I Speak BASIC to *My* Atari®

Aubrey B. Jones, Jr.

For the Atari 400, 800, and 1200XL Microcomputers

A field-tested computer literacy course that introduces students to BASIC language programming.

HAYDEN

I Speak BASIC to My Atari®

Aubrey B. Jones, Jr.

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Contents

PART 1

The Hardware (Or The "Boxes")

What You Will Learn

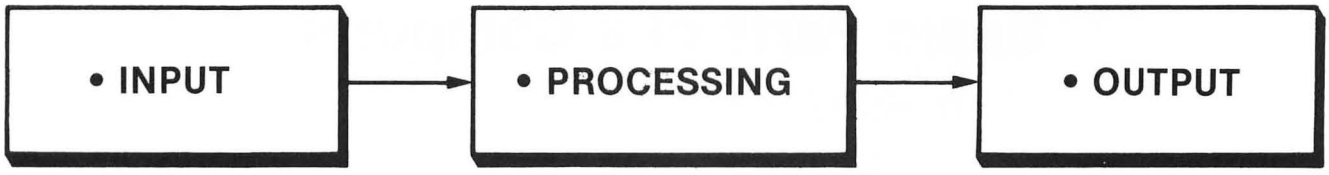
1. That the computer is a valuable tool that can solve problems, print words, draw pictures, store information, retrieve information, compare information, play games, and do many other things to help you in everyday life.
2. That people control computers and that computers cannot think (despite what you might have heard).
3. To identify and explain the basic parts of a computer and relate them to a "box diagram" of a general purpose computer.
4. To identify and explain the function of the basic parts of an Atari microcomputer.
5. To define and explain the terms hardware, software, microcomputer, microprocessor, RAM, ROM, processor, input unit, output unit, memory, and binary.
6. That computers are simple and easy to use; and above all that computers are fun!

Welcome to the World of Computers!

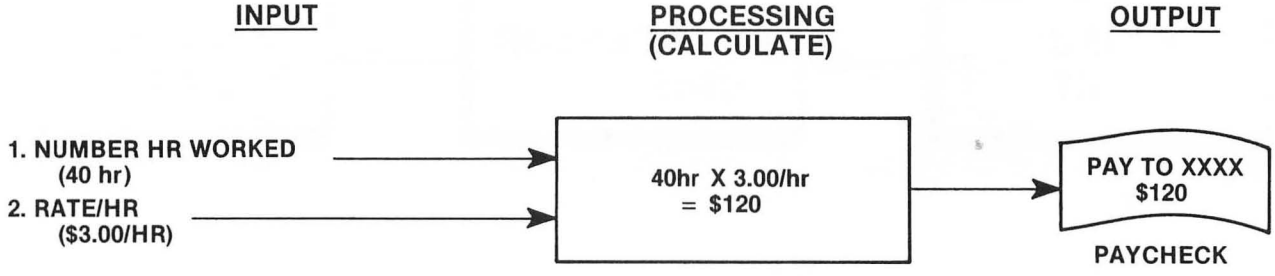
People Control Computers!

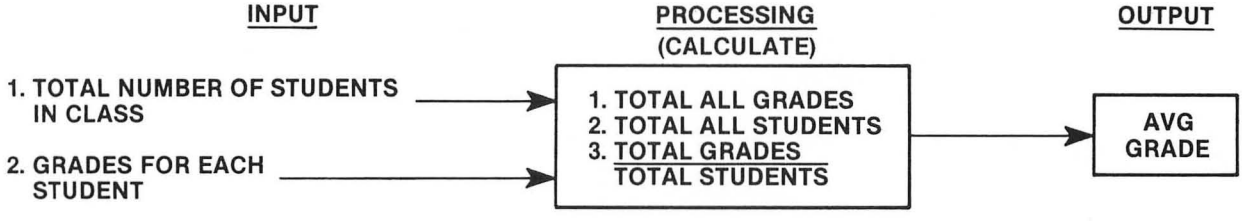
Computers Can't Think!

Typical Data Processing Operation
"Box" Diagram

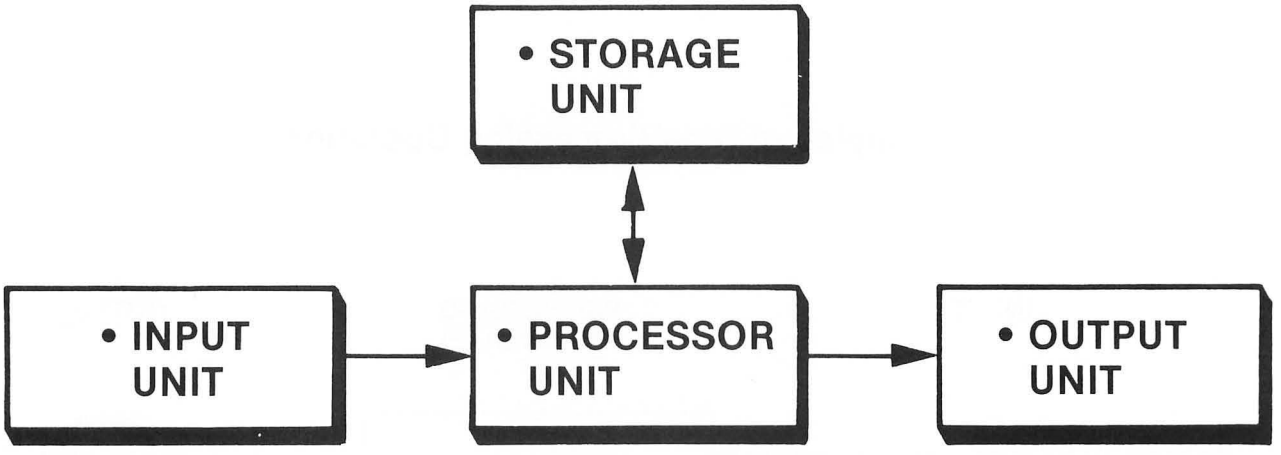


Examples of Data Processing Operation





BOX Diagram
Showing
Basic Parts of a Computer



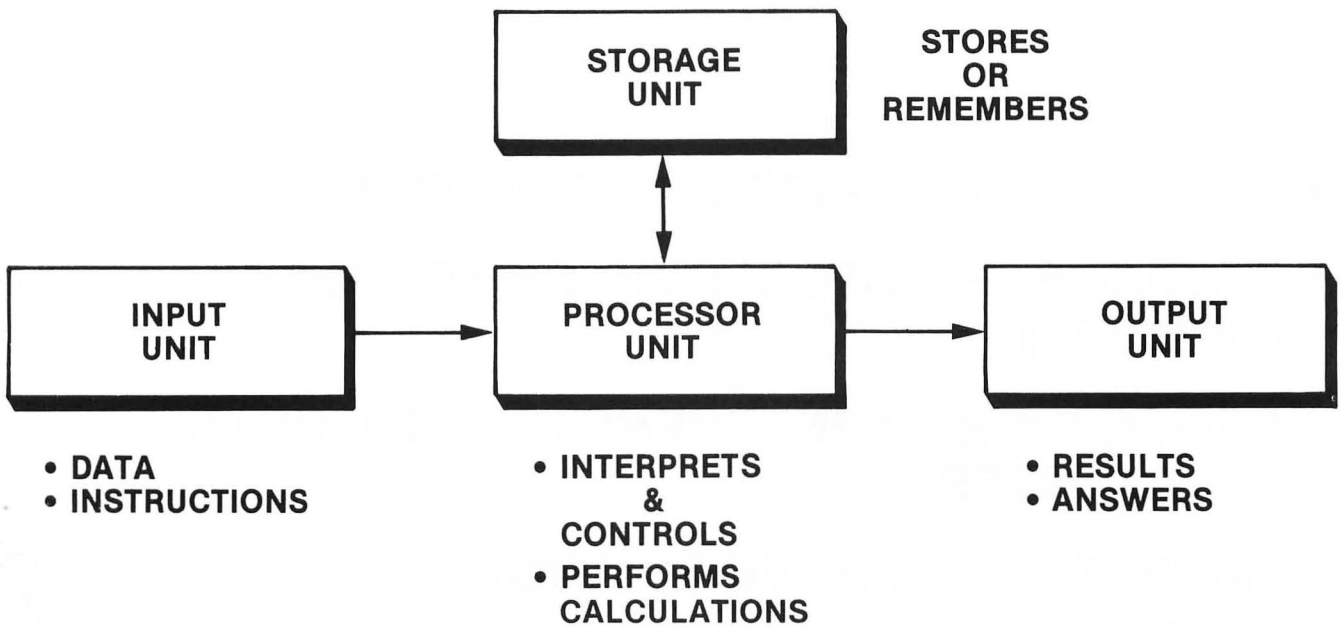
Stores or Remembers

- **Storage unit (memory)**
  - **— Stores both information and instructions until needed (requested)**

Interprets, Controls, & Calculates

- PROCESSOR UNIT
  - — INTERPRETS (DECODES) INSTRUCTIONS AND REGULATES (CONTROLS) THEIR EXECUTION
  - — PERFORMS ALL OF THE CALCULATIONS

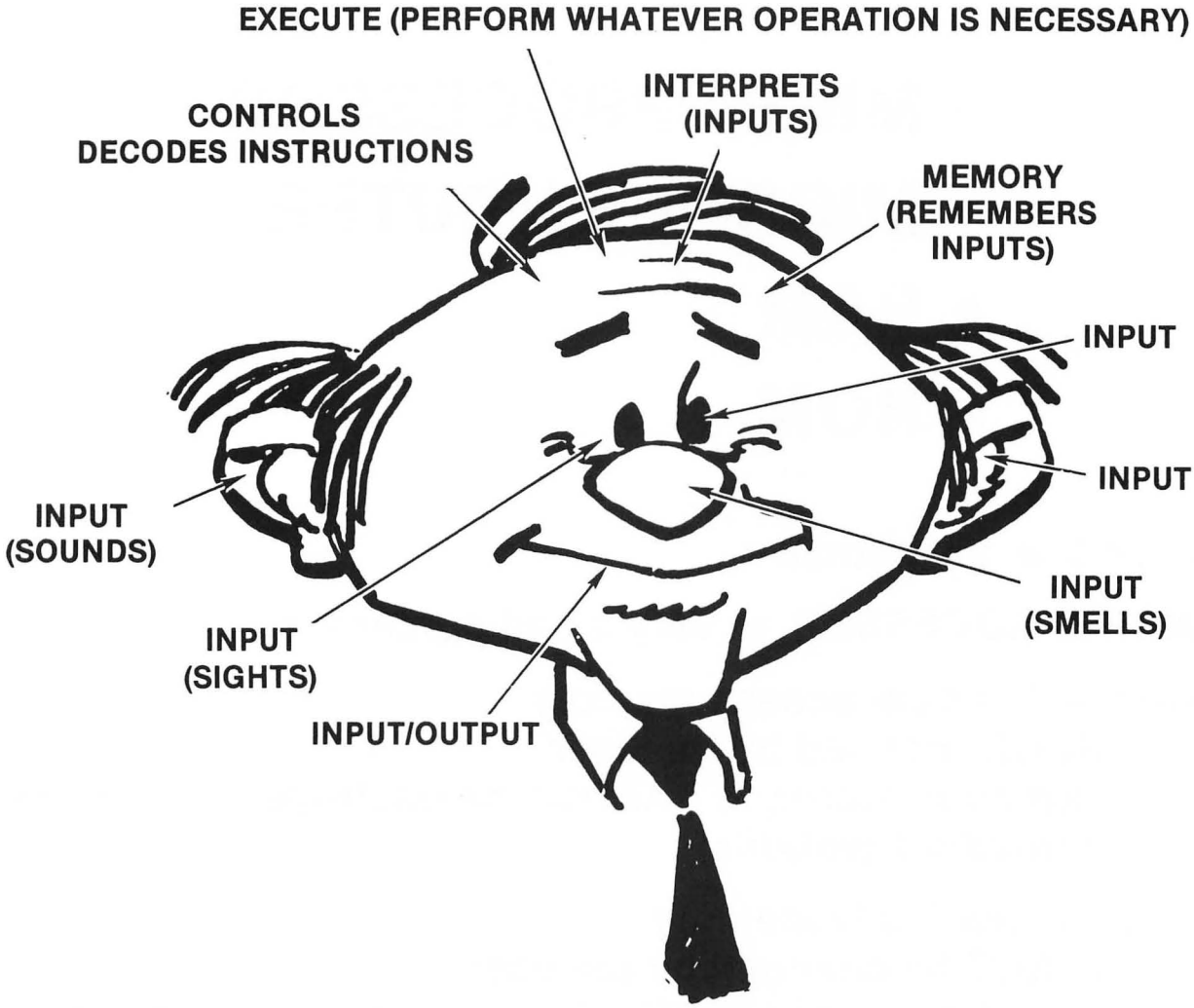
Box Diagram of a Basic Computer System



What We Have Learned

- INPUT ⟶ PROVIDES INSTRUCTIONS AND DATA
- STORAGE ⟶ STORES OR REMEMBERS (MEMORY)
- PROCESSOR ⟶ INTERPRETS, CONTROLS, & CALCULATES
- OUTPUT ⟶ PROVIDES ANSWERS AND RESULTS

"Human Computer"
Man Can Think But Computer Can't!

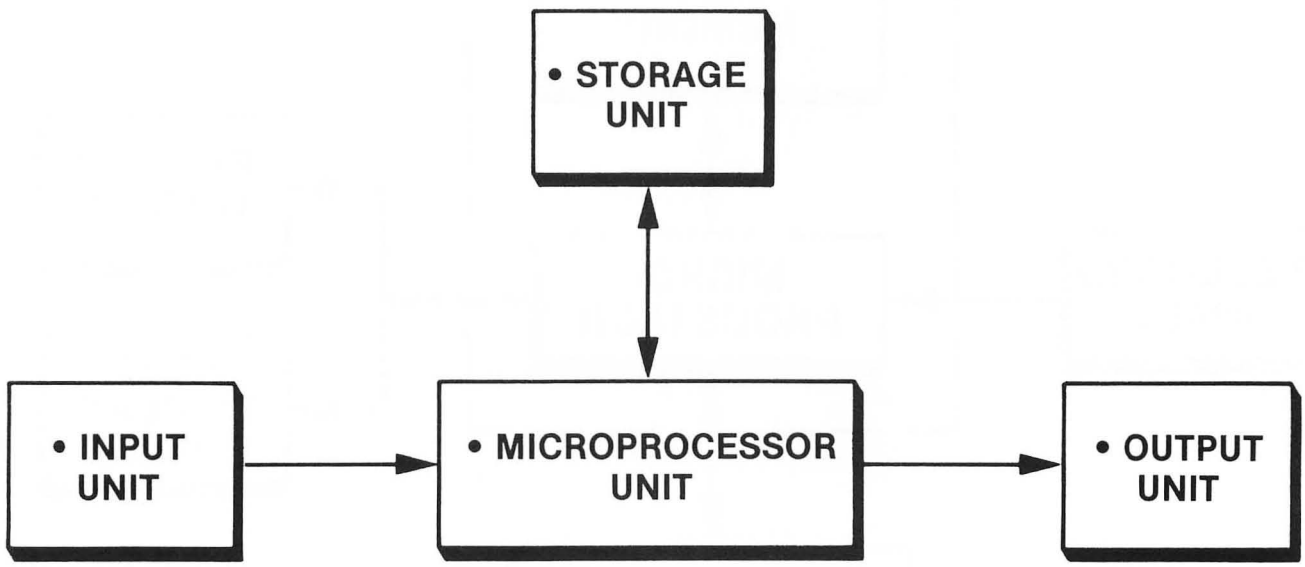


Some Terms You Should Know

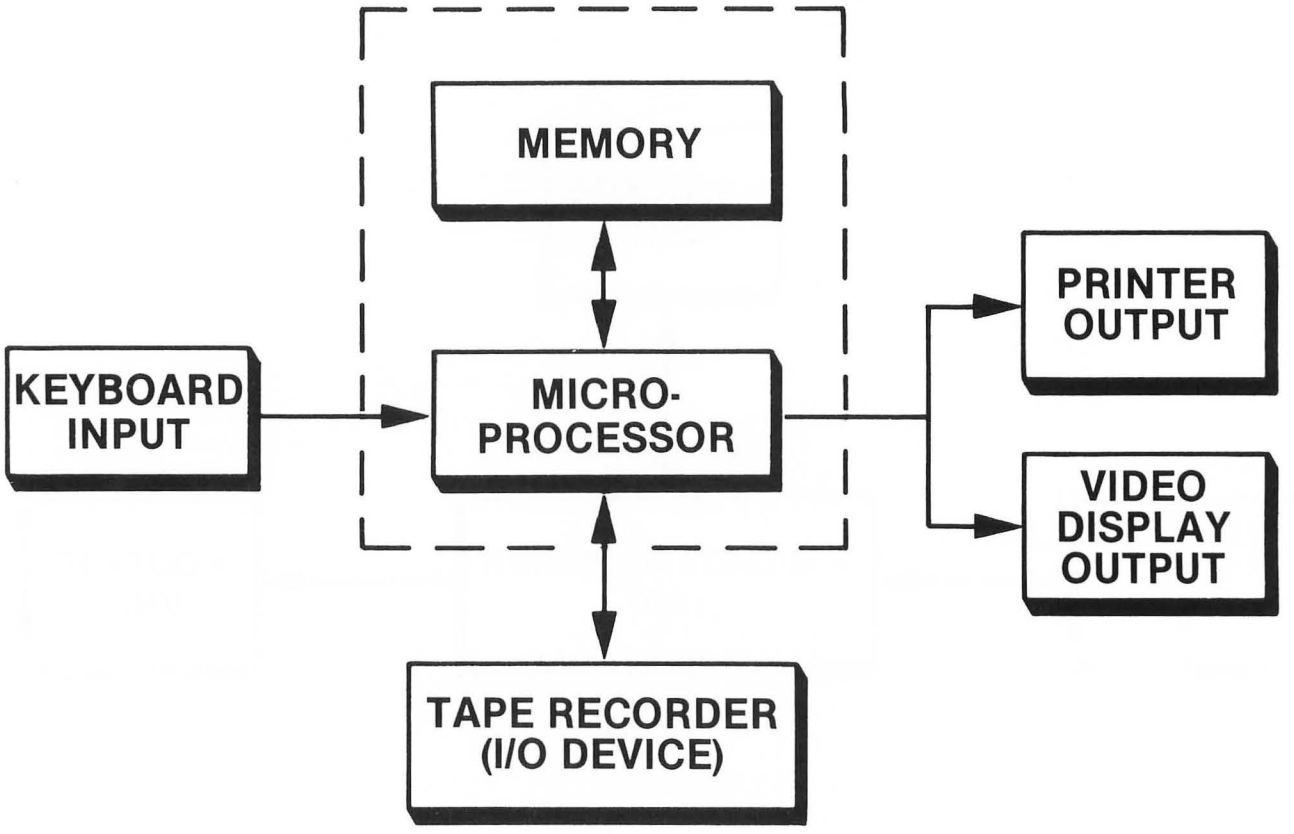
- **MICROPROCESSOR**
- **MICROCOMPUTER**
- **RAM**
- **ROM**

- MICRO = Very small
- MICROPROCESSOR = Very small processor
- RAM = Random access memory
  - — CAN BE changed by the user
  - — Information stored in RAM will be destroyed if power fails or turned-off (volatile)
- ROM = Read only memory
  - — CANNOT be changed by the user
  - — Information stored in ROM is not destroyed if power fails or is turned-off (non-volatile)
  - — Control program (BASIC interpreter) stored here

Box Diagram of a Microcomputer



Basic Components of the Atari Computer



Atari 400 Microcomputer

Courtesy of Atari, Inc.

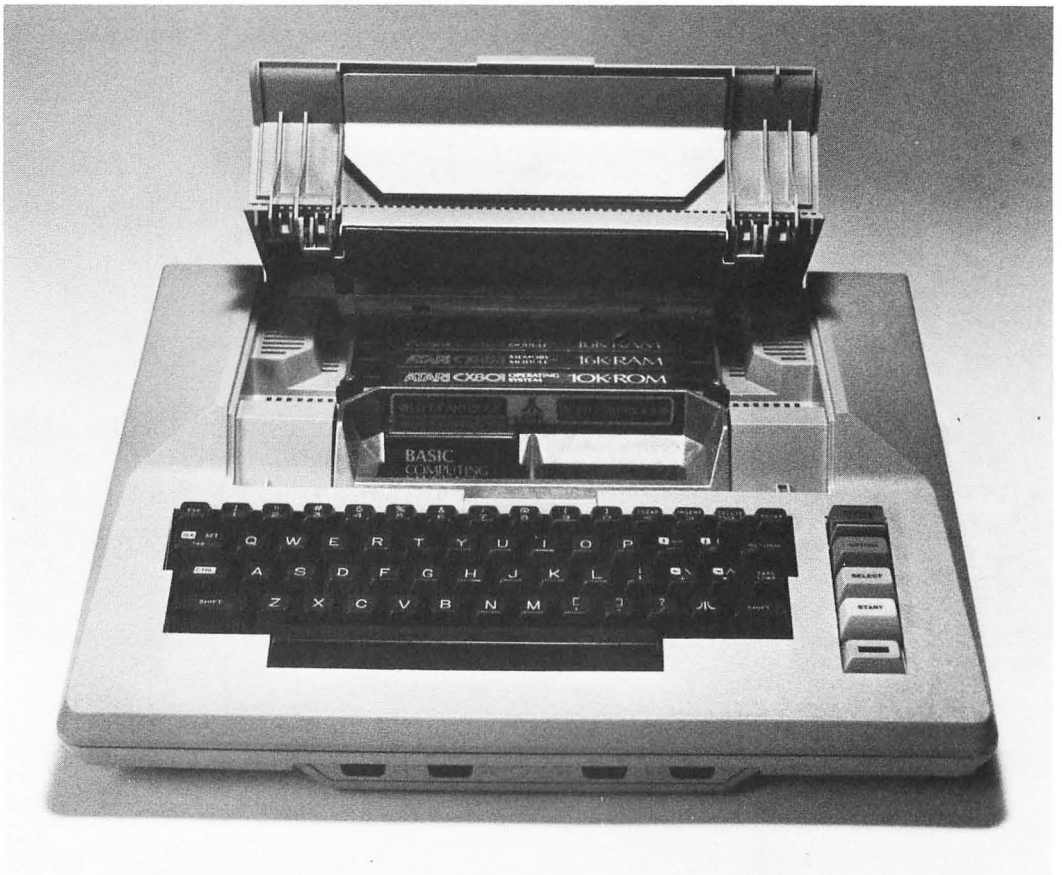
Atari 1200XL Microcomputer

Courtesy of Atari, Inc.

Atari 800 Microcomputer

Courtesy of Atari, Inc.

Atari 800 with Cartridge Slots Visible



Courtesy of Atari, Inc.

What We Have Learned

DATA PROCESSING OPERATION STEPS:	BASIC COMPUTER PARTS:	MICROCOMPUTER PARTS:
• INPUT →	• INPUT UNIT →	• INPUT UNIT
• PROCESSING →	• PROCESSOR UNIT + MEMORY UNIT →	• MICROPROCESSOR + MEMORY
• OUTPUT →	• OUTPUT UNIT →	• OUTPUT UNIT

PRACTICE 1

Box Diagram of a Computer

1. Draw the BOX DIAGRAM of a BASIC computer.
   a. Label each box with the correct name.
   b. List the functions of each box.

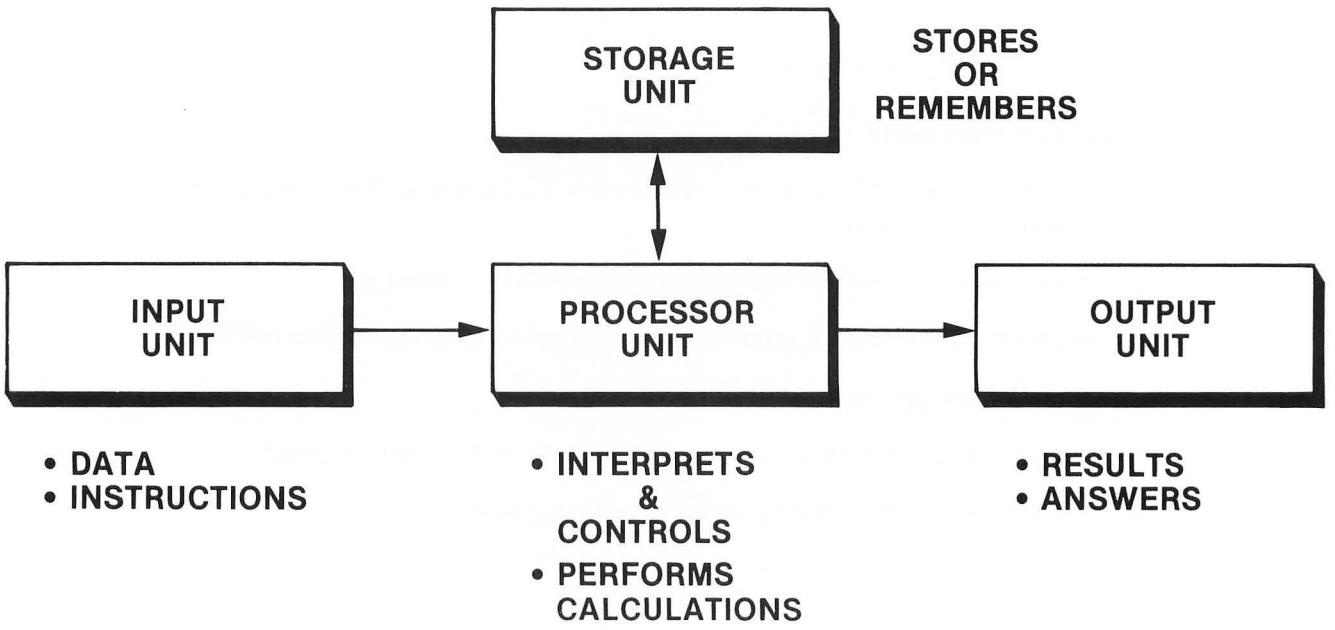
PART 2

The Software (The "Program")

What You Will Learn

1. To define the terms hardware, software, BASIC, binary, and interpreter, and to relate them to computers.
2. That computers speak a foreign language: machine language.
3. How humans talk to computers via a programming language called BASIC.
4. To identify the principal parts of a BASIC program.
5. To identify and explain the purpose of all the keys on the Atari keyboard.
6. How to connect and power up an Atari microcomputer.

