

01532 D

Program Description I

Program Title MOON LANDER WITH UNINTERRUPTABLE CONTINUOUS COUNTDOWN

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Program Description, Equations, Variables

This version of the moon lander replaces the pausing countdown of Standard Pac program #14 A with a continuous countdown during which all keyboard functions are locked out. If you wish, you can delete the countdown entirely and have the calculator blank out for several seconds before it asks for your burn.

You can record this program over your "protected" standard pac card but will need an additional half a card for data.

This program also has an onboard computer that provides advice on landing. The program also corrects errors in the standard pac program.

THE COUNTER To make counters, you must generate non-normalized numbers. The information below about non-normalized numbers and program overwriting is taken from the Personal Programmable Calculator Club Journal. If you want to know more about these and other tricks, write to the PPC Club at 2541 W Camden Place, Santa Ana, California 92704.

Key in the following program, taking care to put the steps at the indicated program lines.

001 FLBL A 31 25 11

002 GTO A 22 11

216 FLBL A 31 25 11

217 FGSO B 31 22 12

222 FLBL B 31 25 12

223 gMERGE 32 41

224 h PAUSE 35 72

(NOTE: To enter step
216, press:
GTO · 215
then key it in)

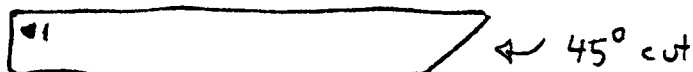
Switch to run and have any two sided program on SIDE 2, ready

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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to push into the reader. (This program will not be overwritten or damaged.) Press **[A]** and push the prerecorded card in at the first pause in the program. The display will show Error after reading the card, so key **[CLX]** and see 10.00 in the display. Key in .000222211 then press **[+]** and see 10.00 in the display. Then do **STO 0 500 STO 1 50 [CHS] STO 2 60 STO 3**. Now also press **[Σ+]** (so the data card you record will ask for another card whenever it is read.) Now press **f w/DATA** and record only the first side of the magnetic card. Press **CLX** to clear the display.

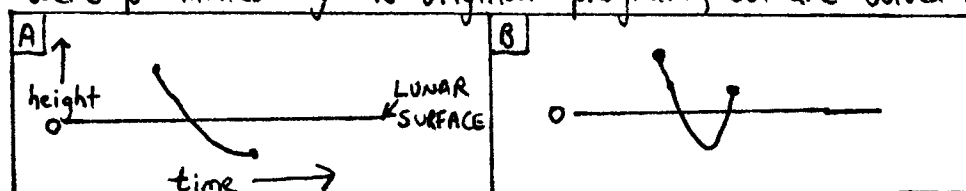
OVERWRITING Before keying in the moon lander program, practice overwriting on "protected" magnetic cards. Make a "correction card" that looks like the one below:



Insert the card into the left side of the calculator as far as it will go. Switch the calculator to **w/PRGM** and enter the "protected" card you want to overwrite, in the normal fashion for recording.

THE CORRECTIONS The version of this game in the standard pac lets you fly through solid rock as part of your "perfect landing". The following maneuvers were permitted by the original program, but are solved correctly here.

FIGURE 1



The corrected program recognizes these as crashes, and gives the correct impact velocity. The basic algorithm is taken from the standard pac version, but the following tests are made: 1) Was the landing underground? (figure 1A), and 2) If you are going up, would you have crashed in the last second? (figure 1B).

THE EQUATIONS

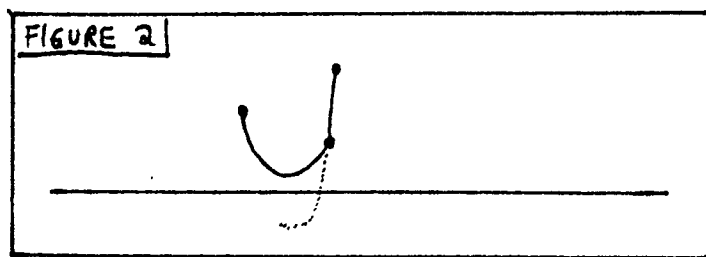
$$a = 2b - g \quad (1)$$

$$V = at + V_0 \quad (2)$$

$$X = \frac{1}{2}at^2 + V_0t + X_0 \quad (3)$$

If a crash may have occurred, the program solves equation 3 for time of impact, with $X_{\text{impact}} = 0$ and $V_0 = V - a$ and $X_0 = X - \frac{a}{2} - V_0 = X + \frac{a}{2} - V$. Using equation 2, V_{impact} is calculated to be $-\sqrt{V^2 - 2ax}$.

Program steps 86-99 are to allow cases such as in figure 2. You have escaped hitting the surface, but later find yourself on a parabola that has real roots.



