appears once in each row and once in each column.

The subgroup axioms hold, so the set of elements forms a subgroup.

The set is a union of conjugacy classes and so it is a normal subgroup.

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f) The set of symmetries of a square, $S(\square)$ is isomorphic to G. The standard labelling of a square is different from the labelling of the figure, but if we consider the permutation forms of the symmetries we can see that the the following is an isomorphism.

| $\phi\ G$ | $\to$ | $S(\square)$ |
|---|---|---|
| $e$ | $\to$ | $e$ |
| $(1234)$ | $\to$ | $a$ |
| $(13)(24)$ | $\to$ | $b$ |
| $(1432)$ | $\to$ | $c$ |
| $(14)(23)$ | $\to$ | $r$ |
| $(24)$ | $\to$ | $s$ |
| $(12)(34)$ | $\to$ | $t$ |
| $(13)$ | $\to$ | $u$ |

The base of the figure is a square, and the only symmetries of the figure are the symmetries of the square. The base, side 5, does not transform to any other side under any symmetry of the figure.

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4)a)i) $\phi_1 : (\mathbb{R}^2, +) \to (\mathbb{R}^2, +)$

$(x, y) \to (2x+y, 4x+2y)$

For a homomorphism

$\phi(v,u) \circ \phi(w,z) = \phi((v,u)\circ(w,z))$

$(2v+u, 4v+2u) + (2w+z, 4w+2z) = \phi(v+w, u+z)$

$(2v+2w+u+z, 4v+4w+2u+2z) = (2v+2w+u+z, 4v+4w+2u+2z)$

$\therefore \phi_1$ is a homomorphism

ii) $\phi_2 (M, +) \to (\mathbb{R}, +)$

$A \to \det A$