

.(...)
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(. ...

1780)

Johann Dobereiner

(1849 _

(Sr)

()

Ca Sr Ba <==== 40 88 137

137.37	87.63	40.07	

$$(40 + 137) \div 2 = 88$$

39	23	7	

$$\text{Li Na K} \leftarrow \text{====} 7 \ 23 \ 39$$

$$\text{Cl Br I} \leftarrow \text{====} 35 \ 80 \ 127$$

Dobereiner's Law of Triads

Johann Dobereiner



John Newlands

John Newlands

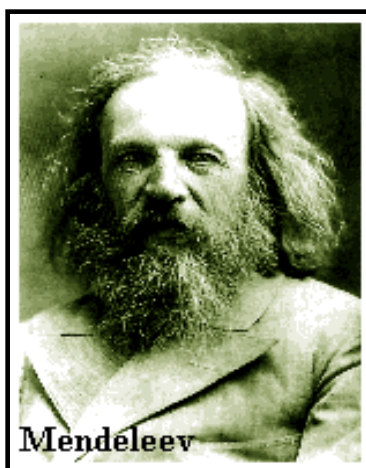
(1828-1895)

(Law of Octaves)

Newlands' Arranged Elements in Octaves:

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

1869



Mendeleev

(Dimitri Mendeleev)

)

(63

(atomic weights)

(Lothar Meyer)

Group	I	II	III	IV	V	VI	VII	VIII
Period 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's Periodic Table

Chemistry of the Elements

Elements in a given group tend to be similar chemically. Click on a group for a discussion of group properties.

Transition Metals

I	II	III	IV	V	VI	VII	0										
H ¹							He ²										
Alkali metals	Alkaline earths	B ⁵	C ⁶	N ⁷	O ⁸	F ⁹	Ne ¹⁰										
		Al ¹³	Si ¹⁴	P ¹⁵	S ¹⁶	Cl ¹⁷	Noble Gases										
		Sc ²¹	Ti ²²	V ²³	Cr ²⁴	Mn ²⁵		Fe ²⁶	Co ²⁷	Ni ²⁸	Cu ²⁹	Zn ³⁰	Al Group	C Group	N Group	O Group	Halogens
		Y ³⁹	Zr ⁴⁰	Nb ⁴¹	Transition Elements				Ag ⁴⁷	Cd ⁴⁸	Al Group	C Group	N Group	O Group			
Fr ⁸⁷	Rf ¹⁰⁴	Ha ¹⁰⁵	W ⁷⁴	Re ⁷⁵	Os ⁷⁶	Ir ⁷⁷	Pt ⁷⁸	Au ⁷⁹	Hg ⁸⁰	Al Group					C Group	N Group	O Group
	89-103		106	107	108	109											
Lanthanides		La ⁵⁷	Ce ⁵⁸	Pr ⁵⁹	Nd ⁶⁰	Pm ⁶¹	Sm ⁶²	Eu ⁶³	Gd ⁶⁴	Tb ⁶⁵	Dy ⁶⁶	Ho ⁶⁷	Er ⁶⁸	Tm ⁶⁹	Yb ⁷⁰	Lu ⁷¹	
Actinides		Ac ⁸⁹	Th ⁹⁰	Pa ⁹¹	U ⁹²	Np ⁹³	Pu ⁹⁴	Am ⁹⁵	Cm ⁹⁶	Bk ⁹⁷	Cf ⁹⁸	Es ⁹⁹	Fm ¹⁰⁰	Md ¹⁰¹	No ¹⁰²	Lr ¹⁰³	

Metal
 Metalloid
 Nonmetal

(1915-1887) (Henry Moseley)

atomic number

Group 0	I		II		III		IV		V		VI		VII		VIII
	a	b	a	b	a	b	a	b	a	b	a	b	a	b	
	H 1														
He 2	Li 3		Be 4		B 5		C 6		N 7		O 8		F 9		
Ne 10	Na 11		Mg 12		Al 13		Si 14		P 15		S 16		Cl 17		
Ar 18	K 19 Cu 29		Ca 20 Zn 30		Sc 21 Ga 31		Ti 22 Ge 32		V 23 As 33		Cr 24 Se 34		Mn 25 Br 35		Fe 26, Co 27, Ni 28
Kr 36	Rb 37 Ag 47		Sr 38 Cd 48		Y 39 In 49		Zr 40 Sn 50		Nb 41 Sb 51		Mo 42 Te 52		I 53		Ru 44, Rh 45, Pd 46
Xe 54	Cs 55 Au 79		Ba 56 Hg 80		57-71* Tl 81		Hf 72 Pb 82		Ta 73 Bi 83		W 74 Po 84		Re 75		Os 76, Ir 77, Pt 78
Rn 86	-		Ra 88		Ac 89		Th 90		Pa 91		U 92				

