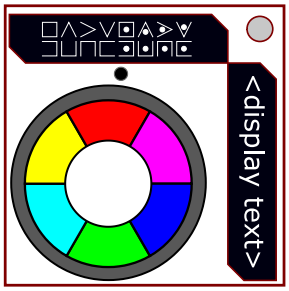
On the Subject of Unfair's Cruel Revenge



Why did he make two versions of Unfair's Revenge? Don't tell me he wanted something harder than just that...

This module has two displays. The display on top shows the encrypted message. There's also a strip of LEDs which will light up to show the current stage.

The display on the right can be clicked to cycle between showing the Module ID, in white, strikes the module is keeping track of, in red, and the extra key. The Module ID and the strike counter are either shown in fixed or broken Roman numerals, or in Arabic form, I.E 1, 2, 3, 5,...

For all operations involving STRIKES, always refer to the number in red on the module itself.

The module encrypts a string of six distant three-letter-long instructions with four different ciphers, using different **keys** for each. Enter the correct combination of inputs to disarm the module.

ALL ciphers referring to the alphabet refers to the A1Z26 standard for each letter unless stated otherwise. Alphabetical order is ALSO modified for the ciphers!

- The basic order of the given encrypted text is the following: **Original -> 4x Ciphers -> Pigpen Ciphered.** Reverse the order to obtain the **original** instruction string.

Key A

1. Start with the bomb's serial number.
2. Transform each letter into its numerical equivalent (A=1,B=2,etc.).
    - Make this a single string of digits.
    - Ignore the first character if its numerical equivalent is 20 or above.
3. Remove the last digit if either the 4th or the 5th character of the serial number are vowels.
    - You should only do this once, even in the case both characters are vowels.
4. Convert this number into **hexadecimal.** Refer to *Appendix D3K2H3X* for instructions.

5. Now read the string of hexadecimal digits as a string of decimal digits and letters. Going from left to right, for every digit:
    - If the digit is followed by another digit and they form a number in the range 10-26, convert the pair into its alphabetical equivalent.
    - Otherwise, convert the single digit into its alphabetical equivalent, or skip it if it is a zero.
6. Transform the Module ID, the number of port plates and the number of battery holders into their alphabetical equivalents, using step 5 if necessary.
7. Append these three characters at the end of the result of the previous conversion.
8. **This is Key A.**

Key B

Obtain Key B from the following table using the month and day of the week of when this module was activated:

		Month											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Day	Mon	ABDA	FEV	DBHC	BLD	DBIE	AFEF	AFCG	CQH	DEAI	FEAA	EFAB	DECC
	Tue	ABDB	FEW	DBHD	BLE	DBIF	AFEG	AFCH	CQI	DEAA	FEAB	EFAC	DECD
	Wed	ABDC	FEX	DBHE	BLF	DBIG	AFEH	AFCI	CQA	DEAB	FEAC	EFAD	DECE
	Thu	ABDD	FEY	DBHF	BLG	DBIH	AFEI	AFCA	CQB	DEAC	FEAD	EFAE	DECF
	Fri	ABDE	FEZ	DBHG	BLH	DBII	AFEA	AFCB	CQC	DEAD	FEAE	EFAF	DED
	Sat	ABDF	FEBG	DBHH	BLI	DBIA	AFEB	AFCC	CQD	DEAE	FEAF	EFB	DEDA
	Sun	ABDG	FEBH	DBHI	BLA	DBIB	AFEC	AFCD	CQE	DEAF	FET	EFBA	DEDB

Key C

Use a Playfair Cipher to encode Key A using Key B as the keyword. The alphabet used is the Modern English Alphabet for this encryption. **This is Key C.**

Refer to *Appendix PL4YF4112 101* for instructions.

Key D

Sum up the value of ALL the false rules in Alphabetize (Alphabetize.html), as if there are no strikes, no solved modules on the bomb. Then take the average of the sum. If this results in a decimal answer, use the 15th row on that manual as Key D, otherwise count that many rows from the top and use that as Key D.