Box Diagram of a Basic Computer System



More Terms You Should Know

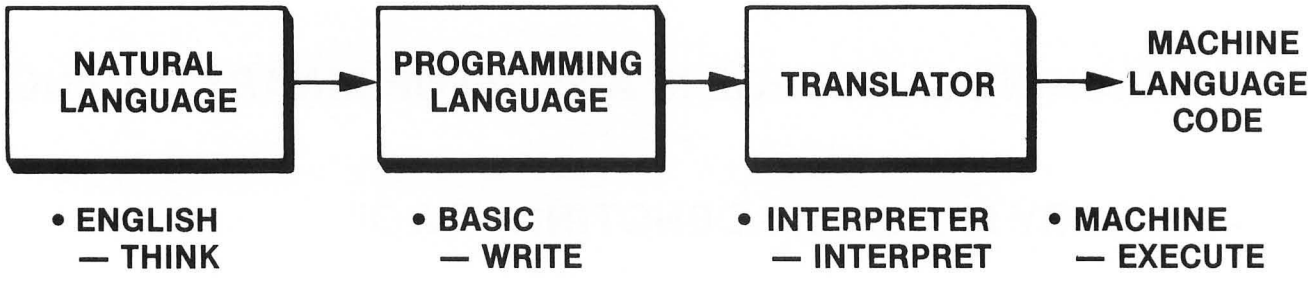
- **HARDWARE**
  - **— THE COMPUTER AND COMPUTER RELATED EQUIPMENT (THE BOXES)**

- **SOFTWARE**
  - **— THE INSTRUCTIONS FOR THE COMPUTER (THE PROGRAM)**

Computers Speak a Foreign Language! (No Speak English, French, German Spanish, or Any Other Natural Language)

- **COMPUTERS SPEAK IN *MACHINE* LANGUAGE**
  - **MACHINE LANGUAGE IS A FORM OF *BINARY* CODING**
  - **BINARY IS A WORD DENOTING "TWO"**
  - **MACHINE LANGUAGE USES TWO BASIC SYMBOLS: "Ø" AND "1"**

How Humans Talk to Computers



- ENGLISH — THINK
- BASIC — WRITE
- INTERPRETER — INTERPRET
- MACHINE — EXECUTE

- **BASIC**

  (Beginner's all-purpose symbolic instruction code)

  — Popular programming language for writing instructions to the computer

- **INTERPRETER**

  — Translates BASIC into machine code
  — (You really don't have to know anything about an interpreter since it is used automatically when you run a BASIC program)
  — Located in the ROM in Atari

To Program You Must Learn the Language First!

A Comparison between English and BASIC

ENGLISH LANGUAGE

- **Words**
  - — Used to make sentences
- **Sentences**
  - — Used to make paragraphs
- **Paragraphs**
  - — Lengths vary
- **Commands**
  - — Can be one word
  - — e.g., STOP! HALT!
- **Sentence Numbers**
  - — Optional (seldom used)

BASIC PROGRAMMING LANGUAGE

- **Key Words**
  - — Used to make statements
- **Statements**
  - — Used to make programs
- **Programs**
  - — Lengths vary
- **Commands**
  - — Executed immediately
  - — e.g., NEW, LIST, RUN
- **Line Numbers**
  - — Must be used for each statement

Learning a New Vocabulary

Here Are the Key Words and Commands You'll Learn:

KEY WORDS

- PRINT
- END
- LET
- INPUT
- GOTO
- IF --- THEN
- REM
- STOP
- FOR --- NEXT
- READ-DATA

COMMANDS

- NEW
- LIST
- RUN
- CONT

Commands vs. Statements

COMMANDS

— **Executed as soon as you type them and press RETURN**

STATEMENTS

— **Put into programs and are only executed after you type the command RUN and press RETURN**

A BASIC Program

	LINE NUMBER	KEY WORD	OTHER PART OF THE STATEMENT	"LOOK AT" REQUEST*
1st STATEMENT	1Ø	PRINT	"HELLO THERE"	RETURN
2nd STATEMENT	2Ø	PRINT	"YOUR NAME"	RETURN
3rd STATEMENT	3Ø	END		RETURN
COMMAND	RUN			RETURN

*Pressing the RETURN key tells the computer to "LOOK AT" (and store) what you have just typed. You must press this key after each statement or command.

Line Numbers

- Serve as a guide to the computer in running the program.
- Tell the computer in what order it should carry out your instructions.
- Computer will start executing at lowest numbered line unless told to start elsewhere.
- Normally are multiples of 5's, 10's, or some other multiples to leave space for inserting new program lines between old one.
- Although it is perfectly legal to number program lines more closely (like 1, 2, 3, 4, etc.), don't do it!

Key Words

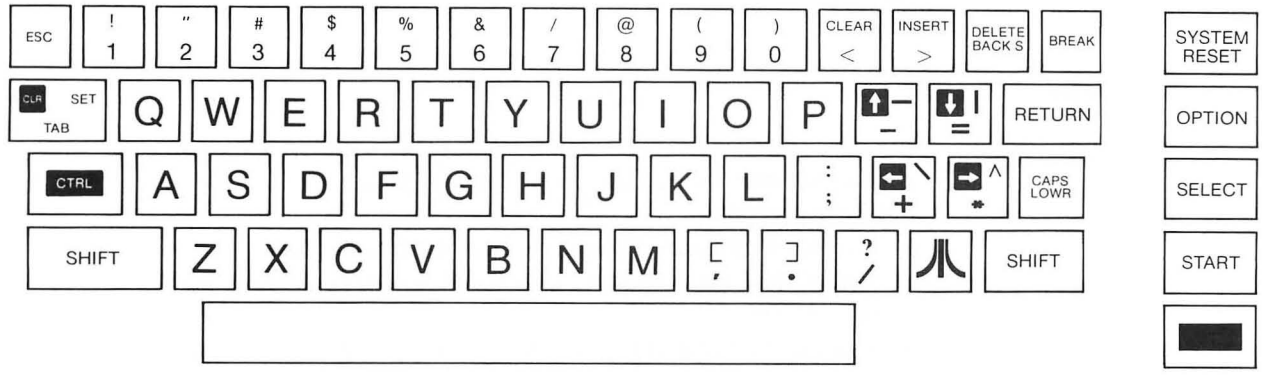
- Never used alone
- Need line number
- Always part of a BASIC statement that has some other part to it*
- Executed only after command RUN is typed and RETURN key is pressed

*To the purist, we know that key words like END and STOP can be used alone; but you still need line numbers, and you must type RUN and press RETURN to execute.

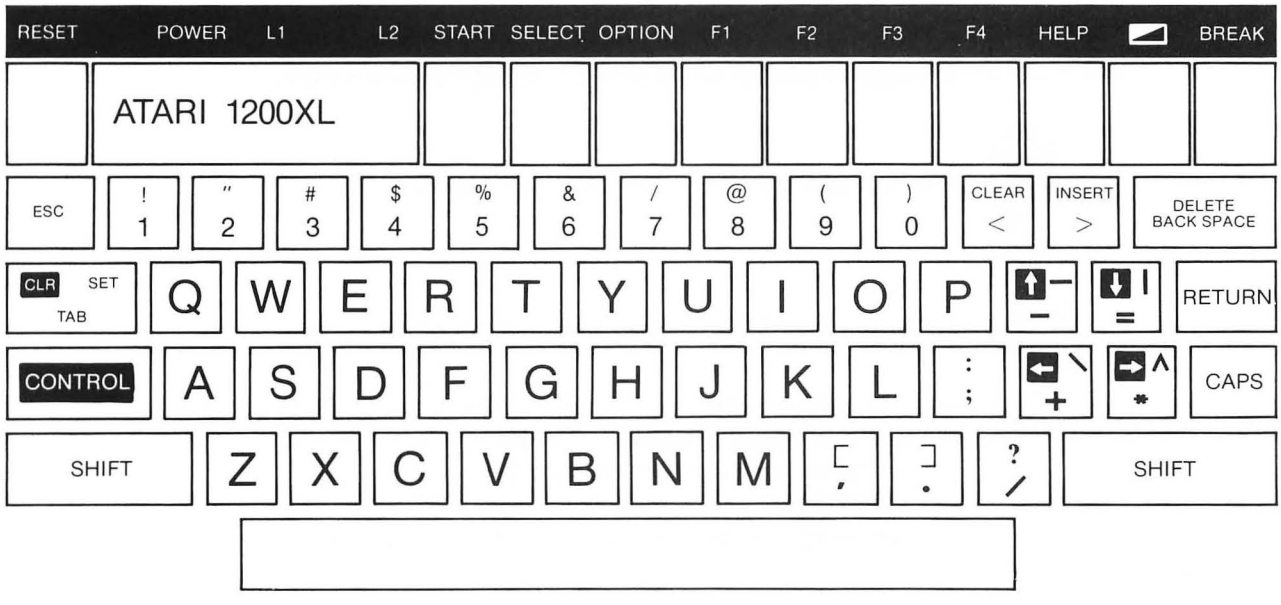
What We Have Learned

- **Key words**
  - **— Used to make statements**
- **Statements**
  - **— Must have line numbers and key words**
  - **— Used to make programs**
- **Programs**
  - **— May vary in length**
- **Commands**
  - **— Executed as soon as you type them and press RETURN**

KEYBOARD FOR ATARI 400 AND ATARI 800



KEYBOARD FOR ATARI 1200 XL



Special Function Keys on the Atari Keyboard

KEY	FUNCTION
CTRL	• Stands for CONTROL. Several keys have an additional function that is obtained by holding down the CTRL key while the other keys are pressed. — Control characters are special characters that appear on the screen and are used to make special displays. They are also used to edit programs.
ESC	• Stands for ESCAPE. It is used to perform special functions in a program. — ESC unlike CTRL key does not have to be held down while typing another key. (Forget about EDIT mode for now.)
SYSTEM RESET	• Press this key if your Atari computer does not respond correctly to your instructions. (If this does not work try turning your Atari on and off again. Of course, if you do this you will lose your program.) Caution should be exercised, especially if a disk drive is active, since it could possibly lose or damage data.
INSERT >	• Pressing this key while pressing SHIFT inserts a line. • Pressing this key while pressing CTRL inserts a space.
400/800 →  1200 → 	• Cause display to show characters in inverse.
CAPS LOWR	• Causes the Atari to display text in upper or lower case.
RETURN	• Causes the computer to "look at" line you just typed in and to act accordingly. This key must be pressed each time you want to enter a line from the keyboard. — RETURN also causes the cursor to "RETURN" to the screen's left edge (a line down from where it was).

Special Function Keys on the Atari Keyboard (cont'd)

KEY	FUNCTION
SHIFT	• Some keys have two characters printed on them. This key permits you to type upper characters such as quotes ("). Hold down SHIFT key while typing key with two symbols if you want to type the upper symbol.
CLEAR <	• Holding down SHIFT and pressing CLEAR < will clear the screen.
DELETE BACK S	• Deletes the character at the location of the cursor and moves the cursor one space left.
	• Holding down SHIFT and pressing DELETE BACK S will delete the entire line, no matter where the cursor is on the line. Cursor then returns to first position on line.
BREAK	• Stops program execution.
CLR SET TAB	• Pressing this key while pressing SHIFT sets the TAB position. • Pressing this key while pressing CTRL clears the TAB position. • Pressing this key alone moves the cursor to the next TAB setting.

Control (CTRL) Key Functions

KEY	FUNCTION
CTRL	• Stands for "CONTROL." Holding down this key while other keys are pressed causes the computer to perform different actions. Here are some examples:
CTRL 1	— Stops a program listing. To restart the program listing, type CTRL 1 again.
CTRL 2	— Causes the computer to "BEEP." CTRL 2 is called a "BELL" because the present keyboard design is based on the teletype where CONTROL 2 actually rings a bell.
CTRL DELETE BACK S	— Deletes next character to the right of cursor but does not affect cursor position.

Cursor Positioning

Cursor positioning allows the cursor to be moved anywhere on the screen without affecting text. This is very useful for editing without having to retype the entire program line.

To use the arrow keys, CTRL must be pressed while pressing the particular arrow key.

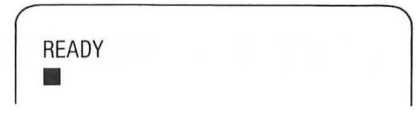
KEY		FUNCTION
CTRL		— Moves the cursor left.
CTRL		— Moves the cursor up.
CTRL		— Moves the cursor down.
CTRL		— Moves the cursor right.

Atari Power-Up Rules

ACTION

1. Make certain system is connected properly. (This procedure assumes you are not using a disk.)
2. If the tape recorder is connected, it should be in the *STOP* mode.
3. Turn on the video display and set the RF modulator to "Computer." (Make certain that channel selection on the television knob matches that on the computer.)
4. Turn on the Atari. The switch is on the right side of the computer next to where the power cord plugs in. Push this switch into the upward position.
5. The display should appear as shown. → (The inverse square is called the "cursor.")
6. If your display does not look as shown in the description above, do the following:
   (a). If your Atari doesn't seem to respond correctly, a press of the SYSTEM RESET key will usually remedy the problem.
   (b). If pressing the SYSTEM RESET doesn't work, turning the Atari off and then turning it back on again will probably correct the problem.

DISPLAY



Getting It Together

- STEP 1 — WRITE YOUR PROGRAM
- STEP 2 — GET THE COMPUTER READY
- STEP 3 — ENTER YOUR BASIC PROGRAM
- STEP 4 — RUN YOUR PROGRAM
- STEP 5 — SIGN OFF

PRACTICE 2

Becoming Familiar with the Atari

Become familiar with the Atari by doing the following (you should actually go through every step):

1. Power up (turn on) the Atari using the power-up rules (see page 35).
2. How many power buttons did you have to press? _____
3. Where were the buttons located? _____
4. Where is the [SYSTEM RESET] button located? _____
5. Where is the power indicator located? _____
6. Locate the [SHIFT] key.
   a. How many [SHIFT] keys are there on the keyboard? _____
   b. Hold down the [SHIFT] key and press every key that has a second character on the key (e.g. ! and #). What happened? _____
   c. What happened when you held down the [SHIFT] key and pressed [2]? _____
   d. Now hold down the [CTRL] key and press [2]. What happened? _____
7. Locate the [DELETE BACK S] key.
   a. Press the [SHIFT] [CLEAR] keys. (This should clear the screen with the exception of the cursor (■).)
   b. Type the following (just as shown)
      PRINT "CAT" ■
      ↑
      cursor
      What does the cursor do each time you type a character? _____
   c. Press the [RETURN] key. What happened? _____
   d. Try additional examples until you feel comfortable. Use the [DELETE BACK S] key.
8. Locate the [CTRL] and [ESC] keys. You will learn more about them later.

PART 3

Your First Computer Program

What You Will Learn

1. To enter and run your first BASIC program.
2. To explain the purpose and use of the following BASIC commands: LIST, NEW, RUN.
3. To explain the purpose and use of the following key words: PRINT, PRINT (for spacing), REM, END.
4. To explain the purpose and use of the following special function keys: [CTRL], [RETURN], [SHIFT], [SYSTEM RESET], [ESC], [DELETE BACK S]
5. To explain the purpose and use of the following miscellaneous points:
   - cursor, " " (quotes), line numbers, system-reset button, power-up rules.

(Review)

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(Review)

Special Function Keys on the Atari Keyboard (cont'd)

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(Review)

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(Review)

Atari Power-Up Rules

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4. Turn on the Atari. The switch is on the right side of the computer next to where the power cord plugs in. Push this switch into the upward position.	
5. The display should appear as shown. → (The inverse square is called the "cursor.")	READY ■
6. If your display does not look as shown in the description above, do the following:	
(a). If your Atari doesn't seem to respond correctly, a press of the SYSTEM RESET key will usually remedy the problem.	
(b). If pressing the SYSTEM RESET doesn't work, turning the Atari off and then turning it back on again will probably correct the problem.	

Typical Display Readout

```
10 PRINT "HELLO THERE"

20 PRINT "YOUR NAME"

30 END

RUN
```

Writing Your First Computer Program

YOUR ACTION	DISPLAY
1. Before you start typing your program, always type NEW and press the RETURN key.	
2. Type the line exactly as shown: ⟶	10 PRINT "HELLO THERE NAME!" ■ Ⓐ
3. Use SHIFT key to type the upper characters like the quotation marks (") and the exclamation point (!).	
4. Do *not* press RETURN key yet!	
5. Go back and examine your typed line *very carefully*. Did you make a mistake? If you did, just press ← while holding down the CTRL key.	
6. Is everything OK? If it is, you can press RETURN. (This tells the computer to "look at" what you just typed in).	10 PRINT "HELLO THERE NAME!" ■
7. When the cursor appears as shown, the computer is saying, "It's your turn . . . I'm waiting for you."	

NOTE
Ⓐ Insert student's name

Go to next page

Common Errors

- Missing quotes (")
- Too many quotes
- Forgot the key word PRINT
- Forgot the line number
- Forgot to press RETURN
- Used the character "O" for the number "ZERO" (Ø).

(Note: A slash is used to help you to recognize a zero.)

Writing Your First Computer Program — Almost? (Errors)

PROBLEM (You Forgot to Follow Instructions)	SOLUTION
1. MISSING QUOTES (") — You forgot to enclose everything after the word PRINT in quotation marks. (If you want something printed, don't forget the quotation marks!)	• If you have already pressed RETURN, you must retype the entire line to correct your error. Here is how you do it:
2. TOO MANY QUOTATION MARKS — You typed too many. (That won't work either!)	• Type in the same line number you wish to change (1Ø in this case). That is, if you want the computer to replace that line with the corrected line.
3. FORGOT THE KEY WORD PRINT — You forgot to type PRINT. (How will the computer know you want to print if you don't tell it to print?)	• Next, retype the line exactly as shown on previous page. (But follow directions this time, Dummy!)
4. FORGOT TO TYPE THE LINE NUMBER (1Ø) — Line numbers tell the computer where to start. The computer always starts executing from the lowest numbered line unless you tell it to start elsewhere. (We will show you how to tell the computer to start at another line later. Keep the faith!)	• Then, check line over for errors. • If everything is OK, don't forget to press RETURN! When you press RETURN it tells the computer to "look at" what you just typed and to act accordingly.

Read this page if you had any errors! Then correct your errors before going to the next page!

Executing Your Program

YOUR ACTION	DISPLAY
1. Tell the computer to execute or run your program. The command for this is simple: RUN. 2. So type *RUN* and press RETURN. 3. If you made no mistakes, the display will read: ——→ 4. If it did not work, try again (i.e., check your program for errors). 5. If it did work, let out a yell, "HEY, I CAN DO IT TOO!"	HELLO THERE NAME! READY ■

Go to next page (if you completed this one OK)

Using the Cursor Keys to Save Time

YOUR ACTION	DISPLAY
1. You typed Line 10 as shown but have *not* pressed RETURN (cursor at the end of that line indicates you have not pressed RETURN).	10 PRINT "AUBREY" ■ ↑ cursor
2. You wish to change the "B" to a "D" or to PRINT AUDREY. So you press the CTRL keys to move the cursor to the left one space at a time.	10 PRINT "AUBREY" ↑ (cursor)
3. Now type "D" but *don't* press RETURN yet. (Note that the cursor has moved to the next letter "R.")	10 PRINT "AUDREY" ↑ (cursor)
4. If you have finished typing the line and everything is correct, press RETURN . (Note that after you press RETURN the cursor moved to the beginning of the next line.)	10 PRINT "AUDREY" ■←(cursor). 10 PRINT "AUDREY" READY ■

Some Helpful Keys and Commands to Remember

ACTION	KEY(S) TO PRESS	COMMAND
• Enter data	RETURN	—
• Clear the screen	Hold down SHIFT and press CLEAR	PRINT CHR$(125)
• Stop the program execution	BREAK	STOP
• Continue program execution	Type C O N T, then press RETURN	CONT
• Stop program listing	Press CTRL and 1	—
• Continue program listing	Press CTRL and 1	—
• Backspace	DELETE BACK S	—
• Type upper symbol on key	Press SHIFT and, desired key	—
• Reset	SYSTEM RESET	—

Expanding Your Program

YOUR ACTION	DISPLAY
1. You now have a program in the computer. (Unless you turned it off. If you did, retype line as shown): →	1Ø PRINT "HELLO THERE NAME"
2. Type in line 2Ø *exactly* as shown: →	2Ø PRINT "I'M GOING TO MAKE YOU A SUPE RSTAR!"
3. Check your new line (2Ø) *very carefully*, especially the quotation marks.	READY ■
4. Everything OK? Press RETURN. (Remember, always press RETURN if you want the computer to look at what you typed.)	
5. Let's run your program. Type RUN and press RETURN.	
6. If you did it right, the screen will read:	HELLO THERE NAME! I'M GOING TO MAKE YOU A SUPERSTAR!
7. If it did not work, check your program for errors.	

Go to next page

Using the Print Statement for Spacing

YOUR ACTION	DISPLAY
1. Look at your video display. Would you like more space between the two lines? OK, this is how you do it.	HELLO THERE NAME! I'M GOING TO MAKE YOU A SUPERSTAR! READY ■
2. Type in a new line as shown ⟶ and then press RETURN.	15 PRINT
3. Now type *RUN* and press RETURN	
4. WOW! A *PRINT* "nothing" puts a space between what you told the computer to print in Lines 1Ø and 2Ø.	HELLO THERE NAME! I'M GOING TO MAKE YOU A SUPERSTAR! READY ■
5. Observe that the PRINT statement (Line 15) was placed between Lines 1Ø and 2Ø. Since you were smart enough to number your lines by 1Ø's, it was much easier to modify your program. (That's because you left room to insert new lines between the old ones.) Although it is perfectly legal to number program lines more closely (like 1, 2, 3, 4), don't do it.	

Go to next page

Inserting Remarks into a Program (But Not Printing Them Out)

YOUR ACTION	DISPLAY
1. Another important key word is REM, which stands for remark. It is often convenient to insert remarks into a program. The main reason for inserting remarks is so you or someone else can refer to them later and know what the program is for and how it is used.	
2. When you tell the computer to execute the program by typing RUN and pressing RETURN, it will skip right over any number line that begins with the key word REM. The REM statement will have no effect on the program. (Let's see about that!)	
3. Type Line 5 exactly as shown and then press RETURN	5 REM MY FIRST COMPUTER PROGRAM
4. Type RUN and press RETURN.	
5. It is the same as before (REM statement was not printed).	HELLO THERE NAME! I'M GOING TO MAKE YOU A SUPERSTAR!

Go to next page

Listing Your Program
(Looking At Your Program to See What It Contains)

YOUR ACTION*	DISPLAY
1. To list your program is easy. The command is LIST.	
2. Now you type LIST and press [RETURN]:	5 REM MY FIRST COMPUTER PROGRAM 1Ø PRINT "HELLO THERE NAME!" 15 PRINT 2Ø PRINT "I'M GOING TO MAKE YOU A SUPE RSTAR"
3. Also, you might only want to list one line. Type LIST 2Ø and press [RETURN] and the screen will display:	2Ø PRINT "I'M GOING TO MAKE YOU A SUPE RSTAR"
4. You might also want to list several program lines, starting at one line and ending at another. For example, type LIST 1Ø, 2Ø and [RETURN].	1Ø PRINT "HELLO THERE NAME!" 15 PRINT 2Ø PRINT "I'M GOING TO MAKE YOU A SUPE RSTAR!"

