CAMBRIDGE

Cambridge University Press
978-0-521-21704-0 - Illustrating Basic: (A Simple Programming Language)
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Excerpt
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1

COMPONENTS OF THE LANGUAGE

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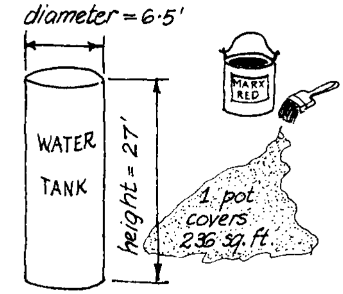
PROBLEM

HOW MANY POTS OF PAINT DO YOU NEED TO PAINT THE ROOF AND WALL OF THIS WATER TANK?



WE COULD GO STRAIGHT AT IT LIKE THIS:

roof area, $T = \pi \times 6{\cdot}5^2 \div 4 = 33{\cdot}2$
wall area, $S = \pi \times 6{\cdot}5 \times 27 = 551$
total area, $A = T + S = 584{\cdot}2$
number of pots, $G = A \div 236 = 2{\cdot}48$
rounding up, $R = 3$
∴ *you need 3 pots of paint*

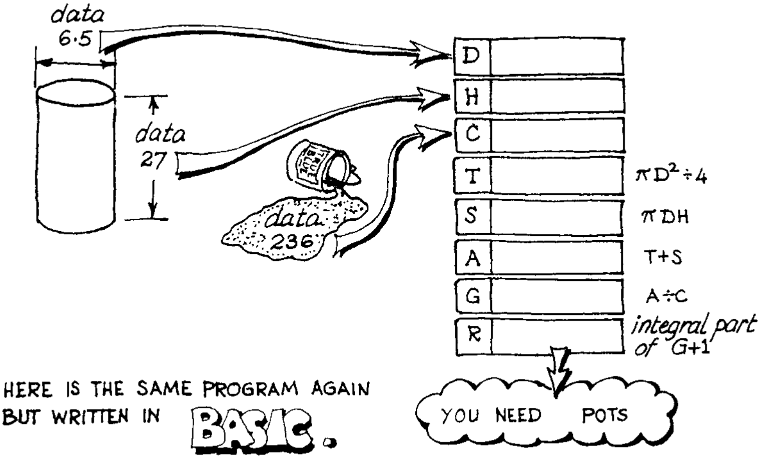
OR WE COULD WRITE A *PROGRAM* (IN ENGLISH) TO SOLVE THE PROBLEM.

```
1. REMARK:  A PROGRAM IN ENGLISH
2. THE FOLLOWING NUMBERS ARE THE DATA  6·5, 27, 236
3. READ THE DATA, CALLING THEM D, H & C RESPECTIVELY
   (think of this as putting the data into little boxes
   labelled D, H & C respectively – see opposite page)
4. WORK OUT 3·14×D²÷4 AND LET THE RESULT BE CALLED T
   (i.e. put the result in a little box labelled T)
5. WORK OUT 3·14×D×H AND LET THE RESULT BE CALLED S
6. ADD T TO S AND LET THE RESULT BE CALLED A
7. WORK OUT A÷C AND LET THE RESULT BE CALLED G
8. ROUND G TO THE NEXT WHOLE NUMBER AND
   LET THE RESULT BE CALLED R
   (i.e. add 1 to G and take the integral part of the result)
9. PRINT "YOU NEED" ; R ; "POTS"
   (i.e. print whatever whole number R turns out to be)
10. THE END
```

THIS HAS THE ADVANTAGE OF BEING GOOD FOR ANY SIZE OF TANK AND PAINT POT ⇝ YOU NEED ONLY REPLACE THE DATA ON LINE 2.

NOW

TRY *OBEYING* THE ENGLISH PROGRAM OPPOSITE & FEEL WHAT IT WOULD BE LIKE TO *BE* A COMPUTER & *DEFILE* THIS PAGE BY WRITING NUMBERS IN THE LITTLE BOXES BELOW.



HERE IS THE SAME PROGRAM AGAIN BUT WRITTEN IN BASIC.

