1. What is the chemical formula for magnesium bromate?

   (A) MgBr   (B) MgBr₂   (C) MgBrO₃   (D) Mg(BrO₃)₂

REASON:
Mg²⁺ BrO₃⁻¹
Mg is +2 because it is located in group 2 of the Periodic Table. Bromate is BrO₃⁻¹ according to Reference Tables p. 7

2. How are compounds with metallic bonds similar to ionic compounds?

   (A) Both tend to have double and triple bonds.
   (B) Both tend to have low boiling points.
   (C) Both tend to have poor conductivity.
   (D) Both tend to have high melting points.

REASON:
Metals do not form double and triple bonds in general because metals want to lose electrons (not share) in order to become stable. Metals have high melting points and so do ionic compounds.

3. Which of these elements has the greatest atomic radius?

   (A) H   (B) N   (C) Cl   (D) Cs

REASON:
The element with the largest atomic radius is closest to the bottom left hand side of the periodic table.

4. How does the amount of heat energy change as a 250 gram sample of water is heated from 5.0°C to 30.0°C?

   (A) The amount of heat energy changes, causing the water to sublime.
   (B) The amount of heat energy changes, causing the water to evaporate.
   (C) As the temperature increases, the amount of heat energy decreases.
   (D) As the temperature increases, the amount of heat energy increases.

REASON:
Temperature changes when heat energy is added to a substance that is not at its melting point or boiling point.

5. This graph represents data collected when a sample of gas is uniformly cooled from 155°C. Why does the temperature of the sample remain constant between point X and point Y?

   (A) because the sample is transitioning from a gaseous state to a solid state
   (B) because the sample is transitioning from a gaseous state to a liquid state
   (C) because the sample is transitioning from a solid state to a gaseous state
   (D) because the sample is transitioning from a liquid state to a solid state
REASON: In the slanted part to the left of the X, the sample is changing temperature as a gas. From X to Y, the sample is changing from a gas to a liquid. In the slanted part after Y, the sample is changing temperature as a liquid.

6. The phases of a substance under various pressure and temperature combinations are shown on this phase diagram. What occurs if the pressure of the substance at point F remains constant, and the temperature increases to point G?

   (A) It will transition from a solid state to a liquid state.
   (B) It will transition from a liquid state to a solid state.
   (C) It will transition from a solid state to a gaseous state.
   (D) It will transition from a gaseous state to a solid state.

7. The potential energy diagram of a chemical reaction is shown below. Which best describes the energy in the chemical reaction?

   (A) Heat energy was released.
   (B) Energy was lowered by a catalyst.
   (C) 8 J of energy were required to start the reaction.
   (D) 10 J of energy were required to start the reaction.

   REASON: Activation energy is the energy needed to start a reaction. $10 - 2 = 8$ See diagram on next page.
8. This balanced chemical equation represents a chemical reaction:

\[ 6\text{NO} + 4\text{NH}_3 \rightarrow 5\text{N}_2 + 6\text{H}_2\text{O} \]

What volume of \(\text{NH}_3\) gas, at Standard Temperature and Pressure (STP), is required to react with 15.0 g of NO?

(A) 5.68 L  
(B) 7.47 L  
(C) 10.0 L  
(D) 11.2 L

**REASON:**

\[
\frac{15.0 \text{ g NO}}{30 \text{ g}} = 0.5 \text{ moles NO} \\
0.5 \text{ moles NO} = \frac{x \text{ moles NH}_3}{6} \\
\frac{4}{x} = 0.333 \text{ moles NH}_3 \\
0.333 \text{ moles} \times 22.4 \text{ L} = 10.0 \text{ L} \\
\frac{1 \text{ mole}}{}
\]

9. The equation represents a chemical reaction at equilibrium:

\[ \text{HCl (aq)} + \text{Mg (s)} \leftrightharpoons \text{MgCl}_2 (aq) + \text{H}_2 (g) + \text{heat} \]

What happens to the system when the temperature is decreased?

(A) The reaction shifts toward the right, and the amount of hydrogen gas increases.

(B) The reaction shifts toward the right, and the amount of hydrogen gas decreases.

(C) The reaction shifts toward the left, and the amount of hydrogen gas increases.

(D) The reaction shifts toward the left, and the amount of hydrogen gas decreases.

**REASON:** “temperature” is represented by the “heat” on the right-hand side of the equation. So, if temperature decreases, then heat decreases. In order to get more heat, the reaction will shift to the right. In addition to more heat, it will also produce more hydrogen gas (and MgCl\(_2\)).

