# Can't Judge a Powder By Its Color

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National Judge, 2003 Columbus, Ohio

2001 Colorado Springs, CO

# Breakdown of Events

- http://www.soinc.org/

**SCIENCE OLYMPIAD EVENTS** are distributed among three broad goal areas of science education:

**Science Concepts and Knowledge**

Can't Judge a Powder
Cell Biology
Disease Detectives
**Forestry**
Fossils
Meteorology
Metric Estimation
Picture This
Polymer Detectives
Qualitative Analysis
Road Scholar
Science of Fitness

**Science Processes and Thinking Skills**

Chemistry Lab
Designer Genes
Dynamic Planet
Experimental Design
Physics Lab
Practical Data Gathering
Process Skills for Life-Sci.
Remote Sensing
Science Crime Busters
**Storm The Castle**
Water Quality
Write It-Do It

**Science Application and Technology**

**Astronomy**
Bottle Rocket
Bridge Building
Mission Possible
**Naked Egg Drop**
Reach for the Stars
Robo-Billiards
Robot Ramble
Sounds of Music
**Tower Building**
**Wheeled Vehicle**
Wright Stuff

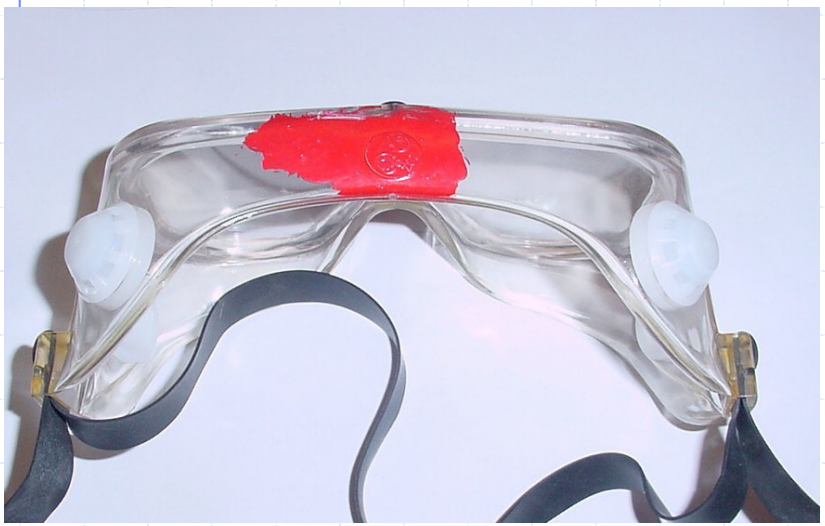
# Can't Judge a Powder by Its Color

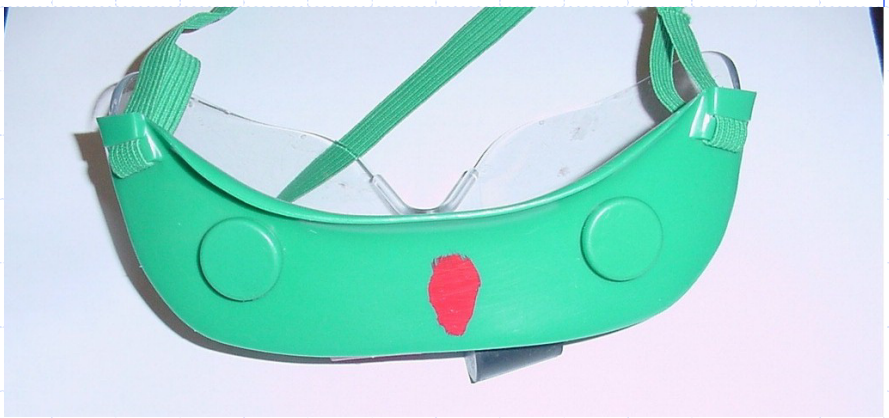
- A team of up to 2 students
- 50 minutes time
  - Subdivided
    - 25-35 minutes for testing
      - Students might want to think about working individually
    - 25-30 minutes for questions
- 2004 changes noted in red
- No flame testing will be done

# Safety in the Laboratory

- Students must bring and wear:
  - Aprons or lab coats
  - OSHA approved splash goggles with indirect vents.
- No tasting
- Or touching of powders is allowed
- No open toed shoes may be worn

# Safety Goggles





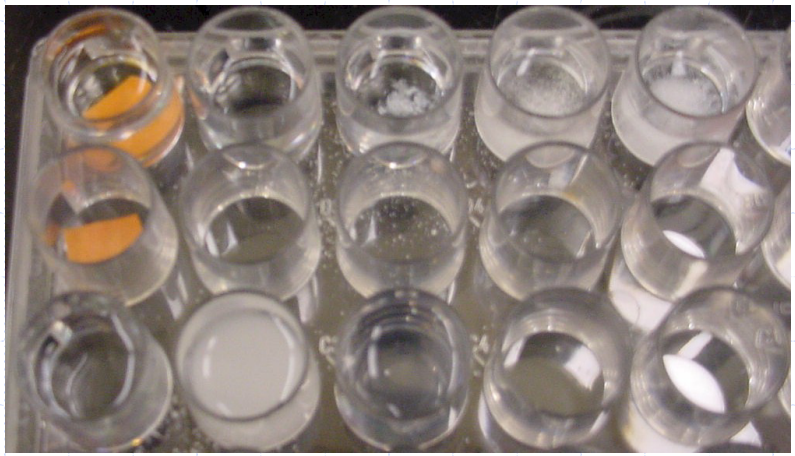
# Students must provide:


