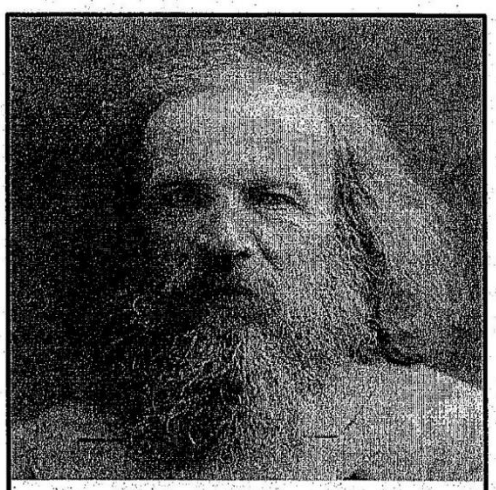
DMITRI MENDELEEV

(1) One of the most iconic images of science is the periodic table, and I, Dmitri Mendeleev am known as the Father of the Periodic Table. At the age of 35, after years of obsessing over the elements, I proposed the periodic table in 1869. My periodic table was so accurate that it predicted the existence and properties of elements that had yet to be discovered. Due to this periodic table, science was changed forever.



Dmitri Mendeleev
Chemist, Inventor (1834-1907)

(2) No one would have thought that I would have become a famous scientist. I was born on February 8th in 1834 in Siberia, Russia. I was one of over twelve siblings (I stopped counting after the twelfth!). My father became blind when I was a child and was unable to support the family. This forced my mom to open a glass factory to support all of us. Bad luck struck again when my dad died when I was 13 and my mom's factory burned down two years later. When I turned 16, my mother was determined that I would get a good education. She believed in my potential and took me across Russia, from Siberia to Moscow to see if the university there would take me as a student. They refused, so my mother took me further until we reached the university in St. Petersburg where my father had studied. They agreed to take me and thus my university education began. I began studying the sciences and training to become a teacher.

(3) While studying, I got sick with tuberculosis and was bedridden. This didn't stop me from studying as I just studied in bed! My hard work paid off as I graduated at the top of my class at the age of 20, even though I was unpopular with many of my classmates and teachers due to my violent bursts of temper. Two years later, in 1856, I got my Master's degree in chemistry. I won an award to study abroad in Germany at the University of Heidelberg. This is where my eyes were really opened to the exploration of science. I became convinced that there was a better way to conduct science and to standardize chemistry. The study of chemistry, up until then, was just a loose mishmash of unconnected findings. I became more and more passionate about chemistry while studying in Germany. They were so advanced in their scientific thinking and their techniques! This exposure made me painfully aware that Russia was falling behind in its scientific training and education and I was determine to fix this.

(4) When I was 27, I embarked on a crazy project to make a Russian language textbook called *Organic Chemistry*. It was 500 pages long and I wrote it in 61 days. This was the first of several science textbooks I wrote to help elevate science education in Russia. I continued to teach in various academic positions and was considered a very engaging and charismatic lecturer. In 1867, at the age of 33, I became the Chair of Chemistry at the University of St. Petersburg which was a very prestigious position. Two years later I wrote the internationally acclaimed textbook, *The Principles of Chemistry*.

(5) Not surprisingly, I had been fascinated with the elements for quite some time. I thought the elements' atomic masses were the key to connecting them in some sort of pattern. In an attempt to figure out this secret pattern, I made description cards of each of the 65 known elements at that time. On each card, I wrote the element's atomic mass as well as the other important physical and chemical properties of that element. When all of the cards were complete, I moved them around my desk trying to decipher a pattern. I kept trying for hours without success until I became exhausted and fell asleep at my desk. While asleep, I dreamt of the table of elements and saw the cards floating in the air and then landing into the correct place. I woke up with the periodic table clearly visualized in my mind. I published my findings two weeks later.

Name _____ per ____ date_____ mailbox _____

DMITRI MENDELEEV

(6) It's a good thing I presented my findings when I did because other chemists were on to the same idea. Lother Meyer was a fellow chemist who had proposed his own periodic table in 1864, and it was similar to mine, but he delayed in publishing his findings until a year after I published mine. Too late and too bad for him! John Newlands published a periodic table 4 years before I did, and it was a good one too, however, people ignored his findings as the scientific community wasn't ready to accept his ideas. As with many revolutionary ideas through the ages, timing determines whether or not an idea will be embraced. Luckily for me, my ideas came at the right time.

