ULTIMATE KCET

CRASH COURSE 2026

Chemistry | Lecture - 01

Classification of elements

By – Sreeja Ma'am

Recap *of previous lecture*

1. Mole concept revision and Biomolecules MCQ


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dilution → $M_1V_1 = M_2V_2$

Mixing → $\frac{M_1V_1 + M_2V_2}{\text{Total volume}} = M_3$

Question

The volume of 0.1 M oxalic acid that can be completely oxidised by 20 mL of 0.025 M $KMnO_4$ solution is [2012]

(A) 25 mL

(B) 12.5 mL

(C) 37.5 mL

(D) 125 mL

$C_2O_4^{2-} + MnO_4^{-} \rightarrow Mn^{2+} + CO_2$ (2e⁻ lost, oxidation; 5e⁻)

$M_1 \times V_1 \times n_{factor} = M_2 \times V_2 \times n_{factor}$

$0.1\,M \times V_1 \times 2e^- = 0.025 \times 20 \times 5e^-$

$\therefore V_1 = \frac{0.025 \times 20 \times 5 \times 10}{0.1 \times 2}$

$V_1 = 12.5$ ml

MnO_4^-

$x + (-2 \times 4) = -1$

$x - 8 = -1$

$x = +7$

$HCl \longrightarrow {}^{1}H + {}^{35.5}Cl$

$M_b = 1 + 35.5 = 36.5$

Question

What will be the molality of the solution containing 18.25 g of HCl gas in 500 g of water?

(A) 0.1 m

(B) 1 M → Molar → $mol\,L^{-1}$

(C) 0.5 m

(D) 1 m → Molal → $mol\,kg^{-1}$

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent (g)}} \times 1000$$

$$m = \frac{w_b \times 1000}{M_b \times w_a} = \frac{18.25 \times 1000}{36.5 \times 500}$$

$= 1\,m$

$= 1\,mol\,kg^{-1}$

Question

One mole of any substance contains 6.022×10^{23} atoms/molecules.
Number of molecules of H_2SO_4 present in 100 mL of 0.02M H_2SO_4 solution is _____.

(A) 12.044×10^{20} molecules

(B) 6.022×10^{23} molecules

(C) 1×10^{23} molecules

(D) 12.044×10^{23} molecules

1 Mole → 6.022×10^{23} molecules.
2×10^{-3} moles → ?

$2 \times 10^{-3} \times 6 \times 10^{23}$
12×10^{20}

Molarity = $\frac{\text{Mole}}{\text{volume (1L)}}$

$= \frac{100 \text{ ml}}{1000} = 0.1 \text{ L}$

$0.02 = \frac{\text{Mole}}{0.1 \text{ L}}$

Mole = 0.02×0.1

Mole = 0.002 → 2×10^{-3} mole.

Question

Molarity = $\frac{\text{No. of moles}}{\text{vol in L}}$

$0.1M = \frac{\text{moles}}{1L}$

$\therefore$ 0.1 mole

Sulphuric acid reacts with sodium hydroxide as follows :

$$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$$

When 1L of 0.1M sulphuric acid solution is allowed to react with 1L of 0.1M sodium hydroxide solution, the amount of sodium sulphate formed and its molarity in the solution obtained is

(A) 0.1 mol L^{-1}

(B) 7.10 g

(C) 0.025 mol L^{-1}

(D) 3.55 g

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$

1 mole ⟶ 2 mole NaOH

Na_2SO_4 ↳ How much this is formed & its concentration

1L, 0.1M → 0.1 mole; 0.1 mole

1L, 0.1M → 0.1 mole → limiting reagent NaOH; 0.2 NaOH

$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + H_2O$

(1) (1)

$2NaOH \longrightarrow 1\ Na_2SO_4$

0.1 Mole of NaOH $\longrightarrow$?

Na_2SO_4, Molarity $= \frac{0.1 \times 1}{2} = 0.05$ mole

Molarity $= \frac{\text{Mole}}{\text{vol in L}}$

$= \frac{0.05 \text{ mole}}{2L}$ (25) $\longrightarrow$ $0.025\ mol\,L^{-1}$

Na_2SO_4

$= 23 \times 2 + 32 + 16 \times 4$

$= 46 + 32 + 64$

$= 142$ g/mol ✓

^{23}Na ^{32}S ^{16}O

Mole $= \frac{\text{Mass of } Na_2SO_4}{\text{Molar mass of } Na_2SO_4}$ ✓

$0.05 \text{ Mole} = \frac{W_{Na_2SO_4}}{142}$

$\therefore W = 142 \times 0.05$

$= 7.10$ g

1

2

Question

$M_b = NaOH = 23 + 16 + 1 = 40$

$KOH = {}^{39}K + {}^{16}O + {}^{1}H = 40 + 16 = 56$

Which of the following solutions have the same concentration?

$M = \frac{W_b \times 1000}{M_b \times V_{(ml)}}$

(A) a and b

(B) c and d

(C) a and c

(D) b and d

a. 20 g of NaOH in 200 mL of solution $= \frac{20 \times 1000}{40 \times 200}$ → 2.5 M

b. 0.5 mol of KCl in 200 mL of solution

$M = \frac{Mole}{Volume} = \frac{0.5 \times 1000}{200} = 2.5 M$

c. 40 g of NaOH in 100 mL of solution $\frac{40 \times 1000}{40 \times 100} = 10M$

d. 20 g of KOH in 200 mL of solution

$\frac{20 \times 1000}{56 \times 200} = \frac{20 \times 5}{56} = \frac{50}{23}$

2.1M

Match the compounds given in List – I with the items given in List – II.

List – I	List – II
(I) Benzenesulphonyl Chloride	(a) Zwitterioin
(II) Sulphanilic acid	(b) Hinsberg reagent
(III) Alkyl Diazonium salts	(c) Dyes
(IV) Aryl Diazonium salts	(d) Conversion to alcohols

(1) I – c, II – b, III – a, IV – d

(2) I – a, II – c, III – b, IV – d

(3) I – c, II – a, III – d, IV – b

(4) I – b, II – a, III – d, IV – c

Which of the following reagents are suitable to differentiate Aniline and N-methylaniline chemical

(1) Acetic anhydride

(2) Br_2 water

(3) Conc. Hydrochloric acid and anhydrous zinc chloride

(4) Chloroform and Alcoholic potassium hydroxide

Which of the following reaction/s does not yield an amine ?

I. $R-X + NH_3 \xrightarrow{\Delta}$ (alc)

II. $R-C\equiv N \xrightarrow[Na(Hg)/C_2H_5OH]{H_2/Ni}$

III. $R-C\equiv N + H_2O \xrightarrow{H^+}$

IV. $R-\overset{O}{\overset{\|}{C}}-NH_2 + 4\,[H] \xrightarrow[ii)\ H_3O^+]{i)\ LiAlH_4}$

(1) Both I and III
(2) Only II
(3) Only III
(4) Both II and IV

Match List-I with List-II for the following reaction pattern

$$\text{Glucose} \xrightarrow{\text{Reagent}} \text{Product} \longrightarrow \text{Structural prediction}$$

List – I (Reagents)	List-II (Structural prediction)
a. Acetic anhydride	i. Glucose has an aldehyde group
b. Bromine water	ii. Glucose has a straight chain of six carbon atoms
c. Hydroiodic acid	iii. Glucose has five hydroxyl group
d. Hydrogen cyanide	iv. Glucose has a carbonyl group

Choose the correct answer from the options given below.

(1) a-iv, b-iii, c-ii, d-i (2) a-iii, b-i, c-ii, d-iv (3) a-i, b-ii, c-iii, d-iv (4) a-iii, b-ii, c-i, d-iv

The correct sequence of α – amino acids, hormone, vitamin, carbohydrates respectively is

(1) Thiamine, Thyroxine, Vitamin A, Glucose

(2) Glutamine, Insulin, Aspartic acid, Fructose

(3) Arginine, Testosterone, Glutamic acid, Fructose

(4) Aspartic acid, Insulin, Ascorbic acid, rhamnose

Which examples of carbohydrates exhibit α – link, (α – glycosidic link) in their structure?

(1) Maltose and Lactose
(2) Amylose and Amylopectin
(3) Cellulose and Glycogen
(4) Glucose and Fructose

Given below and the atomic masses of the elements:

Element:	Li	Na	Cl	K	Ca	Br	Sr	I	Ba
Atomic Mas $(g\,mol^{-1})$:	7	23	35.5	39	40	80	88	127	137

Which of the following doesn't form triad?

(1) Ba, Sr, Ca
(2) Cl, Br, I
(3) Cl, K, Ca
(4) Li, Na, K

Topics *to be covered*

1. Synopsis and mcqs

Chapter analysis

01–02 → weightage

Class 11th

2025 → law of triad → 1 mark

Classification of elements and periodicity in properties

Ionisation enthalpy	2023, 2022, 2021, 2015, 2014, 2012, 2011, 2006
Amphoteric oxide (Most imp)	2023, 2022, 2017
Trends – electronegativity, atomic radius, density, electron gain enthalpy	2022, 2017, 2018
Isoelectronic species	2013

Law of triad - Johann Dobereiner

- This law states that certain groups of three elements (known as triads) have similar chemical properties, and the atomic weight of the middle element is approximately the average of the atomic weights of the other two elements.

Law of Triads

Element	Atomic weight
Li	7
Na	23
K	39

$\frac{39+7}{2} = \frac{46}{2} = 23$

Element	Atomic weight
Ca	40
Sr	88
Ba	137

Element	Atomic Weight
Cl	35.5
Br	80
I	127

{ S, Se, Te } Triad

Law of Octaves

- Newlands' Law of Octaves states that when elements are arranged in order of increasing atomic weights, every eighth element has properties similar to the first, just like every eighth note that resembles the first in octaves of music.
- This law is applicable only up to calcium.

