GOVERNMENT OF KARNATAKA
DEPARTMENT OF SCHOOL EDUCATION (PRE-UNIVERSITY)
18TH CROSS, MALLESHWARAM, BENGALURU – 560 012
CHAPTERWISE MULTIPLE CHOICE QUESTIONS FOR COMPETATIVE EXAM
SUBJECT: I PUC CHEMISTRY
NAME OF THE CHAPTER: UNIT: 03-Classification of Elements and Periodicity in Properties

GENESIS OF PERIODIC TABLE

Dobereiner triads:

He classified elements into group of three called triad. In the triads of elements, the atomic weight of the middle element was the arithmetic mean of the other two.

Eg: 1) Li, Na, K 2) Ca, Ba, Sr 3) Cl, Br, I

Newland's law of octaves:

He arranged the elements in increasing order of their atomic weights and noted that every eighth element had properties similar to the first element.

Limitation: Worked only up to Calcium.

Mendeleev's periodic table:

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.

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

Left gaps for undiscovered elements - Both gallium and germanium were unknown at the time Mendeleev published his Periodic Table. He left the gap under aluminium and a gap under silicon, and called these elements Eka Aluminium and Eka-Silicon.

Modern Periodic Law:

Properties of elements are the periodic function to their atomic numbers. In the modern periodic table, the elements are arranged in rows and columns. These rows and columns are known as periods and groups respectively. The table consists of 7 periods and 18 groups

NOMENCLATURE OF ELEMENTS WITH ATOMIC NUMBERS > 100

Notation for IUPAC Nomenclature of Eleme

Digit	Name	Digit	Name	
0	nil (n)	5	pent (p)	The name ends with **– ium**
1	un (u)	6	hex (h)	
2	bi (bi)	7	sept (s)	
3	tri (t)	8	oct (o)	

4	quad (q)	9	enn (e)	

Elements:	**Valence Shell Electronic Configuration**	**Nature**	**Position in Modern Periodic Table**
s-block	ns^{1-2}	Metals	1 and 2 group elements
p – block	ns^2np^{1-6}	Metalloids & nonmetals but some of them are metals also.	Groups 13 to 18
d-Block	(n-1) d^{1-10} ns^{1-2}	Metals	3 to 12 groups
f-Block	(n-2) f^{1-14}(n-1) $d^{0-1}ns^2$	Metals Radioactive metals	4fseries– Lanthanoids 5f series– Actinoids

Periodicity in Atomic Properties:

1. Atomic Radius:

Within a given period, atomic radius **decreases from left to right**. This is due to the effect of increase in nuclear charge while the electrons are being added to the same shell.

Within a given group atomic radius increases down the group. This is due to the increase in number of shells.

Isoelectronic ions: Species containing same number of electrons.

For example, O^{2-}, F^-, Na^+ and Mg^{2+} have the same number of electrons (10).

➢ The cation with the greater positive charge will have a smaller radius because of the greater attraction of the electrons to the nucleus.

➢ Anion with the greater negative charge will have the larger radius.

2) Ionisation potential or Ionisation Energy: A quantitative measure of the tendency of an element to lose electron is given by its Ionization Enthalpy. It represents the energy required to remove an electron from an isolated gaseous atom in its ground state

Ionization energy increases along the period while decreases down the group.

Factors which influence I.E.

Atomic size: the larger the size of the atom, the smaller the I.E.

Effective nuclear charge: The greater the effective charge on the nucleus of an atom, greater energy will be required to remove the electron.

Penetration effect of orbitals: The order of energy required to remove electron from s,p,d-and-orbitals of a shell is s>p>d>f.

Shielding or screening effect: Screening effect results in decrease of force of attraction between the nucleus and the outermost electron and lesser energy is required to separate the electron. Thus, the value of I.P. decreases.

Stability of half-filled and fully-filled orbitals: According to Hund's rule the stability of half-filled or completely filled degenerate orbitals is comparatively high. So comparatively more energy is required to separate the electron from such atoms.

EXCEPTIONS: a) IE of N > IE of O b) IE of Be > IE of B

3) Electron Gain Enthalpy: When an electron is added to a neutral gaseous atom (X) to convert it into a negative ion, the enthalpy change accompanying the process is defined as the Electron Gain Enthalpy ($\Delta_{eg}H$).

EXCEPTIONS: EGE of O/F is less than EGE of S/Cl

Electron affinity increases along the period while decreases down the group

Chlorine has the highest value for electron gain enthalpy.

