Chapter 3 Periodic Table and Periodicity of Properties

Section A Multiple Choice Questions (M.C.Qs)

Tick mark (✓) the correct answer:

01. He proposed the classification of Triads in which several groups of three elements classified based on atomic masses.
(a) Dobereiner (b) Newland (c) Mendeleev (d) Moseley

02. In the classification of Triads central element had an atomic mass average of the other:
(a) five elements (b) four elements (c) three elements (d) two elements

03. In 1864 British chemist Newland put forward the:
(a) classification of Triads (b) Law of Octaves
(c) 8 columns and rows arrangement (d) 9 columns and groups arrangement

04. It is order of increasing atomic masses.
(a) classification of Triads (b) Law of Octaves
(c) 8 columns and rows arrangement (d) 9 columns and groups arrangement

05. According to him the eighth element has similar properties as the first element in a group of eight elements.
(a) Dobereiner (b) Moseley (c) Newland (d) Mendeleev

06. In 1869, he published eight vertical columns (groups) and horizontal rows (periods) on the basis of physical and chemical properties of elements.
(a) Dobereiner (b) Newland (c) Mendeleev (d) Moseley

07. In 1869, this German scientist published a periodic table in which 56 elements were arranged in 9 vertical columns or groups based on atomic masses.
(a) Lother Meyer (b) Mendeleev (c) Newland (d) Moseley

08. His periodic table was the first attempt to arrange the elements.
(a) Dobereiner (b) Moseley (c) Newland (d) Mendeleev

09. Based on periodic Law a periodic table developed in which vertical columns are called:
(a) periods (b) groups (c) triads (d) classes

10. In periodic table, horizontal lines are called:
(a) periods (b) groups (c) triads (d) classes

11. In 1869, he proposed a periodic law based on physical and chemical properties empirically.
(a) Dobereiner (b) Newland (c) Mendeleev (d) Moseley

12. Periodic law states that "The properties of the elements are a periodic function of their:
(a) atomic number (b) atomic radius (c) atomic charge (d) atomic weight

13. It is a fundamental property because it increases regularly from element to element and is fixed for every element.
(a) atomic number (b) atomic radius (c) atomic charge (d) atomic weight

14. *In the periodic table, the atomic number increases from:*
(a) right to left (b) left to right (c) top to bottom (d) bottom to top

15. *In 1913, he discovered that Atomic number is the basic property of an atom.*
(a) Dobereiner (b) Moseley (c) Newland (d) Mendeleev

16. *He proposed a modern periodic law.*
(a) Dobereiner (b) Newland (c) Mendeleev (d) Moseley

17. *The long form of periodic table composed with:*
(a) 9 rows & 8 columns (b) 8 rows & 9 columns
(c) 7 rows and 8 columns (d) 8 rows and 7 columns

18. *There are seven horizontal lines in periodic table known as:*
(a) periods (b) groups (c) triads (d) classes

19. *The first period is the shortest period which contains only:*
(a) one elements (b) two elements (c) three elements (d) four elements

20. *The second and the third periods contain:*
(a) 2 elements (b) 8 elements (c) 14 elements (d) 32 elements

21. *These periods contain 18 elements.*
(a) The 6^{th} & 7^{th} (b) The 5^{th} & 6^{th} (c) The 4^{th} and 5^{th} (d) The 2^{nd} & 3^{rd}

22. *The 6th period contains:*
(a) 2 elements (b) 8 elements (c) 14 elements (d) 32 elements

23. *The 14 elements in the bottom of the 6th period are named as:*
(a) Lanthanides (b) Actinides (c) Alkali metals (d) Transition elements

24. *It is the longest period of the periodic table.*
(a) 4^{th} (b) 5^{th} (c) 6^{th} (d) 7^{th}

25. *This period is consider as incomplete.*
(a) 4^{th} (b) 5^{th} (c) 6^{th} (d) 7^{th}

26. *The 7th period contains a group of 14 elements known as:*
(a) Lanthanides (b) Actinides (c) Alkali metals (d) Transition elements

27. *All the periods except the first period start with a/an:*
(a) alkali metal (b) transition element (c) noble gas (d) Actinide

28. *All the periods except the first-period end at a/an:*
(a) alkali metal (b) transition element (c) noble gas (d) Actinide

29. *There are eight vertical columns in periodic table known as:*
(a) periods (b) groups (c) triads (d) classes

30. *In periodic table, the sub groups are divided on the basis of their:*
(a) atomic masses (b) atomic numbers (c) similar properties (d) None of these

