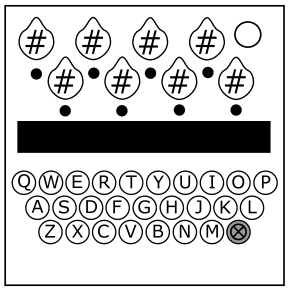
On the Subject of The Ultimate Cycle



How much security does one word need?

This module consists of a screen, eight dials with red labels, and a QWERTY keyboard.

The labels on the dials, when decrypted and read from left to right, spell out an eight letter word.

The word has been encrypted through a series of ciphers, indicated by the direction each dial is pointing, from left to right.

Once deciphered, find the word in the table below, the word written below it is the word that should be entered.

Apply the same sequence of encryptions to the response word, and type out the encrypted response word using the keys.

The word is automatically submitted when eight keys are pressed.

The red button can be pressed at any time before the eighth key is pressed to cancel the input.

Inputting any of the eight letters incorrectly will cause a strike to be issued and reset the module.

Note: Unless stated otherwise, any reference to a letter's alphabetic position starts at A = 1. Similarly, any reference to the position of a dial starts from the leftmost dial = 1.

N: Atbash Logic Cipher

Logic component

For each dial: if the number of 45° rotations, starting from north, is odd, then the bit given by the dial is 1. Otherwise, it is 0.

Form four pairs of bits by grouping the bits corresponding to adjacent pairs of dials from left to right.
Form another four pairs of bits by grouping the bits corresponding to adjacent pairs of dials in reading order.
Each of the eight pairs of bits correspond to each of the eight dials from left to right.

Using the operator corresponding to the position of the north pointing dial, find the truth values of each pair; the encrypted letter depends on whether each is true or false.

AND	OR	XOR	⇒	NAND	NOR	XNOR	⇐

	Letter	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
Truth Value	True	U	F	Z	W	D	B	V	C	L	S	H	I	J	M	N	Q	G	X	K	Y	T	E	O	P	R	A
	False	N	V	Y	P	W	A	H	O	Q	C	M	U	G	F	D	I	R	L	T	X	B	S	K	Z	J	E

Atbash component

Each letter in the word is swapped with the letter with the same alphabetic position in the reversed alphabet.
That is, a letter with alphabetic position X will become the letter with alphabetic position 27 − X.

If the LED below the north pointing dial is lit, the Atbash cipher is applied to the input of the Logic cipher.
Otherwise, the Atbash cipher is applied to the output of the Logic cipher.

NE: Caesar Cipher

Each letter in the word has been shifted forwards through the alphabet by the number of 45° clockwise rotations, starting from north, to the direction its corresponding dial is pointing.

If the LED corresponding to this dial is lit, each letter is then shifted further by the position of the dial corresponding to this cipher.
Otherwise, each letter is then shifted backwards through the alphabet by the position of the dial corresponding to this cipher.

E: Playfair Cipher

The indexing of the lists start at zero.

- If the last dial is pointing east, use the word corresponding to the number of 45° rotations, starting from north, of the first dial.
- Otherwise, the number of 45° rotations, starting from north, of the **next** dial corresponds to which of the words in the lists below is the keyword for this cipher.
  - If there are less than three unique* ports on the bomb, use the keyword from List A.
  - Otherwise, use the keyword from List B.
- The keyword gives the first ten letters/top two rows of the keysquare.
  - If the LED corresponding to this cipher is unlit, the keyword is entered into the keysquare in reading order.
  - Otherwise, the keyword is entered into the keysquare in reverse reading order.
- The remaining 15 letters fill the rest of the keysquare in alphabetical order, excluding X, which is never used.
- The word is split into four pairs of letters.
- Each pair of letters is altered:
  - If both letters are the same, the encrypted pair is two of the letter diametrically opposite in the keysquare.
  - Otherwise, if both letters belong to the same row of the keysquare, shift both letters one space to the right along the row.
  - Otherwise, if both letters belong to the same column of the keysquare, shift both letters once space down the column.
  - Otherwise, the letters lie on diagonally opposite corners of a rectangle, the encrypted pair consists of the letters in the horizontally opposite corners from the original pair.

*A port is unique if there is only one of its type on the bomb.

List A: ALGORITHMS, AUTHORIZED, BLUEPRINTS, DESPICABLY, FORMIDABLE, HYPERBOLIC, IMPORTANCE, LABYRINTHS

List B: WANDERLUST, VANQUISHED, ULTRASONIC, SCRAMBLING, PRECAUTION, OSTRACIZED, METHODICAL, MAGNITUDES

Important:

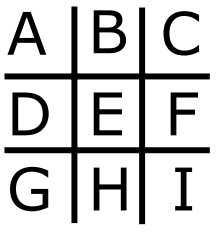
- If the pair of letters is **XX**, the pair is unchanged by the cipher.
- If the pair of letters is either **X#** or **#X**, where # is not X, the X is changed to the other letter, forming a double letter pair, and enciphered normally.
  Then, the new letter is changed back to an X.

