Program Title CHESS - THE EIGHT QUEENS PROBLEM

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Program Description, Equations, Variables It is possible to place eight queens on a chessboard in such a way that no queen attacks another. In fact, there are 92 ways that this can be done. However, there are twelve distinct solutions, the other 80 can be derived by rotating and/or reflecting the twelve distinct solutions. This program will find all twelve distinct solutions. On an HP-97 they will be listed. The solutions are also stored in the data registers for easy retrieval, even on the HP-67. They will be in R_{10} through R_{21} ($R_{80} - R_{89}$, R_A and R_B).

The method used is a sequential search. Working a row at a time, a queen is placed on the first square, and checks are made down, down and left, and down and right, to see whether it attacks

(next page, please)

Necessary Accessories None required

Operating Limits and Warnings The program requires about eight hours to find all twelve solutions.

Reference(s) Winslow, David "Eight Queen Problem" PPC Journal V6N1P22-23. PPC Journal is the newsletter of the PPC, an independent HP users' group. Information can be obtained from: Richard Nelson; 2541 W. Camden Pl.; Santa Ana, Calif. 92704.

a queen placed previously. If not, the search goes to the next row up, until all eight rows are done. If an attack is found, the queen is moved one square to the left. If it cannot be moved left, the procedure backs down one row.

When a possible solution is found, it is checked against a list of previously found distinct solutions. Also, its seven rotations and mirror-images are also checked. If no match is found, it is added to the list, and the search continues until twelve solutions are found.

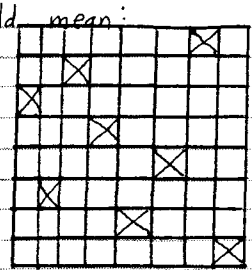
Each solution is given as an eight-digit number $n_1 n_2 n_3 n_4 n_5 n_6 n_7 n_8$.

n_i means a queen on the n_i^{th} square of the i^{th} row.

The sequence 73146258 would mean:

1st row, 7th square
2nd row, 3rd square
3rd row, 1st square
4th row, 4th square
5th row, 6th square
6th row, 2nd square
7th row, 5th square
8th row, 8th square

OR



NOTE:
This is not a solution; you didn't expect me to give you one, did you?

About one hour is required for the first solution, the entire list requires about eight hours.

If you do not have the time (or patience) for a complete list at one sitting, the following procedure may be used:

(1) Stop the program when a solution (not solution number) is being printed.
(2) Record a data card. (Press W/DATA and feed in both sides of a blank card)

To continue:

(3) Load program (both sides).
(4) Load data card from step 2 (both sides)
(5) Press GSB Ø.

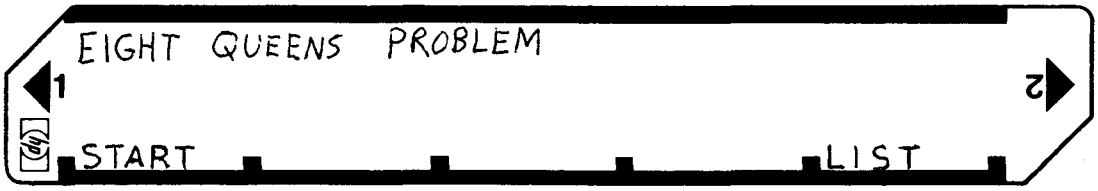
PROGRAM DESCRIPTION II

Sample Problem (Sketch if Desired)

SOLUTION:

Input	Function	Display	Comments
	A		Begin execution
		Solution number ***	} This is repeated for
		Solution ***	} twelve solutions.
			Optional: List solutions
	E	Solution 1	
		...	
		Solution 12	12 solutions followed by 4 addional numbers
			or Review solutions
	P≷S		
	RCL n	Solution # n+1	for $0 \leq n \leq 9$
	RCL A	Solution # 11	
	RCL B	Solution # 12	

User Instructions



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1	Load Program (Both sides)			
2	Execute		A	
	Output follows automatically:			
	Solution number (1 ≤ soln # ≤ 12)			Soln # ***
	Solution			Soln ***
	Program halts after the twelfth solution			
	(about eight hours)			
	Optional: list solutions:		E	Soln 1
	A "print registers" command is used, so			Soln 2
	the 12 solutions will be followed by			•••
	4 more numbers. The extra numbers should			Soln 12
	be disregarded.			