1. pHydrion paper
2. Hand lens
3. Conductivity tester must be 9V no testers will be allowed to run on 120 volts
4. Beral pipettes or eye droppers
5. Test tube rack or holder if using test tubes

# Students must provide:

6. Containers appropriate for testing conductivities, solubility, etc.
   - One or two 50 or 100 mL beakers

   Size should be made compatible with the amount of powder a student will be using



- Clear plastic spot plate
- Nunclon ΔMultidishes and OmniTray
  - NNI # 12-565-75

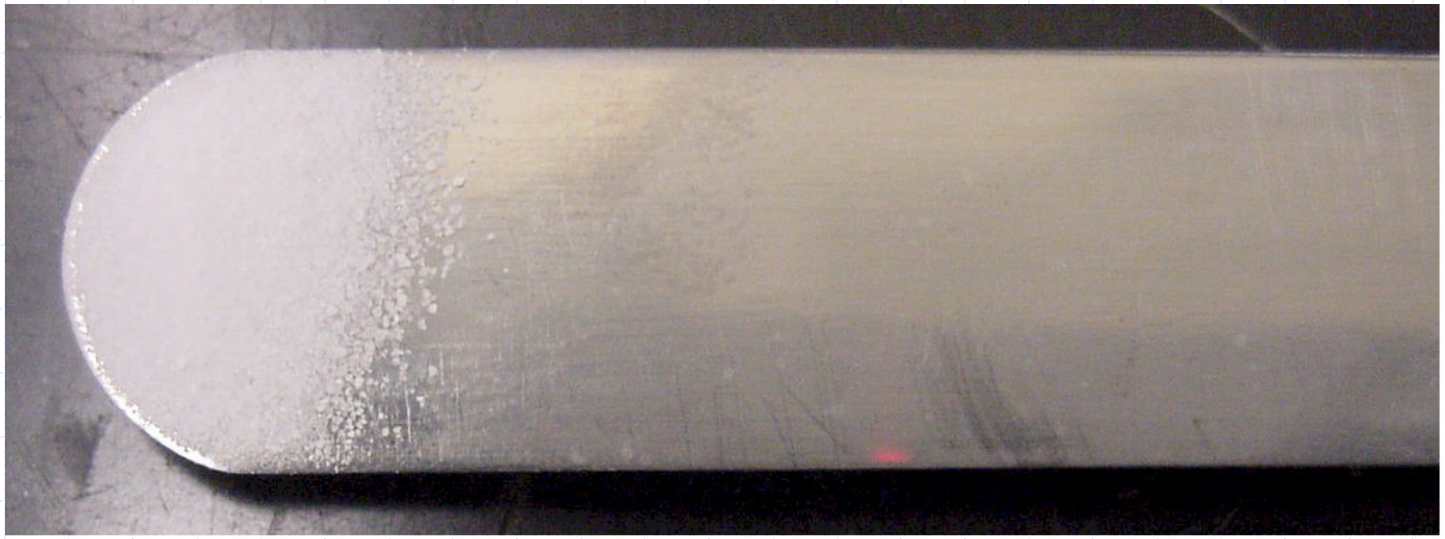
# Students must provide:

7. Spatula
8. Stirring Rod
9. Gloves are optional

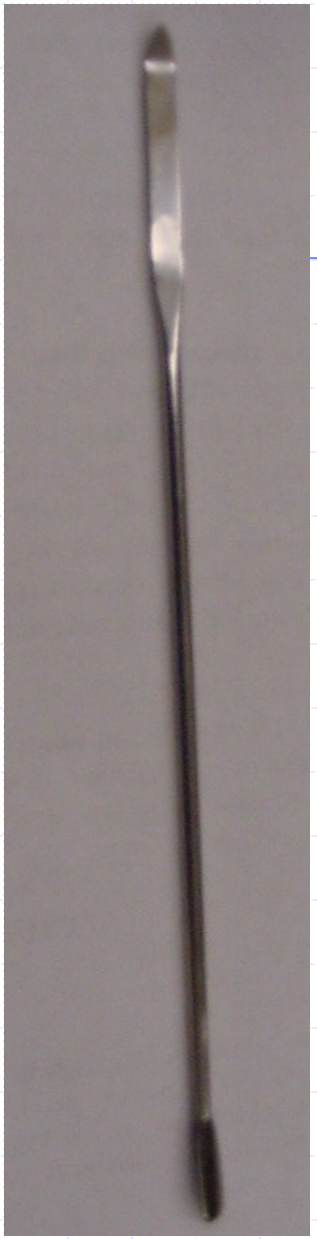
NOTE:

The team may bring no other items. Supervisors will check the equipment and have the right to disqualify a team for using equipment not on this list.

