



Unplugged Lesson

Lesson Title:	Element Characteristics
Grade Level:	High School
Subject:	Chemistry
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Engagement:

- Students will sort shapes that are different colors. They can sort how they like based on categories that they come up with (size, angles, color, number of sides).
- Once sorting is done, teacher will ask what things in science can be sorted using different categories?
- Have you ever heard of the periodic table? It was made using different characteristics of elements.
- Students will ask themselves: How was the periodic table made? What characteristics were used to sort elements?

Exploration:

- Students will be given cards with various elements and a few characteristics about each element. They will come up with their own categories and sort the elements into their categories.

What are some ways that you could sort these elements based on their characteristics?

Students can use the categories they have sorted to try to come up with their own idea of how the elements may fit together to make the periodic table.

Explanation:

- Students share out how they sorted the elements, as well as how they would set up the periodic table based upon how they sorted the elements.
- How do you think the different categories you came up with could be used to make the periodic table? Would your system be able to be used for new elements being added?
- Why does your system work? How could you argue that some characteristics of an element may be more important than others?



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Elaboration:

- Write down your process for sorting. Try to make it applicable if I were to give you more element cards. Write instructions so that one of your classmates/me/someone else could come in and use your system to sort more elements
- Share the story of how Mendeleev established the periodic table:
 - Dimitri Mendeleev was a Russian chemist in the 1800s
 - Wanted to organize the elements
 - Made element cards just like played solitaire and us.
 - Everywhere he went he took cards and tried reorganizing them.
 - The story goes: on a day he was supposed to catch a train, he took out the cards and got to work. He missed his train and stayed up for 3 days and nights, just arranging and rearranging the cards. Exhausted, he went to sleep, and this (see below) table came to him in a dream.
 - He even left space for some undiscovered elements, that were discovered in the next few years (Gallium, germanium, and scandium)
- Discuss with students how the different periodic tables are arranged and the importance as to why they are arranged (i.e. ionization energy trend, electron affinity trend, atomic radius/size, non-metals/metals/transition metals, etc)
- Discuss the similarities and differences between their own sorting of the elements/their own organization of the periodic table, Mendeleev's periodic table, and the current periodic table.
- Discuss the importance of having any type of information arranged instead of it just being random (does it make our lives easier?)

Evaluation:

- Using their sorted periodic tables and the actual periodic table, students will show the trends of ionization energy and electronegativity on the table.
 - Give copy of periodic table and have students use colored pencils to draw arrows showing the trend of decrease/increase for ionization energy, electronegativity, and atomic radius
 - Students will color code the periodic table based on metal/nonmetal/transition metal etc



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- Students will demonstrate understanding of how/why the periodic table is set up the way it is using characteristics of elements that make it up


Na 496 kJ/mol 0.93 227 pm Alkali metal	Ag 731 kJ/mol 1.93 172 pm Transition metal	O 141 kJ/mol 3.44 152 pm nonmetal
F 328 kJ/mol 3.98 147 pm nonmetal	Cr 653 kJ/mol 1.66 125 pm Transition metal	Sr 549 kJ/mol 0.95 215 pm metal




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Periodic Table of Elements based on Mendeleev's Periodic Law

0	I	II	III	IV	V	VI	VII			
He 4.00	Li 6.94	Be 9.01	B 10.8	● C 12.0	N 14.0	O 16.0	F 19.0			
Ne 20.2	Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	● S 32.1	Cl 35.5	VIII		
Ar 40.0	K 39.1	Ca 40.1	Sc 45.0	Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	● Fe 55.9	Co 58.9	Ni 58.7
	● Cu 63.5	Zn 65.4	Ga 69.7	Ge 72.6	As 74.9	Se 79.0	Br 79.9			
Kr 83.8	Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9	Tc (99)	Ru 101	Rh 103	Pd 106
	● Ag 108	Cd 112	In 115	● Sn 119	Sb 122	Te 128	I 127			
Xe 131	Ce 133	Ba 137	● La 139	Hf 179	Ta 181	W 184	Re 180	Os 194	Ir 192	Pt 195
	● Au 197	● Hg 201	Tl 204	● Pb 207	Bi 209	Po (210)	At (210)			
Rn (222)	Fr (223)	Ra (226)	● Ac (227)	● Th 232	● Pa (231)	● U 238				

