



### Cycle 5 Chemistry I Lesson 2

#### AGENDA – The Periodic Law

Lab day is TOMORROW Be Prepared

**Warmup:** Lithium catches fire in water. Sodium reacts explosively with water. Potassium is extremely explosive in water. What do you think Rubidium does when put into water? And WHY?

**Vocab:** “Periodic Law”, “Group”, “Period”

**Classwork:** p. 122 2-4, 6-7

**HONORS:** Flying Saucer Scenario



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### The Periodic Law

- **Periodic Law:** When elements are arranged in order of atomic number, their chemical and physical properties tend to repeat.
- **Period:** A horizontal row of elements on the Periodic Table. Element properties tend to repeat every period. [leave space, we will add to this]
- **Group:** A vertical column of elements on the Periodic Table. Elements in a group tend to have similar chemical and physical properties. [leave space, we will add to this]



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### “The Alkali Metals” - Example

- Li, Na, K, Rb, Cs are all in the same GROUP
- All are soft metals which tarnish in air
- All react violently with water
- All form oxides of formula  $M_2O$
- All form chlorides of formula  $MCl$  which are ionic compounds and are soluble in water
- These elements are all RELATED. This is an example of the Periodic Law





### John Newlands' Early Periodic Table

- In 1865, the English chemist John Newlands arranged the known elements according to their properties and in order of increasing atomic mass. He placed the elements in a table.
- Newlands noticed that all of the elements in a given row had similar chemical and physical properties.
- Because these properties seemed to repeat every eight elements, Newlands called this pattern the *law of octaves*.



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# Chapter 4

## Section 1 How Are Elements Organized?



### John Newlands “Law of Octaves” Table (it’s not that good. Why not?)

No.	No.	No.	No.	No.	No.	No.	No.
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	Os 51
G 3	Mg 10	Ca 17	Zn 24	Sr 31	Cd 38	Ba & V 45	Hg 52
Bo 4	Al 11	Cr 19	Y 25	Ce & La 33	U 40	Ta 46	Tl 53
C 5	Si 12	Ti 18	In 26	Zr 32	Sn 39	W 47	Pb 54
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	Th 56

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### Dmitri Mendeleev Invented the First Periodic Table

- In 1869, the Russian chemist **Dmitri Mendeleev** used Newlands's observation and other information to produce the first orderly arrangement, or periodic table, of all 63 elements known at the time.
- Mendeleev arranged the elements by atomic mass, placed in columns based on chemical/physical properties – he did not stick with the 'octave' rule.
- Mendeleev's brilliant insight – he left GAPS!



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## Section 1 How Are Elements Organized?



### Mendeleev's Original Table

Reihen	Gruppe I. — R <sup>0</sup>	Gruppe II. — RO	Gruppe III. — R <sup>0</sup> ³	Gruppe IV. RH <sup>4</sup> RO <sup>2</sup>	Gruppe V. RH <sup>5</sup> R <sup>0</sup> ⁵	Gruppe VI. RH <sup>6</sup> RO <sup>3</sup>	Gruppe VII. RH R <sup>0</sup> ⁷	Gruppe VIII. — RO <sup>4</sup>
1	II=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, Cu=63.
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, Ag=108.
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, Au=199.
11	(Au=199)	Hg=200	Tl=204	Pb=207	Bi=208	—	—	
12	—	—	—	Th=231	—	U=240	—	— — — —

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## Section 1 How Are Elements Organized?



### Patterns in Element Properties, *continued*

### Dmitri Mendeleev Invented the First Periodic Table

### Predicted Versus Actual Properties for Three Elements

Properties	Ekaaluminum (gallium, discovered 1875)		Ekaboron (scandium, discovered 1877)		Ekasilicon (germanium, discovered 1886)	
	Predicted	Observed	Predicted	Observed	Predicted	Observed
Density	6.0 g/cm <sup>3</sup>	5.96 g/cm <sup>3</sup>	3.5 g/cm <sup>3</sup>	3.5 g/cm <sup>3</sup>	5.5 g/cm <sup>3</sup>	5.47 g/cm <sup>3</sup>
Melting point	low	30°C	*	*	high	900°C
Formula of oxide	Ea <sub>2</sub> O <sub>3</sub>	Ga <sub>2</sub> O <sub>3</sub>	Eb <sub>2</sub> O <sub>3</sub>	Sc <sub>2</sub> O <sub>3</sub>	EsO <sub>2</sub>	GeO <sub>2</sub>
Solubility of oxide	*	*	dissolves in acid	dissolves in acid	*	*
Density of oxide	*	*	*	*	4.7 g/cm <sup>3</sup>	4.70 g/cm <sup>3</sup>
Formula of chloride	*	*	*	*	EsCl <sub>4</sub>	GeCl <sub>4</sub>
Color of metal	*	*	*	*	dark gray	grayish white



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### Patterns in Element Properties, *continued* The Physical Basis of the Periodic Table

- About 40 years after Mendeleev published his periodic table, an English chemist named **Henry Moseley** studied the lines in the X-ray spectra of 38 different elements. He found that the wavelengths of the lines in the spectra decreased in a regular manner as atomic mass increased.
- **Henry Moseley** had measured 'Atomic Number'!
- Question: Was Mendeleev right to 'cheat' the masses of Iodine and Tellurium?



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### Patterns in Element Properties, *continued* The Physical Basis of the Periodic Table

- Elements in a **group** tend to have the same number of valence electrons
  - Note: In transition metals, the outer 2 shells will have the same total even if the valence shell does not!
- Elements in a **period** have the same number of electron energy levels



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### Section 1 How Are Elements Organized?



#### Be like Mendeleev! “Type II” writing.

A flying saucer crashes. It is discovered to be coated with a shiny metal, heavier than any known element.

This metal does not react with water, and does not tarnish in air.

At high temperatures the metal reacts with oxygen to form an oxide of formula  $M_2O$ .

Which Group of the Periodic Table should this metal be placed in? Why? Reference both chemical & physical properties