***Type [SHIFT] [CLEAR] and press [RETURN] so you can start with a clean display.**

Go to next page

Ending Your Program

YOUR ACTION

1. **The end of a program is the last statement you want the computer to execute. Most computers require you to place an END statement after this point, so the computer will know it is finished. However, the Atari does *not* require an END statement. (Other computers might require it though.)**
2. **Let's add an END statement to your program. Type and enter: ⟶**
3. **Now type RUN and press RETURN.**
4. **No change from before! The program ended, but it did not print "END."**
5. **Let's make it print the END. (How do we do that?)**
6. **Oh, I remember! We need a PRINT statement. So let's try it. Type and enter: ⟶**
7. **Now *RUN* your program.**
8. **IT WORKED AGAIN! (If not, check the program.)**
9. **Note that there is no space between THE END and the line above it. Why? Because you did not tell the computer to put a space between them!**

DISPLAY

```
99 END
RUN
HELLO THERE NAME!

I'M GOING TO MAKE YOU A SUPERSTAR!

READY
■
```

```
98 PRINT "THE END"
```

```
HELLO THERE NAME!

I'M GOING TO MAKE YOU A SUPERSTAR!
THE END

READY
■
```

Learned in This Session

COMMANDS*

- SHIFT CLEAR <
- LIST
  — LIST MM
- NEW
- RUN
  — RUN MM

* Executed as soon as you type them and press RETURN

KEY WORDS**

PRINT "MESSAGE"
PRINT (SPACE)
REM
END

** Used to make statements. Statements are executed after you type RUN and press RETURN

MISCELLANEOUS

■ CURSOR

" " QUOTATION MARKS

LINE NUMBERING

POWER (light)

- KEYBOARD LAYOUT
- ATARI POWER-UP RULES

SPECIAL FUNCTION KEYS

CTRL CONTROL

ESC ESCAPE

RETURN

SHIFT

DELETE BACK S

SYSTEM RESET

NOTE: If you don't understand everything on this page, stop!
Go back over this session until you understand it thoroughly!
MM = Any line number (e. g., 1Ø, 2Ø, 3Ø, etc.)

Assignment* 3-1

1. WRITE* A PROGRAM TO PRINT ON SEPARATE LINES
   - A. Your Name
   - B. Your Entire Address
   - C. Your Telephone Number
2. EXPAND* YOUR PROGRAM TO INCLUDE THE FOLLOWING:
   - A. Remark Statement to Describe Your Program
   - B. Spacing between Each of the Lines Displayed (Printed)
   - C. Include an End Statement
3. TYPE YOUR PROGRAM AND PRESS RETURN
4. RUN YOUR PROGRAM
5. LIST YOUR PROGRAM

* WRITE YOUR PROGRAM ON PAPER AND GET IT CHECKED BY YOUR TEACHER FIRST.

PRACTICE 3

Writing and Running Your First Program

1. Write a program to PRINT the following:
   a. Your name (first and last)
   b. Your school's name
   c. Your teacher's name
2. Enter and RUN it.

PRACTICE 4

Inserting Remarks and Spacing into Your Program

1. If you have erased the program from Practice 3, rewrite the program and do the following: (If you still have the program from Practice 3 in the computer, you do not have to rewrite the program.)
   a. Add a new program line with a remark statement to your program (any remarks you want to make).
   b. Have the computer insert one space between your name and your school's name in the output on the display (that is, you add the necessary program line).
   c. Have the computer insert two spaces between your school's name and your teacher's name in the output on the display.

PRACTICE 5

Listing and Ending Your Program

1. Rewrite the program from Practice 4 and do the following (Again, if you have the program in the computer, you don't have to rewrite it. But in case you don't know what is in the computer, just type NEW and rewrite the program.):
   a. Add an END statement to tell the computer it is the end of your program.
   b. Add a statement to have your computer PRINT "The END."
   c. RUN your program.
2. List your program.
   a. How large is your program now? (How many lines?)
   b. Copy the program in your notebook.

PART 4

More Programming Tools

What You Will Learn

1. To enter and run more BASIC programs: mathematical programs, area of rectangle program.
2. To explain the order of mathematical operations using the M.D.A.S. rule.
3. To explain the purpose and use of the keyword: LET.
4. To explain the purpose and use of the BASIC mathematic operators: multiply (*), divide (/), add (+), subtract (—), exponentiate or raising a number to a power (^).
5. To explain the function and use of commas, semicolons, and print zones.
6. To list and identify variables that can be used with Atari BASIC.

Review of Part 3

COMMANDS*

- SHIFT CLEAR <
- LIST
  — LIST MM
- NEW
- RUN
  — RUN MM

* Executed as soon as you type them and press RETURN

KEY WORDS**

PRINT "MESSAGE"
PRINT (SPACE)
REM
END

** Used to make statements. Statements are executed after you type RUN and press RETURN

MISCELLANEOUS

■ CURSOR

" " QUOTATION MARKS

LINE NUMBERING

POWER (light)

- KEYBOARD LAYOUT
- ATARI POWER-UP RULES

SPECIAL FUNCTION KEYS

CTRL CONTROL

ESC ESCAPE

RETURN

SHIFT

DELETE BACK S

SYSTEM RESET

NOTE: If you don't understand everything on this page, stop!
Go back over this session until you understand it thoroughly!
MM = Any line number (e. g., 1Ø, 2Ø, 3Ø, etc.)

Math Operators

= (Equal)

+ (Add)

– (Subtract)

* (Multiply)

/ (Divide)

∧ (Exponentiation)

(∧) means raising a number to a power like 2^2, 2^3, or 2^4

Order of Arithmetic Operations

- **Multiply → Divide → Add → Subtract**
  (Left to Right)
  — "My Dear Aunt Sally"

- **If Parentheses are used**
  — Innermost level operations first
  — Then next level out
  — M.D.A.S. order inside parentheses

Order of Operations Example — (Without Parentheses)

- If there are no parentheses, the computer performs operations by going from left to right doing exponentiation operations ($\wedge$) first. Then (*) and (/) are done in order from left to right and finally (+) and (−) are done in order from left to right. (Remember M.D.A.S.!)

Example:

4 + 5 * 4 $\wedge$ 3 − 4/2 =
4 + 5 * 64 − 4/2 =
4 + 320 − 4/2 =
4 + 320 − 2 =
324 − 2 = 322

Order of Operations Example — (With Parentheses)

- If there are parentheses, the computer starts at the inner pair of parentheses and converts everything to a single number. Then the computer repeats the process with the next pair of parentheses working "inside" out.

Example:

((6 + 4) * 2) /4 =

(10 * 2) /4 =

20 /4 = 5

In-Class Exercise 4-1

You Try Some Now (Without Parentheses)

1) 2 ∧ 3 + 4 * 5 − 4/2 * 5 = _____
2) 14 − 2 * 2 + 6 − 2 * 3 * 2 = _____
3) 14/2 * 3 − 2 ∧ 3 + 4 = _____

Now Try Some With Parentheses

1) 6 + (9 * 2) = _____
2) (6 + (9 * 2)) * 5 = _____
3) 3 * ((4 + (6 * 2)) * (9/3 − 1)) = _____

A computer is not required here, but it could be used to check the answers. You don't need a line number for calculator mode. Simply type PRINT and the calculations you want done. Example: If you wish to multiply 2 asterisk 3, simply PRINT 2 * 3 and press RETURN. The answer (6) will be displayed.

Tips on Using Parentheses — Summary

- When in doubt, use parentheses. They can't do any harm!
  — Use parentheses around operations you want performed first
- Make sure that every left parenthesis has a matching right parenthesis
  — Count them to be sure!
- Order of Operations
  — Inner most pair of parentheses first (M.D.A.S. rule inside parentheses)
  — Then work "inside" out
  — In case of a "tie," computer starts to the left and works right doing exponentiation (∧) and the M.D.A.S. rule.
- Assignment 4-1
  — Given the formula for converting Fahrenheit to Celsius as follows:

$$C° = (F° - 32) * (5/9)$$

  1. Write and RUN a program that converts 75° Fahrenheit to Celsius.
  2. Change the value of F from 75° to 45° and RUN the program again.

  — Given the formula for converting Celsius to Fahrenheit as follows:

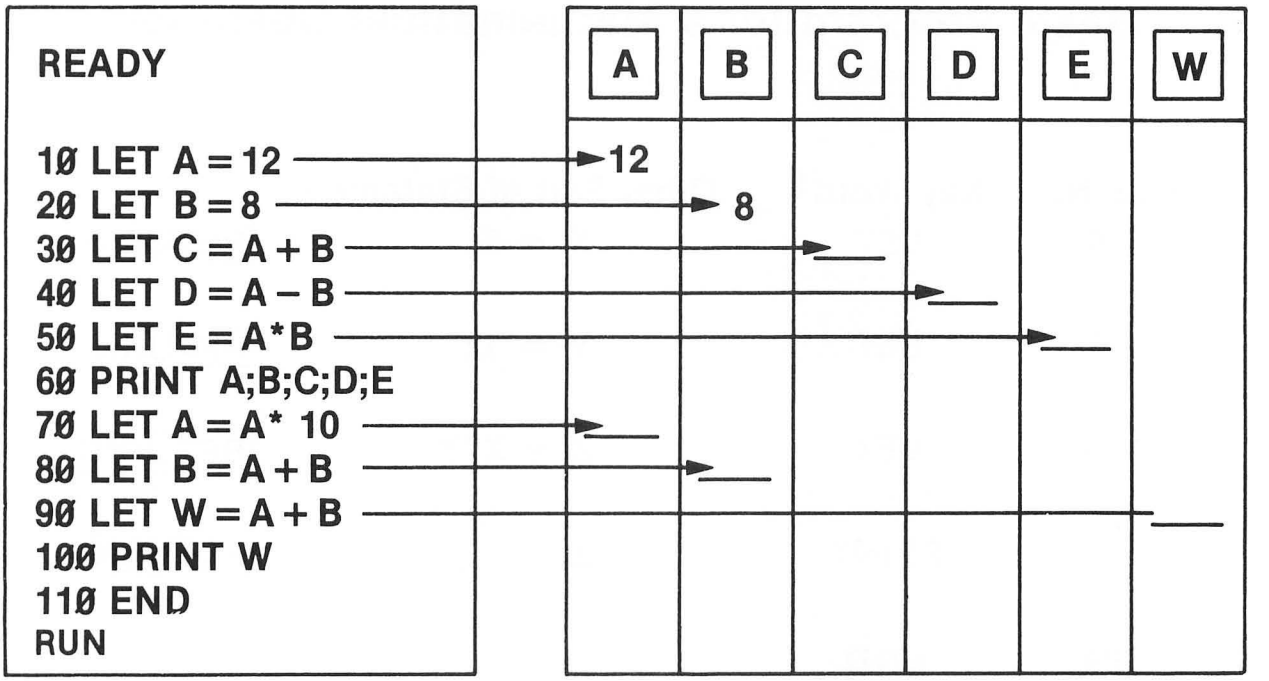
$$F° = 9/5 * C° + 32$$

  1. Write and RUN a program to find F if C is 20°.
  2. Change the value of C from 20° to 35° and RUN the program to find F.

Variable Names Used with Atari BASIC

- Must begin with a capital letter (A-Z)
  - — The rest of the characters used in naming a variable can be capital letters or digits
  - — The maximum length of a variable name is 114 characters
- Some examples of variable names include:
  - — A, B, A7, C302, AAB, AMOUNTCHARGED
- Some examples of illegal variable names include:
  - — 7AB, Total, PERSON'SADDRESS, PLACE BORN
- There are some words with special meaning in the BASIC language and they *cannot* be used as variable names.
  - — The complete list of reserved words, which cannot be used in variable names, appears in Appendix A of the *Atari BASIC Reference Manual*.

In-Class Exercise 4-2
(Assigning Numeric Values to Variables)



Basic Program for a Mathematical Operation

Line No.	Key Word[1]	Other Part of Statement	
10	LET	X = 5	RETURN
20	LET	Y = 12	RETURN
30	LET	Z = X*Y	RETURN
40	PRINT	Z	RETURN
99	END		

RUN

(1) LET is an optional key word for Atari BASIC. Some computers require you to use LET however. Beware of this if you use another computer.

Analysis of the BASIC Program for a Mathematical Operation

Line No.	Statement	Meaning to Computer
1Ø	LET X = 5	Assign a value of 5 to variable X
2Ø	LET Y = 12	Assign a value of 12 to variable Y
3Ø	LET Z = X*Y	Take the values of X and Y, multiply them together, and assign the resulting value to the variable Z
4Ø	PRINT Z	Print the value of Z (which is 6Ø in the example)
99	END	END PROGRAM
RUN		EXECUTE PROGRAM

A BASIC Mathematical Program — Area of Rectangle

YOUR ACTION **DISPLAY**

1. **Type NEW and press RETURN.**
2. **Type and enter.** → **Line 5 clears the screen.**

```
5 PRINT CHR$(125)
10 REM AREA OF A RECTANGLE PROBLEM
20 REM AREA (A) = LENGTH (L) * WIDTH (W)
30 LET L = 10
40 LET W = 5
50 LET A = L*W
60 PRINT A                                   (A)
RUN ■                                        (B)
50

READY
■
```

3. **Type RUN and press RETURN.**

NOTES:

Ⓐ **In Line 60, there were no quotes around the letter A because we wanted the computer to PRINT the *value* of A. If we wanted the computer to PRINT the exact word or letter, we would put quotes around the word or variable.**

Ⓑ **After pressing RETURN, the screen clears before the answer is printed.**

Area of Rectangle Program Modified

YOUR ACTION	DISPLAY	
1. Type 5, then press RETURN.		
2. Add Line 7Ø to read then press RETURN.	7Ø PRINT "AREA (IN SQ. IN.) IS", A	
3. Type RUN and press RETURN.	AREA (IN SQ. IN.) IS 5Ø	Ⓐ
4. Add Line 8Ø to read then press RETURN.	8Ø PRINT "THE AREA IS", A, "SQ. IN."	
5. Type RUN and press RETURN.	THE AREA IS 5Ø SQ. IN.	Ⓑ
6. Add Line 9Ø to read then press RETURN.	9Ø PRINT "THE AREA IS"; A; "SQ. IN." 1ØØ PRINT "THE AREA IS ";A;" SQ. IN."	
7. Type RUN and press RETURN.	THE AREA IS5ØSQ. IN. THE AREA IS 5Ø SQ. IN.	Ⓒ & Ⓓ

Notes:

Ⓐ Comma in Line 7Ø told the computer to print two separate items on the same line.

Ⓑ Commas in Line 8Ø told the computer to print three separate items on the same line.

Ⓒ In Line 9Ø, a semicolon tells the computer to print the output close together without spacing. But in line 1ØØ, we inserted a space between the word "is" and the second quotes ("). Also, we inserted a space between the third quote and the word "sq." Note the difference in the outputs.

Ⓓ LIST your program when you finish. Run your program several times and note that you have printed your answer five different ways.

Assignment 4-1

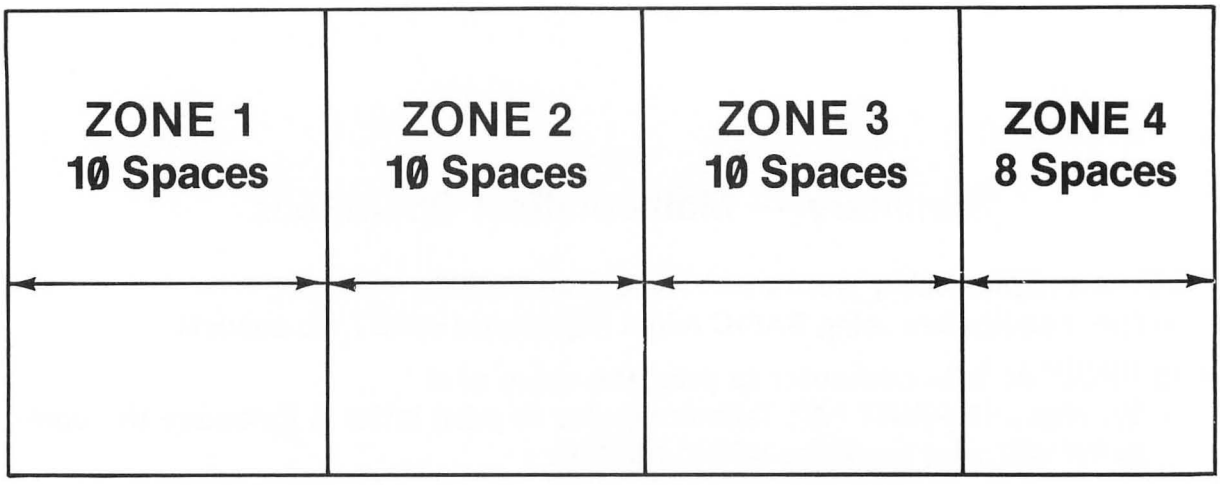
1. Write a Program to Find Area of a Triangle
   A. GIVEN: A = ½ bh WHERE b = 5, h = 1Ø
   B. Include Remarks Statement
   C. Have Program Print "THE AREA = " (Your Answer) "SQ. FT."

2. Write a Program to Find the Volume of a Rectangular Solid
   A. GIVEN V = L*W*H, L = 5, W = 1Ø, H = 2
   B. Include Remarks Statement
   C. Have Program PRINT "THE VOLUME = " (Your Answer) "CUBIC IN."

Summary — Mathematical Operations

- **LET is an optional key word when using Atari BASIC.**
  — Other computers using BASIC might require use of LET, so beware!
- **10 PRINT A: Tells computer to print the value of A**
  — Whereas 10 PRINT "A": Tells computer to print letter A (because the computer will print anything within quotes).
- **A comma in a PRINT statement tells the computer to leave several spaces between items separated by the commas.**
- **A semicolon in a PRINT statement tells the computer to print the output close together without spacing.**

Print Zones



- The Atari is divided into four PRINT zones.
  - — Each of the first three PRINT zones has 10 spaces for up to 10 characters.
  - — The fourth PRINT zone has 8 spaces for up to 8 characters.
  - — The Atari can display up to 38 characters per line (3 × 10 + 8 = 38).
  - — There are 2 spaces at the beginning of a line which are not used when LISTing or RUNning most programs. (You will learn how to place characters in the first 2 spaces later on.)

Print Zones and the Use of Commas

YOUR ACTION	DISPLAY	NOTES
1. Type NEW and press RETURN.		
2. Type Line 10 to read then press RETURN.	10 PRINT "ZONE 1", "ZONE 2", "ZONE 3", "ZONE 4"	
3. Type RUN and press RETURN.	ZONE 1 ZONE 2 ZONE 3 ZONE 4	A B
4. Type Line 20 to read then press RETURN.	20 PRINT "ZONE 1",, "ZONE 3"	
5. Type RUN and press RETURN.	ZONE 1 ZONE 2 ZONE 3 ZONE 4 ZONE 1 ZONE 3	C

NOTES

(A) There are three (3) 10-character PRINT zones and one 8-character PRINT zone per line (since $3 \times 10 + 8 = 38$, the screen can display up to 38 characters per line).

(B) Note that there are two commas between ZONE 1 and ZONE 3.

(C) The comma tells the computer to move to the next PRINT zone each time a comma is encountered.

Semicolon vs. Comma

YOUR ACTION	THE DISPLAY READS:
1. Type NEW and press RETURN.	
2. Type exactly as shown then RETURN.	10 PRINT "A";"SEMICOLON";"PACKS";"I TEMS";"CLOSE";"TOGETHER" 20 PRINT "BUT A COMMA", "LEAVES", "SPACE S"
3. Type exactly as shown then RETURN.	
4. Type RUN and press RETURN.	ASEMICOLONPACKSITEMSCLOSETOGETHER BUT A COMMA LEAVES SPACES
5. Type Lines 30, 40, 50, and 60 as shown then press RETURN.	30 LET A = 5 40 LET B = 10 50 LET C = 15 60 PRINT A; B; C
6. Type RUN 30 and press RETURN.	51015

Use of the Semicolon — Summary

- The effect of the semicolon from computer to computer varies, but it is always true that a semicolon leaves less space between the answers or results printed than the COMMA.
- GENERAL RULE: when you want more than one item on the same line and
  - — If you want your results or output spread out, use a comma.
  - — If you want your results or output close together, use a semicolon.

PRACTICE 6

Area of a Rectangle Program

Part I

1. Enter and RUN this progam:

```
10 REM AREA OF A RECTANGLE PROGRAM
20 REM AREA (A)=LENGTH(L)*WIDTH(W)
30 LET L = 10
40 LET W = 5
50 LET A = L*W
60 PRINT A
```

2. Add a new program line to include a label on your answer. For example, the area of the rectangle is 50 square inches.
3. Add new program lines to PRINT the following:
   a. The length of the rectangle is 10 inches.
   b. The width of the rectangle is 5 inches.

Part II

1. *Do not* type NEW.
2. Change the values of L and W in the program. (Think before you change the lines! How many lines do you have to change? Change only those lines!)

PRACTICE 7

Program Using Mathematical Operators

1. Enter and RUN the following program:

```
10 REM MATH PROBLEMS
20 LET A = 75
30 LET B = 50
40 LET C = A+B
50 PRINT C
```

2. Change the values of A and B in the program and RUN it. Fill in the results: A = _____, B = _____, C = _____.
3. Add a program line to label the answer. Example: "The sum is (your answer)."
4. Write a program to multiply (*) two numbers (any two).
5. Add the program line to PRINT: "The product of (your no.) "*" (your no.) "is" (your answer). Example: The product of 5 * 5 is 25.
6. Write a program to divide (/) two numbers (any two).
7. Add the program line to PRINT: "The quotient of" (your #) "/" (your #) is (your answer). Example: The quotient of 10/2 is 5.
8. Write a program to subtract (–) two numbers (any two).
9. Add the program line to PRINT: "The difference between "(your #) "–" (your #) is (your answer). Example: The difference between 10–5 is 5.

Additional practices for this Part will be found in the back of the book.

PART 5

Scientific Notation

What You Will Learn

To understand and use scientific notation.

Review and Feedback

The purpose of this part of the program is to evaluate students' overall performance and determine which students are having problems. The students who are having problems will be given the opportunity to review concepts they have not mastered. The review and feedback phase is divided into the following parts:

1. Exam — written/lab
2. Open discussion with students about their concerns and interests
3. Evaluation of student's performance
4. Recommendations

Scientific Notation

- Scientists often express large numbers like 186,ØØØ and small numbers like Ø.ØØØ15 as the product of two numbers. For example:

a) 186,ØØØ = $1.86 \times 1Ø^{5}$
b) Ø.ØØØ15 = $1.5 \times 1Ø^{-4}$
c) 764,ØØØ = $7.64 \times 1Ø^{5}$
d) Ø.Ø347 = $3.47 \times 1Ø^{-2}$
e) 5,ØØØ,ØØØ = $5 \times 1Ø^{6}$

Scientific Notation

Ordinary Notation		Scientific Notation		Scientific Notation in Atari BASIC	Meaning
5,000,000,000	=	5 X 10^{9}	=	5E + 09	ADD 9 zeroes after 5
.000005	=	5 X 10^{-6}	=	5E − 06	Shift decimal 6 places to left
.00000005	=	5 X 10^{-8}	=	5E − 08	Shift decimal 8 places left
5 (with 15 zeroes)	=	5 X 10^{15}	=	5E + 15	ADD 15 zeroes after 5
5 (with 16 zeroes)	=	5 X 10^{16}	=	5E + 16	ADD 16 zeroes after 5

- Atari BASIC uses scientific notation for very large and very small numbers.
- Rule 1: E + 09 means move the decimal point 9 places to the right.
- Rule 2: E – 09 means move the decimal point 9 places to the left.

Assignment 5-1 — (Scientific Notation)

1. Type, enter, and RUN the following program:

```
5 PRINT CHR$(125)
1Ø PRINT 5ØØØ ØØØ,  Ø.ØØØØØ5,  .ØØØØØØØ5,  5 ØØØ ØØØ ØØØ
15 PRINT
2Ø PRINT 5 ØØØ ØØØ ØØØ ØØØ ØØØ,  5 ØØØ ØØØ ØØØ ØØØ ØØØØ
                  (15 zeroes)                (16 zeroes)
```

2. Experiment with scientific notation until you feel comfortable with it.

Review and Feedback

A. Quiz — Written/Lab

B. Open discussion with students on concerns and interest

C. Evaluation of student's performance

D. Recommendations

FEEDBACK QUESTIONNAIRE

1. Do you like working with computers? _____ (yes, no) If not, why not? _____
   _____
2. What things do you like most about computers? _____
   _____
3. What do you dislike most about computers? _____
   _____
4. If you were a design engineer and could design the computer to do anything you wanted it to, what kinds of things would you include in your design? (Use your imagination!)
   _____
   _____
5. What was the hardest thing for you to understand about the computer so far? _____
6. What was the easiest thing for you to understand? _____
   _____
7. Were you afraid or nervous when you first used the computer? _____ (yes, no)
8. Do you feel comfortable using the computer now? _____ (yes, no)
9. Would you prefer to be doing something else rather than learning about computers? _____ (yes, no) If yes, what would you like to do? _____
   _____
10. Is the teacher going too fast, too slow, or just right for you? _____
11. Do you find the lessons interesting, boring, or so-so? _____
12. If you could teach this course, what would you do to make the lessons more interesting? _____
    _____
13. Have you decided what you want to do for a vocation? _____ (yes, no)
    If yes, what? _____
14. Would you like to take additional courses to learn more about computers and programming? _____ (yes, no)
15. Do you have any additional comments? _____
    _____
    _____
    _____
    _____
    _____
    _____

PRACTICE 8

Scientific Notation

1. Convert the following to standard scientific notation (example: 5,ØØØ,ØØØ = 5×1Ø^6):
   a. 5,165,123
   b. .ØØØØØ7
   c. .ØØØØØØØ8
   d. 6,ØØ1,255
   e. 8Ø ØØØ ØØØ ØØØ ØØØ ØØØ (16 zeros)
   f. 8ØØØ ØØØ ØØØ ØØØ ØØØ (15 zeros)
   g. 9,ØØØ,156,ØØØ
   h. 7,7Ø1,777
   i. 77,7Ø1,777,ØØØ
   j. 5,612,345,ØØØ
2. Change the above numbers to computer scientific notation used in the Atari (example: 5,ØØØ,ØØØ,ØØØ = 5E+Ø9).

