

# Can't Judge a Powder By Its Color

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Continuing Lecturer

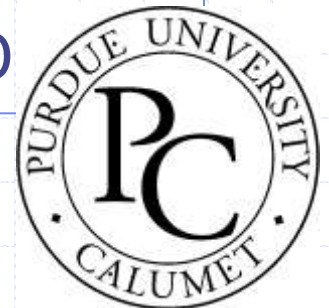
Purdue University Calumet

Site Coordinator Purdue Regional Science Olympiad

Regional Judge, 1999 to present

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  
△Multidishes 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

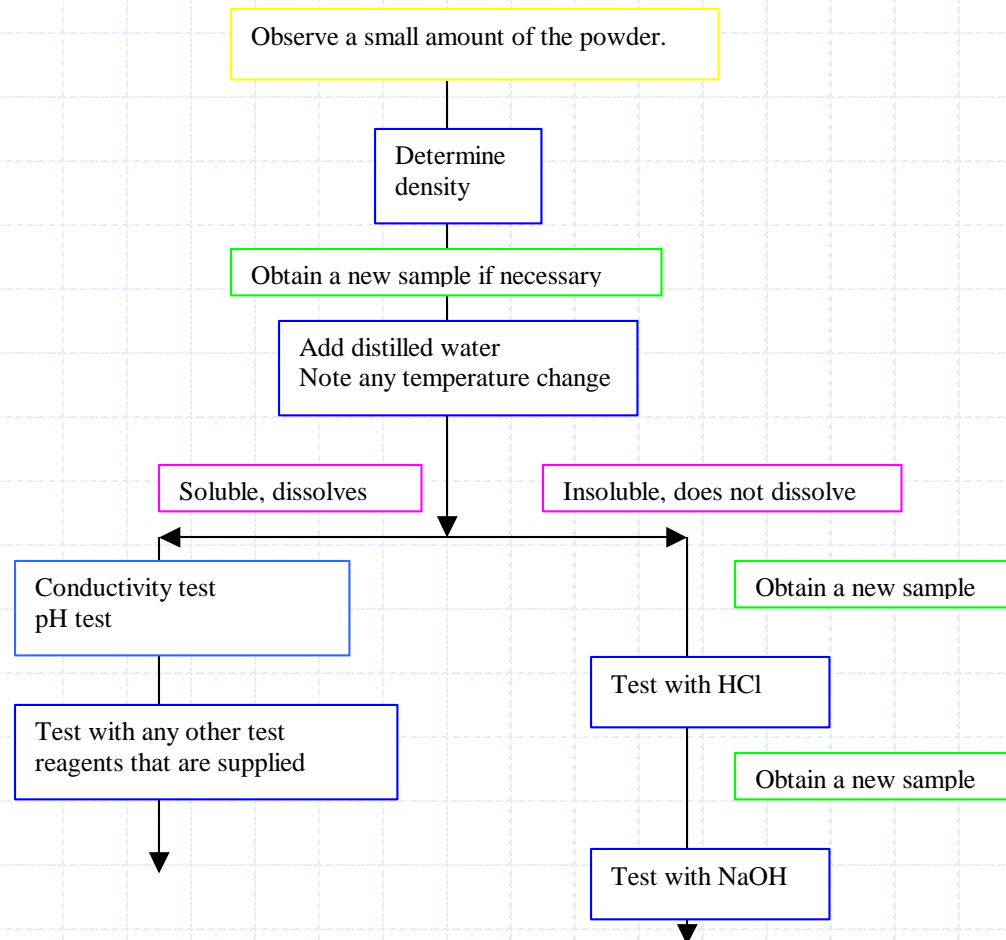


- ◆ Control Company
- ◆ Cat. No. 4378
- ◆ Traceable Lollipop Thermometer
- ◆ Reads in both °F and °C
- ◆ Be sure students use °C
- ◆ Or a spirit thermometer

# Neutralizing Distilled Water

- ◆ 2003-04 will be provided event leader
- ◆ [http://www.ncsu.edu/science\\_olympiad/leaderrinfo/neutralizewater.html](http://www.ncsu.edu/science_olympiad/leaderrinfo/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<sub>2</sub>.

