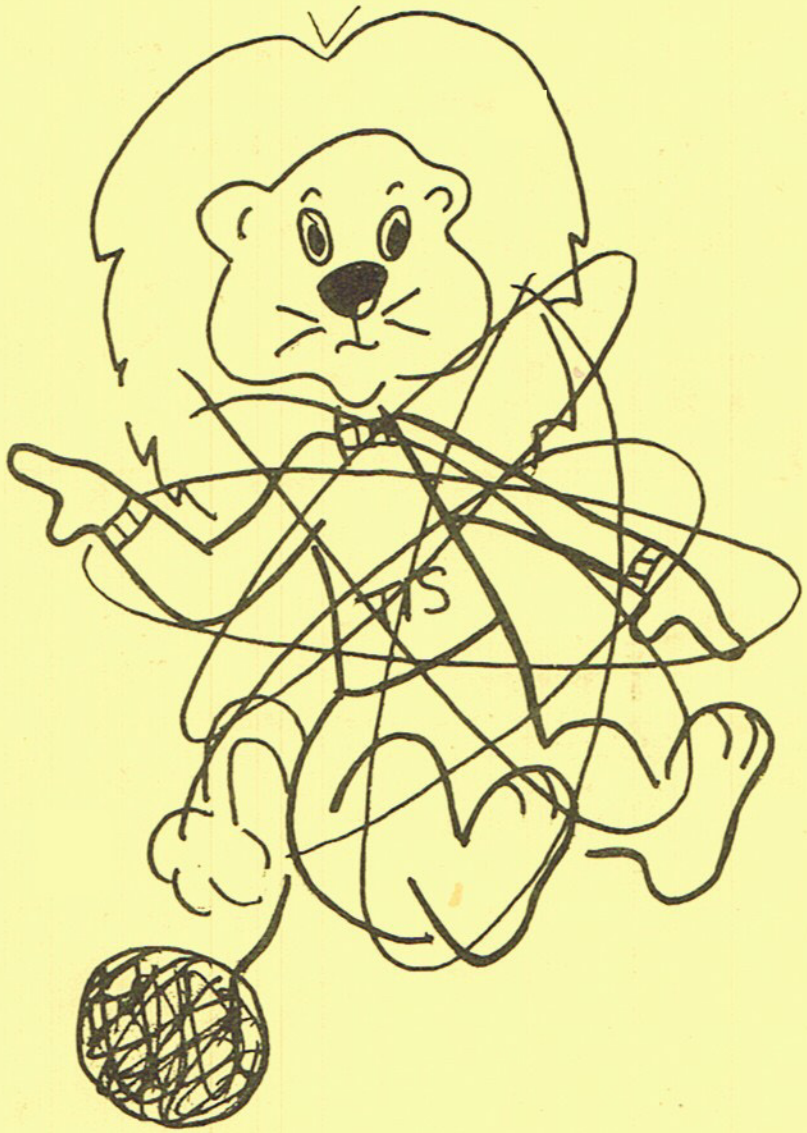
TIS Workbook 2

TOTAL INFORMATION SERVICES



PET String and Array Handling

CONTENTS

I. INTRODUCTION

This workbook gives a series of exercises that show the new user how to use the Commodore PET 2001 computer. The most effective way to use the workbook is to sit down with a PET and go through the exercises as they are presented. Enough space has been provided in the workbook for you to add your own examples as you develop them. Later, when you need to refresh your memory on a particular topic, these examples should supply pertinent, meaningful information.

A. Assumptions Made About the User

Some PET users are comfortable with mathematics. However this workbook assumes that the majority are not. For that reason, most exercises will use nothing more than high school arithmetic.

This workbook also assumes you know something about the syntax and semantics of the BASIC programming language. If you do not, we recommend that you obtain one of the following books:

BASIC Programming, J. Kemeny and T. Kurtz
BASIC, Albrecht, Finke, Brown
What Do You Do After You Hit Return? Peoples Computer Co.
Basic BASIC, James Coan
Advanced BASIC, James Coan

Read about BASIC syntax; then alternate between this workbook and your text on BASIC. That way you will learn both BASIC and how to use the PET.

B. Notation Used in This Workbook

We use a consistent notation in this workbook to indicate what is to be typed on the keyboard (T:), what appears on the TV display (R:), and what indicates blanks are to be typed (b). For example:

T: info ('RETURN') key

means to type the characters contained on the line after the colon (:) followed by a 'RETURN'.

R: response

means that the system response to the previous T: line should be a line on the TV.

Blanks are important. They are specified by b. For example:

```
T:  ?"ABbC" ('RETURN' key)
```

means type ?, then ", then the letter A, then the letter B, then a space, then the letter C, then " followed by a 'RETURN'. Now let's run that example all together:

```
T:  ?"ABbC" ('RETURN' key)
R:  AB C
```

The special keys on the PET keyboard can cause some confusion. This workbook identifies the special keys with the notation 'KEYNAME'. 'KEYNAME' means press the named key. The unquoted sequence of characters OTHER means, press the five keys O T H E R in succession.

Example: Special key notation

```
T:  'STOP'
```

means press the key labeled STOP.

```
T:  STOP
R:  BREAK
R:  READY.
```

means press the 4 keys S T O P in succession.

II. SUBSCRIPTED VARIABLES

Just like a regular variable, a subscripted variable names a logical location in the computer's memory. These locations may be thought of as small, contiguous boxes, such as post office boxes, where the subscripted variable is the name of a box and the contents of the box is the value of the subscripted variable. Another way of thinking of these memory locations is as rows or columns. In the example below the memory locations are the boxes, the contents of the memory are the numbers in the boxes, and the address or name of the memory location is the subscripted variables on the left.

A(0)	1
A(1)	3
A(2)	10
A(3)	211

The value of A(0) is 1
The value of A(3) is 211
The name of the location of 3 is A(1)

An array of one column or one row is called a one-dimensional array or vector. Two-dimensional arrays consist of both rows and columns, sometimes called a matrix. The subscripts define the row and the column.

	Col 1	Col 2	Col 3
Row 1	A(1,1)	A(1,2)	A(1,3)
Row 2	A(2,1)	A(2,2)	A(2,3)

Subscripted variables make keeping track of elements in an array or table much easier. In the PET BASIC, numeric, integer, and string variables may be subscripted. Using subscripted variables makes it easy to assign a lot of values to a lot of variables. The reason this is so easy is that subscripted variables work so well in FOR-NEXT loops. We will be using several examples where the subscripted variable is set to the value of the subscript.

Exercise: Input and output of non-subscripted and subscripted arrays.

```
T:  NEW
T:  10 DATA 5,7,8,11,12
T:  20 READ A1,A2,A3,A4,A5
T:  30 PRINT A1;A2;A3;A4;A5
T:  RUN
R:  5  7  8  11  12
```

Without subscripted arrays you must write each variable separately. This isn't bad with only five variables but think of 100. The following code uses subscripts to do the same thing.

```
T:  20 FOR I = 1 TO 5
T:  30 READ A(I)
T:  40 PRINT A(I);
T:  50 NEXT I
T:  RUN
R:  5  7  8  11  12
```

A. Legal Subscripts

Legal values for subscripts are non-negative integers. Variables, formulas, functions, and constants may be used for subscripts.

Exercise: Show that variables, functions, and formulas are legal subscripts.

```
T: NEW
T: 10 A=2
T: 20 B=3
T: 30 C=5
T: 40 FOR I=1 TO 10
T: 50 D(I)=I
T: 60 NEXT I
T: 70 PRINT D(A*B-C)
T: 80 PRINT D(INT(C/A))
T: 90 PRINT D(C-INT(B/A)+A)
T: RUN
R: 1
R: 2
R: 6
R: READY.
```

B. Dimensions

A subscripted variable does not need a corresponding DIM statement as long as the value of the subscript does not exceed 10 (this is true even in multiple subscripts). If you intend to use a subscript of 0, the maximum value of a subscript is still 10. So if you use 0 as a subscript you may have up to 11 for each subscripted variable without needing a DIM statement for that variable.

Exercise: Find the limit of non-dimensioned subscripted numeric variables.

```
T:  10 FOR J=1 TO 20
T:  20 FOR I=1 TO 20
T:  30 A%(I,J)=I
T:  40 PRINT A%(I,J);I;J
T:  50 NEXT I
T:  60 NEXT J
T:  70 END
T:  RUN
R:  1 1 1
R:  2 2 1
      .
      .
      .
R:  10 10 1
R:  ? BAD SUBSCRIPT ERROR IN 30
```

Without a DIM statement for A% the system will not continue when either I or J exceeds 10.

Exercise: Demonstrate a non-dimensioned subscripted variable starting with 0.

```
T:  NEW
T:  10 FOR I=0 TO 10
T:  20 A(I)=I
T:  30 PRINT A(I);I
T:  40 NEXT I
T:  RUN
R:  0 0
R:  1 1
R:  2 2
    .
    .
    .
R:  10 10
R:  READY.
```

The following list is the maximum allowable DIMensions for an 8K PET without getting a ?OUT OF MEMORY ERROR. These were checked out using the calculator mode, which means there was no program in the machine. The maximum number of subscripts is 3.

DIM A(1439)	DIM A(37,36)	DIM A(10,10,10)
DIM A$(1431)	DIM A$(38,37)	DIM A$(11,11,10)
DIM A%(1432)	DIM A%(41,40)	DIM A%(14,14,14)

If you observe that the maximum value of the 3-dimensional array for A is 10, it follows from previous examples that A would never need a DIM statement.