Value X Table

Condition	Operation
For each BOB, CAR, or CLR indicator:	+1 if lit, -1 if unlit
For each FRK, FRQ, MSA, or NSA indicator:	+2 if lit, -2 if unlit
For each SIG, SND, or TRN indicator:	+3 if lit, -3 if unlit
For the number of batteries:	+4 for odd, -4 for even
There are port plates with parallel port:	+5 each, -4 if paried with serial port
There are port plates with DVI-D:	-5 each, +4 if paired with Stereo RCA

Start with 0 and perform all operations from the table above in this section for each matching condition. If the value is negative, make it positive. This will be referred to as X for decypting.

Value A Table

Condition	Operation
For every **port type**	-2
For every **port plate**	+1
For every **consonant** in the serial number	+1
For every **vowel** in the serial number	-2
For every **lit** indicator	+2
For every **unlit** indicator	-2
For every **battery**	-1
No batteries	+10
No ports	×2
31 or more modules	÷2

Start with 0 and perform all operations in the following table for each matching conditon from top to bottom. This will be refered to as Value A for decrypting.

Drop any remainders and/or decimals when using the division operation. I.E, if you get -1.5 after division, turn -1.5 into -1 instead.

Solving — Step 1: Figuring out Which Ciphers Were Used

Because Unfair Cipher and it's sequel have consistent ciphers to decrpyt out of, this version will not have consistent decrypting methods.

The table on the right will show all possible ciphers that can be used on Unfair's Cruel Revenge. The original instructions are encrypted by the top-most 4 ciphers after the modifications, and then encrypted with Pigpen Cipher to be displayed on the module. The expert will need to grab those 4 ciphers that are used in this module, and then decrpyt them by reversing the procedure.

If the defuser has colorblind mode enabled for this module, hovering over the colored button will show the color of that given button for that given position on the top screen.

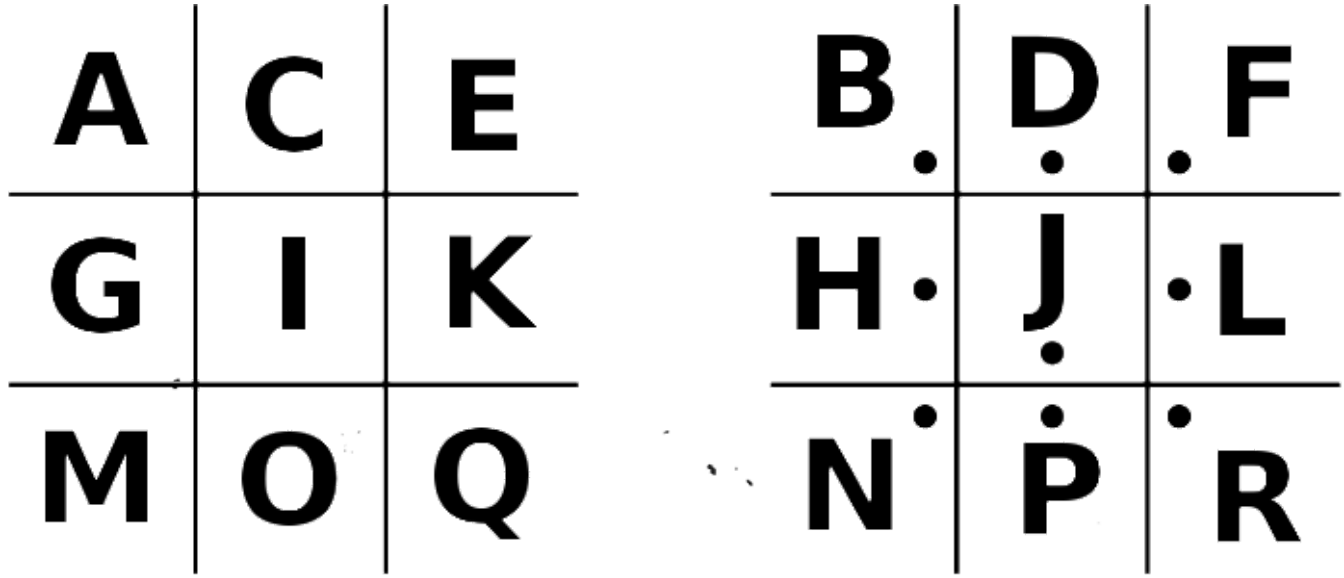
Playfair Cipher (Key C)
Affine Cipher (Value X)
Caesar Cipher (Value A)
Playfair Cipher (Key A)
Playfair Cipher (Key B)
Playfair Cipher (Key D)
Four Square Cipher (Keys ?)
ROT13 Cipher
Atbash Cipher
Myszkowski Transposition
Autokey Cipher
Scytale Transposition
Basic Columnar Transposition
Anagram Shuffler