10. This equation represents a chemical reaction at equilibrium:

\[ 2\text{SO}_2 (g) + \text{O}_2 (g) \leftrightharpoons 2\text{SO}_3 (g) \]

What will happen when the concentration of \(\text{SO}_3\) is increased?

(A) The reaction shifts to the right, and the concentrations of \(\text{SO}_2 (g)\) and \(\text{O}_2 (g)\) decrease.
(B) The reaction shifts to the right, and the concentrations of SO\(_2\) (g) and O\(_2\) (g) increase.
(C) The reaction shifts to the left, and the concentrations of SO\(_2\) (g) and O\(_2\) (g) decrease.
(D) The reaction shifts to the left, and the concentrations of SO\(_3\) (g) and O\(_2\) (g) increase.

**REASON:** If the concentration of SO\(_3\) increases, then the reaction will shift to the left in order to “get rid of” the extra SO\(_3\). When the reaction shifts to the left, more SO\(_2\) and O\(_2\) are produced.

11. A student conducts an experiment to identify the pH of some common household substances. The data is recorded in this table.

<table>
<thead>
<tr>
<th>Substance</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ammonia</td>
<td>11.9</td>
</tr>
<tr>
<td>Drain Cleaner</td>
<td>13.5</td>
</tr>
<tr>
<td>Hand Soap</td>
<td>10.1</td>
</tr>
<tr>
<td>Lemon Juice</td>
<td>2.3</td>
</tr>
<tr>
<td>Vinegar</td>
<td>3.0</td>
</tr>
<tr>
<td>Water</td>
<td>6.8</td>
</tr>
</tbody>
</table>

Which substance would be classified as containing the highest concentration of hydroxide ions?
(A) ammonia  (B) drain cleaner  (C) lemon juice  (D) vinegar

**REASON:** Highest concentration of hydroxide ions (OH\(^{-}\)) = most basic
Most basic = highest pH

12. A newly synthesized ionic compound is placed in water to make an aqueous solution. Which best describes the new ionic solution?
(A) The ionic solution conducts electricity.
(B) The ionic solution dissolves nonpolar solutions.
(C) The ionic solution cannot conduct electricity.
(D) The ionic solution is a neutral solution.

**REASON:** In order for a substance to be an electrolyte, it must be ionic and able to dissolve in water. Both of these criteria fit. (Note: the “aqueous solution” part implies that the ionic compound dissolved.)

13. Why is potassium chloride able to dissolve in water?
(A) because potassium ions are attracted to the partial negative charge of hydrogen
(B) because potassium ions are attracted to the partial positive charge of hydrogen
(C) because potassium ions are attracted to the partial negative charge of oxygen
(D) because potassium ions are attracted to the partial positive charge of oxygen

**REASON:** Potassium ions are positively charged (K\(^{+}\)), so they will be attracted to the negative part of the water. Oxygen has the partial negative charge because it is more electronegative than hydrogen.

14. Which occurs if an electron transitions from n = 5 to n = 2 in a hydrogen atom?
(A) Energy is absorbed, and visible light is emitted.
(B) Energy is released, and visible light is emitted.
(C) Energy is released, and visible light is not emitted.
(D) Energy is absorbed, and visible light is not emitted.

**REASON:** When an electron moves from a higher energy level to a lower energy level, energy is released. When energy is released, some form of electromagnetic radiation must be emitted.
15. When a gamma ray is emitted by an element, what happens to the atomic mass and the atomic number?

(A) The atomic mass stays the same, and the atomic number stays the same.

(B) The atomic mass changes, and the atomic number stays the same.

(C) The atomic mass stays the same, and the atomic number changes.

(D) The atomic mass changes, and the atomic number changes.

REASON: Gamma radiation does not have a mass or a charge. It is simply energy.

16. How does a single covalent bond between two carbon atoms compare to a double covalent bond between two carbon atoms?

(A) A single covalent bond is stronger and has a longer bond length than a double covalent bond.

(B) A single covalent bond is stronger and has a shorter bond length than a double covalent bond.

(C) A single covalent bond is weaker and has a shorter bond length than a double covalent bond.

(D) A single covalent bond is weaker and has a longer bond length than a double covalent bond.

REASON: Two shared pairs of electrons is stronger than one shared pair of electrons. The stronger bond pulls the atoms closer to each other, resulting in a shorter bond length.

All of the questions above are from: http://www.ncpublicschools.org/docs/accountability/common-exams/chemrelease14.pdf
Reasoning is from Ms. Duncan