

# Powder Puzzles

## Kit #12

# Black Line Masters

Revised June 2008  
Logo and footers-revision June 2008

OCM BOCES Science Center

Aluminum

Iron

Copper

Zinc

Plaster of Paris

Citric acid

Salt

Sugar

Water

Epsom Salt

**Sand**

**Baking Soda**

**Vinegar**

**BTB**

**Corn Starch**

## Session 2: Reference List for Sample Materials

List 1: Chemical Names

Common Name	"Chemical Name"	Chemical Formula
aluminum	Aluminum	
baking soda	Sodium bicarbonate	
BTB	Bromothymol blue	
citric acid	Citric acid	
copper	Copper	
corn starch	Corn starch	
epsom salt	Magnesium sulfate	
iron	Iron	
plaster of paris	Calcium sulfate	
salt	Sodium chloride	
sand	Silicon dioxide	
sugar	Sucrose	
vinegar	Acetic acid	
water	Water	
zinc	zinc	

List 2: Chemical Names and Chemical Formulas

Common Name	"Chemical Name"	Chemical Formula
aluminum	Aluminum	Al
baking soda	Sodium bicarbonate	NaHCO <sub>3</sub>
BTB	Bromothymol blue	C <sub>27</sub> H <sub>28</sub> Br <sub>2</sub> O <sub>5</sub> S
citric acid	Citric acid	C <sub>6</sub> H <sub>8</sub> O <sub>7</sub>
copper	Copper	Cu
corn starch	Corn starch	(C <sub>6</sub> H <sub>12</sub> O <sub>5</sub> ) <sub>n</sub>
epsom salt	Magnesium sulfate	MgSO <sub>4</sub>
iron	Iron	Fe
plaster of paris	Calcium sulfate	Ca <sub>2</sub> H <sub>2</sub> O <sub>9</sub> S <sub>2</sub>
salt	Sodium chloride	NaCl
sand	Silicon dioxide	SiO <sub>2</sub>
sugar	Sucrose	C <sub>6</sub> H <sub>12</sub> O <sub>6</sub>
vinegar	Acetic acid	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>
water	Water	H <sub>2</sub> O
zinc	zinc	Zn

# The Elements

Symbol	Number	Name	Symbol	Number	Name	Symbol	Number	Name
H	1	hydrogen	Rb	37	rubidium	Ta	73	tantalum
He	2	helium	Sr	38	strontium	W	74	tungsten
Li	3	lithium	Y	39	yttrium	Re	75	rhenium
Be	4	beryllium	Zr	40	zirconium	Os	76	osmium
B	5	boron	Nb	41	niobium	Ir	77	iridium
C	6	carbon	Mo	42	molybdenum	Pt	78	platinum
N	7	nitrogen	Tc	43*	technetium	Au	79	gold
O	8	oxygen	Ru	44	ruthenium	Hg	80	mercury
F	9	fluorine	Rh	45	rhodium	Tl	81	thallium
Ne	10	neon	Pd	46	palladium	Pb	82	lead
Na	11	sodium	Ag	47	silver	Bi	83	bismuth
Mg	12	magnesium	Cd	48	cadmium	Po	84*	polonium
Al	13	aluminum	In	49	indium	At	85*	astatine
Si	14	silicon	Sn	50	tin	Rn	86*	radon
P	15	phosphorus	Sb	51	antimony	Fr	87*	francium
S	16	sulfur	Te	52	tellurium	Ra	88	radium
Cl	17	chlorine	I	53	iodine	Ac	89*	actinium
Ar	18	argon	Xe	54	xenon	Th	90	thorium
K	19	potassium	Cs	55	cesium	Pa	91	protactinium
Ca	20	calcium	Ba	56	barium	U	92	uranium
Sc	21	scandium	La	57	lanthanum	Np	93	neptunium
Ti	22	titanium	Ce	58	cerium	Pu	94*	plutonium
V	23	vanadium	Pr	59	praseodymium	Am	95*	americium
Cr	24	chromium	Nd	60	neodymium	Cm	96*	curium
Mn	25	manganese	Pm	61*	promethium	Bk	97*	berkelium
Fe	26	iron	Sm	62	samarium	Cf	98*	californium
Co	27	cobalt	Eu	63	europium	Es	99*	einsteinium
Ni	28	nickel	Gd	64	gadolinium	Fm	100*	fermium
Cu	29	copper	Tb	65	terbium	Md	101*	mendelevium
Zn	30	zinc	Dy	66	dysprosium	No	102*	nobelium
Ga	31	gallium	Ho	67	holmium	Lr	103*	lawrencium
Ge	32	germanium	Er	68	erbium	Rf	104*	rutherfordium
As	33	arsenic	Tm	69	thulium	Ha	105*	hahnium
Se	34	selenium	Yb	70	ytterbium	Sg	106*	seaborgium
Br	35	bromine	Lu	71	lutetium	Ns	107*	neilsbohrium
Kr	36	krypton	Hf	72	hafnium	Hs	108*	hassium
						Mt	109*	meitnerium

\*These elements have not been found on the earth. They are human-made elements that have been created inside atomic reactors. The names given here are those approved by the American Chemical Society.