# Spatulas



- Fisher Cat# 14-365B
- Normal spatula found in most labs



# Spatulas

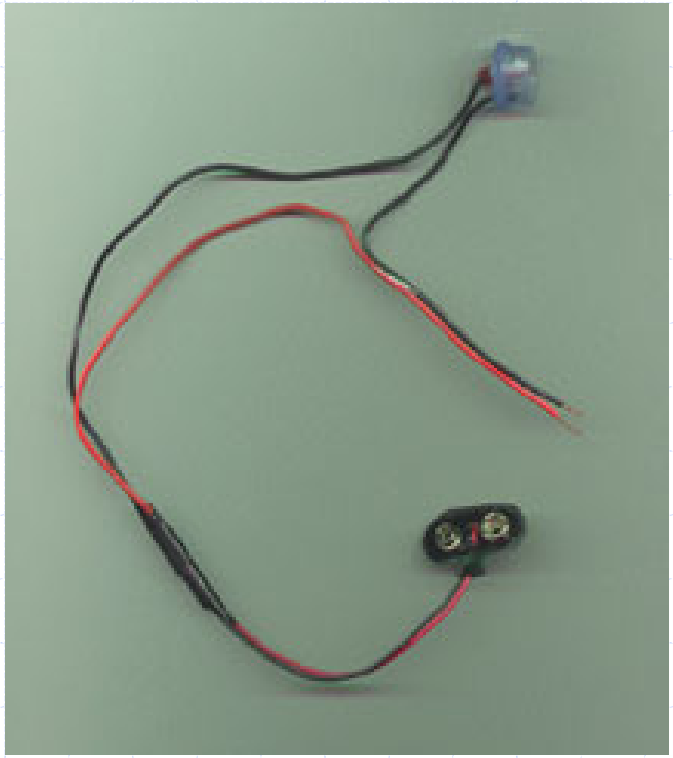
- Micro Spatula
- Hayman style
- Fisher #21-401-25B
- Type used for testing at Purdue

# Conductivity Tester

- http://www.soinc.org/condtstr.htm

- Parts:
- 1 - LED (Light Emitting Diode)
  1 - Resistor(330 ohm, 1/4 watt)
  1 - 9 volt Transistor Radio Battery
  1 - Battery Clip to fit Battery)
  1 - 8 inch piece Red wire
  1 - 8 inch piece Black wire
  1 - 4 inch piece Black wire
  tape

# Conductivity Tester

# Conductivity Tester

- Omega.com
- CDH 5021 or 5022

# Conductivity Tester

- Fishersci.com
- 10 level RCI junior
- 20 level RCI-Dx

# Conductivity Tester


- Fishersci.com
- DiST 5
- DiST 6

# Event Leaders will provide

- Definitely:
  - The white powder
  - Or a colored powder
  - Distilled water
  - 1.0 M NaOH
  - 1.0 M HCl
  - A blue or black pen
  - A pencil
- May also provide:
  - Thermometer
  - Calculator
  - Balance
  - Hot plate
  - An observation sheet
  - Anything else the supervisor decides to distribute.

# Event Leaders will announce

- Whether refills of the solid will be provided
- Whether there are any additional reagents and how to use them
- Waste disposal rules
- Clean up procedure

# The water:

- Buy distilled water from the store.
  - Not spring water
- Use procedure to degas (boil).
- Adding HCl or NaOH will change conductivity of water
- All tests at Purdue Calumet done with D.I. (de ionized) water from our water tanks