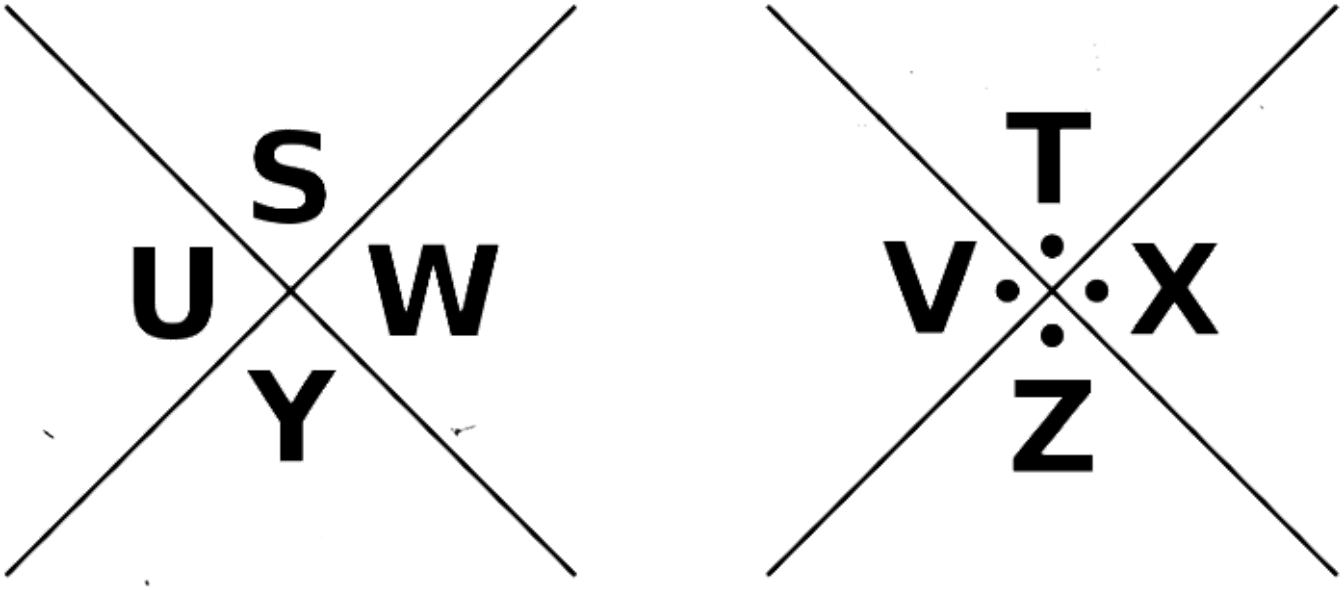
Encryption Modifications	
Condition	**Response**
The module ID is displayed in Broken or Fixed Roman Numerals	Put Playfair Cipher (Key D) at the top.
The strike counter is displayed in Arabic numerals	Put ROT13 Cipher at the top. And then put Scytale Transposition at the bottom.
Unfair Cipher is NOT present	Put Playfair Cipher (Key A), Caesar Cipher (Value A), Playfair Cipher (Key C) at the bottom, maintaining its previous order.
Orange Cipher is present	Put Four Square Cipher (Keys ?) at the top.
Alphabetize is NOT present but Reverse Alphabetize is	Swap Autokey Cipher with Atbash Cipher.

Encryption Modifications	
Condition	**Response**
Cryptography is present	Take all of the even positioned ciphers out of the list, reverse it, and then place that at the top of the list.
Anagrams is present	Put Anagram Shuffler at the top.
Word Scramble is present	Swap the 3rd item from the top with the 3rd item from the bottom.
The NE colored button is Yellow	Put the top-most 4 ciphers at the bottom, maintaining its order.
Red is diametrically opposite to the Cyan	Swap ROT13 Cipher with Myszkowski Transposition, and Basic Columnar Transposition with Anagram Shuffler.
Blue and Yellow are both on the upper half of the module	Take the bottom-most cipher in the list and place it at the top.
Blue and Yellow are both on the lower half of the module	Take the top-most cipher in the list and place it at the bottom.
Unfair's Revenge is present	Cycle all the ciphers up by the number of steps it takes to get to Cyan on this module, starting on the NW button and going clockwise. (0 steps to get to Cyan is **not** 6 for this.)
Value X is 13n + 6	Swap Affine Cipher (Value X) with Atbash Cipher and then remove Affine Cipher (Value X) from the table.
Value A is 26n	Swap Caesar Cipher (Value A) with ROT13 Cipher and then remove Caesar Cipher (Value A) from the table.

Solving — Step 2: Pigpen Cipher

Convert the symbols on the top screen into letters using the chart below.





Solving — Step 3: Modifying the Base Alphabet

Did he put a "Blue Arrows" in "Unfair's Revenge?" Don't tell me he did...

You will need to modify the starting alphabet in order to use the ciphers and transpositions on the next page when it is needed.

1. Start the alphabet with "ABCDEFGHIJKLMNOPQRSTUVWXYZ".
2. Shift the entire alphabet to the right [1 + the last digit of the serial number (10 if none)] times.
3. Move the last letter of the serial number to the front of the alphabet if there are any letters in the serial number. If that letter in the front, move it to the back instead.
4. Then, perform the extra modifications from the table below. Your alphabet for decrypting will be the string after using the table.

Condition	Action
Exactly all of these: Lit BOB, no batteries, no port plates, no unlit indicators, serial number contains a vowel	Throw away your current string from this point and use the starting alphabet instead for decrpyting. Skip the rest of the conditions from this table.
Lit BOB is present	Reverse the entire string.
Odd number of battery holders	Move the vowels ("A", "E", "I", "O", "U") to the back of the string, keeping the order they appeared. If "W" is also in the serial number, move that letter as well in respect with the other vowels.
DVI-D port is present	Reverse the first half of the string.
Stereo RCA port is NOT present	Move R, C, and A to the very back of the string, in that specific mentioned order.
Even number of batteries	Take the letters where the current 1-start position in the string has exactly 3 or 4 distant factors divisible by its position, reverse that set, and then put it back of the sequence.
"Green Arrows", "The Sphere", or "Yellow Arrows" are present.	Put "LAZYDOG" at the very front of the string and remove duplicate letters afterwards.
Duplicates of Unfair's Cruel Revenge are present	Reverse the 2nd half of the string, put "THEQUICK" at the very front of the string, and then remove duplicate letters afterwards.

Solving — Step ?: Caesar Cipher

To decrypt from Caesar Cipher, shift every letter on the screen forwards by this many letters in the alphabet if the offset is negative, backwards if positive. Wrap back to the other side of the alphabet if you have to go backwards from the first letter in the modified alphabet or forwards from the last letter in the modified alphabet.

Solving — Step ?: ROT13 Cipher

Each letter is encrypted by using Caesar Cipher with a key of 13 on the given alphabet, wrapping around to the first letter if needed.

To decrypt, simply do Caesar Cipher with a key of 13.

Solving — Step ?: Affine Cipher

For each letter in the plain text:

- The alphabetic position of that letter is multiplied by (2X + 1).
- 26 is subtracted from the product until it falls within the range [1, 26].
- This is the alphabetic position of the encrypted letter.

To decrypt, add 26 to the alphabetical postion of the encrypted letter until it is divisible by (2X + 1), then divide it by (2X + 1) to get the alphabetical position of the unencrypted letter.