Note: The Atari will print a number in scientific notation if:

A. For positive numbers
   1. The value is greater than 999999999
   2. The value is less than .Ø1

B. For negative numbers
   1. The value is less than −999999999
   2. The value is greater than −.Ø1

Another way of indicating this is to say that the number will be printed in scientific notation if its *absolute value* is larger than 999999999 or less than .Ø1.

PART 6

Relational Operators and IF-THEN/GOTO Statements

What You Will Learn

1. How computers compare (or relate) one value with another.
2. To explain the purpose and use of the six relational operators: =, >, <, <=, >=, <>.
3. To explain the purpose and use of the key words IF-THEN, GOTO.
4. To write, enter, and run programs that use IF-THEN and GOTO statements.
5. To understand and use the counting program.

Relational Operators

- Allow computer to compare one value with another.
  - — The three relational operators include

Symbol	Meaning	Examples
=	Equal	A = B
>	Greater than	A > B
<	Less than	A < B

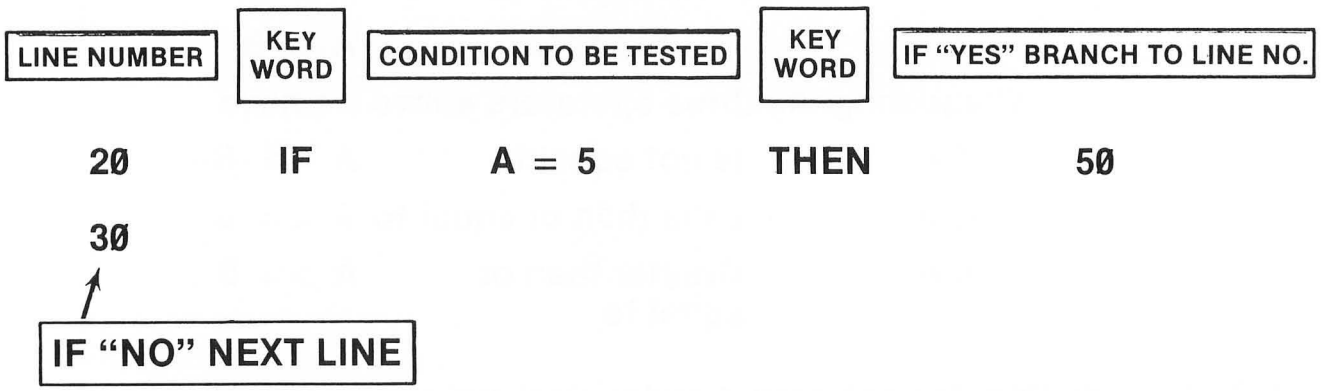
  - — Combining the three operators above we have

<>	Is not equal to	A <> B
<=	Less than or equal to	A <= B
>=	Greater than or equal to	A >= B

NOTE: To distinguish between < and >, just remember that the smaller part of the < symbol points to the smaller of two quantities being compared.

IF-THEN

- IF-THEN is used in conditional branching.
  - — That is, the program will "branch" to another part of the program on the condition that it passes the test it contains.
  - — If the test fails, the program simply continues to the next line.
- Example:



Sample Program Using IF-THEN (Conditional Branching)

- Program

```
1Ø LET A = 5
2Ø IF A = 5 THEN 5Ø
3Ø PRINT "A DOES NOT EQUAL 5"
4Ø END
5Ø PRINT "A EQUALS 5"
RUN
```

- The screen should display

```
A EQUALS 5
```

- Why is Line 2Ø above a conditional branching statement?
  — What's the condition or test?

In-Class Exercise 6-1 (IF-THEN)

Given: A = 1Ø, B = 2Ø, C = 3Ø

Exercises:

Exercise No.	Statement	Condition is (T or F)	Branch to (Line N) Ⓐ
1.	1Ø IF A = B THEN 4Ø	F	2Ø
2.	1Ø IF A <> B THEN 5Ø		
3.	1Ø IF A > B THEN 6Ø		
4.	1Ø IF A < B THEN 7Ø		
5.	1Ø IF C < = A + B THEN 8Ø		
6.	1Ø IF C > = A + B THEN 9Ø		
7.	1Ø IF B > A THEN 1ØØ		
8.	1Ø IF B/A > = C/A THEN 11Ø		
9.	1Ø IF A * B < = A * C THEN 12Ø		
1Ø.	1Ø IF C/A < = A * B THEN 13Ø		

Ⓐ **Note: If condition is false (F), the computer will execute the next line (i.e., 2Ø).**

A Counting Program — Using IF-THEN

- Program

```
10 LET J = 0
20 LET J = J + 1
30 PRINT J
40 IF J < 10 THEN 20
RUN
OUTPUT IS*
```

* OUTPUT
1
2
3
4
5
6
7
8
9
10

- In-Class Exercise 6-2

  Modify above program to count to 50 by 5's

IF-THEN Counter Program Analysis

	PROGRAM EXECUTION	"J" COUNTER STATUS	DISPLAY
INITIALIZE	10 J = 0	[0]	
1ST TIME	20 J = J + 1	[1] = 0 + 1	
	30 PRINT J,		
	40 IF J < 4 THEN 20		
2ND TIME	20 J = J + 1	[2] = 1 + 1	
	30 PRINT J,		
	40 IF J < 4 THEN 20		
3RD TIME	20 J = J + 1	[3] = 2 + 1	
	30 PRINT J,		
4TH TIME	40 IF J < 4 THEN 20	[4] = 3 + 1	
	20 J = J + 1		
	30 PRINT J		
	40 IF J < 4 THEN 20		
END	50 END		[1 2 3 4]

IF-THEN COUNTER — Program Analysis (Stop-Action)

	PROGRAM EXECUTION	"J" COUNTER STATUS	DISPLAY
INITIALIZE	10 J = 0	10 [0]	
1ST TIME	20 J = J + 1	20 [1] = 0 + 1	
	30 PRINT J	30	[1]
	40 STOP		
	45 REM TYPE CONT TO CONTINUE		
	50 IF J < 4 THEN 20		
2ND TIME	20 J = J + 1	20 [2] = 1 + 1	
	30 PRINT J	30	[2]
	40 STOP		
	45 REM TYPE CONT TO CONTINUE		
	50 IF J < 4 THEN 20		
3RD TIME	20 J = J + 1	20 [3] = 2 + 1	
	30 PRINT J	30	[3]
	40 STOP		
	45 REM TYPE CONT TO CONTINUE		
	50 IF J < 4 THEN 20		
4TH TIME	20 J = J + 1	20 [4] = 3 + 1	
	30 PRINT J	30	[4]
	40 STOP		
	45 REM TYPE CONT TO CONTINUE		
	50 IF J < 4 THEN 20		
END	60 END		

In-Class Exercise 6-3
(GOTO — Unconditional Branching)

- Type and RUN this program:

```
10 PRINT CHR$(125)
20 PRINT "YOUR NAME";
30 GOTO 20
```

- What happened?
  - — Do you know how to stop the program? (What about the BREAK key?)
    Explain this simple program (Line 10 merely clears the screen).
    But what does Line 30 tell the computer to do?
  - — Were there any tests or conditions to be satisfied in Line 30 before it does what it has to do?
  - — Do you understand now why the GOTO statement is called an unconditional branching statement?

- Don't leave this page until you understand everything!

Exercise 6-4 (GOTO/IF-THEN)

Exercise:

- **Study the program below and write the message that would be printed if the program were executed.**

```
10 PRINT "WELCOME TO LEEDS MIDDLE SCHOOL"
20 GOTO 70
25 PRINT
30 PRINT "HELLO SUPERSTAR"
35 PRINT
40 PRINT "COMPUTERS ARE MY THING"
50 GOTO 100
60 IF A = 5 THEN 90
70 PRINT "COMPUTER WORKSHOP"
80 GOTO 40
90 GOTO 120
100 LET A = 5
110 GOTO 60
120 PRINT "AND I'M A SUPERSTAR!"
130 END
140 PRINT "ATARI MICROCOMPUTER"
150 PRINT "I CAN DO IT TOO"
160 PRINT "I SPEAK BASIC"
```

Assignment 6-1

1. Read pages 18 and 19 in the *Atari BASIC Reference Manual.*
2. Write a program of your choice using conditional (IF-THEN) and unconditional (GOTO) statements.
3. Write a counting program.
   — Count to 100 by 10's.

What We Have Learned — Summary

- **Relational operators:** =, >, <, <>, < =, > =
- **IF-THEN**
- **GOTO (No space between GO and TO)**
- **Conditional Branching**
  - — If condition is met, (i.e., TRUE), branch to designated line in program.
  - — If condition is not met, (i.e., FALSE), go to next line number in program.
- **Unconditional branching**
  - — GOTO line XX (no conditions or tests required)
  - — A GOTO statement, as the name implies, forces the computer to go to a specific statement anywhere in the program.

PRACTICE 9

Using IF-THEN

Part I.

1. Enter and RUN the following program:

```
10 LET A = 10
20 IF A = 10 THEN 50
30 PRINT "A DOES NOT EQUAL 10"
40 END
50 PRINT "A EQUALS 10"
```

2. Change Line 10 to Let A = 5 and then RUN it.
3. Change Line 10 to Let A = 3 and then RUN it.

Part II.

1. Using this program as an example, write a new program to PRINT A EQUALS 3 and RUN it.
2. Change the values of A in Line 10 and RUN the program several times.

PRACTICE 10

Counting Program Using IF-THEN

1. Enter and RUN this program:

```
10 LET  J = 0
20 LET  J = J+1
30 PRINT J
40 IF J < 10 THEN 20
```

2. Write a program to count from 1 to 15.
3. Write a program to count to 50 by 5's.
4. Write a program to count to 100 by 10's
5. Write a program to count from 15 to 30 and PRINT the answers in one column (vertically).
   Example: 15
   16
   17
   18
   and so forth
6. Write a program to count from 20 to 40. PRINT answers horizontally, with one space between answers.
   Example:
   20 21 22 23 and so forth.

PART 7

Input Statements

What You Will Learn

1. To explain the purpose and use of the key word input.
2. To explain the purpose and use of a trailing semicolon on a program line.
3. To identify and use string variables A$, B$, C$, and so forth.
4. To explain the difference between numeric and string variables.
5. To write, enter, and run programs that use the concepts of this lesson.

Input Statement

STATEMENT	FUNCTION
1Ø INPUT A	• Causes the computer to stop, PRINT a ?, and wait for you to type in a decimal number. • After you type in a value for A, the computer continues the program when you press the RETURN key.

Input Statements

YOUR ACTION	DISPLAY
1. Type NEW and press RETURN.	
2. Type and enter Lines 5 & 10 as shown.	5 PRINT "THE # I'M THINKING OF IS" 10 INPUT A
3. Type RUN and press RETURN.	THE # I'M THINKING OF IS ? ■ (A)
4. Enter a number (e.g., type 5 and enter).	
5. RUN this program several times to get the feel of it.	THE # I'M THINKING OF IS ? 5 READY ■

(A) The question mark on the screen means, "It's your turn and I'm waiting."

Input Statements —
(Area of Rectangle Program)

```
10  REM AREA OF A RECTANGLE PROBLEM
20  REM A = L * W
30  PRINT "THE LENGTH IS"
40  INPUT L
50  PRINT "THE WIDTH IS"
60  INPUT W
70  A = L * W
80  PRINT "THE AREA IS"
90  PRINT A
```

Area of Rectangle Problem Revisited (Using Input Statements)

YOUR ACTION	DISPLAY
1. Type in program Lines 1Ø through 6Ø as shown.	1Ø REM AREA OF A RECTANGLE PROBLEM 2Ø PRINT "THE LENGTH IS "; 25 INPUT L 3Ø PRINT "THE WIDTH IS "; 35 INPUT W 4Ø A = L * W 5Ø PRINT "THE AREA IS "; 6Ø PRINT A (A)
2. Type RUN then press RETURN. **3. Type in the length (say 1Ø) and enter.** **4. Type in the width and press RETURN.** **5. What is your answer?**	THE LENGTH IS ■ THE LENGTH IS 1Ø THE WIDTH IS ■ (B)

(A) Note the trailing semicolon. It is used to hook Lines 5Ø and 6Ø together.

(B) Note that the program waits for an input from the keyboard. If you don't enter a number or press RETURN, it will just stay at that line until the machine is turned off or reset.

Assignment 7-1

Write a simple program to do the following:
(using input statement)
a) Input your age
b) Input your zip code
c) Input your weight
d) Input your height in inches
e) PRINT each of the above with the proper labels
(for example: My age is 15 or I am 15 years old).

What We Have Learned

- Trailing semicolon hooks two lines together.
- Input statements cause the computer to stop and wait for an input from the keyboard.
- Input statements cause the Atari to print a ?.

Numeric vs. String Variables

Numeric Variable		Declaration Character		String Variable
A	+	$	=	A$
A1	+	$	=	A1$
CHECKBAL	+	$	=	CHECKBAL$
ANDMORE	+	$	=	ANDMORE$

The DIM Statement

In order to use a string variable with the Atari, it is necessary to tell the Atari the maximum number of characters that can be stored in the variable. This is accomplished with the command DIM. For example, DIM A$(6) tells the Atari to leave space for a maximum of 6 characters to be stored in the string variable A$. DIM stands for DIMension.

Note:

1. **If you accidentally try to assign a string with more than 6 characters to A$, the Atari will simply ignore all characters beginning with the seventh.**
2. **Once you DIM a string variable, you cannot DIM it to a different length (unless you type NEW first, which would result in the loss of your program).**

Example of Use of String Variables

YOUR ACTION	DISPLAY
1. Type and enter.	10 PRINT CHR$(125) 20 DIM A$(20) 30 PRINT "YOUR NAME IS"; 40 INPUT A$ 50 PRINT "HELLO THERE, "; A$
2. Type RUN and press RETURN.	YOUR NAME IS? ■ HELLO THERE, BILL READY ■ Ⓐ
3. Type RUN and press RETURN	YOUR NAME IS?
4. Type and enter.	YOUR NAME IS? WILLIAM THE FAMOUS SUPER STAR HELLO THERE, WILLIAM THE FAMOUS S READY ■ Ⓑ

Ⓐ **NOTE:**
It will print your name and not "BILL," unless your name is "BILL."

Ⓑ **Since you entered more than 20 characters (remember, spaces count, too), the Atari stored only the first 20 characters in A$.**

In-Class Exercise 7-1 (String Variables)

YOUR ACTION **DISPLAY**

1. Type and enter. →

```
5 PRINT CHR$(125)
10 DIM A$(10), B$(10), C$(20)
20 PRINT "YOUR FIRST NAME";
30 INPUT A$
40 PRINT "YOUR MIDDLE NAME";
50 INPUT B$
60 PRINT "YOUR LAST NAME";
70 INPUT C$
80 PRINT A$; "  "; B$ "  "; C$
```

Ⓐ

2. Type RUN and press RETURN. →

(Sample)

```
YOUR FIRST NAME? AUBREY
YOUR MIDDLE NAME? BRIGHT
YOUR LAST NAME? JONES
AUBREY BRIGHT JONES

READY
■
```

Ⓐ **NOTES**

You can combine string variables.
You must insert a space between string variables using " " marks.
A semicolon will not cause a space to be printed.

Assignment 7-2 (String Variables)

1. Run and analyze the following program:

```
10  DIM A$(25), B$(30)
20  PRINT "YOUR NAME IS";
30  INPUT A$
40  PRINT "YOUR HOUSE NUMBER";
50  INPUT A
60  PRINT "YOUR STREET NAME";
70  INPUT B$
80  INPUT "YOUR ZIP CODE";
90  INPUT B
100  PRINT A$
110  PRINT A; "   "; B$
120  PRINT "ZIP CODE  "; B
```

2. Answer the following questions:

   a) Why were A$ and B$ (string variables) required in Lines 30 and 70?
   b) Why were quotes (" ") inserted in Line 110?
   c) Why did we use $ symbol (or string declaration character) with A and B in Lines 30 and 70?

String Variables — Summary

- String variables can be assigned to indicate letters, words, and/or combinations of letters.
- String variables can be combined.
- Use " " marks to insert a space between string variables.

PRACTICE 11

Area of Rectangle Problem (Using INPUT Statement)

1. Enter and RUN this program:

```
10 PRINT "THE LENGTH IS";
15 INPUT L
20 PRINT "THE WIDTH IS";
25 INPUT W
40 LET A = L*W
50 PRINT "THE AREA IS "; A
```

2. Write a new program using INPUT statements to find volume (volume = length × width × height).
3. Include a statement: The volume is _____.

PRACTICE 12

More INPUT Statement Programs

Part I.

1. Write a program using INPUT statements to change meters to centimeters (centimeters = 100 × meters).
2. Include a statement: _____ meters equals _____centimeters.

Part II.

1. Write a new program using INPUT statements to do the following:
   a. Input your age.
   b. Input your zip code.
   c. Input your weight.
   d. Input your height.
2. PRINT each with the proper labels.
   Example: My age is _____.

PRACTICE 13

String Variables

Part I.

1. Enter and RUN the following program:

```
10 DIM A$(25), B$(30)
20 PRINT "YOUR NAME IS";
30 INPUT A$
40 PRINT "YOUR HOUSE NUMBER";
50 INPUT A
60 PRINT "YOUR STREET NAME";
70 INPUT B$
80 PRINT "YOUR ZIP CODE";
90 INPUT B
100 PRINT A$
110 PRINT A; " "; B$
120 PRINT "ZIP CODE "; B
```

2. Answer the following questions:
   a. Why are A$ and B$ (string variables) required in Lines 30 and 70?
   b. Why were quotes (" ") inserted in Line 110?
   c. Why didn't we use $ symbol (or string declaration character) with A and B in Lines 50 and 90?

Part II.

1. Write a new program using INPUT statements, string variables, and a space between each line. PRINT all information (example: My best friend is _____) to give the following information:
   a. Your best friend.
   b. Your favorite subject.
   c. Your favorite food.
   d. Your favorite movie star.
   e. Your favorite color.
   f. Your zodiac sign.

PART 8

Using the Calculator Mode and Sizing Memory

What You Will Learn

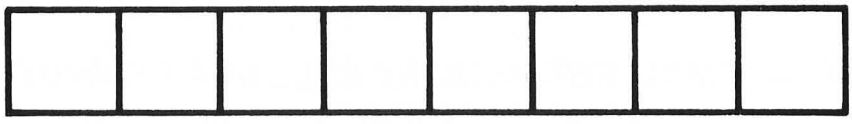
1. To define and use the terms bit, byte, k, kbytes.
2. To determine how much memory is used in a BASIC program.
3. To explain the purpose and use of the command PRINT FRE (Ø).
4. To use the Atari in calculator mode (i.e., without having to write a program).

BIT = BINARY—DIGIT

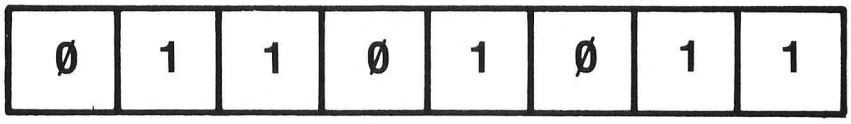
BIT = SMALLEST MEMORY CELL IN A COMPUTER

BIT = "1" OR "Ø"

MEMORY CELL WITH 1 BIT



8 MEMORY CELLS



8 BITS = 1 BYTE

BYTE = 8 BITS

K = 1ØØØ

KBYTES = 1ØØØ BYTES

KBYTES = 8ØØØ BITS

How Much Memory Is Used in BASIC Programs

WHAT'S STORED	HOW MUCH MEMORY
1 ALPHA CHARACTER (A-Z)	1 BYTE
1 SPECIAL CHARACTER (e.g., ", !, +, −, etc.)	1 BYTE
1 NUMERIC CHARACTER (Ø–9)	1 BYTE
1 SPACE	2 BYTES
1 RETURN KEY AND OTHER	3 BYTES } MEMORY
1 RESERVE WORD SUCH AS FOR, GOTO, PRINT	1 BYTE } OVERHEAD*

EXAMPLE:

10 PRINT "MY NAME IS AUBREY" RETURN

2* + 1* + 1 + 1* 19 1* = 25 BYTES

*Included as part of memory overhead. Memory overhead means you will use 5 bytes of memory for each line, short or long.

NOTE! The above is just an exercise to help you understand memory allocation. You don't have to count bytes to determine how much memory was used. (Page 118 will show you an easy way to find out how much memory is available for your use.)

The Memory Command

- PRINT FRE (Ø)
  - — This command is used to let you know how much memory is available to you.
  - — Sometimes it may be important to know how much memory you are using for a given program.
  - — If the amount of memory available in the Atari you are using is 16K, this means that there are about 16,ØØØ different memory locations to store and process your programs (actually 16,384).
- Note!
  - — With no program loaded, there are less than 16,384 memory locations available for use. The difference in memory space, between actual space and 16,384, is set aside for processing programs and overall management and monitoring of what the computer is doing.
  - — Also, your Atari might have more than 16K of memory. So make certain you know how much memory you have in your computer. (The next page will show you how to determine the amount of memory available to you.)

Assignment 8-1

1. Determining available memory:
   a) Type NEW and press RETURN.
   b) Type PRINT FRE (Ø) and press RETURN.
   c) Display reads: _____
   d) Now type the following and enter 1Ø PRINT "Leeds Middle School".
   e) Type PRINT FRE (Ø) and press RETURN.
   f) How much space is left in memory? _____

2. Use Atari in calculator or immediate mode to solve the following:
   a) 25 * 4/2
   b) (25 + 6) − 7 + (2 * 5)
   c) 7/2 * 5 * 2 ∧ 3
   d) Any other problems you want to try

   Remember! You don't need a line number for calculator mode. Simply type PRINT and the calculations you want done. Example: If you wish to multiply 2 asterisk 3, simply type PRINT 2 * 3, and press RETURN. The answer (6) will be displayed.

What We Have Learned

- COMPUTERS SPEAK IN MACHINE LANGUAGE
- MACHINE LANGUAGE IS A FORM OF BINARY CODING
- BINARY CODE CAN BE EITHER "Ø" OR "1" BITS
- BIT = BINARY DIGIT
- BYTE = 8 BITS
- YOU DO NOT HAVE TO KNOW MACHINE LANGUAGE TO USE COMPUTERS!

PRACTICE 14

Sizing Memory and Calculator Mode

Part I.

1. To determine available memory:
   a. Type NEW and press [RETURN].
   b. Type PRINT FRE (Ø) and press [RETURN].
   c. Display reads: _____.
   d. Now type the following and enter 1Ø PRINT "LEEDS MIDDLE SCHOOL."
   e. Type PRINT FRE (Ø) and press [RETURN].
   f. How much space is left in memory? _____

Part II.

1. Use Atari in calculator or immediate mode to solve the following:
   a. 25 * 4/2
   b. (25 + 6) − 7 + (2 * 5)
   c. 7/2 * 5 * 2 ^ 3
   d. Any other problems you want to try.

PART 9

Using the Cassette Recorder and the Disk Drive

What You Will Learn

1. How to use the cassette and the disk drive as output devices to save information stored in memory.
2. How to use the cassette and the disk drive as input devices to load information from tape to memory.
3. How to explain and use the commands CSAVE, CLOAD.

A Cassette Recorder Is an I/O Device

Using Cassette Tape Recorder

- The cassette tape recorder is an input/output (I/O) device that allows you to "save" information on cassette or "load" information from cassette.
  - — When you have typed a long program and wish to save it, you can save it on cassette (CSAVE).
  - — When you are ready to use it again, you can load it from the cassette (CLOAD).
- Note! You can only save your program on cassette (not the program output).
- Refer to the Atari Reference Manual for tips on using the recorder.

Using the Tape Cassette Recorder as an Input Device (That Is, to Load a Program from Tape Into Memory)

STEP	ACTION
1.	Place a program tape into your recorder.
2.	Rewind tape (if necessary).
3.	Set the volume at approximate level. (You may want to start with volume in the range 5-7). If the volume setting is too low or too high, you will get an error message. To find the right volume setting, you will have to use a trial-and-error method.
4.	Press the PLAY button on the tape recorder.
5.	Type CLOAD and then press RETURN. After one beep, press RETURN again.
6.	It may take up to 15 seconds before one of the following happens: a. ERROR 138 appears. b. ERROR 143 appears. c. READY and the cursor appears.
7.	If case (a) or (b) occurs, rewind tape and try again.
8.	Important Note! Trying to load a tape can be a very frustrating experience sometimes, so hang in there! After you load the tape, move the position of the recorder's volume control so you can use this setting each time you load a tape in the future.
9.	If case (c) above occurs, you did it! (You can RUN your program now.) But be careful! Once in a while the load command may not work properly and although you see the prompt character and the blinking cursor, the tape was not loaded. If this happens, try turning the power off and then on again and then try again to load the tape.