The previous list of dimensioned arrays is somewhat misleading. If the dimension of a variable exceeds 255, the array wraps around and starts over.

Exercise: Demonstrate the 255 limit on arrays.

```
T:  DIM A(300)
T:  A(0)=0:A(255)=255:PRINT A(0);A(255)

R:  0  255

T:  A(256)=256:PRINT A(0);A(255);A(256)

R:  256  255  256
```

As you can see, the number 256 was stored in A(0).

Let's use an array and a subscripted variable to check the PET random-number generator by rolling a die. We'll let D(1) be the storage location when a 1 is rolled, D(2) the location for a 2, and so on. Let's roll the die 6000 times and see if each number has an equal probability of coming up.

Exercise: Check if the random number generator gives reasonable results throwing a die.

```
T:  NEW
T:  10 FOR J=1 TO 6
T:  20 D(J)=0
T:  30 NEXT J
T:  40 FOR I=1 TO 6000
T:  50 K=INT(6*RND(1)+1)
```

Generate random numbers 1 through 6. RND(1) generates random numbers between 0 and 1. A given random number may be equal to 0 but will always be less than 1.

```
T:  60 D(K)=D(K)+1
T:  70 NEXT I
T:  80 PRINT D(1);D(2);D(3);D(4);D(5);D(6)
T:  RUN
R:  1015 1005 964 964 1050 1002
R:  READY.
```

The run time for this many random numbers is over a minute. These numbers should vary each time the program is run. What does this prove?

III. STRINGS

Each computer system has its own character set, that is, a collection of symbols which the computer recognizes. These symbols may be digits, alphabetic letters, or special characters. In our case, we are talking about the symbols on the PET keyboard. A number is assigned to each character (symbol) that represents the character in the computer. A string is defined to be one or more characters. A string may be a message, a name, an address, etc. The PET uses two character sets. One set is defined for the POKE statement while the other character set is defined for the PRINT statement.

You may switch back and forth between graphics and lower case characters by changing memory location 59468 to a 14 for lower case or a 12 for graphics. When location 59468 contains a 14 both the PRINT and POKE statements will display lower case characters.

To switch

```
T:  POKE 59468,14
R:  READY.
```

Using the shift key will now give lower case characters.

```
T:  A (when holding shift key down)
R:  a
R:  READY.
T:  POKE 59468,12
R:  READY.
```

Using the shift key will now give graphic characters.

To permit intercomputer communication and establish a standard, the American Standard Code for Information Interchange (ASCII) character set was defined. It includes all letters (both upper and lower case), digits, and many special symbols. Some of the characters used in BASIC are taken from the ASCII character set. The character set used with the POKE command will be described in the workbook on graphics. Both character sets are in the APPENDIX of this workbook. When we talk about strings in this workbook, we will mean the ASCII character set and its numerical representation. For example, the ASCII character A is represented by the number 65, the character B by the number 66, and the character 1 by the number 49. The numerical representation of the PET keyboard uses the numbers Ø-255. The PRINT statement displays some characters and treats others as cursor control so that not all 256 characters are visible on the screen.

The string functions make the PET a powerful and versatile computer. By using the string functions the PET can truly become a personal computer.

It is reasonably easy to tailor your programs so that they actually carry on a dialogue with you. ANIMAL[1] and ELIZA[2] are examples of programs that make extensive use of strings to carry on a dialogue. Strings are also useful in computer-aided instruction and in searching library indexes.

There are several programs at the end of this workbook showing the various techniques for using strings. There are also several problems for you to solve. The best way to learn to use strings is to write programs that use strings. As you go through the examples in this section, be sure you understand what is being done before you continue. Some of the examples are easy to read and understand; other examples are more complicated. All examples should be tried on your PET.

A. Legal String Names

A string name is a variable name followed by a dollar sign ($). A string name may be up to 6 characters, including the dollar sign ($). Only the first two characters of the name are actually used, however. The first character must be alphabetic. If more than 6 alphabetic characters are used, a syntax error results. However, you may use at least 50 characters if they are all numeric except the first which must be alphabetic. Since only the first two characters are used in the variable name, you must be careful in your naming conventions. A string is defined by enclosing it in quotes. For example, to show that only the first two characters are used.

Exercise: Check string variable names.

```
T:  NEW
T:  ABCDE$="J"
T:  AB123$="K"
T:  PRINT ABCDE$,AB123$
R:  K           K
T:  PRINT AB$
R:  K
T:  A123456789$="S"
T:  PRINT A1$
R:  S
T:  ABCDEFG$="B"
R:  ?SYNTAX ERROR
```

The ?SYNTAX ERROR shows that 7 characters are not legal for a string variable name.

1 101 Games, David Ahl

2 Creative Computing July-Aug 1977 Vol 3, No 4

B. Subscripted String Variables

A subscripted variable need not be dimensioned if the subscript will not exceed 10. A non-subscripted variable is unique and distinct from a subscripted variable of the same name. For example, A$ is distinct from A$(0) or A$(1).

Exercise: Show the independence of variable names.

```
T:  NEW
T:  10 A$="A"
T:  20 A$(0)="B"
T:  30 A$(1)="C"
T:  40 A$(2)="D"
T:  50 PRINT A$;A$(0);A$(1);A$(2)
T:  RUN
R:  ABCD
```

Note that 0 is a valid subscript. Also note in statement 10, A$ is not subscripted and is unique and distinct from all subscripted variables of the same name. It was not necessary to DIMension A$(0)-A$(3) because the subscript does not exceed 10.

Exercise: Show that string arrays greater than 10 must be dimensioned.

```
T:  10 FOR I=1 TO 11
T:  20 A$(I)="*"
T:  30 NEXT I
T:  40 END
T:  RUN
R:  ?BAD SUBSCRIPT ERROR IN 20
```

In the above example, A$ must have a DIM A$(11) statement since the subscript value does exceed 10.

C. Maximum String Length

Exercise: Determine the maximum string length.

```
T:  NEW
T:  FOR I= 1 TO 255:A$=A$+"D":NEXT I
R:  READY
```

Note that 255 characters in a string is ok.

```
T:  NEW
T:  FOR I= 1 TO 256:A$=A$+"D":NEXT I
R:  ?STRING TOO LONG ERROR
```

Note that 256 characters in a string is invalid.

IV. OPERATIONS ON STRINGS

A string variable may be lengthened by concatenation. Concatenate means to attach.

Exercise: Concatenate three strings.

```
T:  NEW
T:  10 A$="P"
T:  20 B$="E"
T:  30 C$=A$+B$+"T"
T:  40 PRINT C$
T:  RUN
R:  PET
```

Let's look at the way the + sign is interpreted when used with numeric values and when used with string values.

Exercise: Show how the + sign is used with numbers and with characters.

```
T:  NEW
T:  10 A$="123"
T:  20 B$="456"
T:  30 A=123
T:  40 B=456
T:  50 C$=A$+B$
T:  60 C=A+B
T:  70 PRINT C$,C
T:  RUN
R:  123456 579
```

In statement 50, the string B$ is concatenated (attached) to the right-hand side of the string in A$. In statement 60, a numeric addition is made.

Strings need to be manipulated in a different manner than numeric values. The + sign is the only arithmetic operator that is valid to use with character strings. However, the relational operators >, <, and = sign do work with strings in the following manner. A character is less than, equal to, or greater than the numerical representation of the character it is being compared to. Since the numerical representation of B is 66 and A is 65, A is less than B. The Boolean (logical) operators AND, OR, and NOT are invalid when used with strings.

Exercise: Show that the logical operators are not allowed with strings.

```
T:  C$=A$ OR B$
R:  TYPE MISMATCH ERROR
```

A. Statements

1. INPUT is used to input strings or numeric values from the keyboard. INPUT works essentially the same when inputting string characters as it does when inputting numeric values. For example:

```
T:  NEW
T:  10 INPUT A$,A
T:  20 PRINT AS,A
T:  RUN
R:  ?
```

At this point you may input up to 72 characters, a comma, and a numeric value. The comma separates the two input values.

```
T:  ATEST=,10
R:  ATEST=   10
R:  READY.
```

In the previous example you can put in the string you want, then hit 'RETURN'. The system will then prompt with another ? and wait until you input the numeric value. Each value may be entered on a separate line by hitting a 'RETURN' for each entry or on the same line by using commas between each value.

Exercise: Use the above program to input values a line at a time.

```
T:  RUN
R:  ?
T:  ATEST=
R:  ?
T:  10
R:  ATEST=      10
```

2. DATA, READ, RESTORE. Data may be put in a program by the DATA statement and a corresponding READ statement. A DATA statement must have a corresponding value for each variable read. However, a RESTORE will restore a DATA statement so that it may be read more than once.

Exercise: Use DATA, READ, and RESTORE statements to get strings into your program.

```
T:  NEW
T:  10 DATA "A","B"
T:  20 DATA C,D
T:  30 READ A$,B$
T:  40 PRINT A$,B$
T:  50 READ C$,D$
T:  60 PRINT C$,D$
T:  70 RESTORE
T:  80 GO TO 30
T:  RUN
R:  A    B
R:  C    D
R:  A    B
R:  C    D
     .
     .
     .
     .
```

The program is now in a continuous loop because RESTORE allows the DATA statements to be read over and over.

```
T:  STOP
R:  BREAK IN 40 (This statement number depends on when the
T:  70           STOP key is hit.)
T:  RUN
R:  A     B
R:  C     D
R:  ?OUT OF DATA ERROR IN 30
R:  READY.
```

When the RESTORE is removed (statement 70) the DATA statements are only "read" once. Notice that in a DATA statement a string character does not have to be enclosed in quotes. See statement 20.