31. *The elements of subgroup B are called:*
(a) Lanthanides (b) Actinides (c) Alkali metals (d) Transition elements

32. *The group number indicates total number of electrons in:*
(a) an atom of the element (b) valence shell of the element
(c) a nucleus of the element (d) the first shell of the element

33. *The elements of group I A are called:*
(a) alkali metals (b) alkaline earth metals
(c) noble gases (d) transition elements

34. *Their valence shell contains one electron.*
(a) Group I A (b) Group II A (c) Group III A (d) Group IV A

35. *The elements of group II A are called:*
(a) alkali metals (b) alkaline earth metals
(c) noble gases (d) transition elements

36. *Their valence shell contains two electrons.*
(a) Group I A (b) Group II A (c) Group III A (d) Group IV A

37. *This is also called the carbon family.*
(a) Group I A (b) Group II A (c) Group III A (d) Group IV A

38. *In their valence shell, the oxygen family has:*
(a) 6 electrons (b) 5 electrons (c) 4 electrons (d) 3 electrons

39. *All of the elements of this group exist in allotropic forms.*
(a) IV A (b) V A (c) VI A (d) VII A

40. *The group or inert or noble gases are:*
(a) VIII B (b) VIII A (c) VII A (d) VII B

41. *These are the groups of transition metals.*
(a) I B to VIII B (b) I A to VIII A (c) III B to VII B (d) III A to VII A

42. *The periodic table has been divided into:*
(a) six blocks (b) five blocks (c) four blocks (d) three blocks

43. *They are colorless, unreactive and diamagnetic gases.*
(a) Transition elements (b) Noble gases
(c) Lanthanides (d) Actinides

44. *They are placed in zero group.*
(a) alkali metals (b) alkaline earth metals
(c) transition elements (d) noble gases

45. *The elements of group IA and IIA are:*
(a) s block elements (b) p block elements (c) d block elements (d) f block elements

46. *Elements of this group/ these groups are p block elements.*
(a) IIIA to VII (b) zero group (c) Both 'a' & 'b' (d) None of these

47. *d-block elements are also called:*
(a) transition elements (b) outer transition elements
(c) inner transition elements (d) noble gases

48. *d-block elements consist of:*
(a) six series (b) five series (c) four series (d) three series

49. *f-block elements are also called:*
(a) transition elements (b) outer transition elements
(c) inner transition elements (d) noble gases

50. *They exhibit electronic configuration* $ns^2(n^2)d1^1$, $(n-^2)f^{1-14}$.
(a) f-block elements (b) d-block elements (c) p-block elements (d) s-block elements

51. *f-block elements consist of:*
(a) five series (b) four series (c) three series (d) two series

52. *Half of this distance is considered to be the radius of the atom. It is measured in:*
(a) centimeters (cm) (b) Angstrom unit (A) (c) decimeters (dcm) (d) None of these

53. *1A = :*
(a) 10^{-3} cm (b) 10^{-5} cm (c) 10^{-5} cm (d) 10^{-11} cm

54. *In the periodic table, that atomic radius increases from:*
(a) left to right (b) right to left (c) top to bottom (d) bottom to top

55. *As the atomic number increases from left to right, the atomic radius:*
(a) decreases (b) increases
(c) remains the same (d) does not follow any rule

56. *The ionization energy is the amount of energy required to:*
(a) add an electron in the outermost shell of a gaseous atom
(b) remove an electron from a gaseous state
(c) to reduce the shielding effect
(d) All of these

57. *The ionization energy is measured in:*
(a) joule/kg (b) joule/gram (c) mole/kg (d) joule/mole

58. *The ionization energy depends upon atomic size and nuclear charge*
(a) atomic size (b) nuclear charge (c) Both 'a' & 'b' (d) None of these

59. *The higher ionization energy means:*
(a) removal of an electron is more difficult (b) removal of an electron is easier
(c) adding of an electron is more difficult (d) adding of an electron is easier

60. *If we move from left to right in periods the value of ionization energy:*
(a) decreases (b) increases
(c) remains the same (d) does not follow any rule

61. *As we move down the group ionization energy decreases from:*
(a) left to right (b) right to left (c) top to bottom (d) bottom to top

62. *The electron affinity is the amount of energy released when:*
(a) an electron is removed from the outermost shell of a gaseous atom
(b) an electron is added to the outermost shell of a gaseous atom
(c) shielding effect is reduced
(d) shielding effect is increased

63. *Electron affinity means tendency to accept electron to form:*
(a) molecule (b) radical (c) cation (d) anion

64. *In a period electron affinity increases from:*
(a) left to right (b) right to left (c) top to bottom (d) bottom to top

