



## Problem of the Week

### Problem D

### Say What?

BEAVER 1  
GROUP

O  
T  
T  
E  
R  
S

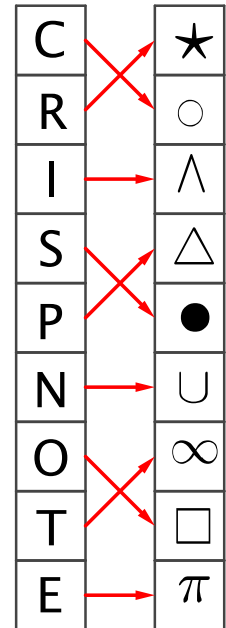
BEAVER 2  
GROUP

The Beavers are playing a game with the Otters. The Beaver 1 group needs to communicate secretly with the Beaver 2 group, but their message will pass through a zone controlled by the Otters (see diagram above).

The Beavers decide to use a mechanism called the B-Enigma machine to encrypt (disguise) their messages while sending them from one side to the other. The device has two rotors. As described below, the left rotor moves after a letter is typed. The right rotor never moves.

The B-Enigma works as follows:

- The machine begins in the START position shown in the diagram to the right.
- A letter on the left rotor is encrypted to the corresponding symbol on the right rotor. If, for example, P is the letter typed first from the START position, it will be encrypted as  $\cup$ . After typing the first letter, the left rotor will move up one position. The top letter moves down to the bottom.
- A second letter is typed and encrypted to the symbol on the right rotor. If, for example, O is typed, it will be encrypted as  $\infty$ . After typing the second letter, the left rotor will move up two positions. The top two letters will move to the bottom and stay in the same order.
- A third letter is typed and encrypted to the symbol on the right rotor. If, for example, R is typed, it will be encrypted as  $\infty$ . After typing the third letter, the left rotor will move up three positions. The top three letters will move to the bottom and stay in the same order.
- A fourth letter is typed and encrypted to the symbol on the right rotor. If, for example, T is typed, it will be encrypted as  $\star$ . After typing the fourth letter, the left rotor will move up four positions. The top four letters will move to the bottom and stay in the same order.



The procedure and pattern repeat until the SEND button (not shown) is pressed. After a message is sent, the left rotor automatically returns to the START position.

Our four-letter message was PORT and it was encrypted  $\Delta \cup \infty \star$ . The process of encrypting the message “PORT” is illustrated with diagrams on the next page.

The Beaver 1 Group sends the message “TOP SECRET SCRIPT” and then presses SEND. Assuming the left rotor is in the START position and spaces in the message are ignored, what is the encrypted message received by the Beaver 2 Group.





Diagrams to illustrate how the word “PORT” is encrypted.

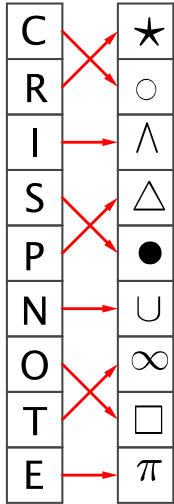
START

⇒

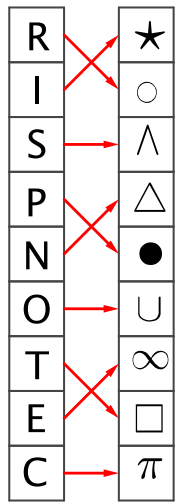
Left rotor moves up one position.  
Top letter moves to bottom position.

⇒

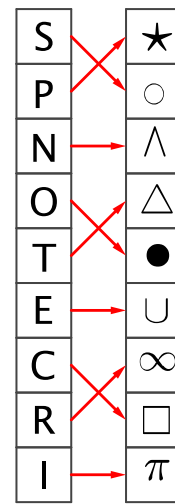
Left rotor moves up two positions.  
Top 2 letters move to bottom 2 positions.



P → △



O → U



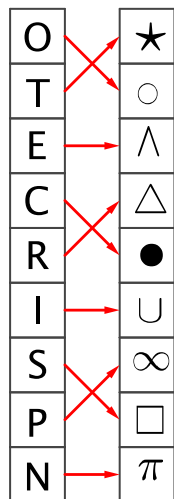
R → ∞

⇒

Left rotor moves up three positions.  
Top 3 letters move to bottom 3 positions.

⇒

SEND  
Resets left rotor to START position.



T → ★