-2

(12)

.(11)

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(A)

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)(B)

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(2A 1A)

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.S

(1A)

1

3 Li	2
11 Na	3
19 K	4
37 Rb	5
55 Cs	6
87 Fr	7

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(2A)

2

4
Be

2

12
Mg

3

20
Ca

4

38
Sr

5

56
Ba

6

88
Ra

7

(lime)

(magnesia)

(beryllia)

.(baryta)

(strontia)

()

.()

(Paracelsus)

(Aristotle)

17

(John Becher)

16

17

(Georg Stahl)

1789 () (Antoine Lavoisier)

(Humphry Davy)

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6.7 3.4.5)

(S , P)

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Al

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Ga

nS^2np^1

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(Alumen)

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(C, Si, Ge, Sn, Pb)

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nS^2np^2

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(N, P, As, Sb, Bi)

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$.nS^2np^3$

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Phos

Phoro

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1669

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(O, S, Se, Te, Po)

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$.nS^2np^4$

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7A

(VII or VIIA)

17

HF, HCl,)

HAt

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(HBr , HI

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Fluorine

(Flow)

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(Flux Traces,

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Iodine

1811

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58.3

(Bromos)

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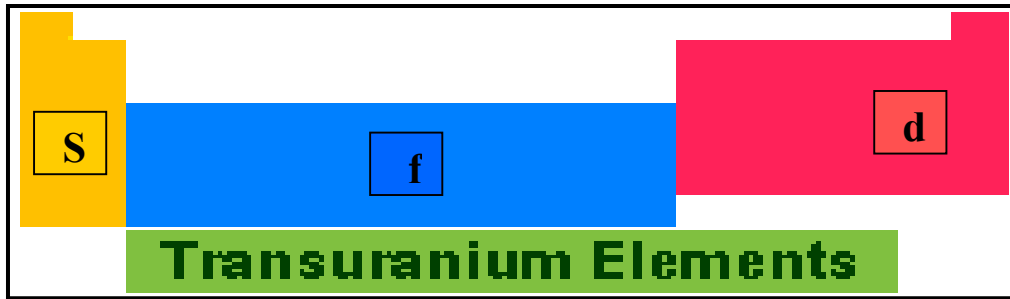
(B)

(S, d)

