1. LARGE FACTORIALS TO 8 PLACES BY: BILL BARRETT #1514

2. _____ BY: _____

LARGE FACTORIALS TO 8 PLACES

67

n! | RCL n | % n! | EXPON.

STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Read both sides of Card			
2	Input n for n! to 8 + places	n	A	n! Char.
3	Find exponent for n!		B	exponent
4	Recall n after computing n!		B	n
5	Calculate approximate n!	n	D	n! Char.
6	Find exponent forn!		E	exponent

Note: in either (2) or (5), n can vary from 1 to $1x10^{98}$.

*(For n between 1 and 69, program uses n! in calculator)

Approximate times to compute n! using step (2):

n	Time to Find n!
100	24 sec.
200	1 min. 23 sec.
500	4 min. 19 sec.
1000	10 min. 14 sec.
10,000	1 hr. 56 min.
1,000,000	197 hrs.

Values Calculated

n	HP 67 n!	Correct n!
100	$9.332621554x10^{157}$	$9.332621544x10^{157}$
1000	$4.023872616x10^{2567}$	$4.023872601x10^{2567}$
10,000	$2.846259718x10^{35659}$	??
100,000	$2.824229458x10^{456573}$	??

n! program works by stripping exponent from 69! and multiplying by 70, 71, etc. to n, removing the exponent whenever the resulting product reaches $1x10^{99}$ in value. Thus it prevents an over-run. Exponent found using log of my modification of Stirling's approximation for large n!. Approximate n! also uses the approximation formula: $n! \approx (1+\frac{1}{12n-0.7})(\frac{n}{e})^n(2\pi n)^{\frac{1}{2}}$ This yields n! of at least 6 place accuracy for n between 70and 2000, to 4 places at n=10,000.

Labels

A	B	C	D	E
n!	RCL n		% n!	EXP
a	b	c	d	e
0 x	1 x	2 x	3	4
5 x	6 x	7	8	9

Flag Set Status

0	1	2	3
OFF	OFF	OFF	OFF

Registers

0 x	1 x	2	3 x	4 x
5 x	6 x	7	8 x	9 x

0	1	2	3	4
5	6	7	8	9

A	B	C	D	E	I
					x

LARGE FACTORIALS TO 8 PLACES PROGRAM

001	*LBL A	21 11	039	STO B	22 05	077	RTN	24			
002	STO 4	35 04	040	STO I	22 45	078	*LBL B	21 00			
003	DSP 9	-63 25	041	*LBL 5	21 05	079	RCL 4	36 04			
004	EEX	-23	042	RCL 9	36 09	080	P-I	16-24			
005	9	09	043	ST+ 3	35-24 03	081	x	-35			
006	3	03	044	STO 1	22 01	082	2	02			
007	STO 9	35 09	045	*LBL 2	21 02	083	x	-35			
008	RCL 4	36 04	046	RCL 4	36 04	084	LOG	16 32			
009	6	06	047	N!	16 52	085	2	02			
010	9	09	048	RTN	24	086	+	-24			
011	STO 1	35 01	049	*LBL 6	21 06	087	1	01			
012	X≷Y	-41	050	RCL 3	36 03	088	e^x	33			
013	X≤Y?	16-35	051	ENT↑	-21	089	RCL 4	36 04			
014	STO 2	22 02	052	LOG	16 32	090	+	-24			
015	RCL 1	36 01	053	INT	16 34	091	1/X	32			
016	N!	16 52	054	10^x	16 33	092	LOG	16 32			
017	EEX	-23	055	+	-24	093	RCL 4	36 04			
018	9	09	056	STO 5	35 05	094	x	-35			
019	8	08	057	GSB 0	23 00	095	+	-35			
020	+	-24	058	STO 8	35 08	096	RCL 4	36 04			
021	STO 3	35 03	059	INT	16 34	097	ENT↑	-21			
022	RCL 1	36 01	060	STO 6	35 06	098	1	01			
023	STO 8	35 08	061	RCL 5	36 05	099	2	02			
024	1	01	062	RTN	24	100	x	-35			
025	1	01	063	*LBL E	21 15	101	.	-62			
026	CHS	-22	064	RCL 6	36 06	102	7	07			
027	STO I	35 46	065	DSP 0	-63 00	103	-	-45			
028	*LBL 1	21 01	066	RTN	24	104	1/X	32			
029	1	01	067	*LBL D	21 14	105	1	01			
030	ST+ 0	35-55 00	068	STO 4	35 04	106	+	-55			
031	RCL 0	36 00	069	DSP 9	-63 09	107	LOG	16 32			
032	ST× 3	35-35 03	070	GSB 0	23 00	108	+	-55			
033	RCL 4	36 04	071	STO 8	35 08	109	RTN	24			
034	X=Y?	16-33	072	INT	16 34	110	*LBL B	21 12			
035	GTO 6	22 06	073	STO 6	35 06	111	RCL 4	36 04			
036	RCL 3	36 03	074	RCL 8	36 08	112	RTN	24			
037	RCL 9	36 09	075	FRC	16 44	113	R/S	51			
038	X≤Y?	16-35	076	10^x	16 33						