As long as the parabola you are on hasn't intersected with the surface in the last second, you are OK. (I.e. $|t_{\text{impact}}| > 1$)

THE AUTOMATIC PILOT Instead of inputting a burn when "0." is flashed, you can ask for advice on landing by pressing [C]. You get the following information:

$b = \text{Burn}$ (the constant burn per turn needed to land at zero velocity)
 $= \frac{1}{2} (g + V_0^2 / 2 X_0)$

$T = \text{Time}$ (number of such burns)
 $= -2 X_0 / V_0$

Fuel needed = Burn $\times$ Time

The equations are derived from equations (1), (2) and (3) with $V = 0$ and $X = 0$.

NOTE: This does not necessarily give the most efficient way to land. It gives the correct burn assuming a constant burn for the rest of the landing.

WARNING: The machine only takes burns that are positive integers. A landing must involve an integral burn or combination of integral burns. If you use the exact advice given by the calculator, the advice will get rounded off to the nearest integer.

WARNING:

DO NOT PRINT OUT NON-NORMALIZED NUMBERS ON THE HP97. THIS MAY CAUSE THE PRINTER TO LOCK ON AND BURN OUT IN A FEW SECONDS. IF THIS HAPPENS BY MISTAKE, TURN THE MACHINE OFF IMMEDIATELY.

MARK YOUR DATA CARD "DON'T PRINT" EVEN IF YOU OWN AN HP 67, since someone else may borrow the card someday.

HEWLETT PACKARD WILL NOT REPAIR THE HP97 ON YOUR WARRANTY IF THIS OCCURS - you are using non-normalized numbers at your own risk.

Reference: PPC Journal Vol. 4 No. 1 Page 13

01532D Program Description II

Sketch(es)

Sample Problem(s) Read in side 1 of data card and both sides of program card.

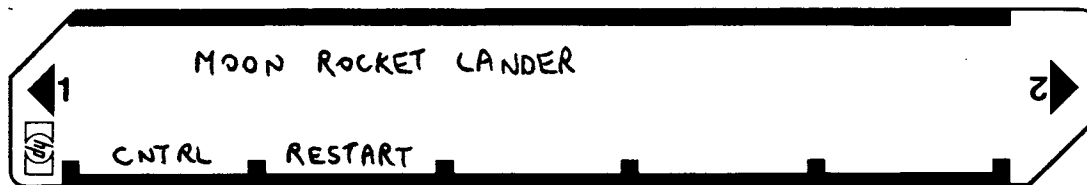
Start by pressing **[A]** → -50.0500, your velocity and altitude, 60., your fuel; -00XXX-----00 where the X's are a decrementing counter. When the zero comes into the display press **[C]** and you are told that a burn of 3.75 units of fuel each turn for 20.00 turns, using up a total of 75.00 units of fuel is the way to land using a constant burn. Next, 60. appears to remind you how much fuel you have available. When the zero appears, enter your choice of burn.

Solution(s)

I have never seen a landing using less than 49 units of fuel. If you discover one, please let me know.

Reference(s) Original Program is HP 67 Standard Pac SD-14A

- HP 65 "Key Notes" Winter 1976 Vol 2 Number 2
- PPC Journal Special Issue A



STEP	INSTRUCTIONS	INPUT DATA/UNITS	KEYS	OUTPUT DATA/UNITS
1.	Read in side 1 of the data card			crd
2.	Read in both sides of the program card			
3.	Optional: blank out the countdown if presently in non-blanked mode, or switch back to non-blanked mode if presently in blanking mode.		D	
4.	Start manual descent		A	V. ALT fuel left COUNTDOWN OR BLANK 0.
5.	When zero is flashed, either: a) Key in burn *	BURN		V. ALT fuel left COUNTDOWN OR BLANK 0.
	b) Ask for advice on landing		C	BURN TIME FUEL NEEDED FUEL LEFT COUNTDOWN OR BLANK 0.
6.	Go to step 5 until you land (flashing zero) or crash (flashing impact velocity)			
7.	If you survived last landing attempt, go to step 2 for another try			
	* If you miss the burn window and flameout, press B for a new engine start		B	