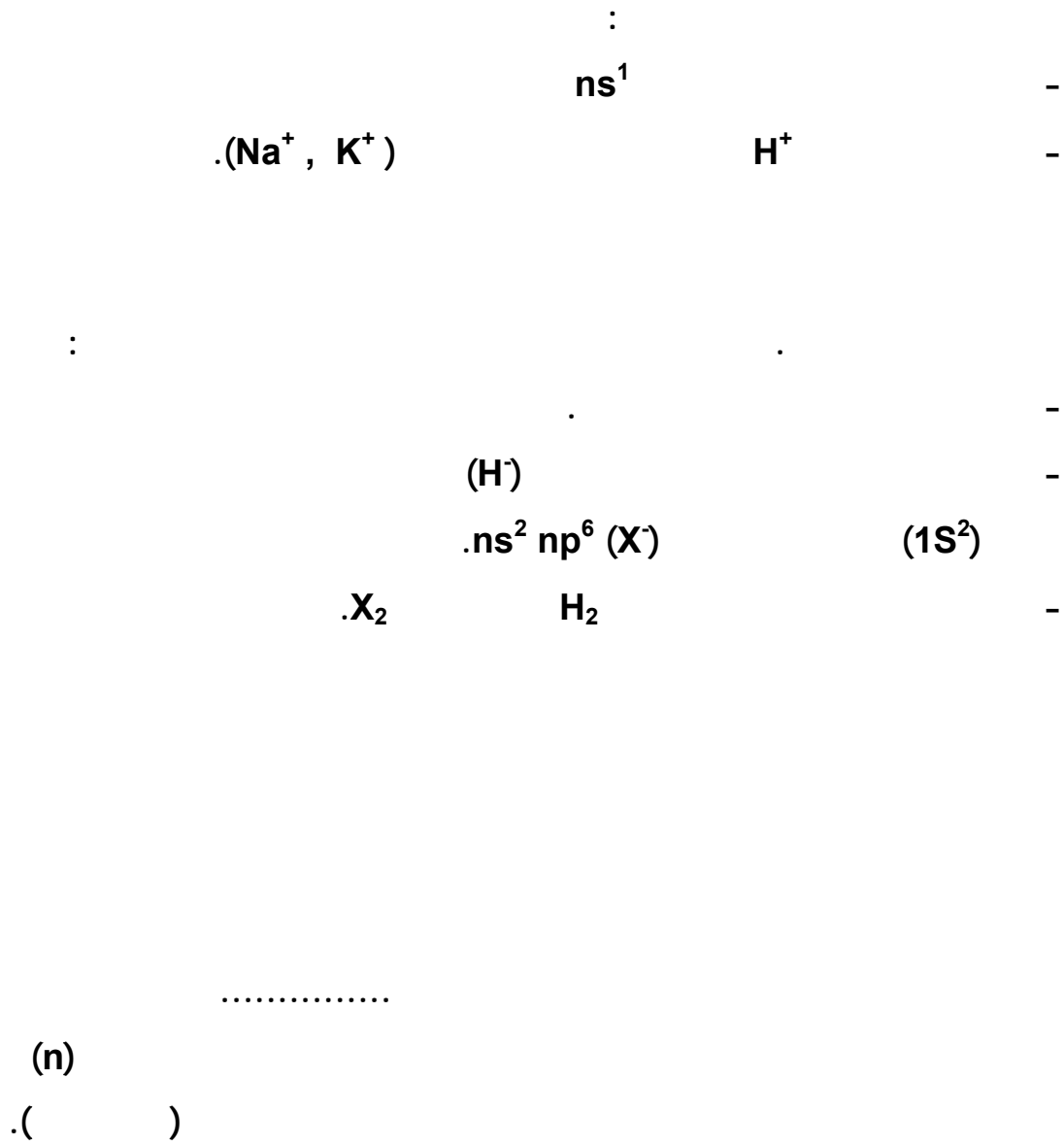
.