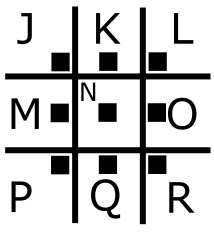
SE: Pigpen Cipher

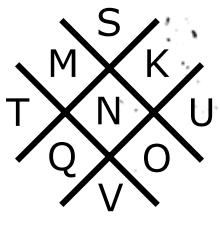
Each letter is translated using one of the two pigpen ciphers below.
Starting from north, the pigpen characters are rotated to face the direction the dial is pointing.
The rotated pigpen characters are then translated back, as though they are still facing north, to produce the encrypted letter.

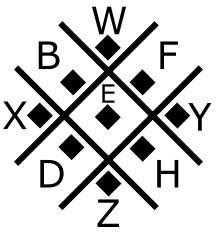
If the LED corresponding to this cipher is unlit, use cipher I. Otherwise, use cipher II.

Cipher I

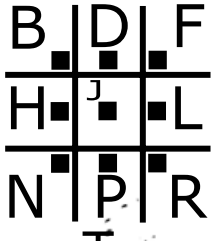


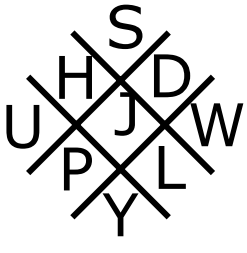


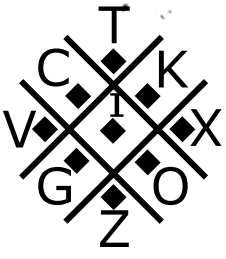




Cipher II







S: Chaocipher

The indexing of the lists start at 0. For this cipher, the leftmost dial has a position of 0.

- The two lists give the keywords for two 5x5 keysquares, the keyword from List A is used for the first keysquare and the keyword from List B is used for the second:
  - If the numbers in the serial number add up to more than 9, the keyword in List A is given by the position of dial and the keyword in List B is given by the number of 45° rotations, starting from north, of the **previous** dial.
  - Otherwise, the keyword in List B is given by the position of dial and the keyword in List A is given by the number of 45° rotations, starting from north, of the **previous** dial.
  - If the first dial is pointing south, the 'previous' dial is the last dial.
- These keywords are used to construct two cipher alphabets where each keyword preceeds the remaining sixteen letters.
- For each letter, from left to right, consider the status of the LED below the dial in its position:
  - If the status of the LED of the south dial is the same, the second cipher alphabet is shifted to the left by the number of 45° rotations from north to where the dial is pointing.
  - Otherwise, the first cipher alphabet is shifted to the left by the number of 45° rotations from north to where the dial is pointing.
- Find the unencrypted letter in the first cipher alphabet.
  The encrypted letter is in the same position as this letter in the second cipher alphabet.

Note: The shifted alphabets are **not** reset after each letter is encrypted.

List A: AFTERSHOCK, DESTROYING, DUPLICATES, FARSIGHTED, GRACIOUSLY, INFAMOUSLY, NIGHTMARES, PALINDROME

List B: DOWNSTREAM, EMORDNILAP, FLASHPOINT, INTRODUCES, PATHFINDER, QUADRICEPS, TRAPEZOIDS, WAVERINGLY

SW: Monoalphabetic Substitution Cipher

The position of the dial corresponds to which of the eight words in the list below is the keyword for this cipher:

DOCUMENTARILY, FLAMETHROWING, FLOWCHARTINGS, HYDROMAGNETIC, METALWORKINGS, MULTIBRANCHED, TROUBLEMAKING, UNPREDICTABLY

If the LED is unlit,the remaining thirteen letters of the alphabet are left in alphabetical order. Otherwise, the remaining thirteen letters are positioned in reverse alphabetical order.

- If there are an even number of batteries, the keyword preceeds the remaining letters to construct a cipher alphabet.
- Otherwise, the keyword follows the remaining letters to construct a cipher alphabet.

Each letter of the alphabet is mapped onto the letter of the cipher alphabet with the same alphabetic position.
The letters in the word change accordingly with these mappings.

W: Hill Cipher

If there are more lit than unlit indicators, the keyword for this cipher belongs to list A.
Otherwise the keyword for this cipher belongs to list B.

The keyword used depends and the rotations of the dials adjacent to the one corresponding to this cipher:

The indexing of the lists start at zero.

