



TRENDSETTER LAB

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**Prepared as part of Target Inquiry Program
at Grand Valley State University**



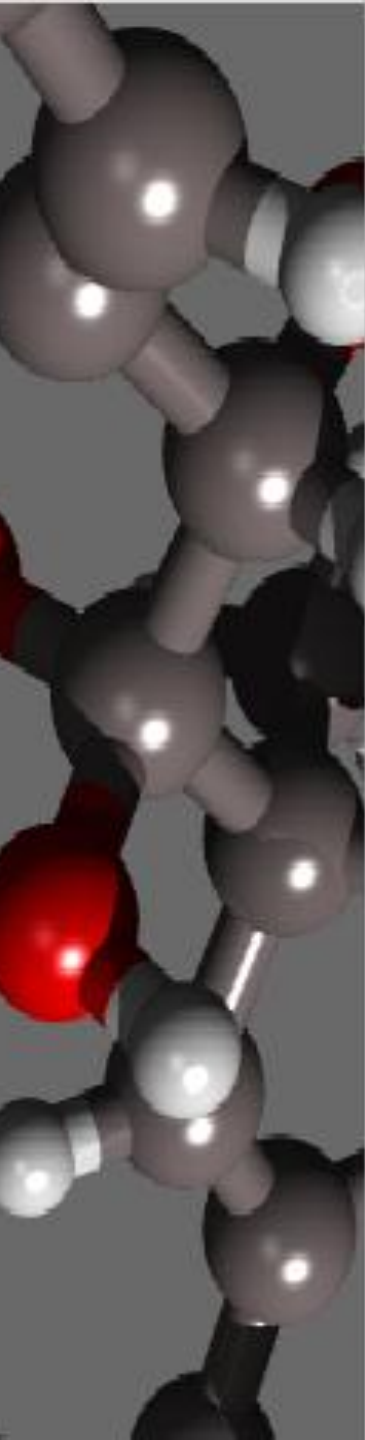
Chemistry Course

- All Michigan students are required to take chemistry OR physics (most take chemistry)
- 80% of our students take general chemistry
- 20% take Chem Essentials (Conceptual Chemistry)
- Students are in 10th or 11th grade.
- This lab is used in both courses.



OBJECTIVES

- The student will be able to identify and explain trends of electronegativity, atomic radii and ionization energy on the periodic table.
- The student will recognize similarities of properties based upon location on the periodic table and be able to predict properties of an element based on the location of that element on the table.



PRIOR KNOWLEDGE

- Students should have a working knowledge of the parts of an atom.
- Students should be able to write the noble gas electron configurations of all the elements on the periodic table.
- Students should know the definition and have a basic understanding of ionization energy, electronegativity and atomic radii.



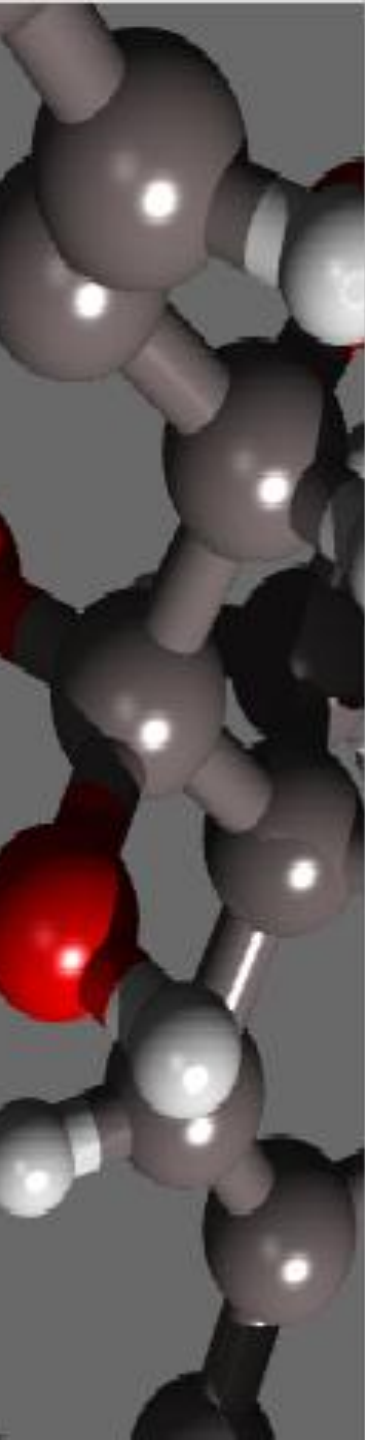
HISTORY OF PERIODIC TABLE

- In 1865, the English chemist, John Newlands arranged the first 16 elements known at that time in order of increasing atomic mass. He placed these elements into two rows and he observed that the elements in each column had similar chemical and physical properties.