(7) My periodic table was by no means complete. I arranged the element cards on the table with gaps left for undiscovered elements, because only with these gaps could the table form a pattern. I was convinced that these elements would be discovered in the future and I predicted the masses and the properties of these elements. Four of these are germanium, scandium, gallium and technetium. As each element was discovered, the credibility of my periodic table grew. These days, the periodic table you study is not the exact one I created. It contains important differences including a better placement for hydrogen, and the inclusion of noble gases, the lanthanide series and actinide series.

(8) I died in 1907, but in 1955, element 101 was discovered by bombarding the element einsteinium with alpha particles. The discoverers named the element Mendelevium in my honor.

Article Questions

1) Name three obstacles that Mendeleev faced in his life.

2) What made Mendeleev's periodic table particularly special?

3) How did Mendeleev feel about Russian science education when he came back from Germany? What did he decide to do about it?

4) How did Mendeleev come up with the periodic table?

5) Name one way that the scientific community has honored Mendeleev's contribution to science.

6) Mendeleev arranged his periodic table according to increasing atomic mass. How is the modern periodic table different from this?

Name _____ **per** ____ **date**_____ **mailbox** _____

Periodic Table Puzzle Lab Back Ground Reading

PEOPLE IN SCIENCE

DMITRI MENDELEEV (1834–1907)

Dmitri Mendeleev (men-duh-LAY-uf) was a Russian chemist. He was a professor of chemistry at St. Petersburg University. Mendeleev also held the important position of Director of the Bureau of Weights and Measures.

Mendeleev is best known for developing the first periodic table of the elements. He wrote a book called *Principles of Chemistry.* For this book, Mendeleev collected thousands of facts about the 63 elements that were known at that time. He tried to find a way to organize this information. Mendeleev thought that a certain pattern, or order, of the elements must exist. Mendeleev decided to test his hypothesis. He wrote the name of each element and the properties of that element on an index card. Then he tried different arrangements of the cards for the 63 elements. When he arranged the cards in order of increasing atomic mass, the elements fell into groups with similar properties.

1a. What factors did Mendeleev likely rely on to assembly his first Periodic Table….? Give 3 (READ Above)

_____ <-WRITE

ASSIGNMENT DIRECTIONS

1b. Assemble your Periodic Table Puzzle using the element puzzle pieces provided. Look at the puzzle pieces. What information will you have to assembly the Periodic Table.

_____ <-WRITE

1c. Separate out the Unknown Cards. Once your table is built, start to try and piece in the "*unknown yet to be discovered elements.*"

2. To be sure you have the proper element in the proper Group/ Family you must investigate more than simply atomic # or atomic mass just as Dmitry Mendeleev once did to construct the Periodic Table in his day.