Using the Tape Cassette Recorder as an Output Device (That Is, to Save a Program from Memory)

STEP	ACTION
1.	Place the blank tape in recorder and rewind to the beginning.
2.	Advance tape past leader (the nonmagnetic part of the tape).
3.	Hold down Play lever while pressing the Record lever on recorder.
4.	Type and CSAVE and press RETURN.
5.	When you press RETURN, the computer will beep twice, and you should hit RETURN again.
6.	When the recording is completed, READY will appear on the screen, with the cursor on the next line.
7.	Push the Stop lever on the recorder and rewind the tape. You have saved your program on tape without affecting your program in memory.

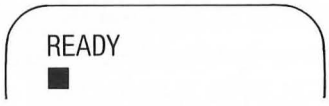
The Disk Drive as an I/O Device

- The disk drive is an input/output (I/O) device which allows you to "save" programs on a disk or "load" programs from a disk.
- The disks you will use with the Atari are square pieces of plastic (5¼" on a side) which are specially treated so that they can store information from the Atari.
- When you pick up a disk, it is very important that you touch only the disk cover and NEVER TOUCH THE DISK SURFACE (or else the programs on the disk may be destroyed). IF YOU ARE NOT FAMILIAR WITH THE HANDLING OF A DISK, REFER TO PAGE 3 OF THE ATARI MANUAL.
- After you store a program on a disk, you will probably want to write your name on the disk label. Be sure to use a soft-tip pen when writing on the disk label.
- Since the Atari can send and retrieve information to and from a disk at a much faster rate than to and from a tape, whenever possible it's much better to use a disk. However, there are special steps to follow to make sure that your disk is ready to be used. These steps are called INITIALIZING THE DISK.

FORMATTING A DISK

STEP **ACTION**

1. **Be sure the Atari is turned off.**
2. **Open the disk-drive door by gently pressing the rectangular surface under the door latch.**
3. **With the drive door open, turn the disk drive on. The drive will whirr for a few seconds.**
4. **Insert the Atari MASTER DISKETTE (or any Atari diskette that contains Atari DOS* files). Push the diskette into the drive door until you hear a click.**
5. **Gently close the door by pressing down on the latch until you hear a click.**
6. **Turn on the Atari. The disk drive will whirr for a few seconds, and you will see:**



7. **Type DOS and press [RETURN]. After the drive stops, you will see the DOS menu on the screen.**
8. **Remove the Atari MASTER DISKETTE. (If necessary, refer to step 2.)**
9. **Insert a blank diskette. (If necessary, see steps 4 and 5, and be sure you insert a blank diskette.)**
10. **Press I and [RETURN]. The Atari will ask which drive to format. Press I and [RETURN]. The Atari will ask you to type Y to format the disk. This extra step is to be certain that you have not inserted a disk on which there is information that you want to save. Any information on the disk to be formatted will be lost once it is formatted.**
11. **Press Y and [RETURN]. Your disk will now be formatted.**
12. **Press H and [RETURN]. This will copy the Atari DOS files onto your disk.**

***DOS = Disk Operating System**

Using the Disk Drive as an Output Device (That is, saving a program on disk)

Actually, in a way you've already saved two programs on disk: the two Atari DOS files. Now you will learn how to save other files as well.

STEP ACTION

1. Boot* your disk. (If necessary, see steps 1-6, page 126.)
2. Type NEW.
3. Enter the following program.

```
5  PRINT CHR$(125)
10 REM THIS IS MY FIRST PROGRAM
20 PRINT "I KNOW HOW TO FORMAT A DISK"
30 PRINT
40 PRINT "AFTER A DISK IS FORMATTED"
50 PRINT
60 PRINT "THE ATARI DOS FILES SHOULD"
70 PRINT
80 PRINT "BE TRANSFERRED TO THE DISK"
```

4. Type SAVE "D:MYFILE1" and press RETURN. Your program will now be saved.
5. Type DOS and press RETURN to display the DOS menu.
6. Press A and press RETURN twice. You will see a listing of all the files on your disk. The listing will include your program file along with the two DOS files.

*Boot refers to starting up the Atari as explained in steps 1-6 on page 126.

Using the Disk Drive as an Input Device (That is, loading a program from disk)

STEP ACTION

1. **Boot your formatted disk. (If necessary, see steps 1-6, page 126.)**
2. **Type LOAD "D:MYFILE1" and press [RETURN]. (Be sure to use the quotes and the colon.)**
3. **Type LIST and press [RETURN]. You will see the listing of your program.**
4. **Type RUN and press [RETURN]. You will see:**

```
I KNOW HOW TO FORMAT A DISK
AFTER A DISK IS FORMATTED
THE ATARI DOS FILES SHOULD
BE TRANSFERRED TO THE DISK

READY
■
```

Note: You can RUN your program without using the LOAD step by doing the following in place of steps 2, 3, and 4.

Type RUN "D:MYFILE1". This will automatically LOAD and RUN your program.

PRACTICE 15

Using the Computer to Solve Problems

1. Write a program to solve the following problem. Include a PRINT statement in your program to describe your answer (output).
   The total enrollment at Armstrong High School is 1,264. There are 367 freshmen, 322 sophomores, and 298 juniors. How many seniors are there?
2. Write a new program using INPUT statements to solve one of the problems.

PRACTICE 16

Finding the Average Problems

1. Write a program to solve the following problem. Include a PRINT statement in your program to describe your answer.
   The weights of three boys are 140 lb, 150 lb, and 130 lb. What is their average weight?
2. Write a new program using INPUT statements to solve the same problem. (That is, you should use the INPUT statement for the weight of the three boys.)

PRACTICE 17

Using the Computer to Solve Problems

1. Write two programs to solve the following problems. Label your answers.
2. Over a period of six years Mr. Smith drove his car 53,862 miles. What was the average distance each year?
3. After 12 dozen bulbs were sold, how many of the 1,000 bulbs were left?

PART 10

Using FOR-NEXT STEP Statements

What You Will Learn

1. To explain the purpose and use of key words FOR-NEXT STEP.
2. To explain the purpose and use of the terms increment, decrement, initialize.
3. To compare key words GOTO, IF-THEN, FOR-NEXT and explain how they relate to one another.
4. To explain the purpose and use of timer loops.

For-Next Statement

- Allows the computer to do the same thing over and over a large number of times (and do it very fast!)

FOR – NEXT Loop

YOUR ACTION

1. Type and enter program as shown. ⟶

2. Type RUN and press RETURN.

DISPLAY

```
5 PRINT CHR$(125)
1Ø FOR J = 1 TO 1Ø
2Ø PRINT " AUBREY " ; J
3Ø NEXT J
```

```
AUBREY 1
AUBREY 2
AUBREY 3
AUBREY 4
AUBREY 5
AUBREY 6
AUBREY 7
AUBREY 8
AUBREY 9
AUBREY 1Ø

READY
■
```

FOR-NEXT STEP Loop

YOUR ACTION	DISPLAY
1. Retype and enter Line 1Ø of resident* program as shown. →	1Ø FOR J = 1 TO 1Ø STEP 3 Ⓐ
2. Type RUN and press RETURN.	AUBREY 1 AUBREY 4 AUBREY 7 AUBREY 1Ø READY ■

***Resident means program currently in memory.**

Ⓐ **If step is not included in the statement, an increment of 1 is assigned by the computer (i.e., step 1).**

Example of Program Statements Using Key Words

FOR-NEXT STEP

```
10 FOR J = 10 TO 1 STEP -1
20 PRINT J;" ";
30 NEXT J
```

```
RUN
DISPLAY READS:
10 9 8 7 6 5 4 3 2 1

READY
■
```

Analysis of FOR-NEXT STEP Statements

LINE NO.	KEY WORD	COUNTER VARIABLE		INITIAL VALUE		FINAL VALUE	INCREMENT/ DECREMENT
1Ø	FOR	J	=	1Ø	TO	1	STEP -1
2Ø	PRINT	J					
3Ø	NEXT	J					

The FOR-NEXT STEP loop works as follows: The first time the FOR statement is executed, the counter is set for the initial value "1Ø." Then it executes Line 2Ø (PRINT J). When the program reaches Line 3Ø (NEXT J), the counter is decremented by the amount specified (Step-1). If this step has a positive value, the counter is incremented by the amount specified (e.g., Step 2 means increment by 2's).

Comparison of GOTO, IF-THEN, and FOR-NEXT Program Loops

A.

GOTO

(Unconditional Loop)

```
5 PRINT CHR$(125)
10 PRINT "AUBREY"
20 GOTO 10
RUN
```

- Program loops one zillion times!
  (or until you stop it)

B.

IF-THEN

(Conditional Loop)

```
5 PRINT CHR$(125)
10 LET J = 0
20 J = J + 1
30 IF J>6 THEN 99
40 PRINT "AUBREY "; J
50 GOTO 20
99 END
RUN
```

- This program loops 6 times!

C.

FOR-NEXT

(Conditional Loop)

```
5 PRINT CHR$(125)
10 FOR J = 1 TO 6
20 PRINT = "AUBREY "; J
30 NEXT J
99 END
RUN
```

- This program loops 6 times!

Comparison of GOTO, IF-THEN, and FOR-NEXT Program Loops

A. "DUMB LOOP"

```
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY
AUBREY

READY
■
```

B. "SMART LOOP"

```
AUBREY 1
AUBREY 2
AUBREY 3
AUBREY 4
AUBREY 5
AUBREY 6

READY
■
```

C. "SMART LOOP"

```
AUBREY 1
AUBREY 2
AUBREY 3
AUBREY 4
AUBREY 5
AUBREY 6

READY
■
```

NOTE: Press the BREAK key to get out of loop.

FOR-NEXT Summary

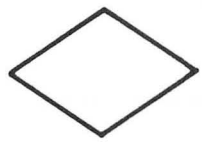
- FOR– NEXT STEP

— FOR – NEXT is always used as a pair.
— If the key word "step" is not used, the increment of 1 is assumed.
— If the step has a negative value, the counter is decremented (e.g., for J = 1Ø to 1 step -1).
— If the step has a positive value, the counter is incremented (e.g., for J = 4 to 1Ø step 2).

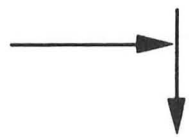
Flowchart Symbols

- Begin or End

- Processing Block



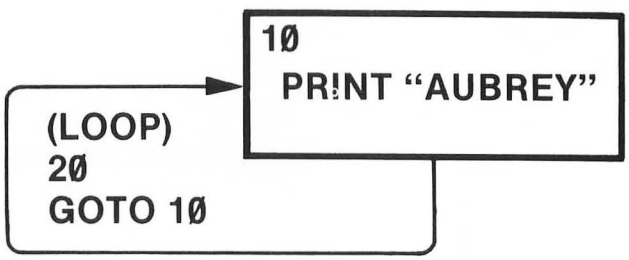
- Decision Diamond



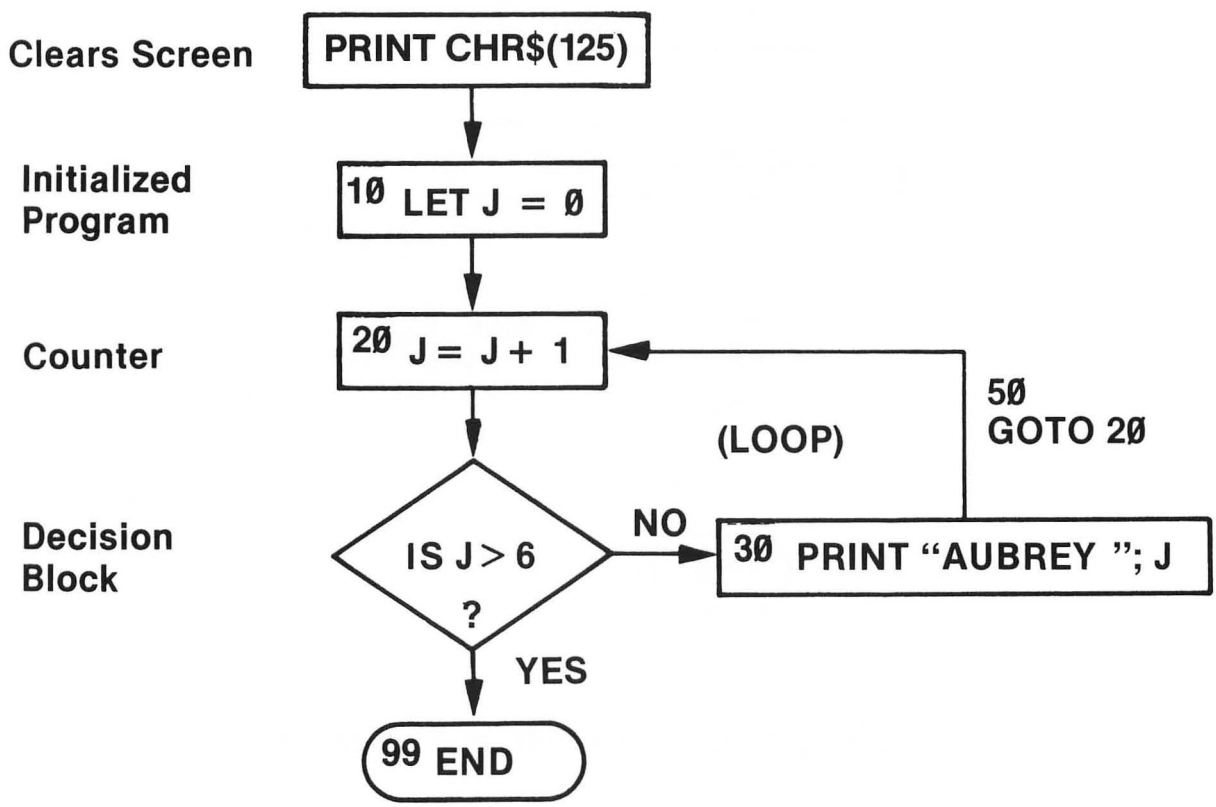
- Connector Arrows

GOTO-LOOP

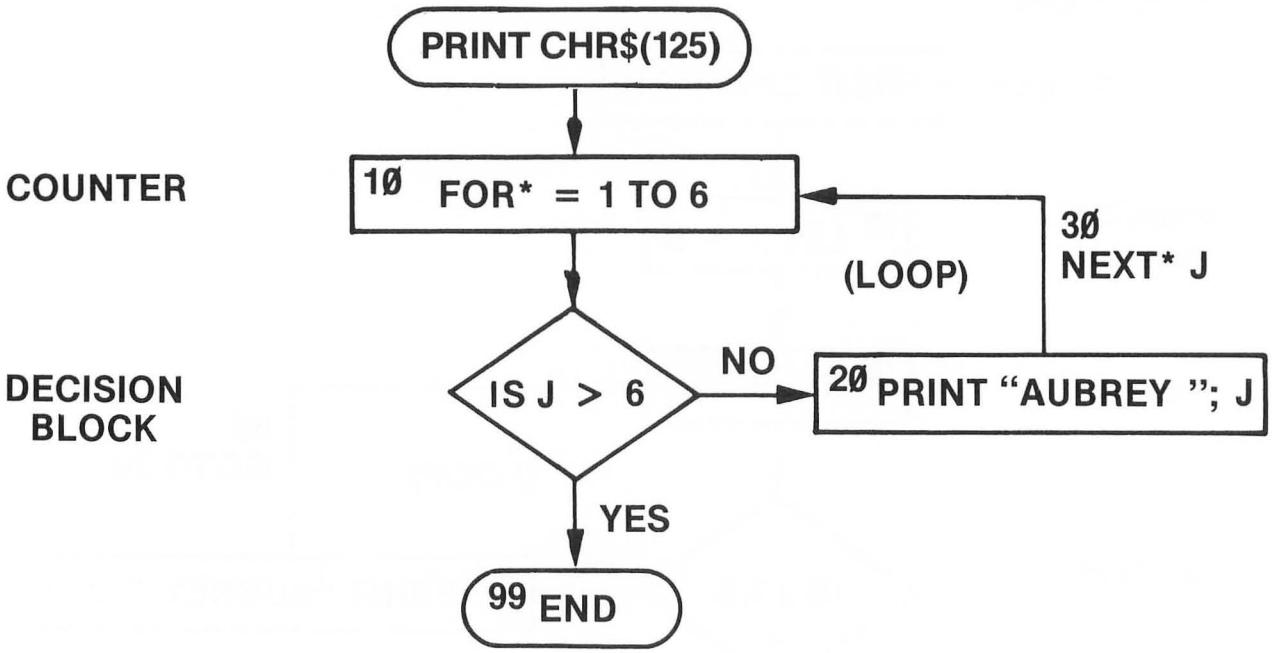
(Unconditional)



Looping with IF-THEN



Looping with FOR-NEXT



*FOR-NEXT *Work together as a counter

Timer Loop

- The Atari can do approximately 500 FOR-NEXT loops per second.
- Example

```
5 REM 15 SECOND TIMER PROGRAM
10 PRINT "TIMER PROGRAM COUNTING"
20 FOR X = 1 TO 7500
30 NEXT X
40 PRINT "TIMER PROGRAM ENDED"
```

- You don't believe the Atari can count? Well, try it! (Type in the above program and RUN.)
  — Don't forget to use your watch!

Assignment 10-1

1. Type, enter, and RUN the following program.

```
5 PRINT "INPUT A VALUE N": PRINT: PRINT
10 PRINT "ENTER 1500, 2500, 3500, or 7500"
15 INPUT N
20 PRINT CHR$(125)
25 PRINT "THIS IS A DEMONSTRATION OF"
30 PRINT: PRINT
35 FOR J = 1 TO N: NEXT J
40 PRINT "USING A FOR-NEXT TIMER LOOP"
45 PRINT: PRINT: PRINT: PRINT
50 FOR J = 1 TO N: NEXT J
60 PRINT "TO CHANGE THE DISPLAY'S SPEED"
65 PRINT: PRINT
70 FOR J = 1 TO N: NEXT J
80 PRINT "CHANGE THE VALUES OF N IN THE FOR-NEXT LOOP"
85 PRINT: PRINT: PRINT: PRINT
90 FOR J = 1 TO N: NEXT J
100 PRINT "IF YOU WISH TO STOP THIS DISPLAY"
105 PRINT: PRINT
110 FOR J = 1 TO N: NEXT J
120 PRINT "PRESS THE  BREAK  KEY"
130 FOR J = 1 TO N: NEXT J
140 GOTO 20
```

2. Make certain that you understand this program and can explain it to your teacher.

PRACTICE 18

Counting Programs Using IF-THEN and FOR-NEXT

1. Using IF-THEN, write a program to count 5's from 50 to 5.
   a. Written vertically
   b. Written horizontally
2. *Do not* type NEW (that is, save the program above).
3. Using FOR-NEXT, write a program to count to 50 by 5's written horizontally.
   Note: Start your second program at Line 100. That is, type Line 100 as follows: 100 PRINT : PRINT (Of course, this is to insert two spaces between your outputs.)
4. How many program lines (excluding Line 100) did it take using FOR-NEXT? _____
   How many using IF-THEN? _____
5. What can you conclude from this task?

PRACTICE 19

Using IF-THEN and FOR-NEXT Statements

1. Using IF-THEN, write a program to generate all the even numbers between 11 and 51 from smallest to the largest (that is, 12, 14, 16, and so forth).
2. *Do not* type NEW.
3. Using FOR-NEXT, write a program that generates the same numbers and PRINT them horizontally. (*Note:* Start at Line 100. Type Line 100 as → 100 PRINT : PRINT and your next line should be 110.)
4. Type NEW and enter.
5. Using IF-THEN, write a program to generate all even numbers between 11 and 51 from largest to the smallest.
6. Do the same using FOR-NEXT.

PART 11

Reading Data

What You Will Learn

1. To explain the purpose and use of the key words READ, DATA, RESTORE.
2. To compare the three different ways you have learned to input data into the Atari.
3. To write, enter, and run programs using READ-DATA and READ-RESTORE key words.

READ-DATA

READ-DATA statements are much more efficient than INPUT or LET statements when you have lots of data to input.

Ways of Inputting Data to the Computer (i.e., Ways We've Learned So Far)

BUILT-IN	FROM KEYBOARD	READ-DATA COMBINATION
10 LET A = 5	10 INPUT A	10 DATA (5) 20 READ A

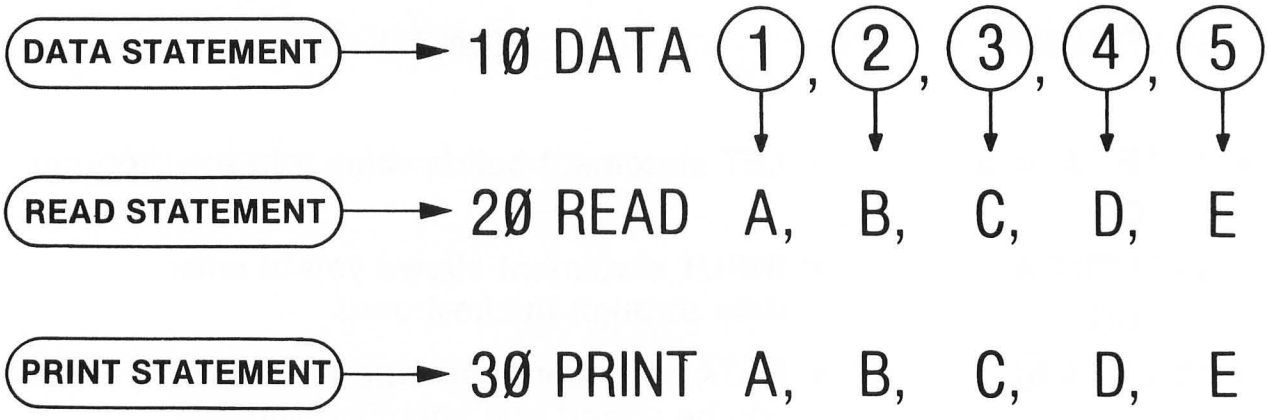
Ways of Inputting Data to the Computer

STATEMENT	FUNCTION
• 1Ø LET A = 5	• LET statement builds value into the program.
OR	
• 1Ø INPUT A	• INPUT statement allows you to enter data through the keyboard.
OR	
• 1Ø DATA(5)	• DATA statement contains the value (5), which will be stored in a specified variable.
2Ø READ A	• READ statement names the variables in which the values are to be stored.

NOTES: Data lines can be read only by READ statements.
The READ-DATA work together to input data to the computer.

READ-DATA Example

```
5 REM READ-DATA EXAMPLE
```



NOTES:

- **Each piece of data must be read by a READ statement.**
- **Each READ statement can read a number of pieces of data if each variable is separated by a comma.**
- **Data lines can only be used by READ statements.**

Exercise 11-1 (Reading Data)

Type and enter.

```
10 DATA 1,2,3,4,5
20 READ A,B,C,D,E
30 PRINT A, B, C, D, E
```

Type RUN and press RETURN .

```
 1        2        3        4
    5
```

NOTES:

- **The display shows that all five pieces of data in Line 1Ø were read by Line 2Ø, assigned letters A through E, and printed by Line 3Ø.**
- **Data lines are always read left to right by READ statements.**

READ-DATA Summary (Key Words)

DATA

- **Key word that lets you store data inside your program to be accessed (read) by READ statements.**
  - **— Data items will be read sequentially starting with the first item in the first DATA statement and ending with the last item in the last DATA statement.**
  - **— Items in data list may be string or numeric constants.**
  - **— When using string values in DATA statements, all characters will appear as seen in the Data line (e.g., quotes, spaces, colons, etc.).**
  - **— Commas can *NEVER* appear in a string DATA statement except to separate DATA statements.**
  - **— DATA statements must match up with the variable types in the corresponding READ statement.**
  - **— DATA statements may appear anywhere it is convenient in a program.**

- **EXAMPLE:**

```
10 DATA JONES A.B., SMITH R.J.
20 DATA LEEDS MIDDLE SCHOOL, COMPUTERS
30 DATA 125, 250, 750, 1000
```

READ-DATA Summary (Key Words)

READ

- Key word that instructs the computer to read a value from a DATA statement and assign that value to the specified variable.
  - — The first time a READ statement is executed, the first value in the first DATA statement is used; the second time, the second value in the DATA statement is used. When all the items in the first DATA statement are used (READ), the next READ will use the first value in the second DATA statement, and so on.
  - — An out-of-data error occurs if there are more attempts to READ than there are data items.

- EXAMPLE:

  40 DIM A$(10), B$(10), C$(20), D$(10)
  50 READ A$, B$, C$, D$, A, B, C, D

  (Note that there are eight READ variables and eight DATA items on previous page for program Lines 10, 20, and 30)

Assignment 11-1

1. Type and enter the following program:

```
 5 DIM A$(2Ø)
 1Ø PRINT "NAME",, "GRADE"
 2Ø READ A$
 3Ø IF A$ = "END" THEN PRINT "END OF LIST": END
 4Ø READ G
 5Ø IF G < 75 THEN PRINT A$, G
 6Ø GOTO 2Ø
 7Ø DATA GRAY BILL, 95, JONES A.B., 65
 8Ø DATA JONES A.C., 1ØØ, SMITH R.L., 7Ø
 9Ø DATA EPPS S.W. , 6Ø,  WELLS DAVE , 1ØØ, END
```

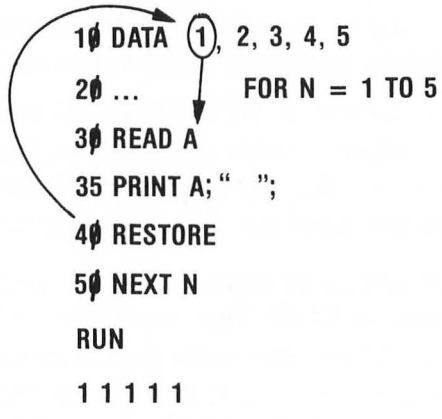
2. Predict the output of the program.
3. Why was the DIM statement used?
4. RUN the program and record the results.