3. GET. The GET statement may be used with either numeric or string variables. Get A$ will accept any single character typed from the keyboard.

   Exercise: Input a character from the keyboard during program execution.

```
T:  NEW
T:  10 FOR I=1 TO 10
T:  20 GET A$:IF A$="" GO TO 20
T:  30 PRINT A$
T:  40 NEXT I
T:  RUN
T:  A
R:  A
```

Statement 20 is set up for a continuous wait loop until a character is typed from the keyboard. The double quote ("") is used because it is the null or empty value of the string. As soon as a character is typed on the keyboard, it will be displayed on the screen.

```
T:  'STOP'
R:  BREAK IN 20
```

B. Functions

1. ASC. The ASC function returns the numeric value corresponding to the ASCII character of the first character in a string. This function may be used to find the numeric values of the PET character set.

Exercise: Determine the numerical value of a PET character.

```
T:  NEW
T:  10 FOR I=1 TO 1000
T:  20 GET A$:IF A$="" GO TO 20
T:  30 A=ASC(A$)
T:  40 PRINT A$,A
T:  50 NEXT I
T:  RUN
T:  A
R:  A     65
T:  any character
R:
T:  'STOP'
R:  BREAK IN 20
```

The numeric value you get using this code will give a different character when used with the POKE statement. For example, if an A is typed using the above code, the integer that is returned is 65.

For example:

```
T:  POKE 33728,65
R:  ♠
```

This character is the upper case character of the A key. A list of both numerical representations of the PET character set may be found in the APPENDIX.

2. CHR$. The CHR$ function returns a character corresponding to the integer given. The integer value must be between 0 and 255. The CHR$ function is the inverse of the ASC function, that is, it converts in the opposite direction. The CHR$ function is given an integer value and returns the corresponding character. The ASC function is given a character and returns the corresponding integer value.

Exercise: Display the numerical equivalent of each character.

```
T:  NEW
T:  10 FOR I=1 TO 255
T:  20 B$=CHR$(I)
T:  30 PRINT I,B$
T:  40 GET A$:IF A$="" GO TO 40
T:  50 NEXT I
T:  RUN
R:  1
T:  any key
```

This program will display an integer code (0-255) and the character corresponding to that integer (only the integers 33-127 and 161-255 will display a character on the screen in this code) each time you type any key on the keyboard.

Exercise: Show that CHR$ is the inverse of ASC.

```
T:  NEW
T:  10 FOR I=0 TO 255
T:  20 B$=CHR$(I)
T:  30 A=ASC(CHR$(I))
T:  40 PRINT A,B$,I
T:  50 GET A$:IF A$="" GO TO 50
T:  60 NEXT I
T:  RUN
R:            0           0
T:  any key
    .
    .
    .
```

Statement 20 converts the value of I to its equivalent PET character. Statement 30 converts the PET character back to its numeric value. Statement 50 is a loop to allow you to control the rate at which things are displayed.

Exercise: Demonstrate the type of CHR$.

```
T:  NEW
T:  10 B=CHR$(5)
T:  20 PRINT B
T:  RUN
R:  ?TYPE MISMATCH ERROR IN 10
```

Remember that CHR$ returns a character and that B is a real variable. To help remember the type of variable to use, remember ASC has no ($) dollar sign, therefore, the variable name must not have a ($) sign. Since CHR$ has a dollar sign ($) the variable name must also have a dollar sign ($).

```
B$ = CHR$(40)

C = ASC("B")
```

3. LEFT$. The LEFT$ function is used to select characters from the left-hand portion of a string. To use LEFT$, give the string name and a count of the characters chosen from the left side of the string.

Exercise: Select characters from a string.

```
T:  NEW
T:  10 A$="ABCDE"
T:  20 B$=LEFT$(A$,1)
T:  40 PRINT B$
T:  RUN
R:  A
R:  READY.
T:  20 FOR I = 1 TO 5
T:  30 B$=LEFT$(A$,I)
T:  50 NEXT I
T:  RUN
R:  A
R:  A B
R:  ABC
R:  ABCD
R:  ABCDE
R:  READY.
```

Caution: No error message is given if I is greater than 5, that is, greater than the number of characters in A$.

4. RIGHT$. The RIGHT$ function is used to select a character from the right-hand portion of a string. It works just like LEFT$ except it selects characters starting from the right-hand side. To demonstrate this, just change LEFT$ to RIGHT$ in the previous example.

Caution: No error message is given if you exceed the length of the string.

5. MID$. The MID$ function is used to select any character or group of characters from a string. MID$ is the most powerful function of the three functions LEFT$, RIGHT$ and MID$. To use MID$, just give the string name, the number of the character you want to start with, and the number of characters you want to select.

Exercise: Select characters from a string.

```
T:  NEW
T:  10 A$="ABCDE"
T:  20 B$=MID$(A$,2,2)
T:  30 PRINT B$
T:  RUN
R:  BC
R:  READY.
T:  20 FOR I = 1 TO 5
T:  30 B$=MID$(A$,1,I)
T:  40 PRINT B$
T:  50 NEXT I
T:  RUN
R:  A
R:  AB
R:  ABC
R:  ABCD
R:  ABCDE
R:  READY.

T:  NEW
T:  5 J=0
T:  10 A$="ABCDE"
T:  20 FOR I = 5 TO 1 STEP -1
T:  30 J=J+1
T:  40 B$=MID$(A$,I,J)
T:  45 PRINT B$
T:  50 NEXT I
T:  RUN
R:  E
R:  DE
R:  CDE
R:  BCDE
R:  ABCDE
R:  READY.
```

Caution: No error message is given if I or J or both are greater than the number of characters in A$.

Exercise: Demonstrate the use of LEFT$, RIGHT$, and MID$ to convert a sentence to pig Latin.

```
T:  NEW
T:  10 PRINT"GIVE ME A SENTENCE"
T:  15 DIM B$(19)
T:  20 INPUT A$
T:  30 J=1    :REM J POINTS TO THE NEXT CHARACTER
T:  50 FOR I=J TO 72
T:  60 FOR K=1 TO 19
T:  80 B$(K)=MID$(A$,J+K-1,1)  : REM GET NEXT CHARACTER
T:  85 IF B$(K)="" THEN I=72   : REM SET UP TO STOP
T:  90 IF B$(K)="b" GO TO 120  : REM CHECK FOR WORD BOUNDARY
T:  95 IF I=72 GO TO 120
T: 100 C$=C$+B$(K)
T: 110 NEXT K
T: 120 J=J+K
T: 130 D$=LEFT$(C$,1)
T: 150 E$=MID$(C$,2,K-2)
T: 160 F$=F$+E$+D$+"Ab"
T: 170 C$=""
T: 180 NEXT I
T: 190 PRINT F$
T: RUN
R: GIVE ME A SENTENCE
R: ?
T: CONVERT THIS TO PIG LATIN
R: ONVERTCA HISTA OTA IGPA ATINLA
R: READY.
```

6. STR$. The STR$ function is used to convert a number to its string equivalent. If the number has more than 9 digits, rounding takes place and the value is converted to exponential form.

STR$ could be used to line up the decimal points in a check balancing program.

Exercise: A program to line up the decimal point.

```
T:  NEW
T:  10 DATA"10.03","100.25",".25","6.13","0"
T:  20 READ A$
T:  30 IF A$="0" GO TO 120
T:  40 FOR I=1 TO LEN(A$)
T:  50 IF MID$(A$,I,1)="." GO TO 70
T:  60 NEXT I
T:  70 FOR J=1 TO 10-I
T:  80 A$="b"+A$
T:  90 NEXT J
T:  100 PRINT A$
T:  110 GO TO 20
T:  120 END
T:  RUN
R:     10.03
R:    100.25
R:       .25
R:      6.13
```

Exercise: Convert a number to its string equivalent.

```
T:  A=1234567885123
T:  PRINT STR$(A)
R:  1.23456789E+12
```

7. VAL. The VAL function is used to convert a string containing numeric characters to a numeric value. This function is the inverse of the STR$ function. If there are characters, other than digits in the string variable, only those digits to the left of the first non-numeric character will be converted to a numeric value. If the number is greater than 1E+38, an overflow error results.

Exercise: Convert a string to its numerical equivalent.

```
T:  NEW
T:  10 A$="1234"
T:  20 B$="A1234"
T:  30 C$="1234B"
T:  40 A=VAL(A$)
T:  50 B=VAL(B$)
T:  60 C=VAL(C$)
T:  70 PRINT A,B,C
T:  RUN
R:  1234      0       1234
```

Statement 10 is converted as you would expect. Statement 20 is set to zero since the first character is a non-digit. Statement 30 is converted up to the first non-digit.

8. LEN. The LEN function counts the number of characters in a string and returns that number.

Exercise: Use the LEN function to split a string into two strings of equal or almost equal length.

```
T:  NEW
T:  10 INPUT A$
T:  20 A=LEN(A$)
T:  30 B=INT(A/2)
T:  35 IF A=1 GO TO 50
T:  40 B$=LEFT$(A$,B)
T:  50 C$=RIGHT$(A$,A-B)
T:  60 PRINT B$,C$
T:  RUN
R:  ?
```

Input a string of your choice.

