Multiple Choice: (4 points each. Put answers in left margin as capital letters.)

1. Which of the following sets of measurements is most accurate for 5.00 g reference weight?
   A) 4.92 g, 5.00 g, 5.02 g  
   B) 4.97 g, 4.98 g, 4.99 g  
   C) 4.93 g, 5.01 g, 5.07 g  
   D) 5.03 g, 5.03 g, 5.04 g  
   E) 4.90 g, 4.95 g, 5.00 g

2. How many significant figures are in the answer to the following problem? \((35 + 74) \times 1226\)?
   A) 1  
   B) 2  
   C) 3  
   D) 4  
   E) 5

3. Which of the following is a pure substance?
   A) air  
   B) concrete  
   C) Jello®  
   D) neon  
   E) saltwater

4. A block has a temperature of 601 °C. What is its temperature in Kelvins?
   A) 316  
   B) 328  
   C) 601  
   D) 874  
   F) 1110

5. Which of the following is an alkaline earth element?
   A) lithium  
   B) beryllium  
   C) oxygen  
   D) fluorine  
   E) neon

6. The correct number of protons, neutrons, and electrons in \(\text{Se}^{4+}\) (Se-79) is:
   A) 30p, 45n, 34e  
   B) 34p, 45n, 30e  
   C) 34p, 45n, 34e  
   D) 79p, 34n, 34e  
   E) 79p, 34n, 34e

7. Which of the following is least likely to represent a real compound?
   A) \(\text{Al(C}_2\text{H}_3\text{O}_2)_3\) \((\text{Al(CH}_3\text{CO}_2)_3)\)  
   B) \(\text{CaBr}_2\)  
   C) \(\text{K}_2\text{SO}_4\)  
   D) \(\text{Mg}_3(\text{PO}_4)_2\)  
   E) \(\text{NH}_4\text{Cl}_2\)

8. Which of the following symbols is used to indicate the addition of light to a chemical reaction?
   A) (g)  
   B) h  
   C) \(\text{hv}\)  
   D) (s)  
   E) \(\Delta\)

9. Which of the following is an example of a decomposition reaction?
   A) \(\text{N}_2 + 3 \text{H}_2 \rightarrow 2 \text{NH}_3\)  
   B) \(\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2\)  
   C) \(\text{AgNO}_3 + \text{NaCl} \rightarrow \text{AgCl} + \text{NaNO}_3\)  
   D) \(\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}\)  
   E) None of these is a decomposition reaction
Discussion Questions: (You must show your work to receive credit.)

1. Define: (12 points)
   energy – the capacity to transfer heat or do work
   element – pure substances that consist of only one type of atom and cannot be broken into simpler substances
   stoichiometry – the quantity relationship between reacting chemical species

2. Magnesium is used in automobile wheels because it is “lighter” than steel. What is a more scientifically correct statement of this? (6 points)
   Magnesium is used in automobile wheels because it is less dense than steel.

3. Complete the following: (11 points)
   \[ \text{WO}_3 (s) + 3 \text{H}_2 (g) \rightarrow \text{W} (s) + 3 \text{H}_2\text{O} (g) \]
   When solutions of magnesium bromide and lithium carbonate are mixed, solid magnesium carbonate forms and lithium bromide remains in solution.
   \[ \text{MgBr}_2 (aq) + \text{Li}_2\text{CO}_3 (aq) \rightarrow \text{MgCO}_3 (s) + 2 \text{LiBr} (aq) \]

4. For the following, give the name or formula where appropriate: (15 points)
   NiF\(_2\) – nickel(II) fluoride
   lithium sulfate – Li\(_2\)SO\(_4\)
   N\(_2\)O\(_4\) – dinitrogen tetroxide
   phosphorus trichloride – PCl\(_3\)
   HNO\(_3\) – nitric acid

5. In early to mid-20\(^{th}\) century warships, smoke screens were created by pouring TiCl\(_4\) into the ocean. It would react with the water to produce clouds of TiO\(_2\), which is now used as the base for house paint. If 454 g of TiCl\(_4\) are mixed with 454 g of water, how much TiO\(_2\) will be produced? How much of which reagent will be left over? (10 points)
   \[ \text{TiCl}_4 (l) + 2 \text{H}_2\text{O} (l) \rightarrow \text{TiO}_2 (s) + 4 \text{HCl} (aq) \]