65. *In a group electron affinity values decrease from:*
(a) left to right (b) right to left (c) top to bottom (d) bottom to top

66. *As the size of iodine is bigger than bromine its electron affinity is:*
(a) more than bromine (b) less than bromine
(c) equal to bromine (d) zero

67. *The ability of an atom to attract the shared pair of electrons towards itself in a molecule is called:*
(a) ionization potential (b) electron affinity
(c) shielding effect (d) electronegativity

68. *In period, electronegativity increases from:*
(a) left to right (b) right to left (c) top to bottom (d) bottom to top

69. *Lanthanides and Actinides are the elements of block:*
(a) s (b) p (c) d (d) f

70. *The repetition of properties after regular intervals is called:*
(a) grouping (b) perioding (c) periodicity (d) None of them

71. ***The elements of sub group A are called:***

(a) transition elements ***(b)*** representative elements

(c) lanthanides ***(d)*** actinides

72. ***In periodic table, the shielding effect increases:***

(a) down the group ***(b)*** down the period ***(c)*** left to the group ***(d)*** down to the group

Answers

01.	(a)	11.	(c)	21.	(c)	31.	(d)	41.	(a)	51.	(d)	61.	(c)	71.	(b)
02.	(d)	12.	(d)	22.	(d)	32.	(a)	42.	(c)	52.	(b)	62.	(b)	72.	(a)
03.	(b)	13.	(a)	23.	(a)	33.	(a)	43.	(b)	53.	(c)	63.	(d)		
04.	(b)	14.	(b)	24.	(c)	34.	(a)	44.	(d)	54.	(c)	64.	(a)		
05.	(c)	15.	(b)	25.	(d)	35.	(b)	45.	(a)	55.	(a)	65.	(c)		
06.	(c)	16.	(d)	26.	(b)	36.	(b)	46.	(c)	56.	(b)	66.	(b)		
07.	(a)	17.	(c)	27.	(a)	37.	(d)	47.	(b)	57.	(d)	67.	(d)		
08.	(d)	18.	(a)	28.	(c)	38.	(a)	48.	(d)	58.	(c)	68.	(a)		
09.	(b)	19.	(b)	29.	(b)	39.	(c)	49.	(c)	59.	(a)	69.	(d)		
10.	(a)	20.	(b)	30.	(c)	40.	(b)	50.	(a)	60.	(b)	70.	(c)		

Section B&C — Short & Detailed Answer Questions

Q.1 ***Write a note on Dobereiner's rule of triads.***

Ans: ***Dobereiner's Classification - Introduction:*** The periodic table of elements which we see now is the product of thousands of years of struggle of scientists to understand the complexity of the existence of elements in this world. When a large number of elements discovered, scientists decided to arrange the elements in a certain order.

First of all German chemist, Dobereiner proposed a classification of Triads in which several groups of three elements classified based on atomic masses.

Law (or Rule) of Triads: In this Triad central element had an atomic mass average of the other two elements.

Example: Calcium (40), Strontium (88) and barium (137) is a triad. In that triad atomic mass of strontium is the average of atomic masses of calcium and barium.

ELEMENTS		ATOMIC MASS	ARITHMATIC MEAN
Traids	Lithium	7	$\frac{7+39}{2} = 23$
	Sodium	23	
	Potassium	39	
Traids	Chlorine	35.5	$\frac{35.5+126.5}{2} = 81$
	bromine	80	
	Iodine	126.5	
Traids	Calcium	40	$\frac{137+40}{2} = 88$
	Strontium	87	
	Barium	137	

Q.2 ***Write a note on Newland's classification of elements or Newland's law of the octave.***

Ans: ***Newland's Classification of Elements:*** In 1864 British chemist Newland put forward the Law of

Octaves in order of increasing atomic masses.

Law (or Rule) of Octave: According to him, the eighth element has similar properties as the first element in a group of eight elements.

Example:

Newlands Classification octaves

Li = 7	Be = 94	B = 11	C = 12	N = 14	O = 16	F = 19
Na = 23	Mg = 24	Al = 27.3	Si = 28	P = 32	Cl = 35.5	

In the above arrangement Li and Na, Be and Mg, B and Al, C and Si, N and P, O and S, F and Cl shows the same chemical properties.

Q.3 ***State Mendeleev periodic law.***

Ans: ***Mendeleev's Periodic Table:*** In 1869 Mendeleev published eight vertical columns (groups) and horizontal rows (periods) based on the physical and chemical properties of elements.

