Periodic Properties Laboratory: Hydrolysis of Metal and Nonmetal Oxides.

Experimental Procedure and Post-lab Assignments
Submit your answers to the questions found at the end of the procedure by the announced due date. The work can be divided up among the group members, but everyone in the group must hand in a complete set of work under their own name. Please include printout from any calculations done using EXCEL or another program.

Materials
- One stainless steel spatula
- Two 250-ml beakers, one to hold waste solution and the other to hold the pipets
- Bottles containing saturated calcium hydroxide (limewater) and 1.0 M hydrochloric acid (HCl)
- Two quart sized Ziploc bags and two large-bulb pipets that are clean and dry
- One clean, dry well plate

Procedures

Hydrolysis of barium oxide and phosphorus pentoxide
Add a few milligrams (mg) of barium oxide and phosphorus pentoxide to two separate wells of the well plate. A few mg is the amount corresponding to the tip of the spatula. Use your wash bottle to transfer enough water to each well to half fill it. Stir with the spatula and add one drop of universal indicator. Provide balanced equations for what you observe and comment on the acid/base character of these oxides.

Preparation and hydrolysis of carbon dioxide
You will use your Ziploc bag to generate and contain the carbon dioxide. The gas is sampled with a large bulb pipet and then bubbled through the test solutions that are kept in the well plate. Put about 2 grams (g) of sodium bicarbonate into the bottom corner of the bag and lay it horizontally on the bench top. Place a small pipet containing 1.0 M hydrochloric acid into the bag as shown. Smooth out the bag and then seal it. Squeeze the small pipet that is in the bag so that the acid slowly drips onto the sodium bicarbonate to generate the carbon dioxide. Make sure that the bag is kept sealed and the reaction mixture is at the bottom. What is happening? Feel the outside of the bag in the vicinity of the ongoing chemical reaction; what is the significance of this observation?

When the reaction is over (how do you know?) you will have a bag partially filled with carbon dioxide. Do not expect the bag to puff up or inflate. To sample the gas, squeeze the bulb of the large pipet to expel the air, and then insert the pipet tip through a corner of the zip seal. With practice, you should be able to insert the pipet tip through the zip seal without opening up the entire seal. Make sure that the tip of the pipet is not in contact with the reaction mixture as you release the bulb and fill it with the generated gas. Remove the pipet tip from the bag and then make sure that you reseal the bag.

Half fill three wells in your well plate with 1) water and one drop of universal indicator, 2) limewater, and 3) limewater and one drop of phenolphthalein indicator. To each of the first
two wells slowly bubble the contents of 1-3 pipet bulbs full of gas. Add just enough gas to effect a visible chemical change. The last well will require the contents of 2-3 pipet bulbs of gas slowly bubbled through the test solution to effect a visible change. Design and carry out the appropriate control experiments. Account for all observations as you provide balanced chemical equations for the above reactions.

**Preparation and hydrolysis of sulfur dioxide**

*Warning:* Sulfur dioxide is toxic in large quantities. Smaller quantities used in the lab are characterized by a sharp penetrating odor. Contain the sulfur dioxide in the plastic bag or pipet. Avoid breathing it. Work in a fume hood.

Repeat the carbon dioxide experiment except that sodium bisulfite is substituted for the sodium bicarbonate.

**Waste disposal and cleanup**

All waste solutions are transferred to your waste beaker, which is emptied at the end of lab into a chemical waste disposal jar. Rinse the pipets with tap water and then deionized water in the dishpan. Rinse out the plastic bags and turn them inside out. Make sure that all of your equipment is clean and that you wash your hands before you leave.

**Post-lab Questions**

1) Predict the type of bonds found in the following binary oxides
   a)  BaO  Bond Type =___________________
   b)  CO$_2$ Bond Type =___________________
   c)  P$_4$O$_{10}$ Bond Type =_______________
   d)  SO$_2$ Bond Type =_______________

2) Write balanced chemical equations for all of the reactions that occurred in the various experimental procedures of today’s laboratory.

3) How does the acid/base behavior of the hydrolysis products of oxide compounds vary with the electronegativity of the elements and bonding between the elements in the binary oxide? Explain and provide example molecules that support your thinking.
Group Evaluation

Evaluate the performance of the other members of your group on a 0 to 4 scale. Your rating should be based on your co-worker’s preparation, quality and quantity of data collected, laboratory record keeping, assistance to other group members in lab and on post-lab questions, safety practices, experimental technique, and contribution to solving problems.

**You cannot give any two group members the same rating.**

**You must write a 1-line justification for each rating.**

**Your instructor will not reveal your ratings to other students.**

**Your instructor will also rate you, and reserves the right to adjust your ratings if they are felt to be inaccurate.**

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