MENDELEEV'S TABLE

- In 1870, Dmitri Mendeleev used this and other information to arrange the 63 elements known at that time. He wrote the element symbol, properties and atomic mass of each element onto individual cards. He noticed that if he put the elements in order of atomic mass, he saw a repeating pattern of properties. By making each successive series of properties into a new row, Mendeleev found a workable table for the elements. Mendeleev recognized a pattern of combining ratios or “valency”.



PRE-LAB

Define

- GROUP
- PERIOD
- ATOMIC MASS
- IONIZATION ENERGY
- ELECTRONEGATIVITY
- ATOMIC RADII

List the properties of

METALS....NONMETALS....& METALLOIDS



PREDICTIONS

Choose two or three of the listed elements that you feel confident may be grouped together. Explain your answer.

Element A	Silver colored liquid metal	Does not react with water	Reacts with Cl to form XCl_2
Element B	Somewhat hard silvery solid metal	Reacts very slowly with water	Reacts with Cl to form XCl_2
Element C	Purple solid nonmetal	Reacts slowly with metals	Reacts with Cl to form XCl
Element D	Soft silvery solid metal	Reacts very slowly with water	Reacts with Cl to form XCl_2

Card Information

Code	Physical Description
Atomic mass	1 st ionization energy
Ratio w/ oxygen	Electronegativity
Ratio w/ fluorine	Atomic radii
Reactivity	Phase @ room

Uu	Brittle, yellow nonmetal
<input type="checkbox"/>	
XO	1.0
XF ₂	2.6
	.104
Reacts slowly with metals	SOLID

li	Soft, silvery metal
26.98	
X ₂ O ₃	.6
XF ₃	1.5
	.125
Does not react in presence of oxygen	SOLID

XF
Reacts with water

Reacts slowly with metals

low
entely hard,
metal

Vv
Red nonmetal
Hard
Reacts violently with water

Qq

[illegible]

Periods 1 & 2

Zz	Colorless, Odorless Nonreactive
1.0	
K_2O	1.3
KF	2.2
	.03
Explodes in air when sparked	0.5

Gg	Silver (metal)
6.9	
K_2O	3
KF	1.0
	.123
Reacts with water	SOLID

Jj	Hard, lead-gray metal
9.0	
KO	0.9
KF_2	1.3
	.089
Does not react with water	SOLID

Pp	Hard, black metallic
10.8	
K_2O_2	1.8
KF_2	2.0
	.088
Does not react with oxygen	SOLID

Rr	Colorless, Odorless Nonreactive
20.18	
—	2.1
—	—
	.071
Unreactive	GAS

Vv	Hard, silver-white metallic (K, soft, black)
12.01	
KO_2	1.2
KF_2	2.6
	.077
Does not react with oxygen	SOLID

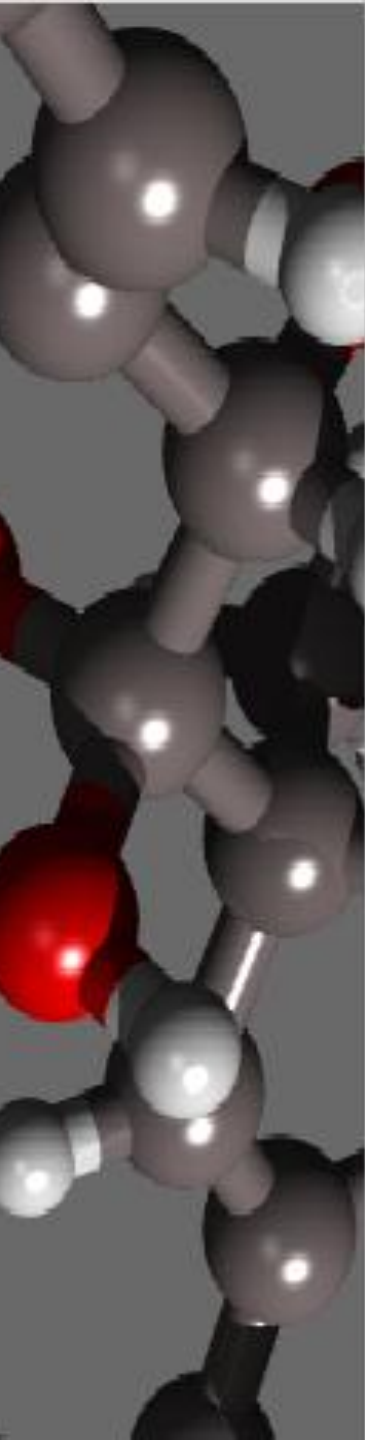
Tt	Colorless, Odorless Nonreactive
14.01	
K_2O_2	1.4
KF_2	3.1
	.07
Not very reactive	GAS