RESTORE

- Key word that causes the next READ statement executed to start over with the first DATA statement.
  - — This lets your program reuse the same data lines.
  - — Sometimes it is necessary to READ the same data more than once without having to run the complete program again; therefore, RESTORE is used.
  - — Whenever the program comes to RESTORE, all data lines are restored to their original unread condition, both those lines that have been READ and those that have not been READ. This allows all data to be available for reading again, starting with the first data item in the first data line.

NOTE! Remember that each piece of data in a data line can only be read once each time the program is RUN. The next time a READ statement requests a piece of data, it will READ the next piece of data in the data line, or, if data on that line are all used up, it will go to the next data line and start reading it. Therefore, the RESTORE statement is needed if the same data is to be READ more than once in the same program.

Illustration of the READ-RESTORE Feature



NOTE:

- **RESTORE caused data Line 1Ø to be restored to its original unread condition, making all data available for reading again.**
- **Since there is only one read variable, A, it starts with the first piece of data, 1, in this case.**

Exercise 11-2 (READ-RESTORE Data in a FOR-NEXT Loop)

YOUR ACTION	DISPLAY	
1. Type and enter.	10 DATA 1,2,3,4,5 20 FOR N = 1 TO 5 30 READ A 40 PRINT A ; " "; 50 NEXT N	
2. Type RUN and press RETURN .	1 2 3 4 5 READY ■	
3. Insert Line 35. (Type and enter)	35 RESTORE	**Restores Data Line to Its Original Unread Condition**
4. Type RUN and press RETURN .	1 1 1 1 1 READY ■	**Therefore Computer Reads First Data Item Over and Over**

READ-DATA Summary

- READ-DATA
  - — Key words used to input lots of data to the computer.
- RESTORE
  - — Key word used to restore (put back) data so it can be used again.
- Data lines can be read only by READ statements.
  - — If more than one piece of data is placed on a data line, they must be separated by commas. Each piece of data must be read by a READ statement.
- Data lines are read from left to right by READ statements.
  - — Data lines can be placed anywhere in a program.
- READ-DATA statements are extremely common.
  - — RESTORE is used less often.

PRACTICE 20

READ-DATA

1. Type and enter the following program:

```
 5 PRINT CHR$(125)
10 PRINT "NAME",, "GRADE"
15 DIM A$(20)
20 READ A$
30 IF A$ = "END" THEN PRINT "END OF LIST":END
40 READ G
50 IF G > 75 PRINT A$, G
60 GOTO 20
70 DATA  GRAY BILL, 95, JONES A.B., 65
80 DATA  JONES A.C., 100, SMITH R.L., 70
90 DATA  EPPS S.W., 60,  WELLS DAVE, 100, END
```

2. Predict the output of the program.
3. RUN the program and record the results.

PART 12

Video Display Graphics

What You Will Learn

1. To explain the purpose of key words COLOR, GRAPHICS, PLOT, POSITION, SOUND, STICK, DRAWTO.
2. To become familiar with the layout of Atari display using the Video Display Worksheets.
3. To draw pictures and letters on the screen.
4. To write and run programs using all the concepts learned in this lesson.

NOTE: The Atari provides the user with an unlimited number of possibilities of graphic application. The student should experiment with graphics. This lesson will introduce the student to some of the basic features of graphics used on the Atari, but we will only "scratch the surface." Students will find out by themselves what other kinds of things can be done with graphics on the Atari.

POSITION X,Y

— Permits you to put the cursor anywhere on the screen.
— X must be from Ø to 39.
— Y must be from Ø to 23.
— Must be used in a program (i.e., you need a line number).
— Uses absolute moves only relative to the borders of the screen (that is, place the cursor anywhere without regard to text or graphics mode).

EXAMPLE

```
NEW
10 PRINT CHR$(125)
20 FOR K = Ø TO 23
30 POSITION K,K
40 PRINT K
50 NEXT K
```

In Class Exercise 12-1

1. Type, enter, and RUN the following program.

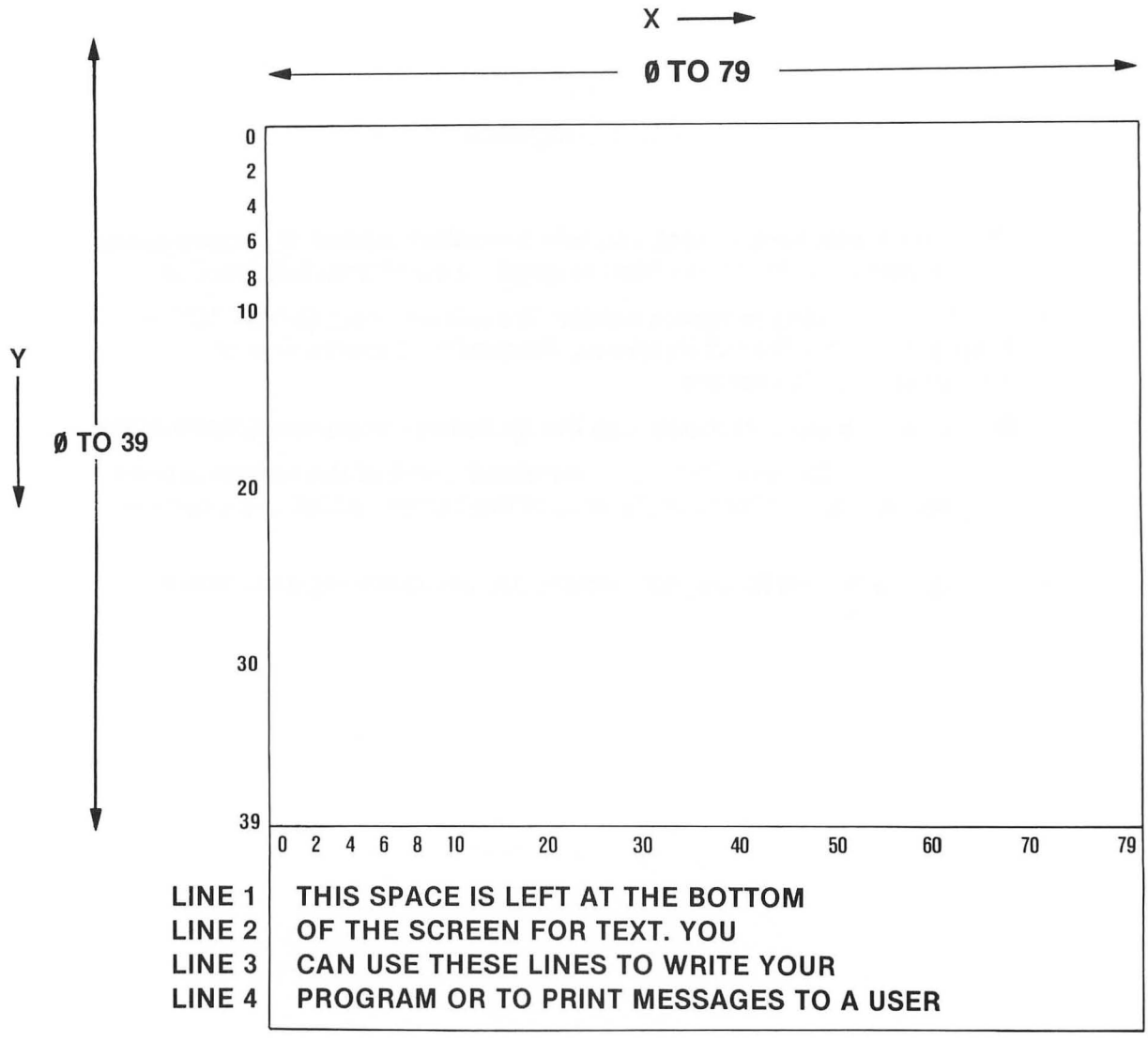
```
 5 PRINT CHR$(125)
1Ø POSITION 14,0:PRINT "POSITION DEMO"
2Ø POSITION 10,10
3Ø PRINT "THIS IS AN EXAMPLE"
4Ø POSITION 18,15
5Ø PRINT "OF"
6Ø POSITION 5,20
7Ø PRINT "USING POSITION FOR FORMATTING"
```

2. Run the program several times. Analyze the program and make certain you understand it.
3. Experiment with POSITION (if you have the time).

Atari Graphics

- This lesson assumes a black and white monitor is used. If you are using a color monitor refer to the Atari manual for additional information.
- The Atari has many graphics modes. We will be using GRAPHICS 5. Refer to the *Atari BASIC Reference Manual* for a discussion of additional graphics modes.
- To get back to the text mode, use the following command: GRAPHICS Ø.
- When you use the GRAPHICS 5 command, most of the screen is used for graphics except for four (4) lines at the bottom which are used for text.
- To clear the screen in graphics mode, use the following command: GRAPHICS Ø.

Atari
Video Display Layout Showing X, Y, Coordinates

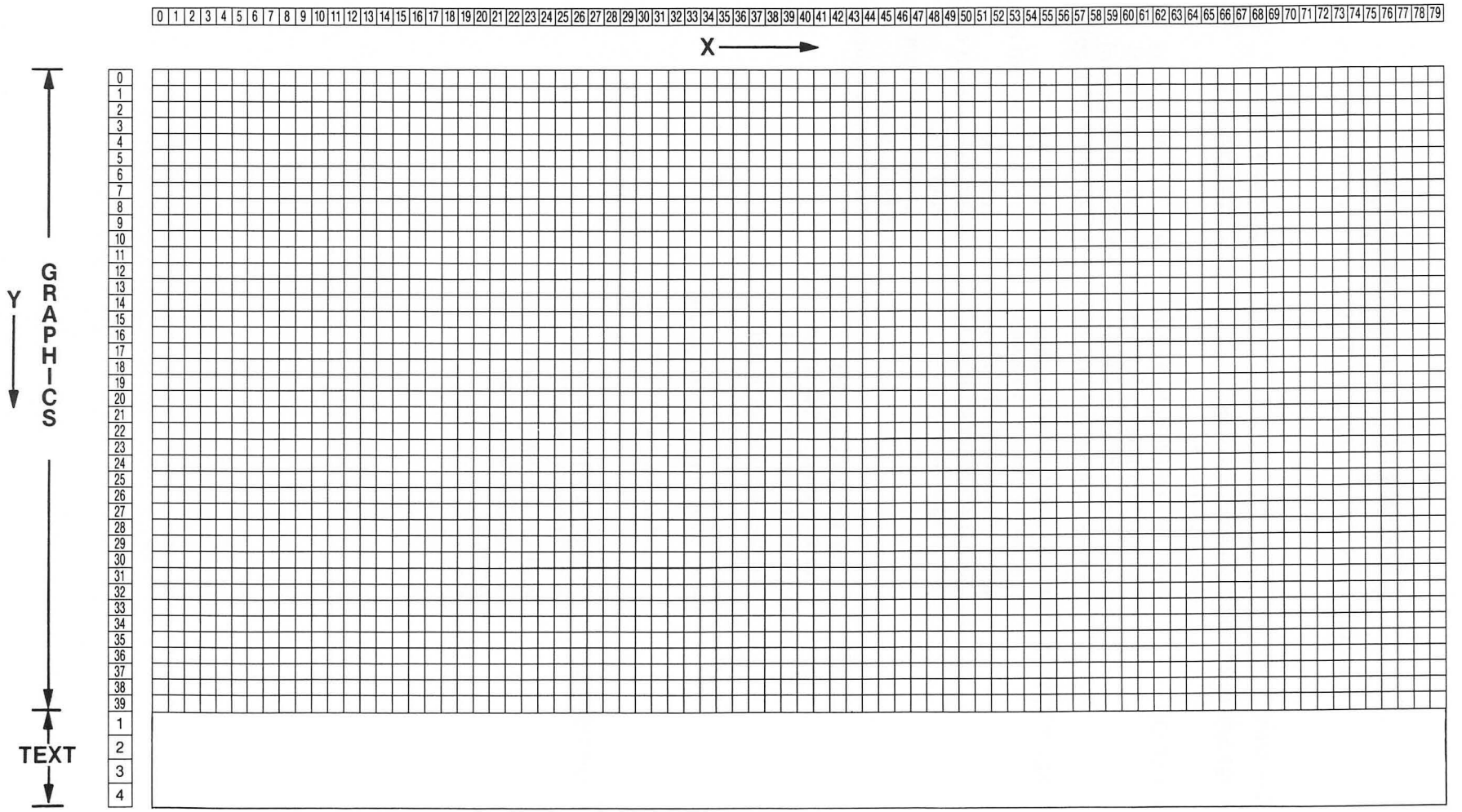


GRAPHICS COMMANDS

— GRAPHICS 5, COLOR, PLOT, GRAPHICS Ø

Key Word	Function	Example
• GRAPHICS 5	• Converts screen to graphics mode	• GRAPHICS 5
• COLOR	• Sets the color for plotting in low-resolution graphics mode (there are 4 colors available; they are numbered from Ø to 3)	• COLOR Ø (black) • COLOR 1 (white) • COLOR 2 (green) • COLOR 3 (orange)
• PLOT X, Y	• Places a dot at the location specified by the X, Y coordinates. (That is, PLOT allows you to turn on or light up a spot at location X,Y) — The color of the spot is determined by the most recent value of COLOR, which is Ø (black) if not previously specified — X value ranges from Ø to 79 — Y value ranges form Ø to 39	• PLOT Ø,Ø (dot in upper left corner) • PLOT Ø,39 (dot in lower left corner) • PLOT 79,Ø (dot in upper right corner) • PLOT 79,39 (dot in lower right corner)
• GRAPHICS Ø	• Converts entire screen back to text (words) mode. Display can handle up to 4Ø characters/line and 24 lines.	

Atari
Video Display Worksheet for Graphics 5 Mode



In-Class Exercise 12-2 (COLOR, GRAPHICS 5, PLOT)

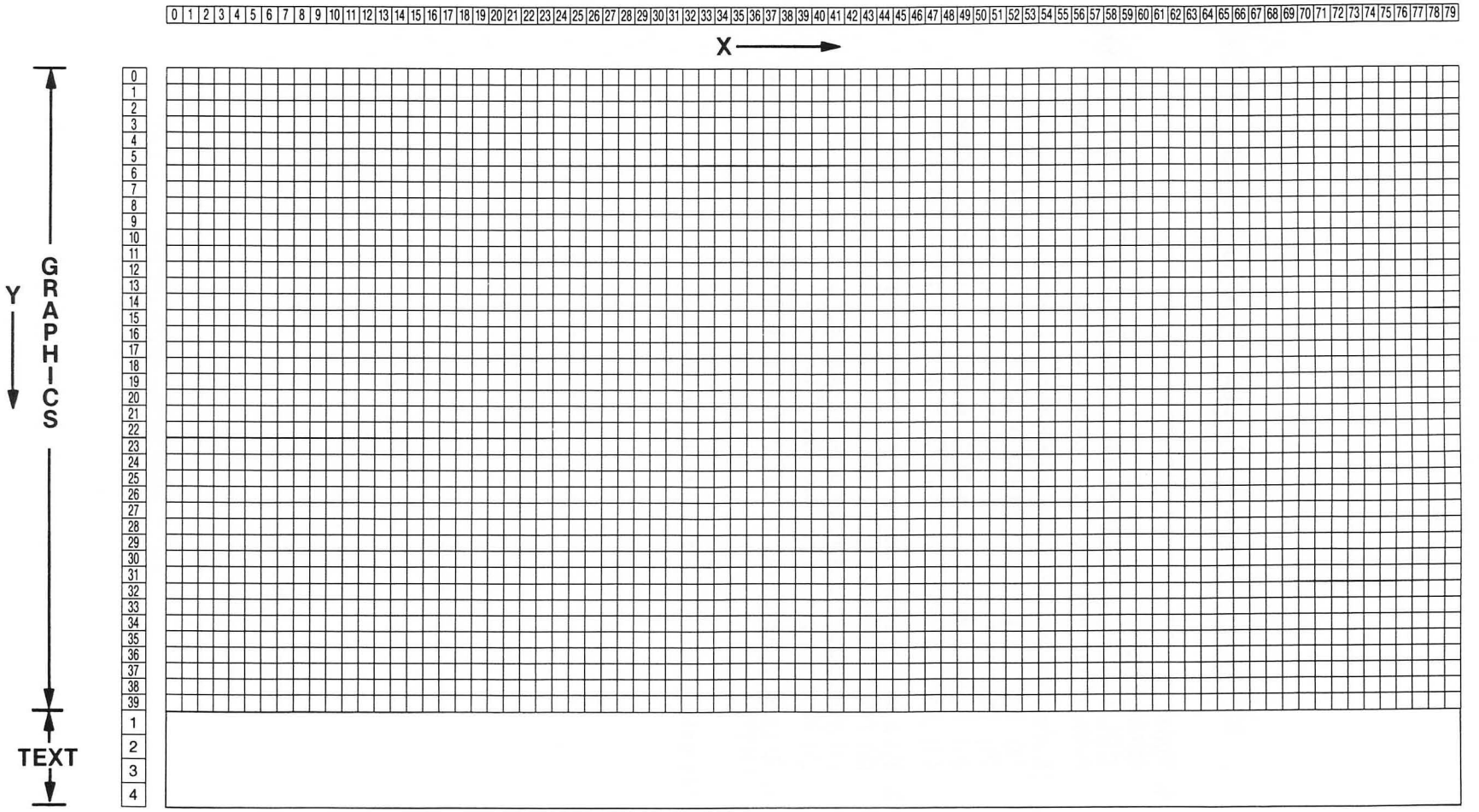
1. Type:
   GRAPHICS 5
   COLOR 1 (If you don't type this key word, you will not see the graphics because the color is set to zero (black) by GRAPHICS command)
2. Locate the following points on your video display worksheet:

(a) PLOT 9,9	(e) PLOT 20,20	(i) PLOT 36,10
(b) PLOT 39,0	(f) PLOT 10,20	(j) PLOT 10,36
(c) PLOT 0,39	(g) PLOT 6,36	(k) PLOT 28,38
(d) PLOT 39,39	(h) PLOT 8,18	(l) PLOT 38,28

3. Type and enter* the above coordinates in your Atari
   (a) Do they match the points you picked on your worksheet?
   (b) What happens if you plot 95,13? Explain.
   (c) What happens if you plot 20,45? Explain.
4. To clear the screen in graphics mode, type GRAPHICS 0 and press RETURN.

*To enter press RETURN (You know this by now!)

Atari
Video Display Worksheet for Graphics 5 Mode



In-Class Exercise 12-3
Drawing Lines on Worksheet

Using the video display worksheet:

1. **Plot the following X, Y coordinates on your worksheet:**

PLOT 10, 20	PLOT 16, 20
PLOT 11, 20	PLOT 17, 20
PLOT 12, 20	PLOT 18, 20
PLOT 13, 20	PLOT 19, 20
PLOT 14, 20	PLOT 20, 20
PLOT 15, 20	

2. **When you finish plotting the above coordinates, you will have a _____ line on your sheet from column (X) _____**
   (vertical, horizontal)
   to column (X) _____ at row (Y) _____.

3. **Plot the following coordinates on the same worksheet used above:**

PLOT 15, 15	PLOT 15, 21
PLOT 15, 16	PLOT 15, 22
PLOT 15, 17	PLOT 15, 23
PLOT 15, 18	PLOT 15, 24
PLOT 15, 19	PLOT 15, 25
PLOT 15, 20	PLOT 15, 26

4. **When you finish plotting the above coordinates (3), you will have a _____ line on your sheet from row (Y) _____**
   (vertical, horizontal)
   to row (Y) _____ at column (X) _____.

5. **Both plots in (1) and (3) above could be used as an _____ axis for graphs.**

In-Class Exercise 12-4
Drawing Lines on Atari (The Hard Way)

1. Horizontal lines
   (a) Set COLOR 1 and enter information below (don't forget to press RETURN after each line).

```
COLOR 1
PLOT 10, 20        PLOT 16, 20
PLOT 11, 20        PLOT 17, 20
PLOT 12, 20        PLOT 18, 20
PLOT 13, 20        PLOT 19, 20
PLOT 14, 20        PLOT 20, 20
PLOT 15, 20
```

   (b) What happened? _____

2. Vertical Lines
   (a) Set COLOR 1 and enter information below (don't forget to press RETURN).

```
COLOR 1
PLOT 15, 15        PLOT 15, 21
PLOT 15, 16        PLOT 15, 22
PLOT 15, 17        PLOT 15, 23
PLOT 15, 18        PLOT 15, 24
PLOT 15, 19        PLOT 15, 25
PLOT 15, 20        PLOT 15, 26
```

   (b) What happened? _____

3. Make up some coordinates on your own and try it!

Summary and Assignment 12-1
GRAPHICS 5, COLOR, PLOT, GRAPHICS Ø

Summary

1. Screen is divided into 4Ø vertical columns and 8Ø horizontal rows.
   — X is the horizontal coordinate counting across from the left-hand side of the screen. X coordinate goes from Ø to 79.
   — Y is the vertical coordinate counting from the top of the screen. Y coordinate goes from Ø to 39.

2. PLOT X,Y lights up a spot on the screen.
   — If you try to plot outside the range of X and Y (e.g., PLOT 2, 7ØØ or PLOT –15, –3Ø), you will get a message of either "ERROR–3" or "ERROR–141."
   — Although the highest number you can use with the Y coordinate is 47, don't do it! A Y coordinate in the range 4Ø to 47 will not show up on the screen.

3. Assignment 12-1
   Experiment with PLOT command on your own time until you feel comfortable with it.

In-Class Exercise 12-5
Drawing Lines on Atari (The Easy Way)

1. Horizontal Lines
   (a) Type and enter the following program:
   ```
   COLOR 1
   PLOT 0,20: DRAWTO 79,20
   RETURN
   ```
   (b) What happened? _____

   (c) How many PLOT statements would you need to type to draw the above line the hard way? _____

2. Vertical Line
   (a) Type and enter the following program:
   ```
   COLOR 1
   PLOT 40,0: DRAWTO 40,39
   RETURN
   ```
   (b) What happened? _____

3. Try some other examples. Play with DRAWTO until you feel comfortable using this key word to draw lines.

4. Can you think of other things you can draw using the DRAWTO command? (Try some, if you have the time.)

Summary of Graphing Lines

- PLOT A*,B*:DRAWTO C*,D* will draw a line from A*,B* to point C*,D*.

*In an actual example, each of these letters would be replaced with a number between Ø and 39 on Y axis and Ø to 79 on X axis.

```
10 GRAPHICS 5
20 COLOR 1
30 PLOT 20,1:DRAWTO 24,1
40 PLOT 20,3:DRAWTO 24,3
50 PLOT 20,1:DRAWTO 20,6
60 PLOT 24,1:DRAWTO 24,6
80 PLOT 30,7:DRAWTO 34,7
100 PLOT 32,7:DRAWTO 32,12
130 PLOT 36,14:DRAWTO 40,14
140 PLOT 36,16:DRAWTO 40,16
150 PLOT 36,14:DRAWTO 36,19
160 PLOT 40,14:DRAWTO 40,19
180 PLOT 44,21:DRAWTO 44,26
190 PLOT 44,21:DRAWTO 48,21
200 PLOT 44,23:DRAWTO 48,23
210 PLOT 45,23:DRAWTO 48,26
220 PLOT 48,21:DRAWTO 48,23
230 PLOT 56,28:DRAWTO 56,33
240 PLOT 54,28:DRAWTO 58,28
250 PLOT 54,33:DRAWTO 58,33
260 PRINT CHR$(125)
270 PRINT "VOILA! ATARI GRAPHICS"
```

- Now RUN the program several times.

In-Class Exercise 12-6*

Match the letter printed in Column I with the line numbers in Column II.

I	II
1. A_____	a. 210-240
2. T_____	b. 30-60
3. R_____	c. 180-190
4. I _____	d. 80-110

5. **Change the color value in Line 20 to 0 (COLOR 0). Before running the program, predict what will happen.**
6. **Write a program to print the first letter of your name.**

***Refer to program on page 173.**

SUMMARY OF GRAPHICS AND JOYSTICKS

- Joystick controls are very powerful tools in the manipulation of screen information.
- The program below shows how to draw pictures on the screen using a joystick.
- Type and enter:

```
30  GRAPHICS 7
40  COLOR 1
50  LX=159:LY=95
60  X1=INT(LX/2):Y1=INT(LY/2)
70  IF X1<0 THEN X1=LX
80  IF X1>LX THEN X1=0
90  IF Y1<0 THEN Y1=LY
100 IF Y1>LY THEN Y1=0
110 PLOT X1,Y1
120 FOR Z=1 TO 50:NEXT Z
130 J=STICK(0)
140 IF J=15 THEN GOTO 130
150 IF J>4 AND J<8 THEN GOTO 190
160 IF J>8 AND J<12 THEN GOTO 230
170 IF J=13 THEN Y1=Y1+1:GOTO 70
180 Y1=Y1-1:GOTO 70
190 X1=X1+1
200 IF J=6 THEN Y1=Y1-1:GOTO 70
210 IF J<>7 THEN Y1=Y1+1:GOTO 70
220 GOTO 70
230 X1=X1-1
240 IF J=10 THEN Y1=Y1-1:GOTO 70
250 IF J<>11 THEN Y1=Y1+1:GOTO 70
260 GOTO 70
```

In-Class Exercise 12-7

1. Write the program so that you cannot move off one side of the screen and reappear on the other side.
2. What happens if Line 120 is deleted?