COMPARE IT CAREFULLY WITH THE *ENGLISH* VERSION OPPOSITE.

```
1   REM   A PROGRAM IN BASIC
2   DATA  6.5, 27, 236
3   READ  D, H, C
4   LET   T = 3.14*D↑2/4
5   LET   S = 3.14*D*H
6   LET   A = T + S
7   LET   G = A/C
8   LET   R = INT (G + 1)
9   PRINT "YOU NEED"; R ; "POTS"
10  END
```

notice
* meaning multiply
↑ meaning raise to a power
/ meaning divide

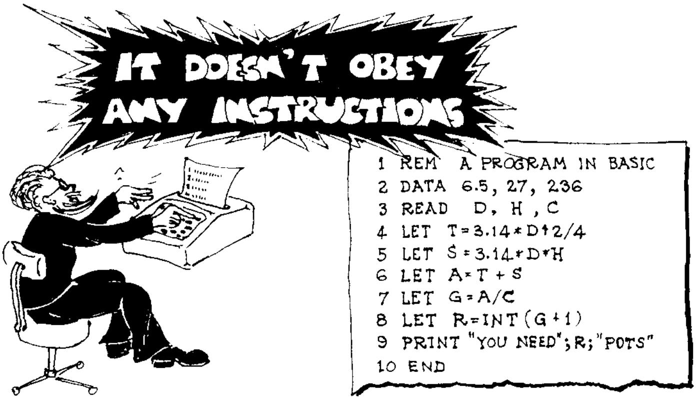
AND THIS, WHEN OBEYED, WOULD PRODUCE :

```
YOU NEED 3 POTS
```

FIRST

PREPARE YOUR PROGRAM BY TYPING INSTRUCTIONS AT THE KEYBOARD ☞ THE COMPUTER SIMPLY *STORES* THE PROGRAM AT THIS STAGE :

IT DOESN'T OBEY ANY INSTRUCTIONS



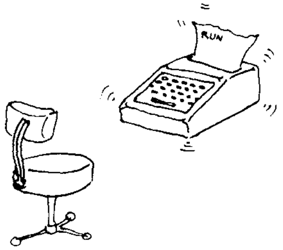
```
1  REM  A PROGRAM IN BASIC
2  DATA  6.5, 27, 236
3  READ  D, H , C
4  LET  T=3.14*D↑2/4
5  LET  S=3.14*D*H
6  LET  A=T+S
7  LET  G=A/C
8  LET  R=INT(G+1)
9  PRINT "YOU NEED";R;"POTS"
10 END
```

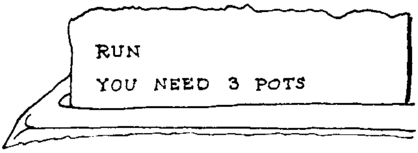
THEN

TYPE RUN

WHICH SETS THE COMPUTER TO WORK *OBEYING* THE STORED INSTRUCTIONS ONE AFTER THE OTHER ☞ IN NUMBERED SEQUENCE ☞ WHILST YOU RELAX .

EVENTUALLY THE COMPUTER WILL OBEY THE INSTRUCTION END . THAT MAKES IT STOP .





```
RUN
YOU NEED 3 POTS
```

BUT

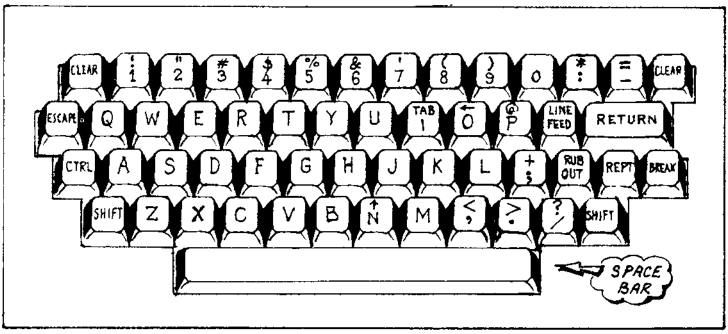
BEFORE YOU CAN TAKE THE FIRST STEP AND START TYPING THE PROGRAM YOU HAVE TO GO THROUGH THE RITUAL OF *SIGNING ON* AND TELLING THE COMPUTER YOU WANT TO USE *BASIC*.