Ww	Colorless, odorless Nonreactive
16.00	
KO	1.3
KF_2	3.5
	.068
Reacts slowly with metals	GAS

Ss	Pale yellow Nonreactive
19.00	
K_2O	1.3
KF	4.3
	.08
Explodes upon contact with metals	GAS

Once the first 10 elements are arranged, the students are asked to complete the rest of the table (all 26 elements) based on similarities and trends that they see.

COMMON ERRORS



Reacts with water SOLID	Does not react with water SOLID	Does not react with oxygen SOLID	Unreactive GAS
Mm Soft, silvery metal <div><div></div></div> 0.5 X_2O 0.9 XF .157 Reacts vigorously with water SOLID	Hh Moderately hard, silvery metal <div><div></div></div> .7 XO 1.2 XF_2 .136 Reacts only slightly with water SOLID	Cc Silvery metal 6.72 X_2O_3 .58 XF_3 1.6 .125 Does not react with oxygen SOLID	Nn Moderately hard, silvery metalloid <div><div></div></div> 0.8 XO_2 1.9 XF_4 .117 Reacts very slowly with oxygen SOLID
Bb Very soft, silvery metal <div><div></div></div> 0.4 X_2O 0.8 XF .203 Reacts violently with water SOLID	Kk Moderately hard silvery metal <div><div></div></div> 0.6 XO 1.0 XF_2 .174 Reacts with water SOLID	Ll Soft, silvery metal 26.98 X_2O_3 .6 XF_3 1.5 .125 Does not react in presence of oxygen SOLID	Xx UNKNOWN ELEMENT

COMPLETE TABLE

Zz	Colorless, Odorless
1.0	1.3
X ₂ O	2.2
XF	.03
Explodes in air when sparked	GAS

Gg	Silver Metal
6.9	5
X ₂ O	1.0
XF	.123
Reacts with water	SOLID

Mm	Soft, silvery metal
<input type="checkbox"/>	0.5
X ₂ O	0.9
XF	.157
Reacts vigorously with water	SOLID

Bb	Very soft, silvery metal
<input type="checkbox"/>	0.4
X ₂ O	0.8
XF	.203
Reacts violently with water	SOLID

Jj	Hard, lead-gray metal
9.0	0.9
XO	1.5
XF ₂	.089
Does not react with water	SOLID

Hh	Moderately hard, silvery metal
<input type="checkbox"/>	7
XO	1.2
XF ₂	.136
Reacts only slightly with water	SOLID

Kk	Moderately hard silvery metal
<input type="checkbox"/>	0.6
XO	1.0
XF ₂	.174
Reacts with water	SOLID

Pp	Hard, black metalloid
10.8	1.8
X ₂ O ₃	2.0
XF ₃	.088
Does not react with oxygen	SOLID

Ii	Soft, silvery metal
16.98	.6
X ₂ O ₃	1.5
XF ₃	.125
Does not react in presence of oxygen	SOLID

Cc	Silvery metal
69.72	.58
X ₂ O ₃	1.6
XF ₃	.125
Does not react with oxygen	SOLID

Rr	Colorless, Odorless
20.18	2.1
—	—
Unreactive	GAS

Nn	Moderately hard, silvery metalloid
<input type="checkbox"/>	0.8
XO ₂	1.9
XF ₄	.117
Reacts very slowly with oxygen	SOLID