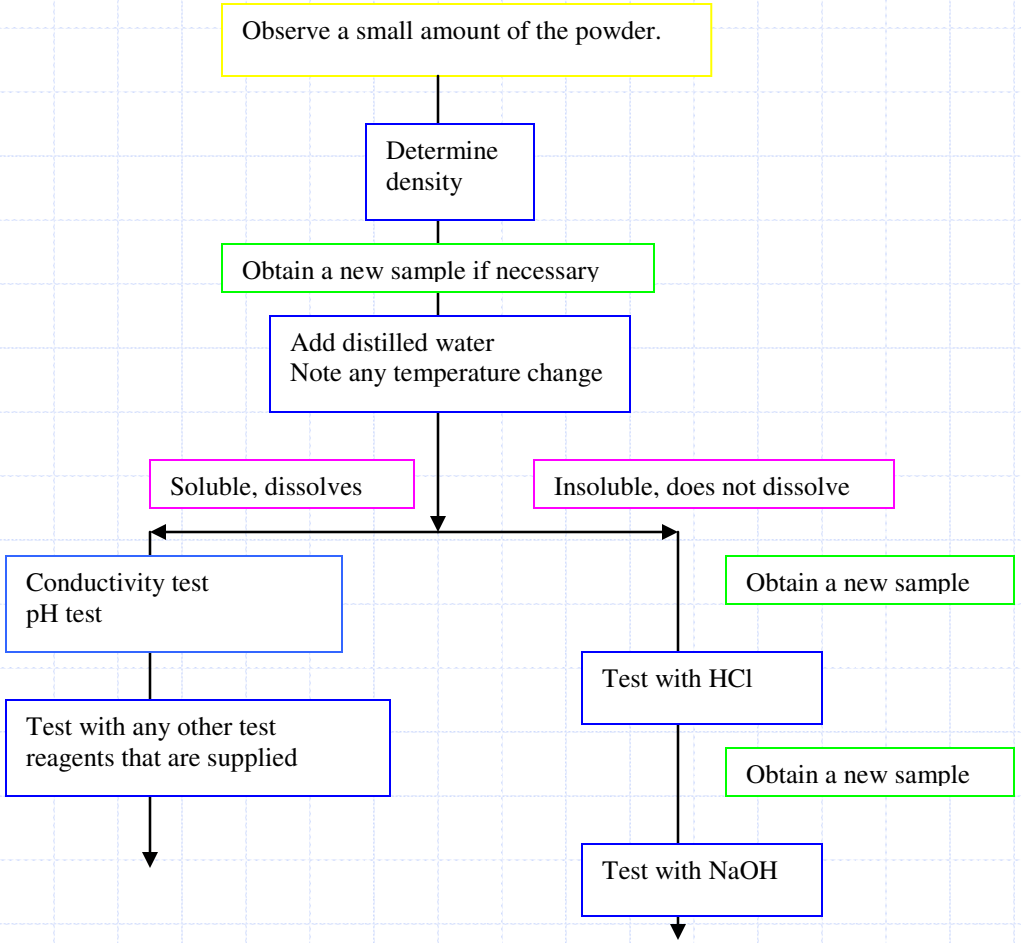
# The Thermometer

- Control Company
- Cat. No. 4378
- Traceable Lollipop Thermometer
- Reads in both $^{o}F$ and $^{o}C$
- Be sure students use $^{o}C$
- Or a spirit thermometer

# Neutralizing Distilled Water

- 2003-04 will be provided event leader
- http://www.ncsu.edu/science_olympiad/leaderinfo/neutralizewater.html
- Boiling:
  - This is accomplished by boiling the water for 5-10 min. Fill a tightly stoppered bottle with the hot water.
  - Once the water is placed in the student's bottle it begins to take up $CO_2$.

# Flow Chart


Observe a small amount of the powder.
Determine density
Obtain a new sample if necessary
Add distilled water
Note any temperature change
Soluble, dissolves
Insoluble, does not dissolve
Conductivity test
pH test
Test with any other test reagents that are supplied
Obtain a new sample
Test with HCl
Obtain a new sample
Test with NaOH

# Observation Sheet

Observation Sheet for Can't Judge a Powder by Its Color

School Name: _____ Team Code # _____

Names of participants: _____

1. Use your blue PEN to complete your observations.
2. Write or print legibly.
3. Please write only one observation per line.
4. Do not write beyond the line on the right hand edge of this paper
5. If your observation will not fit on one line, then indent subsequent lines. .

1.With your PENCIL
2.Write and circle the correct question number on the first line of the corresponding observation.
3.Any remembered answers are to be written below the observations written in pen. The question number should be written and circled in the right hand column as before.

1. _____

2. _____

3. _____

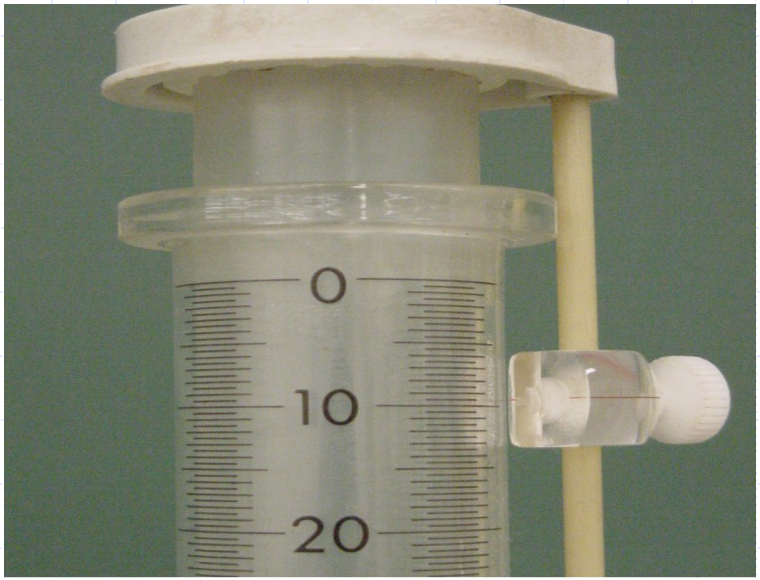
4. _____

# Consistency

- Encourage your students to be consistent with:
  - The size of the sample
  - The volume of water or any other liquid added
  - Perhaps, the container for testing

