Building a Periodic Table

You are a group of four scientists in the year 1904 and you have to try to arrange 30 of the naturally occurring elements in a table based on previous information about Mendeleev's periodic table, Dobereiner's Triads, Newlands' Law of Octaves and the discovery of noble gases.

Each group will be given the atomic radii, ionization energies, and formulas of oxides and hydrides along with chemical reactivity of the elements to aid in the classification and the grouping of the elements. The elements are arranged in a random order with different symbols. Find the identity of the unknown elements and try grouping the elements with similar properties together in a table. (It does not necessarily have to be like the current periodic table. You can be as innovative as you like).

Background information

Dobereiner's Triads

German chemist, Johann Dobereiner noted similar physical and chemical properties among elements and arranged them in Triads (sets of 3) between 1817 and 1829 and observed that the middle element had the atomic mass close to the average of masses of all 3 elements.[1] His table is shown below.

Table 1. Dobereiner's Triads

Elements	Atomic Mass (amu)	Elements	Atomic Mass (amu)	Elements	Atomic Mass (amu)
Li	6.94	Ca	40.078	Cl	35.45
Na	22.99	Sr	87.62	Br	79.904
K	39.098	Ba	137.33	I	126.90

The drawbacks of this were that it worked only for a few elements and it was dismissed as a mere coincidence.

Newlands' Law of Octaves

English chemist, John Newlands offered the Law of Octaves. He arranged the elements in increasing order of atomic masses and noted that every eighth element had properties like the first one.[1] His table is shown below.

Table 2. Newlands' Table of Octaves.[2]

Newlands' Octaves						
H	Li	Ga	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co,Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce,La	Zr	Di,Mo	Ro,Ru
Pd	Ag	Cd	U	Sn	Sb	Te
I	Cs	Ba,V	Ta	W	Nb	Au
Pt,Ir	Tl	Pb	Th	Hg	Bi	Cs

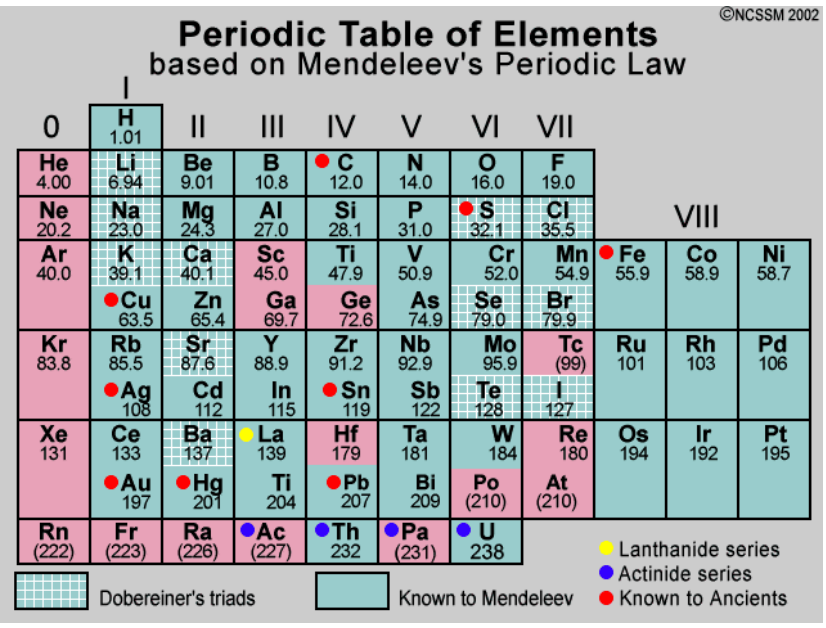
It was however found that this only worked for the first twenty elements and not afterwards.

Mendeleev's Periodic Table

Dmitri Mendeleev in 1869 gave the Periodic Law which states that, "*The Properties of chemical elements are a periodic function of their atomic weights.*"[1]

Mendeleev arranged elements in a table with elements with similar properties were placed in the same vertical column (group). Mendeleev considered the overall chemical and physical properties and not just the order of the weights. His table is shown below.