HP HOCUS POCUS

R/S

Imagine being shown a deck of ordinary palying cards. You fan them out and remove the Jokers. There is no apparent order to the deck but you cut the cards several times anyway and riffle-shuffle once or twice using your best "water-fall" flourish to square up the cards again. The cards are now divided into two nearly equal piles. You remove a card from the middle of one pile, memorize it, and place it in the middle of the opposite pile. Set either one of the two piles aside since it won't be needed. Cut the remaining pile several times and shuffle it again to be certain the cards are well mixed. You proceed to enter the value and suit of each card from the chosen pile on your calculator. When you press R/S, the calculator will concentrate intently for a few moments and display the card you selected.

Perhaps you would like the following variation even more. After the cards are cut several times and riffle-shuffled once, you divide the deck into a small and a large pile. The small pile contains a dozen or so cards. You remove a card from the small pile and place it, sight unseen, in your pocket. Now select a card from the middle of the large pile. Memorize it and place it in the middle of the small pile. Thoroughly shuffle the small pile and enter the value and suit of each card on the calculator. After a few seconds, the calculator will display the selected card. When you are ready to continue, press R/S again. This time the calculator will predict the unknown card in your pocket!

Sounds impossible? Both of these feats are easy with the Impossible Discovery program described here. The original version of this program was first published in V3N3 of "65 NOTES." A major drawback of that program was that it required a deck of 48 numbered cards such as those found in a game called "RACK-O." A playing card version was subsequently created and published under the title "Impossible Discovery II" and may be obtained from the HP-65 Users Library (#04746A). The program described here is the result of many requests for a version that would run on the HP-67 or HP-97. It features a number of improvements over the previous versions such as: faster data entry, faster execution time, the entire program is contained on a single magnetic card, the last card entered can be recalled or deleted, and the program discovers two cards and not just one.

In order to perform the trick, you must arrange the cards beforehand in a predetermined order. The best way to accomplish this is to divide the cards into four suits. Arrange each suit in ascending order by counting off the cards, face up, starting with the Ace and ending with the King. After the suits are arranged, cut the Spades so that the 3 is on top. Cut the Hearts, Clubs and Diamonds so that the 6, 9 and Queen respectively are on top. Now pick up the top card from each pile in rotation, placing it face down in your left hand. Mentally check yourself by adding

three to the previous card and always pick up the cards in the same order: Spades, Hearts, Clubs, Diamonds. When you are finished, the order of the face down cards from the bottom of the deck to the top should be 3S, 6H, 9C, QD, 2S, 5H, etc. Put the two Jokers on top if you have them.

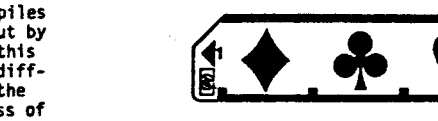
The presentation of the trick has already been described. There are a few limitations, however, you must keep in mind to be successful. First, only simple cuts are permitted. You may avoid false cuts by asking the spectator to cut the deck into two piles at the start. Once this is done, tell him to complete the cut by placing one pile on the other. Tell him that he may repeat this process a time or two if he desires. Actually, it makes no difference how many times he does this. The riffle-shuffle, on the other hand, introduces a measure of uncertainty to the process of finding the selected cards. The chance of a mis-calculation is minimized by: 1) restricting the spectator to one riffle-shuffle, 2) having sufficient cards in each pile, and 3) selecting a card close to the middle of the pile. Under ideal circumstances, the trick can be performed with as few as five or six cards and the card may be as close as third from the end. With two riffle-shuffles, it is essential that the deck be divided into nearly equal piles and that cards near the center be selected. The probability of finding the selected cards decreases if the shuffling is sloppy. With two "average" shuffles, you have about a 70 percent chance of getting both cards.