# A way to dispense liquids

- Dropper bottles
- Empty soap dispenser
- Small graduated cylinder



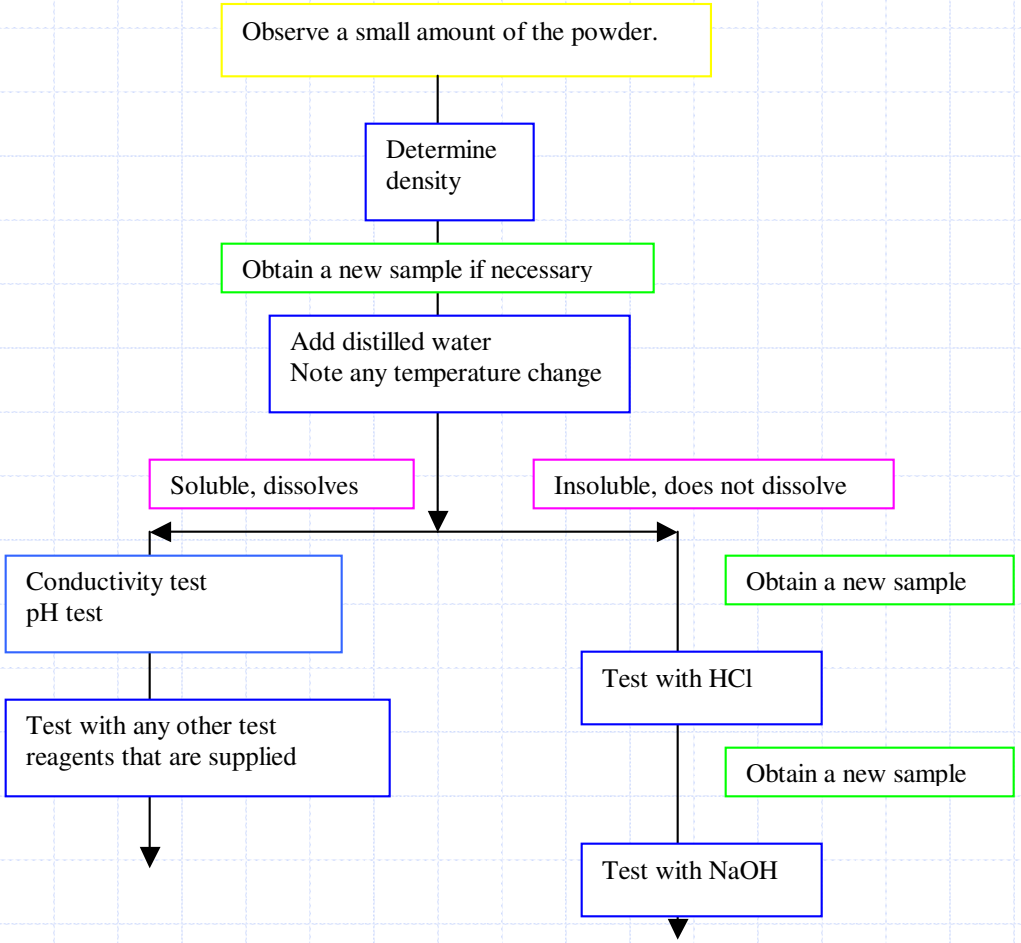
# Proper usage of pH paper


- pH hydronium paper
- Cut into small pieces that will fit into container for testing

# Proper Usage of pH paper

- Do not place pH paper in a solution
- Use the tip of a stirring rod to spot a small piece of pH paper
- Read pH immediately

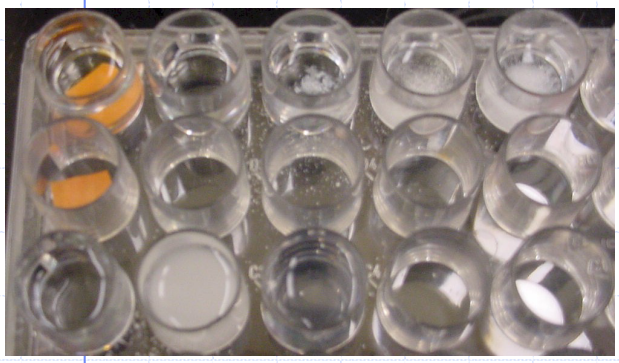
# Flow Chart for testing sample



# Testing Various Powders

- Across each spot plate
- Water, 1M HCl, 1M NaOH, 2-propanol(isopropyl alcohol), methanol
- Second row: pH paper
- Third row: 2 drops $Ca(NO_3)_2$
  2 drops $Ba(NO_3)_2$
  2 drops $AgNO_3$