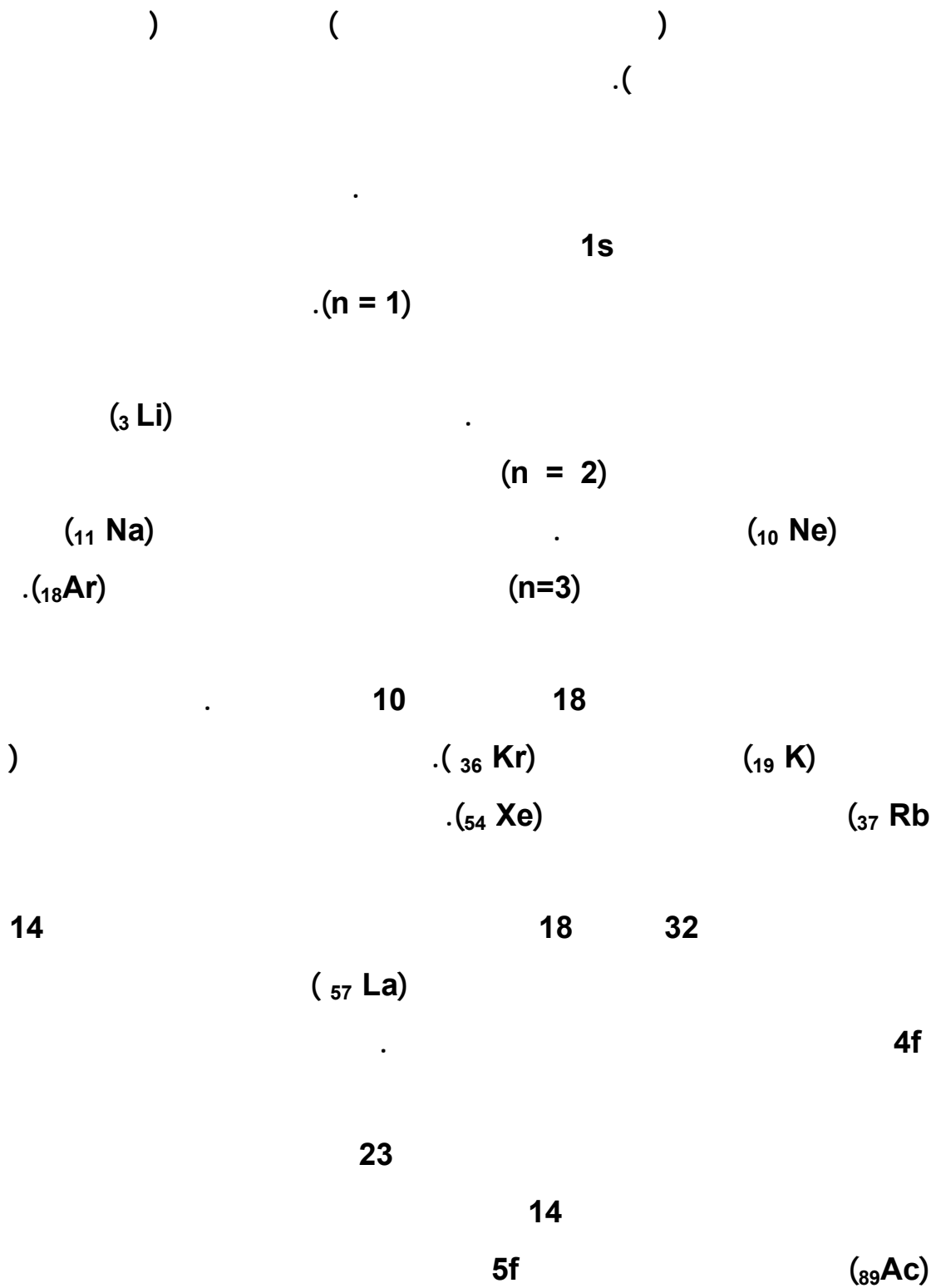
(f)

.

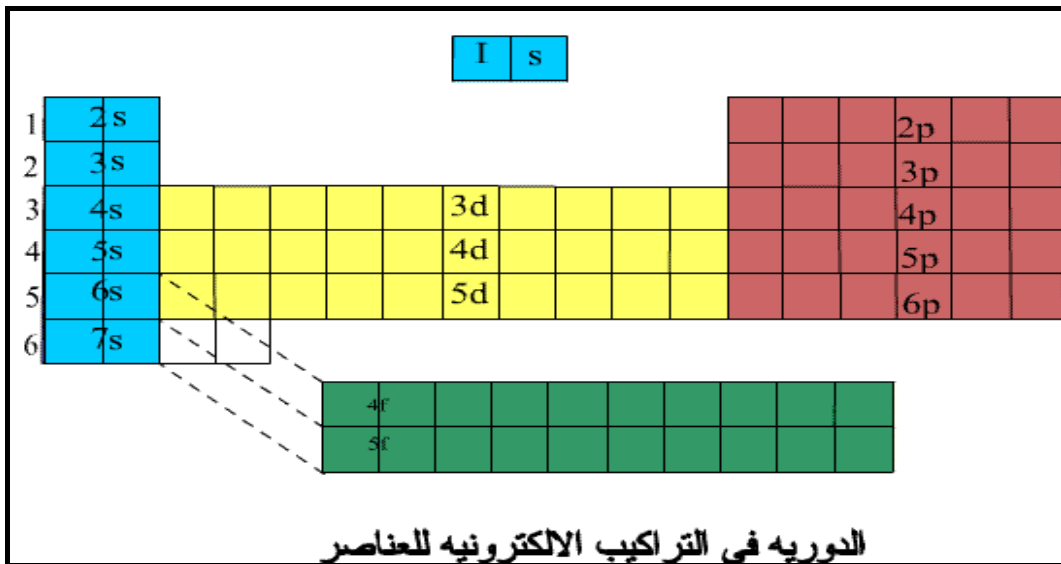


()





(2A) (1A) S -1
 (s)
 7A 3A P -2
 (p)
 (B) d -3
 (d) f -4
 ()
 (f)