4) Electronegativity: A qualitative measure of the ability of an atom in a chemical compound to attract shared electrons to itself is called electronegativity. Unlike ionization enthalpy and electron gain enthalpy, it is not a measurable quantity.

Electronegativity of elements increases along the period while decreases down the group.

Fluorine is the most electronegative element in the periodic table.

5) Metallic Character of an Element

Non-metallic elements have strong tendency to gain electrons.

Non-metallic character is directly related to electronegativity and metallic character is inversely related to electronegativity.

Across a period, electronegativity increases. Hence, non-metallic character increases (and metallic character decreases).

Down a group, electronegativity decreases. Hence, non-metallic character decreases (and metallic character increases).

Property	**Along the period**	**Down the group**
Atomic size	Decreases	Increases
Ionisation energy	Increases	Decreases
Electron gain enthalpy	Increases	Decreases
Electronegativity	Increases	Decreases
Effective nuclear charge	Increases	Decreases
Metallic property	Decreases	Increases
Non-metallic property	Increases	Decreases

Periodic Trends in Chemical Properties

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. Nowadays the term oxidation state is frequently used for valence.

Anomalous Properties of Second Period Elements

The first element of each of the groups 1 (lithium) and 2 (beryllium) and groups 13-17 (boron to fluorine) differs in many respects from the other members of their respective group. For example, lithium unlike other alkali metals, and beryllium unlike other alkaline earth metals, form compounds with pronounced covalent character; the other members of these groups predominantly form ionic compounds. In fact the behaviour of

lithium and beryllium is more similar with the second element of the following group i.e., magnesium and aluminium, respectively. This sort of similarity is commonly referred to as diagonal relationship in the periodic properties.

The anomalous behaviour is attributed to their small size, large charge/ radius ratio and high electronegativity of the elements.

In addition, the first member of group has only four valence orbitals (2s and 2p) available for bonding, whereas the second member of the groups have nine valence orbitals (3s, 3p, 3d). As a consequence of this, the maximum covalency of the first member of each group is 4, whereas the other members of the groups can expand their valence shell to accommodate more than four pairs of electrons.

Furthermore, the first member of p-block elements displays greater ability to form pπ – pπ multiple bonds to itself (e.g., C = C, C ≡ C, N = N, N ≡ N) and to other second period elements (e.g., C = O, C = N, C ≡ N, N = O) compared to subsequent members of the same group.

Periodic Trends and Chemical Reactivity

The maximum chemical reactivity at the extreme left (among alkali metals) is exhibited by the loss of an electron leading to the formation of a cation and at the extreme right (among halogens) shown by the gain of an electron forming an anion.

The chemical reactivity of an element can be best shown by its reactions with oxygen and halogens. Elements on two extremes of a period easily combine with oxygen to form oxides. 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 centre are amphoteric (e.g., Al_2O_3 , As_2O_3) or neutral (e.g., CO, NO, N_2O). Amphoteric oxides behave as acidic with bases and as basic with acids, whereas neutral oxides have no acidic or basic properties.

Concept 1: Need for Classification, Genesis of Periodic Classification and Nomenclature of elements with Z > 100

1. Which pair is an example of Dobereiner's triad?
   (a) Li, Na, K (b) H, He, Li
   (c) Na, Mg, Al (d) Cl, Ar, K
2. The major limitation of Newlands' law was that it worked well only up to:
   (a) Hydrogen (b) Calcium
   (c) Iron (d) Copper
3. Mendeleev left gaps in his periodic table to:
   (a) Reduce size of table (b) Adjust isotopes
   (c) Accommodate undiscovered elements (d) Avoid noble gases
4. The modern periodic table contains how many groups?
   (a) 7 (b) 8
   (c) 16 (d) 18

5. The atomic number of the element unnilennium is

(a) 119 (b) 108

(c) 102 (d) 109

6. Eka-aluminium predicted by Mendeleev was later discovered as:

(a) Germanium (b) Gallium

(c) Scandium (d) Indium

7. Given below and the atomic masses of the elements:

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

Which of the following doesn't form triad? CET 2025

(a) Ba, Sr, Ca (b) Cl, Br, I

(c) Cl, K, Ca (d) Li, Na, K

8. The IUPAC symbol for the element with atomic number 119 would be

(a) Une (b) Uun

(c) Uue (d) Unh

9. Consider the two statements and choose the correct answer

Statement I: Periodicity in properties arises due to repetition of valence shell electronic configuration.