# The Periodic Table of the Elements

1 <b>H</b> Hydrogen 1.00794																	2 <b>He</b> Helium 4.003				
3 <b>Li</b> Lithium 6.941	4 <b>Be</b> Beryllium 9.012182															5 <b>B</b> Boron 10.811	6 <b>C</b> Carbon 12.0107	7 <b>N</b> Nitrogen 14.00674	8 <b>O</b> Oxygen 15.9994	9 <b>F</b> Fluorine 18.9984032	10 <b>Ne</b> Neon 20.1797
11 <b>Na</b> Sodium 22.989770	12 <b>Mg</b> Magnesium 24.3050															13 <b>Al</b> Aluminum 26.981538	14 <b>Si</b> Silicon 28.0855	15 <b>P</b> Phosphorus 30.973761	16 <b>S</b> Sulfur 32.066	17 <b>Cl</b> Chlorine 35.4527	18 <b>Ar</b> Argon 39.948
19 <b>K</b> Potassium 39.0983	20 <b>Ca</b> Calcium 40.078	21 <b>Sc</b> Scandium 44.955910	22 <b>Ti</b> Titanium 47.867	23 <b>V</b> Vanadium 50.9415	24 <b>Cr</b> Chromium 51.9961	25 <b>Mn</b> Manganese 54.938049	26 <b>Fe</b> Iron 55.845	27 <b>Co</b> Cobalt 58.933200	28 <b>Ni</b> Nickel 58.6934	29 <b>Cu</b> Copper 63.546	30 <b>Zn</b> Zinc 65.39	31 <b>Ga</b> Gallium 69.723	32 <b>Ge</b> Germanium 72.61	33 <b>As</b> Arsenic 74.92160	34 <b>Se</b> Selenium 78.96	35 <b>Br</b> Bromine 79.904	36 <b>Kr</b> Krypton 83.80				
37 <b>Rb</b> Rubidium 85.4678	38 <b>Sr</b> Strontium 87.62	39 <b>Y</b> Yttrium 88.90585	40 <b>Zr</b> Zirconium 91.224	41 <b>Nb</b> Niobium 92.90638	42 <b>Mo</b> Molybdenum 95.94	43 <b>Tc</b> Technetium (98)	44 <b>Ru</b> Ruthenium 101.07	45 <b>Rh</b> Rhodium 102.90550	46 <b>Pd</b> Palladium 106.42	47 <b>Ag</b> Silver 107.8682	48 <b>Cd</b> Cadmium 112.411	49 <b>In</b> Indium 114.818	50 <b>Sn</b> Tin 118.710	51 <b>Sb</b> Antimony 121.760	52 <b>Te</b> Tellurium 127.60	53 <b>I</b> Iodine 126.90447	54 <b>Xe</b> Xenon 131.29				
55 <b>Cs</b> Cesium 132.90545	56 <b>Ba</b> Barium 137.327	57 <b>La</b> Lanthanum 138.9055	72 <b>Hf</b> Hafnium 178.49	73 <b>Ta</b> Tantalum 180.9479	74 <b>W</b> Tungsten 183.84	75 <b>Re</b> Rhenium 186.207	76 <b>Os</b> Osmium 190.23	77 <b>Ir</b> Iridium 192.217	78 <b>Pt</b> Platinum 195.078	79 <b>Au</b> Gold 196.96655	80 <b>Hg</b> Mercury 200.59	81 <b>Tl</b> Thallium 204.3833	82 <b>Pb</b> Lead 207.2	83 <b>Bi</b> Bismuth 208.98038	84 <b>Po</b> Polonium (209)	85 <b>At</b> Astatine (210)	86 <b>Rn</b> Radon (222)				
87 <b>Fr</b> Francium (223)	88 <b>Ra</b> Radium (226)	89 <b>Ac</b> Actinium (227)	104 <b>Rf</b> Rutherfordium (261)	105 <b>Db</b> Dubnium (262)	106 <b>Sg</b> Seaborgium (263)	107 <b>Bh</b> Bohrium (262)	108 <b>Hs</b> Hassium (265)	109 <b>Mt</b> Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114								

58 <b>Ce</b> Cerium 140.116	59 <b>Pr</b> Praseodymium 140.90765	60 <b>Nd</b> Neodymium 144.24	61 <b>Pm</b> Promethium (145)	62 <b>Sm</b> Samarium 150.36	63 <b>Eu</b> Europium 151.964	64 <b>Gd</b> Gadolinium 157.25	65 <b>Tb</b> Terbium 158.92534	66 <b>Dy</b> Dysprosium 162.50	67 <b>Ho</b> Holmium 164.93032	68 <b>Er</b> Erbium 167.26	69 <b>Tm</b> Thulium 168.93421	70 <b>Yb</b> Ytterbium 173.04	71 <b>Lu</b> Lutetium 174.967
90 <b>Th</b> Thorium 232.0381	91 <b>Pa</b> Protactinium 231.03588	92 <b>U</b> Uranium 238.0289	93 <b>Np</b> Neptunium (237)	94 <b>Pu</b> Plutonium (244)	95 <b>Am</b> Americium (243)	96 <b>Cm</b> Curium (247)	97 <b>Bk</b> Berkelium (247)	98 <b>Cf</b> Californium (251)	99 <b>Es</b> Einsteinium (252)	100 <b>Fm</b> Fermium (257)	101 <b>Md</b> Mendelevium (258)	102 <b>No</b> Nobelium (259)	103 <b>Lr</b> Lawrencium (262)

Name: \_\_\_\_\_

1.

Match a substance from List A with a property from List B by writing the letter of the property on the blank line front of the substance.