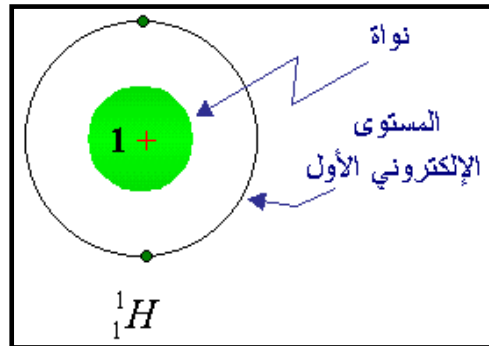
.()

(7)

(1)

87Cs

(1)

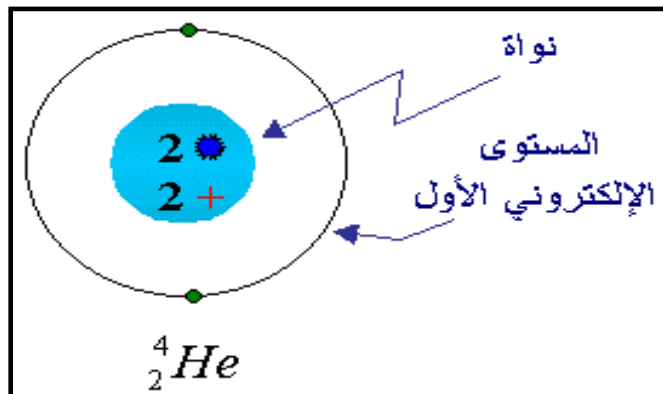


(n)

() (p)

(e)

(e)

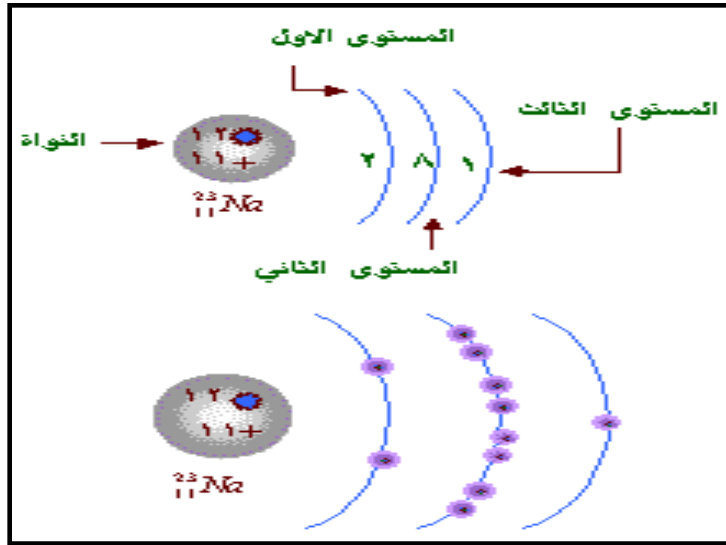


(11)

(12)

(11)

(Na)



2	8	1

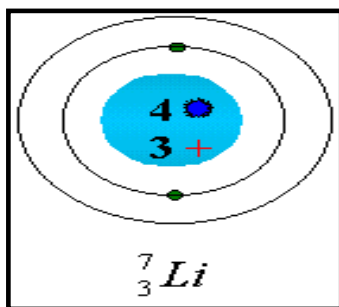
$_{2}\text{Li}$	$_{11}\text{Na}$	$_{11}\text{K}$

()

.2

(2 = 2 - 4)H

-1



Li

Li

Li

)

(

n L

3d

4s

(4)

4s

n = 4

L = 0

(5)

3d

n = 3

L = 2

.3d

4s

.6p

4f

(7)

4f

n = 4

L = 3

(7)

6p

n = 6

L = 1

6p

4f

(

)

.6p

4f

) p

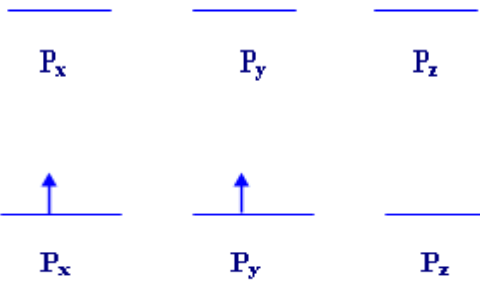
f

(d)

(

p

:

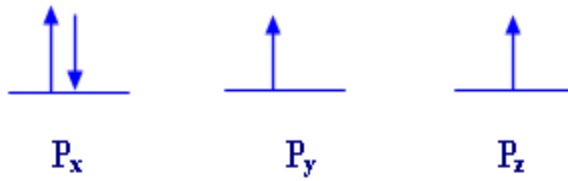


p

p

(4)

(7)



d

.....

