Learning Guide for Lecture 1D – The Periodic Table
Chem 1010

Review

Name some elements that you remember from the previous lecture, and what you remember about them.

Where do the names of the elements come from?

What are the symbols for the following elements?

argon	nickel
arsenic	neptunium
astatine	nitrogen
antimony	niobium

What is the most common element in the universe? What is next?

What are the two most common elements on the earth?

What are the four most common elements in your body?

What are the three categories of elements based on what they look like in their pure form?

If a pure element can exist in two or more different forms, what are these forms called?

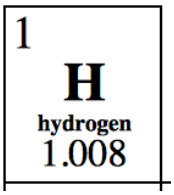
How many elements can be found native (in their pure form in nature)?

How are the other elements found?

Introduction

Take a good look at the Periodic Table of Elements that you were given. What objective observations can you make about it?

What does each block of the Periodic Table contain?



Why isn't the atomic mass a whole number?

99.98% have 1 proton

0.015% have 1 proton, 1 neutron

1 in 1018 have 1 proton, 2 neutrons

mass of hydrogen found in nature:

What about atoms whose mass is a whole number in parenthesis?

Today we will discuss the Periodic Table.

1. Why did chemists need a new way to organize the elements?
2. What does “periodic” mean?
3. How does the Periodic Table show repeating patterns?
4. How can the Periodic Table of Elements be used to predict the properties of elements?

1. Why did chemists need a new way to organize the elements?

There are lots of ways that you could organize a list of elements.

How is this list organized?

advantage:

problem:

How was Dalton's 1805 list of elements organized?

advantage:

problem:

How is the list that I gave you organized?

As more and more elements were being discovered, chemists tried to find a way to organize them that would show how their properties were related.

A chemist named _____ discovered the key.

Mendeleev was a card player. He wrote the names, masses, and properties of the 63 known elements on playing cards and shuffled and dealt them again and again, looking for a good way to organize them.

Eventually he realized that:

2. What does "periodic" mean?

If something is periodic, then it:

Let's consider some examples of things you are familiar with: numbers, letters, days of the month, temperature, and wind speed.

Numbers:

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 etc

Is there a pattern to how we write the numbers?

How could you make a chart to represent this?

0	1	2	3	4	5	6	7	8	9
10	11	12	13	14	15	16	17	18	19
20	21	22	23	24	25	26	27	28	29
30	31	32	33	34	35	36	37	38	39
40	41	42	43	44	45	46	47	48	49
50	51	52	53	54	55	56	57	58	59
60	61	62	63	64	65	66	67	68	69
70	71	72	73	74	75	76	77	78	79
80	81	82	83	84	85	86	87	88	89
90	91	92	93	94	95	96	97	98	99

If you go across the rows of this table:

If you go down a column of this table:

Are numbers periodic?

Letters:

A B C D E F G H I J K L M N O P Q R S T U V W X Y Z

Are there any repeating patterns in the letters?

We could make a chart by starting a new row every time there is a vowel.

A	B	C	D		
E	F	G	H		
I	J	K	L	M	N
O	P	Q	R	S	T
U	V	W	X	Y	Z

Across the rows:

Down the columns:

Are the letters periodic?

Days in a month:

Sat, Dec1	Wed, Dec 4	Sat, Dec 7
Mon, Dec 2	Thurs, Dec 5	Sun, Dec 8
Tues, Dec 3	Fri, Dec 6	Mon, Dec 9

Are there any repeating patterns?

How can we make a chart showing this?

Sun	Mon	Tues	Wed	Thurs	Fri	Sat
						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

rows:

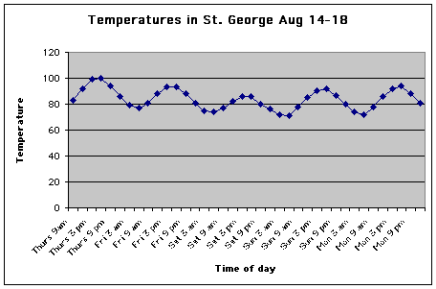
columns:

Are days of the month periodic?

