Free Worksheet of the Month, June 2000

The Exploding Balloon

Since it's getting to be the end of the year, I've decided to send off a demo lab rather than a worksheet. It's called "The Exploding Balloon" lab. Don't worry, nothing explodes or catches fire.

Here's how you do the demo part:

1) Get the materials:
   - 250-mL Erlenmeyer flask
   - ring stand and ring
   - wire gauze
   - Bunsen burner and striker
   - utility clamp
   - large round balloon
   - two rubber bands
   - fume hood or plastic safety shield
   - Goggles for everybody!

2) Set up the ring stand such that the Bunsen burner is placed directly under the ring and wire gauze. The utility clamp should be attached to the ring stand at a height such that when the Erlenmeyer flask is placed on the ring stand the clamp can be attached to the neck of the flask.

3) Make everybody put on goggles. Place 50 mL of water in the Erlenmeyer flask. Pull the balloon over the mouth of the flask so it becomes covered. Use the rubber bands to attach the balloon to the mouth of the flask. These must be very tight, or the balloon just flies off.

4) Clamp the Erlenmeyer flask over the Bunsen burner so it sits on the wire gauze. It should be very firmly attached so it cannot break free.

5) Turn on the Bunsen burner and pull the safety shield/fume hood sash such that if the balloon were to explode violently, nobody would get hurt. Of course, the balloon will NOT explode violently (it'll only be filled with steam), but it's better to be safe than sorry.

6) You will observe the balloon filling up with steam as the water boils. As time progresses, the water will condense in the balloon and it will start to droop. When the balloon droops enough, it will be melted by the burner and pop. Steam and warm water will be splattered all over the inside of the shield/hood sash, making it appear even more surprising.

7) Clean up: Let everything cool down and throw the balloon away.

Why did we do this?

During the early part of the year, your students learned that gases are much larger than liquids. They also learned that hot gases (like steam) have more volume than cool gases. However, the chances are good that they've never seen this phenomenon for themselves. With this lab you can show them how dramatic a change this is.

Done correctly this is a completely safe lab, especially since the students aren't going to be anywhere near the balloon. I want to strongly caution you not to do this lab if you don't have a fume hood or safety shield. Hot steam is one of the most dangerous things that can be found in a chemistry lab – it can cause more damage to the skin and eyes in a short period of time than any other substance that you'll use. That's why I caution in the procedure that you should have everything set up such that if the balloon were to explode violently, everybody would be safe. The danger inherent in using steam is not as well appreciated as it should be, so be careful.

The important thing is that this is a fun demo and the kids really enjoy it. The worksheet that goes along with it is not something they enjoy as much, though it really gives them an appreciation for the concepts we discussed above.

Solutions to the worksheet:

1) 5 grams / 18 grams/mole = 0.28 moles

2) Using PV = nRT, where P = 1.00 atm, n = 0.28 moles, R = 0.08206 L·atm/mol·K, V = 8.57 L.

3) 8,750 mL / 5 mL x 100% = 175,000 %

4) Liquid water condensed in the balloon and caused it to sag. When the balloon sagged it got closer to the heat. Eventually the heat caused the balloon to pop!

The Exploding Balloon Demo Lab

Please answer the following questions based on what you've learned this year:

1) At any given time, the amount of water which was in the form of steam was very small, perhaps five grams. How many moles of water are there in five grams?

2) If five grams of water were vaporized, how big would the balloon become? Assume the temperature of the steam was exactly 100.0^0 C and the atmospheric pressure was exactly 1.00 atm.

3) Using the volume you found in problem 2, find the percent increase in volume caused by vaporization.

4) Why do you think the balloon eventually popped? Your answer should reflect your observations of this experiment.