1

n=1

.1s

. L=0 1

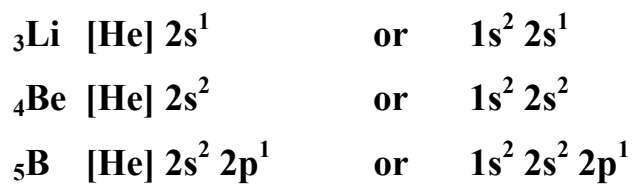
2

(i₃Li)

(i₂ = n)

.(i₁₀Ne)

. L=1 2p L=0 2s



:

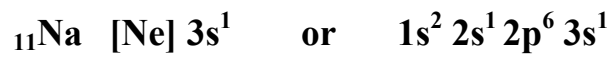
-1

-2

(p) (s)

3

.3p, 3s

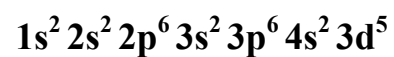


3d

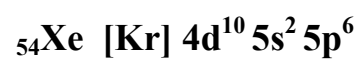
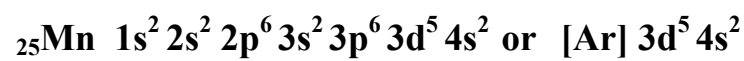
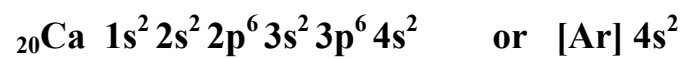
() 4s

.4

1



2



(A)

-

(B)

-

B

A

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-

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Atomic Radius

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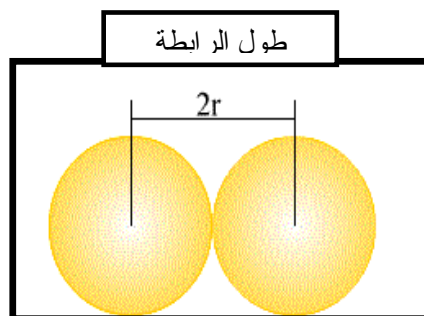
"

Cl H

Cl₂ H₂

()

(Pm)	(Pm)	
37	74	H ₂
100	200	Cl ₂



	IA	IIA	IIIA	IVA	VA	VIA	VIIA	VIIIA
الدورة الاولى	H							He
الدورة الثانية	Li	Be	B	C	N	O	F	Ne
الدورة الثالثة	Na	Mg	Al	Si	P	S	Cl	Ar
الدورة الرابعة	K	Ca	Ga	Ge	As	Se	Br	Kr
الدورة الخامسة	Rb	Sr	In	Sn	Sb	Te	I	Xe
الدورة لستة	Cs	Ba	Tl	Pb	Bi	Po	At	Rn

تغير حجم ذرات العناصر الممثلة مع تغير العدد الذري

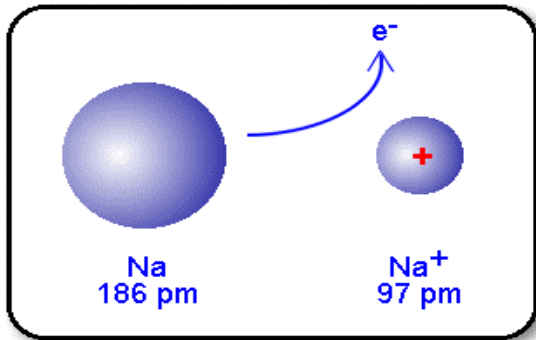
(n)

(Pm)

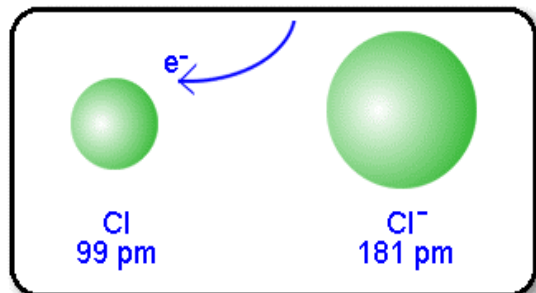
(Br₂)