Xx	UNKNOWN ELEMENT
----	-----------------

Vv	Hard, very hard metalloid (sil. spl. brit)
12.01	1.1
XO ₂	2.6
XF ₃	.077
Does not react with oxygen	SOLID

Oo	Red
35.97	1.0
X ₂ O ₃	2.2
XF ₃	.110
Does not react with oxygen	SOLID

Qq	Brittle, steel-gray metalloid
74.92	.95
X ₂ O ₃	2.0
XF ₃	.121
Reacts very slowly with oxygen	SOLID

Tt	Colorless, Odorless
14.01	1.4
X ₂ O ₃	3.1
XF ₃	.07
Not very reactive	GAS

Ju	Brittle, yellow
<input type="checkbox"/>	1.0
XO	2.6
XF ₃	.104
Reacts slowly with metals	SOLID

Ee	Gray
<input type="checkbox"/>	.98
XO	2.5
XF ₃	.117
Reacts slowly with metals	SOLID

Ww	Colorless, odorless
16.00	1.3
XO	3.1
XF ₃	.066
Reacts slowly with metals	GAS

Uu	Greenish-yellow
<input type="checkbox"/>	1.3
X ₂ O	1.2
XF	.099
Reacts violently with metals	GAS

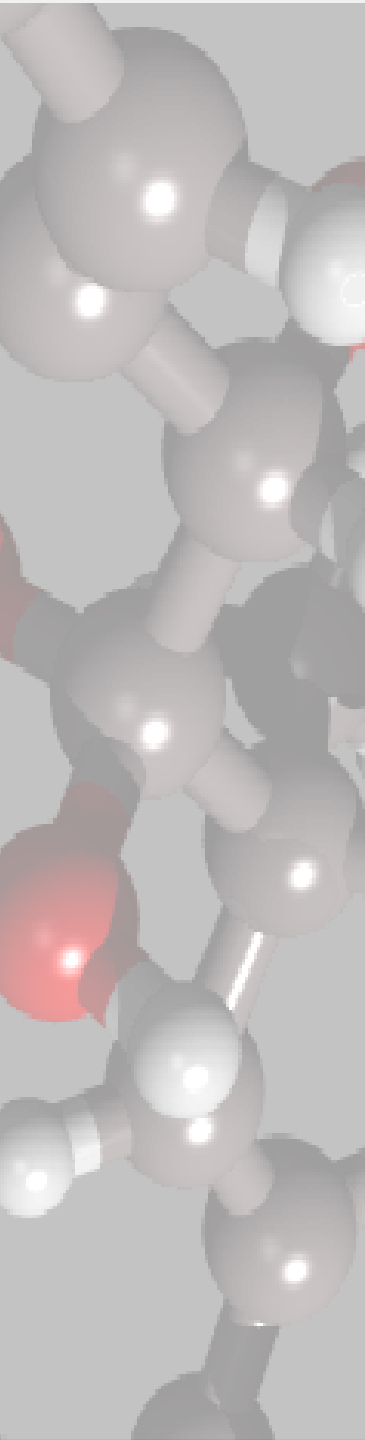
Aa	Reddish-brown
<input type="checkbox"/>	1.14
X ₂ O	2.9
XF	.114
Reacts vigorously with metals	SOLID

Vv	Colorless, Odorless
4.00	2.1
—	—
Unreactive	GAS

Ss	Pale yellow
19.00	1.3
X ₂ O	3.1
XF	.066
Explodes upon contact with metals	GAS

Dd	Colorless
<input type="checkbox"/>	—
—	—
Unreactive	GAS

Hh	Colorless
<input type="checkbox"/>	—
—	—
Unreactive	GAS



I	II	III	IV	V	VI	VII	VIII
Zz							He
Gg	Jj	Pp	Vv	Tt	Ww	Ss	Rr
Mm	Hh	Ii	Nn	Oo	Uu	Ll	Dd
Bb	Kk	Cc	Xx	Qq	Ee	Aa	Ff



IN THE LAB

- Place samples of **CALCIUM** and **MAGNESIUM** into separate beakers of water (with drop of phenolphthalein).
- Observe difference in reactivity.
- Assign Ca and Mg to the cards Hh & Kk.

