Name: ______________________________________ Team: _____________ Date: ______________________

Wizardry and Chemistry Lab Handout

BACKGROUND
The key instrument of every successful wizard is his/her wand. This wand is chosen by the up-in-coming wizard and is unique to that wizard.

> *"Harry took the wand. He felt a sudden warmth in his fingers. He raised the wand above his head, brought it swishing down through the dusty air and a stream of red and gold sparks shot from the end like a firework, throwing dancing spots of light onto the walls."*

However, in the Muggle world, we never use magic wands, but perhaps use something similar to a wand—SPARKLERS! Why the sparkler? This fantastic spell (light) caster is unique to the creator and ignites with brilliant colors, just as Harry's wand did for him.

Today you are muggle chemists making your own fast-acting magic wands. To complete this task, you must read and understand the cautionary note below. 🡻

CAUTION!! The ingredients that you will be using are reactive when exposed to certain conditions and are to be handled as instructed and with care.
Following the instructions ensures that the materials are safe for handling.

MATERIALS
Sparkler 1: "Gryffindor"
- 5 g iron powder (-200 mesh)
- 1.0 g magnesium powder (-325 mesh)
- 7.0 g aluminum powder (-40 + 325 mesh)
- 6 g barium nitrate
- 25 g potassium nitrate

Sparkler 2: "Slytherin"
- 10 g iron powder (-200 mesh)
- 1.0 g magnesium powder (-325 mesh)
- 2.0 g aluminum powder (-40 + 325 mesh)
- 6 g potassium nitrate
- 25 g barium nitrate

Other General Materials:
- 9 g dextrin (starch)
- 20 ml distilled water
- 20 cm length 2 mm diameter Fe wire
- 150 ml beaker
- stir rod
- hot plate
- 18 x 150 mm test tube and test tube rack
- oven capable of 120°C
- apron, goggles and fume hood
- wash bottle
- (optional) hair dryer

PROCEDURE

1. Place 9 g of dextrin in a 150 ml beaker and add 15ml distilled water.
2. While stirring, heat the starch mixture gently; heat until it makes a paste.
3. Using separate weighing dishes under the fume hood, measure to the nearest gram the listed ingredients. Make sure all container lids are sealed tightly after each use.
4. Remove the beaker from the heat and add inorganic ingredients to the starch solution and stir. Perform this step under the fume hood until the mixture is uniform.
5. Pour/scrape the entire mixture into a test tube.
6. Quickly, dip iron wire into test tube, making sure to have an even coat along the length of the submerged wire. NOTE: If the mixture is too dry, add a few drops of distilled water and mix.
7. Pull the coated wire out of test tube and begin drying the paste using a hair dryer positioned approximately 10 cm away from the coated wire.
8. During drying, rotate the wire to keep the paste on the wire.
9. Once the mixture is no longer runny, stand the coated wire in the test tube rack.
10. To dry thoroughly, place the rack in an oven set at 120° C for one to three hours.
11. Give waste material in test tube to your teacher for proper disposal.
12. Wash all glassware using a wash bottle, taking care to dispose of the liquid and remaining sludge into a material waste container.
13. When finished cleaning up, complete the problem set.

*** Problem Set on Next Page ***

Wizardry and Chemistry Problem Set

1. Nitrates are stable at room temperature but decompose rapidly when sufficient heat is applied. Additionally, when nitrates decompose they form nitrites. For barium and potassium nitrates the newly formed nitrites are unstable. What happens if the newly formed nitrites are not stable? Do they react to form new products? Write a brief explanation along with the overall decomposition reaction for barium nitrate and potassium nitrate. Make sure your chemical equations are balanced.

2. Sparklers eject glowing metal particles for entertainment. What reaction products from the above equations propel these metal particles?

3. Fe, Al and Mg are very reactive in the presence of oxygen at elevated temperatures. Write and balance the respective reactions. Show which element is the oxidizing agent and which is the reducing agent.

4. Based on your sparkler chemistry what is the gas composition produced from the overall decomposition of potassium nitrate?

5. Based on your overall barium nitrate and potassium nitrate decomposition equations, calculate the enthalpy (KJ) for each reaction at room temperature. Are both reactions exothermic or endothermic? Predict the sign of the entropy term and explain the temperature dependence this term has on the spontaneity of each reaction.

Enthalpies of formation at room temperature (KJ/mol)			
$Ba(NO_3)_2$	**KNO_3**	**BaO**	**K_2O**
-988.00	**-494.628**	**-548.104**	**-363.171**

6. Given the thermodynamic data below, calculate the free energy and equilibrium constant for each metal powder oxidation reaction. Rank the reactions in order from least spontaneous to most spontaneous and explain what this means in terms of reactivity with oxygen.

Gibb's free energy of formation (KJ/mol)		
Al_2O_3	**MgO**	**FeO**
-1569.663	**-568.945**	**-251.429**

7. At room temperature, barium nitrate and potassium nitrate decomposition is spontaneous. However, both are relatively stable at room temperature and begin to decompose when the temperature is raised. Explain the following: Room temperature decomposition kinetics; temperature influence on reaction rate; reaction rate between the two nitrates based on their thermodynamic nature.

   Given:
   ΔG_{rxn} KNO_3 Decomposition = -934.232 KJ/mol

   ΔG_{rxn} $Ba(NO_3)_2$ Decomposition = -544.436 KJ/mol

8. Assuming that all of the barium nitrate and potassium nitrate completely decompose, how much oxygen is available to react with the powder metals present in your sparkler composition? Calculate the amount of excess oxygen present, if any. *HINT: More spontaneous reaction preferentially react first, then the second and finally the third reaction.*