**List A: Substance**

\_\_\_\_\_ water  
 \_\_\_\_\_ paper  
 \_\_\_\_\_ iron metal  
 \_\_\_\_\_ copper wire  
 \_\_\_\_\_ diamond  
 \_\_\_\_\_ ruby

**List B: Property.**

A. red color  
 B. cold  
 C. conducts electricity  
 D. very hard  
 E. burns  
 F. freezes at 0°C  
 G. beautiful  
 H. rusts

2. Using the Periodic Table as a reference, place an **E** in front of the substances in the list that are **Elements**, a **C** in front of those that are **Compounds** and a **N** for those that are **Neither**.

\_\_\_\_\_ Calcium chloride (CaCl)  
 \_\_\_\_\_ Water (H<sub>2</sub>O)  
 \_\_\_\_\_ Silicon (Si)  
 \_\_\_\_\_ Gold (Au)  
 \_\_\_\_\_ Sand (SiO<sub>2</sub>)  
 \_\_\_\_\_ Hydrogen (H)

1. True or False, write true or false in front of each statement.

If the statement is False, rewrite it the right way.

- A. \_\_\_\_\_ Elements are made up of atoms.
- B. \_\_\_\_\_ All atoms are exactly alike.
- C. \_\_\_\_\_ All atoms of an element are exactly alike.
- D. \_\_\_\_\_ Since water is a compound made up of Hydrogen and Oxygen, it is made up of 2 different types of atoms.
- E. \_\_\_\_\_ Molecules make up elements.
- F. \_\_\_\_\_ All molecules of water are exactly alike.



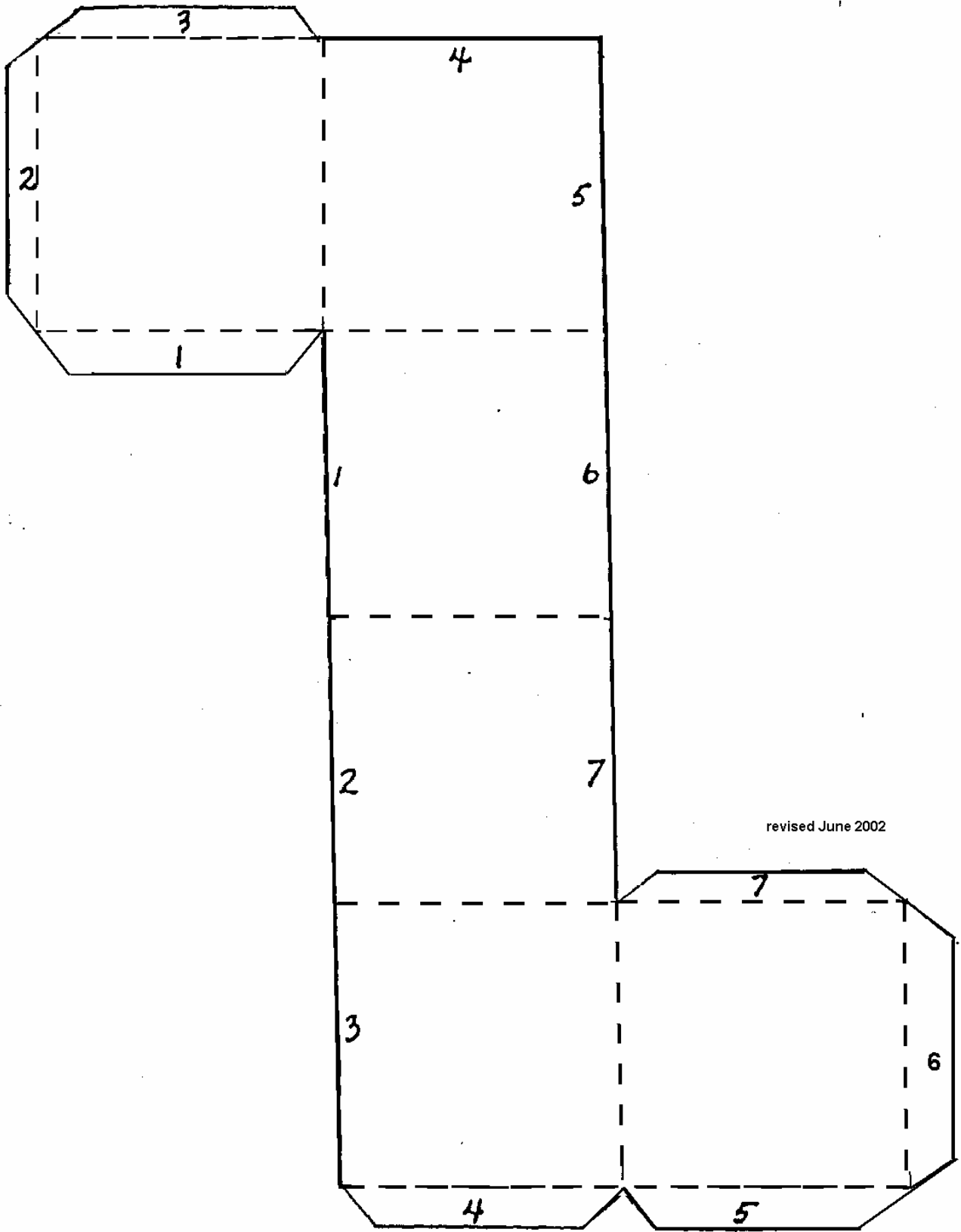
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*Challenge Question:*