Mendeleev's Periodic Law: In 1869 Mendeleev Proposed a periodic law based on physical and chemical properties empirically. Periodic law states that "The properties of the elements are a periodic function of their atomic weight". In certain cases, Mendeleev left gaps, which modified by Moseley. Mendeleev periodic table was the first attempt to arrange the elements although this periodic table was failed due to many demerits but provide the base for the discovery of Periodic Law.

Q.4 ***What do you know about Lother Meyer's periodic table?***

Ans: ***Lother Meyer's Periodic Table:*** In 1869 German scientist Lother Meyer published a periodic table in which 56 elements were arranged in 9 vertical columns or groups based on atomic masses.

Q.5 ***Define groups and periods of a periodic table.***

Ans: On the basis of periodic Law a periodic table developed in which vertical columns are called groups and horizontal lines are called periods. This periodic table predicts the properties of elements.

Q.6 ***What do you know about the Modern Periodic Table?***
OR Discuss in detail the long form of the periodic table.

Ans: ***Modern Periodic Table:*** Atomic number is a fundamental property because it increases regularly from element to element and is fixed for every element.

It was noticed in the arrangement of elements that atomic number increases from left to right in a horizontal row and properties of elements were found repeating after regular intervals. Due to this reason elements of the same properties and same electronic configuration are placed in the same group.

Modern Periodic Law: In 1913 Moseley discovered that Atomic number is the basic property of an atom. He proposed a modern periodic law. Moseley states that "The Physical and Chemical properties of elements are the periodic function of their atomic numbers."

The atomic number of an element is equal to the number of electrons in a neutral atom so atomic number also provides the electronic configuration of elements of the periodic table. So based on electronic configuration, an arrangement of elements was made in the long form of the periodic table and which was composed of 7 rows and 8 columns.

Q.7 Define and explain the periods in the periodic table.

Ans: *Periods in Periodic Table:* There are seven horizontal lines in the periodic table known as periods. In periods physical and chemical properties changes from left to right. Elements of a period show different properties because the electronic configuration continuously changing within a period and the number of valence electrons decides the position of an element in a period. These periods are categorized as short periods and long periods.

Q.8 Explain the periods in the modern periodic table.

Ans: There are 7 periods in the modern periodic table.

The First Period (Shortest Period)

(i) This period contains only two elements Hydrogen (H) and Helium (He).
(ii) K-shell is filled in this period.

The Second and the Third Period (Short Period)

(i) Each period contain eight elements.
(ii) In these periods, L and M shells are being filled by electrons.
(iii) The second period contains Li, Be, B, C, N, O, F and Ne.
(iv) The third period contains Na, Mg, Al, Si, P, S, Cl, and Ar.

The Fourth and the Fifth Period (Long Period)

(i) Each period contain 18 elements.
(ii) In these periods, M and N shells are being filled by electrons.
(iii) The fourth period starts from Potassium (K) and ends on Krypton (Kr).
(iv) The fifth period starts from Rubidium (Rb) and ends on Xenon (Xe).

The Sixth Period (Longest Period)

(i) This period contains 32 elements.
(ii) The 14 elements in the bottom are named Lanthanides.
(iii) The sixth period starts from Caesium (Cs) and ends with Radon (Rn).

The Seventh Period (Incomplete Period)

