I. (20) Define the following:

A. Mineral

A mineral is a naturally occurring, homogeneous solid with definite but not fixed chemical composition and an ordered atomic arrangement that is formed by inorganic processes.

B. Isomorph

Minerals of the same structure but different compositions.

C. Crystal form

A face plus its symmetric equivalents

D. Acicular

Needle-like

E. Siderophile

Those elements near the center of the periodic table that form metallic bonds and are enriched in the core of the Earth and iron metal of meteorites.
II. (14) Name a mineral that has the following values of Mohs' hardness:

A. 10 __ Diamond _____________  B. 8. __ Topaz ________________

C. 7. __ Quartz ________________  D. 5. __ Apatite ________________

E. 4. __ Fluorite _______________  F. 2. __ Gypsum ________________

G. 1. __ Talc _________________

III. (18) Write the number of the appropriate mineral group (right column) next to the following minerals (left column):

a. 6 ___ Diamond (C)  1. Halide
b. 1 ___ Fluorite (CaF$_2$)  2. Carbonate
c. 2 ___ Rhodochrosite (MnCO$_3$)  3. Sulfate
d. 7 ___ Marcasite (FeS$_2$)  4. Hydroxide
e. 4 ___ Goethite (FeOOH)  5. Phosphate
f. 3 ___ Celestine (SrSO$_4$)  6. Native Element
g. 9 ___ Olivine (Mg$_2$SiO$_4$)  7. Sulfide
h. 5 ___ Apatite (Ca$_5$(PO$_4$)$_3$OH)  8. Oxide
i. 12 __ Quartz (SiO$_2$)  9. Nesosilicate (Orthosilicate)
j. 11 __ Biotite (K(Mg,Fe)$_3$(AlSi$_3$)O$_{10}$(OH)$_2$)  10. Inosilicate (Chain silicate)
k. 8 ___ Corundum (Al$_2$O$_3$)  11. Phyllosilicate (Sheet silicate)
l. 10 __ Enstatite (Mg$_2$Si$_2$O$_6$)  12. Tektosilicate (Framework silicate)

IV. (12) Illustrated below is a crystallographic plane (crystal face) that intercepts the a-axis at 2 units, the b-axis at 3 units, and the c-axis at 4 units. Give the Miller indices of the plane.

\((2,3,4) = \frac{1}{2} 1/3/1/4 \ (6\ 4\ 3)\)
V. (12) For each of the following point-group symmetry diagrams, identify the point group (crystal class), crystal system, and give the multiplicity (of a general face).

A

Point Group: -3

Crystal System: Trigonal

Multiplicity: 6

B

Point Group: 4/m 2/m 2/m

Crystal System: Tetragonal

Multiplicity: 16

VI. (12) Identify the lattice type (P, A, B, C, I, F, or R) and give the number of lattice points per cell for each of the following

B

2

R

3

P

1
VII. (12) Give the axial constraints \((a \neq b \neq c; \quad \alpha \neq \beta \neq \gamma \neq 90^\circ, 120^\circ)\) for the following crystal systems:

A. Triclinic _______ \(a \neq b \neq c; \quad \alpha \neq \beta \neq \gamma \neq 90^\circ, 120^\circ)\) _________________

B. Trigonal _______ \(a = b \neq c; \quad \alpha = \beta = 90^\circ, \gamma = 120^\circ\) ________________

C. Tetragonal _____ \(a = b \neq c; \quad \alpha = \beta = \gamma = 90^\circ\) __________

D. Orthorhombic _____ \(a \neq b \neq c; \quad \alpha = \beta = \gamma = 90^\circ\) __________

E. Cubic (Isometric) _____ \(a = b = c; \quad \alpha = \beta = \gamma = 90^\circ\) __________

F. Monoclinic _____ \(a \neq b \neq c; \quad \alpha = \gamma = 90^\circ\) __________