

Program Description I

Program Title MULTIPLICATION OF A 25-DIGIT NUMBER BY A 25-DIGIT NUMBER

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Program Description, Equations, Variables LET A 25-DIGIT NUMBER BE REPRESENTED AS FOLLOWS: GROUP ITS DIGITS INTO 5 SETS OF 5 DIGITS EACH. CALL THE RIGHTMOST a_0 , THE NEXT a_1, \dots , UP TO THE LEFTMOST (a_4). LABEL THE 25 DIGIT MULTIPLIER SIMILARY (USE b_0, \dots, b_4 INSTEAD OF a_0, \dots, a_4). THEN:

$$\begin{array}{r} a_4 a_3 a_2 a_1 a_0 \\ \times b_4 b_3 b_2 b_1 b_0 \\ \hline \end{array}$$

$$c_9 c_8 c_7 c_6 c_5 c_4 c_3 c_2 c_1 c_0$$

WHERE THE c_l 'S ARE ALSO GROUPS OF 5 DIGITS, COMPUTED BY

$$c_l = \sum_{\substack{j+k=l \\ 0 \leq m \leq 4}} \left\{ \text{INT} \left(\frac{a_j b_m}{10^5} \right) + 10^5 \text{FRAC} \left(\frac{a_j b_m}{10^5} \right) \right\} \quad 0 \leq l \leq 9$$

AND $c_0 = \text{FRAC} \left(\frac{a_0 b_0}{10^5} \right) \times 10^5$, $c_9 = \text{INT} \left(\frac{a_4 b_4}{10^5} \right)$

IF ANY GROUPING LIKE 362,56281,... IS ENCOUNTERED, SET $a_0 = 56281$, $a_1 = 00362$. THE SAME IS TRUE FOR OUTPUT.

AS AN EXAMPLE, 2,430,658,100,328 WOULD BE GROUPED AS:

$$\left. \begin{array}{l} a_0 = 00328 \\ a_1 = 06581 \\ a_2 = 00243 \end{array} \right\} \text{ AND OUTPUT AS } \left\{ \begin{array}{l} c_2 = 243 \\ c_1 = 6581 \\ c_0 = 328 \end{array} \right. \text{ PUTTING}$$

ZERO(S) IN FRONT OF THOSE GROUPINGS WITH LESS THAN 5 DIGITS GIVES YOUR ANSWER

Operating Limits and Warnings INPUT DATA IS NOT CHECKED. HENCE INVALID INPUT RESULTS IN INVALID ANSWERS

This program has been verified only with respect to the numerical example given in Program Description II. User accepts and uses this program material AT HIS OWN RISK, in reliance solely upon his own inspection of the program material and without reliance upon any representation or description concerning the program material.

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Sketch(es)

Sample Problem(s) ① $576,460,752,303,423,488$
 $\times 144,115,188,075,855,872$

3,486,784,401

3,486,784,401

$83,076,249,736,557,242,056,487,941,267,521,536$ 12,153,665,459,056,928,801

NOTE THAT MULTIPLIERS AND MULTIPLICAND ARE INPUT FROM THE LAST DIGIT FORWARD (IE. START WITH THE 8 AND END WITH THE 5) AND ARE INPUT IN GROUPS OF 5.

BUT THE PRODUCT IS OUTPUT FROM LEFT TO RIGHT, AGAIN IN GROUPS OF 5.

