

# 04338D Program Description I

Program Title FAST COMBINATIONS, PERMUTATIONS, AND FACTORIALS

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Program Description, Equations, Variables THIS PROGRAM COMPUTES COMBINATIONS, PERMUTATIONS, AND FACTORIALS FOR POSITIVE INTEGERS UP TO AND INCLUDING  $10^{98}$ . AVERAGE ACCURACY IS SEVEN SIGNIFICANT DIGITS, AND AVERAGE RUN TIME IS LESS THAN NINE SECONDS. METHOD USED:

COMBINATIONS OF  $n$  ITEMS TAKEN  $r$  AT A TIME =  $C_r^n = \frac{n!}{r!(n-r)!}$

PERMUTATIONS OF  $n$  ITEMS TAKEN  $r$  AT A TIME =  $P_r^n = \frac{n!}{(n-r)!}$

FOR FACTORIALS, WHEN  $n \leq 69$  THE BUILT IN  $N!$  FUNCTION IS USED. WHEN  $n > 69$  THE FOLLOWING APPROXIMATION IS USED:

$$n! \cong \text{antilog} \left[ n \log \frac{n}{e} + \log \sqrt{2\pi n} + \log \left( 1 + \frac{1}{12n} \right) \right]$$

WHEN THE POWER OF TEN EXPONENT EXCEEDS  $10^{99}$  FOR THE RESULT, IT IS SHOWN SEPERATELY, AS THE SECOND NUMBER DISPLAYED.

Operating Limits and Warnings ONLY THE ABSOLUTE VALUE OF THE INTEGER PORTION OF  $n$  IS USED;  $n$  MUST BE LESS THAN OR EQUAL TO  $10^{98}$ . FOR COMBINATIONS AND PERMUTATIONS,  $r$  MUST BE LESS THAN OR EQUAL TO  $n$ . ACCURACY DETERIORATES WITH EXTREMELY LARGE NUMBERS.

NOTE: LABEL 4 IS USED TO GENERATE ERROR MESSAGE.

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 USING A STANDARD 52 CARD DECK, HOW MANY POSSIBLE HANDS COULD YOU RECEIVE IF YOU ARE DEALT 5 CARDS?

② IF A CYPHER LOCK USES A 4-DIGIT CODE TO OPEN A DOOR, AND THE NUMBERS 0 THROUGH 9 MAY BE USED IN ANY ORDER, HOW MANY UNIQUE CODES EXIST?

③ WHAT IS THE FACTORIAL OF 521?

Solution(s) ① SINCE THE ORDER IN WHICH YOU ARE DEALT YOUR 5 CARDS DOES NOT MATTER, WE COMPUTE THE POSSIBLE COMBINATIONS OF 52 ITEMS TAKEN 5 AT A TIME:  $\boxed{5} \boxed{2} \boxed{\text{ENTER} \uparrow} \boxed{5} \boxed{A} \rightarrow 2598960$

② SINCE THE ORDER OF THE NUMBERS MATTERS IN THIS CASE, WE COMPUTE THE PERMUTATIONS OF 10 ITEMS TAKEN 4 AT A TIME:  $\boxed{1} \boxed{0} \boxed{\text{ENTER} \uparrow} \boxed{4} \boxed{B} \rightarrow 5040$

③  $\boxed{5} \boxed{2} \boxed{1} \boxed{C} \rightarrow 9.1750 \rightarrow 1190$  WHICH MEANS  $9.1750 \times 10^{1190}$

Reference(s) VAN NOSTRAND'S SCIENTIFIC ENCYCLOPEDIA, FIFTH EDITION, PAGE 1733, VAN NOSTRAND REINHOLD COMPANY, 1976

## FAST COMBINATIONS, PERMUTATIONS, AND FACTORIALS

$$\boxed{(hp)} \quad n \uparrow r \rightarrow C_r^n \quad n \uparrow r \rightarrow P_r^n \quad n \rightarrow n!$$
[illegible]

