

This application can be used either to express one permutation as a product of permutations of a particular kind, such as transpositions, or to express the composite of two, or more, permutations in its cycle decomposition.

It may be used to demonstrate

- how to compose permutations;
- that every permutation can be expressed as a product of transpositions;
- to explain and illustrate standard formulae for expressions as in (b);
- that every transposition can be expressed as a product of adjacent transpositions or transpositions of the form $(1\ j)$;
- that every even permutation can be expressed as a product of cycles of length three;
- the impossibility of expressing an odd permutation as a product of cycles of length three;
- various sets of generators for the groups S_4 and A_4 ;
- conjugates in S_4 (though a separate applet for this is under development).

In its most basic role, the applet is effectively a calculator in S_4 . Two or more permutations can be selected from an array showing all 24 elements of S_4 and then composed, with the composition displayed. Alternatively, one permutation can be set as a target to be expressed as a composite of permutations of a particular type.

Navigation

- The initial display shows the 24 elements of S_4 in an array, each with a selection button.
- To compose two or more permutations, select them from the array, in the order in which they are to be applied; the effect of each will be displayed and the permutations will appear in the panel above the array.
- When all the permutations to be composed have been entered, click successively on **Compose**; the cycle decomposition of the composite will be displayed one symbol at a time.
- To express one permutation as a product of permutations of a given type, select the permutation from the array, click **Target**, and select the type from the drop-down menu **Available permutations**. The array will be restricted to permutations of the required type.
- Select potential factors in the order in which they are to be applied; successive compositions will be displayed and, optionally, a joyful message should greet achievement of the target (see configurability).

Examples 1. To express $(1\ 4\ 3\ 2)$ as a product of three transpositions.

1. From the array, select $(1\ 4\ 3\ 2)$ by clicking on the circle next to it.
 2. Click on **Target**.
 3. Click on **Available permutations** and, from the drop-down menu, choose **transpositions**.
 4. Select a first move from those available, perhaps by aiming to get a particular symbol in its target position.
 5. Aim to achieve the target by applying two more transpositions.
-
2. To find the cycle decomposition of $(1\ 4\ 3\ 2)(3\ 4)$.
 1. Click **reset** if you have already used the applet for another calculation.
 2. Select $(3\ 4)$ from the panel, and then select $(1\ 4\ 3\ 2)$.
 3. Click on **compose** until the full cycle decomposition appears.
 4. The intermediate display (14 shows that 1 is sent to 4 by the composite; the next click reveals that 4 is sent to 2 and this can be seen by tracking the 4th symbol ♣ through the display.