- If the first dial is pointing west, use the keyword corresponding to six plus the number of 45° rotations, starting from north, of the second dial.
- If the last dial is pointing west, use the keyword corresponding to six plus the number of 45° rotations, starting from north, of the seventh dial.
- Otherwise, use the keyword corresponding to the sum of the numbers of 45° rotations, starting from north, of the two dials adjacent to this one.

List A: AEON, COPY, EACH, GOOD, IOTA, KILO, MARK, ONCE, QUIT, RIOT, SYNC, UNDO, WORK, YEAR, ZEAL

List B: BOMB, BUSY, DICE, FAUX, HUSK, JUKE, LIMA, LOCI, NAME, PUSH, RISE, TASK, VOID, XYST, ZOOM

The alphabetic positions of the letters in the keyword modulo 26 form the entries of a 2x2 square keymatrix in reading order.
If the LED corresponding to this cipher is lit, the matrix is then transposed, swapping its top-right and bottom-left entries.
The word to be enciphered is broken into four pairs of letters and their alphabetic positions modulo 26 form entries in 2x1 vectors.
The vectors are multiplied by the keymatrix and taken modulo 26 to obtain the alphabetic positions of the encrypted pairs of letters.
(Because Z has an alphabetic position of 26, its corresponding entry in the encrypted vector is zero.)

NW: Bitshift Cipher

Find the 3 digit binary representations the numbers of rotations, starting from north, of each of the dials.

If the LED corresponding to a dial is lit, swap the 0s for 1s and the 1s for 0s in its binary representation.

Combine all of the binary representations together, from left to right.
Prepend a 0 and append a 1 to the combined binary representations to produce a 26 bit string.

Separate the alphabet into two sets, depending on whether each letter's alphabetic position in the string of bits is a 1 or a 0.
The letters in these sets remain in alphabetical order.

If the LED corresponding to the NW dial is lit, each letter in the word is shifted to the right by the position of the NW dial.
Otherwise, each letter is shifted to the left by the position of the NW dial.

Keyword Table

ADVANCED	ADVERTED	ADVOCATE	ADDITION	ALLOCATE	ALLOTYPE	ALLOTTED	ALTERING
PROGRESS	ZYGOTENE	QUARTICS	LINKAGES	QUICKEST	ORDERING	UNDOINGS	ZUGZWANG

BINARIES	BINORMAL	BINOMIAL	BILLIONS	BULKHEAD	BULLHORN	BULLETED	BULWARKS
YOKOZUNA	COMMANDO	GLOOMING	TRICKIER	GATEWAYS	INCOMING	ZYGOMATA	FORMULAE

CIPHERED	CIRCUITS	CONNECTS	CONQUERS	COMMANDO	COMPILER	COMPUTER	CONTINUE
BULKHEAD	RELATION	LINKWORK	NANOTUBE	MONOTONE	YIELDING	ILLUMINE	KILOBYTE

DECRYPTS	DECEIVED	DECIMATE	DIVISION	DISCOVER	DISCRETE	DISPATCH	DISPOSAL
NANOBOTS	QUINTICS	ZIGZAGGY	MONOMIAL	ULTERIOR	KNUCKLED	UNDERWAY	ULTRARED

ENCIPHER	ENCRYPTS	ENCODING	ENTRANCE	EQUALISE	EQUATORS	EQUATION	EQUIPPED
JUNKYARD	QUADRANT	TRIANGLE	RELAYING	NANOGRAM	CONNECTS	INDICATE	BINORMAL

FINALISE	FINISHED	FINDINGS	FINNICKY	FORMULAE	FORTUNES	FORTRESS	FORWARDS
DISCRETE	JUNCTION	KILOWATT	ROTATION	POSITRON	DISPATCH	ENCIPHER	STANDOUT

GARRISON	GARNERED	GATEPOST	GATEWAYS	GAUNTLET	GAMBLING	GATHERED	GLOOMING
STOCKADE	FINDINGS	ADVANCED	JOURNEYS	STOPPING	LANDMARK	EQUATORS	VICELESS

HAZARDED	HAZINESS	HOTLINKS	HOTHEADS	HUNDREDS	HUNKERED	HUNTSMAN	HUNTRESS
DISCOVER	JUNCTURE	TOGETHER	GARRISON	WHATNOTS	DIVISION	TOGGLING	YEASAYER

INCOMING	INDICATE	INDIRECT	INDIGOES	ILLUDING	ILLUSION	ILLUSORY	ILLUMINE
VENOMOUS	FORTUNES	OBSERVED	QUITTERS	HUNKERED	HOTHEADS	TOMOGRAM	KNOWABLE