   a) Determine the limiting reagent by first calculating the number of moles of each substance present.
   \[
   \text{mol}_{\text{TiCl}_4} = (454 \text{ g}_{\text{TiCl}_4}) \left( \frac{1 \text{ mol}_{\text{TiCl}_4}}{189.7 \text{ g}_{\text{TiCl}_4}} \right) = 2.39 \text{ mol}_{\text{TiCl}_4}
   \]
   \[
   \text{mol}_{\text{H}_2\text{O}} = (454 \text{ g}_{\text{H}_2\text{O}}) \left( \frac{1 \text{ mol}_{\text{H}_2\text{O}}}{18.01 \text{ g}_{\text{H}_2\text{O}}} \right) = 25.2 \text{ mol}_{\text{H}_2\text{O}}
   \]
   Now determine how much water is required to use up all of the titanium(IV) chloride.
**mol**<sub>H₂O</sub>(required) = \((2.39 \text{ mol}_{\text{TiCl}_4})\left(\frac{2 \text{ mol}_{\text{H}_2\text{O}}}{1 \text{ mol}_{\text{TiCl}_4}}\right) = 4.78 \text{ mol}_{\text{H}_2\text{O}}\)

But you have 24.2 mol<sub>H₂O</sub>, which is more than enough so titanium(IV) chloride is limiting.

\[
\text{mass}_{\text{TiO}_2} = (454 \text{ g}_{\text{TiCl}_4}) \left(\frac{1 \text{ mol}_{\text{TiCl}_4}}{189.7 \text{ g}_{\text{TiCl}_4}}\right) \left(\frac{1 \text{ mol}_{\text{TiO}_2}}{1 \text{ mol}_{\text{TiCl}_4}}\right) \left(\frac{79.87 \text{ g}_{\text{TiO}_2}}{1 \text{ mol}_{\text{TiO}_2}}\right) = 191 \text{ g}_{\text{TiO}_2}
\]

b) \[
\text{mass}_{\text{H}_2\text{O}}(\text{remaining}) = 454 \text{ g}_{\text{H}_2\text{O}} - (2.39 \text{ mol}_{\text{TiCl}_4}) \left(\frac{2 \text{ mol}_{\text{H}_2\text{O}}}{1 \text{ mol}_{\text{TiCl}_4}}\right) \left(\frac{18.02 \text{ g}_{\text{H}_2\text{O}}}{1 \text{ mol}_{\text{TiCl}_4}}\right) = 368 \text{ g}_{\text{H}_2\text{O}}
\]

6. Milk of magnesia is one of the oldest antacids. The material is a slurry of a magnesium compound in water. The compound is 41.7% magnesium, 54.9% oxygen, and 3.5% hydrogen. The mineral weighs about 60 g per mole. What are its empirical and molecular formulas? (10 points)

Assume 100 g of compound:

\[
\text{mol}_{\text{Mg}} = \left(\frac{41.7 \text{ g}_{\text{Mg}}}{24.305 \text{ g}_{\text{Mg}}}\right) = 1.72 \text{ mol}_{\text{Mg}}
\]

\[
\text{mol}_{\text{O}} = \left(\frac{54.9 \text{ g}_{\text{O}}}{15.9994 \text{ g}_{\text{O}}}\right) = 3.43 \text{ mol}_{\text{O}}
\]

\[
\text{mol}_{\text{H}} = \left(\frac{3.5 \text{ g}_{\text{H}}}{1.00794 \text{ g}_{\text{H}}}\right) = 3.47 \text{ mol}_{\text{H}}
\]

\Rightarrow \text{ empirical formula} = \text{MgO}_2\text{H}_2

\[
\text{empirical weight} = \left(\frac{24.0 \text{ g}_{\text{Mg}}}{\text{mol}_{\text{Mg}}}\right)\left(\frac{1 \text{ mol}_{\text{Mg}}}{\text{eu}}\right) + \left(\frac{16.0 \text{ g}_{\text{O}}}{\text{mol}_{\text{O}}}\right)\left(\frac{2 \text{ mol}_{\text{O}}}{\text{eu}}\right) + \left(\frac{1.0 \text{ g}_{\text{H}}}{\text{mol}_{\text{H}}}\right)\left(\frac{2 \text{ mol}_{\text{H}}}{\text{eu}}\right) = 58 \text{ g/\text{eu}}
\]

\[
\text{empirical units} = \left(\frac{60 \text{ g}}{\text{molecule}}\right)\left(\frac{\text{eu}}{58 \text{ g}}\right) = 1.03 \text{ eu/molecule} \approx 1 \text{ eu/molecule}
\]

Thus the molecular formula is \text{MgO}_2\text{H}_2.