Computer is out of memory space.

PAUSED AID was pressed.

STOPPED BACK was pressed.

TELL ME HOW TO Computer didn't understand the command, often a typing error.

TELL ME MORE Computer needs a number or a variable to go with the command.

TELL ME WHAT TO DO WITH Computer understands instructions but doesn't know what to do

with it.

YOU TRIED TO DIVIDE BY ZERO Computer cannot divide by zero.

15.2. TURTLE

Message Explanation

OUT OF INK

Turtle has no more tiles to draw on. To continue, clear the

screen.

15.3. PROCEDURE

Message Explanation

A LABEL IS OUT OF PLACE A label in the procedure is misplaced.

AT LEVEL LINE OF The computer states the level, line, and name of the procedure

where it doesn't understand something.

...DIDN'T OUTPUT A procedure cannot return a value to the level from which it was

called.

ELSE IS OUT OF PLACE In an IF THEN ELSE command, ELSE is out of place.

...MUST BE IN A PROCEDURE Information must appear in a procedure.

PROCEDURE NOT

BEING DEFINED END appears as the last command without TO being the first

command.

THEN IS OUT OF PLACE In an IF THEN ELSE command, THEN is out of place.

TOO MANY SUBLISTS

Too many brackets in one procedure.

WHERE IS THE LABEL A label is missing.

15.4. SYMBOLS

Message Explanation

MISMATCHED BRACKETS Brackets need to match.

UNEXPECTED ")" One parenthesis is misplaced.

()S NEEDED AROUND Parentheses are needed.

16. CARING FOR THE MODULE

These modules are durable devices, but they should be handled with the same care you would give any other piece of electronic equipment. Keep the module clean and dry, and don't touch the recessed contacts.

CAUTION:

The contents of a Command Module can be damaged by static electricity discharges.

Static electricity build-ups are more likely to occur when the natural humidity of the air is low (during winter or in areas with dry climates). To avoid damaging the module, just touch any metal object (a doorknob, a desk lamp, etc.) before handling the module.

If static electricity is a problem where you live, you may want to buy a special carpet treatment that reduces static build-up. These commercial preparations are usually available from local hardware and office supply stores.

17. IN CASE OF DIFFICULTY

If the module activities do not appear to be operating properly, return to the master title screen by pressing **QUIT**. Withdraw the module, align it with the module opening, and reinsert it carefully. Then press any key to make the master selection list appear. Repeat the selection process. (*Note*: In some instances, it may be necessary to turn the computer off, wait several seconds, and then turn it on again.)

If the module is accidentally removed from the slot while the module contents are being used, the computer may behave erratically. To restore the computer to normal operation, turn the computer console off, and wait a few seconds. Then, reinsert the module, and turn the computer on again.

If you have any difficulty with your computer or the TI LOGO module, please contact the dealer from whom you purchased the unit and/or module for service directions.

Additional information concerning use and service can be found in your *User's Reference Guide*.

18. BYE command

In certain instances when you type and enter the BYE command to leave the module, the computer console may lock up. If this happens, simply turn the console off, wait a moment, and then turn it on again.

19. WARRANTY

Texas Instruments Incorporated extends this consumer warranty only to the original consumer purchaser.

19.1. WARRANTY COVERAGE

This warranty covers the electronic and case components of the software module and diskette. These components include all semiconductor chips and devices, plastics, boards, wiring, and all other hardware contained in this module and diskette ("the Hardware"). This limited warranty does not extend to the programs contained in the software module, the diskette, and the accompanying book materials ("the Programs").

The Hardware is warranted against malfunction due to defective materials or construction. THIS WARRANTY IS VOID IF THE HARDWARE HAS BEEN DAMAGED BY ACCIDENT, UNREASONABLE USE, NEGLECT, IMPROPER SERVICE OR OTHER CAUSES NOT ARISING OUT OF DEFECTS IN MATERIALS OR WORKMANSHIP.

19.2. WARRANTY DURATION

The Hardware is warranted for a period of three months from the date of the original purchase by the consumer.

19.3. WARRANTY DISCLAIMERS

ANY IMPLIED WARRANTIES ARISING OUT OF THIS SALE, INCLUDING BUT NOT LIMITED TO THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, ARE LIMITED IN DURATION TO THE ABOVE THREE-MONTH PERIOD. TEXAS INSTRUMENTS SHALL NOT BE LIABLE FOR LOSS OF USE OF THE HARDWARE OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES, OR DAMAGES INCURRED BY THE CONSUMER OR ANY OTHER USER.

Some states do not allow the exclusion or limitation of implied warranties or consequential damages, so the above limitations or exclusions may not apply to you in those states.

19.4. LEGAL REMEDIES

This warranty gives you specific legal rights, and you may also have other rights that vary from state to state.

19.5. PERFORMANCE BY TI UNDER WARRANTY

During the above three-month warranty period, defective Hardware will be replaced when it is returned postage prepaid to a Texas Instruments Service Facility listed below. The replacement Hardware will be warranted for three months from date of replacement. Other than the postage requirement, no charge will be made for replacement.

TI strongly recommends that you insure the Hardware for value prior to mailing.

19.6. TEXAS INSTRUMENTS CONSUMER SERVICE FACILITIES

Texas Instruments Service Facility Geophysical Services Incorporated

P.O. Box 2500 41 Shelley Road

Lubbock, Texas 79408 Richmond Hill, Ontario, Canada L4C 5G4

Consumers in California and Oregon may contact the following Texas Instruments offices for additional assistance or information.

Texas Instruments Consumer Service

831 South Douglas Street El Segundo, California 90245

(213)973-1803

Texas Instruments Consumer Service

6700 Southwest 105th Kristin Square, Suite 110 Beaverton, Oregon 97005

(503)643-6758

19.7. IMPORTANT NOTICE OF DISCLAIMER REGARDING THE PROGRAMS

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Texas Instruments Incorporated

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