 Dobereiner's triads

 Known to Mendeleev

 Lanthanide series
 Actinide series
 Known to Ancients

Source: <https://corrosion-doctors.org/Periodic/Periodic-Mendeleev.htm>



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Fisher Science Education

PERIODIC TABLE OF THE ELEMENTS

1 H Hydrogen (1.00794)																	2 He Helium (4.0026)																	
3 Li Lithium (6.941)	4 Be Beryllium (9.012182)											5 B Boron (10.81)	6 C Carbon (12.0107)	7 N Nitrogen (14.00674)	8 O Oxygen (15.9994)	9 F Fluorine (18.9984032)	10 Ne Neon (20.1797)																	
11 Na Sodium (22.989770)	12 Mg Magnesium (24.3050)											13 Al Aluminum (26.981538)	14 Si Silicon (28.0855)	15 P Phosphorus (30.973761)	16 S Sulfur (32.066)	17 Cl Chlorine (35.4527)	18 Ar Argon (39.948)																	
19 K Potassium (39.0983)	20 Ca Calcium (40.078)	21 Sc Scandium (44.955910)	22 Ti Titanium (47.867)	23 V Vanadium (50.9415)	24 Cr Chromium (51.9961)	25 Mn Manganese (54.938044)	26 Fe Iron (55.845)	27 Co Cobalt (58.933200)	28 Ni Nickel (58.6934)	29 Cu Copper (63.546)	30 Zn Zinc (65.39)	31 Ga Gallium (69.723)	32 Ge Germanium (72.61)	33 As Arsenic (74.92160)	34 Se Selenium (78.96)	35 Br Bromine (79.904)	36 Kr Krypton (83.80)																	
37 Rb Rubidium (85.4678)	38 Sr Strontium (87.62)	39 Y Yttrium (88.90585)	40 Zr Zirconium (91.224)	41 Nb Niobium (92.90638)	42 Mo Molybdenum (95.94)	43 Tc Technetium (98)	44 Ru Ruthenium (101.07)	45 Rh Rhodium (102.90550)	46 Pd Palladium (106.42)	47 Ag Silver (107.8682)	48 Cd Cadmium (112.411)	49 In Indium (114.818)	50 Sn Tin (118.710)	51 Sb Antimony (121.760)	52 Te Tellurium (127.60)	53 I Iodine (126.90447)	54 Xe Xenon (131.29)																	
55 Cs Cesium (132.90545)	56 Ba Barium (137.327)	57-71 La Lanthanum (138.9055)	72 Hf Hafnium (178.49)	73 Ta Tantalum (180.9479)	74 W Tungsten (183.84)	75 Re Rhenium (186.207)	76 Os Osmium (190.23)	77 Ir Iridium (192.217)	78 Pt Platinum (195.078)	79 Au Gold (196.96655)	80 Hg Mercury (200.59)	81 Tl Thallium (204.3833)	82 Pb Lead (207.2)	83 Bi Bismuth (208.98038)	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)																	
87 Fr Francium (223)	88 Ra Radium (226)	89-103 Ac Actinoids	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (269)	111 Rg Roentgenium (272)	112 Cn Copernicium (277)	113 Nh Nihonium	114 Fl Flerovium	115 Mc Moscovium	116 Lv Livermorium	117 Ts Tennessine	118 Og Oganesson																	
																		57 La Lanthanum (138.904)	58 Ce Cerium (140.12)	59 Pr Praseodymium (140.90768)	60 Nd Neodymium (144.242)	61 Pm Promethium	62 Sm Samarium (150.36)	63 Eu Europium (151.964)	64 Gd Gadolinium (157.25)	65 Tb Terbium (158.92534)	66 Dy Dysprosium (162.50014)	67 Ho Holmium (164.93032)	68 Er Erbium (167.259)	69 Tm Thulium (168.93048)	70 Yb Ytterbium (173.054)	71 Lu Lutetium (174.967)		
																		89 Ac Actinium	90 Th Thorium (232)	91 Pa Protactinium (231)	92 U Uranium (238)	93 Np Neptunium	94 Pu Plutonium	95 Am Americium	96 Cm Curium	97 Bk Berkelium	98 Cf Californium	99 Es Einsteinium	100 Fm Fermium	101 Md Mendelevium	102 No Nobelium	103 Lr Lawrencium		

