History of the Periodic Table

Reading Passage Lesson: Science Informational Text

Author	ADE Specialists
Grade Level	8th Grade
Duration	1 class period

Aligns to:
R08-S1C6
R08-S3C1
Optional-
W08-S1
W08-S2
W08-S3

Connects to:
SC08-S2C1-01
SC08-S2C2-02
SC08-S2C2-03
SC08-S5C1-06

Overview

Independent Reading Passage: "History of the Periodic Table"
This passage provides a detailed overview of how and why the Periodic Table has changed over time.

Purpose

General: The purpose of the reading lesson is to support students' access to science content through the effective use of reading comprehension strategies. **It is not intended as a substitute for the focused study of science content.**

Specific: The specific purpose behind this reading passage is to provide opportunities for students to develop and apply cognitive processes and practical strategies that are relevant to understanding informational text. As part of the lesson, students will *build vocabulary;* and *locate specific information by using organizational features.* If the teacher chooses to include the optional writing link, students will write an *explanatory essay.*

Materials

Student copies of the "History of the Periodic Table" reading materials.

Objectives

By the end of the lesson, the students will:

- demonstrate their understanding of vocabulary in context;
- demonstrate their ability to locate information by using text features;
- demonstrate their ability to write an explanatory essay (Optional).

Lesson Components

Prerequisite skills:

- Students should be independent readers.
- Students should be familiar with writing responses to questions.
- Students should be familiar with the concept of "text features."
- Students should be familiar with the elements of essay writing.

Before reading:

- Pre-teach vocabulary – The teacher should select specialized and high-utility academic vocabulary.

  - Write new words on the board. Have students repeat them chorally.
  - Remind students that one important strategy for understanding text is *building vocabulary* and that one way to build vocabulary is to ask about and talk about new words.
  - Pre-teach selected vocabulary words, using questions to determine whether or not students are familiar with any of them.
  - Define unfamiliar words, using student-friendly definitions. Have students repeat the definitions chorally.
  - Provide examples of vocabulary in multiple contexts. (Example: Define element by saying something like: "Outside the context of science, an *element* can be defined as a part of something larger or an ingredient of something larger. From this context, a father is an element (or part) of a family, and flour is an element (or an ingredient) in pie crust. In the context of science, an *element* is any of more than 100 fundamental substances that consist of atoms of only one atomic number and that singly or in combination constitute all matter. In science, the *elements* are organized on the Periodic Table.
  - Ask students to think of their own applications of the term *element*.
  - Provide visual representations (maps, pictures) of key vocabulary whenever possible.

- Set the purpose for reading – The teacher should place the passage within the context of the science unit as a whole and should emphasize that:

- we read in order to acquire knowledge and in order to gain understanding;
- we read in order to develop the comprehension processes and strategies that reinforce the knowledge and understanding; and
- we are reading the passage on the "History of the Periodic Table" in order to learn how scientists over time have built upon the knowledge and understanding of those who came before them.

During reading:

- Monitor students' reading processes – The teacher should move about the classroom and monitor students' reading processes, providing students with guidance in the use of comprehension strategies, rather than simply providing them with outright answers to their questions about the text.

- Encourage students to annotate as they read – The teacher should remind students to highlight, underscore, clarify, and question the text as they read in order to make connections and to identify questions for group discussions later.

After reading:

- Continue students' engagement in and analysis of the text – The teacher should provide students with time to collaborate and to clarify their understandings of the text.

  - Have students pair up or meet together in small groups to share their annotations, questions, and points of clarity with one another.

- Provide students with additional time to think about and to talk about the assessment questions – The teacher should provide students with time to discuss and speculate, to infer and to conclude.

  - Make clear that discussion time is for *discussion only* and **not** for *writing*. Make clear that students **should not** be using their time together to generate group responses to the questions or to jot down superficial responses that they'll use later.
  - Remind students that when the time comes for them to respond to the questions, they will be responding *independently* and *thoughtfully*.
  - Remind students that while there may not be one right answer to a particular question, that's not the same as saying that "all responses are correct," or that "any old answer will do." Responses need to be thoughtful and logical.

Assessment

The following questions assess students' abilities to apply reading processes and strategies for comprehending informational text. They are <u>not</u> intended to serve as science content assessments.