JIGSAWED	JIMMYING	JOURNEYS	JOUSTING	JUNCTION	JUNCTURE	JUNKYARD	JUDGMENT
YEARNING	TRIGONAL	VOLITION	DECRYPTS	LABELING	STARTING	OCTUPLES	ROTATORS

KILOWATT	KILOVOLT	KILOBYTE	KINETICS	KNOCKING	KNOCKOUT	KNOWABLE	KNUCKLED
POSITIVE	BILLIONS	WHATEVER	FINALISE	ENCRYPTS	OBSTACLE	ENCODING	ADVOCATE

LANGUAGE	LANDMARK	LIMITING	LINEARLY	LINGERED	LINKAGES	LINKWORK	LABELING
CONQUERS	EQUATION	GATEPOST	ILLUSION	QUIRKISH	NUMERATE	STANDARD	POSTSYNC

MONOGRAM	MONOLITH	MONOMIAL	MONOTONE	MULTITON	MULTIPLY	MULCTING	MULLIGAN
HUNTRESS	WINNABLE	ZYMOLOGY	ILLUSORY	VOLATILE	TOMAHAWK	OCTANGLE	ADVERTED

Keyword Table cont.

NANOBOTS	NANOGRAM	NANOWATT	NANOTUBE	NUMBERED	NUMEROUS	NUMERALS	NUMERATE
ZIPPERED	STOCCATA	VENDETTA	LINGERED	FINNICKY	JUDGMENT	HUNDREDS	ILLUDING

OCTANGLE	OCTUPLES	ORDERING	ORDINALS	OBSERVED	OBSCURED	OBSTRUCT	OBSTACLE
KNOCKING	WINGDING	UNDERLIE	LINEARLY	TRIGGERS	PROJECTS	ALLOTYPE	YIELDERS

PROGRESS	PROJECTS	PROPHASE	PROPHECY	POSTSYNC	POSSIBLE	POSITRON	POSITIVE
JIGSAWED	KILOVOLT	ALLOTTED	RELATIVE	PROPHASE	COMPILER	LIMITING	NANOWATT

QUADRANT	QUADRICS	QUARTILE	QUARTICS	QUICKEST	QUIRKISH	QUINTICS	QUITTERS
YELLOWED	MULCTING	GATHERED	WEAKENED	WHATNESS	HAZINESS	REVOLVED	ENTRANCE

REVERSED	REVOLVED	REVEALED	ROTATION	ROTATORS	RELATION	RELATIVE	RELAYING
FORTRESS	WHATSITS	BULLHORN	GARNERED	INDIGOES	LANGUAGE	CIRCUITS	VOLTAGES

STARTING	STANDARD	STANDOUT	STANZAIC	STOCCATA	STOCKADE	STOPPING	STOPWORD
REVERSED	JIMMYING	DECEIVED	QUARTILE	GAUNTLET	HAZARDED	MULTIPLY	ZYMOGRAM

TRICKIER	TRIGONAL	TRIGGERS	TRIANGLE	TOMOGRAM	TOMAHAWK	TOGGLING	TOGETHER
MULLIGAN	ZIGGURAT	ALLOCATE	NUMERALS	BULWARKS	BINARIES	INDIRECT	REVEALED

UNDERRUN	UNDERWAY	UNDERLIE	UNDOINGS	ULTERIOR	ULTIMATE	ULTRARED	ULTRAHOT
JOUSTING	VICINITY	QUADRICS	MONOLITH	ORDINALS	KNOCKOUT	NUMEROUS	STOPWORD

VENOMOUS	VENDETTA	VICINITY	VICELESS	VOLITION	VOLTAGES	VOLATILE	VOLUMING
UNDERRUN	DISPOSAL	WEAPONED	HUNTSMAN	BULLETED	ALTERING	MONOGRAM	POSSIBLE

WEAKENED	WEAPONED	WINGDING	WINNABLE	WHATEVER	WHATNESS	WHATNOTS	WHATSITS
EQUALISE	OBSTRUCT	COMPUTER	STANZAIC	DECIMATE	EQUIPPED	BINOMIAL	YEARLONG

YELLOWED	YEARLONG	YEARNING	YEASAYER	YIELDING	YIELDERS	YOKOZUNA	YOURSELF
CIPHERED	CONTINUE	KINETICS	FORWARDS	ADDITION	FINISHED	GAMBLING	MULTITON

ZIPPERED	ZIGGURAT	ZIGZAGGY	ZUGZWANG	ZYGOMATA	ZYGOTENE	ZYMOLOGY	ZYMOGRAM
VOLUMING	ULTIMATE	HOTLINKS	NUMBERED	PROPHECY	YOURSELF	ULTRAHOT	OBSCURED