DIFFERENT COMPUTERS (EVEN IDENTICAL COMPUTERS RUN BY DIFFERENT ORGANISATIONS) OFTEN HAVE DIFFERENT WAYS OF DOING THESE THINGS , SO IF YOU WANT TO TRY THE PROGRAM NOW GET SOMEONE WHO "KNOWS THE SYSTEM" TO SIGN ON FOR YOU AND CALL UP *BASIC*.

KEYBOARD

EVERY PROGRAM IN *BASIC* HAS TO BE TYPED ON A KEYBOARD

PROBABLY SOMETHING LIKE THIS


CLEAR ! 1 " 2 # 3 $ 4 % 5 & 6 ' 7 (8) 9 0 * : = - CLEAR
ESCAPE Q W E R T Y U TAB I ← O @ P LINE FEED RETURN
CTRL A S D F G H J K L + ; RUB OUT REPT BREAK
SHIFT Z X C V B ↑ N M < , > . ? / SHIFT
SPACE BAR

ALTHOUGH POSITIONS OF LETTERS & DIGITS ARE THE SAME ON MOST KEYBOARDS, KEYS LIKE RUB OUT & BREAK IN THE PICTURE ABOVE VARY IN NAME, POSITION AND FUNCTION FROM ONE INSTALLATION TO ANOTHER.

NOTICE ALL LETTERS ARE CAPITAL LETTERS. NOTICE ALSO THERE IS A KEY FOR 1 AND A KEY FOR ZERO (BOTH IN THE TOP ROW). NEVER PRESS THE LETTERS I AND O IN THEIR PLACE.

AS ON AN ORDINARY TYPEWRITER, PRESSING SHIFT AT THE SAME TIME AS ANOTHER KEY GIVES THE CHARACTER SHOWN ON THE UPPER HALF OF THAT KEY: THUS # 3 TOGETHER WITH SHIFT GIVES # WHEREAS # 3 ALONE, 3.

THE "BACK ARROW" ← SERVES TO DELETE THE CHARACTER ON ITS LEFT FROM THE COMPUTER'S MEMORY; TWO OF THEM DELETE THE PREVIOUS TWO CHARACTERS, AND SO ON. THUS IF YOU TYPE PRIMP←←NT THEN *BASIC* RECEIVES THE WORD PRINT. (REMEMBER THIS BY EXCLAIMING *OH SHIFT!* WHEN YOU HIT THE WRONG KEY.) SOME *BASICS*, HOWEVER, USE AN UNDERSCORE CHARACTER FOR THIS PURPOSE: PRIMP__NT.

MOST *BASICS* USE A KEY (PERHAPS "RUBOUT") WHICH, WHEN PRESSED, DELETES THE WHOLE OF THE LINE YOU ARE TYPING FROM THE COMPUTER'S MEMORY; ANOTHER (PERHAPS "BREAK") STOPS A PROGRAM RUNNING.

FOR A *NEW LINE* IN *BASIC* PRESS RETURN

WHEN TYPING "OFF LINE" PRESS RETURN then LINEFEED

TYPING

IF YOU INTEND TO USE *BASIC* A LOT, LEARN TOUCH TYPING. TEN FINGERS ARE FASTER AND LESS FRUSTRATING THAN TWO.

THERE IS A LIMIT TO THE LENGTH OF A TYPED LINE ☛ MOST *BASICS* ALLOW LINES UP TO 72 CHARACTERS LONG. SOME ALLOW LONGER LINES BUT IT IS BEST TO ACCEPT A LIMIT OF 72.

SOME *BASICS* ALLOW GREAT FREEDOM WITH THE SPACE BAR; SOME DISREGARD SPACES EXCEPT THOSE BETWEEN QUOTATION MARKS. THUS IT WOULD BE ALLOWABLE TO TYPE:

```
8FORD=STOP
```

INSTEAD OF:

```
8  FOR  D = S  TO  P
```

BUT IT IS OBVIOUSLY SILLY TO OBSCURE THE MEANING OF THE PROGRAM IN ORDER TO SAVE A FEW TAPS ON THE SPACE BAR.