PREDICTING PROPERTIES OF THE UNKNOWN ELEMENT

<p>9.0 XO XF₂</p> <p>0.9 1.5 .089</p> <p>10.8 X₂O₃ XF₃</p> <p>1.8 2.0 .088</p> <p>Does not react with water</p> <p>SOLID</p> <p>Does not react with oxygen</p> <p>SOLID</p>	<p>20.18 — —</p> <p>Nonmetal</p> <p>2.1 — .071</p> <p>Unreactive</p> <p>GAS</p>	<p>12.01 XO₂ XF₄</p> <p>1.1 2.6 .077</p> <p>metalloid Or soft, black</p> <p>Does not react with oxygen</p> <p>SOLID</p>	<p>14.01 X₂O₃ XF₃</p> <p>1.4 3.1 .07</p> <p>Nonmetal</p> <p>Not very reactive</p> <p>GAS</p>
<p>Hh Moderately hard, silvery metal</p> <p><input type="text"/></p> <p>.7 1.2 .136</p> <p>Reacts only slightly with water</p> <p>SOLID</p>	<p>li Soft, silvery metal</p> <p>26.98 X₂O₃ XF₃</p> <p>.6 1.5 .125</p> <p>Does not react in presence of oxygen</p> <p>SOLID</p>	<p>Nn Moderately hard, silvery metalloid</p> <p><input type="text"/></p> <p>0.8 1.9 .117</p> <p>Reacts very slowly with oxygen</p> <p>SOLID</p>	<p>Oo Red</p> <p>30.97 X₂O₃ XF₃</p> <p>1.0 2.2 .110</p> <p>Does not react with oxygen</p> <p>SOLID</p>
<p>Kk Moderately hard silvery metal</p> <p><input type="text"/></p> <p>0.6 1.0 .174</p> <p>Reacts with water</p> <p>SOLID</p>	<p>Cc Silvery metal</p> <p>69.72 X₂O₃ XF₃</p> <p>.58 1.6 .125</p> <p>Does not react with oxygen</p> <p>SOLID</p>	<p>Xx</p> <p>UNKNOWN ELEMENT</p>	<p>Qq Brittle, steel-gray metalloid</p> <p>74.92 X₂O₃ XF₃</p> <p>.95 2.0 .121</p> <p>Reacts very slowly with oxygen</p> <p>SOLID</p>
			<p>Ee Gray</p> <p><input type="text"/></p> <p>.94 2.5 .117</p> <p>Reacts slowly with metals</p> <p>SOLID</p>



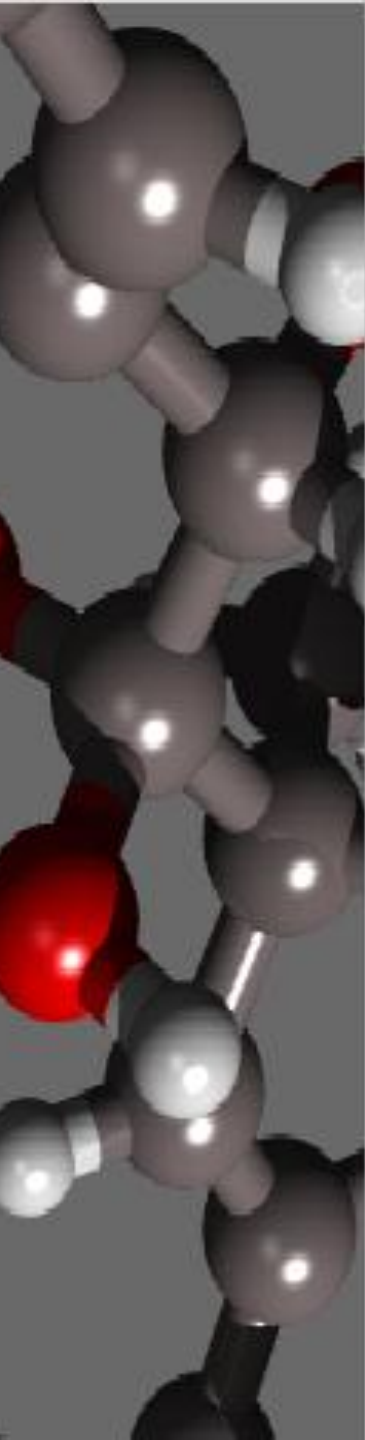
Consider the Trends

- Explore trends of atomic radii, ionization energy, electronegativity, etc.
- Teacher explanations may extend to WHY at this point OR that explanation may be saved for later.