Temperature:

If you took the outside temperature every three hours for five days, what pattern would you see?

We can show this by making a graph.

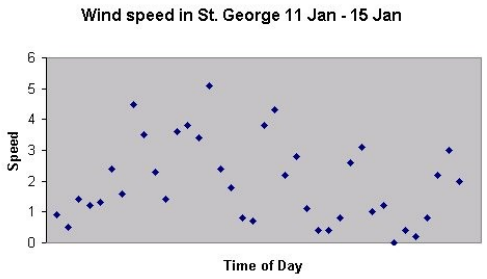


Is temperature periodic?

Wind speed:

If you took the wind speed every three hours for five days, what pattern would you see?

Here's what the graph would look like:



Is wind speed periodic?

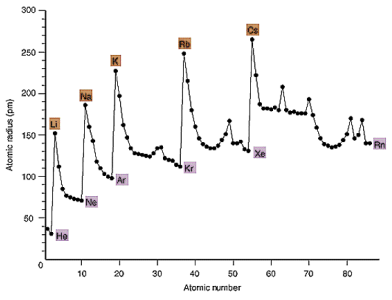
_____ can show whether something is periodic or not.

If something is periodic, a _____ will show a relationship both across rows and down columns.

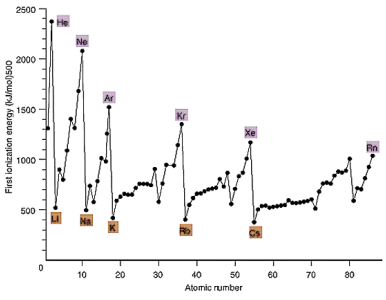
Elements:

Here are three graphs showing different properties of the elements.

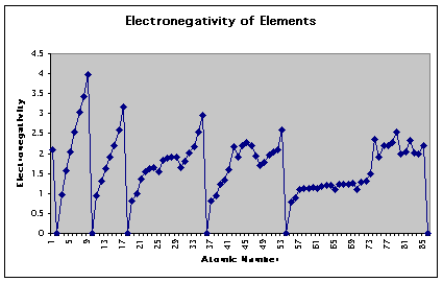
Is there a repeating pattern?



radius of an atom



first ionization potential



electronegativity

Since the elements are periodic, there must be a way to make a chart which will make use of these repeating patterns.

3. How does the Periodic Table show repeating patterns?

To show how Mendeleev used the repeating patterns in the elements to create the Periodic table, we'll use a set of colored cards with numbers on them.

numbers =

colors =

Step 1: Random order (this is like an alphabetic list of the elements).

Step 2: Arrange the cards in a long row in numerical order (this is like a list of the elements in order of mass).

Step 3: Turn the row into a table by starting over every time there is an orange card.

Step 4: Slide the cards over so that the columns match up.

rows:

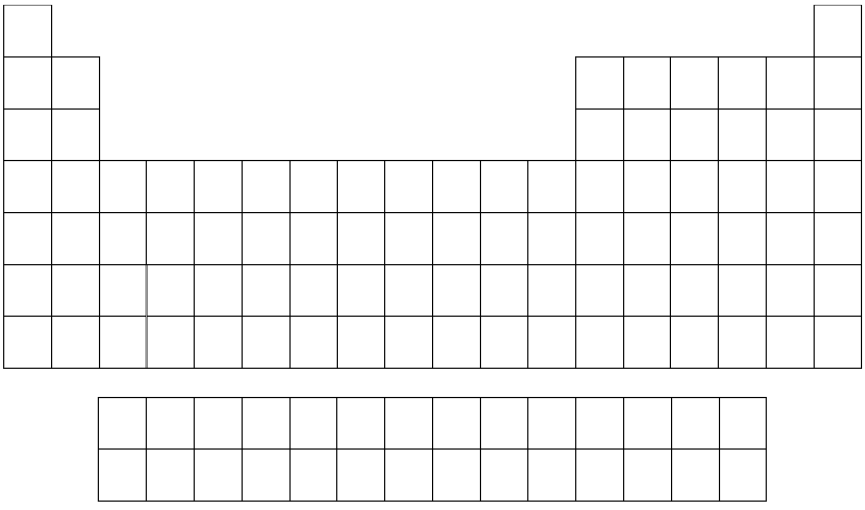
columns:

How does the table you have made compare to the Periodic Table of Elements?

rows:

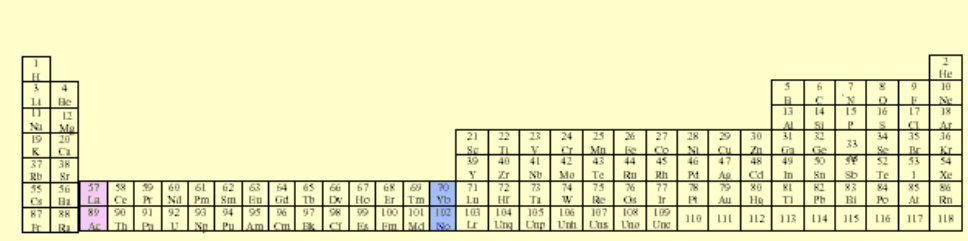
columns:

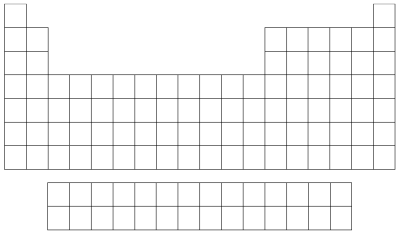
Draw arrows to show how the atomic number increases:



What's going on with the two rows at the bottom of the table?

Here's what the Periodic Table should really look like:



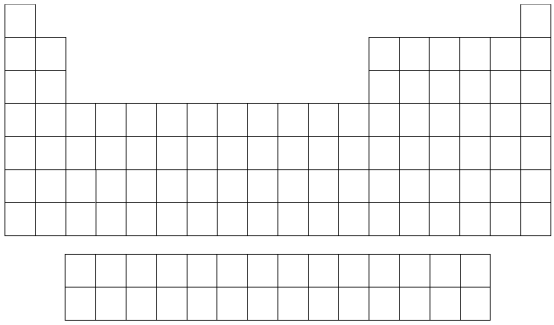


To make the table smaller, they took some elements out of the middle and made them into two separate rows.

If a new element with the atomic number 119 was created, where would it go?

Rows are called:

Periods are numbered:



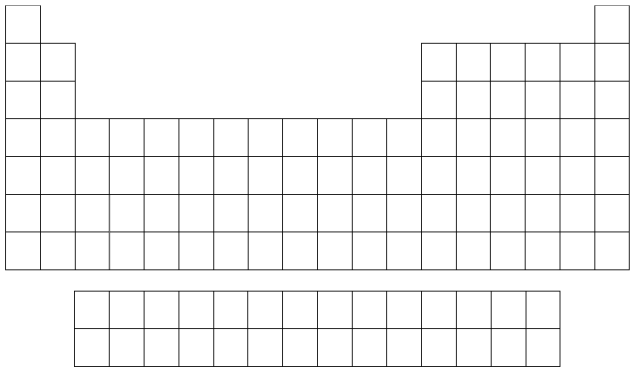
Which period are the following elements in?

beryllium (4) tungsten (74)

titanium (22) curium (96)

Columns are called:

Some families have names.



All other columns are named after:

Elements in the same family have:

Halogens

- all occur in pure form as diatomic molecules which are highly reactive

- all form a highly acidic compound with one hydrogen atom and one halogen atom

- all form a highly acidic compound with one hydrogen atom and one halogen atom

- all form a compound with one halogen atom, one carbon atom, and three hydrogen atoms

noble gases

- all occur in pure form as colorless gases
- all are highly unreactive, forming few if any compounds with themselves or other elements
- all give off light in gas discharge lamps

alkali metals

- all are soft, highly reactive metals in pure form
- all easily lose one electron to form +1 ions
- all react with water to form hydrogen gas (which ignites!)

alkaline earth metals

- all are reactive silver colored, soft metals (but less reactive and harder than alkali metals)
- all are more dense than alkali metals and melt at very high temperatures – stay solid in a fire