The table underneath can be used to quickly decrypt each letter for Affine Cipher if needed. The table uses the Standard English Alphabet order however the alphabet used on the module may be different. X = 0 denotes to the first row in the table and the decrypted letter, X = 1 for the 2nd row for the encrypted letter, X = 2 for the 3rd row, etc.

The contents in this table are editable, you may modify this in order to use a different alphabet.

Affine Encryption Table																								
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
C	F	I	L	O	R	U	X	A	D	G	J	M	P	S	V	Y	B	E	H	K	N	Q	T	W	Z
E	J	O	T	Y	D	I	N	S	X	C	H	M	R	W	B	G	L	Q	V	A	F	K	P	U	Z
G	N	U	B	I	P	W	D	K	R	Y	F	M	T	A	H	O	V	C	J	Q	X	E	L	S	Z
I	R	A	J	S	B	K	T	C	L	U	D	M	V	E	N	W	F	O	X	G	P	Y	H	Q	Z
K	V	G	R	C	N	Y	J	U	F	Q	B	M	X	I	T	E	P	A	L	W	H	S	D	O	Z
The message to decrypt would result in very ambiguous conditions if using X = 6.																								
O	D	S	H	W	L	A	P	E	T	I	X	M	B	Q	F	U	J	Y	N	C	R	G	V	K	Z
Q	H	Y	P	G	X	O	F	W	N	E	V	M	D	U	L	C	T	K	B	S	J	A	R	I	Z
S	L	E	X	Q	J	C	V	O	H	A	T	M	F	Y	R	K	D	W	P	I	B	U	N	G	Z
U	P	K	F	A	V	Q	L	G	B	W	R	M	H	C	X	S	N	I	D	Y	T	O	J	E	Z
W	T	Q	N	K	H	E	B	Y	V	S	P	M	J	G	D	A	X	U	R	O	L	I	F	C	Z
Y	X	W	V	U	T	S	R	Q	P	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A	Z

Solving — Step ?: Playfair Cipher (Key X)

Use a Playfair Cipher with Key X as the keyword to decrypt the string you just deciphered.

Refer to *Appendix PL4YF4112 101* for instructions.

Solving — Step ?: Atbash Cipher

Each letter is encrypted to the alphabetical position of (27 - P), where P is the alphabetical position of the unencrypted letter.
To decrypt simply get the alphabetical position of (27 - E), where E is the alphabetical position of the encrypted letter.

Solving — Step ?: Basic Columnar Transposition

The extra key will contain random numbers when rearranged form consectutive numbers. These have been used to encrypt the instructions.

To decrypt follow the process for Columnar Transposition from Green Cipher (Green%20Cipher.html), except with 18 characters from the encrypted text.

Solving — Step ?: Myszkowski Transposition

These seem very familar to the last one...

Keywords						
ARCHER	ATTACK	BANANA	BLASTS	BURSTS	BUTTON	CANNON
CALLER	CELLAR	DAMAGE	DEFUSE	DEVICE	KABOOM	LETTER
LOOPED	MORTAR	NAPALM	OTTAWA	PAPERS	POODLE	POOLED
RASHES	RECALL	ROBOTS	SAPPER	SHARES	SHEARS	WIRING

Take the sum of the serial number digits, modulo it by 28, add 1, and count that many words in reading order from the table to get your keyword, starting on "ARCHER".

The encryption process follows by splitting the unencrypted letters up so that each row is equal to the length of the keyword. The letters are then read in alphabetical order in accordance to the keyword, from left to right, top to bottom. Refer to this (https://en.wikipedia.org/wiki/Transposition_cipher) for clarification.

To decrypt, place each letter underneath the keyword, in alphabetical order. In the case of duplicate letters in the keyword, place them from left to right for the current duplicate letter, and then top to bottom until each have been filled. Then read the message in reading order to get the decrypted text. The example of Myszkowski Transposition being used is demonstrated on the next page.

Example: Myszkowski Transposition

The decrypted text reads "BOBRAN FASTER THANON EHORSE." The keyword used is "PAPERS" using the Modern English Alphabet for encrypting. The text when encrypted reads "OAHH RTNR BBFS TAEO AEOS NRNE." Spaces are provided in the quotes for readibility for decrypting and encrypting.