# Testing Various White Powders



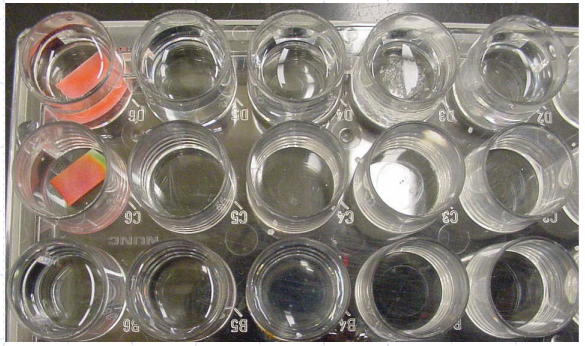
Alum

Aspirin

Baking Powder

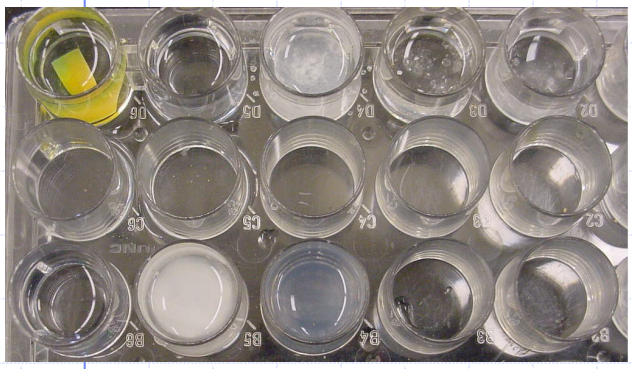
Borax

Chalk



Citric acid

# Testing Various White Powders



Epsom Salt

Sugar

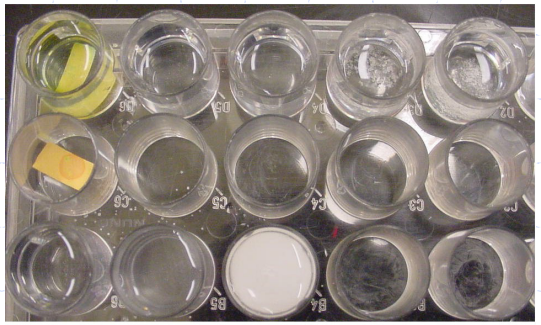


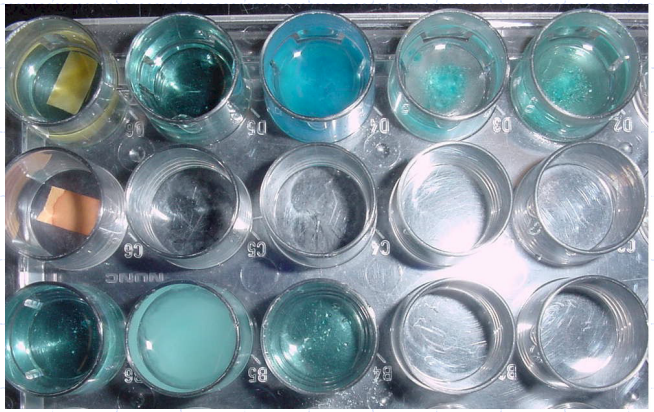
Table salt

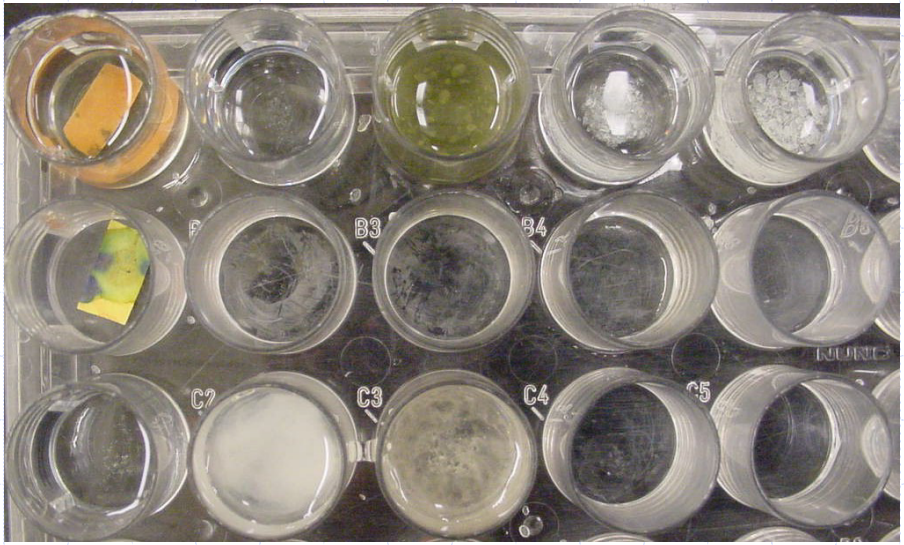
# Conductivities

A solution showing conductivity

A solution showing little conductivity

# Testing Various Colored Powders





Copper sulfate

Ferrous ammonium sulfate

# Summarizing:

| | Epsom Salt | Table Salt | Borax | Alum | Sugar | Aspirin | Baking Powder | Chalk | Citric acid | Ferrous Ammonium sulfate | Copper sulfate |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Solubility in water | Mostly | Soluble | Very little | Yes | Soluble | Insoluble | Slightly, bubbling | Insoluble | Soluble | Slightly | Slightly |
| conductiity | Yes | Yes | Yes | Yes | No | A little | Yes | Yes | Yes | Yes | Yes |
| pH of solution | 6 | 6 | 9 | 4-5 | 7-8 | 3 | 8 | 10 | 2 | 9 | 9 |
| Solubility in 1M HCl | Slightly no gas | Soluble no gas | Slightly no gas | Soluble not gas | Soluble no gas | Insoluble | Soluble bubbles | Soluble lots of bubbles | Soluble | | Soluble |
| Solubility in 1M NaOH | Soluble ? how much wt. ppt. | Soluble | Very little | Slightly, changed to bigger whiter crystals | Soluble | Soluble | Soluble jelly like ppt. | Insoluble | Soluble | Soluble yellow ppt. | Soluble dark ppt. |
| Solubility in 2-propanol | Insoluble | Insoluble | Insoluble | Insoluble | Slightly soluble | insoluble | Insoluble | Soluble | Insoluble | Insoluble | Insoluble |
| Solubility in methanol | Insoluble | Insoluble | Insoluble (?) slightly cloudy | Insoluble | Insoluble | Slightly | Slightly | Insoluble | Mostly | Insoluble | Insoluble |
| PPT with $Ca(NO_3)_2$ | No ppt. | No ppt. | Wt. ppt | No ppt. | No ppt | No ppt | No ppt | No ppt. | No ppt | No ppt. | No ppt. |
| PPT with $Ba(NO_3)_2$ | Wt. ppt. | No ppt. | Wt. ppt | Bright wt ppt. | No ppt | No ppt | Slight wt ppt. | No ppt. | No ppt | Wt. ppt. | Wt. ppt. |
| PPT with $AgNO_3$ | Small amount ppt. | Bright white ppt. | Wt. ppt | Very small amount wt. ppt. | Brown ppt | No ppt | Yellow ppt. | No ppt. | No ppt | No ppt. | No ppt. |

# Scoring the Event

- The judge:
  - will collect the samples and the pens.
  - issue pencils.
  - provide the students with the questions
- Students will be told:
  - to write and circle the question number in the column on the right hand side of the observation sheet
  - Any remembered answers are to be written below the observations written in pen. The question number should be written and circled in the right hand column as before.

# Potential Questions:

1. What do the crystals look like?
   a. Are they:
      a. colored,
      b. white,
      c. clear?
   b. Definition of hygroscopic:

   A substance having a tendency to absorb water from the atmosphere and become damp, but not form a solution