Law of Octaves

Element	Li	Be	B	C	N	O	F
At. wt.	7 (P+N)	9	11	12	14	16	19
Element	Na	Mg	Al	Si	P	S	Cl
At. wt.	23	24	27	29	31	32	35.5
Element	K	Ca					
At. wt.	39	40					

Mendeleev's law

The properties of the elements are a periodic function of their atomic weights.

- Mendeleev arranged elements in horizontal rows and vertical columns of a table in order of their increasing atomic weights in such a way that the elements with similar properties occupied the same vertical column or group.

Mendeleev's law

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Eka-aluminium (Gallium) and Eka-silicon (Germanium)

Property	Eka-aluminium (predicted)	Gallium (found)	Eka-silicon (predicted)	Germanium (found)
Atomic weight	68	70	72	72.6
Density/(g/cm^3)	5.9	5.94	5.5	5.36
Melting point/K	Low	302.93	High	1231
Formula of oxide	E_2O_3	Ga_2O_3	EO_2	GeO_2
Formula of chloride	$E\ Cl_3$	$GaCl_3$	ECl_4	$GeCl_4$

already Existed → Al, Si, B

found → Ga, Ge, Sc

Al	Si	B
Ga	Ge	Sc

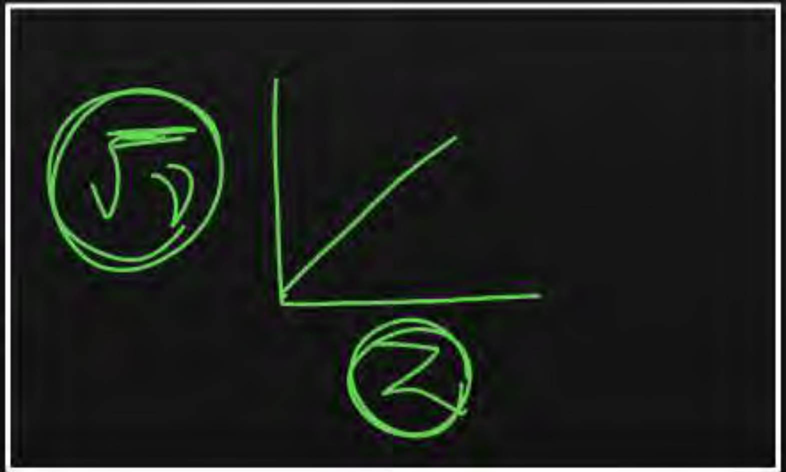
PERIODIC SYSTEM OF THE ELEMENTS IN GROUPS AND SERIES

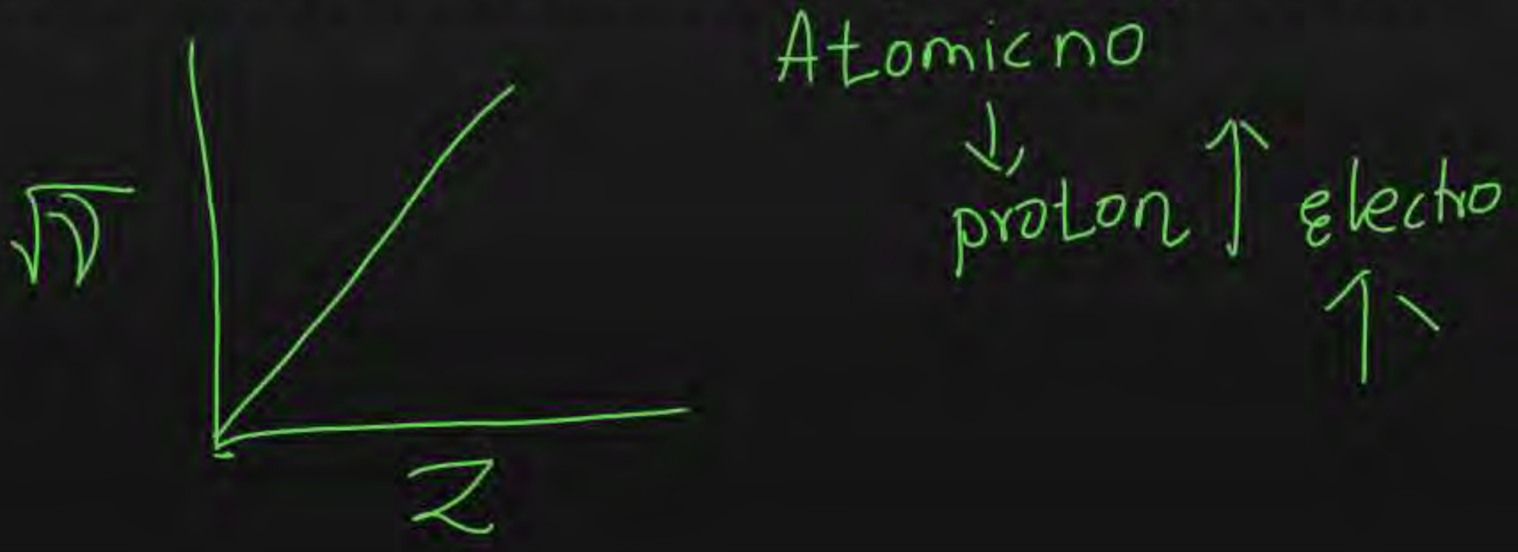
SERIES	GROUPS OF ELEMENTS 0	I	II	III	IV	V	VI	VII	VIII
1	-	Hydrogen H 1.008	-	-					
2	Helium He 4.0	Lithium Li 7.03	Beryllium Be 9.1	Boron B 11.0	Carbon C 12.0	Nitrogen N 14.04	Oxygen O 16.00	Fluorine F 19.0	
3	Neon Ne 19.9	Sodium Na 23.5	Magnesium Mg 24.3	Aluminium Al 27.0	Silicon Si 28.4	Phosphorus P 31.0	Sulphur S 32.06	Chlorine Cl 35.45	
4	Argon Ar 38	Potassium K 39.1	Calcium Ca 40.1	Scandium Sc 44.1	Titanium Ti 48.1	Vanadium V 51.4	Chromium Cr 52.1	Manganese Mn 55.0	Iron Fe 55.9, Cobalt Co 59, Nickel Ni 59 (Cu)
5		Copper Cu 63.6	Zinc Zn 65.4	Gallium Ga 70.0	Germanium Ge 72.3	Arsenic As 75	Selenium Se 79	Bromine Br 79.95	
6	Krypton Kr 81.8	Rubidium Rb 85.4	Strontium Sr 87.6	Yttrium Y 89.0	Zirconium Zr 90.6	Niobium Nb 94.0	Molybdenum Mo 96.0	-	Ruthenium Ru 101.7, Rhodium Rh 103.0, Palladium Pd 106.5 (Ag)
7		Silver Ag 107.9	Cadmium Cd 112.4	Indium In 114.0	Tin Sn 119.0	Antimony Sb 120.0	Tellurium Te 127.6	Iodine I 126.9	
8	Xenon Xe 128	Caesium Cs 132.9	Barium Ba 137.4	Lanthanum La 139	Cerium Ce 140	-	-	-	
9		-	-	-	-	-	-	-	
10	-	-	-	Ytterbium Yb 173	-	Tantalum Ta 183	Tungsten W 184	-	Osmium Os 191, Iridium Ir 193, Platinum Pt 194.9 (Au)
11		Gold Au 197.2	Mercury Hg 200.0	Thallium Tl 204.1	Lead Pb 206.9	Bismuth Bi 208	-	-	
12	-	-	Radium Ra 224	-	Thorium Th 232	-	Uranium U 239		
HIGHER SALINE OXIDES	R	R_2O	RO	R_2O_3	RO_2	R_2O_5	RO_3	R_2O_7	RO_4
HIGHER GASEOUS HYDROGEN COMPOUNDS					RH_4	RH_3	RH_2	RH	

Fig. 3.1 Mendeleev's Periodic Table published earlier

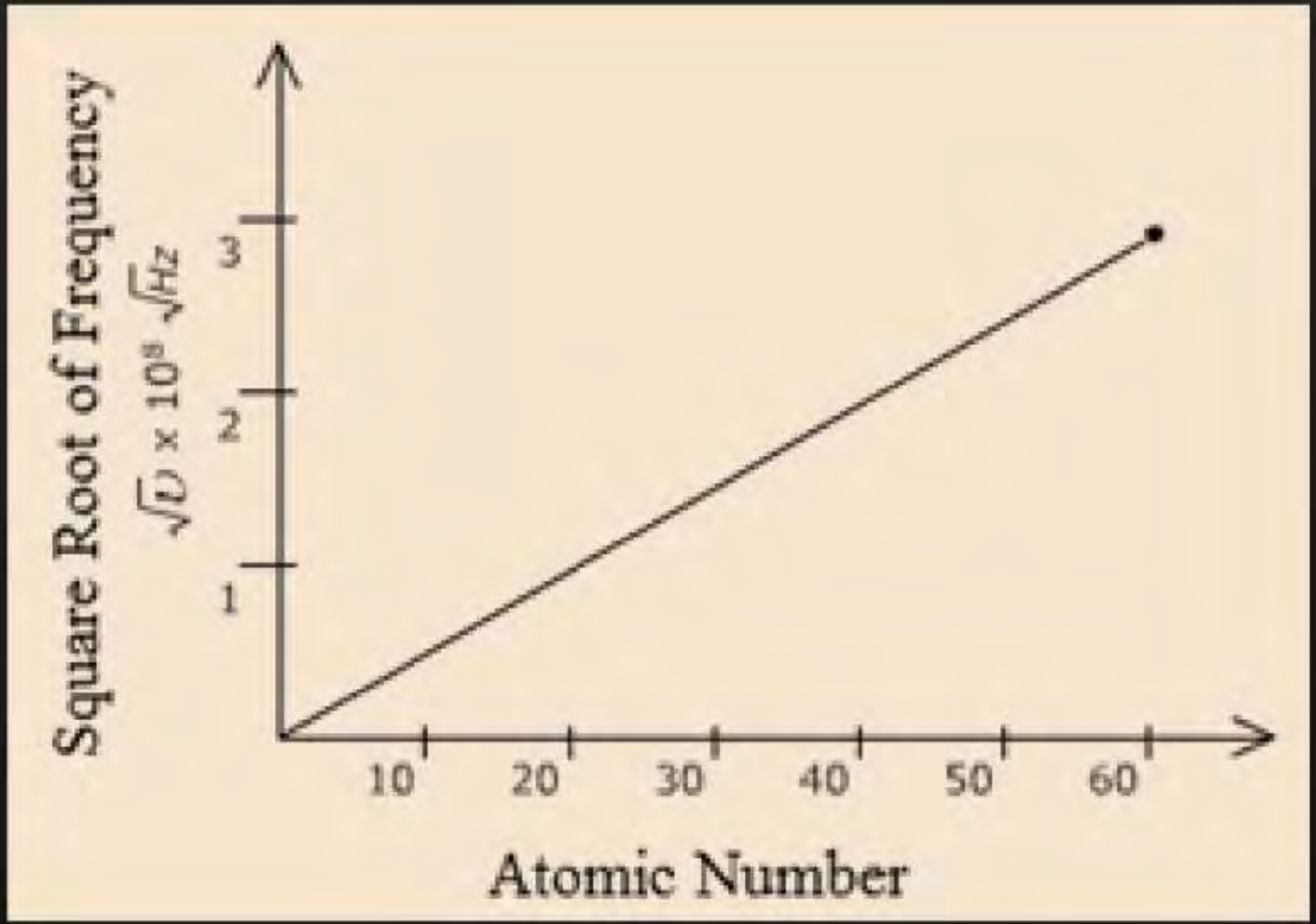
MODERN PERIODIC LAW AND THE PRESENT FORM OF THE PERIODIC TABLE

- In 1913, the English physicist, Henry Moseley observed regularities in the characteristic X-ray spectra of the elements.
- A plot of $\sqrt{v}$ (where v is frequency of X-rays emitted) against atomic number (Z) gave a straight line and not the plot of $\sqrt{v}$ us atomic mass.
- He thereby showed that the atomic number is a more fundamental property of an element than its atomic mass.





MODERN PERIODIC LAW AND THE PRESENT FORM OF THE PERIODIC TABLE

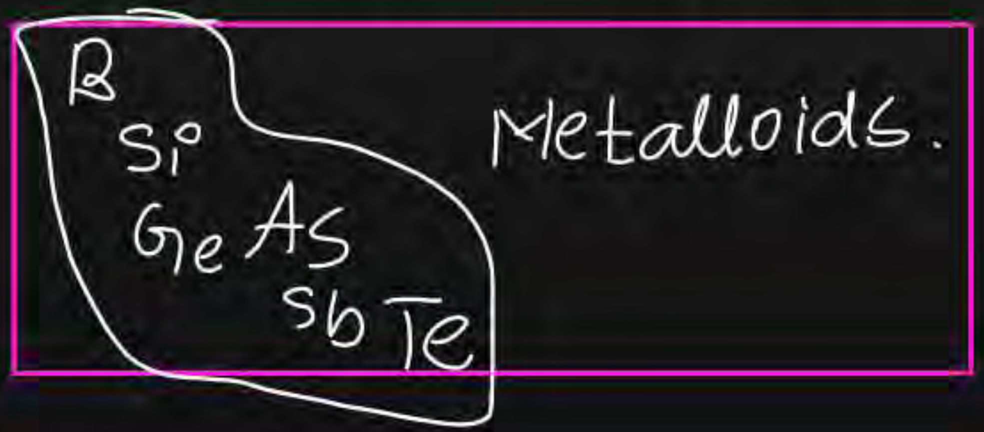


Modern Periodic Law

The physical and chemical properties of the elements are periodic functions of their atomic numbers.

- Periodic Law is essentially the consequence of the periodic variation in electronic configurations, which indeed determine the physical and chemical properties of elements and their compounds.

- The horizontal rows are called periods and the vertical columns, groups.
- Elements having similar outer electronic configurations in their atoms are arranged in vertical columns, referred to as groups or families.
- According to the recommendation of International Union of Pure and Applied Chemistry (IUPAC), the groups are numbered from 1 to 18 replacing the older notation of groups IA VIIA, VIII, ... IB... VIIB and 0.
- The period number corresponds to the highest principal quantum number (n) of the elements in the period. The first period contains 2 elements. The subsequent periods consists of 8, 8, 18, 18 and 32 elements.



Nomenclature of elements with atomic numbers > 100

- A systematic nomenclature be derived directly from the atomic number of the element using the numerical roots for 0 and numbers 1-9.
- Digits which make up the atomic number and "ium" is added at the end.

Notation for IUPAC Nomenclature of Elements

Digit	Name	Abbreviation
0	nil	n
1	un	u
2	bi	b
3	tri	t
4	quad	q
5	pent	p
6	hex	h
7	sept	s
8	oct	o
9	enn	e

112

unumbi + ium

unumbium

124

unbiquadium

120 → unbinilium

[Noble gas] ns^{1-2}

Group 1 → [Noble gas] ns^1

Group 2 → [Noble gas] ns^2

The s-Block Elements

- Reactive metals with low ionization enthalpies.
- They lose the outermost electron(s) readily to form 1^+ ion (in the case of alkali metals) or 2^+ ion (in the case of alkaline earth metals).
- The metallic character and the reactivity increase as we go down the group. Because of high reactivity they are never found pure in nature.
- The compounds of the s-block elements, with the exception of those of lithium and beryllium are predominantly ionic.

Li, Be → covalent

Na, Mg, K, Ca, Rb, Sr, Cs, Ba → ionic

Fr, Ra

The p-Block Elements [Noble gas] $ns^2 np^{1-6}$ (ns^2np^1 — ns^2np^6)

- The p-Block Elements comprise those belonging to Group 13 to 18.
- The s-Block and p-block Elements are called the Representative Elements or Main Group Elements.
- The outermost electronic configuration varies from ns^2np^1 to ns^2np^6 in each period.
- At the end of each period is a noble gas element with a closed valence shell ns^2np^6 configuration.
- All the orbitals in the valence shell of the noble gases are completely filled by electrons and it is very difficult to alter this stable arrangement by the addition or removal of electrons.
- The noble gases thus exhibit very low chemical reactivity.
- They are the halogens (Group 17) and the chalcogens (Group 16).
- These two groups of elements have highly negative electron gain enthalpies and readily add one or two electrons respectively to attain the stable noble gas configuration.
- The non-metallic character increases as we move from left to right across a period and metallic character increases as we go down the group.

Metal + Nonmetals + Metalloids (10)

Group 13 → Boron family → [Noble gas] ns^2np^1

Group 14 → Carbon family → [Noble gas] ns^2np^2

Group 15 → pnicogens → [Noble gas] ns^2np^3

" 16 → Chalcogen → [Noble gas] ns^2np^4

" 17 → Halogen → [Noble gas] ns^2np^5

" 18 → Raregas element → [Noble gas] ns^2np^6 → $8e^-$

or

Noble gas elements

The d-Block Elements

- These are the elements of Group 3 to 12 in the center of the Periodic Table.
- These are characterized by the filling of inner d orbitals by electrons and are therefore referred to as d-Block Elements.
- These elements have the general outer electronic configuration $(n-1)d^{1-10}ns^{0-2}$ except for Pd where its electronic configuration is $4d^{10}5s^{0}$.
- They are all metals.
- They mostly form colored ions, exhibit variable valence (oxidation states), paramagnetic and often used as catalysts.
- However, Zn, Cd and Hg which have the electronic configuration, $(n-1)\ d^{10}ns^{2}$ do not show most of the properties of transition elements.
- In a way, d- block elements form a bridge between the chemically active metals of s-block elements and the less active elements of Groups 13 and 14 and thus take their familiar name "Transition Elements".

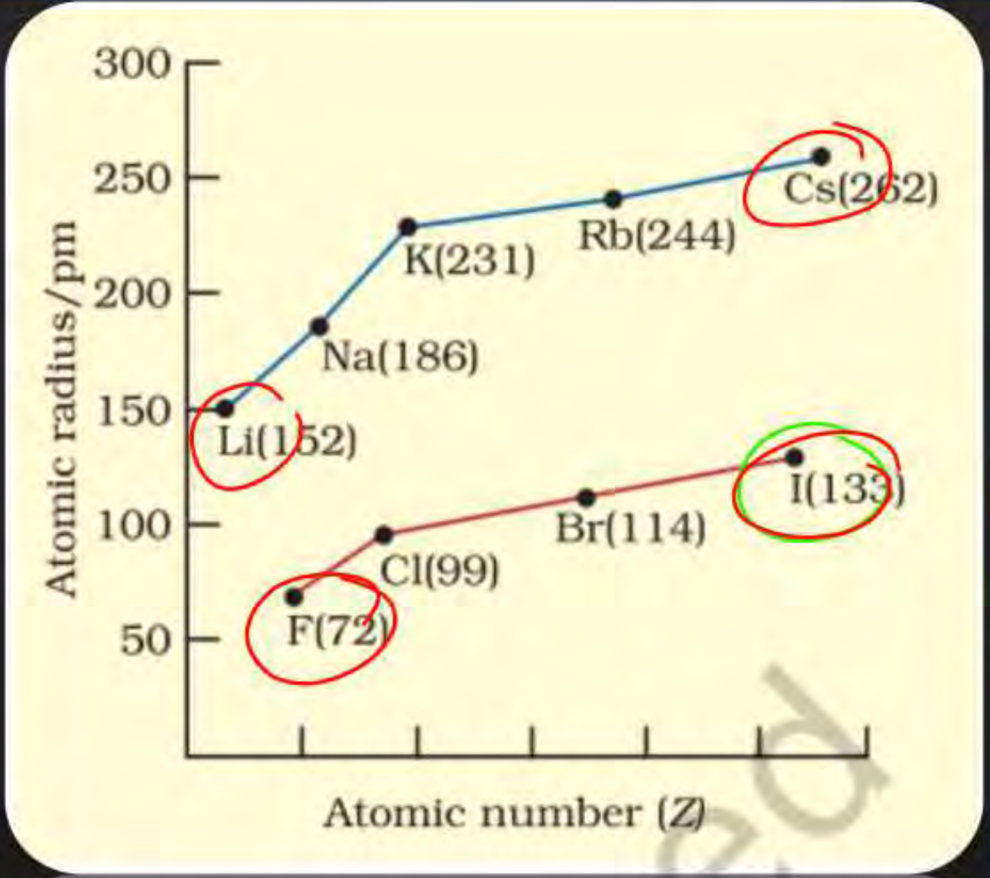
The f-Block Elements (Inner-Transition Elements)