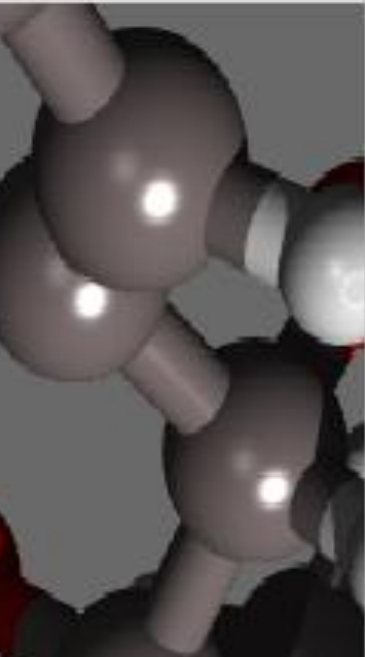
Scaffolding of Questions

- Look at the table you created. List patterns and/or trends you used while arranging the element cards.
- Identify where the metals, metalloids and nonmetals are found on the table.
- Identify where most of the gases are found on the table.



The next level of questions:

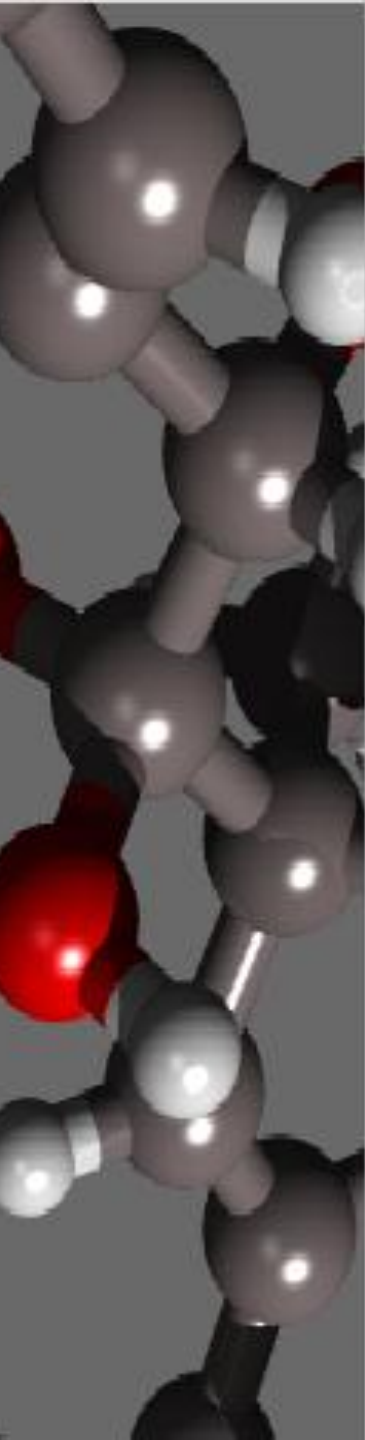
- In which two areas of the table do you find the most reactive elements? What property trends are related to reactivity? Predict an explanation for this.
- Find strontium on the periodic table. Considering Part B of the procedure, predict the reactivity of strontium with water.



ASSESSMENT

Students create a table of their own design to highlight trends and properties of elements.

I	II											III	IV	V	VI	VII	VIII



GOING FURTHER – more scaffolding of questions

1. a) What do you think happens to the size of an atom as the number of electrons increase?

b) Does your explanation correspond to the trend seen for atomic radii? Explain.

2. The 10 groups added between the main group elements are called Transition Elements.

(a) Predict what phase they will be in at room temperature. Explain.

(b) What do the electron configurations of these elements have in common?



REFERENCES

- Stacy, Angelica M., Coonrod, Jan, and Claesgens, Jennifer, Living by Chemistry General Chemistry, Alchemy, Key Curriculum Press, 2003.
- Winter, Mark, WebElements: The Periodic Table on the WWW (<http://webelements.com/>), University of Sheffield and WebElements Ltd, UK, 2003-2009.



QUESTIONS?

- Check out the materials at the **Target Inquiry** Web site.
- Contact me directly for more information and/or comments.

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