c. Do the crystals seem to absorb water from the air?
d. Or, were the crystals hygroscopic?

# Potential Questions:

2. Density:
   a. D = m/v
   b. Using a graduated cylinder:

The judge would have to provide a balance

1) What is the calculated density of the solid?

Some potential thought questions: The students would probably answer these as additional questions.

1) How many grams would 2mL of the solid weigh?
2) How many mL would 3 grams occupy

# Potential Questions:

2. Density cont:

Relative density using a solvent:

a. Does the solid sink or float in the solvent supplied by the judge?
b. Is the solid more or less dense than the solvent supplied by the judge?
c. Potential solvents:
    1. Hexane d = 0.6591
    2. Methanol d = 0.8100  wood alcohol, methyl alcohol
    3. Ligroin d = 0.850- 0.870  painter's naphtha

# Potential Questions:

3. Solubility
    1. Definition: The mass of a solid substance that can be dissolved in 100 g. of solvent to form a saturated solution.
    2. Most ionic compounds are soluble in water by undergoing the process of solvation.
    3. Most covalent compounds will not be soluble in water.

# Potential Questions:

3. Solubility
   a. Is the substance soluble, totally, partially, little, or not soluble?
   b. Is the substance soluble in the extra solvent the judge provided?
   c. Is the substance more or less soluble in either HCl or NaOH than it was in water?

# Potential Questions:

4. Temperature Change: The judge would have to provide a thermometer
   a. This must be done only with the aqueous solution
   b. Need a larger sample size to obtain measurable results
   c. Definitions:
      1. Exothermic: a reaction that gives out heat to its surroundings, $\Delta H$ is negative, because the system loses heat.
      2. Endothermic: a reaction that takes in heat from its surroundings, $\Delta H$ is positive, because the system gains heat

# Potential Questions:

4. Temperature Change: cont
   a) What was the temperature of the water (before the powder was added)?
   b) What was the temperature of the solution after the powder was added?
   c) Did the temperature of the water increase or decrease when the powder was added?
   d) What was the temperature change for the solution after the powder was added?
   e) Was the process of dissolving endothermic or exothermic?

# Potential Questions:

## 5. Conductivity:

The SI unit for conductivity is Siemens (S). The scales on various devices will vary. The most important property of a conductor is the amount of current it will carry when a voltage is applied. Conductance is the inverse of resistance.

Conductance = S= 1/ohm.

Electrolyte: Any compound which in solution conducts electric current. The solvent is usually water. Adjectives to describe electrolytes include: strong, weak, non.

Always test the solution of the powder in water (aqueous solution).

Do not test powder with NaOH or HCl.

