

The group of symmetries of a square

This applet demonstrates symmetries of a square, in particular their composites. Composites of up to seven symmetries may be displayed, with intermediate steps shown and with labels indicating the symmetries applied so far. Two composites may be compared using separate squares at the top and bottom of the screen. The applet may be used to demonstrate

- composition of symmetries;
- closure of the group of symmetries under composition;
- failure of the commutative law in general;
- instances where two symmetries commute;
- inverses in the group of symmetries;
- the order of each symmetry.

### Navigation

- The dropdown menu for selecting symmetries is labelled **Group element**.
- The **which square?** button selects which of the two displayed squares, top or bottom, the symmetry is to be applied to. The default is top.
- On application of a given symmetry, the combined effect is shown in a new square to the right of the original. A label below the square shows the symmetries applied so far. This is configurable (see configurability) to indicate composition from right or left.
- The **Undo** button undoes the previous symmetry and the **Reset** button restores the original screen.
- The toggle bar allows the screen to be scrolled horizontally.

**Example** To show the composite of two symmetries:

1. Click on the **Group element** button and, from the drop-down menu, choose the first symmetry to be applied.
2. Click on **apply**; the symmetry is applied once to the top square.
3. Repeat Steps 1 and 2 to select and apply a second symmetry.
4. The **which square?** button will have been set to **Top**. Click this button and select the **bottom** square from the drop-down menu.
5. Using the **group element** button, select the symmetry believed to be the composite of the previously selected pair. Click on **apply**; the symmetry is applied once to the bottom square and its effect can be compared with the composite.
6. Commutativity or noncommutativity for a chosen pair of symmetries can be demonstrated by applying them to the top and bottom squares in opposite orders.

**Configurability** From the html file, the following can be configured:

1. The preferred name for the group of symmetries of the square,  $D_4$  or  $D_8$  or whatever, is set using the parameter *gpName*. (Avoid the use of subscripts; use  $D4$  for  $D_4$ .)
2. The preferred names for the symmetries of the square are set using the parameters *gr1* to *gr8*.
3. Whether the composites shown in label indicate that composites are composed from the right ( $(i)fg = ((i)f)g$ ) or the left ( $fg(i) = f(g(i))$ ). Set the parameter *op* to *r* or *l*.
4. Colours used for background, foreground (text) and highlighted text (these can also be set within the applet); the parameters *background*, *foreground* and *highlight* can each be set to any of b(blue), r(red), g(green), y(yellow), c(cyan), p(pink), w(white), 0(black), n(navy).
5. The font size (this can also be set within the applet); the parameter *size* can be set to any of 1(normal), 2(large), 3(huge).