Exercise: A program to input any word and tell if it is spelled the same backward as forward.

```
T:  NEW
T:  10 INPUT A$
T:  15 C$= ""
T:  20 FOR J=LEN(A$) TO 1 STEP-1
T:  30 C$=C$+MID$(A$,J,1)
T:  40 IF C$=A$ THEN 80
T:  50 NEXT J
T:  60 PRINT A$;" IS NOT THE SAME SPELLED BACKWARD"
T:  70 GO TO 10
T:  80 PRINT A$;" IS THE SAME SPELLED BACKWARD"
T:  90 GO TO 10
T:  RUN
R:  ?
T:  KOOK
R:  KOOK IS THE SAME SPELLED BACKWARD
R:  ?
```

V. EXERCISES

The following problems are to check yourself to see how well you understand strings and arrays.

1. Write a program that will input a string and print out the number of characters in the string.

2. Write a program that will input a day of the week and tell whether or not it is a weekend day.

3. Write a program that will input a string and print it out in reverse order

4. Write a program that will count the number of words in a string. A word is defined to be any sequence of one or more alphabetic characters delimited by 'SPACE', coma, period, exclamation mark, colon, or end of line.

5. Write a program that will input the time of day in the form 11;15 A.M. or 8;20 P.M. and print out the time of day based on the 24 hour clock. 11;45 A.M. = 1145 HOURS: 8;20 P.M. = 2020 HOURS.

6. Write a program to input a string and print out how many vowels it contains and in what positions.

7. Write a program to input a string and change all J's to H's.

8. Write a program that changes every letter in the alphabet to another letter. For example, A's might become C's and C's might become Z's, etc.

9. Write a program that will input any letter in the alphabet and print out the number 1-26 to which it corresponds.

10. Write a program to read a sentence and squeeze out all blanks.

11. Write a program to sort character strings in alphabetic order.

Examples of programs to solve these problems can be found at the end of this section. Try to write these 11 programs yourself. When you have finished compare your programs to the ones shown. Test data is provided for you to check how well your program works. Try to allow for all legal and illegal input.

1.
```
  5 REM INPUT A STRING AND PRINT OUT THE NUMBER OF CHARACTERS
  7 REM IN IT
 10 PRINT "TYPE A STRING"
 20 INPUT A$
 30 L=LEN(A$)
 40 PRINT L
 50 GO TO 10
100 REM TEST DATA
110 REM INPUT A SINGLE CHARACTER (TEST END POINT)
120 REM INPUT A LONG LINE WITH EXACTLY 38 CHARACTERS IN IT (TEST
125 REM END POINT OF INPUT)
130 REM ""(TEST NULL STRING)
140 REM TEST A LINE EXACTLY 39 CHARACTERS LONG.  CLEAR THE SCREEN
143 REM AND USE THE DOWN CURSOR SO
145 REM THAT THE INPUT REQUEST IS ON THE BOTTOM LINE, I.E. TEST
146 REM THE EFFECT OF SCROLLING.
150 REM INPUT JUST A 'RETURN'
160 REM TEST A LINE EXACTLY 78 CHARACTERS LONG.
170 REM TEST A LINE 80 CHARACTERS LONG.  AFTER THIS TEST, 'STOP',
175 REM 'RETURN' THEN PRINT A$
180 REM TRY A STRING WITH A COMMA (,), THEN TRY A COLON (:)
190 REM THE LAST 5 ARE LIMITATIONS OF THE PET INPUT STATEMENT.
195 REM YOU CANNOT AVOID THEM UNLESS YOU USE GET$.
210 END
```

2.
```
  5 REM A PROGRAM TO INPUT A DAY OF THE WEEK AND TELL IF IT IS A
  7 REM WEEK DAY
 10 INPUT A$
 20 IF A$="SUNDAY" OR A$="SATURDAY" GO TO 80
 30 IF A$="MONDAY" OR A$="TUESDAY" GO TO 100
 40 IF A$="WEDNESDAY" OR A$="THURSDAY" GO TO 100
 50 IF A$="FRIDAY" GO TO 100
 60 PRINT A$,"IS NOT A DAY OF THE WEEK"
 70 GO TO 10
```

Statements 20 through 50 check the input against the days of the week branching to the appropriate message when a comparison is found. Statement 60 is an error message because no comparison was found. Statement 70 gives another chance for a correct input.

```
 80 PRINT A$,"IS A WEEKEND DAY"
 90 GO TO 10
100 PRINT A$,"IS A WEEK DAY"
110 GO TO 10
200 REM TEST DATA
210 REM TRY ALL 7 LEGAL DAYS
220 REM TRY AN ILLEGAL DAY
230 REM TRY""
240 REM TRY 'RETURN'
250 END
```

3.

```
  5 REM A PROGRAM TO INPUT A STRING AND PRINT IT OUT IN
  7 REM REVERSE ORDER.
 10 INPUT"INPUT A STRING";A$
 20 B$=""
 25 IF LEN(A$)=0 GO TO 60
```

Check for null input.

```
 30 FOR I=LEN(A$)TO 1 STEP -1
```

Start at the end of the string and decrease I by one each time through the loop.

```
 40 B$=B$+MID$(A$,I,1)
```

Each time through the loop add a character to B$. We start with I set to the position of the right most character . We then decrease the position count by 1 each time. The MID$ function will pick one character each time. In other words, put characters from the end of the input string on the beginning of the output (reversed) string.

```
 50 NEXT I
 60 PRINT"REVERSED STRING IS:";
 70 PRINT B$
 80 GO TO 10
100 REM TEST DATA
110 REM INPUT A SINGLE CHARACTER (TEST END POINT)
120 REM INPUT A LONG LINE WITH EXACTLY 23 CHARACTERS IN IT (TEST
125 REM END POINT OF INPUT)
130 REM""(TEST NULL STRING)
140 REM TEST A LINE EXACTLY 24 CHARACTERS LONG.  CLEAR THE SCREEN
143 REM AND USE THE DOWN CURSOR SO
145 REM THAT THE INPUT REQUEST IS ON THE BOTTOM LINE, I.E. TEST
146 REM THE EFFECT OF SCROLLING.
150 REM INPUT JUST A'RETURN'
160 REM TEST A LINE EXACTLY 63 CHARACTERS LONG.
170 REM TEST A LINE 64 CHARACTERS LONG.  AFTER THIS TEST, 'STOP',
175 REM 'RETURN' THEN PRINT A$
177 REM TRY A STRING WITH A COMMA (,), THEN TRY A COLON (:)
180 REM THE LAST 5 ARE LIMITATIONS OF PET INPUT STATEMENT.  YOU
185 REM CANNOT AVOID THEM UNLESS YOU USE GET$.
200 END
```

4.

```
  5 REM COUNT THE WORDS IN A STRING
  8 B$=" ,.:!"
 10 PRINT "TYPE A STRING"
 20 INPUT A$
 24 N=0
 26 S=0
```

```
 30  L=LEN(A$)
 31  IF L=0 THEN 50
 32  FOR I=1 TO L
 34  FOR J=1 TO LEN(B$)
 36  IF MID$(A$,I,1)<>MID$(B$,J,1)THEN 44
 38  IF I-S>1 THEN N=N+1
 40  S=I
 42  GO TO 46
 44  NEXT J
 46  NEXT I
 48  IF S<>L THEN N=N+1
 50  PRINT N;" IS NUMBER OF WORDS"
 52  GO TO 10
100  REM TEST DATA
110  REM INPUT A SINGLE CHARACTER (TEST END POINT)
120  REM INPUT A LINE OF ALL SEPARATORS .,! ETC.
130  REM "" (TEST NULL STRING)
140  REM TEST WORD WITH LOTS OF TRAILING SEPARATORS
150  REM INPUT JUST A 'RETURN'
160  REM TEST A WORD EXACTLY 78 CHARACTERS LONG.
170  REM TEST A WORD 80 CHARACTERS LONG.  AFTER THIS TEST, 'STOP',
175  REM 'RETURN' THEN PRINT A$
```

bv. 5. voer in AB;CD;EF A.m.

```
  5  REM CONVERT TIME TO THE 24 HOUR CLOCK
 10  INPUT "WHAT IS THE TIME" ; A$
 20  L=LEN(A$)
 30  IF L > 6 THEN 60
 40  PRINT "BAD TIME"
 50  GO TO 10
 60  B$=RIGHT(A$,4)
 70  IF(B$<> "A.M.") AND (B$<>"P.M.") THEN 40
 80  H=VAL(A$)
 90  IF H<0 OR H>12 THEN 40
100  FOR I=1 TO L-4
110  IF MID$(A$,I,1)=";"THEN 140
```

B$ = A.m.

