A. Multiple Choice:

1. Which sample of matter has particles arranged in a crystalline structure?
   (1) Ne(g)          (2) Br2(l)         (3) NaCl(aq)        (4) CuSO4(s)

2. At STP, which element is malleable and a good conductor of electricity?
   (1) xenon         (2) silicon       (3) platinum       (4) hydrogen

3. Which formula represents a polar molecule?
   (1) O2            (2) CO2           (3) NH3            (4) CH4

4. According to Table F, which compound is least soluble in water?
   (1) AlPO4         (2) Li2SO4        (3) Ca(OH)2        (4) AgC2H3O2

5. Which term represents an intermolecular force in a sample of water?
   (1) hydrogen bonding (2) covalent bonding (3) metallic bonding (4) ionic bonding

6. Which statement describes the general trends in electronegativity and atomic radius as the elements in Period 2 are considered in order from left to right?
   (1) Both electronegativity and atomic radius increase. 
   (2) Both electronegativity and atomic radius decrease. 
   (3) Electronegativity increases and atomic radius decreases. 
   (4) Electronegativity decreases and atomic radius increases.

7. Which element is least likely to undergo a chemical reaction?
   (1) lithium        (2) carbon        (3) fluorine        (4) neon

8. Which property is used to determine the degree of polarity between two bonded atoms?
   (1) density        (2) electronegativity (3) pressure        (4) temperature

9. A molecule must be nonpolar if the molecule
   (1) is linear       (2) is neutral      (3) has ionic and covalent bonding (4) has a symmetrical charge distribution

10. At STP, graphite and diamond are two solid forms of carbon. Which statement explains why these two forms of carbon differ in hardness?
    (1) Graphite and diamond have different ionic radii.
    (2) Graphite and diamond have different molecular structures.
    (3) Graphite is a metal, but diamond is a nonmetal.
    (4) Graphite is a good conductor of electricity, but diamond is a poor conductor of electricity.
B. Short Answer: Some questions may require the use of the 2011 Edition Reference Tables for Physical Setting/Chemistry.

Base your answers to questions 1 through 3 on the information below and on your knowledge of chemistry.

A technician recorded data for two properties of Period 3 elements. The data are shown below.

<table>
<thead>
<tr>
<th>Element</th>
<th>Na</th>
<th>Mg</th>
<th>Al</th>
<th>Si</th>
<th>P</th>
<th>S</th>
<th>Cl</th>
<th>Ar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ionic Radius (pm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>212</td>
<td>184</td>
<td>181</td>
<td>—</td>
</tr>
<tr>
<td>Reaction with Cold Water</td>
<td>reacts vigorously</td>
<td>reacts very slowly</td>
<td>no observable reaction</td>
<td>no observable reaction</td>
<td>no observable reaction</td>
<td>no observable reaction</td>
<td>reacts slowly</td>
<td>no observable reaction</td>
</tr>
</tbody>
</table>

1. Identify the element in this table that is classified as a metalloid.  **Si** [2]

2. State the phase of chlorine at 281 K and 101.3 kPa.  **gaseous (Table S, MP)** [2]

3. State evidence from the technician’s data which indicates that sodium is more active than aluminum.

   **Sodium (Na) reacts vigorously in cold water but aluminum (Al) has no observable reaction.** [2]

Base your answers to questions 4 and 5 on the information below and on your knowledge of chemistry.

At standard pressure, water has unusual properties that are due to both its molecular structure and intermolecular forces. For example, although most liquids contract when they freeze, water expands, making ice less dense than liquid water. Water has a much higher boiling point than most other molecular compounds having a similar gram-formula mass.

4. Explain why H₂O (s) floats on H₂O (l) when both are at 0 °C.

   **Ice is less dense than liquid water.** [2]

5. State the type of intermolecular force responsible for the unusual boiling point of H₂O (l) at standard pressure.

   **Hydrogen bonds.** [2]

Go on to the next page.
6. Potassium phosphate, $\text{K}_3\text{PO}_4$, is a source of dietary potassium found in a popular cereal. Identify two types of chemical bonding in the source of dietary potassium in this cereal.

Ionic ($\text{K}^+$ and $\text{PO}_4^{3-}$) and polar covalent (or covalent) $\text{P} \rightarrow \text{O}$ bonds. [2]

7. Explain, in terms of intermolecular forces, why iodine is a solid at STP but chlorine is a gas at STP.

The van der Waals forces in I$_2$ are stronger than the van der Waals forces in Cl$_2$. [2]

Base your answers to questions 8 through 10 on the information below and on your knowledge of chemistry.

The equation below represents a chemical reaction at 1 atm and 298 K.

$$2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$$

8. State the change in energy that occurs in order to break the bonds in the hydrogen molecules.

Bond breaking is always endothermic. [2]

9. Compare the strength of attraction for electrons by a hydrogen atom to the strength of attraction for electrons by an oxygen atom within a water molecule. [2]

Oxygen attracts the bonded electrons more strongly than hydrogen does. (The electronegativity of O = 3.4 and only 2.2 for H. [2]

10. In the space below, draw a Lewis electron-dot diagram for a water molecule. [2]

$$\text{H}:\overset{\text{\textbullet\textbullet}}{\text{O}}:\text{H} \quad \text{or} \quad \text{H}$$

This is the last page.