| | | | | |
|----------------------------------|-----------------------------|------------------------------|-------------------------------|----------|
| Solution(s) ① $A \rightarrow 0.$ | $144 [RIS] \rightarrow -4.$ | $48794.$ | $84401 [RIS] \rightarrow -1.$ | $0.$ |
| $23488 [RIS] \rightarrow 1.$ | $0 [RIS] \rightarrow$ | $12675,$ | $34867 [RIS] \rightarrow -2.$ | $0.$ |
| $23034 [RIS] \rightarrow 2.$ | ANSWER: $0.$ | $21536.$ | $0 [RIS] \rightarrow -3.$ | $12157.$ |
| $46075 [RIS] \rightarrow 3.$ | $0.$ | ② $A \rightarrow 0.$ | $0 [RIS] \rightarrow -4.$ | $66545.$ |
| $576 [RIS] \rightarrow 4.$ | $0.$ | $84401 [RIS] \rightarrow 1.$ | $0 [RIS] \rightarrow$ | $90569.$ |
| $0 [RIS] \rightarrow 0.$ | $83076.$ | $34867 [RIS] \rightarrow 2.$ | ANSWER: $0.$ | $28801.$ |
| $55872 [RIS] \rightarrow -1.$ | $74973.$ | $0 [RIS] \rightarrow 3.$ | $0.$ | |
| $80758 [RIS] \rightarrow -2.$ | $65572,$ | $0 [RIS] \rightarrow 4.$ | $0.$ | |
| $11518 [RIS] \rightarrow -3.$ | $42056.$ | $0 [RIS] \rightarrow 0.$ | $0.$ | |

Reference(s)