H = AB

The semicolon is chosen as a separator instead of the colon because the INPUT statement thinks the colon is a delimiter.

```
120  NEXT I
130  GO TO 40
140  C$=RIGHT$(A$,L-I)
150  M=VAL(C$)
160  IF M<0  OR M>59 THEN 40
170  FOR J=I+1 TO L-4
180  IF MID$(A$,J,1)=";" THEN 210
190  NEXT J
200  GO TO 40
210  D$=RIGHT$(A$,L-J)
220  S=VAL(D$)
230  IF S<0  OR S>59 THEN 40
250  IF B$="P.M." THEN H=H+12
```

m = CD

S = EF.

```
260  TP$=STR$(H)
270  IF LEN(TP$)< 3 THEN TP$=" 0" +RIGHT$(TP$,1)
280  T$=TP$
290  TP$=STR$(M)
300  IF LEN(TP$)< 3 THEN TP$=" 0" +RIGHT$(TP$,1)
310  T$=T$+":"+RIGHT$(TP$,2)
320  TP$=STR$(S)
330  IF LEN(TP$)< 3 THEN TP$=" 0" +RIGHT$(TP$,1)
340  T$=T$+":"+RIGHT$(TP$,2)
350  PRINT " 24 HOUR TIME IS ";T$
360  GO TO 10
400  REM TEST DATA
410  REM TRY THE FOLLOWING LEGAL DATA
420  REM TRY 07;15;00 A.M.
430  REM TRY 07;15;A.M.
440  REM TRY 07;;A.M.
450  REM TRY 07;15;00 P.M.
460  REM TRY 07;15;P.M.
470  REM TRY 07;;P.M.
480  REM TRY 7;15;0 A.M.
490  REM TRY 7;15;P.M.
500  REM TRY 0;01;00 A.M.
510  REM TRY ;;;P.M.
520  REM TRY 0;0;05 A.M.
530  REM TRY 0;;3P.M.
540  REM TRY THE FOLLOWING ILLEGAL DATA
550  REM TRY 13;05;01 A.M.
560  REM TRY 1;15;01 X.Y.
570  REM TRY 5;61;11 A.M.
580  REM TRY 3;-4;2 P.M.
590  REM TRY 3;4;-1 A.M.
600  REM TRY 2;4;60 P.M.
610  REM TRY -1;5;1 A.M.
```

6.

```
  1  REM A PROGRAM TO COUNT THE VOWELS IN A STRING
  5  DIM PL(78)
 10  INPUT "INPUT A STRING";A$
 15  N=0
 17  FOR I=1 TO 78:PL(I)=0:NEXT I
 20  B$="AEIOU"
 30  FOR I=1 TO LEN(A$)
 40  FOR J=1 TO 5
 50  IF MID$(A$,I,1)<>MID$(B$,J,1) GO TO80
```

The outer loop is used to check each character in A$ while the inner loop is to check each character in B$. Since non-vowels are not interesting, simply branch to the end of the inner loop.

```
 60  N=N+1
 70  PL(I)=1
```

N is used as a counter for the total number of vowels. The array PL is used to calculate the position of each vowel found. Each position that has a vowel is set to 1.

```
 80  NEXT J
 90  NEXT I
100  PRINT "NUMBER OF VOWELS ARE";N;"POSITIONS ARE";
```

Since the total number of vowels is to be printed only once, it is done in statement 100. At the same time set up to print the positions on the same line by ending the PRINT statement with a;

```
110  FOR J=1 TO 78
120  IF PL(J)=0 GO TO 140
130  PRINT J;
140  NEXT J
```

The above loop is set up to find the positions of each vowel; that is, if PL(J)=1 then J is the position number of a vowel. The PRINT statement at 130 will print on the same line as statement 100 each time through the loop because of the semicolon (;) at the end of the statement.

```
145  PRINT
146  PRINT
150  GO TO 10

200  REM TEST DATA
210  REM INPUT A SINGLE CHARACTER
220  INPUT A LONG LINE WITH ALL VOWELS IN IT
230  REM INPUT "" (TEST A NULL STRING)
240  INPUT JUST A 'RETURN'
250  REM TRY A STRING WITH NO VOWELS IN IT
260  END
```

7.

```
  5  REM A PROGRAM TO CHANGE ALL J's TO H's.
 10  INPUT "INPUT A STRING";A$
 20  L=LEN(A$)
 30  FOR I=1 TO L
 40  B$=MID$(A$,I,1)
 50  IF B$="J" THEN B$="H"
 60  C$=C$+B$
 70  NEXT I
 80  PRINT "NEW STRING IS ";C$
100  REM TEST DATA
110  REM INPUT A SINGLE J
120  REM INPUT A SINGLE CHARACTER
130  REM INPUT A "" (TEST A NULL STRING)
140  REM INPUT A STRING WITH A J AS THE LAST CHARACTER
150  END
```

8.

```
 10  REM A PROGRAM TO CHANGE EVERY LETTER IN THE ALPHABET TO
 15  REM ANOTHER LETTER.
 20  INPUT "TYPE A STRING"; A$
 25  C$=""
 30  FOR I=1 TO LEN(A$)
 40  B$=MID$(A$,I,1)
 45  IF B$= "" GO TO 90
 50  B=ASC(B$)-3
```

Statement 40 gets a character. Statement 50 converts the character to its equivalent number and then subtracts 3 in order to change it to a different character.

```
 60  IF B>=65 GO TO 80
 70  B=B+26
```

Since the alphabetic characters are the numbers between 65 and 90, adjustments must be made if the character is less than 65. By adding 26 only when it is less than 65, we can never exceed 91. However, the case where the input characters do not fall in the range 65 - 90 is not provided for.

```
 80  C$=C$+CHR$(B)
```

Add the new character to the string.

```
 90  NEXT I
100  PRINT C$
110  REM TEST DATA
120  REM INPUT A SINGLE CHARACTER (TEST END POINT)
130  REM INPUT A LONG LINE WITH EXACTLY 24 CHARACTERS IN IT
135  REM (TEST END POINT OF INPUT)
140  REM ""(TEST NULL STRING)
150  REM TEST A LINE EXACTLY 25 CHARACTERS LONG.
155  REM TEST A LINE OF SPECIAL CHARACTERS
160  REM INPUT JUST A 'RETURN'
170  REM TEST A LINE EXACTLY 64 CHARACTERS LONG.
180  REM TEST A LINE 65 CHARACTERS LONG.  AFTER THIS TEST, 'STOP',
185  REM 'RETURN' THEN PRINT A$
190  REM TRY A STRING WITH A COMMA (,), THEN TRY A COLON (:)
200  REM THE LAST 5 ARE LIMITATIONS OF THE PET INPUT STATEMENT
205  REM YOU CANNOT AVOID THEM
210  REM UNLESS YOU USE GET$.
220  END
```

9.
```
  5 REM A PROGRAM TO COMPUTE THE ALPHABETIC POSITION OF A CHARACTER.
  8 PRINT "ENTER CHARACTER"
 10 INPUT A$
 15 IF LEN(A$)>1 THEN PRINT "ENTER SINGLE CHARACTER":GO TO 10
 20 FOR I=1 TO 26
 30 B$="ABCDEFGHIJKLMNOPQRSTUVWXYZ"
 40 IF A$=MID$(B$,I,1) GO TO 70
 50 NEXT I
 60 PRINT "NOT AN ALPHABETIC CHARACTER"
 65 GO TO 8
 70 PRINT A$;" IS IN POSITION";I
 80 GO TO 8
 90 END
100 REM TEST DATA
110 INPUT A SINGLE CHARACTER
120 REM INPUT A LONG LINE
130 REM "" (TEST NULL STRING)
140 REM TEST A SPECIAL CHARACTER
```

10.
```
  5 REM A PROGRAM TO SQUEEZE OUT BLANKS.
 10 INPUT A$
 15 B$=""
 18 IF LEN(A$)=0 THEN 60
 20 FOR I=1 TO LEN(A$)
 30 IF MID$(A$,I,1)=" "GO TO 50
 40 B$=B$+MID$(A$,I,1)
 50 NEXT I
 60 PRINT "SQUEEZED STRING:"
 65 PRINT B$
 70 GO TO 10
100 REM TEST DATA
110 INPUT A SINGLE CHARACTER (TEST END POINT)
120 REM INPUT A LINE WITH NO BLANKS IN IT
130 REM ""(TEST NULL STRING)
140 REM TEST A LINE WITH ALL BLANKS
150 REM INPUT JUST A 'RETURN'
180 REM TRY A STRING WITH A COMMA (,), THEN TRY A COLON (:)
210 END
```

11.

```
    5  REM EXAMPLE OF A PROGRAM TO SORT CHARACTER STRINGS IN
    6  REM ALPHABETIC ORDER USING HEAPSORT.
   10  DIM R$(100)
  100  PRINT "PLEASE INPUT THE NAMES YOU WANT SORTED"
  110  PRINT "WHEN YOU ARE FINISHED INPUT EOF."
  120  N=0
  130  N=N+1
  140  INPUT R$(N)
  150  IF R$(N)<>"EOF" GO TO 130
  160  N=N-1
  170  L=INT(N/2)+1
  180  IR=N
  190  IF L=1 GO TO 212
  200  L=L-1
  210  S$=R$(L)
  211  GO TO 220
  212  S$=R$(IR)
  213  R$(IR)=R$(1)
  214  IR=IR-1
  215  IF IR<=1 GO TO 310
  220  J=L
  230  I=J
  240  J=2*J
  250  IF J=IR GO TO 265
  260  IF J>IR GO TO 290
  261  IF R$(J)>=R$(J+1) GO TO 265
  262  J=J+1
  265  IF S$>=R$(J) GO TO 290
  270  R$(I)=R$(J)
  280  GO TO 230
  290  R$(I)=S$
  300  GO TO 190
  310  R$(1)=S$
  320  FOR I=1 TO N
  330  PRINT R$(I)
  340  NEXT I
  350  END
  400  REM TEST DATA
  410  REM INPUT A SINGLE CHARACTER
  420  REM TRY 123
  430  REM TRY ""
  440  REM TRY 'RETURN'
  450  REM TRY 2 LONG STRINGS
  460  REM TRY A STRING WITH A COMMA (,) IN THE MIDDLE
  465  REM END ALL TEST CASES WITH "EOF"
```

VI. APPENDIX - Character Sets

The following character sets are those used by the Commodore PET. The character sets described will be those used with the POKE statement and those used with the PRINT,CHR$, and ASC statements. There are three sets for the POKE statement, graphics, lower case, and reverse video There are only two sets for the PRINT, CHR$, and ASC statements. One is for graphics and the other is for lower case.

