Development of the Periodic Table

Unit: Periodicity

MA Curriculum Frameworks (2016): HS-PS1-1

Mastery Objective(s): (Students will be able to…)

- Describe how our understanding of groups of elements with similar properties developed into the modern periodic table.
- List scientists who contributed to our understanding of periodicity and their contributions.

Success Criteria:

- Descriptions include specific developments and prior developments that they supplanted.

Language Objectives:

- Describe how the modern periodic table developed over time.

Notes:

The Fifth Element

In ancient times, the world was believed to be made of four elements: earth, air, fire, and water. Every substance on Earth was thought to be made of one of these four elements.

When sulfur was discovered, it could be detected in the presence of each of the other four elements. For this reason, philosophers eventually decided that sulfur must be a fifth element.

Use this space for summary and/or additional notes:

Chemical Symbols

By the early 1800s, more than twenty separate elements were known. Swedish chemist Jöns Jacob Berzelius developed a system of notation in which each element was given a one- or two-letter symbol based on its Latin name. This is the system in use today, though newer symbols are based on the elements' names in English rather than Latin. Some of Berzelius's names and symbols included:

Symbol	Latin Name	English Name	Symbol	Latin Name	English Name
Ag	argentum	silver	Na	natrium	sodium
Au	aurum	gold	Pb	plumbum	lead
Cu	cuprum	copper	Sb	stibium	antimony
Fe	ferum	iron	Sn	stannum	tin
Hg	hydrargyrum	mercury	W	wolfram	tungsten
K	kalium	potassium			

Berzelius also developed a system of notation for chemical compounds with the number of atoms of an element denoted as a superscript (*e.g.,* H^2O). Later in the 19th century, the superscript was changed to a subscript, in order to avoid confusing the number of atoms in a molecule with exponents, electrical charges, *etc.*, so H^2O became H_2O.

Early Classifications of the Elements

Johnann Wolfgang Döbereiner: German chemist; classified elements into triads (groups of three) with similar properties (1817).

John Newlands: British chemist; arranged the elements in order of increasing atomic mass. Proposed the *law of octaves* (1829).

law of octaves: when the elements are arranged by increasing atomic mass, every 8th element has similar properties. This worked for the first 20 elements.

Use this space for summary and/or additional notes:

Valence Numbers

valence number: the "combining power" of an element, meaning the number of atoms that would need to combine with that element in order to "satisfy" it. Initially, the valence number was the largest number of atoms of oxygen that could form a compound with the element. Note that valence numbers were in use in the early 1800s, almost a century before electrons were discovered.

Valence Number	Metals	Valence Number	Metals	Valence Number	Metals
I.	K, Na, Li, Ca, Ba, Sr, Mg	III.	Cu, Pb, Sb, Bi, U, Ti, Ce, Te	V.	Hg, Ag, Au, Pt, Pd, Rh, Os, Ir
II.	Mn, Fe, Zn, Sn, Cd, Co, Ni	IV.	As, Mo, Cr, V, W, Ta	VI.	Be, Zr, Y, Th, Al, Si

We now define the valence number to be the number of electrons that an atom has in its outer (valent) shell.

The Periodic Table

Julius Lothar Meyer: German chemist. Published the first periodic table (1864), with 28 elements arranged in order of increasing atomic mass and grouped according to valence numbers.

Dmitri Mendeleev: Russian chemist, considered the author of the modern periodic table. Mendeleev's table was published in 1869, with elements arranged by increasing atomic mass, and grouped in columns by similar chemical & physical properties (including valence number).

Use this space for summary and/or additional notes:

Mendeleev's Periodic Table

(Highlights within vertical columns indicate Döbereiner's triads.)

Period	Group I	II	III	IV	V	VI	VII	VIII
1	H=1							
2	Li=7	Be=9.4	B=11	C=12	N=14	O=16	F=19	
3	Na=23	Mg=24	Al=27.3	Si=28	P=31	S=32	Cl=35.5	
4	K=39	Ca=40	?=44	Ti=48	V=51	Cr=52	Mn=55	Fe=56; Co=59; Ni=59
5	Cu=63	Zn=65	?=68	?=72	As=75	Se=78	Br=80	
6	Rb=85	Sr=87	?Yt=88	Zr=90	Nb=94	Mo=96	?=100	Ru=104; Rh=104; Pd=106
7	Ag=108	Cd=112	In=113	Sn=118	Sb=122	Te=125	J=127	
8	Cs=133	Ba=137	?Di=138	?Ce=140				
9								
10			?Er=178	?La=180	Ta=182	W=184		Os=195; Ir=197; Pt=198
11	Au=199	Hg=200	Tl=204	Pb=207	Bi=208			
12				Th=231		U=240		

Mendeleev correctly predicted the existence and chemical and physical properties of undiscovered elements gallium ("eka-aluminum", labeled "?=68" above), and germanium ("eka-silicon", labeled "?=72" above). Mendeleev's periodic table gained significant credibility when gallium and germanium were discovered (during Mendeleev's lifetime) and were found to have the properties that he predicted.

Mendeleev's group numbers were chosen first based on the elements' chemical and physical properties, and second by increasing atomic mass. Tellurium (Te) was later found to have an average atomic mass of 128 (heavier than iodine, which was labeled "J" on Mendeleev's table), but Mendeleev kept the elements where they were, because tellurium is more like the other elements in group 6, and iodine is more like the other elements in group 7.

periodic law: when the elements are arranged in order of increasing atomic number, their properties repeat in regular intervals (periods). (This is the modern version of the law of octaves.) The periodic table is arranged so that each row represents one of these periods.

Use this space for summary and/or additional notes:

Big Ideas	Details	Unit: Periodicity
	Henry Moseley: British chemist; rearranged the elements by increasing nuclear charge (atomic number) instead of atomic mass (1913). This arrangement resulted in elements with similar properties falling into groups without the exceptions (such as the positions of iodine *vs.* tellurium) that occurred in Mendeleev's table. The modern periodic table is Moseley's table, extended to include elements that have been discovered since his death.	

Use this space for summary and/or additional notes: