I. (24) Define the following:
   A. Mineral
   B. Polymorph
   C. Crystal form
   D. Vitreous
   E. Chalcophile
   F. Atmophile
II. (9) Give an example of a mineral with the following values of Mohs' hardness:

A. 1. ___________________________  D. 6. __________________________________
B. 3. _____________________________ E. 8. __________________________________
C. 4. _____________________________ F. 10. _________________________________

III. (15) Write the number of the appropriate mineral group (right column) next to the following minerals (left column):

a. _____ Celestine (SrSO₄) 1. Orthosilicate  
b. _____ Galena (PbS) 2. Chain Silicate  
c. _____ Sylvite (KCl) 3. Layer Silicate  
d. _____ Biotite (K(Mg,Fe)₃AlSi₃O₁₀(OH)₂) 4. Framework Silicate  
e. _____ Sanidine (feldspar) KAlSi₃O₈ 5. Native Element  
f. _____ Proto-enstatite (MgSiO₃) 6. Halide  
g. _____ Graphite (C) 7. Sulfide  
h. _____ Olivine (Mg₂SiO₄) 8. Sulfate  
i. _____ Witherite (BaCO₃) 9. Phosphate  
j. _____ Apatite (Ca₅(PO₄)₃OH) 10. Carbonate

IV. (12) For each of the following point-group symmetry diagrams, identify the point group (crystal class) and crystal system:

Point Group: ________________  _________________  _______________
Crystal System: ________________  _________________  _______________
V.  (6) As illustrated below, a lattice plane intercepts the \( b \)-axis at 3 units, the \( c \)-axis at 2 units, and is parallel to \( a \). Give the Miller indices for the plane.

VI.  (6) Identify the lattice type (P, A, B, C, I, F, or R) for each of the following:

VII.  (12) Identify the crystal system:

A. \( a = b = c; \quad \alpha = \beta = \gamma = 90^\circ \) ________________________________
B. \( a = b \neq c; \quad \alpha = \beta = \gamma = 90^\circ \) ________________________________
C. \( a \neq b \neq c; \quad \alpha = \beta = \gamma = 90^\circ \) ________________________________
D. \( a = b \neq c; \quad \alpha = \beta = 90^\circ, \gamma = 120^\circ \) ________________________________
E. \( a \neq b \neq c; \quad \alpha = \gamma = 90^\circ \) ________________________________
F. \( a \neq b \neq c; \) ________________________________
VIII. (8) Shown below are two symmetry diagrams for primitive orthorhombic space groups in standard orientation (a-vertical, b horizontal, and c normal to page). Give the Hermann-Mauguin symbol for the space group and for the crystal class (point group) to which it belongs.

<table>
<thead>
<tr>
<th>axis</th>
<th>plane</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td></td>
</tr>
</tbody>
</table>

H-Msymbol __________
Point Group __________

IX. (10) Last year, some colleagues and I synthesized a sample of clinopyroxene at 120 kbar and 1400ºC using the 5000-ton press at the Bavarian Geological Institute at Bayreuth in Germany. Given below is a chemical analysis of the sample we made. Calculate the formula (Numbers of Si, Mg, and Fe cations per six oxygens).

<table>
<thead>
<tr>
<th>Oxide</th>
<th>MolWt Oxide</th>
<th>Wt%</th>
</tr>
</thead>
<tbody>
<tr>
<td>SiO₂</td>
<td>60.086</td>
<td>59.00</td>
</tr>
<tr>
<td>MgO</td>
<td>40.312</td>
<td>37.77</td>
</tr>
<tr>
<td>FeO</td>
<td>71.846</td>
<td>3.23</td>
</tr>
</tbody>
</table>

Atom    AtWt  Cations per 6 Oxygens
O       15.9994  6.000
Si      28.087
Mg      24.305
Fe      55.847