Entering cards on the calculator is easy. First load both sides of the magnetic card and press R/S to initialize the program. Press the digit corresponding to the value of the card (Ace=1, Jack=11, Queen=12, King=13) and then press "A" for Diamonds, "B" for Clubs, "C" for Hearts, or "D" for Spades. To reduce the chance of error, use a small piece of gummed typewriter correction tape over the -, + and x keys. Relabel these keys Jack, King and Queen, respectively. The calculator will now automatically produce the correct value when the appropriate key is pressed. Also note that it is not necessary to press "1" for an Ace; in this case, simply press the key corresponding to the suit.

If you make a mistake or can't remember the last card entered, press "E" and the display will briefly show the value and suit of the last card entered. The value is displayed to the left of the decimal point and the suit is displayed to the right according to the scheme: Diamonds=.01, Clubs=.02, Hearts=.03, and Spade=.04. This is easy to remember since it is the same order as the suit entry keys. You may delete the last card, if it is incorrect, by pressing "f" and then "e." When all of the cards are entered, press R/S to obtain one of the selected cards. If the card is among those read in, a positive value is displayed. A negative value, on the other hand, indicates that the card in the display is not among those read in, i.e., in the pocket or the other pile.

There are several things you should keep in mind that will enhance your presentation. At no time should you ever see the selected cards. This will remove suspicion that you are in any way helping the calculator. It also helps if you let the spectator enter the cards on the calculator. As with any trick, the presentation should be practiced several times to be sure that you understand and remember the directions, and that you have the cards arranged properly. You may also want to work out a patter to go with the trick. Perhaps something about automation taking over magic or how you and the HP-67 are going to beat the odds at Vegas. You should emphasize whatever aspects of the trick impress you the most. For example the fact that the cards are completely mixed up when they are read in, that the calculator doesn't know whether the selected card is among those read in or not, or that you've only given the calculator about a dozen cards out of the whole deck. You may also want to have a second deck prepared in your coat pocket in case someone insists that you do it again. In this eventuality, you want everyone to be convinced that the cards are in complete disarray when you begin the second time. You can help create this impression by idly shuffling the first deck while the cards are being picked up and the trick is being discussed. Make a production of this by spilling a few cards or exaggerating the shuffle as you describe how well the cards were mixed. Insist that the HP-67 never repeats a trick and pocket the first deck. Make up some excuses about it being too much strain on the batteries and the logic having to cool down before you reluctantly agree to do it again. This time produce the second deck from the same pocket. You may also want to do the handling yourself to avoid any mischief. Explain that you will do things just the same way in slow-motion so that everyone can follow what is happening. Better yet, you should actually demonstrate the other variation to add a slightly different twist to the mystery.

Inevitably people will want to know how it works. Unless you have really done your homework, the best response is an honest "I don't know." I usually tell everyone that it was a lucky guess or that it's actually magic and leave it at that. For an explanation, though, you should read "Mathematics, Magic and Mystery" by Martin Gardner, available from Dover Publications (T335). The original trick was created by Charles Jordan and called Magic by Mail because the selected card was literally determined through the mail. The computerized version described here is considerably faster and avoids much of the work involved. In a future article, I will tell you how to add another amazing card discovery to this program. In the meantime, you can enjoy demonstrating the marvelous power of your HP-67 to your friends. Keep the secret. W.M.KOLB (265)



