Combustion Demonstrations (Redox Reactions) – *ANSWERS*

1. The whoosh jug

a. Observations:
When a match is dropped into the jug, a big whoosh of flame

b. Reaction for combustion of ethyl alcohol (C_2H_5OH):
$C_2H_5OH_{(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 3\ H_2O_{(g)}$

c. What is it that is whooshing out of the jug?
When the burn occurs, more gases are formed than are started with, AND the gases get heated up which make them expand. Both of these reasons cause gases to push up and out of the top of the jug.

d. Why was the jug rotated and twirled for a minute or two before the reaction?
The twirling was necessary to help the alcohol to evaporate and turn into a vapor.

e. Extra unburned liquid alcohol remained in the jug after the initial combustion. This alcohol could be poured out onto the lab bench and ignited. Why did it not all burn inside the jug?
There was no oxygen left in the jug after the first burn thus a second combustion could not occur in the jug, just at the mouth of the jug.

f. When the same alcohol is ignited on the lab bench, why doesn't it give off a big whoosh?
The whoosh will only occur when the burn takes place in an enclosed container, and the hot expanding gases push out through the small opening.

g. Why does the jug collapse when the opening was covered right after the whoosh?
The hot gases all whooshed out. The gases left are hot, but as soon as the flame was extinguished, the gases began to cool and shrink (or cause less pressure). Since the opening is covered, the air can't push back in through the opening, so the air tries to push in through the plastic, collapsing the jug.

2. Burning dollars

a. Observations:
Dipped in one liquid the paper (dollar) does not burn. Dipped in the other solution, the paper burns.

b. Reaction for combustion of isopropyl alcohol (C_3H_7OH):
$2\ C_3H_7OH_{(g)} + 9\ O_{2(g)} \rightarrow 6\ CO_{2(g)} + 8\ H_2O_{(g)}$

c. Why did the paper burn, yet the dollar bill remained intact?
The bill was dipped in a 50% alcohol/50% water solution. The presence of the water absorbed much of the energy from the burning alcohol so that the bill never got hot enough to ignite.

d. Why does the fire department use water to put out fires?
Water is used to put out fires because it cools the unburned fuel (wood that hasn't burned yet) so much that there isn't enough heat to allow the combustion to continue. For fire to occur, all three items in the fire triangle must be present.

3 Methane bubbles vs Propane bubbles

a. Observations:
Methane bubbles rose to the ceiling, and propane bubbles sank to the floor. Both bubbles ignited when lit with the candle.

b. Reaction for combustion of propane (C_3H_8):
$C_3H_{8(g)} + 5\ O_{2(g)} \rightarrow 3\ CO_{2(g)} + 4\ H_2O_{(g)}$

c. Methane is CH_4 , propane is C_3H_8 , oxygen is O_2 , and nitrogen is N_2 . What do the molar masses of these chemicals imply about the density of these gases? Why does the methane balloon rise up to the ceiling, yet the propane bubble sinks to the floor?
Methane, CH_4 weighs 16 g/mole, propane, C_3H_8 weighs 44 g/mole. Air weighs 29 g/mole (80% N_2 = 28, 20% O_2 = 32)
This methane is less dense than air so it floats, and propane is more dense than air so it sinks.

4 Pop the cork (small scale and big scale)

a. Observations:
When the Oudin sparker coil is touched to the nails, a pop is heard, and the cork flies up out of the bottle.

b. Reaction for combustion of methyl alcohol (CH_3OH):
$2\ CH_3OH_{(g)} + 3\ O_{2(g)} \rightarrow 2\ CO_{2(g)} + 4\ H_2O_{(g)}$

c. Why were there two nails (not one) stuck in the sides of the bottle and why was it important that they were not touching yet not too far apart?
They were not touching to that the spark from the Oudin coil would jump across the gap and ignite the alcohol vapor. If they were too far apart, they spark may not jump and thus not ignite the alcohol.

d. What actually causes the cork to get pushed out of the top?
The cork goes out of the top for the very same reasons that the whoosh occurred with the whoosh jug (#1c)

e. What two factors cause the gases to take up more space than the bottle can hold?
The fact that more gases are produced (6 moles) than we start with (5 moles) and the fact that the gases get heated up during the burn and therefore expand.

5 Flaming suds

a. Observations:
Suds filled with methane gas give a large flame when ignited.

b. Reaction for combustion of methane (CH_4):
$CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

c. Why doesn't the flame burn your hands?
The hands had water on them which helped to cool the flame, and the methane is less dense that air so that it floats upward as soon it is released from the bubble and it starts to burn. This helps to take the flame off of the hands.

d. To put the suds on someone's head, why is it a good idea to wet the hair first?
Hair is quite flammable and it would be very important to wet the hair so that it wouldn't burn.

6 Burning ice cubes

a. Observations:
Brown pellets sprinkled on ice cubes cause sizzling and foamy milky liquid. When a flame is introduced to the beaker a pop and flames begin to burn on top of the cubes

b. Obviously ice cubes don't burn. The first reaction that occurs is a modified double replacement reaction in which calcium carbide, CaC_2, reacts with water to produce acetylene, C_2H_2, and calcium hydroxide. Write out the balanced education
$CaC_{2(s)} + 2\ H_2O_{(L)} \rightarrow C_2H_{2(g)} + Ca(OH)_{2(aq)}$

c. Then the acetylene combusts when an ignition flame is introduced. Write out the balanced equation for the combustion of acetylene.
$2\ C_2H_{2(g)} + 5\ O_{2(g)} \rightarrow 4\ CO_{2(g)} + 2\ H_2O_{(g)}$

d. The combustion of acetylene is an incomplete combustion at the fuel / oxygen ratio available in the beaker. What was floating through the room that was a product of the incomplete combustion?
Little thingys of soot, $C_{(s)}$ are forming because there was not enough oxygen available.
When there is not enough quantity of oxygen available or the temperature of the burn is not hot enough, the carbon may not turn completely into carbon Dioxide. Carbon MONoxide or just carbon may form.
When carbon monoxide forms and people are around, it is particularly dangerous because the hemoglobin in you blood will 200x preferentially choose carbon monoxide over oxygen gas. This of course leads to death more quickly than if you were in a room with some oxygen and some carbon dioxide.

7 "Egg-splosion"

a. Observations:
A flame is lit on the top of the egg, after some time passes, the egg explodes.

b. Reaction for combustion of hydrogen gas. (This is also a synthesis reaction.)
$2H_2 + O_2 \rightarrow 2H_2O$

c. The hydrogen flowing out of the top ignites immediately, but the egg does not blow up until time passes. Why?
The egg is full of hydrogen with no oxygen in the egg. As the hydrogen gas flows out, it can burn when it combines with oxygen in the air. As hydrogen flows out the top, air will flow in the bottom. Eventually enough air will flow in and allow the flame to move in an burn inside the egg, causing the explosion.