

## 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  $a = 5.517 \text{ \AA}$ . Remember that the bond valence of a single bond is  $s = \exp((R_0 - R)/B)$ . The value of  $R_0$  for the  $\text{Ba}^{2+}/\text{O}^{2-}$  pair is  $2.285 \text{ \AA}$  and  $B = 0.37 \text{ \AA}$ . [2+3]
6. The crystal structure of Ga is unusually complex. This is one form.  
Space Group =  $Cmca$  (No. 64).  $a = 4.5230 \text{ \AA}$ ,  $b = 7.6610 \text{ \AA}$ , and  $c = 4.5240 \text{ \AA}$ .

Atom	Wyckoff Symbol	$x$	$y$	$z$
Ga	$8f$	0.0000	0.1549	0.0810

  - (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