The character set used with the PRINT statement is not as straight forward as the one used with the POKE statement. For example, to get a reverse video character with the PRINT you must first hit the double quote (") then the 'RVS' key. All characters after that will be reverse video until the terminating double quote (").

Example of displaying reverse video characters.

T: PRINT"[R]AB"
R: [A][B]
R: READY.

The characters in boxes represent reverse video characters. The [R] is the character you get when the reverse video key is hit.

An alternative method to get reverse video characters is to type CHR$(18) rather than hit the 'RVS' key.

Example of displaying reverse video characters.

T: PRINT CHR$(18);"ABC"
R: [A][B][C]
R: READY.

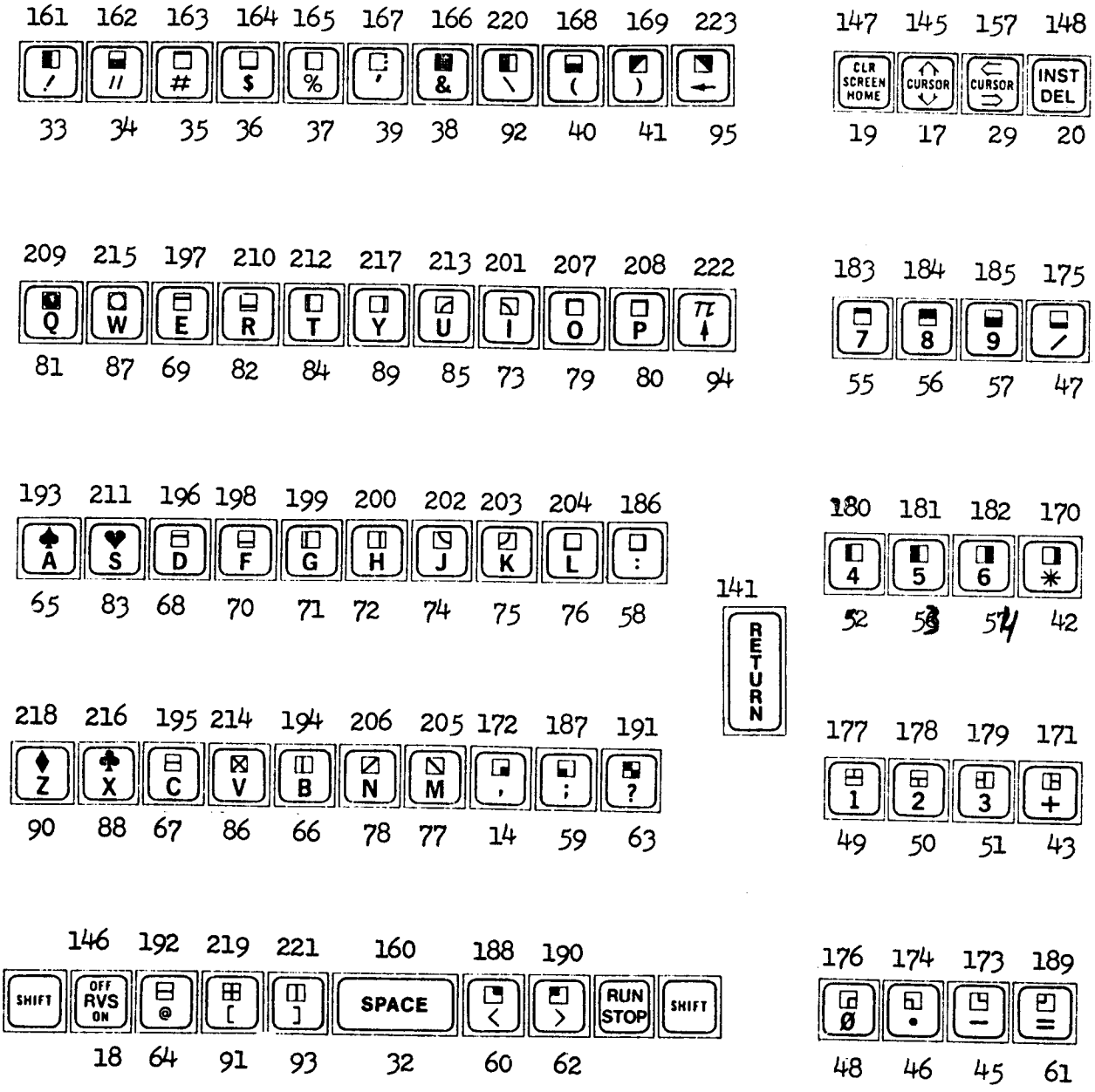
Some characters have a dual numeric representation when used with the CHR$ function. For example, CHR$(35) = CHR$(99) = #. The following is a list of those numbers that represent the same character.

33,97	47,111	60,124	170,234	183,247
34,98	48,112	61,125	171,235	184,248
36,100	49,113	62,126	172,236	185,249
37,101	50,114	63,127	173,237	186,250
38,102	51,115	161,225	174,238	187,251
39,103	52,116	162,226	175,239	188,252
40,104	53,117	163,227	176,240	189,253
41,105	54,118	164,228	177,241	190,254
42,106	55,119	165,229	178,242	222,255
43,107	56,120	166,230	179,243	
44,108	57,121	167,231	180,244	
45,109	58,122	168,232	181,245	
46,110	59,123	169,233	182,246	

APPENDIX

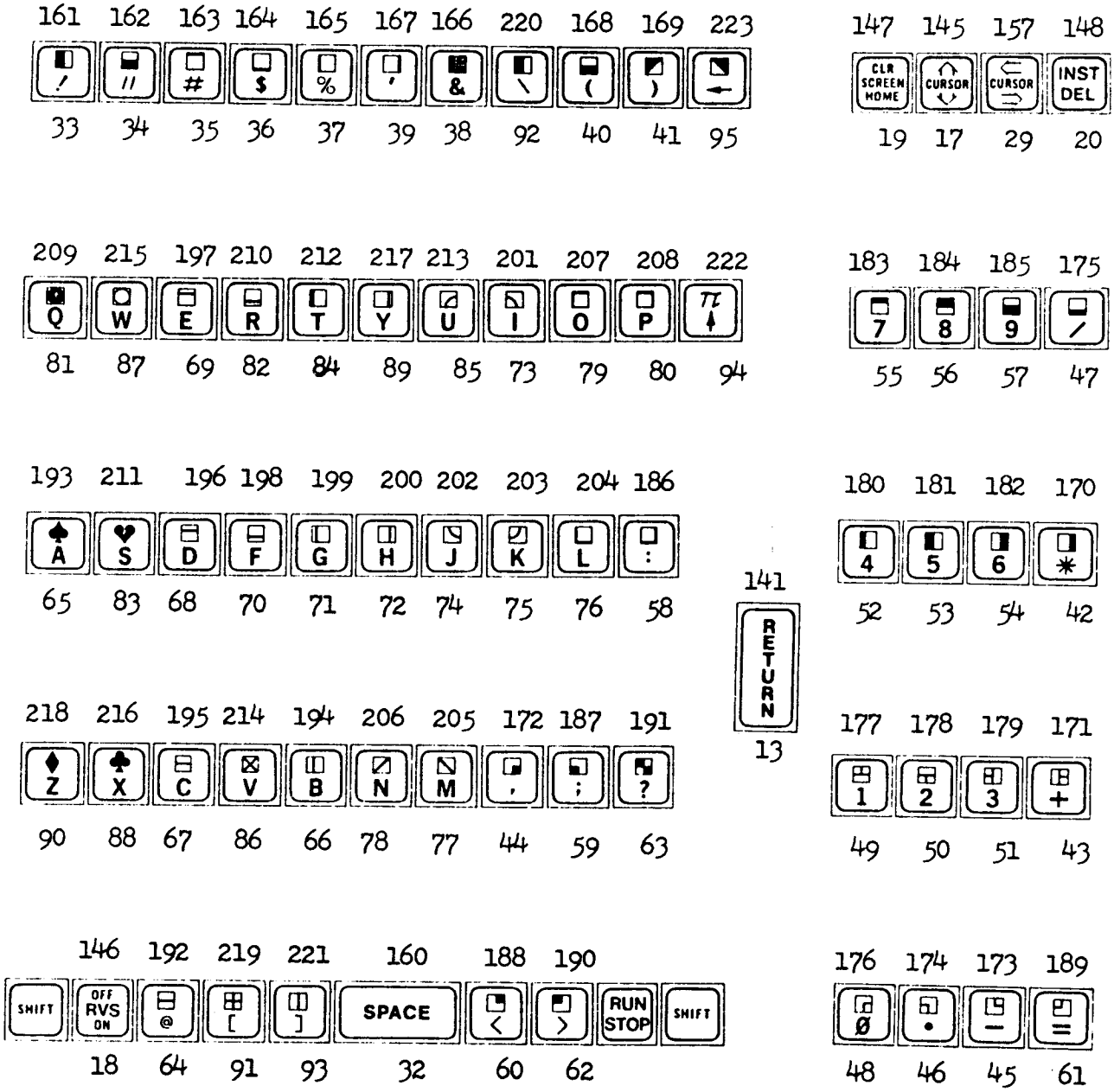
A. Character Codes for the PRINT, CHR$, and ASC.

