Midterm from last year

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1. Why is it that binary compounds tend to be easier to prepare as amorphous solids than elemental compounds? What about ternaries and quaternaries? Brief answer please. [3+2]

2. Illustrate the $4_1$, $4_2$, and $4_3$ symmetry operations with sketches. How are $4_1$ and $4_3$ related? [3+2]

3. Sketch 2D objects that display the following symmetries and label the rotation axes and mirrors: (i) $4mm$ (ii) $2'm'm$. [3+3]

4. Sketch the zinc-blende crystal structure in sections. How is it related to the (i) diamond and (ii) fcc? [3+2+2]

5. BaO forms the rock salt structure. Sketch the bond valence net for BaO. Use bond valence sums to determine the lattice parameter, and compare with the experimental value of $a = 5.517\text{Å}$. Remember that the bond valence of a single bond is $s = \exp((R_0 - R)/B)$. The value of $R_0$ for the Ba$^{2+}$/O$^{2-}$ pair is 2.285 Å and $B = 0.37\text{Å}$. [2+3]

6. The crystal structure of Ga is unusually complex. This is one form.
   Space Group = $Cmca$ (No. 64). $a = 4.5230\text{Å}$, $b = 7.6610\text{Å}$, and $c = 4.5240\text{Å}$.

<table>
<thead>
<tr>
<th>Atom</th>
<th>Wyckoff Symbol</th>
<th>$x$</th>
<th>$y$</th>
<th>$z$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ga</td>
<td>8f</td>
<td>0.0000</td>
<td>0.1549</td>
<td>0.0810</td>
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</tbody>
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   (a) What is the nature of the centering in the cell? 2
   (b) What sort of a crystal system does this structure belong to? 2
   (c) What do the $c$ and the $a$ in the name of the space group indicate. No need to sketch. 2
   (d) How many atoms in the unit cell? 1