MOVING THE CURSOR

- Another use of graphics and controllers is moving a cursor on the screen. The program below illustrates this point.
- Type and enter:

```
10 GRAPHICS 0
20 LIST
30 J=STICK(0)
40 FOR Z=1 TO 10:NEXT Z
50 REM LINE 40 SLOWS CURSOR MOVEMENT
60 IF J=15 THEN GOTO 30
70 IF J>12 THEN GOTO 180
80 IF J>8 AND J<12 THEN GOTO 140
90 REM MOVE CURSOR WITH ARROW CHARACTERS
100 PRINT CHR$(31);
110 IF J=6 THEN PRINT CHR$(28);
120 IF J=5 THEN PRINT CHR$(29);
130 GOTO 30
140 PRINT CHR$(30);
150 IF J=10 THEN PRINT CHR$(28);
160 IF J=9 THEN PRINT CHR$(29);
170 GOTO 30
180 IF J=14 THEN PRINT CHR$(28);
190 IF J=13 THEN PRINT CHR$(29);
200 GOTO 30
```

- Hit the BREAK key when finished.

In-Class Exercise 12-8

1. What happens if Line 40 is deleted?
2. Write the program so the cursor cannot move "off" the screen.

SUMMARY OF ATARI GRAPHICS CAPABILITY

- The Atari computer system is a capable graphics computer. The three programs below will illustrate these capabilities. Notice how figures can be magnified and reduced using different graphics modes.
- Type and enter:

```
20 GRAPHICS 5
30 COLOR 1
40 PLOT 26,14:DRAWTO 40,14
50 DRAWTO 48,6:DRAWTO 36,6
60 DRAWTO 26,14:DRAWTO 26,30
70 DRAWTO 40,30:DRAWTO 48,22
80 DRAWTO 36,22:DRAWTO 26,30
90 PLOT 36,6:DRAWTO 36,22
100 PLOT 48,6:DRAWTO 48,22
110 PLOT 40,14:DRAWTO 40,30
120 FOR I=1 TO 10000:NEXT I
130 END
```

- Run this program several times.

In-Class Exercise 12-9

1. Write the program using GRAPHICS 7. What happened to the cube?
2. Now use GRAPHICS 8. Notice the reduction.
3. Center the cube by changing the corners of the cube.
4. Enlarge the cube to twice its original size.

ATARI SOUND CAPABILITY

- The following three programs will give insight into using the Atari sound system. The last program is a jet passing overhead. The other three programs are note-generation programs.
- Type and enter:

```
10 SOUND 0,121,10,8
20 SOUND 1,96,10,8
30 SOUND 2,81,10,8
40 SOUND 3,60,10,8
50 FOR I=1 TO 2000:NEXT I
60 SOUND 0,0,0,0
70 SOUND 1,0,0,0
80 SOUND 2,0,0,0
90 SOUND 3,0,0,0
100 END
```

In-Class Exercise 12-10

1. What happens if Line 50 is deleted?
2. Retype Line 50 and use different values. What happens?

- Type and enter:

```
10 FOR J=1 TO 43
20 READ A,B
30 FOR I=1 TO A
40 SOUND 0,B,10,10
50 NEXT I
60 NEXT J
70 DATA 50,96,50,108,50,121,50,108
80 DATA 50,96,5,0,50,96,5,0,75,96
90 DATA 10,0,50,108,5,0,50,108
100 DATA 5,0,75,108,10,0,50,96
110 DATA 5,0,50,81,5,0,75,81,50,0
120 DATA 50,96,50,108,50,121,50,108
130 DATA 50,96,5,0,50,96,5,0,50,96
140 DATA 5,0,50,96,5,0,50,108,5,0
150 DATA 50,108,5,0,50,96,5,0,50,108
160 DATA 5,0,100,121
170 END
```

3. Describe what happens when Line 30 is changed to FOR I=1 TO

   (a) A/2
   (b) A/3
   (c) A/10
   (d) 2*A
   (e) 3*A

- Run the program several times.

In-Class Exercise 12-11

- Type and enter:

```
10 FOR I=1 TO 100
20 SOUND 0,9,8,I
30 NEXT I
40 FOR A=10 TO 140
50 SOUND 0,10,8,A/10
60 NEXT A
70 FOR B=10 TO 50
80 SOUND 0,B,8,15
90 NEXT B
100 FOR C=140 TO 1 STEP-1
110 SOUND 0,50,8,C/10
120 NEXT C
130 END
```

1. Change the divisor values in Lines 50 and 110 and see (or hear) what happens.

SOME FUN PROGRAMS TO TRY ON YOUR OWN

- The three programs below are short (but sweet) sound or graphics demonstrations for the Atari. Have fun!
- Type and enter:

```
5 REM PHASOR FIRE SOUND PROGRAM
10 FOR I=0 TO 120
20 SOUND 0,I,8,10
30 FOR X=1 TO 5
40 NEXT X
50 NEXT I
60 END
```

- Type and enter:

```
10 REM CANNON GRAPHICS PROGRAM
20 GRAPHICS 7
30 COLOR 1
40 PLOT 10,79
50 DRAWTO 15,70
60 PLOT 10,75
70 DRAWTO 15,79
80 PLOT 10,75
90 DRAWTO 10,79
100 FOR X=-7 TO 7 STEP 0.2
110 Y=X^2
120 COLOR 1
130 PLOT X*10+85,Y+20
140 FOR I=1 TO 10
150 NEXT I
160 COLOR 0
170 PLOT X*10+85, Y+20
180 NEXT X
190 PRINT "BOOM!"
200 END
```

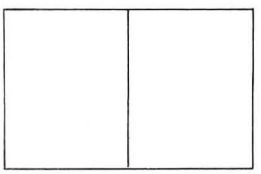
- Type and enter:

```
5 REM NOISE GENERATION SOUND PROGRAM
10 FOR I=0 TO 31
20 SOUND 0,I,12,10
30 FOR X=1 TO 25
40 NEXT X
50 NEXT I
60 FOR I=1 TO 200
70 NEXT I
80 END
```

PRACTICE 21

Graphics

1. Write a program that will do the following:
   a. Draw a horizontal line across the top of the screen (Line Ø).
   b. Add the necessary steps to your program to draw a vertical line down the middle of the screen.
   c. Add the necessary steps to your program to draw a horizontal line across the bottom of the screen (last line of the display).
   d. Add the necessary steps to draw a vertical line on the far left side of the display.
   e. Add the necessary steps to draw a vertical line to the far right side of the display.
   f. Enter and RUN your program.



Display should look like this after part (E).

PART 13

Arrays

What You Will Learn

1. To explain the purpose of using arrays.
2. To set up one- and two-dimensional numeric arrays.
3. To explain the purpose and use of the terms DIM, A(3), A(2,3), DIM A(10), DIM DB(7,5).
4. To develop, enter, and run programs using numeric arrays.

Arrays

A. What is an array?

- **An array is a lineup, an arrangement, or an orderly grouping of things.**

B. Why use an array?

- **Use it when we wish to have more variables available in a program.**
  - **— Although the Atari BASIC permits the use of approximately 128 variables for numerics, sometimes thousands of variables are required for storing and retrieving many pieces of data.**
  - **— The array allows you to arrange your data so that it can be stored and retrieved easily.**

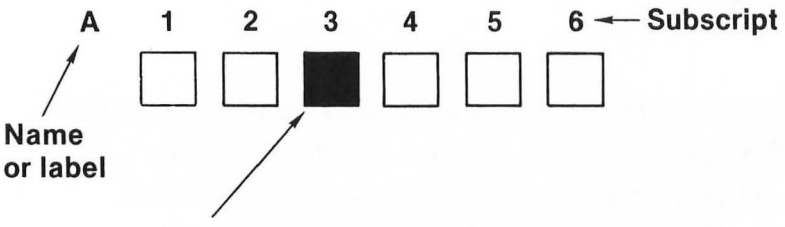
C. How to use a numeric array in Atari BASIC*

- **The Atari must be instructed how much memory space to reserve for an array.**
  - **— This is done by using the DIM statement.**
  - **— To use the arrays A and B on the next page, you would write: DIM A(6),B(6).**
  - **— DIM stands for DIMension. When you DIMension an array, you tell the Atari the maximum number of array elements your array can have.**
  - **— DIM A(6) actually reserves 7 spaces for the array, since A(Ø) is the first element of the array.**
  - **— Computers, unlike people, begin counting with the number Ø.**

***Other computers use arrays differently, so when using another computer, be careful!**

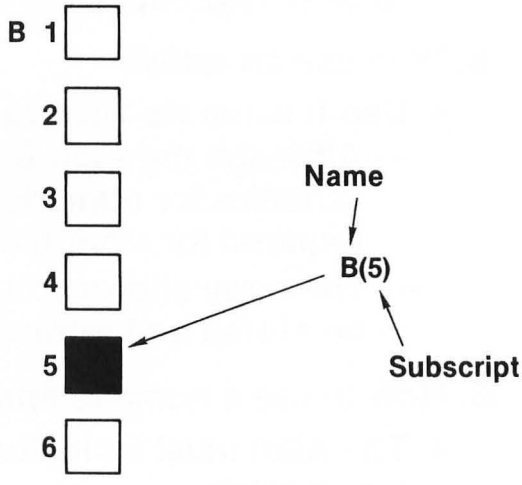
One-Dimensional Array — Illustration

SIX-ELEMENT ARRAY — NAMED A*



- A(3) is pronounced A SUB 3.
  - — A(3) represents the third cell or box in the array (lineup).
  - — Data stored in this cell would be addressed by the label A(3).
  - — Suppose data were stored in the sixth cell: A(6)? (You got it!)

SIX-ELEMENT ARRAY — NAMED B*



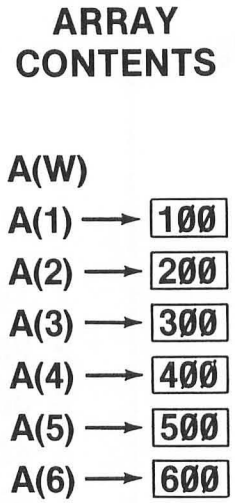
- B(5) represents the fifth cell in the array where data can be stored and retrieved.

*A and B are optional names. Any valid variable name can be used to name an array in Atari BASIC.

One-Dimensional Array — Program Example

PROGRAM	DISPLAY	REMARKS
5 DIM A(6) 10 DATA 100, 200, 300, 400, 500, 600 20 FOR W = 1 to 6 30 READ A(W) 40 NEXT W		• Lines 20-40 store data in array A(W)
50 FOR W = 1 to 6 60 PRINT W, A(W) 70 NEXT W RUN	1 100 2 200 3 300 4 400 5 500 6 600	• Lines 50-70 retrieve data from array A(W)

One-Dimensional Array — Program Example (Con't)



Above is an illustration of what happens after data are stored in array A(W). Note that in location A(1), the first data element (100) is stored. In location A(2), the second data element (200) is stored, and so on until the sixth data element (600) is stored in location A(6). Remember that Line 10 of the program contained the data elements that were read using Lines 20 through 40.

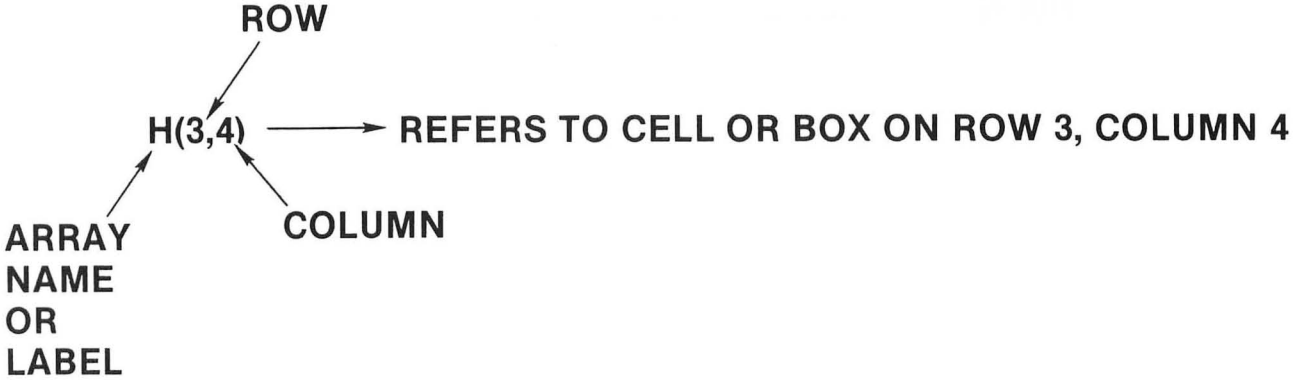
Two-Dimensional Array — Illustration

COLUMN

H	1	2	3	4	5	6
1	11	12	13	14	15	16
2	21	22	23	24	25	26
3	31	32	33	34	35	36
4	41	42	43	44	45	46
5	51	52	53	54	55	56
6	61	62	63	64	65	66

ROW

36 ELEMENT ARRAY (MATRIX)
(NAMED H)



In-Class Exercise 13-1

(Fill in the Blanks Using the Matrix)

LABEL	ROW	COLUMN	CONTENTS
H(1,1)	_____	_____	_____
H(4,5)	_____	_____	_____
H(3,3)	_____	_____	_____
H(2,3)	_____	_____	_____
H(6,6)	_____	_____	_____
H(1,6)	_____	_____	_____
H(2,4)	_____	_____	_____
H(4,4)	_____	_____	_____

DIM Statement

- **Review the DIM statement on page 183.**

- **EXAMPLE**

```
1Ø  DIM  A(6),        B(2,3),        C(21)
```

Sets a one-dimension array A with 6 elements A(Ø) — A(5) or A(1) — A(6)*

Sets a two-dimension array B with 3 ROWS (numbered Ø-2) and 4 COLUMNS (numbered 0-3)

Sets a one-dimension array with 21 elements A(Ø) — A(2Ø) or A(1) — A(21)*

***If A(Ø) is not used**

Checkbook Array Example

- Consider the following table of checkbook information:

Check #	Date Written	Amount
1ØØ	6/5/81	$ 15.5Ø
1Ø1	6/7/81	25.ØØ
1Ø2	6/15/81	145.ØØ
1Ø3	6/22/81	65.ØØ
1Ø4	6/3Ø/81	211.ØØ
1Ø5	6/3Ø/81	79.5Ø

- Note that every item in the table may be specified by reference to two numbers: the row number and the column number. For example, (Row 3, Column 3) refers to the amount $145.ØØ.
- The above table can be set up in a 6 × 3 array or matrix (see next page).

Checkbook Array Example (Con't)

CK	1	2	3
1	100	60581	15.50
2	101	60781	25.00
3	102	61581	145.00
4	103	62281	65.00
5	104	63081	211.00
6	105	63081	79.50

6 × 3 MATRIX (ARRAY) — NAMED CK

NOTES:

1. Data recorded in form mm ddyy where mm = month number, dd = day, and yy = last two digits of year.
2. Since CK is a numeric array, alpha-numerical characters such as dashes cannot be stored.

Checkbook Array Example (Con't)

YOUR ACTION **DISPLAY**

1. Setting Up the Array (Lines 1Ø through 11Ø)

A. Let's type and enter Lines 1Ø through 11Ø as shown: →

```
10 DIM CK(6,3)
20 FOR ROW = 1 TO 6
30 FOR COL = 1 TO 3
40 READ K
50 CK(ROW,COL) = K
60 NEXT COL
70 NEXT ROW
100 DATA 100,60581,15.50
110 DATA 101,60781,25.00
120 DATA 102,61581,145.00
130 DATA 103,62281,65.00
140 DATA 104,63081,211.00
150 DATA 105,63081,79.50
160 FOR ROW = 1 TO 6
170 SUM = SUM + CK(ROW,3)
180 NEXT ROW
190 PRINT "TOTAL AM'T OF CKS $ "; SUM
```

(NOTE: Line 1Ø sets up dimension of array. Lines 2Ø-15Ø read the values into array CK.)

NOTE: DIM CK (6, 3) Sets up a 6 × 3 array (excluding zero subscripts) with 6 rows (numbered 1 to 6) and 3 columns (numbered 1 to 3)

2. Manipulating the Array (Finding the Sum)

A. Add Lines 16Ø through 19Ø to the program as shown:

(NOTE: Lines 12Ø-16Ø add up all the checks written.)

B. Type RUN and press RETURN.

```
TOTAL AM'T OF CKS $541
```

Checkbook Array Example (Con't)

YOUR ACTION | **DISPLAY**

3. Manipulating the Array (Print out all checks written on a given day)

A. Do not type NEW.

B. Add the following steps to your program: →

```
195 PRINT:PRINT
200 PRINT "LIST CKS FROM (MM DD YY)";
205 INPUT DT: PRINT:PRINT
210 PRINT "CKS WRITTEN ON ";DT;
220 PRINT " ARE LISTED BELOW"
225 PRINT:PRINT
230 PRINT "CHECK #",, "AMOUNT" :PRINT
240 FOR ROW = 1 TO 6
250 IF CK(ROW,2) = DT THEN PRINT CK(RO
W,1),, CK(ROW,3)
260 NEXT ROW
```

C. Type RUN and press RETURN.

```
TOTAL OF CHECKS WRITTEN $541.ØØ
LIST CHECKS WRITTEN ON (MM DDYY)?
CHECKS WRITTEN ON 63081 ARE LISTED BELOW;
CHECK #          AMOUNT
  1Ø4             211
  1Ø5             79.5
```

D. Enter a date (e.g., 63081 which is 6/30/81). →

Assignment 13-1

Read pages 41–43 in the *Atari BASIC Reference Manual.*

Summary

- A2 ≠ A(2)
  - — A2 is an ordinary variable
  - — A(2) is a subscripted variable
- Any time you use an array, you must use a DIM statement.
  - — Example:

    1Ø DIMA (25), B(17, 18)
- One-Dimensional Array

  SUBSCRIPT

  — A(3) is pronounced A SUB 3

  NAME
- Two-Dimensional Array (Matrix)

  ROW

  — H(3,4) refers to cell or box on row 3, column 4

  NAME COLUMN

PRACTICE 22

Arrays

1. Write a program to read the following numbers into an array and then PRINT them out:
   676 15Ø 175 188 19Ø 277 876 976 912 544
2. Change program to find the sum and average of the 1Ø numbers given.
3. Label the answer: The sum is _____, and the average is _____.

PRACTICE 23

One-Dimensional Array

1. Suppose we had the following results of a quiz given to a class of 1Ø students:

Student #	1	2	3	4	5	6	7	8	9	1Ø
Student's Grade	75	85	95	87	100	77	83	69	98	88

   a. Using a one-dimensional Array, write a program to find the class average.
   b. Add the necessary program lines to find the highest grade and the lowest grade.
   c. Have the program PRINT : Class Average is _____, Highest Grade is _____ and Lowest Grade is _____.
   d. Enter and RUN each of these programs several times.

PART 14

INT(X), ABS(X) & RND(X) Functions

What You Will Learn

1. To explain the purpose and use of INT(X), ABS(X), and RND(X) functions.
2. To write, run, and analyze programs using the INT(X), ABS(X), and RND(X) functions.

INT(X) Function

- INT(X) or integer function allows you to round off any number, large or small, positive or negative, into a whole number (or integer).
- INT(X) means
  - — If X is a positive number, then the largest whole number can be found by chopping off the decimal part.

    Example:

    INT (5.7) = 5

    INT (Ø.7) = Ø
  - — If X is a negative number, the largest whole number can be found by moving down to the next lowest whole number (that is, make a negative number more negative).

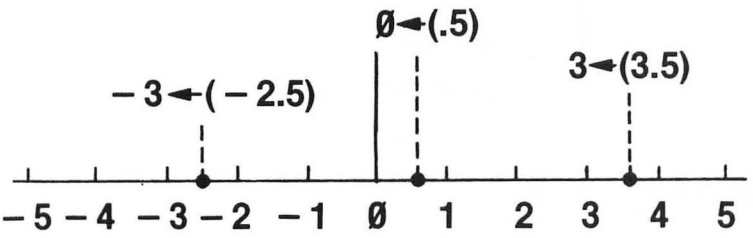
    Examples:

    INT (−. 6) = −1 INT (−3.14) = −4

    INT (−.2) = −1 INT (−7.28) = −8

Exercise 14-1 INT(X)

Graphical Representation



For negative numbers:
"Move to next lowest whole number"

For positive numbers:
"Chop off decimal part"

X	INT(X)
Ø.5	_____
– 1.7	_____
2.345	_____
– Ø.8	_____
Ø	_____
3.1415	_____
76.14	_____
– 1Ø.35	_____

INT(X) FUNCTION — ROUNDING $$

YOUR ACTION

1. Type and enter this program.

2. Now RUN.

3. Add Line 15 to program as shown.
(Note: In Line 15 we multiply by 100, add .5, take the INT, which is now 667, and then divide 667 by 100. 667/100 is 6.67, which is what we want, two decimal places.)

4. Now RUN program.

DISPLAY

```
10 LET A = 20/3
20 PRINT "$"; A
$6.6666666
15 A = INT (100*6.66667+.5)/100


$6.67

READY
■
```

Assignment 14-1 INT(X)

1. Type NEW and enter this program for finding the area of a circle:

   ```
   10 REM  AREA OF A CIRCLE 3.14159* R ∧ 2
   20  PRINT "THE RADIUS IS";
   25  INPUT R
   30 P  =  3.14159
   40 A = P*R ∧ 2
   50 PRINT "THE AREA IS "; A
   ```

2. RUN the program several times to make sure it works.
3. Change the program to suppress (chop off) all of the numbers to the right of the decimal point. (RUN the program to make sure it works.)
4. Change the program to make the answer accurate to one decimal place. (For example, if R = 1, then Area (A) = 3.1.)

ABS(X) Function

- ABS(X) = Abbreviation for absolute value of X
- Examples:

ABS (12) = 12	ABS (– 1Ø) = 1Ø
ABS (Ø) = Ø	ABS (– 357) = 357

- Note! ABS (25 – 1Ø) = ABS (1Ø – 25) = 15

Assignment 14-2 ABS(X)

YOUR ACTION	DISPLAY
1. Type and enter the program shown.	1Ø PRINT "TYPE ANY POS. OR NEG. #"; 15 INPUT N 2Ø X = ABS (N) 3Ø PRINT "N", "X" 4Ø PRINT N,X
2. RUN the program several times using both positive and negative numbers. (Note that regardless of the number you input as N, the absolute value of X is the same number without the sign.)	

RND(X) Function

- RND(X) or random number function causes the computer to give you a "surprise" number.
  - — It's as though the computer spins a wheel of chance.
  - — It's like pulling a number out of a hat.
  - — It's unpredictable!
- The random number function – general form

  Let N = INT (X * RND(1)) + 1

  Where N = The random number

  RND = Abbreviation for random

  X = Any number between 1 and 32767
- The general form for finding random numbers may seem a little complicated at first but it's not once you understand how to use it. All you need to do is just give "X" the value or number you wish to be the highest random number. When you run the program, you will have a number between 1 and X.

  Example:

  10 PRINT INT (4 * RND (1)) +1 (will give you a random number from 1 to 4 inclusive)

  20 PRINT INT (6 * RND (1)) +1 (will give you a random number from 1 to 6 inclusive)

  30 PRINT INT (10 * RND (1)) +1 (will give you a random number from 1 to 10 inclusive)
- Type, enter, and RUN the above program several times or until you understand how random numbers work.

Random Number — Program Example

YOUR ACTION	DISPLAY
1. Type and enter. (Line 5 allows you to enter "X" or the highest random number you want.)	5 PRINT "ENTER A # FROM 1 TO 100"; 10 INPUT X 20 FOR J = 1 TO 10 30 PRINT INT (X * RND (1))+1 40 NEXT J
2. Type RUN and press RETURN.	(SCREEN SHOULD HAVE TEN RANDOM NUMBERS BETWEEN 1 AND X.)
3. RUN program again to get the idea.	
4. Change Line 10 to read:	10 FOR J = 1 TO 100
5. RUN. (Get the idea?)	(SCREEN SHOULD HAVE ONE HUNDRED RANDOM NUMBERS BETWEEN 1 AND X.)