SOME *BASICS* REFUSE TO ALLOW SPACES WITHIN THE CONTROLLING WORDS OF THE LANGUAGE. THUS THE FOLLOWING WOULD BE WRONG:

```
23 L E T  A = B+C
```

SOME *BASICS* DEMAND AT LEAST ONE SPACE BEFORE EACH CONTROLLING WORD, OR AFTER IT, OR BOTH:

```
20DATA   6.5, 27, 236
80 PRINT"YOU NEED";R;"POTS"
```

SOME *BASICS* REFUSE TO ACCEPT SPACES WITHIN LINE NUMBERS BUT DO NOT OBJECT TO THEM INSIDE OTHER NUMBERS:

```
1 000  LET  A = 1 000 . 0
1000  LET  A = 1000.0
```

SOME BASICS OBJECT TO THESE TOO

SOME *BASICS* DO NOT ALLOW SPACES IN FRONT OF LINE NUMBERS:

```
 95 LET  A = B
100 LET  C = D*F + G
```

SPACES OPTIONAL HERE

GENERALLY WHEN *ONE* SPACE IS ALLOWED (OR DEMANDED) THEN *SEVERAL* ARE ALLOWED. AND GENERALLY A SPACE IS OPTIONAL ON EITHER SIDE OF THESE ⇒ (, ; * + / − = ↑ > <) BUT NOT IN 1.5E2 (SEE PAGE 9) NOR BETWEEN > AND = (SEE PAGE 41).

A PROGRAM WHICH ACCEPTS ALL THESE RESTRICTIONS SHOULD BE ACCEPTABLE TO ANY VERSION OF *BASIC*.

LINE NUMBERS

LEAVE GAPS IN THEIR SEQUENCE THUS:

```
10  REM    A PROGRAM IN BASIC
20  DATA   6.5,  27,  286←←36
30  READ   D, H, C
40  LET    T = 3.14 * D↑2/4
50  LET    S = 3.14 * D * H
60  LET    A = T + S
70  LET    G = A/C
80  PRINT "YOU NEED"; R; "POTS"
90  END
```

USE 10s OR 5s

THIS IS 236. SEE PAGE 5

THERE IS A *MISTAKE* IN THIS PROGRAM: THE LAST LET WAS FORGOTTEN. INSERTING IT IS SIMPLE; JUST TYPE:

```
75  LET  R = INT (G+1)
```

AND THE COMPUTER PUTS LINE 75 BETWEEN LINE 70 & LINE 80. IT MAKES NO DIFFERENCE IN WHAT ORDER YOU *TYPE* THE LINES; THE COMPUTER SORTS THEM INTO ASCENDING ORDER OF LINE NUMBER.

IF YOU TYPE SEVERAL LINES WITH THE *SAME* LINE NUMBER THE COMPUTER OBLITERATES EACH PREVIOUS VERSION THUS ACCEPTING THE LINE TYPED LAST. IF THE LINE TYPED LAST IS *JUST* A LINE NUMBER WITH NOTHING AFTER IT THEN THE *WHOLE LINE VANISHES* FROM THE COMPUTER'S MEMORY — INCLUDING THE LINE NUMBER. THAT IS HOW TO DELETE UNWANTED LINES. THUS:

```
120 LET  A = B + C
125 LET  E = F
120 LET  A = B + G
125
120 LET  A = B
```

RESULTS IN THE COMPUTER REMEMBERING ONLY:

```
120 LET  A = B
```

THE FIRST LINE NUMBER IN A PROGRAM MUST BE GREATER THAN 0. THERE IS ALWAYS A LIMIT TO THE HIGHEST LINE NUMBER: SOME *BASICs* STOP AT 9999, SO IT IS BEST TO ACCEPT THIS AS THE LIMIT.

THE *LAST* STATEMENT OF EVERY PROGRAM MUST BE: **END**
(NO OTHER STATEMENT BUT THE LAST MAY SAY END).

STATEMENTS

A *BASIC* PROGRAM IS A SEQUENCE OF NUMBERED LINES CALLED *STATEMENTS*.