  Li 180^{o}C Na 98^{o}C K 63^{o}C Rb 38^{o}C Cs 28^{o}C Fr 27^{o}C
  Be 1278^{o}C Mg 650^{o}C Ca 839^{o}C Sr 764^{o}C Ba 725^{o}C Ra 700^{o}C

- all react with water, but not as vigorously as alkali metals
- all form compounds with chlorine with a 1:2 ratio

  LiCl NaCl KCl RbCl CsCl FrCl
  $BeCl_2$ $MgCl_2$ $CaCl_2$ $SrCl_2$ $BaCl_2$ $RaCl_2$

4. How can the Periodic Table of Elements be used to predict the properties of elements?

When Mendeleev first published his Periodic Table in 1869, there were only _____ known elements, which is only about _____ of the naturally occurring elements.

Mendeleev used the patterns that he had found to do something rather astonishing. When there was a space in the pattern with no element to fill it, he left a space open and predicted that a new element would be found to fill it.

Within a few years, these three elements were found in nature.

1879 ? = 68

1879 ? = 45

1886 ? = 70

Can you predict what is missing in this table?

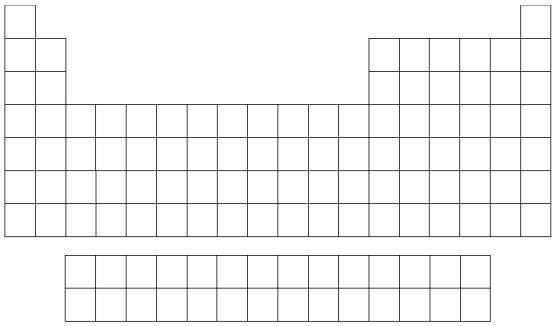
1			
2	3		
	6		7
9	10	11	
14		16	17
	20	21	22

Here is what our current table looks like with only the elements Mendeleev knew.

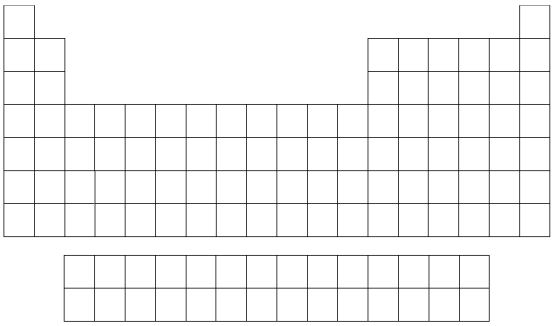
What's missing?

Let's look at some of the patterns the Periodic Table reveals.

Where are the naturally occurring and artificial elements?



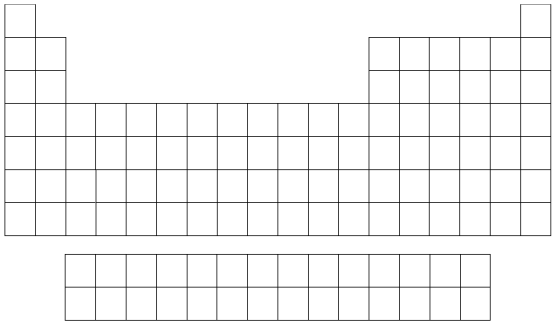
Where are the metals, nonmetals, and metalloids?



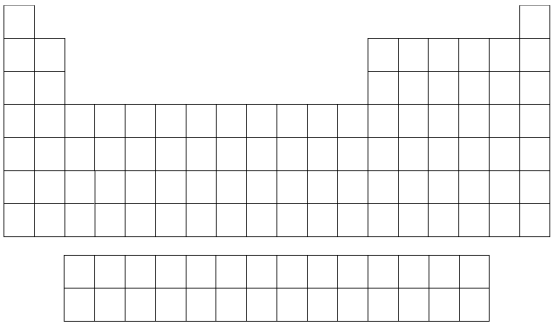
What would you guess about the appearance of the following elements?

francium
seaborgium
mendelevium
ununhexium
astatine

How are the main group metals divided up?



Where are the solids, liquids, and gases?



Can you predict the physical state of the unknown elements?