The two rows of elements at the bottom of the Periodic Table, called the Ce(Z = 58) – Lu(Z = 71) Lanthanoids,
Th(Z = 90) – Lr (Z = 103) Actinoids,
and these are characterized by the outer electronic configuration
$(n-2)f^{1-14}(n-1)d^{0-1}ns^2$.
The last electron added to each element is filled in f-orbital.
These two series of elements are hence called the Inner-Transition Elements (f-Block Elements)

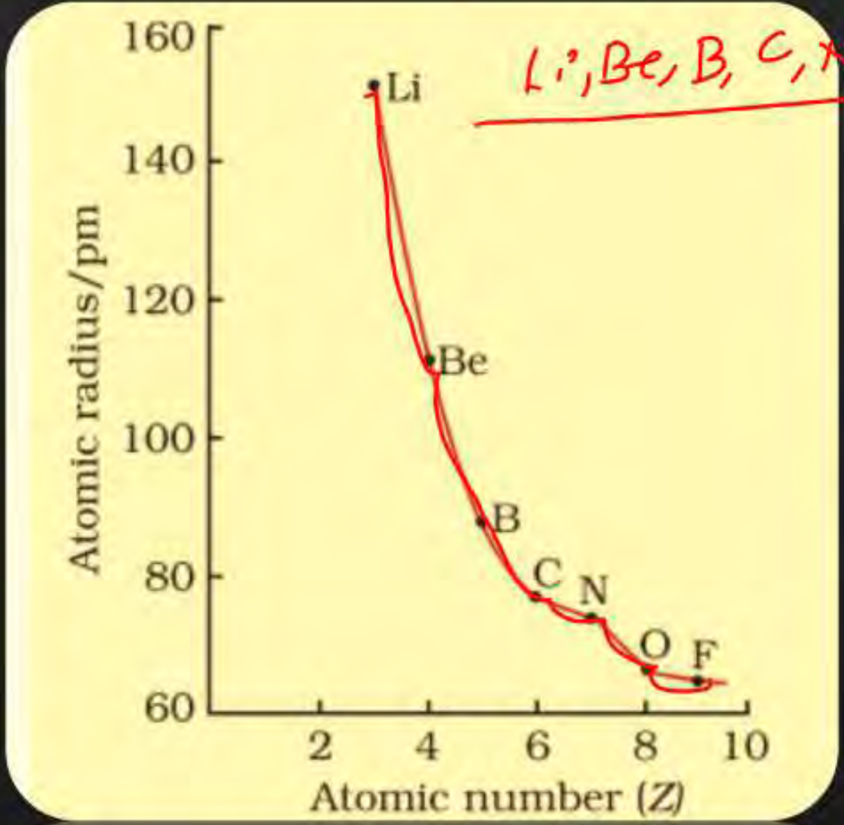
The f-Block Elements (Inner-Transition Elements)

The chemistry of the early actinoids is more complicated than the corresponding lanthanoids, due to the large number of oxidation states possible for these actinoid elements.
Actinoid elements are radioactive.
The elements after uranium are called Transuranium Elements

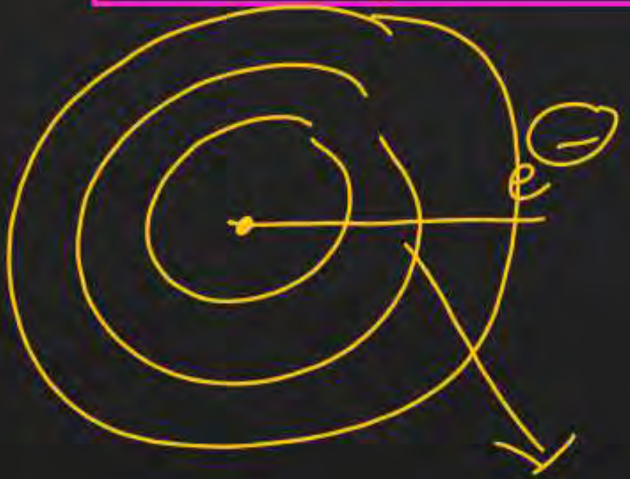
Trends in Physical Properties - Atomic Radius



F
Cl
Br
I



Atomic size



Atomic radius

Li, Be, B, C, N, O, F →

along the period atomic radius decreases ↓

e⊖ → same shell

effective nuclear charge is more.

Z effect

Li
Na
K
Rb
Cs

More shells

$_3Li$, $_4Be$, $_5B$, $_6C$, $_7N$, $_8O$

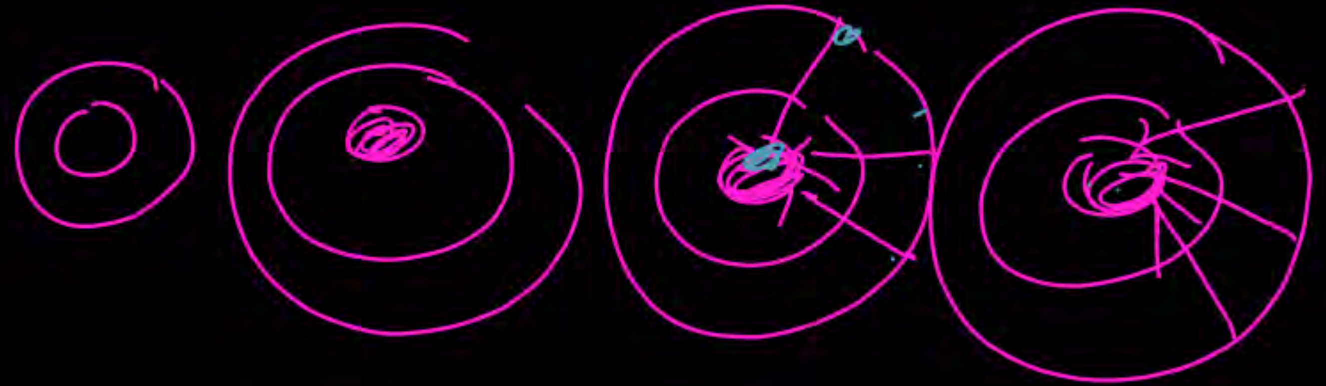
$2s^1$ $2s^2$ $2s^2 2p^1$

$2s^2, 2p^2$ $2s^2, 2p^3$

$2s^2, 2p^4$

Screening effect

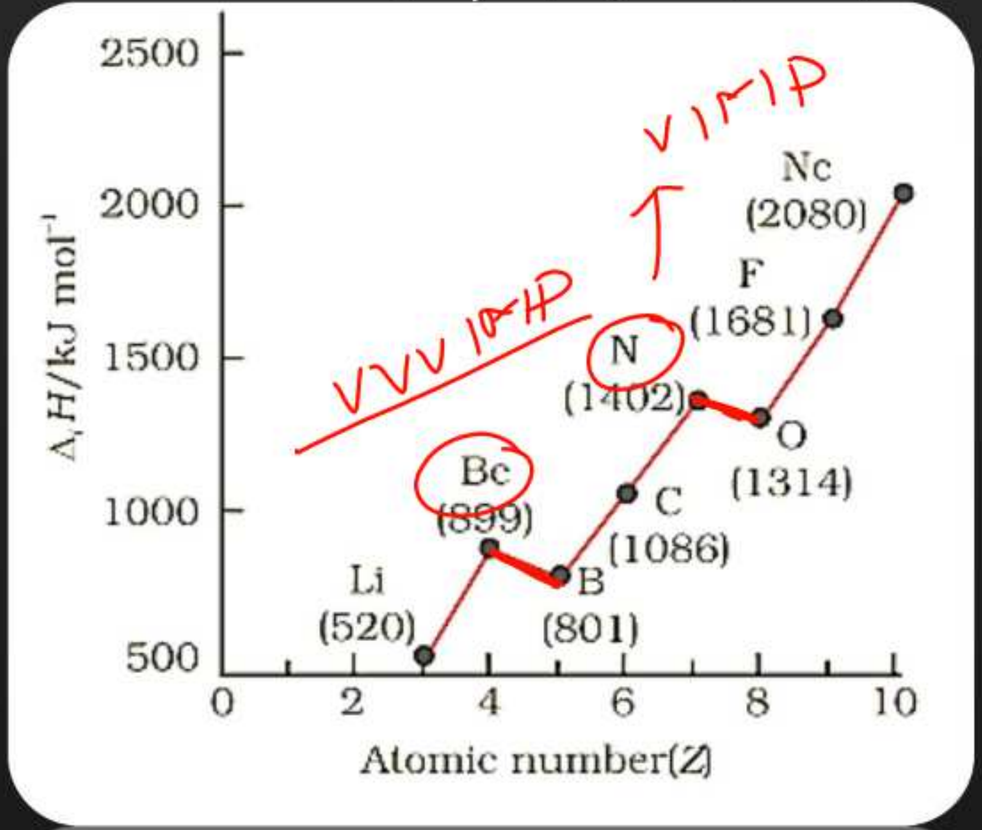
Atomic radius
More
size more.