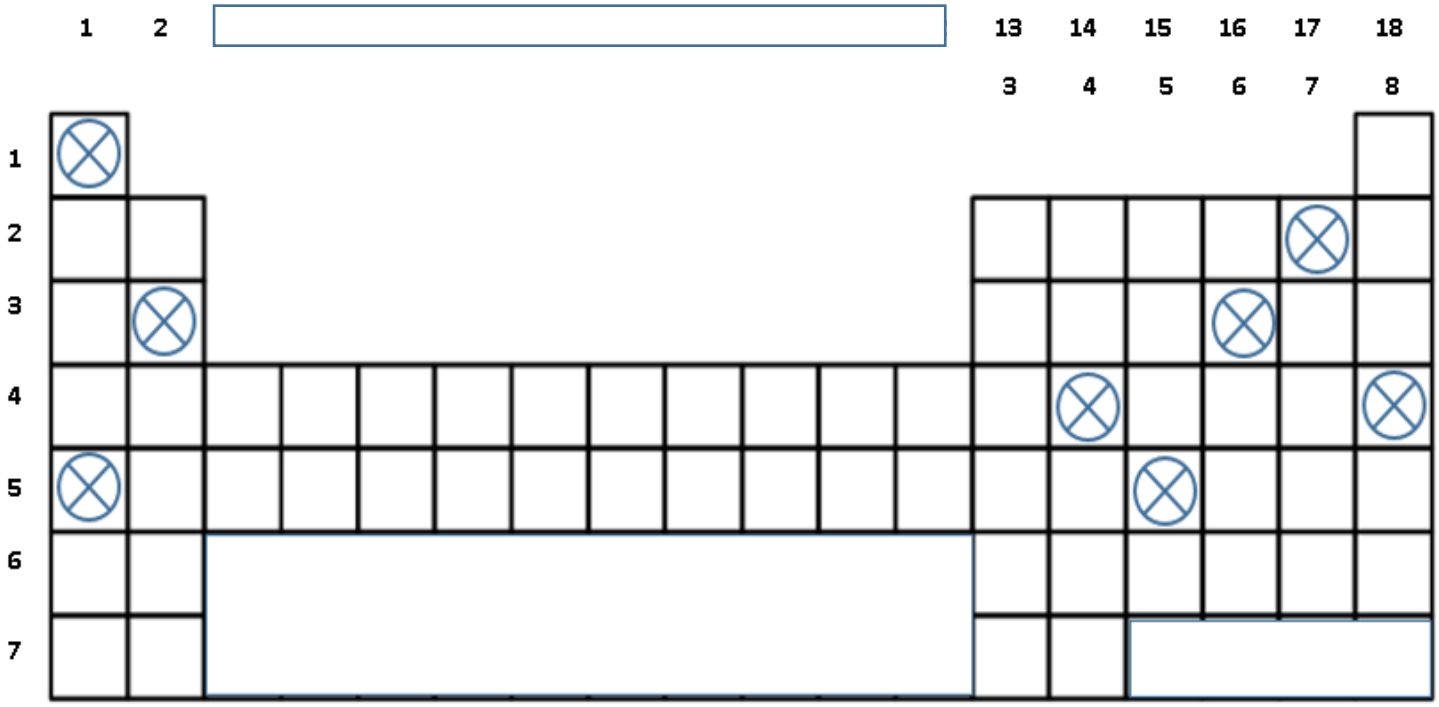
3. Be sure to investigate and compare – Density, Melting Point, Color, Conductivity & Reactivity

4. Finally, in laboratory write-up provide evidence for why you placed an unknown in a particular location.

Vocabulary	PERIODIC TABLE PUZZLE LAB Review – Element Property Vocab Matching
Element Color **Valence e⁻** **Ionization energy** **Density** **Melting Point** **Conductivity** **Reactivity** **Physical State**	
_____1.	This is related to how well elements pass heat or electricity within their atoms. Metals tend to do this well and nonmetals poorly. Within the metal Groups this tends to increase or decrease by regular amounts up or down the Group.
_____2.	This is solid, liquid or gas and can be a weak indicator of element placement into Groups. Example: Noble Gas are all gases on earth. Weak indicator of element placement on the Periodic Table in general because, state or phase change depends on temperature.
_____3.	The temperature at which an element changes from solid to liquid is a discrete physical property. This phase change temperature tends to increase or decrease very orderly moving up or down an Element Group.
_____4.	This property describes an elements likelihood of reacting with and bonding to form compounds with other elements. The tendency to react is often very similar throughout the Group and follows a pattern.
_____5.	This property on occasion has a correlation within groups, but not always and in fact can be miss leading too when trying to place elements into their respective Groups. For the metals it often isn't much help has many are simply described as shiny, white, metallic, silvery, silver-gray, etc.
_____6.	This is the energy released or absorbed as electrons jump from one quanta, (energy level) or shell to the next. It is strongly correlated moving both up or down Groups and often across the Periods. Ionization energy for an element often falls between the elements above & below and from side to side.
_____7.	This property is the same for all elements within their respective Groups with the exception of the Transition Metals. Group 1 has 1. Group 2 has 2. Group 13 has 3. Group 14 has 4 and so on all the way to Group 18.
_____8.	This is the measure of hardness or softness of a substance. Elements within a particular group tend to have a pattern of increasing or decreasing measures of this property. The S.I. unit of measure for it is g/cm^3.

Write the **NUMBERS of unknown element squares** in the appropriate boxes below.

Be sure to debate a thoroughly review your selection with peers.



Battleship Location	Write number of unknown 1-8	Identity – find it on a true Periodic Table	Evidence for placement? (list at least two relevant things from our periodic puzzle)
1 – 1 **x - y**			
2 – 7 **Per -Group**			
3 – 2 **Per -Group**			
3 – 6 **Per -Group**			
4 – 4 **Per -Group**			
4 – 8 **Per -Group**			
5 – 1 **Per -Group**			
5 – 5 **Per -Group**			

If this is confusing simply write the numbers on the Xs above in the chart.