Use **headings** to locate information in response to the following questions. Respond in complete sentences.

1. Explain the "law of triads."

2. What problem did Stanislao Cannizzaro solve?

3. What **analogy** did John Newlands use to help explain his "law of octaves?"

4. Why is Mendeleev's work with the Periodic Table considered *great*?

5. Today, scientists believe that the current Periodic Table *may* be revised in the future. Why?

Extensions

<u>Extend the lesson by including the optional writing link</u>.

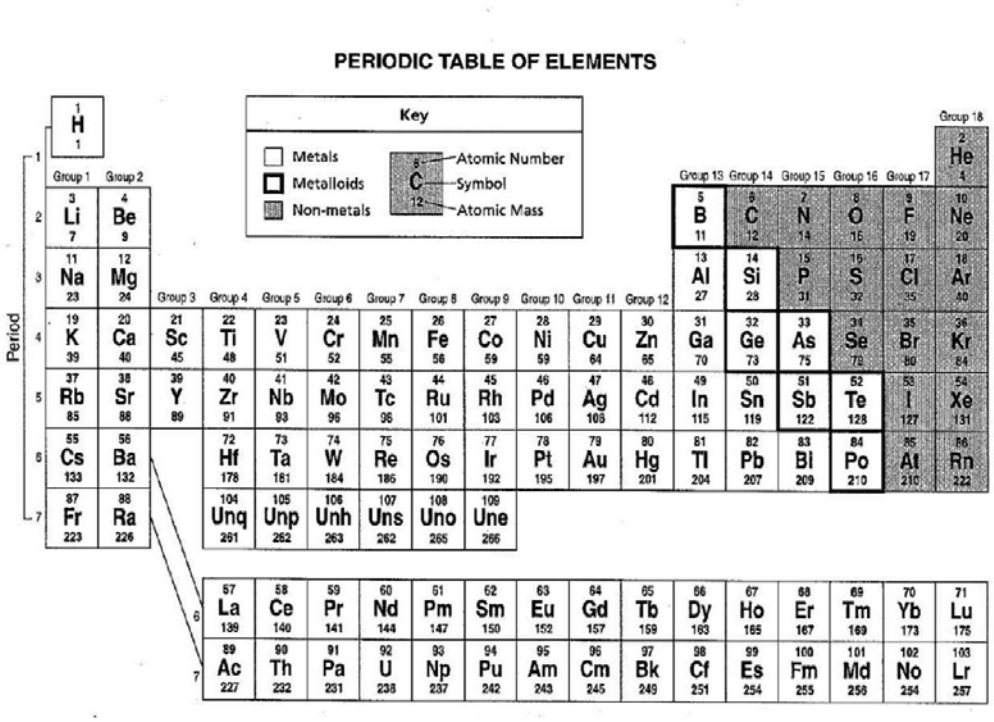
1. Write an essay that explains ***why*** the Periodic Table has changed over time.

Passage

History of the Periodic Table

Open just about any chemistry textbook and you will see a copy of the periodic table of elements. The periodic table is a framework for classifying information about the properties of all of the known **elements** on Earth. Each box on the table contains the essential information about each element's name or chemical symbol, its atomic number, and its relative atomic mass.

This system of organizing information about elements was not always available, nor did it always look as it does today. While Dmitri Mendeleev is given credit for the development of the periodic table, many scientists across Europe made significant contributions that eventually enabled Mendeleev to construct his table. In fact, the periodic table did not end with Mendeleev but continued to take shape for the next 75 years.



http://www.ade.az.gov/standards/aims/downloads/PeriodicTable-ScienceGrade8.pdf

Periodic table of elements

The Early Years

Before written history, people were aware of some of the elements in the periodic table. The first pure elements have been known since the time of the Ancient Greeks, who used the metallic elements such as gold (Au), silver (Ag), copper (Cu), lead (Pb), tin (Sn), and mercury (Hg). The first person known to discover an element using scientific inquiry was Hennig Brand, a German scientist who discovered phosphorus (P) in 1649.

In 1789, a French scientist, Antoine Lavoisier defined what was meant by a chemical element and drew a table that contained 33 known elements at that time. He grouped them into four categories: gases, nonmetals, metals, and earths.