P	A	P	E	R	S
B	O	B	R	A	N
F	A	S	T	E	R
T	H	A	N	O	N
E	H	O	R	S	E

Solving — Step ?: Scytale Transposition

Railfence, meet your inferior cousin.

1. Add 2 to (the number of ports on the bomb modulo 4); this is how many rows you will need to make.
2. Create dashes that match the length of the string, and to match the height of the theoretical cylinder. The dashes should start on the top-left and repeat every X letters, based on the height of the cylinder.

Example, with 3 rows and 11 letters:

-			-			-			-	
	-			-			-			-
		-			-			-		

3. Fill each dash in reading order with each letter in the string you have encrypted.
4. The read each letter like reading a ribbon wrapped around the cylinder.
5. This results in your decrypted string for Scytale Transposition.

An example to decrypt to "ORANGEJUICE" from "ONJCRGUEAEI" in 3 rows can be demonstrated here.

O			N			J			C	
	R			G			U			E
		A			E			I		

Solving — Step ?: Autokey Cipher

You're telling me he can do 18 letters for 1 cipher!? That's completely out of his mind!

The portion of the extra key will consist of a falsely selected word from the module, Word Search (Word%20Search.html). The actual word used for encrypting is the word in the same cell as the falsely selected word, E.G if the falsely selected word is "TEST", the word used for encrypting is "JINX."

Part of the plain text is added to the right of the base key to form a length equivalant to the length of the plain text.

Then the module is encrypted from a theoretical table called *Tabula Recta*, except using the modified alphabet, instead of the standard alphabet. Each letter of the plain text is used for the column, and each letter of the key is used for the row.

Because of this, the theoretical table from *Tabula Recta* has a glaring flaw that can be easily described as the following for each encrypted letter:

1. Take the index of the letter in the 0-indexed alphabet in the plain text.
2. Add the index of the letter in the 0-indexed alphabet from the key.
3. Keep this number within 0-25 and grab that letter of the result in the 0-indexed alphabet.
4. This is your encrypted letter.

To decrypt:

1. Start with the first X characters of the encrypted string where X is the length of the keyword.
2. Decrypt this set by undoing the procedure mentioned on this page to get the first set of letters that was appended to the keyword.
3. Repeat this with the next set of letters in your encrypted string until you have decrypted your entire encrypted string.

An example of the decrpytion procedure for decrypting to get "APPLES" with the keyword "ATE" can be shown here. The alphabet used in this example is the Standard English Alphabet.

?	?	?	?	?	?
A	**T**	**E**	**?**	**?**	**?**
A	I	T	L	T	H

Initial Setup, may differ from module

A	P	P	?	?	?
A	**T**	**E**	**?**	**?**	**?**
A	I	T	L	T	H

Decrypt letters from keyword provided

A	P	P	?	?	?
A	**T**	**E**	**A**	**P**	**P**
A	I	T	L	T	H

Add some decrypted text to keyword

A	P	P	L	E	S
A	**T**	**E**	**A**	**P**	**P**
A	I	T	L	T	H

Decrypt Section → Result of decrypting

Go here (http://www.crypto-it.net/eng/simple/autokey-cipher.html) for infomation about autokey cipher. This link provided is NOT secure and should be entered with caution.

Solving — Step ?: Anagram Shuffler

Did you know that "Orange" is an anagram of "A Goner?"

Anagrams					
TAMERS	STREAM	MASTER	ARM SET	MRS TEA	MR SEAT
BARELY	BARLEY	BLEARY	LAB RYE	A BERYL	ALB RYE
RUDEST	DUSTER	RUSTED	ED RUST	EDS RUT	DUST RE
IDEALS	SAILED	LADIES	A SLIDE	DEAL IS	SEA LID

Use the even rows if the pigpen set is at the top on the extra key screen, otherwise use the odd rows. Use the top half of the same table if the Columnar Transposition key is to the left of the falsely selected word used for Autokey Cipher, otherwise use the bottom half.

Then count the anagrams in that row from left to right, by the number of steps it takes to reach to Green, starting on the NW button and going CW if the current button is not Green until landing on Green, plus 1. That will be the base key for the unencrypted string.

If the base key consists of 2 words, swap them if the serial number does not contain a vowel (A, E, I, O, U).

Finally, count the anagrams in the same row from left to right, by the number of steps it takes to reach to Magenta, starting on the NW button and going CW if the current button is not Magenta until landing on Magenta, plus 1. That will be the encryption key.

If the encryption key consists of 2 words, swap them if there are an odd number of battery holders on the bomb.

To <u>decrypt</u>, place each letter in reading order in respect to the length of the encryption key. Then for each letter in the base key, place the exact combination of letters from the encrypted string underneath the corresponding letter for the base key. Finally, read the string underneath the base key in reading order to get your <u>decrypted</u> string.

An example of this is shown here.

P	R	I	N	C	E
A	F	A	I	N	T
S	O	U	N	D	T
H	R	I	C	E	D

P	I	N	C	E	R
A	A	I	N	T	F
S	U	N	D	T	O
H	I	I	E	D	R

Solving — Step ?: Four Square Cipher (Keys ?)

I think he ran out of ideas for potential reasonable ciphers.

The extra key consists of 12 random pigpen letters, which are used for square D. Decrypt this by using step 2 from the manual. For the other 3 keys:

1. Grab the first true and last false rule from Reverse Alphabetize (Reverse%20Alphabetize.html), as if the module had no strikes, no solved modules. The strings from the first true and last false rules are used for squares B and C respectively.
2. Then grab the median of the true rules from the same manual with the same criteria. If there is none or it doesn't exist, use the alphabet that was created on step 3. Otherwise, use the string to the right of the median of the true rules. This will need to be built for square A.
3. Subsitute the 10th letter in the alphabet being used with the 9th letter in the alphabet for each key, then remove duplicate letters and fill in the rest of the alphabet if necessary at the end of each key.
4. Create 4 5x5 squares in that regard.
5. Rearrange the squares into the following: A on the TL, B on the TR, C on the BL, D for the BR. Refer to the table for this step for the order.

A	B
C	D

6. Now refer to Orange Cipher (Orange%20Cipher.html) in order to decrypt this. This page will repeat steps from Step 3's Orange Cipher if the link is broken.
7. To decrypt, split the encrypted string into pairs, making sure all letters from the 10th letter in the alphabet are substituted with the 9th letter in the alphabet. Then for each pair:
    - Grab the row and column of the 1st letter in the pair from the TR square.
    - Grab the row and column of the 2nd letter in the pair from the BL square.
    - Use the row position of the 1st letter and the column position of the 2nd letter to get your 1st decrypted letter in the TL square for that pair.
    - Use the column position of the 1st letter and the row position of the 2nd letter to get your 2nd decrypted letter in the BR square for that pair.
9. Concatinate the decrypted pairs to get your decrypted string.

Solving — Step 8: Executing the Instructions

If at this point the expert has least 1 instruction not in the given list of instructions, the expert will need to redo the decryption process.

Tap the screen on the right to cycle between showing the module ID, the number of strikes obtained so far, which is shown in red, or the extra key.

Again, if the defuser has colorblind mode enabled for this module, hovering over the colored button will show the color of that given button for that given position on the top screen.

Instructions:

'%' refers to the module (remainder) operation.
Inner Center refers to the white button in the middle.
Outer Center refers to the gray circular frame around the colored buttons.

Refer to *Appendix PRIM3* for a list of prime numbers.

- **PCR:** Press the Red button.
- **PCG:** Press the Green button.
- **PCB:** Press the Blue button.
- **SCC:** Press the Cyan button.
- **SCM:** Press the Magenta button.
- **SUB:** Press **Inner Center** when the seconds digits on the countdown timer match.
- **MIT:** Press **Outer Center** when the last digit on the seconds timer is $(m + c + (5 - s)) \% 10$, with m being the Module ID, c being the number of times a colored (R, G, B, C, M, Y) button has been pressed since the last strike on this module (or since the beginning if there are no strikes) and s being the current stage, starting with 1.
- **PRN:** Press **Inner Center** if Module ID % 20 is a prime number; otherwise press **Outer Center.**
- **CHK:** Press **Outer Center** if Module ID % 20 is a prime number; otherwise press **Inner Center.**
- **REP** or **EAT:** Repeat the last input, or press **Inner Center** if this is the first instruction. Ignore timing constraints.
- **STR** or **IKE:** Starting from the last colored button you pressed or Red if you have not pressed any colored buttons yet, count as many colored buttons clockwise as there are strikes and press the resulting button. In the case of 0 strikes, press the starting button.
    - For these instructions, refer to the Strike Counter on the screen to the right of the module itself.

- **SKP:** Press **Inner Center.** Then press **Outer Center** and **skip the next instruction.** If this instruction is unable to skip the next instruction, or this is the very last instruction, only the **Inner Center** press is needed.
- **PVP** or **NXP:** Start from the last colored button you pressed (or the NW button if you have not pressed any yet). Go (counter-clockwise if PVP / clockwise if NXP) until you get to a button that is a primary color (R, G, B), then press that button.
- **PVS** or **NXS:** Start from the last colored button you pressed (or the NW button if you have not pressed any yet). Go (counter-clockwise if PVS / clockwise if NXS) until you get to a button that is a secondary color (C, M, Y), then press that button.
- **OPP:** Press the button that is diametrically opposite to the last button you pressed. If your last button pressed was **Outer Center** then press **Inner Center** and vice versa. Otherwise, if this is the first instruction, press **Outer Center.**
- **FIN** or **ISH:** This is the only instruction that **CANNOT** be skipped and also the last instruction. Take the number of **Inner Center** and **Outer Center** buttons you pressed up to this point and call it X. Count X buttons clockwise starting from the last colored button you pressed, or the NW button if you have not pressed a colored button yet. Then count Y buttons counter-clockwise from that button, where Y is the number of solved modules on the bomb. Press that button when the last seconds digit on the countdown timer is the least significant digit of the number of unsolved modules on the bomb. The number of solved/unsolved modules will take into account once you press the button.

Appendix — D3K2H3X

Follow these steps to convert an integer to hexadecimal:

1. Divide the number by 16. Obtain the remainder and quotient.
2. Convert the remainder into a hexadecimal digit. See the corresponding table for a quick reference.
3. Repeat steps 1 and 2 with the quotient as the new number. Keep repeating until the quotient is zero.
4. Reverse the order of the hexadecimal digits obtained.
5. Remove leading zeros.

DEC	HEX
0-9	0-9
10	A
11	B
12	C
13	D
14	E
15	F
16	10
17	11
26	1A
...	...

Appendix — PR1M3

- A prime number is referred to a number that is only divisible by 1 and itself. 1 is not considered prime even though it is divisible by 1 and itself.
- Prime numbers (to 20): 2, 3, 5, 7, 11, 13, 17, 19

Appendix — PL4YF411 101

- Create a 5×5 matrix of letters. Start with your **keyword** and fill the rest with the unused letters of the alphabet you are using. Each letter must occur only **once** in the matrix, so only add the first occurrence. The 9th and 10th letters of the alphabet being used are interchangeable.
- In the following text, use the instructions marked (d) when decrypting and those marked (e) when encrypting.
- Split the **message** into character pairs. If you cannot form a pair, add **the 24th letter in the alphabet**. For each pair:
    - If the letters are exactly identical, do not modify them at all.
    - If the letters appear on the same row of your matrix, replace them with the letters to their immediate left (d)/right (e) respectively, wrapping around to the other side of the row if necessary.
    - If the letters are on the same column of your matrix, replace them with the letters immediately above (d)/below (e), wrapping to the other side of the column if necessary.
    - If the letters are on different rows and columns, replace each of them with the letter on the same row but in the column of the other letter in the original pair.
- Drop any final (24th letter)'s that don't make sense and locate any (9th letter)'s that should be (10th letter)'s if necessary.