| STEP | KEY ENTRY | KEY CODE | COMMENTS | STEP | KEY ENTRY | KEY CODE | COMMENTS |
|------|-----------|----------|---------------------------------|------|-----------|----------|---|
| 001 | f LBL A | 31 25 11 | INITIALIZE | | STO+(i) | 33 61 24 | $10^5 \text{FRC}(\frac{R_E}{10^5}) + R_{(i)} \rightarrow R_{(i)}$ |
| | f CLREG | 31 43 | | | f DSZ | 31 33 | $\text{INT}(\frac{R_E}{10^5}) + R_{(i+1)} \rightarrow R_{(i+1)}$ |
| | 0 | 00 | | | RCL E | 34 15 | |
| | ENTER↑ | 41 | | 060 | g GSBfe | 32 22 15 | $10^5 \text{FRC}(R_D/10^5) + R_{(i+2)} \rightarrow R_{(i+2)}$ |
| | f LBL 3 | 31 25 03 | LOAD FIRST NUMBER | | STO+(i) | 33 61 24 | $\text{INT}(R_D/10^5) + R_{(i+2)} \rightarrow R_{(i+2)}$ |
| | h xzy | 35 52 | | | RCL D | 34 14 | |
| | R/S | 84 | | | g GSBfd | 32 22 14 | |
| | STO (i) | 33 24 | | | STO+(i) | 33 61 24 | |
| | f ISZ | 31 34 | | | f DSZ | 31 33 | |
| 010 | h RCI | 35 34 | | | RCL D | 34 14 | |
| | 5 | 05 | | | g GSBfe | 32 22 15 | |
| | g xzy | 32 81 | | | STO+(i) | 33 61 24 | |
| | GTO 3 | 22 03 | | | RCL C | 34 13 | $10^5 \text{FRC}(R_C/10^5) + R_{(i+2)} \rightarrow R_{(i+2)}$ |
| | 1 | 01 | INITIALIZE | 070 | g GSBfd | 32 22 14 | |
| | 0 | 00 | | | STO+(i) | 33 61 24 | |
| | f LBL 4 | 31 25 04 | | | f DSZ | 31 33 | |
| | - | 51 | | | RCL C | 34 13 | $\text{INT}(R_C/10^5) + R_{(i+3)} \rightarrow R_{(i+3)}$ |
| | 5 | 05 | LOAD SECOND NUMBER | | g GSBfe | 32 22 15 | |
| | + | 61 | | | STO+(i) | 33 61 24 | |
| 020 | CHS | 42 | | | RCL B | 34 12 | $10^5 \text{FRC}(R_B/10^5) + R_{(i+3)} \rightarrow R_{(i+3)}$ |
| | R/S | 84 | | | g GSBfd | 32 22 14 | |
| | STO (i) | 33 24 | | | STO+(i) | 33 61 24 | |
| | f ISZ | 31 34 | | | f DSZ | 31 33 | |
| | h RCI | 35 34 | | 080 | RCL B | 34 12 | $\text{INT}(R_B/10^5) + R_{(i+4)} \rightarrow R_{(i+4)}$ |
| | 1 | 01 | | | g GSBfe | 32 22 15 | |
| | 0 | 00 | | | STO+(i) | 33 61 24 | |
| | g xzy | 32 81 | | | RCL A | 34 11 | $10^5 \text{FRC}(R_A/10^5) + R_{(i+4)} \rightarrow R_{(i+4)}$ |
| | GTO 4 | 22 04 | | | g GSBfd | 32 22 14 | |
| | f PDS | 31 42 | INITIALIZE FOR MULTIPLICATION | | STO+(i) | 33 61 24 | |
| 030 | f CLREG | 31 43 | | | f DSZ | 31 33 | |
| | 5 | 05 | | | h SPC | 35 84 | $\text{INT}(R_A/10^5) + R_{(i+5)} \rightarrow R_{(i+5)}$ |
| | h STI | 35 33 | | | RCL A | 34 11 | |
| | f LBL 1 | 31 25 01 | PREPARE FOR SUMS | 090 | g GSBfe | 32 22 15 | |
| | f PDS | 31 42 | | | STO+(i) | 33 61 24 | $R_I + 1 \rightarrow R_I$ |
| | RCL (i) | 34 24 | | | f ISZ | 31 34 | (i.e. $R_I + 6 \rightarrow R_I$) |
| | RCL 0 | 34 00 | | | f ISZ | 31 34 | |
| | x | 71 | $b_I \cdot a_0 \rightarrow R_A$ | | f ISZ | 31 34 | |
| | STO A | 33 11 | | | f ISZ | 31 34 | |
| | RCL (i) | 34 24 | $b_I \cdot a_1 \rightarrow R_B$ | | f ISZ | 31 34 | |
| 040 | RCL 1 | 34 01 | | | f ISZ | 31 34 | |
| | x | 71 | | | h RCI | 35 34 | |
| | STO B | 33 12 | | | 1 | 01 | IF $R_I = 10$, THE MULTIPLICATION IS COMPLETE. IF NOT, GO BACK. |
| | RCL (i) | 34 24 | $b_I \cdot a_2 \rightarrow R_C$ | | 0 | 00 | |
| | RCL 2 | 34 02 | | 100 | g xzy | 32 81 | |
| | x | 71 | | | GTO 1 | 22 01 | |
| | STO C | 33 13 | | | 0 | 00 | INITIALIZE FOR CORRECTION |
| | RCL (i) | 34 24 | $b_I \cdot a_3 \rightarrow R_D$ | | h STI | 35 33 | |
| | RCL 3 | 34 03 | | | f LBL 0 | 31 25 00 | |
| | x | 71 | | | RCL (i) | 34 24 | |
| 050 | STO D | 33 14 | | | g GSBfd | 32 22 14 | IF ANY C _i HAS MORE THAN FIVE DIGITS, ADD THE EXTRA DIGITS TO C _{i+1} AND DROP THEM FROM C _i . |
| | RCL (i) | 34 24 | $b_I \cdot a_4 \rightarrow R_E$ | | ENTER↑ | 41 | |
| | RCL 4 | 34 04 | | | ENTER↑ | 41 | |
| | x | 71 | | | EEX | 43 | |
| | STO E | 33 15 | | 110 | 5 | 05 | |
| | f PDS | 31 42 | | | x | 71 | |
| | g GSBfd | 32 22 14 | | | STO-(i) | 33 51 24 | |

| REGISTERS | | | | | | | | | |
|-------------|-------------|-------------|-------------|-------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 0 C_0 | 1 C_1 | 2 C_2 | 3 C_3 | 4 C_4 | 5 C_5 | 6 C_6 | 7 C_7 | 8 C_8 | 9 C_9 |
| S0 a_0 | S1 a_1 | S2 a_2 | S3 a_3 | S4 a_4 | S5 b_0 | S6 b_1 | S7 b_2 | S8 b_3 | S9 b_4 |
| A USED | B USED | C USED | D USED | E USED | F REGISTER CONTROL | G REGISTER CONTROL | H REGISTER CONTROL | I REGISTER CONTROL | J REGISTER CONTROL |