Lower case character set (location 59468 = 14).



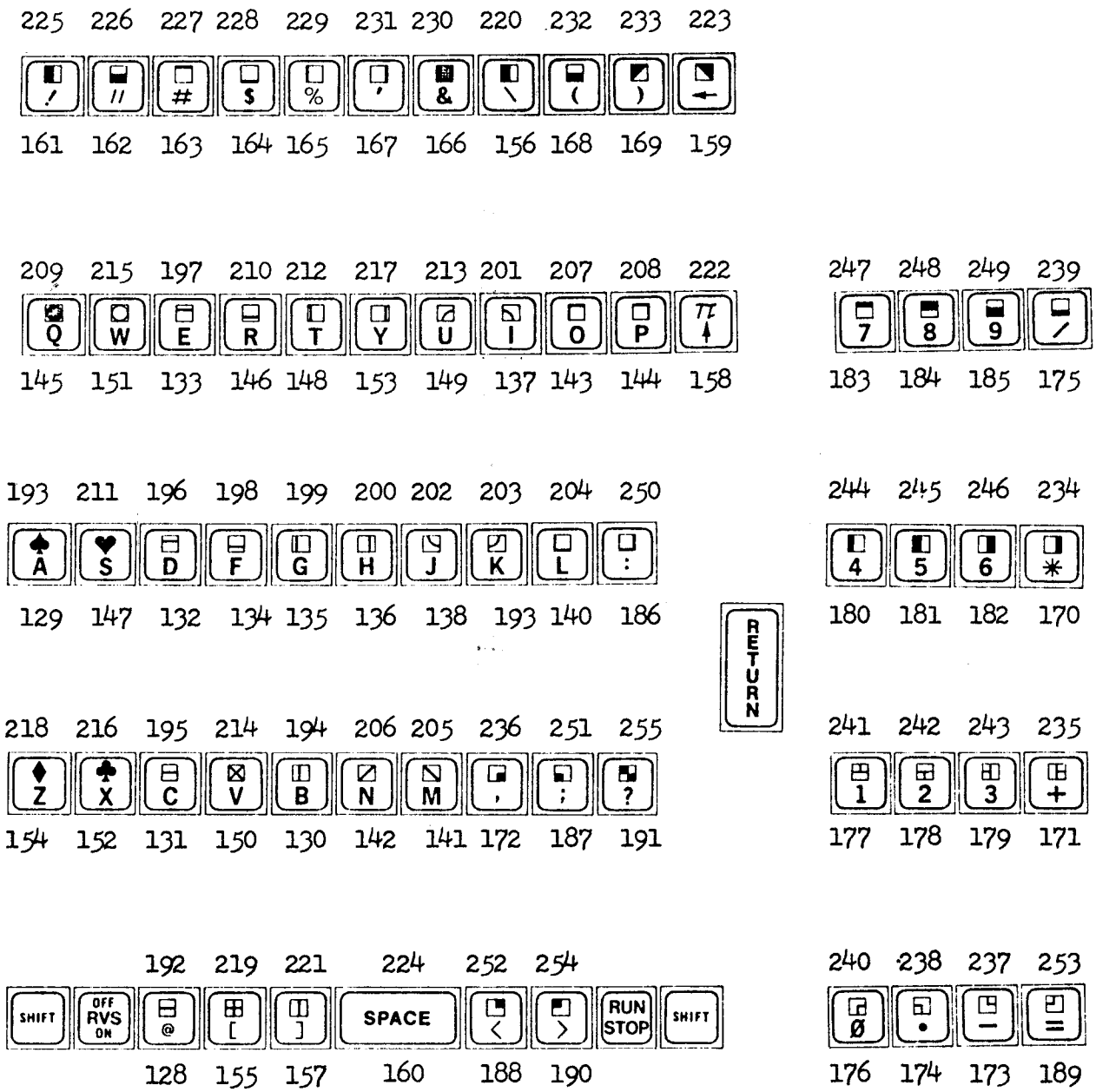
B. Character Codes for the PRINT, CHR$, and ASC.

Graphics character set (location 59468 = 12).



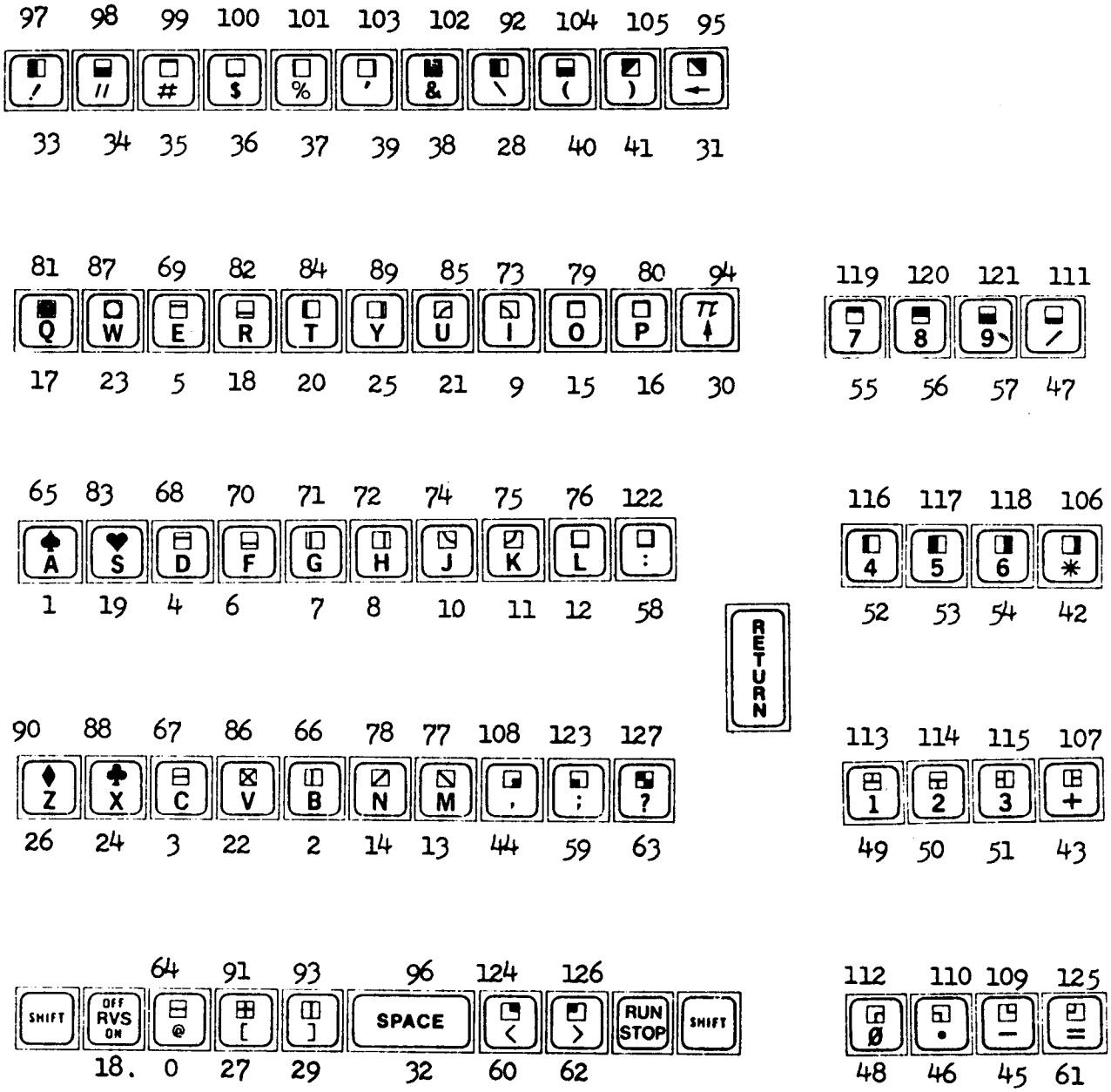
C. Character Codes for the POKE Statement.

Reverse ~~video~~ lower case character set (location 59468 = 14).