Statement II: Therefore, atomic number is more fundamental than atomic mass for classification.

(a) Statement I is correct but Statement II is incorrect

(b) Both Statement I and Statement II are correct

(c) Statement I is incorrect but Statement II is correct

(d) Both Statement I and Statement II are incorrect

Concept 2: Electronic configurations of elements and the periodic table

10. A metalloid is CET 2024

(a) Bi (b) Sb

(c) P (d) Se

11. Match List I with List II CET 2026

List - I (Element-Atomic number)	**List - II (Position in periodic table)**
(a) Ra - 88	(i) 4th period, 13th group
(b) Ga - 31	(ii) 6th period, 6th group
(c) W - 74	(iii) 5th period, 10th group
(d) Pd - 46	(iv) 7th period, 2nd group

Choose the correct answer from the options given below.

(a) a – iv, b – i, c – ii, d – iii (b) a– i, b - ii, c - iii, d – iv

(c) a – iv, b – ii, c – iii, d – i (d) a – iii, b – iv, c – i, d – ii

12. An element with atomic number 21 is

(a) transition metal (b halogen

(c) representative element (d) alkali metal

13. An element having atomic number 120 is

(a) transition metal (b inner transition metal

(c) alkaline earth metal (d) alkali metal

14. The element Z = 114 has been discovered recently. It will belong to which of the following family /group and its electronic configuration NEET 2017

(a) Halogen family, $[Rn]5f^{14}\ 6d^{10}\ 7s^2\ 7p^5$ (b) Nitrogen family, $[Rn]5f^{14}6d^{10}7s^2 7p^6$

(c) Oxygen family, $[Rn]5f^{14}6d^{10}7s^2 7p^4$ (d) Carbon family, $[Rn]5f^{14}\ 6d^{10}\ 7s^2\ 7p^2$

15. The elements in which electrons are progressively filled in 4f orbitals are called CET 2019

(a) lanthanoids (b) halogens

(c) actinoids (d) transition elements

16. The electronic configuration of an element is $1s^2\ 2s^2\ 2p^6\ 3s^2 3p^3$. What is the atomic number of the element, which is present just below the above element in the periodic table?

(a) 33 (b) 34

(c) 36 (d) 39

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

(a) $5f^{14}\ 6d^{10}\ 7s^2\ 7p^6$ (b) $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$

(c) $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$ (d) $7s^2\ 7p^6$ CET 2020

Concept 3: Periodic trends in properties of elements – Atomic radius & Ionic radius

18. Which of the following orders of ionic radii is correctly represented? CET 2018

(a) $H^- > H > H^+$ (b) $Na^+ > F^- > O^{2-}$

(c) $F^- > O^{2-} > Na^+$ (d) $Al^{3+} > Mg^{2+} > N^{3-}$

19. The correct arrangement for the ions in the increasing order of their radii is CET 2014

(a) Na^+, Cl^-, Ca^{2+} (b) Ca^{2+}, K^+, S^{2-}

(c) Ca^{2+}, K^+, S^{2-} (d) Cl^-, F^-, S^{2-}

20. Identify the wrong statement in the following

(a) Amongst isoelectronic species, smaller the positive charge on the cation, smaller is the ionic radius.

(b) Amongst isoelectronic species, greater the negative charge on the anion, larger is the ionic radius.

(c) Atomic radius of the elements increases as one move down the first group of the periodic table.

(d) Atomic radius of the elements decreases as one move across from left to right in the second period of the periodic table.