# Flow Chart



# 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



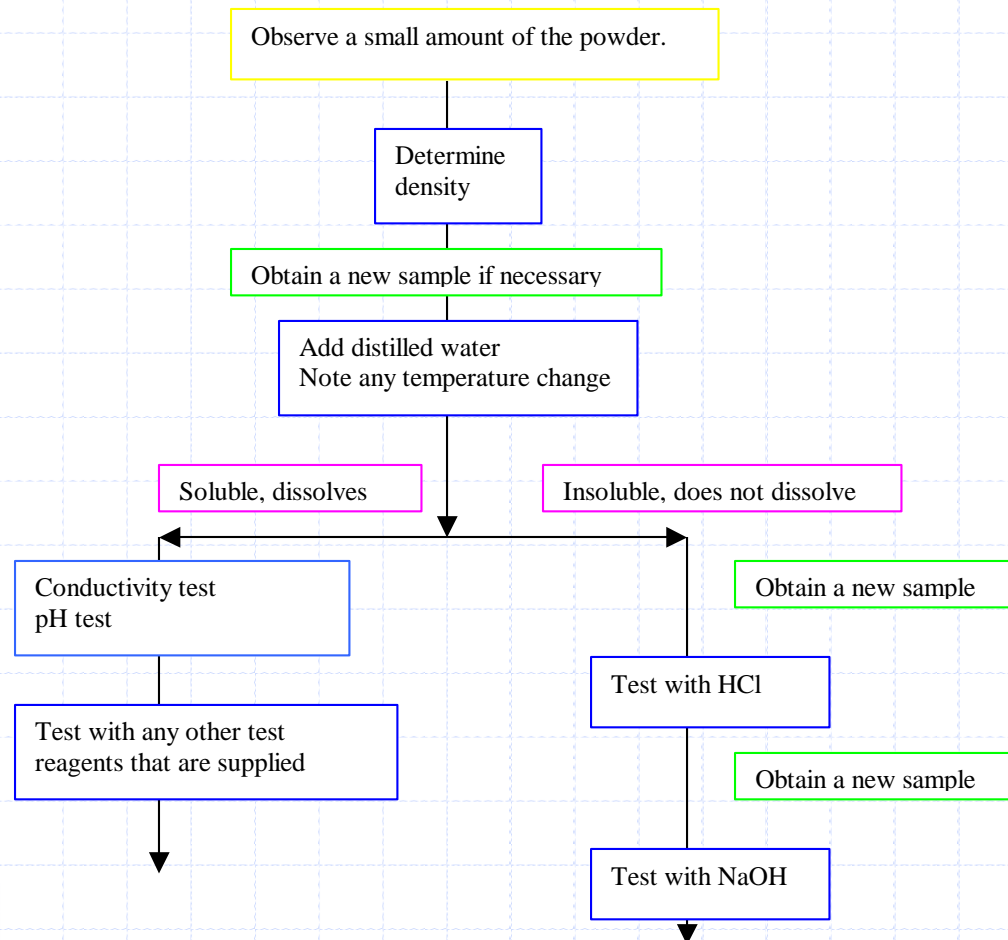
- ◆ pH hydronium paper
- ◆ Cut into small pieces that will fit into container for testing

# 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



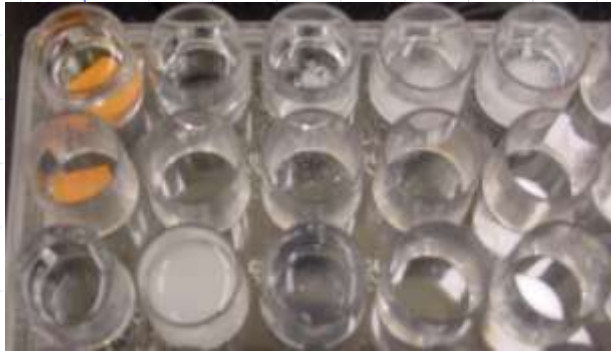
# Flow Chart for testing sample



# 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  $\text{Ca}(\text{NO}_3)_2$   
2 drops  $\text{Ba}(\text{NO}_3)_2$   
2 drops  $\text{AgNO}_3$