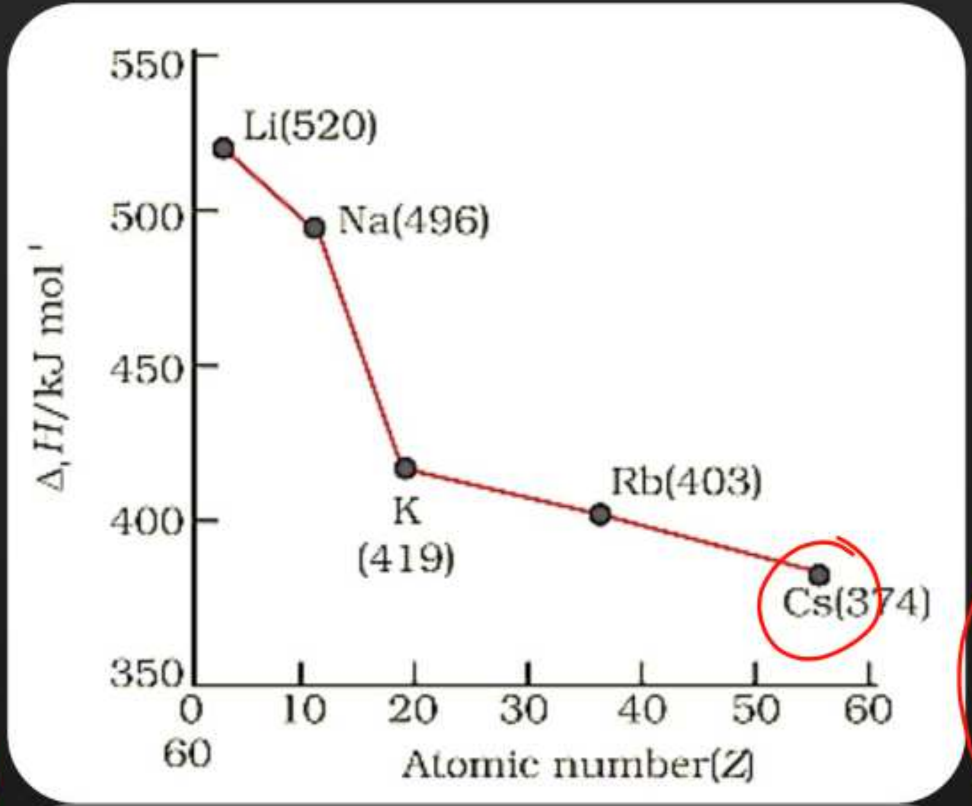


Trends in Physical Properties – ionisation enthalpy

Ne > F > N > O > C > Be > B > Li

Amount of energy required to remove outermost e⊖ from isolated gaseous atom.





$1s^2 2s^2 2p^3$

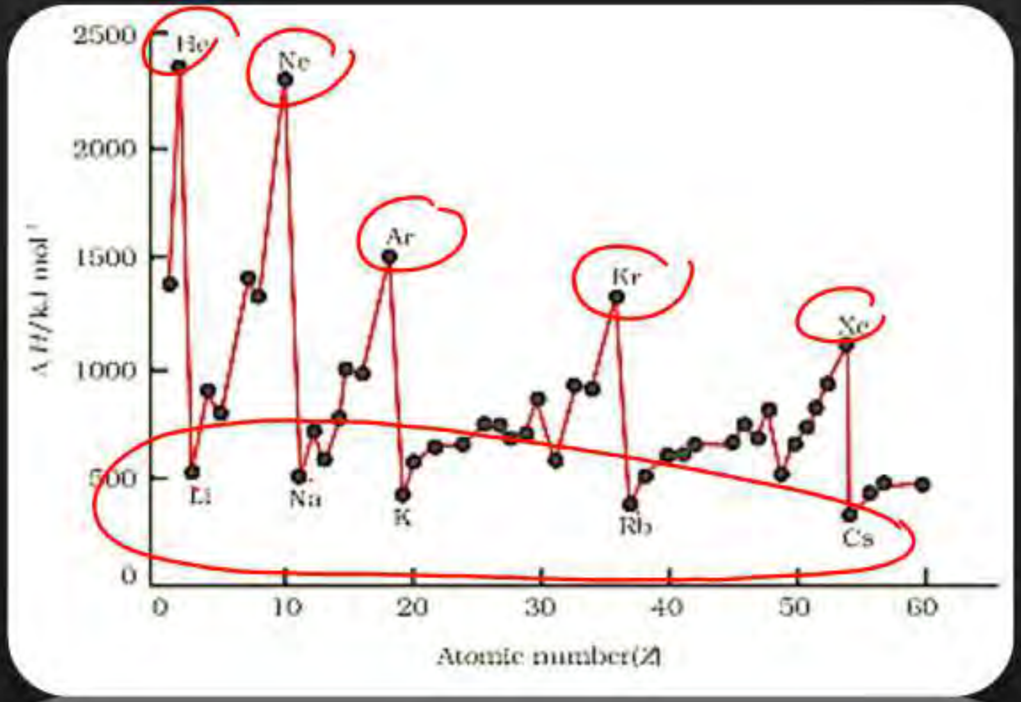
Li Be 5B 6C 7N 8O 9F → $1s^2, 2s^2, 2p^5$

$1s^2, 2s^2$ $1s^2, 2s^1$ $1s^2, 2s^2 2p^1$ $1s^2 2s^2 2p^2$ → $1s^2 2s^2 2p^4$

$1s^2 2s^2$

$1s^2, 2s^2 2p^6$ $3s^1$

Comparison of ionisation enthalpy between group 1 and group 18 elements



1st group	Noble gas
Li	He
Na	Ne
K	Ar
Rb	Kr
	Xe
	Rn

ns^2np^6

$8e^-$

Electron Gain Enthalpy/electron affinity :

When an electron is added to a neutral gaseous atom to convert it into a negative ion, the enthalpy change accompanying the process is defined as the Electron Gain Enthalpy

$F^{\ominus}$ $Cl^{\ominus}$ $Br^{\ominus}$ $I^{\ominus}$

Cl > F > Br > I > At

Group 1	$\Delta_{eg}H$	Group 16	$\Delta_{eg}H$	Group 17	$\Delta_{eg}H$	Group 0	$\Delta_{eg}H$
H	– 73					He	+ 48
Li	– 60	O	– 141	F	– 328	Ne	+ 116
Na	– 53	S	– 200	Cl	– 349	Ar	+ 96
K	– 48	Se	– 195	Br	– 325	Kr	+ 96
Rb	– 47	Te	– 190	I	– 295	Xe	+ 77
Cs	– 46	Po	– 174	At	– 270	Rn	+ 68

S > Se > Te > Po > O

→ attracting bond electrons.

Electronegativity:

Ability of an atom in a chemical compound to attract shared electrons to itself is called electronegativity.

H → F

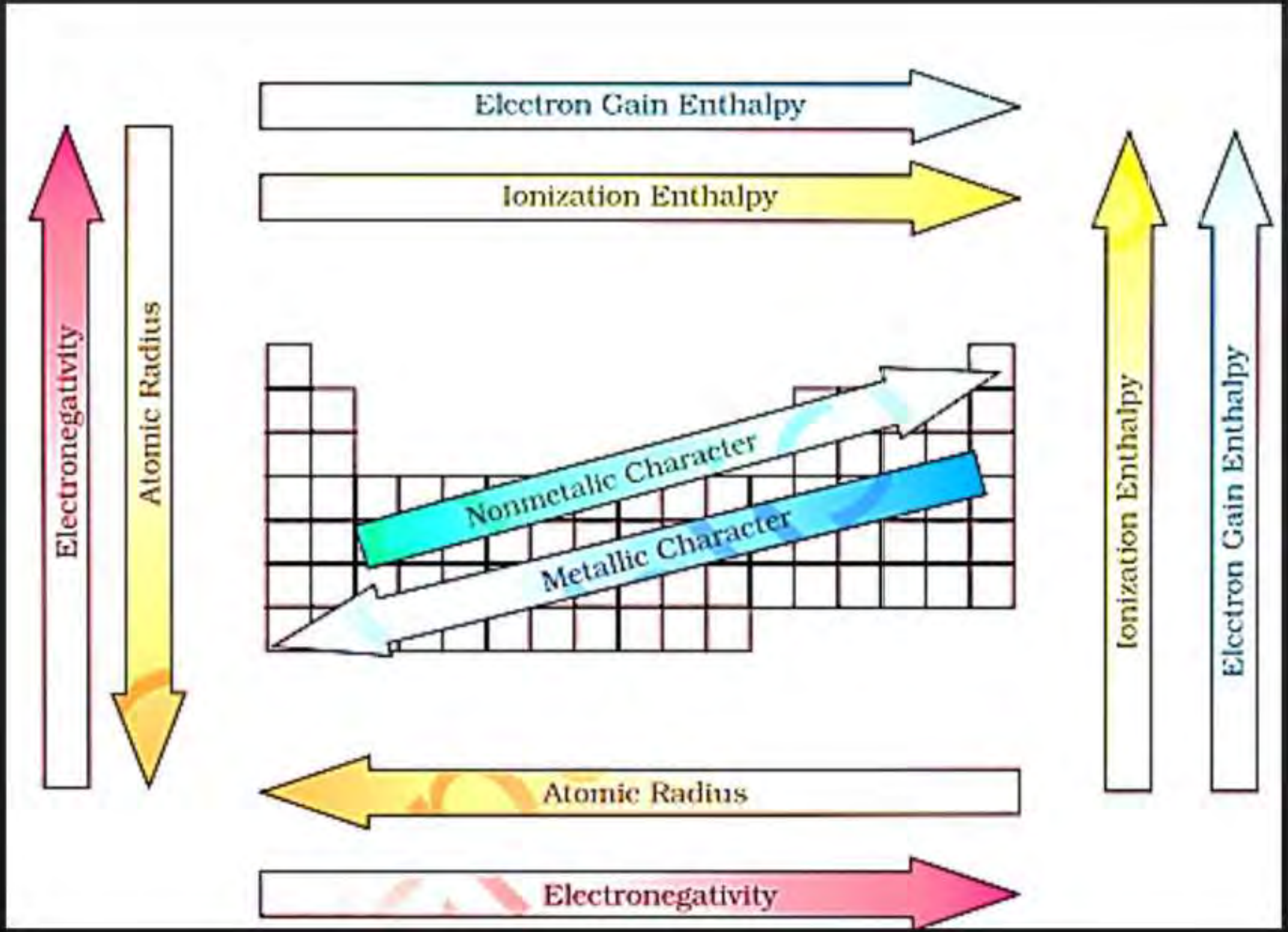
F → 4.0
O → 3.5
N & Cl → 3.0
C & S → 2.5

