1. Below is a projection of equivalent points (equipoints) taken from the International Tables of Crystallography.

(a) Draw on top of it all the symmetry operator(s)/element(s) that are active. Also, label (define) each operator/element.
(b) What is the 3-D crystal system? 3-D Bravais lattice? 3-D Space group?

2. Cementite, Fe$_3$C, has an orthorhombic crystal structure with lattice parameters $a=0.508$ nm, $b=0.673$ nm and $c=0.451$ nm.
(a) What are the Miller indices of the family of directions in which the $\{101\}$ planes intersect?
(b) Calculate the $d$-spacing for the plane?

3. AlFe$_3$ structure exhibits cubic space group 225 (see page 2). Al is in $4a$, and Fe is in $4b$ and $8c$ positions.
(a) List all the basis positions and what is the Bravais Lattice.
(b) Draw the 3-D unit cell and label all elements.
(c) Looking at your unit cell in (b), what type of site(s) do Al and Fe occupy?
(d) The density of AlFe$_3$ is 6.69 g/cm$^3$ at room temperature. Calculate the lattice constant, $a$, for AlFe$_3$.
(e) Is the structure centric? Why?
(f) Determine the AlFe$_3$ structure factor ($F_{hkl}$).
(g) For the first 3 $hkl$ reflections you would observe in XRD, what are the values of $F$ (leave your answers in terms of the atomic scattering factors)?
(h) Without calculating the XRD intensities, and based on your answer in (g), how would you rank the XRD intensities for the 3 $hkl$ reflections (from highest to lowest). Explain how you determined your answer.
### Space Group 225

Co-ordinates of equivalent positions

\[(0,0,0); \quad 0,\frac{1}{2},\frac{1}{2}; \quad \frac{1}{2},0,\frac{1}{2}; \quad \frac{1}{2},\frac{1}{2},0)\]

<table>
<thead>
<tr>
<th>Number of positions, Wyckoff notation, and point symmetry</th>
<th>Co-ordinates</th>
</tr>
</thead>
<tbody>
<tr>
<td>192 (l) (1)</td>
<td>(x,y,z;) (z,x,y;) (y,z,x;) (x,y,z;) (z,y,x;) (x,y,z;) (z,x,y;) (y,z,x;) (x,y,z;) (z,y,x;) (x,y,z;) (z,x,y;) (y,z,x;) (x,y,z;) (z,y,x;) (x,y,z;) (z,x,y;) (y,z,x;) (x,y,z;) (z,y,x;) (x,y,z;) (z,x,y;) (y,z,x;) (x,y,z;) (z,y,x;)</td>
</tr>
</tbody>
</table>