# Testing Various White Powders



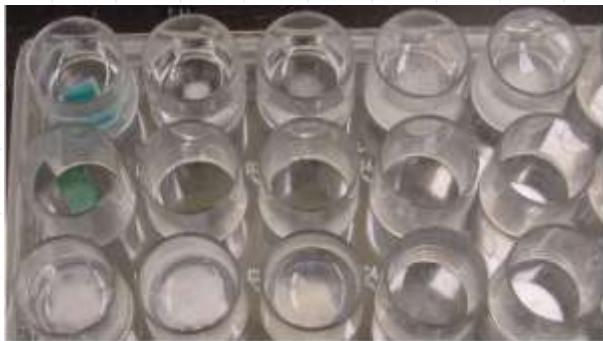
Alum



Aspirin



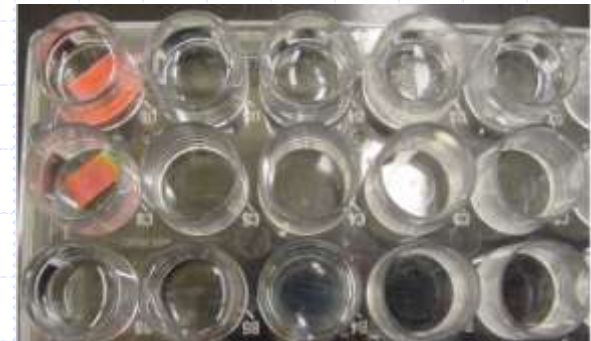
Baking Powder



Borax



Chalk



Citric acid



# Testing Various White Powders



Epsom Salt



Sugar



Table salt

# Conductivities

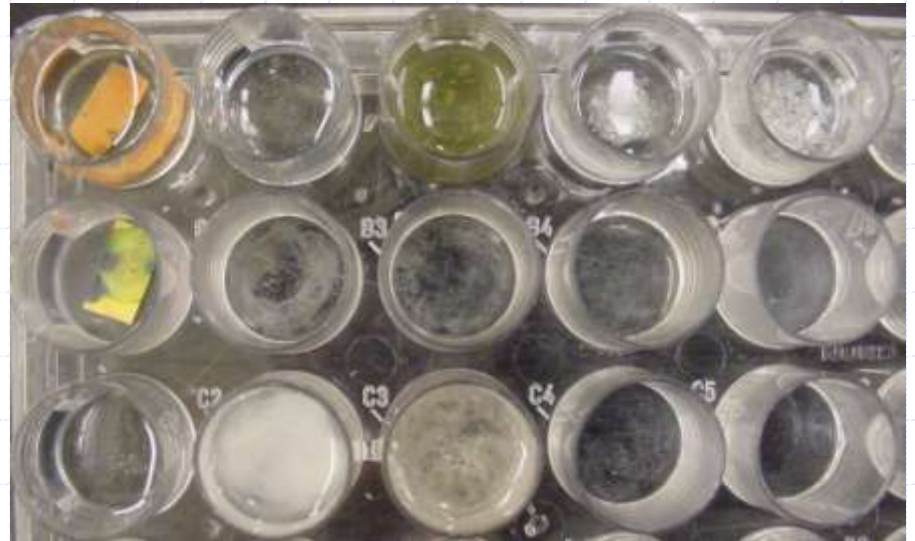


A solution showing conductivity



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 $\text{Ca}(\text{NO}_3)_2$	No ppt.	No ppt.	Wt. ppt	No ppt.	No ppt	No ppt	No ppt	No ppt.	No ppt	No ppt.	No ppt.
PPT with $\text{Ba}(\text{NO}_3)_2$	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 $\text{AgNO}_3$	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 =  $S = 1/\text{ohm}$ .

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

- Only test aqueous solution
- Correct use of pH paper

Definitions:

Acidic solutions have a  $\text{pH} < 7$

Basic solutions have a  $\text{pH} > 7$

- What is the pH of the aqueous solution?
- 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: \_\_\_\_\_

Names of Participants (please print) \_\_\_\_\_

Team Code # \_\_\_\_\_

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
<b>Total</b>						<b>/80</b>

# 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:

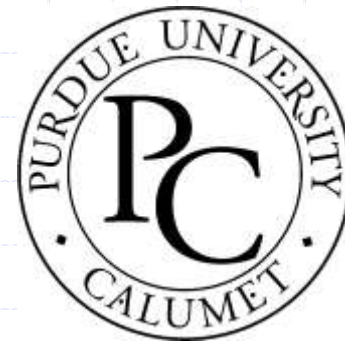
5. Perhaps supply a third liquid to test solubility
6. Perhaps supply a test reagent solution to look for precipitates
7. For #5 and #6 decide about waste problems
  - a. Is it worth is it?

# 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](mailto: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.
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# Flow chart for testing sample