001	CLRG	16-53	061	X≠Y?	16-32	121	*LBL5	21 05
002	.	-62	062	SF2	16 21 02	122	CF8	16 22 08
003	5	05	063	LSTX	16-63	123	RCLC	36 13
004	STO2	35 02	064	INT	16 34	124	×	-35
005	2	02	065	ISZI	16 26 46	125	X≠Y	-41
006	STO4	35 11	066	GTO3	22 03	126	RCLB	36 12
007	4	04	067	R↓	-31	127	×	-35
008	STOB	35 12	068	RCL1	36 01	128	+	-55
009	1	01	069	GTO3	22 03	129	RCLE	36 15
010	3	03	070	*LBL4	21 04	130	+	-24
011	STOC	35 13	071	X≠0?	16-42	131	FRC	16 44
012	ENT↑	-21	072	SF2	16 21 02	132	RCLE	36 15
013	+	-55	073	LSTX	16-63	133	×	-35
014	STOD	35 14	074	STO0	35 00	134	RND	16 24
015	ENT↑	-21	075	2	02	135	STO3	35 03
016	+	-55	076	5	05	136	EEX	-23
017	STOE	35 15	077	RCL1	36 46	137	X≠Y	-41
018	CF1	16 22 01	078	+	-55	138	X=0?	16-43
019	CLX	-51	079	GSB6	23 16 12	139	SF1	16 21 01
020	STO0	35 00	080	F2?	16 23 02	140	X=Y?	16-33
021	STO1	35 01	081	CHS	-22	141	SF2	16 21 02
022	*LBL1	21 01	082	R/S	51	142	RCLA	36 11
023	DSP0	-63 00	083	GTO4	22 16 11	143	X≠Y	-41
024	*LBL2	21 02	084	*LBL6	21 16 12	144	RCLD	36 14
025	1	01	085	STO3	35 03	145	X>Y?	16-34
026	2	02	086	EEX	-23	146	SF0	16 21 00
027	ENT↑	-21	087	X≠Y	-41	147	F0?	16 23 00
028	EEX	-23	088	3	03	148	CLX	-51
029	R/S	51	089	×	-35	149	-	-45
030	RCLD	36 14	090	RCLC	36 13	150	Y^	31
031	CHS	-22	091	+	-24	151	STO4	35 04
032	X≥1	16-41	092	FRC	16 44	152	F0?	16 23 00
033	STO6	35 06	093	-	-45	153	ST+0	35-55 00
034	DSZI	16 25 46	094	RCLC	36 13	154	F0?	16 23 00
035	RCLA	36 11	095	×	-35	155	CLX	-51
036	RCLD	36 14	096	RCL3	36 03	156	ST+1	35-55 01
037	Y^	31	097	RCLB	36 12	157	ISZI	16 26 46
038	F1?	16 23 01	098	+	-24	158	GTO2	22 02
039	ST+1	35-55 01	099	FRC	16 44	159	*LBLE	21 15
040	ENT↑	-21	100	RCLB	36 12	160	RCL3	36 03
041	+	-55	101	×	-35	161	GSB6	23 16 12
042	F2?	16 23 02	102	EEX	-23	162	FSE	16 51
043	ST+1	35-55 01	103	+	-55	163	GTO1	22 01
044	*LBL6	21 16 11	104	EEX	-23	164	*LBLE	21 16 15
045	RCL1	36 01	105	2	02	165	RCL4	36 04
046	ISZI	16 26 46	106	+	-24	166	F0?	16 23 00
047	RCL0	36 00	107	+	-55	167	ST-0	35-45 00
048	STO0	35 00	108	DSP2	-63 02	168	F0?	16 23 00
049	RCL2	36 02	109	RTN	24	169	CLX	-51
050	×	-35	110	*LBLA	21 11	170	ST-1	35-45 01
051	FRC	16 44	111	RCL5	36 05	171	RCL3	36 03
052	RCL0	36 00	112	GTO5	22 05	172	X=0?	16-43
053	*LBL3	21 03	113	*LBLB	21 12	173	CF1	16 22 01
054	RCL2	36 02	114	EEX	-23	174	EEX	-23
055	λ	-35	115	GTO5	22 05	175	X≠Y?	16-33
056	FRC	16 44	116	*LBLC	21 13	176	CF2	16 22 02
057	F2?	16 23 02	117	RCLA	36 11	177	DSZI	16 25 46
058	X≠Y?	16-33	118	GTO5	22 05	178	GTO2	22 02
059	F2?	16 23 02	119	*LBLD	21 14	179	GTO2	22 02
060	GTO4	22 04	120	3	03	180	R/S	51

R/S

LARGE FACTORIALS, PERMUTATIONS & COMBINATIONS

This program is based on Jim Davidson's (547) HP-25 program for large n factorials in V5N2P24. It is quite reliable for at least 8 digit accuracy, tho firmware and approximation formulas may be more accurate in the range of applicability of each of them. This program makes it possible to go well beyond the hardware limit of dynamic range, however.

Record the card in Display FIX 0 mode. The program will print the arguments and answer on the HP-97. The Print commands should be deleted for the HP-67. Answers are printed in scientific notation: mantissa on one line, exponent of ten on following line.

User Instructions:

1. For factorial n: Key n; key A
   Machine prints: n; mantissa; exponent.
2. For permutation of m things taken n at a time:
   Key: m, Enter, n, B(Printout as above.)
3. For combination of m things taken n at a time:
   Key: m, Enter, n, C