114=

Ionic Radius



()



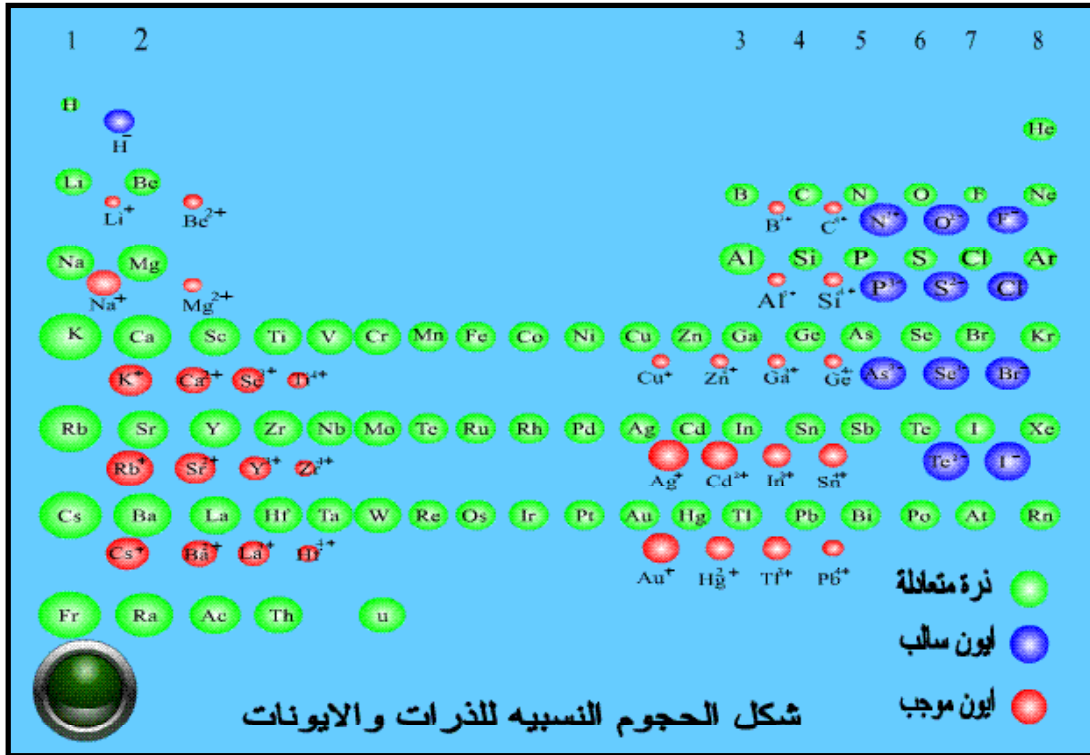
186

(Pm)
(Pm) 97

(Pm)181

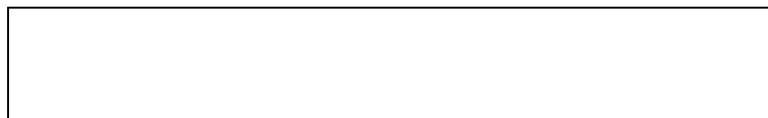
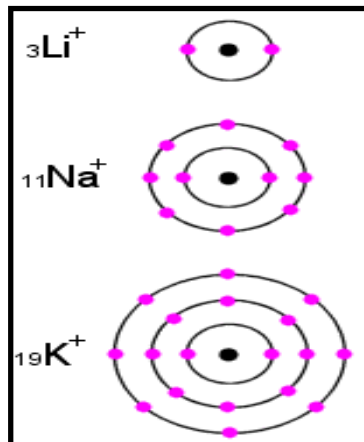
(Pm)99

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Ca⁺² **Ca** -

Br⁻¹ **Br** -

.

Ca⁺² **Ca** -

.

₂₀Ca 1s² 2s² 2p⁶ 3s² 3p⁶ 4s² or [Ar] 4s²

₂₀Ca⁺² 1s² 2s² 2p⁶ 3s² 3p⁶ or [Ar]

()

Br⁻ **Br** -

.

₃₅Br [Ar] 4s² 3d¹⁰ 4p⁵

₃₅Br⁻¹ [Ar] 4s² 3d¹⁰ 4p⁶

()

.