A STATEMENT MAY SIMPLY *STATE* SOMETHING

```
110 DATA 1, 2, 4
120 END
```

```
30 READ A,B,C
40 LET G=A*B↑2 +C
50 PRINT "ANSWER IS"; G
```

OR IT MAY *INSTRUCT* THE COMPUTER TO *DO* SOMETHING. A COMMON SYNONYM FOR *STATEMENT* IS *INSTRUCTION*; THE STATEMENTS THAT *DO* THINGS ARE *EXECUTABLE* INSTRUCTIONS.

THE COMPUTER FINDS OUT WHAT IS STATED OR WHAT TO DO BY LOOKING AT THE FIRST WORD: DATA, END, READ, LET *etc.*

OR SOMETIMES AT THE FIRST *TWO* WORDS: MAT READ, MAT PRINT *etc.* (WE MEET MAT ON PAGE 76).

BUT THERE IS AN IMPORTANT EXCEPTION:

THE WORD **LET** MAY BE *OMITTED* IN MOST VERSIONS OF *BASIC*.

```
40 G = A*B↑2 + C
```

REM

REM STANDS FOR *REMARK*. REM STATEMENTS CAUSE NO ACTION BY THE COMPUTER; YOU INCLUDE THEM TO CLARIFY YOUR PROGRAM.

```
10 REM          *** WATER TANKS ***
20 REM
30 REM   A PROGRAM TO ILLUSTRATE BASIC
40 REM   -*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
50 DATA    6.5,     27,     236
60 REM    DIAM, HEIGHT, COVERAGE
```

REM FOR BLANK LINES

REM FOR EMBELLISHMENT

REM FOR CLARITY

THE EXAMPLES IN THIS BOOK DO NOT HAVE MANY "REM" STATEMENTS BECAUSE I HAVE ANNOTATED PROGRAMS WITH LITTLE ARROWS AND CLOUDS SO AS TO SAVE SPACE.

NUMBERS

YOU CAN TYPE NUMBERS THREE WAYS ☞ AS *INTEGERS*, AS *REALS* OR IN *E-FORM*.

INTEGER FORM
(WHOLE NUMBERS)

```
160 DATA  0, 2, +4, 1000, -30
```

REAL FORM
(DECIMAL NUMBERS)

```
170 DATA +0.70, 4., .6, -1.3, 987.65
```

4. MEANS 4.0

E-FORM
(EXPONENT FORM)
WHERE *E* SAYS: "TIMES TEN TO THE..."

```
190 DATA 1E3, 13.6E-4,-13.6E6,-.0136E9
```

1.0×10^{3} $=1,000$

13.6×10^{-4} $=0.00136$

-13.6×10^{6} $=-13,600,000$

$-.0136\times10^{9}$ $=-13600,000$

E INTRODUCES AN *INTEGER* SAYING HOW MANY PLACES TO SHIFT THE DECIMAL POINT. SHIFT TO THE RIGHT IF THE INTEGER IS POSITIVE; OTHERWISE LEFT.

```
190 DATA   E3, 13.6E1.2 , 13.6 E 2
```

IN THE *E* FORM THERE MUST ALWAYS BE A NUMBER IN FRONT OF THE *E* AND AN *INTEGER* AFTER IT. SOME *BASIC*S ALLOW SPACES WITHIN AN *E* FORM BUT IT IS BEST NOT TO HAVE THEM.

$\pm10^{38}$

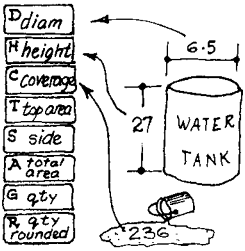
IN SOME *BASIC*S THE BIGGEST NUMBER THAT CAN BE STORED IS APPROXIMATELY $\pm10^{38}$ (*BIG* MEANS FAR FROM ZERO ON EITHER SIDE; *SMALL* MEANS CLOSE TO ZERO ON EITHER SIDE). OTHER *BASIC*S CAN HANDLE MUCH BIGGER NUMBERS THAN $\pm10^{38}$; IT DEPENDS ON THE COMPUTER'S "WORD LENGTH" AND WHETHER THE "WORDS" ARE USED SINGLY, IN PAIRS, OR IN MULTIPLES. BUT ***NO*** *BASIC* SHOULD REFUSE TO HANDLE A NUMBER AS BIG AS ±100,000,000,000,000,000,000,000,000,000,000,000,000.