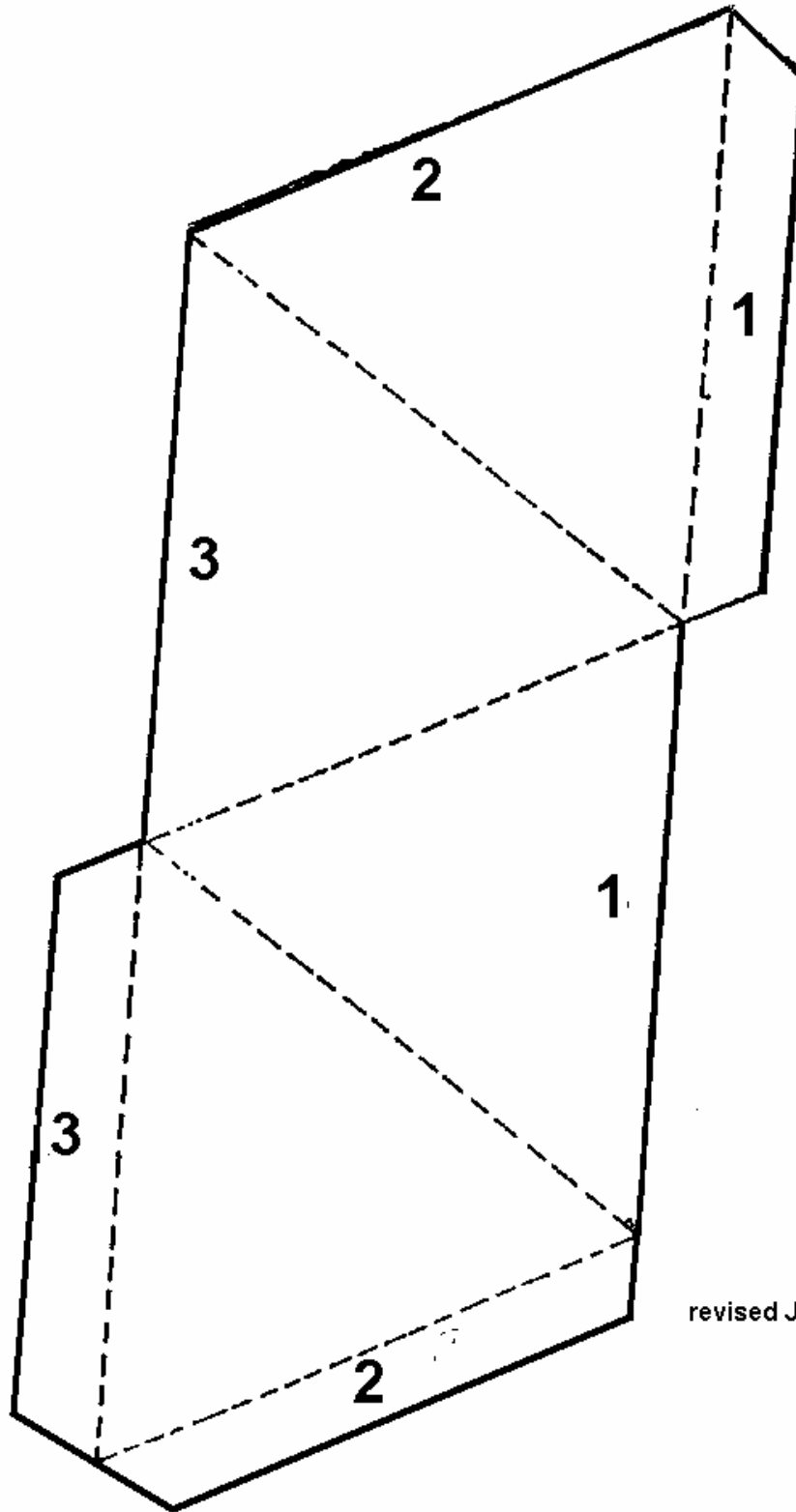
7. The air around us is made up of 21% O<sub>2</sub> (oxygen molecules) and 78% N<sub>2</sub> (nitrogen molecules).

If you add 21% and 78% you get a total of 99%. For percentages 100% is the whole thing. Therefore, most of all the air is made up of oxygen and nitrogen.

Using your Periodic Table as a resource, try to give a reason why a balloon filled with Helium (He<sub>2</sub>) rises or floats in the “sea” of air that surrounds us.