Program Listing I

STEP	KEY ENTRY	KEY CODE	COMMENTS
001	*LBLA	21 11	START
002	CLRG	16-53	
003	8	08	
004	STO1	35 01	
005	EEX	-23	EEX is faster than 1.
006	STO0	35 00	
007	EEX	-23	
008	1	01	
009	STOE	35 15	
010	SPC	16-11	
011	*LBL1	21 01	
012	EEX	-23	
013	ST+0	35-55 00	
014	8	08	
015	STO9	35 09	
016	RCL0	36 00	
017	9	09	
018	X=Y?	16-33	Feasible solution?
019	GTOD	22 14	Yes, check distinctiveness.
020	*LBL2	21 02	No, keep trying.
021	RCL0	36 00	
022	STOI	35 46	
023	RCL9	36 09	
024	STOD	35 14	
025	*LBL3	21 03	
026	DSZI	16 25 46	
027	GTO5	22 05	
028	RCL0	36 00	
029	STOI	35 46	
030	RCL9	36 09	
031	STOD	35 14	
032	*LBL4	21 04	
033	DSZI	16 25 46	
034	GTO6	22 06	
035	GTO7	22 07	
036	*LBL5	21 05	
037	RCLi	36 45	
038	RCL9	36 09	
039	X≠Y?	16-32	
040	GTO3	22 03	
041	GTO5	22 05	
042	*LBL6	21 06	
043	EEX	-23	
044	ST+9	35-55 09	
045	9	09	
046	RCL9	36 09	
047	X=Y?	16-33	
048	GTO7	22 07	
049	RCLi	36 45	
050	X≠Y?	16-32	
051	GTO4	22 04	
052	GTO5	22 05	
053	*LBL7	21 07	
054	RCL0	36 00	
055	STOI	35 46	
056	RCLD	36 14	
057	STO9	35 09	
058	*LBL8	21 08	
059	DSZI	16 25 46	Decrement skip on non-zero (i is always ≥ 0)
060	X<0?	16-45	
061	GTO6	22 06	
062	EEX	-23	
063	ST-9	35-45 09	
064	RCL9	36 09	
065	X=0?	16-43	
066	GTO6	22 06	
067	RCLi	36 45	
068	X≠Y?	16-32	
069	GTO8	22 08	
070	*LBL5	21 05	
071	CF0	16 22 00	
072	GTO7	22 07	
073	*LBL6	21 06	
074	SF0	16 21 00	
075	*LBL7	21 07	
076	RCLD	36 14	
077	STO9	35 09	
078	F0?	16 23 00	
079	GTO5	22 05	
080	*LBL9	21 09	
081	EEX	-23	
082	ST-9	35-45 09	
083	RCL9	36 09	
084	X≠0?	16-42	
085	GTO2	22 02	
086	*LBL0	21 00	Entry point for next solution.
087	EEX	-23	
088	ST-0	35-45 00	
089	RCL0	36 00	
090	STOI	35 46	
091	RCLi	36 45	
092	STO9	35 09	
093	ST-i	35-45 45	
094	GTO9	22 09	
095	*LBL5	21 05	
096	RCL0	36 00	
097	STOI	35 46	
098	RCL9	36 09	
099	ST+i	35-55 45	
100	GTO1	22 01	
101	*LBLD	21 14	A solution has been found. Check all rotations and reflections.
102	8	08	
103	STOI	35 46	
104	CLX	-51	
105	*LBLa	21 16 11	
106	RCLI	36 46	
107	RCLi	36 45	
108	EEX	-23	
109	-	-45	
110	10^x	16 33	
111	x	-35	
112	+	-55	

REGISTERS

0	1	2	3	4	5	6	7	8	9
USED	Row_1	Row_2	Row_3	Row_4	Row_5	Row_6	Row_7	Row_8	USED
S0	S1	S2	S3	S4 SOLUTIONS	S5	S6	S7	S8	S9