Between 1649 and 1869, the amount of knowledge about properties of elements and their compounds was discovered by chemists. By 1869, 63 elements had been discovered and recorded. As the number of known elements grew, scientists began to recognize patterns in properties of the elements and began to develop a system for classifying them.

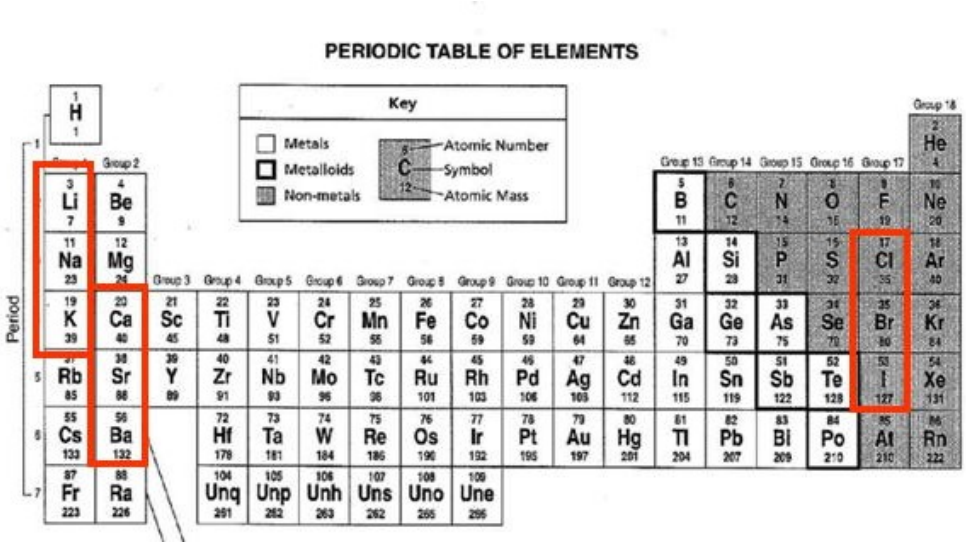
The Law of Triads

http://en.wikipedia.org/wiki/Image:Johann_Wolfgang_D%C3%B6bereiner.jpg

Johann Döbereiner

The development of the periodic table begins with German chemist Johann Döbereiner, who grouped elements based on similarities. In 1829, Döbereiner announced his law of **triads**, which referred to groups of three chemically similar elements in which the properties of the middle element could be inferred from the lighter and heavier ones.

Calcium (atomic mass 40), strontium (atomic mass 88), and barium (atomic mass 137) possess similar chemical properties. Döbereiner noticed the atomic weight of strontium fell midway between the weights of calcium and barium. Was this a coincidence or did some pattern in the elements exist? Döbereiner noticed the same pattern for the alkali metal triad (Li/Na/K) and the halogen triad (Cl/Br/I). The idea of triads became a popular area for chemists to study.

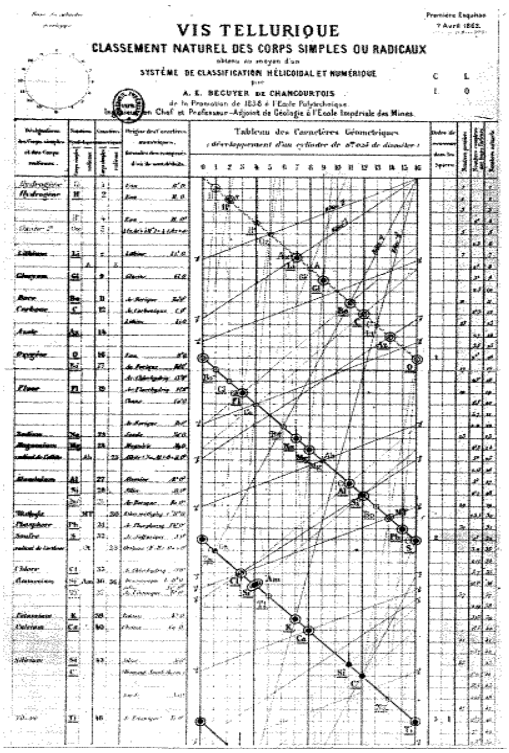


Position of triads on a current version of the periodic table

During the next 30 years, several other scientists studied triads and discovered that elements could be grouped into sets larger than three. Fluorine was added to Cl/Br/I group. Sulfur, oxygen, selenium and tellurium were grouped into a family. Nitrogen, phosphorus, arsenic, antimony, and bismuth were classified as another group. Scientists may have been able to group larger numbers of elements, but measurements of atomic mass were not always accurate or reliable. This problem was solved by the Italian chemist, Stanislao Cannizzaro in 1858.