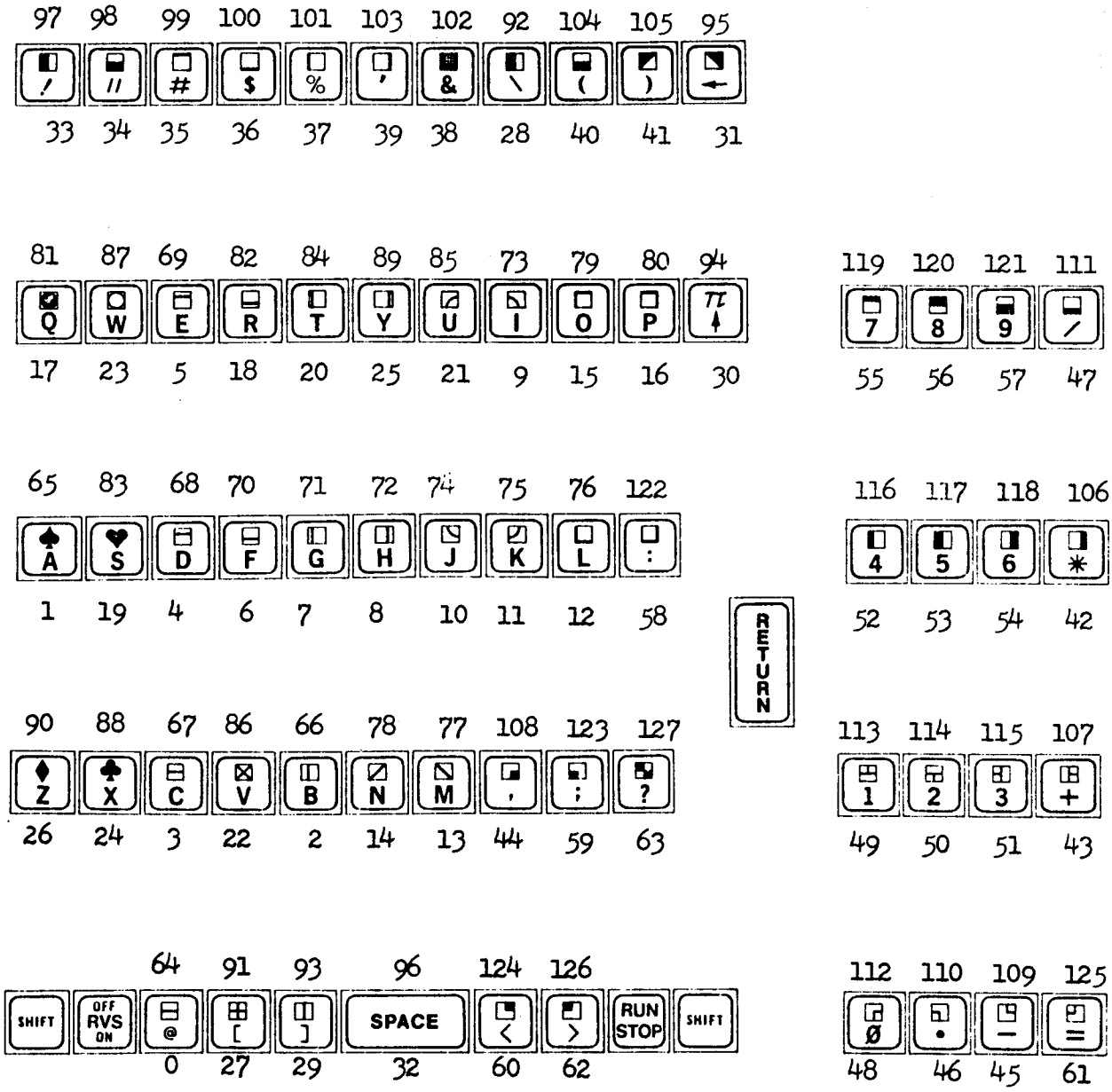
D. Character Codes for the POKE statement.

Graphics character set (location 59468 = 12).



E. Character Codes for the POKE statement.

Lower case character set (location 59468 = 14).




TIS
THE END

Notes

Array 2-1

Randomgenerator; Dobbelsteen 2-4

String 3-1

ASCII 3-1

Poke 59468, 12/14 3-8 ~~plaats~~
33728 4-4

\+ > < = } bij vergelijken en
AND OR NOT } koppelen alfanum info 4-1.

invoer bij INPUT 4-2.

RESTORE

GET: A$ = "" 4-3.
vgl. A=0.

For -- STEP -α 4-7.

Het onder elkaar krijgen van decimale punt 4-9.

Het zoeken naar symmetrische woorden 4-10

IF -- THEN 5-4 5-8

Print α [;] 5-2.

Het alfabetisch rangschikken 5-9.

Notes

Sorteren

```
10  Dim A$(1431)
20  ? " Voer de namen in die je wilt sorteren
30  ? " Als je klaar bent voer dan 'eind' in
40  k = 0
50  k = k+1
60  input A$(k)
70  if A$(k) ≠ "eind" goto 50
80  k = k-1
90  for j = k to 2 step -1
100 for i = 1 to j-1
110 if A$(i) ≦ A$(i+1) then x = 0 : goto 160
~~120 goto 170~~
120 x = 1   (geeft aan dat gewisseld is)
130 B$ = A$(i)
140 A$(i) = A$(i+1)
150 A$(i+1) = B$
160 next i
170 next j
~~190 if x = 1 goto 90 nodig?~~
190/180 for i = 1 to k
200/190 print A$(i)
210/200 next i
220/210 print
230/220 print.
240/230 END of GOTO 20
```

Bij de regels 90 en 100 (accolade):
A$(i) en A$(i+1) worden gewisseld. Daardoor komt de grootste op de laatste plaats (k); vandaar

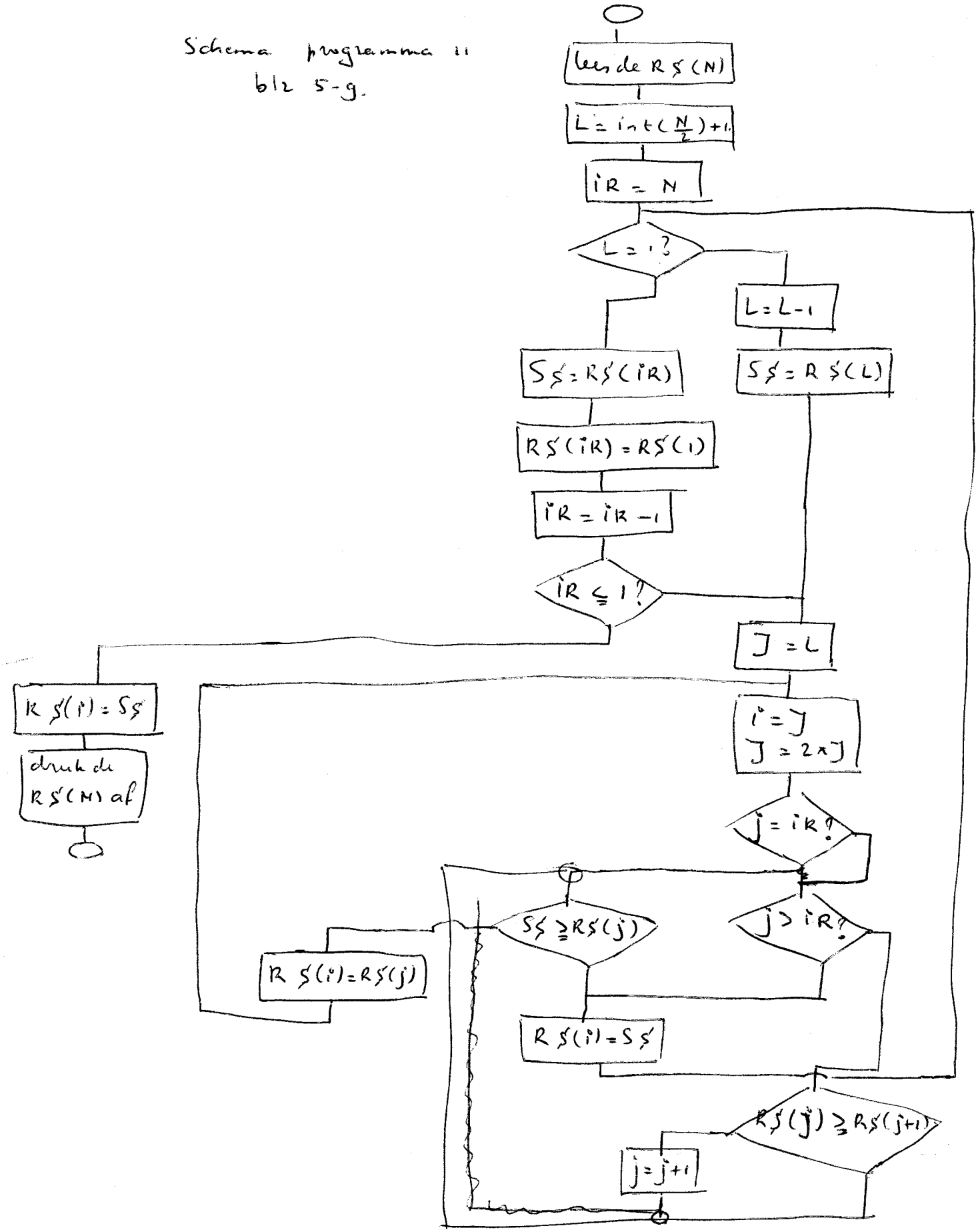
Bij regel 190: Nummeren? dan print i;"b";A$(i) (of A$(i);) → voor achter elkaar.

Dit programma ordent ook getallen, maar dan wel getallen met evenveel cijfers

Bij rangschikken 1235 en 365 → 365, 1235

op te vangen door 1235, 0365

Schema programma 11
blz 5-9.



Twee gevallen. N even , N oneven

N even 1, 2, --, L ; L+1, ---, 2L-2 = N.

N oneven 1, 2, --, L ; L+1, --, 2L-1 = N.

Notes