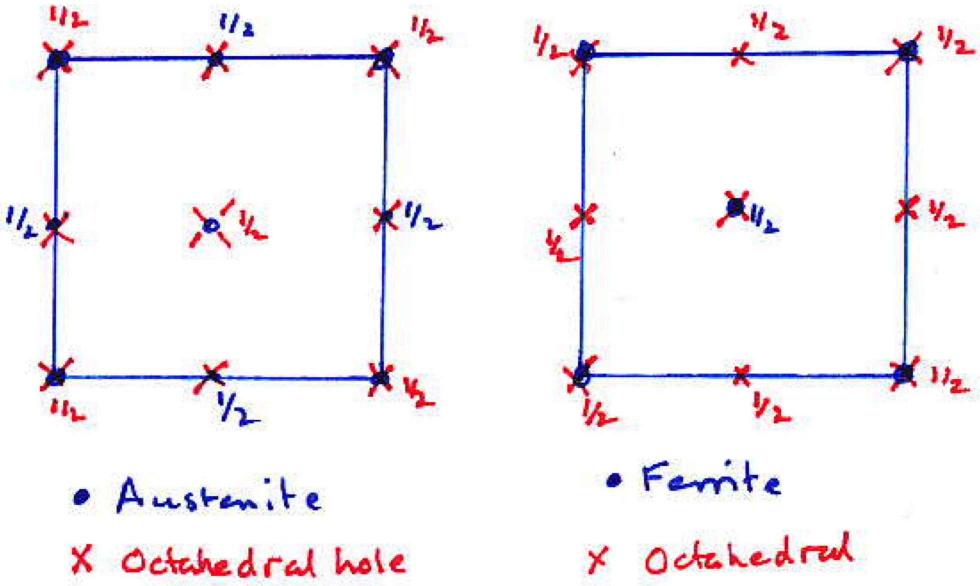
Answers to Examples Class 1

Point groups and consequences

a.



b. Austenite: regular octahedral interstice lies at a centre of symmetry. Therefore, in the table of point group symmetries for the seven crystal classes, focus on those relevant for centrosymmetric structures. Along z axis is a mirror plane, a triad passes through the interstice and another mirror parallel to the x-axis. Therefore, point group is $m3m$, a regular octahedron. In the case of ferrite, the octahedral interstice has point group $4/mmm$, i.e. tetragonal class.

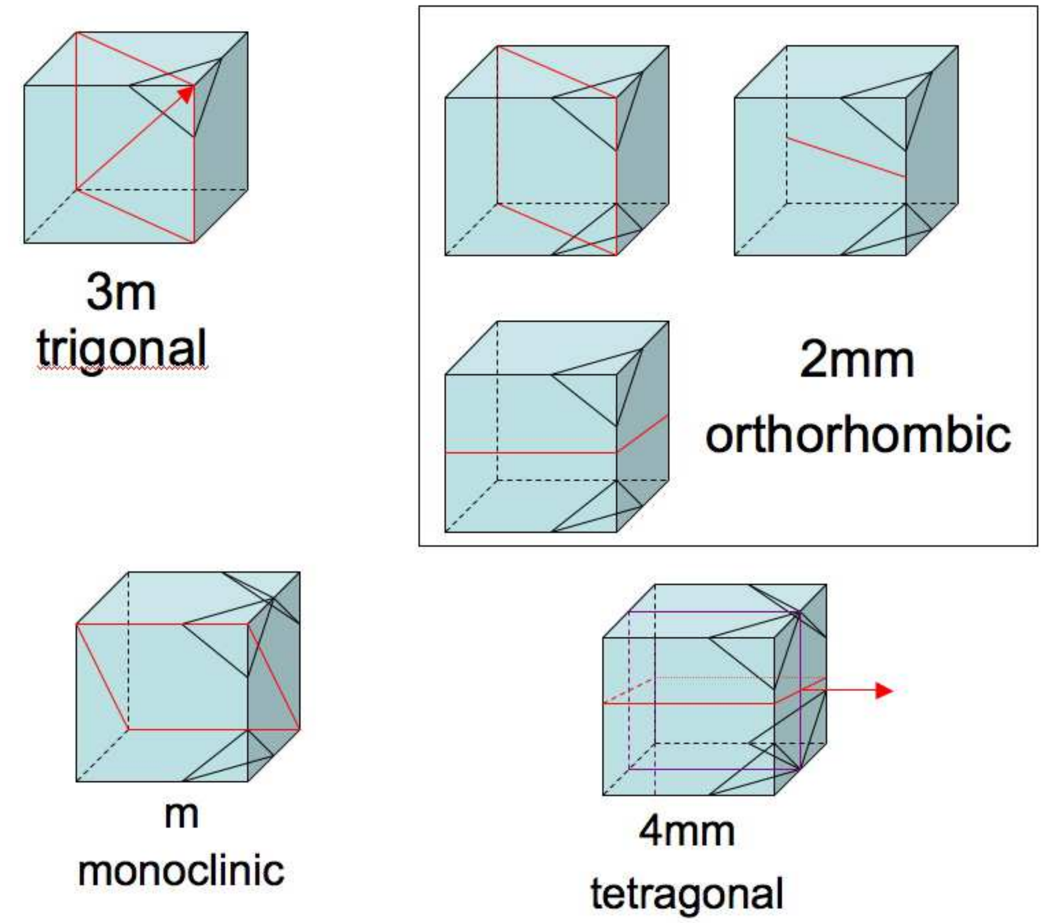
c. In austenite the octahedron is regular so the insertion of a carbon atom causes an isotropic expansion. This interacts only with the hydrostatic components of the dislocation strain field, i.e., weak solution hardening, rather like substitutional solutes.