http://en.wikipedia.org/wiki/Image:Cannizzaro_Stanislao.jpg
Stanislao Cannizzaro

The First Periodic Table



http://en.wikipedia.org/wiki/Image:Vis_tellurique_de_Chancourtois.gif
A. E. Beguyer de Chancourtois

In 1862, a French geologist named Alexandre Beguyer de Chancourtois published a list of all the known elements. The list was constructed as a helical graph wrapped around a cylinder. This list is the first example of recognized **periodicity** in the chemical and physical properties of the elements. Elements were organized by increasing atomic mass, and those with similar properties lined up vertically on the cylinder. Because de Chancourtois used geological terms, published without the diagram, and his list also included some ions and compounds, his ideas were completely ignored until the work of Mendeleev.

Law of Octaves

English chemist John Newlands arranged the 62 known elements by atomic mass into a table using eight columns. This arrangement produced some misalignments, but Newlands put similar elements in the same column even if it meant putting two elements into some of the boxes. Newlands recognized silicon and tin as part of a triad and predicted that there would be a missing element between these, with atomic mass of about 73. This prediction predated Mendeleev's predictions about germanium (which has an atomic mass of about 72.6) by about five years. However, Newlands did not leave a space for this missing element in his table of 1865. In fact, he left no vacant slots, which reveals that he did not find an order that went beyond his data.

Newlands made an **analogy** between his table and the tonic scale of seven musical notes and their **octaves**, calling this organization the 'Law of Octaves'. His efforts were criticized and publicly ridiculed. It wasn't until 1887, 18 years after Mendeleev's work, that the importance of Newlands' contribution was recognized.

H 1	F 8	Cl 15	Co/Ni 22	Br 29	Pd 36	I 42	Pt/Ir 50
Li 2	Na 9	K 16	Cu 23	Rb 30	Ag 37	Cs 44	Tl 53
Gl 3	Mg 10	Ca 17	Zn 25	Sr 31	Cd 34	Ba/V 45	Pb 54
Bo 4	Al 11	Cr 18	Y 24	Ce/La 33	U 40	Ta 46	Th 56
C 5	Si 12	Ti 19	In 26	Zr 32	Sn 39	W 47	Hg 52
N 6	P 13	Mn 20	As 27	Di/Mo 34	Sb 41	Nb 48	Bi 55
O 7	S 14	Fe 21	Se 28	Ro/Ru 35	Te 43	Au 49	Os 51

Newlands' arranged elements in octaves

Mendeleev's Periodic Table

Who deserves credit for being the "father" of the periodic table? German chemist Lothar Meyer and Russian chemist Dmitri Mendeleev produced similar results at the same time, each working independently from the other. Meyer's 1864 textbook showed an abbreviated version of a periodic table used to classify the elements. This table consisted of about half of the known elements listed in order of their atomic weight and demonstrated periodic changes as a function of atomic mass. In 1868, Meyer constructed an extended table which he gave to a colleague for evaluation. Unfortunately for Meyer, Mendeleev's table was published in 1869 before Meyer's in 1870. Because Mendeleev's work was published first, he is generally given credit for the development of the periodic table.

но въ ней, мнѣ кажется, уже ясно выражается примѣнимость выставляемаго мною начала ко всей совокупности элементовъ, изъ которыхъ извѣстенъ съ достовѣрностію. На этотъ разъ я и желалъ преимущественно найдти общую систему элементовъ. Вотъ этотъ опытъ:

			Ti=50	Zr=90	?=180.
			V=51	Nb=94	Ta=182.
			Cr=52	Mo=96	W=186.
			Mn=55	Rh=104,4	Pt=197,4
			Fe=56	Ru=104,4	Ir=198.
			Ni=Co=59	Pl=106,6	Os=199.
H=1			Cu=63,4	Ag=108	Hg=200.
	Be=9,4	Mg=24	Zn=65,2	Cl=112	
	B=11	Al=27,4	?=68	Ur=116	Au=197?
	C=12	Si=28	?=70	Sn=118	
	N=14	P=31	As=75	Sb=122	Bi=210
	O=16	S=32	Se=79,4	Te=128?	
	F=19	Cl=35,5	Br=80	I=127	
Li=7	Na=23	K=39	Rb=85,4	Cs=133	Tl=204
		Ca=40	Sr=87,6	Ba=137	Pb=207.
		?=45	Ce=92		
		?Er=56	La=94		
		?Yt=60	Di=95		
		?In=75,6	Th=118?		

а потому приходится въ разныхъ рядахъ имѣть различное количество разностей, чего нѣтъ въ главныхъ числахъ предлагаемой таблицы. Или не придется предполагать при составленіи системы очень много недостающихъ членовъ. То и другое надо выходно. Мнѣ кажется притомъ, наиболѣе естественнымъ составить кубическую систему (предлагаемая есть плоскостная), но и попытки для ея образованія не повели къ надлежащимъ результатамъ. Слѣдующія двѣ попытки могутъ показать то разнообразіе сопоставленій, какое возможно при допущеніи основнаго начала, высказаннаго въ этой статьѣ

Li	Na	K	Cu	Rb	Ag	Cs	—	Tl
7	23	39	63,4	85,4	108	133		204
Be	Mg	Ca	Zn	Sr	Cd	Ba	—	Pb
B	Al	—	—	—	Ur	—	—	Bi?
C	Si	Ti	—	Zr	Sn	—	—	—
N	P	V	As	Nb	Sb	—	Ta	—
O	S	—	Se	—	Te	—	W	—
F	Cl	—	Br	—	J	—	—	—
19	35,5	58	80	190	127	160	190	220.

http://www.chemistryexplained.com/images/chfa_03_img0697.jpg

Mendeleev's Periodic Table in 1869

Mendeleev's periodic table of 1869 contained 17 groups with two partial periods of seven elements each (Li-F & Na-Cl) followed by two nearly complete periods (K-Br & Rb-I). In 1871 Mendeleev revised the 17-group table with eight columns (the eighth group consisted of transition elements). This table exhibited similarities not only in small units such as the triads, but showed similarities in an entire network of vertical, horizontal, and diagonal relationships.

Mendeleev's work is considered great in two respects. His periodic table was designed in such a way that not only did it organize the known elements, but it left spaces for elements that were not yet discovered. In addition, Mendeleev was able to predict properties of five of the missing elements and their compounds. Three of the elements that Mendeleev predicted were discovered by other scientists within the next 15 years.

Discovery of the Noble Gases

Even though Mendeleev is considered the “father” of the periodic table, the work did not end with him. The English scientists Lord Rayleigh and Sir William Ramsey added to the periodic table by discovering the “inert gases.” In 1895, Rayleigh reported the discovery of a new gaseous element named argon. This element was chemically **inert** and did not fit any of the known periodic groups. Ramsey discovered the other inert gases and positioned them in the periodic table. Rayleigh and Ramsey were awarded Nobel prizes in 1904. Today the group is more appropriately called the noble gases.

Atomic Structure and the Periodic Table

Even though Mendeleev's table showed the periodic nature of the elements, it did not provide an explanation of why the properties of the elements recur periodically. In 1911, Ernest Rutherford a physicist from New Zealand discovered the proton and published studies that led to the determination of nuclear charge. He demonstrated that the nuclear charge on a nucleus was proportional to the atomic mass of the element. Also in 1911, the Dutch physicist Antonius van den Broek, proposed that the atomic mass of an element was approximately equal to the charge on an atom. This charge, later termed the atomic number, could be used to number the elements within the periodic table.