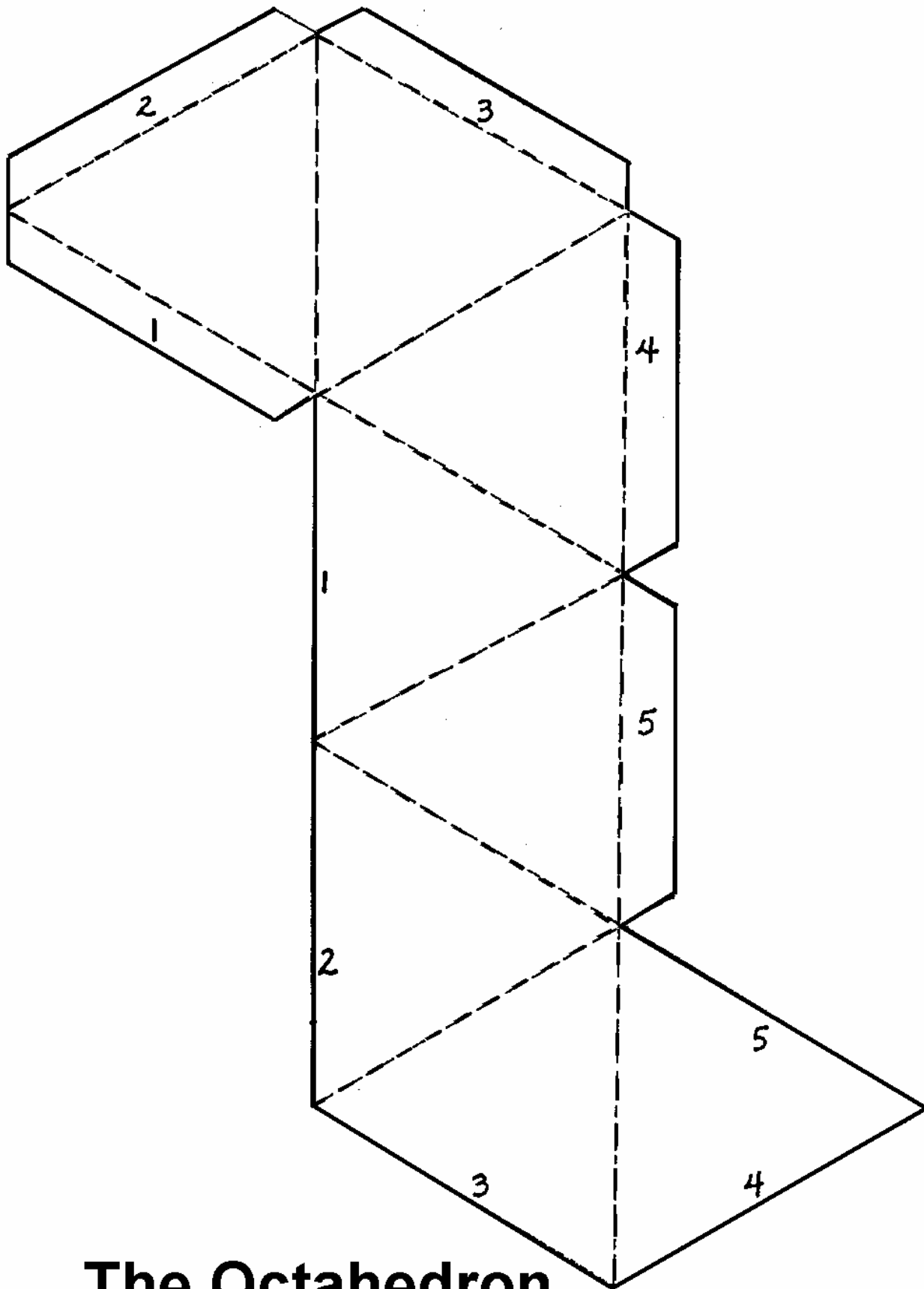


# The Cube



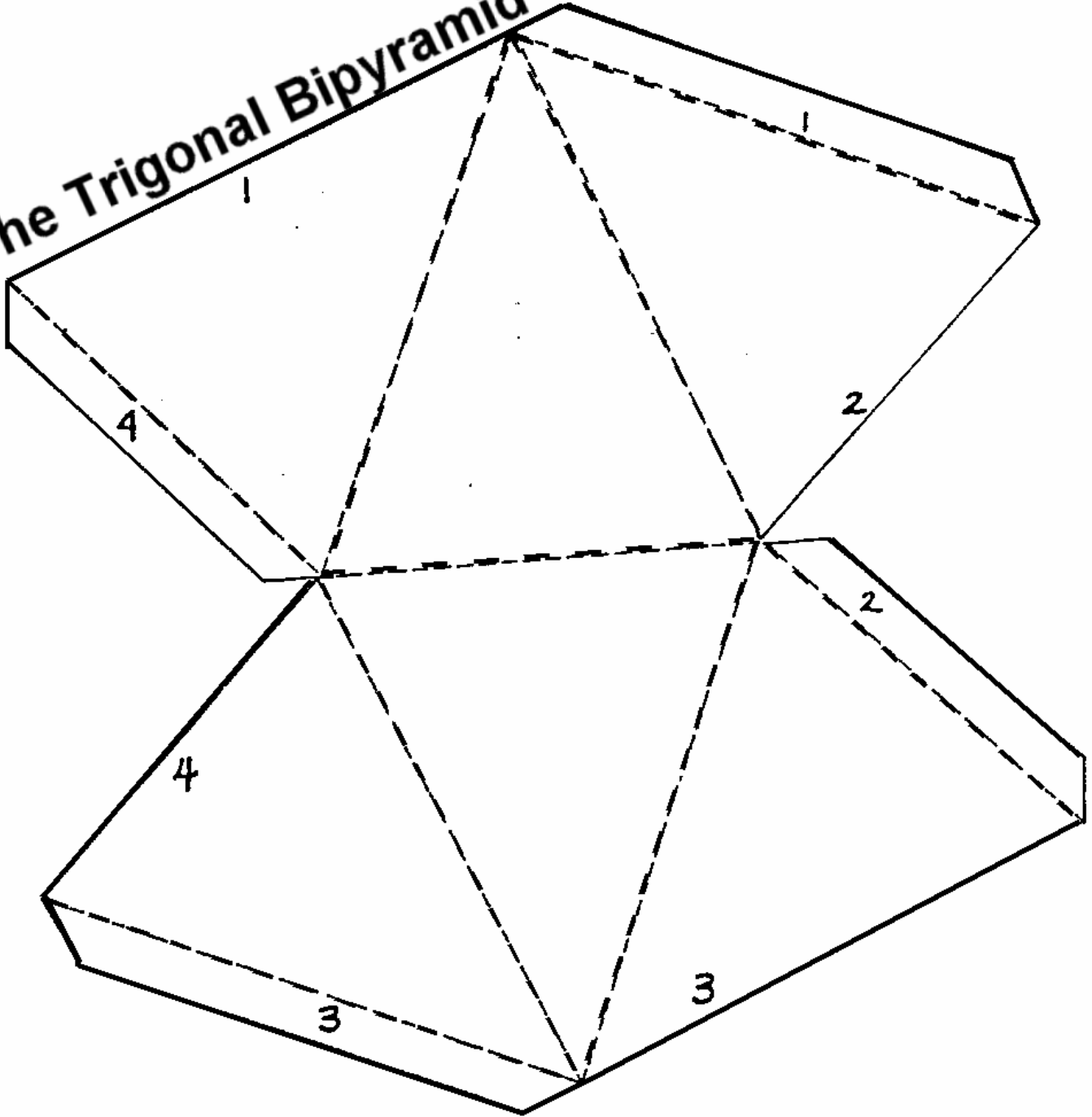
revised June 2002

# The Tetrahedron



# The Octahedron

# The Trigonal Bipyramid



NAME: \_\_\_\_\_

Group: \_\_\_\_\_

Powder Puzzles Evaluation 2; This worksheet reviews many of the concepts you explored in the "WHO DID IT Lab " experience. Some questions are direct answer, some are thought provoking, You may use your Lab Journal as a resource. You do not have to do the questions in order.

- In "Session 2: It's Elemental My Dear Newbie" you explored elements and compounds. After observing each of the samples the question was asked "Which are elements and which are compounds?" You went through a process of gathering information about each of the samples (such as, the common name, chemical name, chemical formula, if found on Periodic Table). From this information you made a conclusion about each of the samples. The conclusion was whether it was an element or compound.

At this point answer one of the following:

- Someone asks you "How can you tell if a substance is an element or compound?", give them an answer.
- Develop a way of finding out whether a substance is an element or a compound. Tell what information you would need about the substance. Tell how you would use the information.

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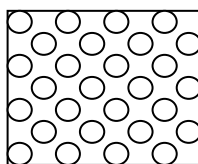
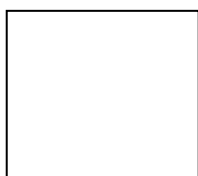


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- You will be drawing circles in the containers below. Draw small circles to show the spacing between molecules of a solid, liquid or a gas. (The liquid is done for you.)



State: SOLID

LIQUID

GAS

- In which container (state) do the molecules have more energy of motion?  
\_\_\_\_\_
- In which container (state) are the molecules bound together most strongly? \_\_\_\_\_

NAME: \_\_\_\_\_

Group: \_\_\_\_\_

3. Which tend to be larger, atoms or molecules? \_\_\_\_\_ Why?

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4. Define the term "crystal".

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5. Give at least one reason for chemists to study crystal shapes of substances.