In ferrite, the octahedral interstice has tetragonal symmetry. Carbon located there causes a tetragonal strain field which interacts also with the shear strain field of a dislocation. This is the major component of a dislocation strain field, therefore, intense hardening.

Use of sketch stereograms

The first four faces are cut in the order (111), $(11\bar{1})$, $(\bar{1}11)$ and $(\bar{1}1\bar{1})$.

- The first cut leaves a single triad along [111] and three {110} mirror planes in that zone. The crystal system is trigonal, defined by the single triad.
- After the second cut, the (001) and $(1\bar{1}0)$ mirror planes remain in the zone [110] (the latter is a diad). The crystal system is orthorhombic, defined by three mutually perpendicular diads (which can include inverse diads, equivalent to mirror planes).
- Only the $(\bar{1}01)$ mirror remains after three cuts, leaving the crystal system monoclinic.
- The fourth cut increases symmetry, with a tetrad along [010] and four mirror planes (100), (001), $(\bar{1}01)$ and (101). The crystal system is tetragonal.



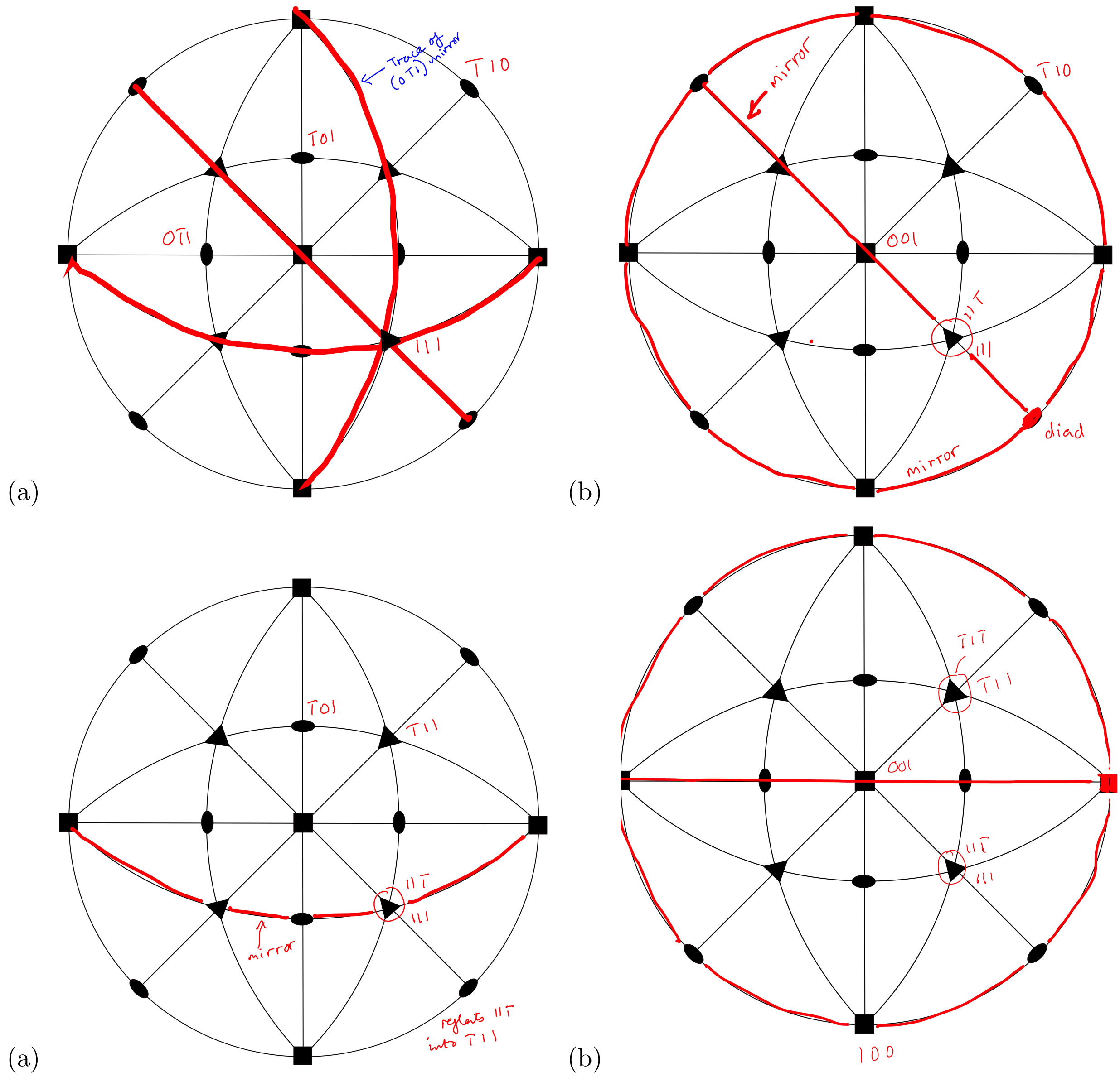


Figure 1: Sketch stereograms showing the surviving symmetry elements in red. (a) $3m$. (b) $2mm$. (c) m (d) $4mm$.