Table 3.8(a) Electronegativity Values (on Pauling scale) Across the Periods

Atom (Period II)	Li	Be	B	C	N	O	F
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Atom (Period III)	Na	Mg	Al	Si	P	S	Cl
Electronegativity	0.9	1.2	1.5	1.8	2.1	2.5	3.0

Table 3.8(b) Electronegativity Values (on Pauling scale) Down a Family

Atom (Group I)	Electronegativity Value	Atom (Group 17)	Electronegativity Value
Li	1.0	F	4.0
Na	0.9	Cl	3.0
K	0.8	Br	2.8
Rb	0.8	I	2.5
Cs	0.7	At	2.2


Electron Gain Enthalpy
Ionization Enthalpy
Electronegativity
Atomic Radius
Nonmetalic Character
Metallic Character
Ionization Enthalpy
Electron Gain Enthalpy
Atomic Radius
Electronegativity

Periodicity of Valence or Oxidation States:

The valence of representative elements is usually equal to the number of electrons in the outermost orbitals and/or equal to eight minus the number of outermost electrons.

Group	1	2	13	14	15	16	17	18
Number of valence electron	1	2	3	4	5	6	7	8
alence	1	2	3	4	3,5	2,6	1,7	0,8

The oxidation state of an element in a particular compound can be defined as the charge acquired by its atom on the basis of electronegative consideration from other atoms in the molecule.

The oxidation state of an element in a particular compound can be defined as the charge acquired by its atom on the basis of electronegative consideration from other atoms in the molecule.

Group	1	2	13	14	15	16	17
Formula of hydride	LiH NaH KH	CaH_2	B_2H_6 AlH_3	CH_4 SiH_4 GeH_4 SnH_4	NH_3 PH_3 AsH_3	H_2O H_2S H_2Se H_2Te	HF HCl HBr HI
Formula of oxide	Li_2O Na_2O K_2O	MgO CaO SrO BaO	B_2O_3 Al_2O_3 Ga_2O_3 In_2O_3	CO_2 SiO_2 GeO_2 SnO_2 PbO_2	N_2O_3, N_2O_5 P_4O_6, P_4O_{10} As_2O_3, As_2O_5 Sb_2O_3, Sb_2O_5 Bi_2O_3 –	– SO_3 SeO_3 TeO_3 –	– Cl_2O_7 – –

react with both, acids & base.

Amphoteric oxides

BeO
Al_2O_3
ZnO
SnO
PbO
Ag_2O
V_2O_5
Cr_2O_3

Neutral oxides

N_2O
NO
CO

Basic oxides

Na_2O, K_2O
CaO, MgO

Acidic oxides

Cl_2O_7, CO_2, NO_2
NO_3

Anomalous Properties of Second Period Elements:

Due to
small size,
Large[charge/ radius ratio]
high electronegativity of the elements.

Covalency → Restricted → 4 bonds

B	C	N	O
Al	Si	P	S
Ga			
In			

→ $2s^2, 2p^3$

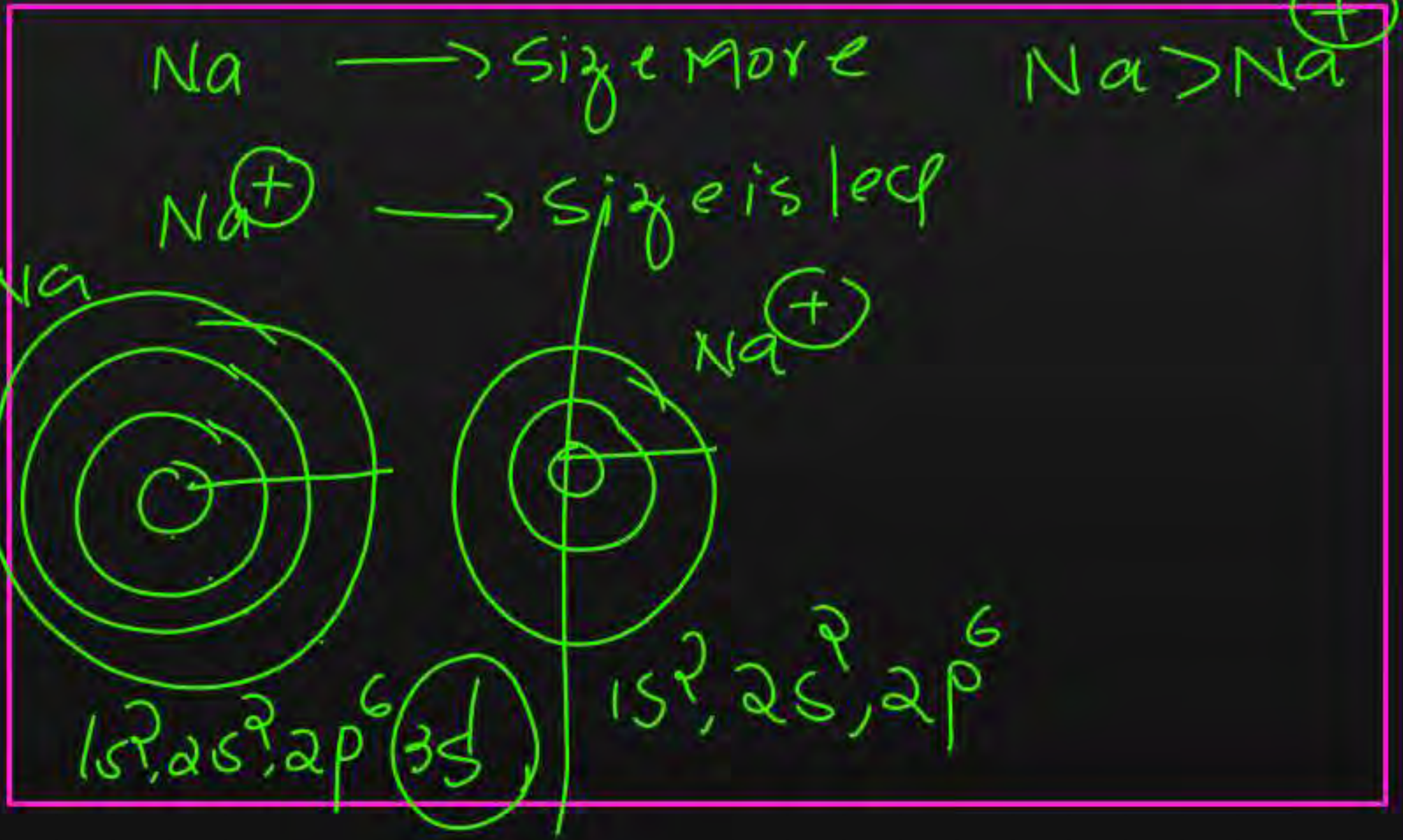
$N^{3-} > O^{2-} > F^{-}$

Diagonal relationship in the periodic properties

Same atomic radius / ionic radius.

Property	Element		
Metallic radius M/pm	**Li** 152	**Be** 111	**B** 88
	Na 186	**Mg** 160	**Al** 143
Ionic radius M^{+}/pm	**Li** 76	**Be** 31	
	Na 102	**Mg** 72	

Behaviour of lithium and beryllium is more similar with magnesium and aluminium, respectively.
This sort of similarity is commonly referred to as diagonal relationship in the periodic properties



Periodic Trends and Chemical Reactivity

The normal oxide formed by the element on extreme left is the most basic (e.g., Na_2O), whereas that formed by the element on extreme right is the most acidic (e.g., Cl_2O_7).

Oxides of elements in the center are amphoteric (e.g., Al_2O_3, As_2O_3) or neutral (e.g., CO, NO, N2O).

Amphoteric oxides behave as acidic with bases and as basic with acids, whereas neutral oxides have no acidic or basic properties

Show by a chemical reaction with water that Na_2O is a basic oxide and Cl_2O_7 is an acidic oxide.

Solution

Na_2O with water forms a strong base whereas Cl_2O_7 forms strong acid.

$Na_2O + H_2O \rightarrow 2NaOH$

$Cl_2O_7 + H_2O \rightarrow 2HClO_4$

Their basic or acidic nature can be qualitatively tested with litmus paper.