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6. Draw a common crystal shape.

7. Give 3 substances commonly found in a crystal form.

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8. In the USA the chemical formula for water is  $H_2O$ , what is the chemical formula for water in France?

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9. What does the chemical formula for water,  $H_2O$ , tell you about this compound?

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10. How does the term "mixture" describe a rainbow?

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11. Tell what "Chromatography" is used for.

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NAME: \_\_\_\_\_

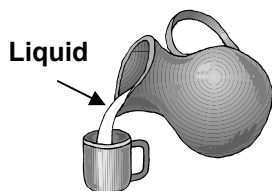
Group: \_\_\_\_\_

12. Give two examples of a compound. \_\_\_\_\_

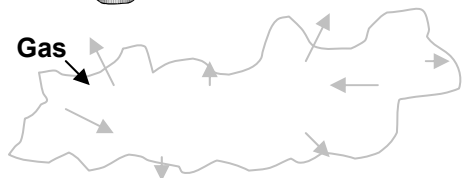
13. Matching: Draw a line from the substance to it's properties.



**Solid**



**Liquid**



**Gas**

	Property
●	A. Has a Volume (takes up a measurable amount of space)
●	C. Has a Shape (able to grab onto, able to hold in your hand)
●	D. Has no definite shape (shape is easily changed)
●	E. Strong Bonds or Weak Bonds ( hard to pull apart)
●	F. Weak Bonds (easy to pull apart)

14. If you had a newspaper, what could you do to it that would be a physical change? (see Session 7)

\_\_\_\_\_

15. What could you do to the newspaper to have it undergo a chemical change?

\_\_\_\_\_

16. What is the difference between a physical change and a chemical change? (think in terms of: chemical make up and chemical properties).

\_\_\_\_\_

\_\_\_\_\_

17. In Sessions 8 - 13, list 5 characteristic properties used to compare the samples.

\_\_\_\_\_

\_\_\_\_\_



NAME: \_\_\_\_\_

Group: \_\_\_\_\_

18. Review the reading in Session 9 titled “The Dissolving Solution”.

a. Define the term “dissolve”. \_\_\_\_\_

b. What can effect the speed at which a substance dissolves in water? \_\_\_\_\_

c. Define the term “solvent”.

\_\_\_\_\_  
d. Define the term “solute”.

\_\_\_\_\_  
e. When you make hot cocoa, what is the solvent and what is the solute?

\_\_\_\_\_  
f. List two substances (or materials) that you know are “insoluble” in water.