Source: <https://www.fishersci.com/shop/products/giant-periodic-table-8x4/s71879>

INCREASING ATOMIC RADIUS

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1 H Hydrogen (1.00794)																	2 He Helium (4.0026)
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Source: <https://www.quora.com/How-does-atomic-size-increase-from-top-to-bottom-in-a-group-when-the-number-of-orbits-increase-with-the-force-of-attraction-of-nucleus-and-electrons>



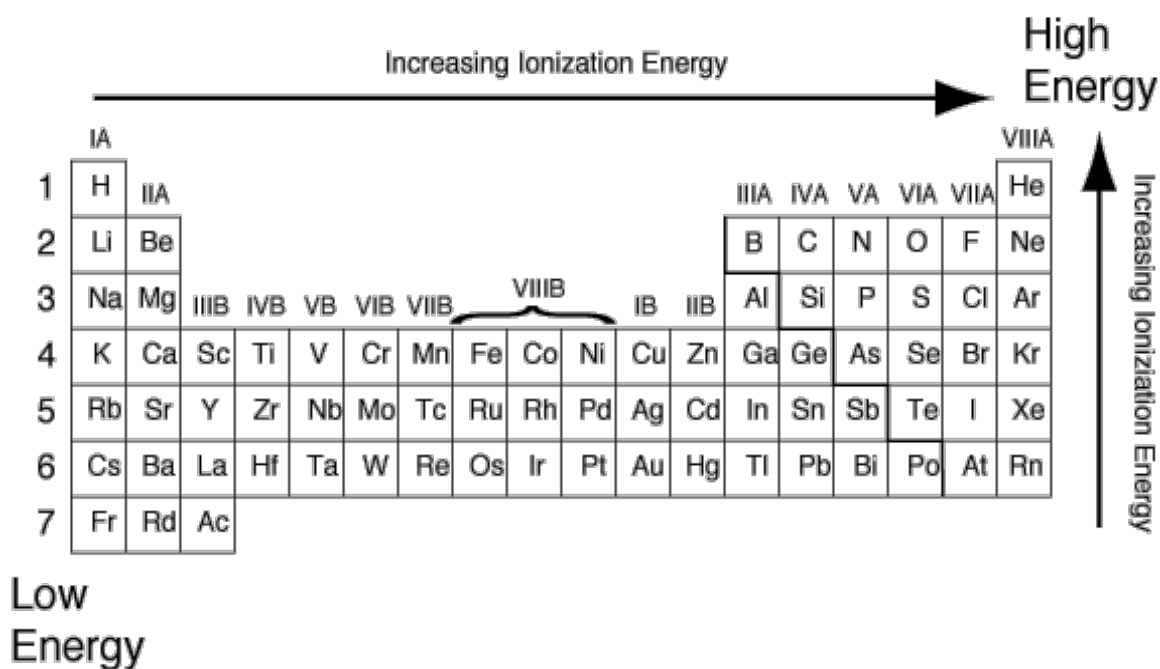
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INCREASING IONIZATION ENERGY

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Source:

[https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_\(Inorganic_Chemistry\)/Descriptive_Chemistry/Periodic_Trends_of_Elemental_Properties/Periodic_Trends_of_Elemental_Properties](https://chem.libretexts.org/Bookshelves/Inorganic_Chemistry/Supplemental_Modules_(Inorganic_Chemistry)/Descriptive_Chemistry/Periodic_Trends_of_Elemental_Properties/Periodic_Trends_of_Elemental_Properties)



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