Question

Consider the isoelectronic species, Na^{+}, Mg^{2+}, F^{-} and O^{2-}. The correct order of increasing length of their radii is

(A) $F^{-} < O^{2-} < Mg^{2+} < Na^{+}$

(B) $Mg^{2+} < Na^{+} < F^{-} < O^{2-}$

(C) $O^{2-} < F^{-} < Na^{+} < Mg^{2+}$

(D) $O^{2-} < F^{-} < Mg^{2+} < Na^{+}$

Question

Which of the following is not an actinoid?

f block

A. Curium (Z = 96)

B. Californium (Z = 98)

C. Uranium (Z = 92)

D. Terbium (Z = 65)

Question

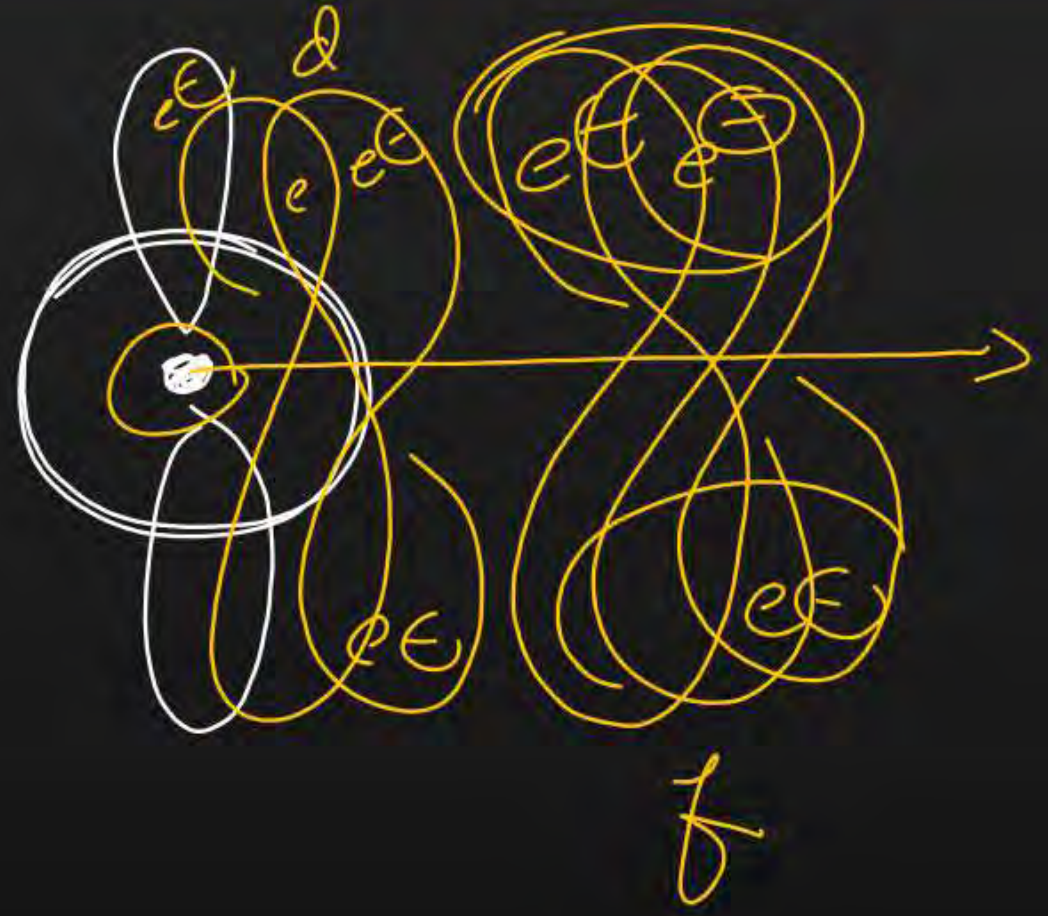
The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is

(A) $s > p > d > f$

(B) $f > d > p > s$

(C) $p < d < s < f$

(D) $f > p > s > d$



Question

The first ionization enthalpies of Na, Mg, Al and Si are in the order

(A) $Na < Mg > Al < Si$

(B) $Na > Mg > Al > Si$

(C) $Na < Mg < Al < Si$

(D) $Na > Mg > Al < Si$

Question

The electronic configuration of gadolinium (Atomic number 64) is

(A) [Xe] $4f^3\ 5d^5\ 6s^2$

(B) [Xe] $4f^7\ 5d^2\ 6s^1$

(C) [Xe] $4f^7\ 5d^1\ 6s^2$

(D) [Xe] $4f^8\ 5d^6\ 6s^2$

f block

f block

$5d^1$ $4f^7$

Question

The statement that is not correct for periodic classification of elements is

(A) The properties of elements are periodic function of their atomic numbers.

(B) Non-metallic elements are less in number than metallic elements.

(C) For transition elements, the 3d-orbitals are filled with electrons after 3p-orbitals and before 4s-orbitals.

(D) The first ionization enthalpies of elements generally increase with increase in atomic number as we go along a period.

Question

Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is

(A) F > Cl > Br > I

(B) F < Cl < Br < I

Cl > F > Br > I or

(C) F < Cl > Br > I

(D) F < Cl < Br > I

Cl > F > Br > I

Question

The period number in the long form of the periodic table is equal to

(A) magnetic quantum number of any element of the period.

(B) atomic number of any element of the period.

(C) maximum principal quantum number of any element of the period.

(D) maximum Azimuthal quantum number of any element of the period.

Question

The elements in which electrons are progressively filled in 4f-orbital are called

A. actinoids.

B. transition elements.

C. lanthanoids.

D. halogens.

Question

Which of the following is the correct order of size of the given species?

A. $I > I > I^+$

B. $I^+ > I^- > I$

C. $i > i^+ > i^-$

D. $i^- > i > i^+$

Question

The formation of the oxide ion, $O^{2-}(g)$, from oxygen atom requires first an exothermic and then an endothermic step as shown below:

$O(g) + e^{-} \rightarrow O^{-}(g), \Delta H = -141 \text{ kJ mol}^{-1}$

$O^{-}(g) + e^{-} \rightarrow O^{2}(g), \Delta H = +780 \text{ kJ mol}^{-1}$

Thus process of formation of O^{2-} ion in gas phase is unfavourable even though O^{2-} is isoelectronic with neon. It is due to the fact that

A. Oxygen is more electronegative.

B. Addition of electron in oxygen results in larger size of the ion.

C. Electron repulsion outweighs the stability gained by achieving noble gas configuration.

D. O^- ion has comparatively smaller size than oxygen atom.

Comprehension given below is followed by some multiple choice questions. Each question has one correct option.

In the modem periodic table, elements are arranged in order of increasing atomic numbers which is related to the electronic configuration. Depending upon the type of orbitals receiving the last electron, the elements in the periodic table have been divided into four blocks, viz, s,p, d and f The modem periodic table consists of 7 periods and 18 groups. Each period begins with the filling of a new energy shell. In accordance with the Aufbau principle, the seven periods (1 to 7) have 2, 8, 18, 18, 32 and 32 elements respectively. The seventh period is still incomplete. To avoid the periodic table being too long, the two series of f-block elements, called lanthanoids and actinoids, are placed at the bottom of the main body of the periodic table.

Question

The element with atomic number 57 belongs to

A. s-block

B. p-block

C. d-block

D. f-block

Question

The last element of the p-block in 6^{th} period is represented by the outermost electronic configuration.

(A) $7s^2\ 7p^6$

(B) $5f^{14}\ 6d^{10}\ 7s^2\ 7p^0$

(C) $4f^{14}\ 5di^0\ 6s^2\ 6$

(D) $4f^{14}\ 5di^0\ 6s^2\ 6p^4$

Question

Which of the elements whose atomic numbers are given below, cannot be accommodated in the present set up of the long form of the periodic table?

A 107

B 118

C 126

D 102

Question

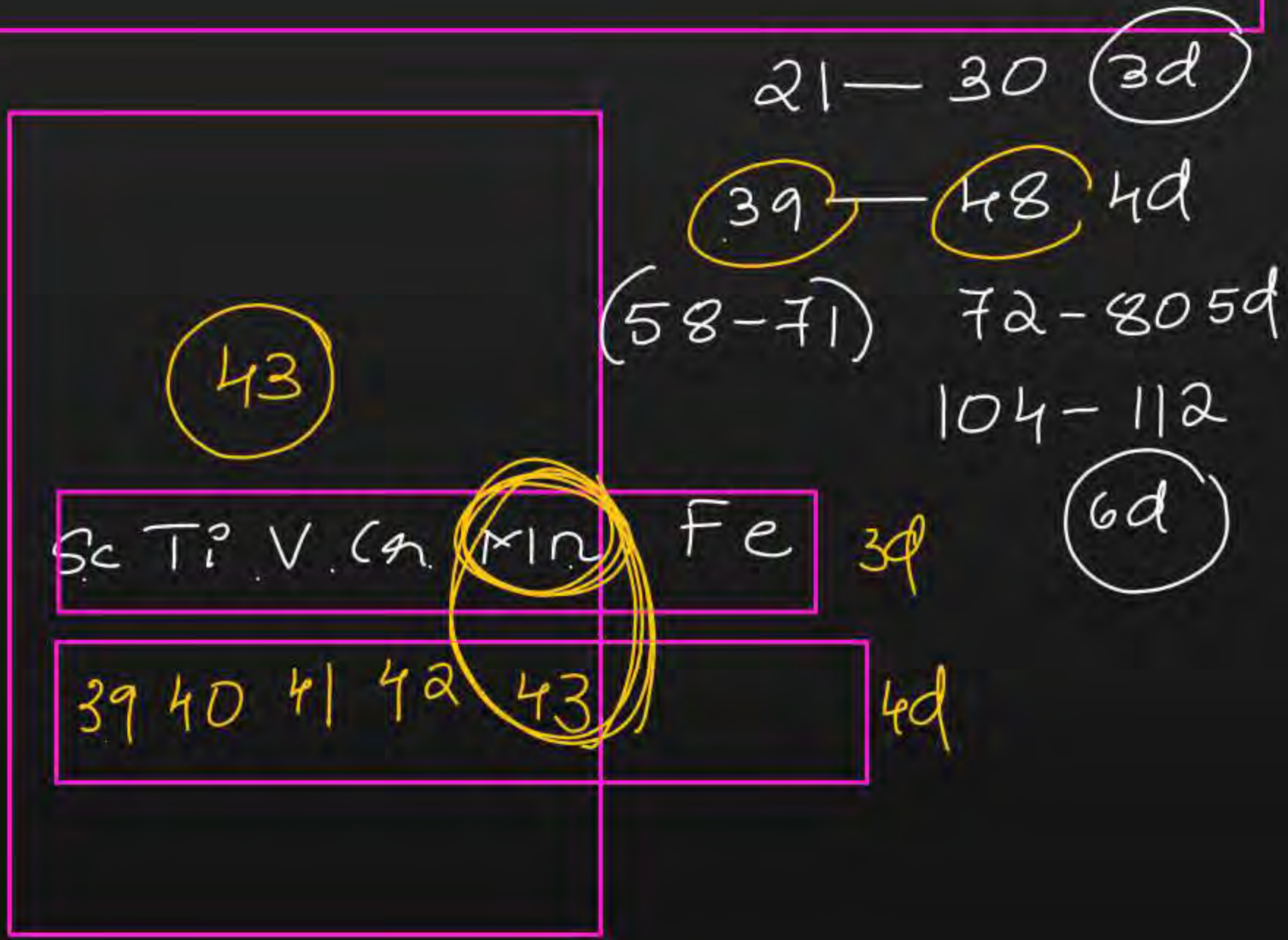
The electronic configuration of the element which is just above the element with atomic number 43 in the same group is______.