Challenge Question! The term “soluble” or solubility” relates to a substance dissolving in a liquid. Look back at the Chromatography experiment (Session 5). What is the solvent and what is the solute?

solvent- \_\_\_\_\_ solute- \_\_\_\_\_

19. In Session 10, does the interaction with vinegar show a physical change or a chemical change? What was the evidence for this?

\_\_\_\_\_  
20. In Session 11, what did you test for using “iodine” as an indicator? \_\_\_\_\_

21. In Session 12 you test the melting point of some substances. What do we mean by the term “melting point”?

\_\_\_\_\_  
\_\_\_\_\_

NAME: \_\_\_\_\_

Group: \_\_\_\_\_

22. Share 2 things you learned about Acids and Bases (Session 13).

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Powder Puzzles: Chemical/Physical Change Station Cards

Station #	Instruction: Rub the crayon across the paper	Write an observation and a conclusion.
Station #	Instruction: Observe the beakers and the contents	Write an observation and a conclusion
Station #	Instruction: Tear a piece off of the paper.	Write an observation and a conclusion.
Station #	Place $\frac{1}{2}$ tsp of the white powder in the small cup. Add a $\frac{1}{2}$ tsp of vinegar.	Write an observation and a conclusion. (throw out the cup when you are done)

Powder Puzzles: Chemical/Physical Change Station Cards

Station #	Look at the different parts of the steel wool.	Write an observation and a conclusion.
Station #	Observe the lit candle	Write an observations and a conclusion.
Station #	Feel each of the items. One is in the package. One is out of the package.	Write an observation and a conclusion



### **The Crime: The Great Candy Caper**

Early this morning the school custodian discovered that someone had entered the school building late in the previous day by using the special code available only to the school staff. After a careful search it was revealed that the supply of candy for the School Candy Sale/Fund Raiser was missing and a note was left in its place. The note indicated that this was the act of a desperate person, obviously a candy-a-holic as it read " Please stop me before I eat it all!"

The movements of the intruder, searching for the candy stash, were tracked through: the cafeteria kitchen area, the art room, several classrooms and storage areas. The trail ended in the "place" that the candy was stored (this location needs to remain confidential for security purposes and will be referred to as "the place"). As investigators searched "the place" looking for clues

they found traces of a substance on the floor that appeared to be tracked in on the intruder's shoes. Investigators also found a handwritten note. These items will be given to the lab teams for analysis. As a follow up, the shoes of all staff who have access to the building were scraped for evidence. Out of the entire staff, six had shoe scrapings that were suspicious and alibis that were not supported (these people could not provide a witness to support their story). These staff members were asked to hand in their favorite marker for analysis as well as an accounting of their whereabouts during the crime. Both the shoe scrapings and markers were forwarded to the crime lab.

**Alibis:** When questioned about their whereabouts at the time of the crime, the suspects answered as follows:

**Suspect 1:** I resent this accusation and in my heart know that justice will prevail. As for my whereabouts at the time of the crime, I was at home by myself watching reruns of the "Iron Chef", my idol.

**Suspect 2:** Well, that is the time of day that I go out into the woods to play my bagpipes as my neighbors kept reporting me to the authorities for torturing my cat. I don't own a cat.

**Suspect 3:** I didn't want this to get out to the public but I guess it can't be helped. I was in my basement practicing my roller blade routine for the Roller Dance competition. You see, I wanted to surprise everyone and now it's all ruined!! I have to go lay down.

**Suspect 4:** Oh dear, I'm afraid my companion at that time won't be much help in supporting my whereabouts. You see I was out walking with my best friend, Tom (he's my pet turtle). We've had so many close calls with traffic that now we go to secluded spots for our walks and he tells me all about his day. You won't want to question him, he's very shy.

**Suspect 5:** I'm not talking. I want to call my lawyer.

**Suspect 6:** My friends all think that I’m a big social type person but actually I lead a very quiet lifestyle. At the time of the crime I was at home, sitting in the closet and doing my meditation.

**Crime Lab Teams:**

Each crime lab team will analyze a sample of a suspect’s “shoe scrapings” and favorite marker (chromatography analysis) to compare to the evidence found at the crime scene. (One group will analyze the evidence.) The samples will be assigned to you by your Lab Director. If there is the proper number of groups it would be best to evaluate each sample twice, as a control for data accuracy.

**Procedures:** Each team will be utilizing the procedures that they have studied and sharing their data with the rest of the lab teams.

**Data:** The data should be organized on a chart by each team and then shared by the group.

**Teacher Preparation:**

**Powders and Crystals:**

In the Science Kit you will find three containers marked A, B, and C. You will be using these for the “shoe scrapings”. (This will be presented to the students as previously obtained evidence.)

**Materials:**

- 7 plastic tumblers
- Containers A, B, C
- teaspoon
- 6 markers
- masking tape

1. Label 6 cups (plastic tumblers), 1 through 6 and label one “RE” for the Room Evidence.
2. Place 14 tsp. of sample A in cups 1 AND 2.
3. Place 14 tsp. of sample B in cups 3 AND 4
4. Place 14 tsp. of sample C in cups 5 AND 6.

Use the chart provided as a guide.

Cup Number, Suspect Shoe Scraping	Powder/Crystal Mix Letter	Marker Number	Suspect assigned to a specific Sample*
1	A	1	
2	A	2	
3	B	3	
4	B	4	
5	C	5	
6	C	6	
Room Evidence (RE)	Mix Letter:	Marker #:	Matching Suspect:

**5. Powder/Crystal Mixes:**

Select a sample to use as the room evidence (A,B or C) and record the letter choice in the chart as the RE Powder. Place 14 tsp of that sample in the cup labeled "RE" for testing.