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## Program Listing I

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| STEP | KEY ENTRY       | KEY CODE | COMMENTS    | STEP | KEY ENTRY      | KEY CODE | COMMENTS |
|------|-----------------|----------|-------------|------|----------------|----------|----------|
| 001  | *LBL C          | 31 25 13 | FACTORIAL   |      | ABS            | 35 64    |          |
|      | GSB 2           | 31 22 02 | COMMAND     |      | G              | 06       |          |
|      | STO 0           | 33 00    | ROUTINE     |      | 9              | 09       |          |
|      | GTO 0           | 22 00    |             | 060  | X $\neq$ Y     | 35 52    |          |
|      | *LBL B          | 31 25 12 |             |      | X > Y          | 32 81    |          |
|      | SF 2            | 35 51 02 | COMBINATION |      | GTO 3          | 22 03    |          |
|      | *LBL A          | 31 25 11 | OR          |      | N!             | 35 81    |          |
|      | X > Y           | 32 81    | PERMUTATION |      | LOG            | 31 53    |          |
|      | GTO 4           | 22 04    |             |      | RTN            | 35 22    |          |
| 010  | STO 1           | 33 01    | COMMAND     |      | *LBL 3         | 31 25 03 |          |
|      | R $\downarrow$  | 35 53    | ROUTINE     |      | EEX            | 43       |          |
|      | GSB 2           | 31 22 02 |             |      | e <sup>x</sup> | 32 52    |          |
|      | STO 0           | 33 00    |             |      | $\div$         | 81       |          |
|      | RCL 2           | 34 02    |             | 070  | LOG            | 31 53    |          |
|      | RCL 1           | 34 01    |             |      | RCL 2          | 34 02    |          |
|      | -               | 51       |             |      | X              | 71       |          |
|      | GSB 2           | 31 22 02 |             |      | TT             | 35 73    |          |
|      | STO - 0         | 33 51 00 |             |      | Z              | 02       |          |
|      | F? 2            | 35 71 02 |             |      | X              | 71       |          |
| 020  | GTO 0           | 22 00    |             |      | RCL 2          | 34 02    |          |
|      | RCL 1           | 34 01    |             |      | X              | 71       |          |
|      | GSB 2           | 31 22 02 |             |      | $\sqrt{x}$     | 31 54    |          |
|      | STO - 0         | 33 51 00 |             |      | LOG            | 31 53    |          |
|      | *LBL 0          | 31 25 00 |             | 080  | +              | 61       |          |
|      | RCL 0           | 34 00    | DISPLAY     |      | RCL 2          | 34 02    |          |
|      | INT             | 31 83    | ROUTINE     |      | 1              | 01       |          |
|      | 9               | 09       |             |      | Z              | 02       |          |
|      | 9               | 09       |             |      | X              | 71       |          |
|      | X $\neq$ Y      | 35 52    |             |      | 1/x            | 35 62    |          |
| 030  | X > Y           | 32 81    |             |      | EEX            | 43       |          |
|      | GTO 1           | 22 01    |             |      | +              | 61       |          |
|      | RCL 0           | 34 00    |             |      | LOG            | 31 53    |          |
|      | 10 <sup>x</sup> | 32 53    |             |      | +              | 61       |          |
|      | DSP 0           | 23 00    |             | 090  | RTN            | 35 22    | END      |
|      | -x-             | 31 84    |             |      |                |          |          |
|      | RTN             | 35 22    |             |      |                |          |          |
|      | *LBL 1          | 31 25 01 |             |      |                |          |          |
|      | RCL 0           | 34 00    |             |      |                |          |          |
|      | FRAC            | 32 83    |             |      |                |          |          |
| 040  | 10 <sup>x</sup> | 32 53    |             |      |                |          |          |
|      | DSP 4           | 23 04    |             |      |                |          |          |
|      | -x-             | 31 84    |             |      |                |          |          |
|      | RCL 0           | 34 00    |             |      |                |          |          |
|      | INT             | 31 83    |             | 100  |                |          |          |
|      | DSP 0           | 23 00    |             |      |                |          |          |
|      | -x-             | 31 84    |             |      |                |          |          |
|      | RTN             | 35 22    |             |      |                |          |          |
|      | *LBL 2          | 31 25 02 | FACTORIAL   |      |                |          |          |
|      | STO 2           | 33 02    | SUBROUTINE  |      |                |          |          |
| 050  | EEX             | 43       |             |      |                |          |          |
|      | 9               | 09       |             |      |                |          |          |
|      | 8               | 08       |             |      |                |          |          |
|      | X $\neq$ Y      | 35 52    |             |      |                |          |          |
|      | X > Y           | 32 81    |             | 110  |                |          |          |
|      | GTO 4           | 22 04    |             |      |                |          |          |
|      | INT             | 31 83    |             |      |                |          |          |

## REGISTERS

|      |    |      |    |    |    |    |    |    |    |
|------|----|------|----|----|----|----|----|----|----|
| 0    | 1  | 2    | 3  | 4  | 5  | 6  | 7  | 8  | 9  |
| USED | r  | USED |    |    |    |    |    |    |    |
| S0   | S1 | S2   | S3 | S4 | S5 | S6 | S7 | S8 | S9 |
| A    | B  | C    | D  | E  | I  |    |    |    |    |

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LIBRARY KEY CODE

[illegible]