6~7 SIG. FIG.

IN SOME *BASIC*S THE PRECISION OF STORAGE AND ARITHMETIC IS BETWEEN 6 AND 7 SIGNIFICANT DECIMAL DIGITS ☞ 987,654,321 WOULD BE STORED AS APPROXIMATELY 987,654,000. OTHER *BASIC*S OFFER MUCH HIGHER PRECISION, 15 SIGNIFICANT FIGURES BEING TYPICAL. AGAIN IT DEPENDS ON THE COMPUTER'S "WORD LENGTH" AND HOW THE "WORDS" ARE USED. BUT ***NO*** *BASIC* SHOULD WORK TO LESS PRECISION THAN 6 TO 7 SIG. FIGS. (THE VAGUENESS OF "6 TO 7" IS BECAUSE MOST COMPUTERS USE BINARY ARITHMETIC, NOT DECIMAL. A MORE PRECISE RENDERING WOULD BE "24 BINARY DIGITS FOR POSITIVE NUMBERS; 23 FOR NEGATIVE; OR VICE VERSA" BUT THESE IMPLICATIONS NEED NOT BOTHER THE NOVICE TO *BASIC*.)

VARIABLES

THERE ARE 286 *SIMPLE* NUMERICAL VARIABLES IN *BASIC*.



WE SAW SOME OF THESE ON PAGE 3. THEY ARE THE LITTLE BOXES USED TO HOLD NUMBERS.

THE FULL 286 ARE SHOWN BELOW. IT IS USEFUL TO KEEP A LARGE-SCALE CHART LIKE THIS AND MAKE A PHOTOCOPY FOR EACH NEW PROGRAM. AS YOU USE EACH VARIABLE WRITE A NOTE IN ITS BOX SAYING WHAT YOU USE IT FOR. THIS STOPS YOU USING VARIABLES ALREADY USED FOR SOMETHING ELSE A COMMON SOURCE OF TROUBLE.

A	A0	A1	A2	A3	A4	A5	A6	A7	A8	A9
B	Bo	B1	B2	B3	B4	B5	B6	B7	B8	B9
C	Co	C1	C2	C3	C4	C5	C6	C7	C8	C9
D	Do	D1	D2	D3	D4	D5	D6	D7	D8	D9
E	E0	E1	E2	E3	E4	E5	E6	E7	E8	E9
F	F0	F1	F2	F3	F4	F5	F6	F7	F8	F9
G	G0	G1	G2	G3	G4	G5	G6	G7	G8	G9
H	H0	H1	H2	H3	H4	H5	H6	H7	H8	H9
I	I0	I1	I2	I3	I4	I5	I6	I7	I8	I9
J	Jo	J1	J2	J3	J4	J5	J6	J7	J8	J9
K	K0	K1	K2	K3	K4	K5	K6	K7	K8	K9
L	Lo	L1	L2	L3	L4	L5	L6	L7	L8	L9
M	M0	M1	M2	M3	M4	M5	M6	M7	M8	M9
N	N0	N1	N2	N3	N4	N5	N6	N7	N8	N9
O	O0	O1	O2	O3	O4	O5	O6	O7	O8	O9
P	P0	P1	P2	P3	P4	P5	P6	P7	P8	P9
Q	Q0	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
R	R0	R1	R2	R3	R4	R5	R6	R7	R8	R9
S	So	S1	S2	S3	S4	S5	S6	S7	S8	S9
T	T0	T1	T2	T3	T4	T5	T6	T7	T8	T9
U	U0	U1	U2	U3	U4	U5	U6	U7	U8	U9
V	Vo	V1	V2	V3	V4	V5	V6	V7	V8	V9
W	W0	W1	W2	W3	W4	W5	W6	W7	W8	W9
X	X0	X1	X2	X3	X4	X5	X6	X7	X8	X9
Y	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9
Z	Zo	Z1	Z2	Z3	Z4	Z5	Z6	Z7	Z8	Z9