Name: ________________________________

**Answer Key: Flame Test: Going Further**

**Background**
On a color wheel, red + yellow = orange and blue + yellow = green. In this lab, you will investigate whether this idea works when doing flame tests of metallic ions.

**Purpose**
Students will mix various metallic salts and then perform flame tests to determine if some dominant colors correspond to the reactivity of metals.

**Safety**
- Use caution around open flames.
- **Barium chloride** is highly toxic. Do not ingest the salt or solution.
- Always wear safety goggles when handling chemicals in the lab.
- Always be aware of an open flame. Do not reach over it, tie back hair, and secure loose clothing.
- Wash hands after handling materials used to prepare for or perform this experiment.

**Materials**
Per group:
- The following solutions:
  - 1.0M NaCl
  - 1.0M LiCl
  - 1.0M KCl
  - 1.0M SrCl₂
  - 1.0M BaCl₂
  - 1.0M CaCl₂
  - 1.0M CuCl₂
- Wood splints
- Forceps
- Bunsen burner
- Striker
- 22 small test tubes
- Test tube rack

**Procedure**
1. Place six small test tubes into a test tube rack.
2. To all six of the test tubes add 10 drops of NaCl solution.
3. To each of the test tubes holding the 10 drops of NaCl add:
   - 10 drops of LiCl to the first test tube and swirl to mix.
   - 10 drops of KCl to the second test tube and swirl to mix.
   - 10 drops of SrCl₂ to the third test tube and swirl to mix.
   - 10 drops of BaCl₂ to the fourth test tube and swirl to mix.
   - 10 drops of CaCl₂ to the fifth test tube and swirl to mix.
   - 10 drops of CuCl₂ to the sixth test tube and swirl to mix.
Notice that these make up the first row in your results table. The remaining solutions will be mixed in a similar fashion according to the subsequent rows in the table.

4. Break three wood splints in half and place one of the pieces into each of the six test tubes. Allow them to soak in the solution.

5. While the wood splints are soaking, prepare the next row of test tubes according to the results table. Start with 10 drops of LiCl in each of 5 test tubes and add 10 drops of the other solutions according to the table.

6. Repeat steps 1 – 5 for the remaining rows of the table to test all combinations of solutions, starting with 10 drops of the solution in the next row in each test tube and adding 10 drops of the solution in each column to one of those test tubes, as before. (Use 1 less test tube for each subsequent row, since you don’t need to retest combinations you have already done in a previous row, X’d out in the table.)

7. Add 10 drops of all seven solutions into the last test tube and swirl to mix. Place a wood splint into the test tube and allow it to soak up the solution.

8. Using the forceps, test each of the mixtures by placing the wood splint into a Bunsen burner flame. Record the colors of the flame in the appropriate box in the results table. Make sure to put only the wet portion of the wood into the flame.

9. Before doing the flame test on the solution holding all of the metallic salts, predict what color you think the flame will be and why. After making your prediction, perform the flame test by putting the wood splint into the fire. Record the color of the flame.

10. When you have finished testing all of the solutions, dispose of the wood splints, pour any of the mixtures left in the test tube into the sink, rinsing with water, and wash the test tubes carefully.
### Results/Observations

Record the flame color for each mixture in as much detail as possible in the appropriate box.

<table>
<thead>
<tr>
<th></th>
<th>10 drops LiCl</th>
<th>10 drops KCl</th>
<th>10 drops SrCl₂</th>
<th>10 drops BaCl₂</th>
<th>10 drops CaCl₂</th>
<th>10 drops CuCl₂</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 drops NaCl</td>
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<td>10 drops LiCl</td>
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<td>10 drops KCl</td>
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<td>10 drops SrCl₂</td>
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<td>10 drops BaCl₂</td>
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<td>10 drops CaCl₂</td>
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<tr>
<td>10 drops CuCl₂</td>
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</tbody>
</table>
Predict what color the mixture of all salts mixed together will be and provide an explanation for your prediction.

<table>
<thead>
<tr>
<th>Actual flame color with 10 drops of all solutions</th>
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</thead>
</table>

Students may predict a variety of colors, but looking at the results from the previous testing, yellow/orange is the predominant color seen so would most likely be the color. Also, all the ones mixed with sodium were that color. They might also notice that all the mixtures containing CuCl₂ have a green tinge to the flame and suggest green.

**Analysis**

1. In your testing, did any one color seem more predominant that others?

All of the mixtures with sodium had the characteristic yellow/orange color that was the same results obtained when testing for the straight sodium chloride solution (which they would only know if they previously did the flame test lab for individual elements). Also, whenever CuCl₂ was present, there was always a green tinge to the flame.

2. If a predominant color corresponds to higher reactivity, place the chemicals tested in order of reactivity.

   1. __Sodium________________
   2. __Copper________________
   3. __Lithium________________
   4. __Calcium________________
   5. __Barium________________
   6. __Potassium_______________
   7. __Strontium_______________

3. Now rank the chemicals tested in order of reactivity according to the activity series of metals provided by your teacher.

   1. __Lithium________________
   2. __Potassium_______________
   3. __Barium________________
   4. __Strontium_______________
   5. __Calcium________________
   6. __Sodium________________
   7. __Copper________________
4. According to these two lists, does the predominance of a flame test color provide an accurate way of ranking reactivity? Why or why not?

No, according to the provided activity series list, the order of metals is very different from the list based on the predominance of flame test color. For example, sodium and copper are at the top of the list based on the flame test, but the top of the list based on the activity series.

5. Would flame testing be a good way to distinguish between mixtures of different chemicals? Explain.

Flame testing would not be a good way to distinguish between mixtures of different chemicals, because many times the flame test of the mixture of elements only gives of the characteristic flame color of one of the elements in the mixture, and different mixtures can show the same flame color depending on the solutions that make up the mixture.

6. Compared to flame tests for individual chemicals rather than mixtures, did any of the chemicals change their characteristic flame color when they were mixed with other chemicals? Explain your answer.

No, each of the metallic salts still had their specific ions in solution, as they were all combined with chlorides. There would be no chemical reactivity between the solutions being mixed, so all of the salts were there whether you could see the flame colors or not. Some metals’ flame colors were more dominant than others and covered the others up, but if they were separated, the original colors of the metals would be visible.