Name _____ per ____ date_____ mailbox _____

Multiple Choice: WRITE ANSWER ON THE LINE

___ Unknown #1 - The strongest evidence for identifying Unknown #1 is …….

A. the 2 outer valence electrons and ionization energy falling between that of **Be and Ca.**

B. the 1 outer valence electron and high reactivity.

___ Unknown #2 - The strongest evidence for identifying Unknown #2 is …….

A. the color yellow and that it is a very poor conductor.

B. low reactivity and increasing ionization energies as you move down the Group.

___ Unknown #3 - The strongest evidence for identifying Unknown #3 is …….

A. reactivity listed as very reactive, good conductivity and a density between **K and Cs.**

B. reactivity is very reactive placing it in Group 17 above Chlorine (Cl).

___ Unknown #4 - The **strongest** evidence for identifying Unknown #4 is …….

A. that the ionization energy alone is clear evidence to classify it as a Noble Gas.

B. that it is a gas, is colorless, has little reactivity & 8 valence electrons.

___ Unknown #5 - The strongest evidence for identifying Unknown #5 is …….

A. the high melting point, yellow color and metalloid properties.

B. the similar reactivity with others in the group along with density and melting point falling between **O and Se**.

___ Unknown #6 - The evidence for identifying Unknown #6 **based on what we had in lab** is …….

A. a density close to that of Arsenic and decreasing ionization energy within Group 15.

B. the valence electrons and atomic mass.

___ Unknown #7 - The strongest evidence for identifying Unknown #7 is …….

A. ionization energy & melting point falling between that of Silicon (Si) and Tin (Sn).

B. the color similarities found in the Group and same conductivities.

___ ___ Unknown #8 - Placing or associating Hydrogen with the Alkali metals is due to ……

(PICK TWO LETTERS)

A. its color and metallic properties

B. the 1 outer valence electron and high reactivity

C. its density and conductivity

D. its atomic mass and atomic number

E. the 2 electrons in the outer valence electron shell and high reactivity

Analyzing the Periodic Table See website if missing any lab data

EXTEND –

1. What is the trend for **mass** of the elements as you move across the periods or down the groups?

   _____ (see standard class Periodic Table)

2. What trend do you see regarding **melting point** as you move down the Alkali Metal Group?

   _____

3. What trend do you see regarding **melting point** as you move down the Alkaline Earth Metals?

   _____

4. What is the trend in **ionization** as you move down the Noble Gases Group?

   _____

VOCAB QUIZ REVIEW

Write the letter that best describes each term.

Vocabulary	Definition
_____1. **Atomic mass**	**A.** The number of protons in an atom
_____2. **Atomic number**	**B.** Subatomic particle with a negative charge
_____3. **Nucleus**	**C.** Center of an atom
_____4. **Electrons**	**D.** Subatomic particle with a positive charge
_____5. **Neutrons**	**E.** The number of neutrons plus the number of protons in an atom
_____6. **Protons**	**F.** Radioactive form of an element with a higher than normal atomic mass due to the addition of neutrons
_____7. **Isotopes**	**G.** Subatomic particle with a neutral charge

3. Imagine you are Dmitri (with a beard and everything and it is 1869) and you think this Unknown element ought to be placed between Beryllium and Calcium.

Be – Beryllium	Atomic **#4**
Physical State	solid
Density	1.85 g/cm^3
Conductivity	excellent
Melting Point	1287 °C
Color	gray
Reactivity	reactive
Ionization energy	9.322

Unknown	Atomic #_
Physical State	solid
Density	1.74 g/cm^3
Conductivity	good
Melting Point	651 °C
Color	silvery white
Reactivity	reactive
Ionization energy	7.646

Ca – Calcium	Atomic **#20**
Physical State	solid
Density	1.57 g/cm^3
Conductivity	good
Melting Point	845 °C
Color	silvery white
Reactivity	reactive
Ionization energy	6.11

1. What regarding the densities might lead you to believe this?

_____

2. Does conductivity help your placement decision?

_____

3. Does melting point help the case for this unknown's placement? Yes or no

Why? _____

4. What is the trend in ionization energy going down the Alkaline Group (this group)?

_____

5. Does the unknown (Rubidium) fit well here?

Yes or no

Explain _____

_____

_____

_____

minimum 2 concrete facts

4. In Mendeleev's day Germanium was unknown to science, however he predicted it, called it Ekasilicon and described its properties with a fair degree of accuracy. Let's critique how well he did.