Table 3. Mendeleev's Periodic Table.[3]



Noble Gases

By 1898 William Ramsay had discovered Helium and Argon, and isolated Neon, Krypton, and Xenon from air into their liquid states at low temperature and high pressure.[4]

Given on the next page is the list of unknown elements along with the corresponding atomic sizes, ionization energies, and formulae of their oxides and hydrides.[5,6]

Physical and Chemical Properties:

The elements B, C, and M are classified as metalloids.

The element D has an electronegativity of 3.98 which is the highest in the periodic table.

Reactions with water:

K_2O, E_2O, LO, AdO form basic hydroxides on reaction with water.

e.g. $K_2O + H_2O \rightarrow 2\ KOH$ [KOH is a strong base]

Af_2O_3 and W_2O_3 form an amphoteric hydroxide (both acidic and basic properties) on reaction with water.

e.g. $Af_2O_3 + 3H_2O \rightarrow 2\ Af(OH)_3$ [$Af(OH)_3$ is amphoteric in nature]

ZX, ZN are acids in aqueous solution.

Note: The symbols of the unknown elements do not correspond to the actual elements. (for example, element P is not phosphorus, element C is not Carbon)

Table 4. Table of unknown elements

Element	Atomic Radius	I.E. 1	I.E. 2	I.E. 3	Formula of the Oxides	Formula of the Hydrides
A	7.6	1907	3693	14359	AO	AH_2
B	4.0	3286	6239	9490	B_2O_5	BH_3
C	3.9	2729	5473	11214	CO_2	CH_4
D	1.5	5833	11708	20995	D_2O	DH
E	9.2	1398	9137	13394	E_2O	EH
F	10.3	1304	7753	11798	F_2O	FH
G	6.6	1720	15830	23979	G_2O	GH
I	3.1	4687	8156	12371	-	-
J	6.7	2078	3975	17046	JO	JH_2
K	5.8	1805	25324	40998	K_2O	KH
L	5.0	2560	5034	26832	LO	LH_2
M	4.3	2644	5335	11458	MO_2	MH_4
N	3.3	3955	7297	12041	N_2O	NH
P	1.1	8232	18219		-	-
Q	3.6	3265	7096	10319	QO_2	QH_2
R	8.4	1453	10590	15337	R_2O	RH
S	2.3	3770	8164	16033	SO_2	SH_4
T	3.4	3511	6617	10113	T_2O_5	TH_3
U	3.1	3469	7814	11649	UO_2	UH_2
V	2.5	5276	9250	13641	-	-
W	4.1	2004	6304	9524	W_2O_3	WH_3
X	2.7	4342	7974	13262	X_2O	XH
Y	1.9	4866	9910	15886	Y_2O_5	YH_3
Z	1.8	4553			Z_2O	ZH
Aa	1.3	7220	13714	21243	-	-
Ab	3.9	3121	6097	51525	AbO	AbH_2
Ac	3.0	2778	8422	12699	Ac_2O_3	AcH_3
Ad	8.8	1745	3349	12492	AdO	AdH_2
Ae	1.7	4559	11757	18393	AeO	AeH_2
Af	4.7	2008	6868	10282	Af_2O_3	AfH_3

References:

1) Chemistry in a High School Curriculum. Classification of Elements and Periodicity in Properties; Class 11. National Council of Educational Research and Training: New Delhi, India, 1991; Part 1, p71-72,82-86,89-91
2) Newlands' Periodic Table. (n.d.). Retrieved October 22, 2019, from https://corrosion-doctors.org/Periodic/Periodic-Newlands.htm
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4) Sir William Ramsay | British chemist | Britannica.com. (n.d.). Retrieved October 22, 2019, from https://www.britannica.com/biography/William-Ramsay
5) Elements, Atomic Radii and the Periodic Radii. (n.d.). Retrieved October 22, 2019, from http://www.crystalmaker.com/support/tutorials/atomic-radii/
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