Coin Toss Program

ACTION AND REMARKS	DISPLAY
1. Type and enter program as shown:	10 REM H = HEADS, T = TAILS
	20 H = 0: T = 0 : PRINT
	30 PRINT "HOW MANY FLIPS OF THE COIN";
	35 INPUT N
	40 PRINT CHR$(125)
	50 PRINT "COIN IS FLIPPING...STANDBY"
	60 FOR K = 1 TO N
(Line 70 generates integers between 1 and 2.)	70 X = INT (2 * RND (1))+1
(Line 80 tells the program to go to Line 90 if X = 1 = heads and to Line 100 if X = 2 = tails.)	80 ON X GOTO 90, 100
(Line 90, "heads" are counted.)	90 H = H + 1 :GOTO 110
(Line 100, "tails" are counted.)	100 T = T + 1
(Line 110 sends control back to Line 60 for "N" passes.)	110 NEXT K
	120 PRINT CHR$(125)

Coin Toss Program (Con't)

ACTION AND REMARKS	DISPLAY
(Line 13Ø prints the headings.)	13Ø PRINT "HEADS", "TAILS", "TOTFLIPS" : PRINT
(Line 14Ø prints the values of H, T, and N.)	14Ø PRINT H, T, N
(Line 15Ø calculates and prints the percentage of heads, percentage of tails.)	15Ø PRINT 1ØØ*H/N; "%", 1ØØ*T/N; "%"
(Line 16Ø provides spacing for better appearance.)	16Ø PRINT: PRINT: PRINT

Assignment 14-3 RND(X)

YOUR ACTION	DISPLAY
1. Type and enter the program as shown. ⟶	5 REM PICK A NUMBER GAME 10 PRINT CHR$(125) 20 X = INT (10 * RND (1)) +1 30 PRINT "ENTER A # FROM 1 TO 10"; 35 INPUT N 40 IF X = N THEN 100 50 IF X < N THEN 110 60 IF X > N THEN 120 100 PRINT "RIGHT ON": GOTO 10 105 FOR J = 1 TO 2500: NEXT: GOTO 10 110 PRINT "LOWER": GOTO 30 120 PRINT "HIGHER": GOTO 30
2. RUN the program.	

Assignment 14-3 RND(X)

3. Analyze the program.

   Line 1Ø _____ the display.

   Line 2Ø is the _____ generator.

   Line 3Ø allows the user to _____ a number.

   Lines 4Ø, 5Ø, and 6Ø are _____ statements that compare
   conditional, unconditional

   the random number _____ with the input number _____.
   X,N X,N

   Lines 1ØØ, 11Ø, and 12Ø are PRINT statements that guide the player. Why does Line 1Ø5 GOTO Line 1Ø and why do Lines 11Ø and 12Ø GOTO Line 3Ø? Explain the function of Line 1Ø5.

4. Modify (change) the program to pick a number between 1 and 1ØØ, and RUN this program several times.

Summary

- **ABS(X) — Provides the absolute value of X regardless of the number you input (i.e., X is that same number without the sign).**
- **INT(X) — Provides integer or whole number value of X.**
  - **— If X is a positive (+) number, it chops off the decimal part.**
  - **— If X is a negative number, it rounds down to the next lowest whole number (e.g., INT (−Ø.6) = −1).**
- **RND(X) — Causes the computer to give you a random number.**
  - **— INT (X * RND (1)) + 1 gives you a random number from 1 to X inclusive.**

PRACTICE 24

INT(X) and ABS(X)

1. Fill in the banks with the appropriate INT(X):

X	INT(X)
0.7	_____
−2.5	_____
6.365	_____
−0.8	_____
−10.65	_____
0	_____
3.2425	_____
−7.61	_____
−0.3	_____
0.3	_____

2. The following program can be used for finding the area of a circle:

```
10 REM AREA OF A CIRCLE = 3.14159*R^2
15 DIM A$(10)
20 PRINT "THE RADIUS IS";
23 INPUT R
25 PRINT "RADIUS IN (IN.,FT,OR YD,)";
27 INPUT A$
30 A = 3.14159*R^2
40 PRINT "THE AREA IS "; A; " SQ. "; A$
```

   a. Enter and RUN the program several times to make certain it works.
   b. Change the program to suppress (chop off) all the numbers to the right of the decimal point (RUN the program to make sure it works).
   c. Change the program to make the answer accurate to one decimal place. (For example if R = 1, then area (A) = 3.1).

PRACTICE 25

Random Number

1. Write a program that will let you pick a random number between 1 and 100. The program should let you input a number from the keyboard and provide the following clues on your guess.
   a. If the number you pick matches the number the computer picks, have the computer PRINT "Right On."
   b. If the number from the keyboard is too high, have the program print "Lower."
   c. If the number from the keyboard is too low, have the program print "Higher."
   d. Enter and RUN the program several times.

PART 15

Subroutines

What You Will Learn

1. To explain the purpose for using subroutines.
2. To explain the purpose and use of terms ON-GOTO, GOSUB, RETURN, ON-GOSUB.
3. To develop, enter, and run programs using subroutines and ON-GOTO statements.

Subroutine

What Is It?

- **A subroutine is a short program or routine that is built into a large program to do specific calculations or perform repetitive functions.**

Why Use It?

- **There are times when you need the same type of calculation at various points in your program, but instead of retyping the statements needed for this calculation each time, you can write a subroutine to perform the needed calculations.**

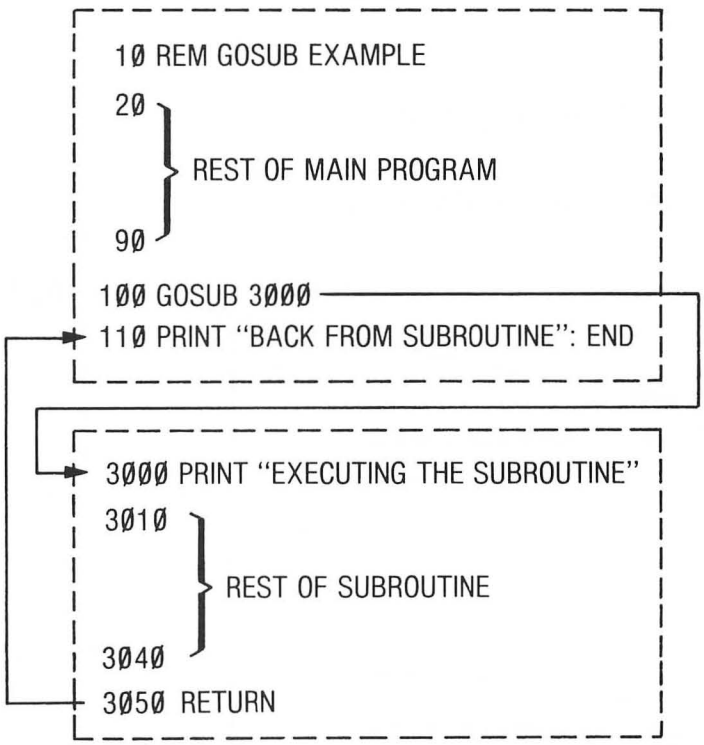
How Do You Call a Subroutine?

- **To call or branch to a subroutine, use the GOSUB statement.**
  - **— The GOSUB XXXXX statement directs the computer to go to that line number and execute the program steps until it reaches the key word RETURN, which ends the subroutine.**
  - **— RETURN is always built into a subroutine and is used to tell the computer that the subroutine is finished. When finished, the control of the program is returned to the statement in the main program immediately following the most recently executed GOSUB.**

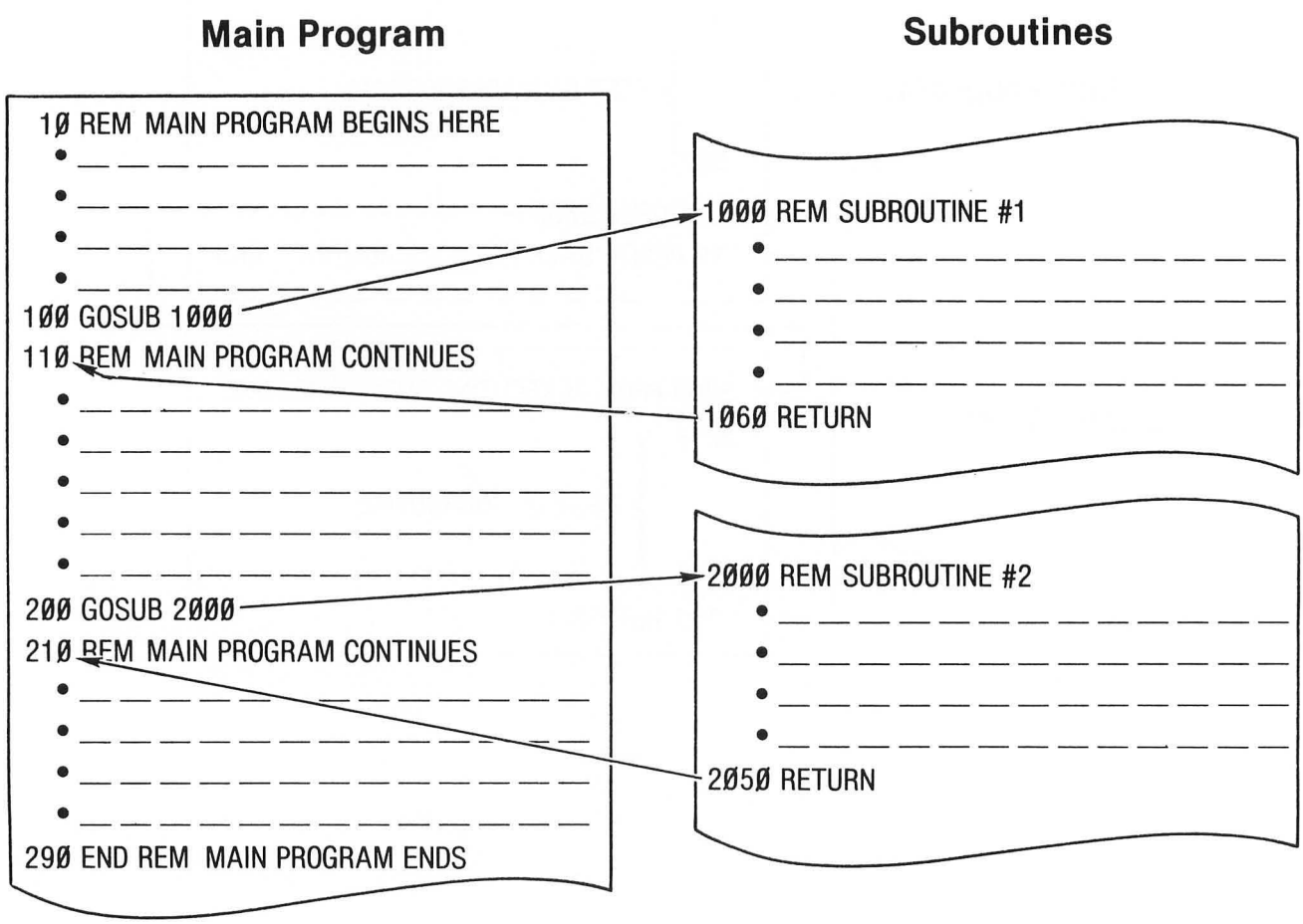
Subroutine Example

Main Program:

Subroutine:



Subroutine Illustration



Subroutine Illustration (Con't)

1. When the computer reaches the GOSUB in Line 1ØØ, the program will branch (GOTO) Line 1ØØØ, which is the beginning of Subroutine #1.
2. After Subroutine #1 is executed and the RETURN (Line 1Ø6Ø) is reached, control is passed back to the main program (Line 11Ø). Note that Line 11Ø is the next higher number after the GOSUB that put it in the subroutine (Line 1ØØ).
3. The computer continues through the main program to the GOSUB in Line 2ØØ, which branches control to Subroutine #2 in Line 2ØØØ.
4. After the subroutine is executed, the RETURN (Line 2Ø5Ø) passes the control back to Line 21Ø in the main program. (Note again that this is the next higher line number after the GOSUB in Line 2ØØ.)
5. An END statement is included in the program (Line 29Ø) after the main program is finished to keep it from accidentally falling into the subroutine. We only want the subroutines to be executed when we call for them by a GOSUB.

Sample Program Using Subroutines (Temperature Conversion)

Main Program

```
10 REM TEMPERATURE CONVERSION PROGRAM
15 PRINT CHR$(125):DIM A$(1)
20 PRINT "CONVERT C TO F (Y OR N)";:INPUT A$
30 IF A$ = "Y" THEN 80
35 PRINT
40 PRINT "INPUT DEGREES FAHRENHEIT";:INPUT F
50 GOSUB 2000
60 PRINT "ARE YOU FINISHED (Y OR N)";:INPUT A$
70 IF A$ = "N" THEN 40
75 END
80 PRINT "INPUT DEGREES CENTIGRADE";:INPUT C
90 GOSUB 1000
100 PRINT "ARE YOU FINISHED (Y OR N)";:INPUT A$
110 IF A$ = "N" THEN 80
120 END
```

Subroutine #1

```
1000 REM CELSIUS TO FAHRENHEIT CONVERSION
1010 F = (9/5)* C + 32 : PRINT
1020 PRINT C; " DEG.  CELSIUS ="; F; " DEG. FAHRENHEIT"
1030 RETURN
```

Subroutine #2

```
2000 REM FAHRENHEIT TO CELSIUS CONVERSION
2010 C = (F-32) * (5/9): PRINT
2020 PRINT F; " DEG. FAHRENHEIT ="; C; " DEG. CELSIUS"
2030 RETURN
```

Analysis of Sample Program Using Subroutines

1. Lines 1Ø through 11Ø comprise the main program.
2. Line 2Ø is an input statement to ask the user if he wants to convert from C to F or from F to C. Yes (Y) means C to F and No (N) means F to C.
3. Line 3Ø is a conditional branch statement. If the user wants to convert Centigrade C to Fahrenheit, then branch to Line 8Ø; otherwise, skip a line (PRINT) and go to Line 4Ø.
4. Line 4Ø allows the user to input the °F to be converted to °C.
5. Lines 5Ø and 9Ø call the subroutines.
6. Line 6Ø asks the user if he is finished. In Line 7Ø the program will branch to Line 4Ø (if B$ = N) or the program will END (if B$ ≠ N).
7. Line 8Ø is similar to Line 4Ø, except that it allows the user to input the °C to be converted to °F.
8. Lines 1ØØ and 11Ø are the same as Lines 6Ø and 7Ø.
9. The first subroutine begins at Line 1ØØØ and ENDS at Line 1Ø3Ø. It RETURNS control to Line 1ØØ in the main program.
10. The second subroutine begins at Line 2ØØØ and ENDS at Line 2Ø3Ø. It RETURNS control to Line 6Ø in the main program.

Subroutine Exercise

```
1Ø PRINT "THIS IS"; "  ";
2Ø GOSUB 1ØØØ
3Ø PRINT "OF HOW"; "  ";
4Ø GOSUB 2ØØØ
5Ø PRINT "WORKS"
6Ø END
1ØØØ PRINT "AN EXAMPLE"; "  ";
1Ø1Ø RETURN
2ØØØ PRINT "A SUBROUTINE"; "  ";
2Ø1Ø RETURN
```

1. Analyze the program and write the message. _____

2. Now type and enter the program.

3. RUN the program. Does it agree with your message?

Assignment 15-1

1. Analyze the program below and write the message:

```
1Ø LET B = 1Ø
2Ø GOSUB 2ØØØ
3Ø B = B + 5
4Ø GOSUB 2ØØØ
5Ø B = B + 10
6Ø GOSUB 2ØØØ
99 END
2ØØØ REM SUBROUTINE
2Ø1Ø IF B<12 THEN 2Ø5Ø
2Ø2Ø IF B = 25 THEN 2Ø7Ø
2Ø3Ø PRINT "PRIME"
2Ø4Ø GOTO 2Ø8Ø
2Ø5Ø PRINT CHR$(125): PRINT "LEEDS"
2Ø6Ø GOTO 2Ø8Ø
2Ø7Ø PRINT "COMPUTERS"
2Ø8Ø RETURN
```

Message _____

ON-GOTO Example

YOUR ACTION	DISPLAY
1. Type NEW and enter this program.	5 PRINT CHR$(125) 10 PRINT "TYPE A NUMBER FROM 1 TO 3"; 15 INPUT N 20 IF N = 1 THEN 110 30 IF N = 2 THEN 130 40 IF N = 3 THEN 150 50 PRINT "REMEMBER, # IS FROM 1 TO 3" 60 GOTO 10 99 END 110 PRINT "N = 1" 120 END 130 PRINT "N = 2" 140 END 150 PRINT "N = 3" 160 END
2. Before you RUN the program, analyze it. Can you predict what will happen when you RUN it? (I sure hope you can by now!)	
3. RUN the program several times until you feel comfortable with it.	

ON-GOTO Example (Con't)

YOUR ACTION	DISPLAY
4. Erase Lines 2Ø, 3Ø, and 4Ø. (Remember, there are two ways to do this! Simply type in each line number separately and then press RETURN.	
5. Type and enter this line:	2Ø ON N GOTO 11Ø, 13Ø, 15Ø
6. List your program.	(SHOULD HAVE NEW LINE 2Ø + LINES 5, 1Ø, AND 5Ø THROUGH 16Ø FROM PREVIOUS PAGE. IF YOU DON'T HAVE THESE LINES, FIX IT!) (WORKS JUST THE SAME AS BEFORE, DOESN'T IT?)
7. RUN the program a few times.	

8. RUN the program again. Use the following inputs:
1.5
1.8
2.8
Ø.8
3.99
	N = 1
	N = 1
	N = 2
	REMEMBER, # IS FROM 1 TO 3!
	N = 3

(Now do you understand that N = INT (N) or whole number?)	READY ■

ON-GOTO Example Analysis

1. Line 2Ø tells the computer to do the following:
   - If, the integer (whole number) value of N is 1, GOTO Line 11Ø.
   - If the integer value of N is 2, GOTO Line 12Ø.
   - If the integer value of N is 3, GOTO Line 13Ø.
   - If the integer value of N is not one of the numbers listed above, then move on to the next line.
2. The ON-GOTO statement has a built-in INT statement, which really acts like this:

   2Ø ON INT (N) GOTO----ETC.

Assignment 15-2 ON-GOTO

1. Type and enter the following program:

```
5 PRINT CHR$(125)
10 INPUT "ENTER # FROM 1 TO 5";
15 INPUT N
20 ON N GOTO 100, 200, 300, 400, 500
30 PRINT "# SHOULD BE FROM 1 TO 5!" : GOTO 10
40 END
100 PRINT "N = 1" : END
200 PRINT "N = 2" : END
300 PRINT "N = 3" : END
400 PRINT "N = 4" : END
500 PRINT "N = 5" : END
```

2. Answer the following questions before running the program
   a. What happens (output) if the input is 1.8 (Line 10)?_____
   b. What happens (output) if the input is 3.99? _____
   c. What happens (output) if the input is 2.89? _____
   d. What happens if the input is 0.5? _____

3. RUN the program several times and record the following:

INPUT	OUTPUT

ON-GOSUB

- Works like ON-GOTO, except control branches to one of the subroutines specified by the line numbers in the line number list.
- Example:

```
10 PRINT "CHOOSE 1, 2, OR 3";
15 INPUT K
20 ON K GOSUB 1000, 2000, 3000
99 END
1000 PRINT "SUBROUTINE #1" : RETURN
2000 PRINT "SUBROUTINE #2" : RETURN
3000 PRINT "SUBROUTINE #3" : RETURN
```

- K may be a numerical constant, variable, or expression.
  — It must have a positive value, however, or an error will occur.
- If K ≠ 1, 2, or 3, the program will go to the next line (99 END).

Summary

- GOSUB XXXX, causes the computer to:
  - — Go to the subroutine beginning at line XXXX (the specified line number).
  - — Work through the subroutine until it finds a RETURN statement.
  - — Return control to the statement that follows the GOSUB statement in the main program.
- ON n GOSUB XXXX, ------, YYYY
  - — Multi-way branching statement that is controlled by a test variable (n), which sends control of the program to one of the subroutines specified by line numbers in the line number list (i. e., XXXX,----, YYYY).
  - — The test variable n must be a numerical constant, variable, or expression that has a non-negative value or else an error will occur.
- ON n GOTO XXXX, ----, YYYY
  - — Works like ON n GOSUB except control branches to one of the line numbers specified (XXXX, ----, YYYY).
  - — ON n GOTO 1st line number, 2nd line number ———— nth line number expression must be between Ø and 255 inclusive.
  - — If n<Ø, an error will occur.

PRACTICE 26

Program to Convert Centigrade to Fahrenheit and Vice Versa

1. Write a program that will do the following:
   a. Convert Centigrade to Fahrenheit.
   b. Convert Fahrenheit to Centigrade.
   c. Allow you to select either A or B above.
   d. Allow you to input from keyboard.
   e. PRINT the answer as follows:

   • ____*____ degrees Celsius = ____**____ degrees Fahrenheit

   or

   ____*____ degrees Fahrenheit = ____**____ degrees Celsius

   * Keyboard input value
   ** Calculated output value

PRACTICE 27

Program for Sample Profit/Loss Statement

1. When a product is sold for more than it costs, the seller receives a profit. When a product is sold for less than it costs, the seller takes a loss.

   Therefore: sell price − cost = profit or loss

   If we let: S = Sell price
   C = Cost
   U = No. of units
   P = Profit
   L = Loss

   Then: P (or L) = S*U − C*U

   a. Write a program that will compute the profit or loss for a business if the sell price and cost are known. (*Note:* Program should permit you to enter cost and sell price from the keyboard.)
   b. Have the computer PRINT the following:

   NO. OF UNITS _____
   UNIT PRICE ($) _____
   UNIT COST ($) _____
   TOTAL SALES ($) _____
   TOTAL COST ($) _____
   PROFIT/LOSS ($) _____
   % OF SALES _____

   c. RUN the program several times and record your answer.

EXTRA PRACTICE 1

Programming Mathematical Operators

1. Given two numbers A=25 and B=5:
   a. Write one program that will add, subtract, divide (A/B), multiply, and square the two numbers (A and B).
   b. The answer should PRINT as shown here:
      The sum of A and B is _____ (your answer).
      The difference of A and B is _____ (your answer).
      The quotient of (A/B) is _____ (your answer).
      The product of A*B is _____ (your answer).
      The square of A is _____ (your answer).
      The square of B is _____ (your answer).

EXTRA PRACTICE 2

Finding the Average

1. Write a program to find the average of three numbers.
2. Have the program PRINT: The average is _____.
3. Add a program line to have the program PRINT the average of your # _____, your # _____, and your # _____ is your answer _____. Example: The average of 3, 4, and 8 is 5.

EXTRA PRACTICE 3

More Mathematical Operations

Write five separate programs to PRINT the answer to these problems (the answer should read 25 * 2 + 4 = 54, and so on.):

1. 25*2+4
2. $3^2 + 4 - 2$
3. $36 \div 4 * 5$
4. $28 + 4 * 6 \div 8$
5. $(18-2) \div 3 + 4\ (6*3) + 2^3$

EXTRA PRACTICE 4

Print Zones

Part I.

Write a program to PRINT the word "Leeds" in the following ways:

	ZONE 1	ZONE 2	ZONE 3
1.	LEEDS	LEEDS	LEEDS
2.	LEEDS		LEEDS
3.		LEEDS	
4.		LEEDS	LEEDS
5.			LEEDS

Part II.

Using page 74:

1. Count the number of characters in all four zones. How many?
2. How many in zone 1 _____, zone 3, _____.

EXTRA PRACTICE 5

Area of Square and Volume of Cube

1. Write a program to solve the following problems. Label your answers.
   a. The side of a square is 27 inches. Find its area (area (A) = s^2).
   b. If the side of a cube is also 27 inches, find its volume (volume (V) = s^3).
2. Using INPUT statements, write a program to find the area of a square and volume of a cube.
   a. Solve the problems above (assume sides of square and cube are equal).
   b. Using different lengths for the side, RUN the program again (assume that the sides of the square and the cube are equal).

EXTRA PRACTICE 6

Printing Tables of Numbers, Squares, and Cubes

1. Write a program to generate the first 25 numbers and PRINT their squares on the same line.
   Example:
   ```
   1     1
   2     4
   3     9
   4     16
   and so forth
   ```
2. Write a program to generate the first 25 numbers and PRINT their cubes on the same line.
   Example:
   ```
   1     1
   2     8
   3     27
   4     64
   and so forth
   ```
3. Write a program to generate all the numbers from 20 to 1 and PRINT the numbers, and their squares and cubes, on the same line and in four columns.
   Example:
   ```
   20    400     8000     160000
   19    361     6859     130321
   18    324     5832     104976
   and so forth
   ```

EXTRA PRACTICE 7

Printing Three Times and Nine Times Tables

1. Write a program to generate the three times table from $3 \times 1 = 3$ to $3 \times 12 = 36$. The printout should look exactly like this:
   ```
   3 * 1 = 3
   3 * 2 = 6
   3 * 3 = 9
   3 * 4 = 12
   and so forth
   ```
2. Write a program to generate the nine times table from $9 \times 1 = 9$ to $9 \times 12 = 108$.

EXTRA PRACTICE 8

Two-Dimensional Array

1. Suppose we have a class of ten students. The course grade is based upon three quizzes, and the results for the class are as follows:

Student #	1	2	3	4	5	6	7	8	9	10
Quiz #										
1	88	41	100	88	79	76	86	90	85	100
2	75	52	65	57	98	86	96	91	86	92
3	71	47	75	77	86	96	85	92	97	82

a. Write a program to PRINT the following information:

Student #

1 ?
2 ?
3 ?
4 ?
and so forth

Course Avg./Student

Computer calculates and PRINTS average

Quiz #

1 ?
2 ?
3 ?

Class Avg./Quiz

Computer calculates and PRINTS average

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