GLY 4200C Name_____
Laboratory Midterm - Closed Book KEY October 9, 2019
8 points - 4 took exam

4 1. If an object has at least one four-fold axis and one three-fold axis which are not collinear, how many three-fold axes must it have? FOUR

0 2. A six-fold rotation involves rotating through an andle of 60° six times.

3 3. Which symmetry operation is associated with the center of symmetry?

INVERSION

3 4. The act that reproduces the motif to create the pattern is a SYMMETRY OPERATION.

5-8.What is the coordination number of a cation in each of the following configurations? (4 points total)

	Configuration	CN
0	Cubic	VIII
0	Trigonal Planar	III
0	Linear	II
0	Tetrahedral	IV

1 Roman numerals

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32 points

1. Examine each model. Determine all of the symmetry elements present. List the number of each type of element in the table below. For the inversion center, indicate YES (it is present) or NO (it is not present). Then indicate the crystal class to which the object belongs. The crystal class sheet is on the reverse of this sheet. You will receive one-half point for each symmetry element correctly listed (number and type). One-half point will be subtracted for elements listed which are not present. You will receive one point for each crystal class correctly listed. (Total 24 points) A_2 through inversion center, ½ point each; Crystal class, 1 point each

Model #	A_2	A_3	A_4	A_6	Mirror Planes	Inversion Center	Crystal Class H-M Symbol	Points Missed
4	6 3	4 3	3 3	0 2	9 3	+ 2	4/m $\bar{3}$ 2/m 3	
13	3 2	4 4	0 2	0 0	3 3	+ 0	2/m $\bar{3}$ 4	
21	4 3	0 3	1 3	0 1	5 3	+ 0	4/m 2/m 2/m 3	
Marble object	0 2	0 1	1 1	0 1	4 2	- 2	4mm 2	
33	3 1	1 1	0 0	0 0	4 2	- 1	$\bar{6}$ m2 2	
Green object	6 3	0 2	0 2	1 3	7 2	-1 2	6/m 2/m 2/m 3	

2. Examine Model E. Is it HCP or CCP? (2 points) a) HCP 0

Name the types of voids are present between the layers? b) Tetrahedral 2

and c) Octahedral 2 (1 point each)

What is the ratio of b voids to c voids (b/c)? 2:1 2

(1 point)

3. Examine Models F, G, and H. Identify the configurations. (1 point each)

0 F. Square Planar

0 G. Linear

2 H. Octahedral

THE THIRTY-TWO CRYSTAL CLASSES AND THEIR SYMMETRY
(PROPER SYMMETRY OPERATIONS ONLY)

Crystal System	Crystal Class	Name	Symmetry Content
TRICLINIC	1	Pedial	None
	$\bar{1}$	Pinacoidal	*i*
MONOCLINIC	2	Sphenoidal	$1A_2$
	m	Domatic	1*m*
	2/*m*	Prismatic	*i*, $1A_2$, 1*m*
ORTHORHOMBIC	222	Rhombic-disphenoidal	$3A_2$
	*mm*2	Rhombic-pyramidal	$1A_2$, 2*m*
	2/*m* 2/*m* 2/*m*	Rhombic-dipyramidal	*i*, $3A_2$, 3*m*
TETRAGONAL	4	Tetragonal-pyramidal	$1A_4$
	$\bar{4}$	Tetragonal-disphenoidal	*i*, $1A_2$
	4/*m*	Tetragonal-dipyramidal	*i*, $1A_4$, 1*m*
	422	Tetragonal-trapezohedral	$1A_4$, $4A_2$
	4*mm*	Ditetragonal-pyramidal	$1A_4$, 4*m*
	$\bar{4}$2*m*	Tetragonal-scalenohedral	$3A_2$, 2*m*
	4/*m* 2/*m* 2/*m*	Ditetragonal-dipyramidal	*i*, $1A_4$, $4A_2$, 5*m*
RHOMBOHEDRAL	3	Trigonal-pyramidal	$1A_3$
	$\bar{3}$	Rhombohedral	*i*, $1A_3$
	32	Trigonal-trapezohedral	$1A_3$, $3A_2$
	3*m*	Ditrigonal-pyramidal	$1A_3$, 3*m*
	$\bar{3}$ 2/*m*	Hexagonal-scalenohedral	*i*, $1A_3$, $3A_2$, 3*m*
HEXAGONAL	6	Hexagonal-pyramidal	$1A_6$
	$\bar{6}$	Trigonal-dipyramidal	$1A_3$, 1*m*
	6/*m*	Hexagonal-dipyramidal	*i*, $1A_6$, 1*m*
	622	Hexagonal-trapezohedral	$1A_6$, $6A_2$
	6mm	Dihexagonal-pyramidal	$1A_6$, 6*m*
	$\bar{6}$*m*2	Ditrigonal-dipyramidal	$1A_3$, $3A_2$, 4*m*
	6/*m* 2/*m* 2/*m*	Dihexagonal-dipyramidal	*i*, $1A_6$, $6A_2$, 7*m*
ISOMETRIC	23	Tetartoidal	$4A_3$, $3A_2$
	2/*m* $\bar{3}$	Diploidal	*i*, $4A_3$, $3A_2$, 3*m*
	432	Gyroidal	$3A_4$, $4A_3$, $6A_2$
	$\bar{4}$ 3*m*	Hextetrahedral	$4A_3$, $3A_2$, 6*m*
	4/*m* $\bar{3}$ 2/*m*	Hexoctahedral	*i*, $3A_4$, $4A_3$, $6A_2$, 9*m*

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