A	B	C	D	E	I
SOLUTIONS			USED	SOLUTION COUNTER	INDIRECT

STEP	KEY ENTRY	KEY CODE	COMMENTS
113	DSZI	16 25 46	
114	GTOa	22 16 11	
115	GSBB	23 12	
116	F2?	16 23 02	
117	GTO0	22 00	
118	GSBe	23 16 15	
119	F2?	16 23 02	
120	GTO0	22 00	
121	8	08	
122	STOI	35 46	
123	CLX	-51	
124	*LBLb	21 16 12	
125	RCLI	36 46	
126	8	08	
127	RCLi	36 45	
128	-	-45	
129	10^x	16 33	
130	x	-35	
131	+	-55	
132	DSZI	16 25 46	
133	GTOb	22 16 12	
134	GSBB	23 12	
135	F2?	16 23 02	
136	GTO0	22 00	
137	GSBe	23 16 15	
138	F2?	16 23 02	
139	GTO0	22 00	
140	8	08	
141	STOI	35 46	
142	CLX	-51	
143	*LBLc	21 16 13	
144	RCLi	36 45	
145	RCLI	36 46	
146	EEX	-23	
147	-	-45	
148	10^x	16 33	
149	x	-35	
150	+	-55	
151	DSZI	16 25 46	
152	GTOc	22 16 13	
153	GSBB	23 12	
154	F2?	16 23 02	
155	GTO0	22 00	
156	GSBe	23 16 15	
157	F2?	16 23 02	
158	GTO0	22 00	
159	8	08	
160	STOI	35 46	
161	CLX	-51	
162	*LBLd	21 16 14	
163	RCLi	36 45	
164	8	08	
165	RCLI	36 46	
166	-	-45	
167	10^x	16 33	
168	x	-35	
169	+	-55	
170	DSZI	16 25 46	
171	GTOd	22 16 14	
172	GSBB	23 12	
173	F2?	16 23 02	
174	GTO0	22 00	
175	GSBe	23 16 15	
176	F2?	16 23 02	
177	GTO0	22 00	
178	RCLE	36 15	A distinct solution has been found.
179	STOI	35 46	
180	EEX	-23	Increment solution counter.
181	+	-55	
182	STOE	35 15	
183	EEX	-23	
184	1	01	
185	-	-45	
186	PRTX	-14	Solution number.
187	RCL9	36 09	
188	STOi	35 45	
189	PRTX	-14	Solution.
190	CLX	-51	
191	1	01	
192	2	02	
193	SPC	16-11	
194	X≠Y?	16-32	Last distinct solution?
195	GTO0	22 00	No, go to search program.
196	RTN	24	Yes, stop.
197	*LBLe	21 16 15	Derive reflection
198	EEX	-23	
199	8	08	
200	RCL9	36 09	
201	-	-45	
202	EEX	-23	
203	-	-45	
204	*LBLB	21 12	Check for distinctiveness
205	STO9	35 09	
206	9	09	
207	STOI	35 46	
208	*LBLC	21 13	
209	ISZI	16 26 46	
210	RCLI	36 46	
211	RCLE	36 15	
212	X=Y?	16-33	
213	RTN	24	
214	RCL9	36 09	
215	RCLi	36 45	
216	X≠Y?	16-32	
217	GTOC	22 13	
218	SF2	16 21 02	
219	RTN	24	
220	*LBLE	21 15	LIST Solutions
221	P≠S	16-51	
222	PREG	16-13	
223	P≠S	16-51	
224	RTN	24	

LABELS

A START	B Distinctiveness check	C Used	D Rotate and Reflect	E LIST	0 USED
a used	b used	c used	d Used	e Reflect	1
0 Next solution	1 used	2 used	3 used	4 used	2 USED
5 used	6 used	7 used	8 used	9 used	3

FLAGS

	ON	OFF
0	☐	☒
1	☐	☒
2	☐	☒
3	☐	☒

SET STATUS

TRIG		DISP	
DEG	☒	FIX	☒
GRAD	☐	SCI	☐
RAD	☐	ENG	☐
		n	0