**6. Marker (Note):**

Label each marker with a piece of tape assigning numbers 1-6. Be sure to use a marker to write the note which matches a Powder/Crystal Mix Sample (A,B or C) chosen as Room Evidence. (For example, if you chose Mix A for the RE, you'll need to choose Marker 1 or 2 for the note)

Record the number of the RE marker in the chart.

7. The note should be written on a paper towel with a trailing line that can be cut off for an analysis. (see example). The teams will need to do chromatography analysis of the markers and the "Note".

**CHECK: THE LETTER AND MARKER OF THE "RE" SHOULD MATCH ONE OF THE SUSPECT'S EVIDENCE**

**Group Testing Options:** This will give your class 7 samples to identify and 7 markers (6 markers and 1 note) to analyze. Scientific methodology would call for each sample to be tested and re-tested or verified.

- ✓ 14 testing groups with each sample set being assigned to two groups (tested twice).
- ✓ 7 testing groups with a final re-testing of "RE" sample and any matches.
- ✓ 7 testing groups with each group testing 2 samples/RE
- ✓ 7 testing groups with each group testing 1 sample/RE

**BUILDING THE STORY**

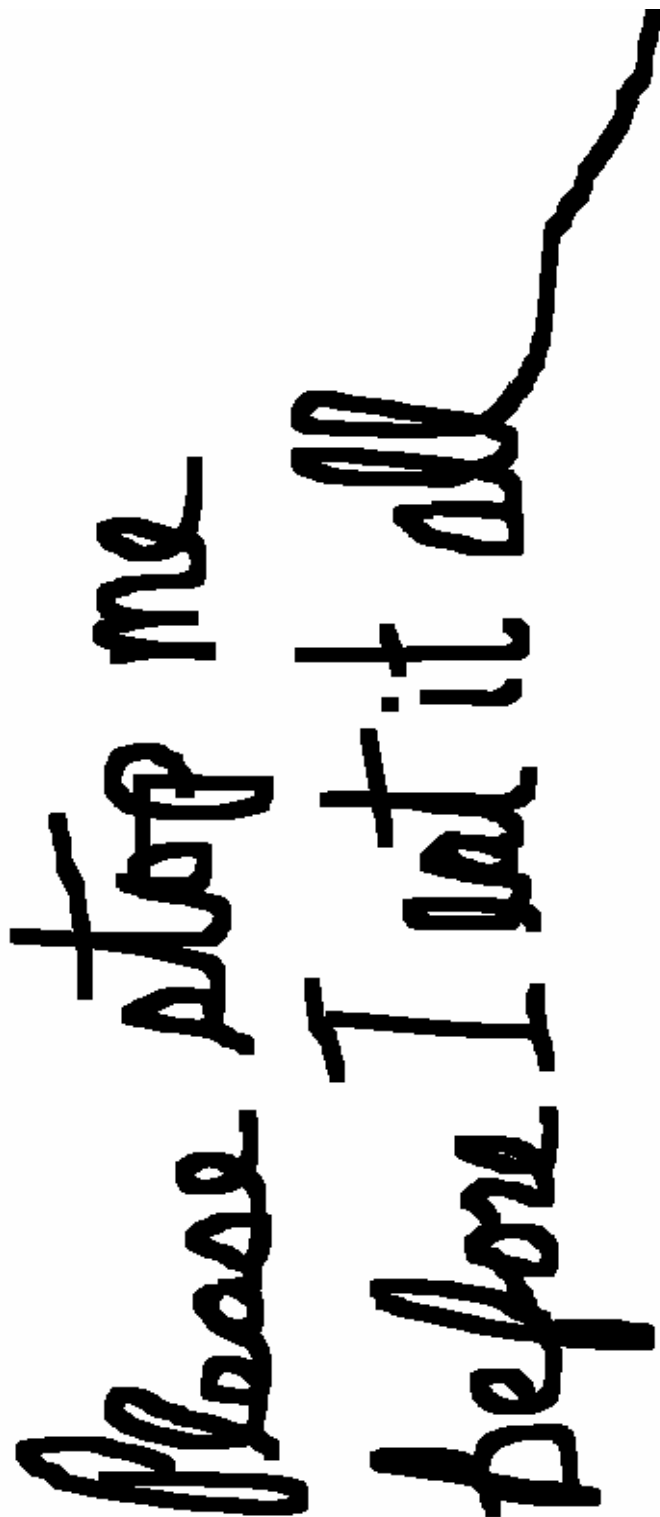
It would be great fun to get 6 or more staff members to "play along". The students could visit the to get their alibi's and to have them hand over a pre-arranged marker to the evidence gathering team. There could be other suspects that are eliminated due to supported alibi's. A bulletin board could be created with the pictures of each suspect, their alibi and the results of the data analysis posted.

**ENDING**

Options:

- a. The concluding evidence could be presented to the Principal who then privately "confronts the criminal". The principal then reports back to the class that, due to their quick work, all the candy was recovered and the individual will be in candy-oholic rehabilitation. Congratulation on a job well done.
- b. The class can be recognized by the "Lab Director" as succeeding in their trial assignment and that they all have a future as Forensic Scientists.

Sample Note (to be written on paper towel with selected kit marker)

A photograph of a white paper towel with black handwritten text. The text is written in a cursive, slanted style and reads "Please stop me before I eat it all".

Please stop me  
before I eat it all