21. Ionic radii are

(a) Inversely proportional to effective nuclear charge

(b) Inversely proportional to square of the effective nuclear charge

(c) Directly proportional to effective nuclear charge

(d) Directly proportional to square of the effective nuclear charge

22. The ions O^{-2}, F^{-1}, Na^{+1}, Mg^{+2} and Al^{+3} are isoelectronic. Their ionic radii show

(a) an increase from O^{-2} to F^{-1} and then decrease from Na^{+1} to Al^{+3}

(b) a decrease from O^{-2} to F^{-1} and then increase from Na^{+1} to Al^{+3} +

(c) a significant increase from O^{-2} to Al^{+3}

(d) a significant decrease from O^{-2} to Al^{+3}

23. Which one of the following ions will be smallest in size?

(a) Na^{+} (b) Mg^{2+}

(c) F^{-} (d) O^{2-}

24. In the isoelectronic species the ionic radii (A^0) of N^{3-}, O^{2-} and F^{-} are respectively given by

(a) 1.71, 1.40, 1.36 (b) 1.71, 1.36, 1.40

(c) 1.36, 1.40, 1.71 (d) 1.36, 1.71, 1.40

25. From the following pairs of ions which one is not an iso-electronic pair?

(a) O^{2-}, F^{-} (b) Na^{+}, Mg^{2+}

(c) Mn^{2+}, Fe^{3+} (d) Fe^{2+}, Mn^{2+}

Concept 4: Periodic trends in properties of elements - Ionisation enthalpy

26. The first ionisation enthalpy of the following elements is in the order CET 2017, CET 2019

(a) Si < P < C < N (b) P < Si < N < C

(c) P < Si < C < N (d) C < N < Si < P

27. Which of the following electronic configuration of an element has the lowest ionisation enthalpy?

(a) $1s^2\ 2s^2\ 2p^5$ (b) $1s^2\ 2s^2\ 2p^3$

(c) $1s^2\ 2s^2\ 2p^6\ 3s^1$ (d) $1s^2\ 2s^2\ 2p^6$

28. The correct order of ionisation energy of C, N, O, F is CET 2009, CET 2012

(a) F < O < N < C (b) F < N < C < O

(c) C < N < O < F (d) C < O < N < F

29. Generally, the first ionisation energy increases along the period. But there are some exceptions. One of which is not an exception is CET 2010, CET 2011

(a) N and O (b) Na and Mg

(c) Mg and Al (d) Be and B

30. Amongst the elements with following electronic configurations, which one may have the highest ionisation energy

(a) [Ne] $3s^2\ 3p^3$ (b) [Ar] $3d^{10}\ 4s^2\ 4p^3$

(c) [Ne] $3s^2\ 3p^2$ (d) [Ne] $3s^2\ 3p^1$

31. Which electronic configuration of an element has abnormally high difference between second and third ionisation energy?

(a) $1s^2\ 2s^2\ 2p^6\ 3s^1$ (b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

(c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ (d) $1s^2\ 2s^2\ 2p^6\ 3s^2$

32. For one of the element various successive ionization enthalpies ($kJmol^{-1}$) are given below.

I.E in $kJmol^{-1}$	1^{st}	2^{nd}	3^{rd}	4^{th}	5^{th}
	577.5	1810	2750	11580	14820

The element is CET 2015

(a) Al (b) Si

(c) Mg (d) P

33. For the second period elements the correct increasing order of first ionization enthalpy is

(a) Li < Be < B < C < N < O < F < Ne (b) Li < B < Be < C < O < N < F < Ne

(c) Li < B < Be < C < N < O < F < Ne (d) Li < Be < B < C < O < N < F < Ne

34. The five successive ionization enthalpies of an element are 800, 2427, 3658, 25024 and 328221 $kJmol^{-1}$. The number of valence electrons in the element is

(a) 2 (b) 3

(c) 4 (d) 5

35. The 3^{rd} ionization enthalpy is highest in

(a) Alkali metals (b) alkaline earth metals

(c) Chalcogen (d) Pnictogens

36. The correct order in which the first ionization potential increases is

(a) K, Be, Na (b) Be, Na, K

(c) Na, K, Be (d) K, Na, Be

37. The correct order of first ionisation enthalpy of given elements is CET 2023

(a) C < B < Be < Li (b) Li < Be < B < C

(c) Li < B < Be < C (d) Be < Li < B < C

Concept 5: Periodic trends in properties of elements - Electron gain enthalpy

38. Which of the following represents the correct order of increasing electron gain enthalpy with negative sign for the elements O, S, F and Cl?

(a) Cl < F < O < S (b) F < S < O < Cl

(c) O < S < F < Cl (d) S < O < Cl < F

39. Within each pair of element F and Cl, S and Se and Li and Na, respectively, the elements that release more energy upon electron gain are

(a) Cl, S & Li (b) F, Se & Na

(c) Cl, Se & Na (d) F, S & Li

40. The electron gain enthalpy (in $kJmol^{-1}$) of fluorine chlorine bromine and iodine respectively are

(a) – 333, –349, – 325, – 296 (b) – 296, – 325, – 333, – 349

(c) –333, – 325, – 349, – 296 (d) – 349, – 333, –325, – 296

41. When the first electron gain enthalpy ($\Delta_{eg}H$) of oxygen is – 141 $kJmol^{-1}$, its second electron gain enthalpy is

(a) A more negative value than the first
(b) Almost the same as that of the first
(c) Negative but less negative than the first
(d) A positive value

Concept 6: Periodic trends in properties of elements - Electronegativity

42. The correct order of electronegativities of N, O, F and P is CET 2012

(a) F > O > P > N
(b) F > O > N > P
(c) N > O > F > P
(d) F > N > P > O

43. The electronic configuration of the elements X, Y, Z and J are given below. Which element has the highest metallic character?