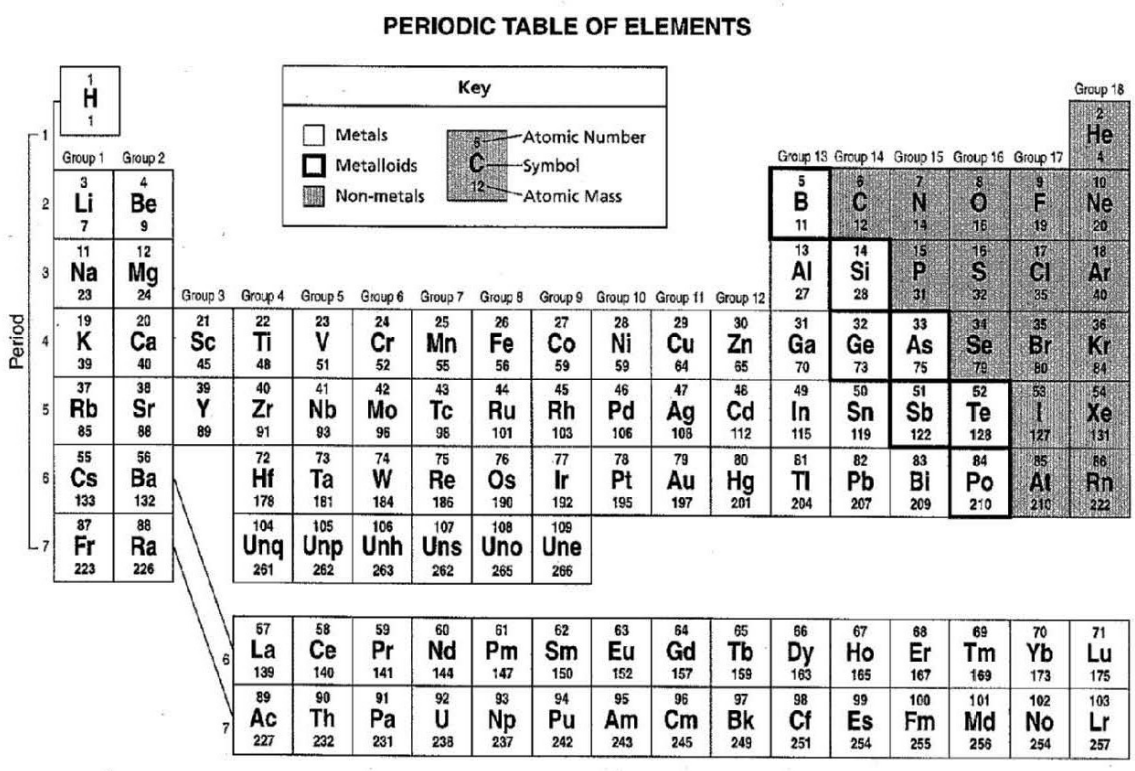
Soon after that, English Physicist Henry Moseley exposed the known elements to x-rays. He was able to determine the relationship between x-ray frequency and number of protons. When Moseley arranged the elements according to increasing atomic numbers and not atomic masses, some of the inconsistencies associated with Mendeleev's table were eliminated.

The modern periodic table is based on Moseley's Periodic Law (atomic numbers). With this discovery, it became clear that atomic mass was not the significant player in the periodic law as Mendeleev and others had proposed, but rather, the properties of the elements varied periodically with atomic number. As more scientists developed an understanding of the electronic structure of the elements, the question of why the periodic law exists was answered.

The Modern Periodic Table

The last major changes to the periodic table resulted from the work of American Glenn Seaborg in the middle of the 20th Century. In 1940, he discovered plutonium and then continued to discover all the transuranic elements from 94 to 102. He reconfigured the periodic table by placing the actinoid series below the lanthanoid series at the bottom of the table. In 1951, Seaborg was awarded the Nobel Prize in chemistry for his work.

Has the periodic table of the chemical elements reached its final form? The location of hydrogen and helium at the top of the table are still unresolved issues. Only time will tell if those elements will remain in their current positions. Additionally, the names of elements 104-109 are controversial and still subject to change.



http://www.ade.az.gov/standards/aims/downloads/PeriodicTable-ScienceGrade8.pdf

Periodic table of elements

Adapted from**:**
http://www.chemsoc.org/Networks/Learnnet/periodictable
http://www.chemsoc.org/viselements/pages/history.html

Standards Connections: Grade 8
Science: Strand 2 Concept 1 PO1; Strand 2 Concept 2 PO2, PO3; and Strand 5 Concept 1 PO6
Reading: Strand 1 Concept 4 and Strand 3 Concept 1