(A) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^2$

(B) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^3\,4p^6$

(C) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^5\,4s^2$

(D) $1s^2\,2s^2\,2p^6\,3s^2\,3p^6\,3d^7\,4s^2$



5 → 2 elemen.

s block (19, 20) — 3d → 21 —— 30 — (31 —— 36) → p

(49, 50, 51, 52, 53, 54) → p block

s block (37, 38) — 4d → (39 —— 48)

s block (55, 56) — 5d → La 57 — (Ce — Lu, 58 — 71) — (72 – 80)

(81, 82, 83, 84, 85, 86) p block

lanthanoids → 4f block

s block (87, 88) — 6d — Ac 89 — (Th – Lr, 90 – 103) → 5f block

6d block (104 – 112)

6 elements (113, 114, 115, 116, 117, 118) p block

Question

The element with atomic number 35, 53 and 85 are all____.

(A) noble gases

(B) halogens

(C) heavy metals

(D) light metals

Question

Electronic configurations of four elements A, B, C and D are given below:

$1s^2\ 2s^2\ 2p^6$

$1s^2\ 2s^2\ 2p^4$

$1s^2\ 2s^2\ 2p^6\ 3s^1$

$1s^2\ 2s^2\ 2p^5$

Question

Which of the following is the correct order of increasing tendency to gain electron?

(A) A < C < B < D

(B) A < B < C < D

(C) D < B < C < A

(D) D < A < B < C

Refer previous slide.

Question

Which of the following elements can show covalency greater than 4?

A. Be

B. P

C. S

D. B

Question

Those elements impart colour to the flame on heating in it, the atoms of which require low energy for the ionization (i.e., absorb energy in the visible region of spectrum). The elements of which of the following groups will impart colour to the flame?

(A) 2

(B) 13

(C) 1

(D) 17

Question

Which of the following sequences contain atomic numbers of only representative elements?

(A) 3, 33, 53, 87

(B) 2, 10, 22, 36

(C) 7, 17, 25, 37, 48

(D) 9, 35, 51, 88

Question

Which of the following elements will gain one electron more readily in comparison to other elements of their group?

(A) S(g)

(B) Na(g)

(C) O(g)

(D) Cl(g)

O F
S Cl

Question

Which of the following statements are correct?

A. Helium has the highest first ionization enthalpy in the periodic table.

B. Chlorine has less negative electron gain enthalpy than fluorine.

C. Mercury and bromine are liquids at room temperature.

D. In any period, atomic radius of alkali metal is the highest.

Question

Which of the following sets contain only isoelectronic ions?

A. Zn^{2+}, Ca^{2+}, Ga^{3+}, Al^{3+}

B. K^{+}, Ca^{2+}, Sc^{3+}, Cl^{-}

C. P^{3-}, S^{2-}, Cl^{-}, K^{+}

D. Ti^{4+}, Ar, Cl^{3+}, V^{5+}

Question

In which of the following options order of arrangement does not agree with the variation of property indicated against it?

(A) $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$ (increasing ionic size)

(B) B < C < N < O (increasing first ionization enthalpy)

(C) I < Br < Cl < F (increasing electron gain enthalpy)

(D) Li < Na < K < Rb (increasing metallic radius)

Question

Which of the following have no unit?

A Electronegativity

B Electron gain enthalpy

C Ionisation enthalpy

D Metallic character

Question

Ionic radii vary in

(A) inverse proportion to the effective nuclear charge.

(B) inverse proportion to the square of effective nuclear charge.

(C) direct proportion to the screening effect.

(D) direct proportion to the square of screening effect.

Question

An element belongs to 3^{rd} period and group-13 of the periodic table. Which of the following properties will be shown by the element?

A. Good conductor of electricity

B. Liquid, metallic

C. Solid, metallic

D. Solid, non metallic

Question

The correct order of first ionisation enthalpy of given elements is [2023]

(A) Li < B < Be < C

(B) Be < Li < B < C

(C) C < B < Be < Li

(D) Li < Be < B < C ✗

Li, Be, B, C, N, O

Li < B < Be < C

Question

A pair of amphoteric oxides is [2023]

(A) Al_2O_3, Li_2O

(B) BeO, BO_3

(C) BeO, MgO

(D) BeO, ZnO

Question

The property of halogens which is not correctly matched is [2022]

(A) F > Cl > Br > I (Electronegativity)

(B) I > Br > Cl > F (Density)

(C) F > Cl > Br > I (Electron gain enthalpy)

(D) F > Cl > Br > I (Ionisation enthalpy)

Question

Elements X, Y and Z have atomic numbers 19, 37 and 55 respectively. Which of the following statements is true about them? [2022]

(A) Y would have an ionisation potential between those of X and Z.

(B) Z would have the highest ionisation potential.

(C) Y would have the highest ionisation potential.

(D) Their ionisation potential would increase with increasing atomic number.

Question

Amphoteric oxide among the following [2022]

(A) CO_2

(B) Ag_2, O

(C) SnO_2

(D) BeO

Question

The third ionisation enthalpy is highest in [2021]

(A) alkali metals

(B) alkaline earth metals

(C) chalcogens

(D) pnictogens

Question

Which of the following is the correct order of radius? [2018]

A. $H^- > H > H^+$

B. $Na^+ > F^- > O^{2-}$

C. $F^- > O^{2-} > Na^+$

D. $Al^{3+} > Mg^{2+} > N^{3-}$

Question

The electronegativities of C, N, Si and P are in the order of [2017]

(A) $P < Si < C < N$

(B) $Si < P < C < N$

(C) $P < Si < N < C$

(D) $Si < P < N < C$

Question

Which of the following metallic oxide exhibit amphoteric nature? [2017]

A. CaO

B. Al_2O_3

C. Na_2O

D. BaO

Question

HCl gas is covalent and NaCl is an ionic compound. This is because [2016]

(A) sodium is highly electropositive

(B) hydrogen is a non-metal

(C) HCl is a gas

(D) electronegativity difference between H and Cl is less than 2.1

Question

For one of the element various successive ionisation enthalpies (in kJ mol^{-1}) are given below.

IE	1st	2nd	3rd	4th	5th
	577.5	1810	2750	11,580	14,820

The element is [2015]

(A) Si

(B) P

(C) Al

(D) Mg

Question

For the properties mentioned, the correct trend for the different species is in

[2014]

(A) strength as Lewis acid – $BCl_3 > AlCl_3 > GaCl_3$

(B) inert pair effect – Al > Ga > In

(C) oxidising property – $Al^{3+} > In^{3+} > Tl^{3+}$

(D) first ionisation enthalpy – B > Al > Tl

Question

The correct arrangement for the ions in the increasing order of their radii is

[2014]

(A) Na^+, Cl^-, Ca^{2+}

(B) Ca^{2+}, K^+, S^{2-}

(C) Na^+, Al^{3+}, Be^{2+}

(D) Cl^-, F^-, S^{2-}

Question

Among the elements from atomic number 1 to 36, the number of elements which have an unpaired electron in their s-subshell is [2014]

(A) 2

(B) 7

(C) 6

(D) 9

Question

Which one of the following sets of ions represents the collection of isoelectronic species? [2013]

(A) $K^+, Cl^-, Mg^{2+}, Sc^{3+}$

(B) $Na^+, Ca^{2+}, Sc^{3+}, F^-$

(C) $K^+, Ca^{2+}, Sc^{3+}, Cl^-$

(D) $Na^+, Mg^{2+}, A^{3+}, Cl^-$

Question

The correct order of ionisation energy of C, N, O and F is [2012]

(A) C < N < O < F

(B) C < O < N < F

(C) F < O < N < C

(D) F < N < C < O

Question

Generally, the first ionisation energy increases along a period. But there are some exceptions. The one which is not an exception is [2011]

A. Be and B

B. Na and Mg

C. Mg and Al

D. N and O

Question

In the following, the element with the highest ionisation energy is : [2006]

(A) [Ne] $3s^2\,3p^1$

(B) [Ne] $3s^2\,3p^3$

(C) [Ne] $3s^2\,3p^2$

(D) [Ne] $3s^2\,3p^4$

Thank

You