Demonstration: Firefighter or Fireball – Answer Key

Pre-lab Questions
1. Define the following vocabulary words:

   a. Reactant – Chemical used in reaction, on the left side of the arrow, consumed in a reaction

   b. Product – Chemical produced in reaction, on the right side of the arrow, produced in a reaction

   c. Synthesis reaction – Two reactants combine to produce one product. There are several classes of synthesis reactions:
      o Metal + nonmetal = salt
      o Nonmetal + nonmetal = covalent compound
      o Metal oxide + nonmetal oxide = metal polyatomic ion compound
      o Metal oxide + water = metal hydroxide
      o Nonmetal oxide + water = acid

   d. Decomposition reaction – One reactant decomposes into more than one product. There are several classes, which mirrors the synthesis reactions.
      o Binary compound = elements
      o Carbonates = oxide + carbon dioxide
      o Sulfates = oxide + sulfur trioxide
      o Nitrates = nitrite + oxygen
      o Chlorates = chloride + oxygen
      o Hydroxides = oxides + water

   e. Single replacement reaction – Metal + compound yields a metal and compound, the metal will replace the cation of the compound. Single replacement reactions are governed by the activity series. You may want to direct the students to point out the place of hydrogen on the activity series and the significance of that with metal/acid reactions producing hydrogen gas.

   f. Double replacement reaction – compound + compound yields two new compounds. The cations can be thought of as switching partners. This type of reaction is driven by the solubility of the products of the reaction.

   g. Combustion reaction – A hydrocarbon + oxygen yields carbon dioxide and water

   h. Reversible reaction – a reaction that can be reversed, meaning the products can be converted back into the reactants by the same path that they were created.

   i. Nonreversible reaction – a reaction that cannot be reversed, meaning that the products cannot be converted back into reactants by the same path.
2. For the following reactions, identify the type of reaction and predict the products of the reaction, then balance the equation:
   a. Synthesis \(2 \text{Na} + \text{Cl}_2 \rightarrow 2 \text{NaCl}\)
   b. Decomposition \(\text{H}_2\text{CO}_3 \rightarrow \text{H}_2\text{O} + \text{CO}_2\)
   c. Single Replacement \(2 \text{Li} + 2 \text{HCl} \rightarrow 2 \text{LiCl} + \text{H}_2\)
   d. Double Replacement \(2 \text{NaCl} + \text{Pb(NO}_3\text{)}_2 \rightarrow 2 \text{NaNO}_3 + \text{PbCl}_2\)
   e. Combustion \(\text{C}_3\text{H}_8 + 5 \text{O}_2 \rightarrow 3 \text{CO}_2 + 4 \text{H}_2\text{O}\)

Analysis
Balloon #1:
Finish the chemical reaction for Balloon #1

\[\text{NaHCO}_3 + \text{HC}_2\text{H}_3\text{O}_2 \rightarrow \text{NaC}_2\text{H}_3\text{O}_2 + \text{CO}_2 + \text{H}_2\text{O}\] (Students may not come up with this right away)

1. Usually, in a double replacement reaction, there are 2 products. What are the products of the reaction above, if it was a typical double replacement reaction? Students should recognize that the products should be sodium acetate and carbonic acid. It may be difficult for the students to identify the products.
2. Since there was a gas produced from the reaction, what is the identity of the gas? Describe how the reaction of the match with the balloon helps to confirm your guess about the identity of the gas. The students should recognize that carbon dioxide is the product, but they may say that it is water.
3. What are the products for a combustion reaction? How is the reaction for Balloon #1 similar to a combustion reaction? \(\text{CO}_2 + \text{H}_2\text{O}\). The products of a combustion reaction are \(\text{CO}_2\) and \(\text{H}_2\text{O}\)

Balloon #2:
Finish the chemical reaction for Balloon #2

\[\text{CaC}_2 + \text{H}_2\text{O} \rightarrow \text{C}_2\text{H}_2 + \text{CaO or Ca(OH)}_2\] (Students may not see that the CaO would react with water to make calcium hydroxide and it doesn’t change the demonstration or reaction either way)
4. What was different for the reaction of the match with Balloon #2? Which product of the reaction was the match reacting with? Balloon 2 ignited because the acetylene, \(\text{C}_2\text{H}_2\), burned.

5. Describe the properties of the gasses produced from both reactions. How were they similar? How were they different? List and describe at least 2 similarities and differences between the two gases. Both gases contain carbon, but one is flammable and one puts out the fire. \(\text{CO}_2\) is a product of combustion and \(\text{C}_2\text{H}_2\) is a reactant in combustion, etc.

6. When the match was brought close to the balloon, why did the reaction of the gas produced in Balloon #2 stop? What reactant was consumed completely? The acetylene was consumed completely, producing carbon dioxide gas and water.