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
001	F LBL A	31 25 11	START		STO 6	33 06	
	RCL 1	34 01			RCL 7	34 07	
	STO 6	33 06			F X > 0	31 81	
	RCL 2	34 02		060	GTO 0	22 00	if going up now, see if have really crashed in the last second
	STO 7	33 07			F LBL 3	31 25 03	
	RCL 3	34 03			RCL 6	34 06	
	STO 8	33 08			F INT	31 83	
	F LBL 9	31 25 09			F X > 0	31 81	
	RCL 6	34 06			GTO 9	22 09	if didn't hit moon, go for another burn
010	DSP 4	23 04			F X < 0	31 71	
	EEX	43			GTO 0	22 00	if hit moon, determine impact velocity
	4	04			DSP 0	23 00	
	÷	81			RCL 7	34 07	
	RCL 7	34 07		070	F X > 0	31 81	if exactly on surface, show velocity ≤ 0
	h CF 2	35 61 02			CLX	44	
	F X < 0	31 71			F LBL 4	31 25 04	
	h SF 2	35 51 02			h PAUSE	35 72	
	h ABS	35 64			GTO 4	22 04	
	+	61			F LBL 0	31 25 00	
020	h F? 2	35 71 02			RCL 7	34 07	
	CHS	42			g X ²	32 54	
	h PAUSE	35 72			RCL 6	34 06	
	h PAUSE	35 72			RCL 9	34 09	
	F LBL 1	31 25 01	DOES COUNTDOWN	080	X	71	
	DSP 0	23 00			2	02	
	RCL 8	34 08			X	71	
	h PAUSE	35 72			-	51	
	h F? 0	35 71 00			F X < 0	31 71	
	F LBL 8	31 25 08			GTO 3	22 03	
030	1	01			F √X	31 54	
	RCL 0	34 00			CHS	42	
	÷	81			DSP 0	23 00	
	CLX	44			RCL 9	34 09	
	h PAUSE	35 72		090	÷	81	
	h ABS	35 64			RCL 7	34 07	
	F RND	31 24			RCL 9	34 09	
	F LBL 5	31 25 05			÷	81	
	RCL 8	34 08			g X ≤ y	32 71	
	h X ≥ y	35 52			GTO 9	22 09	
040	g X > y	32 81			h X ≥ y	35 52	
	GTO 2	22 02			RCL 9	34 09	
	STO -8	33 51 08			X	71	
	2	02			GTO 4	22 04	
	X	71		100	F LBL 2	31 25 02	
	5	05			RCL 8	34 08	
	-	51			2	02	
	STO 9	33 09			.	83	
	2	02			5	05	
	÷	81			-	51	
050	RCL 6	34 06			STO + 6	33 61 06	
	+	61			2	02	
	RCL 7	34 07			X	71	
	+	61			STO + 7	33 61 07	
	RCL 9	34 09		110	RCL 6	34 06	
	STO + 7	33 61 07			1	01	
	h R↓	35 53			0	00	

REGISTERS

0 NON NORMALIZED NUMBER	1 X ₀ = 500	2 V ₀ = -50	3 fuel ₀ = 60	4	5	6 X	7 V	8 fuel	9 Accel.
S0	S1	S2	S3	S4	S5	S6	S7	S8	S9
A	B	C	D	E	I				

STEP	KEY ENTRY	KEY CODE	COMMENTS	STEP	KEY ENTRY	KEY CODE	COMMENTS
	X	71					
	RCL 7	34 07		170			
	g x ²	32 54					
	+	61					
	f√x	31 54					
	CHS	42					
	GTO 4	22 04					
120	f LBL 6	31 25 12	FLAME-OUT RECOVERY				
	5	05					
	STO-8	33 51 08					
	0	00					
	GTO 5	22 05		180			
	f LBL C	31 25 13	BURN, TIME, FUEL				
	DSP 2	23 02					
	RCL 7	34 07	for v=0 use a special loop				
	f x=0	31 51					
	GTO 6	22 06					
130	h 1/x	35 62					
	CHS	42					
	2	02					
	x	71					
	RCL 6	34 06		190			
	x	71					
	ENTER	41	save a copy of t				
	h 1/x	35 62					
	RCL 7	34 07					
	x	71					
140	CHS	42					
	5	05					
	+	61					
	2	02					
	÷	81		200			
	f LBL 7	31 25 07	DISPLAY ADVICE				
	f-x-	31 84	Burn				
	h x=y	35 52					
	f-x-	31 84	Time (t)				
	x	71					
150	f-x-	31 84	Fuel needed				
	GTO 1	22 01	Do countdown				
	f LBL 6	31 25 06					
	1	01					
	ENTER	41		210			
	2	02					
	GTO 7	22 07					
	f LBL D	31 25 14	CHANGE COUNTDOWN				
	h F?0	35 71 00					
	GTO fd	22 31 14					
160	h SF 0	35 51 00					
	h RTN	35 22					
	g LBL fd	32 25 14					
	h CFO	35 61 00					
	h RTN	35 22		220			

LABELS					FLAGS	SET STATUS		
A START	B RESTART	C BURN, TIME, FUEL	D CHANGE COUNTDOWN	E	0 counter ON/OFF	FLAGS	TRIG	DISP
a	b	c	d	e	1	ON OFF		
0 CRASH VELOCITY	1 DOES COUNTDOWN	2 fuel = 0	3 crash	4 flash	2 sign	0 ☐ ☒	DEG ☒	FIX ☒
5 used	6 v = 0	7 display ADVICE	8 used	9 NEXT SECOND	3	1 ☐ ☒	GRAD ☐	SCI ☐
						2 ☐ ☒	RAD ☐	ENG ☐
						3 ☐ ☒		n 0