-1

S⁻² -

N⁻³ -

O⁻² -

Ionization Energy

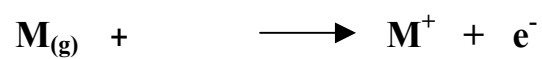
"

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$3s^1$

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1A	
	5.390
	5.138
	4.339
	4.176
	3.893

	9.320
	8.300
	11.260
	14.540
	13.62
	17.42
	21.56

-

-1

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-2

-3

Electronegativity Trends in Periodic Table

	1A	→																8A
1	H	2A	8B										3A	4A	5A	6A	7A	He
2	Li	Be											B	C	N	O	F	Ne
3	Na	Mg	3B	4B	5B	6B	7B	8B		1B	2B	Al	Si	P	S	Cl	Ar	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
6	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
7	Fr	Ra	Ac	Rf	Ha	Sg	Ns	Hs	Mt									
Lanthanides	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu				
Actinides	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr				

Electronegativity increases from bottom to top in a column.
 Electronegativity increases from left to right across a group.

(metals)

(Metalloids)

(Sb)

(As)

(Si)

:

()

له خواص نوعية مختلفة عن بقية العناصر

	المجموعة																		1																	2
	IA		IIA												III A	IV A	VA	VIA	VII A	He																
الدورة الثانية	3	Li	4	Be																	5	B	6	C	7	N	8	O	9	F	10	Ne				
الثالثة	11	Na	12	Mg	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar																				
الرابعة	19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
الخامسة	37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	(Tc)	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
السادسة	55	Cs	56	Ba	57	La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
السابعة	87	Fr	88	Ra	89	Ac	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118															
					58	Ce	59	Pr	60	Nd	61	Pm	62	Sm	63	Eu	64	Gd	65	Tb	66	Dy	67	Ho	68	Er	69	Tm	70	Yb	71	Lu				
					90	Th	91	Pa	92	U	(Np)	(Pu)	(Am)	(Cm)	(Bk)	(Cf)	(Es)	(Fm)	(Md)	(No)	(Lw)															

اللافلزات
أشباه الفلزات

	IA																		0																	
1	1	H	IIA																		2	He														
2	3	Li	4	Be											5	B	6	C	7	N	8	O	9	F	10	Ne										
3	11	Na	12	Mg	13	Al	14	Si	15	P	16	S	17	Cl	18	Ar																				
4	19	K	20	Ca	21	Sc	22	Ti	23	V	24	Cr	25	Mn	26	Fe	27	Co	28	Ni	29	Cu	30	Zn	31	Ga	32	Ge	33	As	34	Se	35	Br	36	Kr
5	37	Rb	38	Sr	39	Y	40	Zr	41	Nb	42	Mo	43	Tc	44	Ru	45	Rh	46	Pd	47	Ag	48	Cd	49	In	50	Sn	51	Sb	52	Te	53	I	54	Xe
6	55	Cs	56	Ba	57	*La	72	Hf	73	Ta	74	W	75	Re	76	Os	77	Ir	78	Pt	79	Au	80	Hg	81	Tl	82	Pb	83	Bi	84	Po	85	At	86	Rn
7	87	Fr	88	Ra	89	+Ac	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118															

*Lanthanide Series
+Actinide Series

58	59	60	61	62	63	64	65	66	67	68	69	70	71
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
90	91	92	93	94	95	96	97	98	99	100	101	102	103
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr

A -1

A B

- - -
-2
-3

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10	9	8	7	6	5	4	3	2	1
X	IX	VIII	VII	VI	V	IV	III	II	I

(Na)

B A

.IA

Al -

Cu -

Be -2

-3

56 - 52 - 19 -

.63 - 76 - 42 -

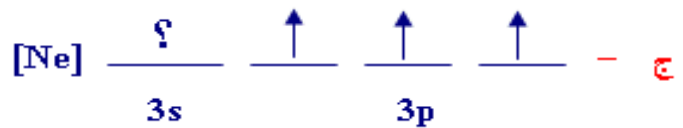
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[Ne] 3s² 3p⁶ - 1s² 2s² 2p⁶ 3s² -



[Xe] 4f² 5d² 6s² 6p¹ -

[Kr] 4d² 5s² 5p² -

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(113)

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Ca ₂₀	Mg ₁₂	Be ₄

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-7

Mg⁺² Ca⁺² Se⁻² K⁺¹ Al⁺³