# Potential Questions:

5. Conductivity: cont
   a) Did the aqueous solution conduct electricity?
   b) Was the aqueous solution a strong, weak or non electrolyte?

# Potential Questions:

6. pH of the solution
   a. Only test aqueous solution
   b. Correct use of pH paper

Definitions:

Acidic solutions have a pH <7

Basic solutions have a pH >7

a) What is the pH of the aqueous solution?

b) Was the aqueous solution acidic or basic?

# Potential Questions:

7. Reaction with HCl or NaOH:
   a. Is there any gas produced?
   b. What is the odor of any gas?
   c. Is there any color change?
   d. Is there any precipitate formed?
   e. Is the substance more or less soluble in either HCl or NaOH than it was in water?

# Potential Questions with other reagents

8. Test solubility of powder in other reagents supplied.
    a. Judge should indicate which reagent to use if there is more than 1 reagent
    b. Is the substance soluble in the extra solvent the judge provided?
        1) What might this indicate about the bonding in the powder?

# Potential Questions with other reagents

9. Test for precipitate formation with addition a precipitation reagent
   a. Judge should indicate reagent, if more than one reagent is available
   b. Judge should tell students how much reagent to add

# Potential Questions with other reagents

9. Test for precipitate formation, cont.

A solid formed from substances in solution.

a. Was a precipitate formed?
b. What color was the precipitate?
c. What was the form of the precipitate?
    1) Was it a powder?
    2) Or did it seem like jello?

# How many questions?

- Question sheet can also function as the scoring sheet.
- 10-12 seems to be a good number.
- Give students the opportunity to note what they think is their best observation.
- A question grading waste disposal and clean up of work area.

# Question Sheet

Can't Judge a Powder by Its Color
Scoring Sheet

School Name: _____

Team Code # _____

Names of Participants (please print)

_____

_____

| Questions | Question Values | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 0 |
| A. Is the substance in a powder or crystalline form? | 1 | 2 | 3 | 4 | 5 | 0 |
| B. What is the shape of the pieces of the powder? | | | | | | |
| C. How much does 3 mL of this substance weigh? | 1 | 2 | 3 | 4 | 5 | 0 |
| D. Is the powder soluble in water? | 1 | 2 | 3 | 4 | 5 | 0 |
| E. Which solvent, water or methanol is the powder more soluble in? | 1 | 2 | 3 | 4 | 5 | 0 |
| F. How well does the water, ALONE, conduct electricity? | 1 | 2 | 3 | 4 | 5 | 0 |
| G. Is WATER a strong, weak or non-electrolyte? | 1 | 2 | 3 | 4 | 5 | 0 |
| H. What is the conductivity of the aqueous solution of the powder? | 1 | 2 | 3 | 4 | 5 | 0 |
| I. What is the pH of the aqueous solution of the powder? | 1 | 2 | 3 | 4 | 5 | 0 |
| J. Were any gases observed? | | | | | | |
| K. What is the color of solution formed when the powder is added to NaOH? | 1 | 2 | 3 | 4 | 5 | 0 |
| L. What was the temperature change when the powder was added to the water? | 1 | 2 | 3 | 4 | 5 | 0 |
| M. Is the powder soluble in hexane? | 1 | 2 | 3 | 4 | 5 | 0 |
| N. When the powder is placed in hexane and stirred, does the powder float or sink to the bottom? | 1 | 2 | 3 | 4 | 5 | 0 |
| O. What happened when silver nitrate was added to the aqueous solution of the powder? | 1 | 2 | 3 | 4 | 5 | 0 |
| P. Use this letter to mark what you think is your best observation | 1 | 2 | 3 | 4 | 5 | 0 |
| Total | | | | | | /80 |

# Thoughts: Practice, Practice, Practice

1. Use common solids
2. Size of sample
3. Supply water in a wash bottle
4. Is temperature worth it?

# Thoughts:

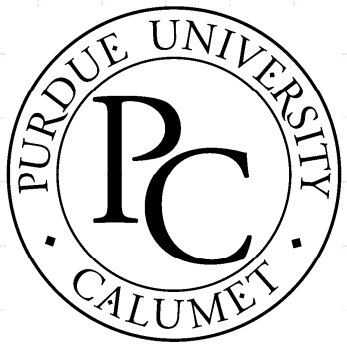
5. Perhaps supply a third liquid to test solubility
6. Perhaps supply a test reagent solution to look for precipitates
7. For #5 and #6 decide about waste problems
    a. Is it worth is it?

# Thoughts:

8. Where is waste from the students work to be disposed?
9. What about clean up of work area?
10. If judging decide on a powder and become familiar with that powder

# In closing:

- Can't Judge a Powder
- Gretchen Wolf may be contacted at:
  - Purdue University Calumet
  - GSWolf@calumet.purdue.edu
  - Or 219-989-2282
- This presentation is available at the following web site.
- http://www.calumet.purdue.edu/chemphys/olympiad/
- Many thanks for this opportunity.
- ©Gretchen S. Wolf 10/01/03



# Flow chart for testing sample