C – Carbon

Atomic mass	12
Physical State	solid
Density	**2.10 g/cm^3**
Conductivity	good
Melting Point	3550◦C
Color	black
Ionization energy	**11.26**

Si – Silicon

Atomic mass	28
Physical State	solid
Density	**2.33g/cm^3**
Conductivity	semi-conductor
Melting Point	1410◦C
Color	gray
Ionization energy	**8.151**

Ekasilicon

Atomic mass	73
Physical State	solid
Density	5.32 g/cm^3
Conductivity	**semi-conductor**
Melting Point	**937◦C**
Color	gray
Ionization energy	**7.899**

Sn – Tin

Atomic mass	122
Physical State	solid
Density	7.31 g/cm^3
Conductivity	good
Melting Point	232◦C
Color	silver
Ionization energy	7.344

1. Does Ekasilicon (*Germanium*) fit in Group 14 based on density? Yes or no

Why, what is the trend for density going down the group.

_____

2. How is Ekasilicon like Silicon? List two things

_____

3. Does melting point help the case for this unknown's placement? Yes or no

What is the trend for going up the group.

_____

4. What is the trend in ionization energy going down the Group 14?

_____

5. Does Ekasilicon fit well here? Was Dimitri right?

Yes or no

Explain _____

_____

_____

minimum 2 concrete facts

Post Lab Reading

An element is the smallest part of matter that cannot be broken down into simpler forms by chemical means. In the early 19th century, scientists began to arrange elements according to similar physical and chemical properties. The scientist who had the greatest success with this was Dmitri Mendeleev, a Russian chemist. He arranged the elements according to increasing atomic mass, as well as in columns according to similar properties. In this way, he was able to predict elements that were yet, still undiscovered, seen simply as gaps on his table. In the early 1900's, Henri Mosely improved Mendeleev's periodic table by arranging it according to similar properties as well as increasing atomic number.

Today's periodic table is arranged according to increasing atomic number and increasing atomic mass (for the most part). It can also be categorized according to the location of **metals** (the left side of the table), **non-metals** (the right side of the table), and **metalloids** inbetween (elements that exhibit the properties of both metals and non-metals). For example, some metalloids are poor conductors of electricity at low temperatures, but when heated, they become very good conductors. The metalloid elements are Si, Ge, As, Sb, Te, Po, and At.

The table has 7 **periods**, or horizontal rows, and 18 **groups**, sometimes called families. The groups are the vertical columns. If you look closely at the periods, you will see that all of the elements in a period have the same number of electron energy levels. The first group (**alkali metals** and **hydrogen**) all have 1 valence outer electron. The second group (**alkaline metals**) all have 2 valence electron. This pattern repeats once you reach the far side of the Transition Metals moving left to right across the table. Starting with the Boron you find 3 valence electrons then 4 for Carbon and so on until you reach the **noble gases** headed by **helium** all the down each respective group. Group 13 is also sometimes referred to as 3 excluding the **transitions metals**. Again, they all have 3 electrons in their outer energy level; the elements in group 14 have 4 electrons in their outer energy level, etc. The transition metals are not included in the trend. This is because they follow a slightly different trend due to the overlap of energy levels and the way those energy levels fill. The number of electrons in the outer energy level determines the element's chemical properties. Therefore, since all the elements of a group have the same number of electrons, they will react similarly in nature. For instance, the **alkali metals** are the most reactive group of metals on the periodic table. **Francium** is the most reactive of the group; reactivity increases as you go from the top to the bottom of this column.

Group 17 or (7A) also has a special name. This is the **halogen group**. The halogen group is the most reactive non-metal group on the periodic table. **Fluorine** is the most reactive non-metal in this group, and reactivity decreases as you go from the top of the column to the bottom.

Group 18 or (8A) is known as the **noble gases** or inert gas group. It has been named this because all of its elements are stable, and unlikely **to** react or bond with other elements. These gases all have 8 electrons in their outer shell, with the exception of helium (He) that only has 2 electrons. Helium only has a single energy level however, so its valence shell is full, just like all the rest in the noble gas group.