(a) X = 2, 8, 4
(b) Y = 2, 8, 8
(c) 2, 8, 8, 1
(d) J = 2, 8, 8, 7

44. One of the characteristic properties of non-metals is that they

(a) are reducing agents
(b) form basic oxides
(c) form cations by the gain of electrons
(d) are electronegative

45. Which of the following sets has strongest tendency to form anions?

(a) Ga, In, Tl
(b) Na, Mg, Al
(c) N, O, F
(d) V, Cr, Mn

46. The most electronegative element in the periodic table is

(a) Nitrogen
(b) fluorine
(c) chlorine
(d) oxygen

47. Among the statements I to IV, the correct ones are:

I) Be has a smaller atomic radius compared to Mg.
II) Be has higher I.E. than Al.
III) Charge /radius ratio of Be is greater than that of Al.
IV) Both Al and Be forums covalent compounds.

(a) I, II & IV
(b) II, III & IV
(c) I, II & III
(d) I, III & IV

48. In the periodic table, with the increase in atomic number, the metallic character of an element

(a) decrease in a period and increases in a group
(b) increases in a period and decreases in a group
(c) increases in a period as well as in the group
(d) decreases in a period and also in the group

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

(a) B < C < O < N (increasing first ionisation enthalpy)

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

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

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

50. In general, the property (magnitudes only) that shows an opposite trend in comparison to other properties across a period

(a) Electronegativity (b) Electron gain enthalpy

(c) ionization enthalpy (d) atomic radius

Concept 7: Periodic Trends in Chemical Properties, Periodic Trends and Chemical Reactivity

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

(a) Be (b) P

(c) F (d) B

52. Diagonal relationship is shown by

(a) Be and Ca (b) Li and Na

(c) Be and Mg (d) Be and Al

53. An element of atomic weight 40 has 2, 8, 8, 2 as the electronic configuration. Which one of the following statements regarding this element is not correct?

(a) It belongs to II group of the periodic table.

(b) It has 20 neutrons.

(c) The formula of its oxide is MO_2

(d) It belongs to 4^{th} period of the periodic table.

54. Which of the following elements form pЛ - pЛ bond with itself? CET 2017

(a) P (b) Se

(c) Te (d) N

55. Which of the following oxides is not expected to react with sodium hydroxide?

(a) B_2O_3 (b) CaO

(c) SiO_2 (d) BaO

56. Among the following, the one which is most basic is

(a) ZnO (b) MgO

(c) Al_2O_3 (d) N_2O_5

57. The oxide of an element with electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^1$ is

(a) amphoteric (b) basic

(c) acidic (d) neutral

58. Which one of the following metallic oxides exhibit amphoteric nature? CET 2017

(a) BaO (b) Al_2O_3

(c) Na_2O (d) CaO

59. Amphoteric oxide among the following is CET 2022

(a) Ag_2O (b) SnO_2

(c) BeO (d) CO_2

60. The electronic configuration of two elements X and Y are given below:

$X = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

$Y = 1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

The formula of the ionic compound that can be formed between these elements is

(a) XY (b) XY_2

(c) X_2Y (d) XY_3

ANSWER KEY

1	2	3	4	5	6	7	8	9	10
a	b	c	d	d	b	c	c	b	b
11	12	13	14	15	16	17	18	19	20
a	a	c	d	a	a	c	a	b	a
21	22	23	24	25	26	27	28	29	30
a	d	b	a	d	a	c	d	b	a
31	32	33	34	35	36	37	38	39	40
d	c	b	b	a	**d**	c	c	a	a
41	42	43	44	45	46	47	48	49	50
d	b	c	d	c	b	a	a	**b**	**d**
51	52	53	54	55	56	57	58	59	60
b	d	**c**	**d**	b	**b**	b	b	c	b

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