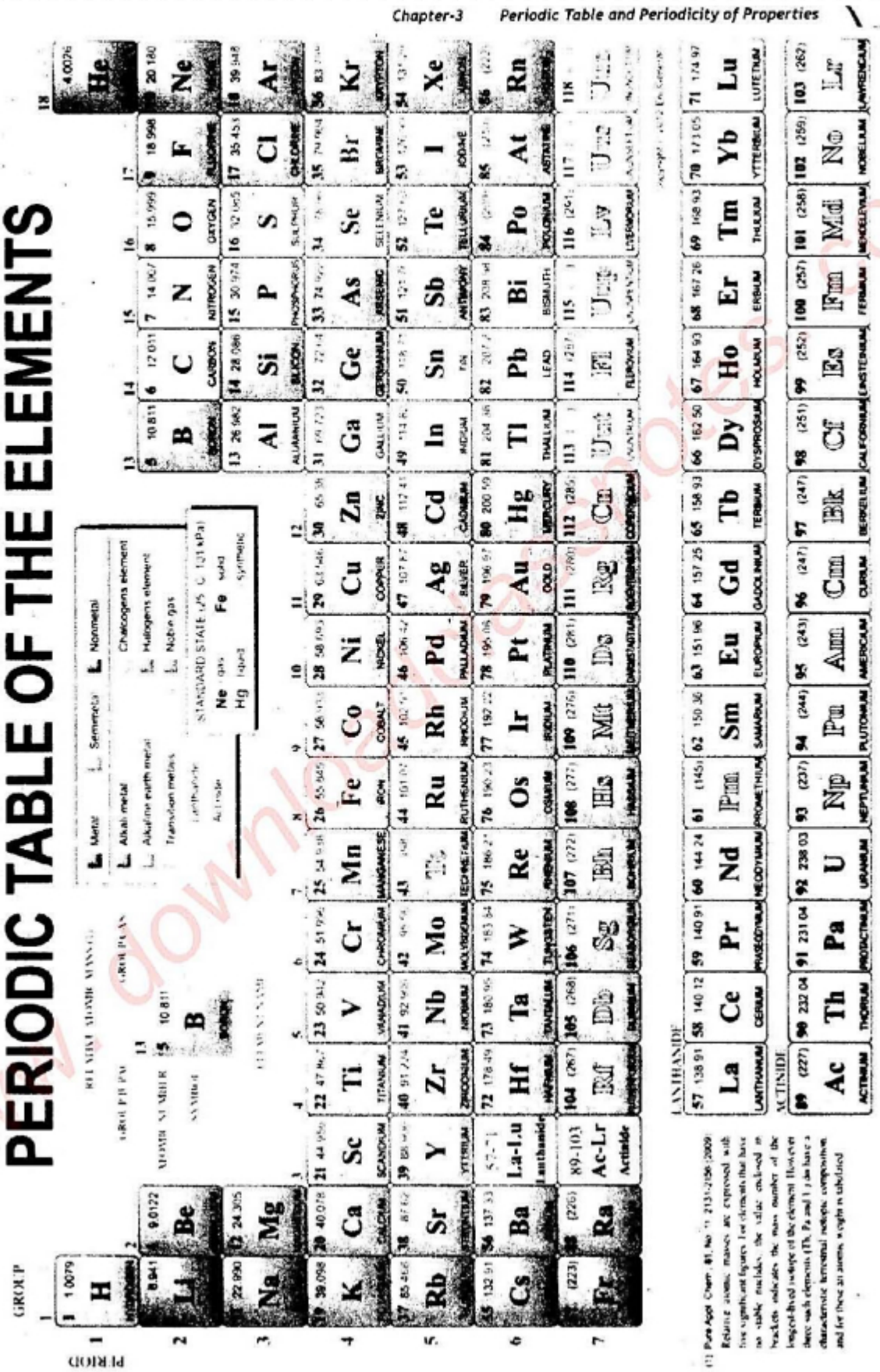
(i) This period starts from Francium (Fr).
(ii) This period is considered incomplete.
(iii) This period contains a group of 14 elements known as Actinides.

All the periods except the first period start with an alkali metal and end at a noble gas. It is observed that some elements are fixed in each period because of a maximum number of electrons accommodation in the particular valence shell of elements. This is shown in the following table.

Period wise Atomic Number of Elements in Periodic Table

Period Number	Number of Elements	Range of Atomic Number
First	2	1 to 2
Second	8	3 to 10
Third	8	11 to 18
Fourth	18	19 to 36
Fifth	18	37 to 54
Sixth	32	55 to 86
Seventh	[32]*	87 to 118*

(Where * Shows incomplete period).



Q.9 Describe the groups in the Periodic Table.

Ans: ***Groups in Periodic Table:*** There are eight vertical columns in the periodic table known as groups. The subgroups are divided on the basis of their similar properties as A and B and placed together in a periodic table.

The elements of subgroup A are called Main or Representative Elements.

The elements of subgroup B are called Transition Elements. The group number indicates the total number of electrons in the valence shell of the element.

Group I A (Alkali Metal) or Lithium Family:

(i) This group includes Lithium (Li), Sodium (Na), Potassium (K), Rubidium (Rb), Cesium (Cs) and Francium (Fr).
(ii) Their valence shell contains one electron.
(iii) On reaction, they lose one electron and form a univalent positive ion.
(iv) They are highly reactive metals.
(v) They have a low melting point.
(vi) Francium (Fr) is a radioactive element of the IA group.

Group II A (Alkaline Earth Metals) or Beryllium Family:

(i) This group includes Beryllium (Be), Magnesium (Mg), Calcium (Ca), Strontium (Sr), Barium (Ba) and Radium (Ra).
(ii) Their valence shell contains two electrons.
(iii) On reaction they lose two electrons and form a divalent positive ion.
(iv) They show irregular densities, melting and boiling points.
(v) Radium (Ra) is a radioactive element of a IIA group.

Group III A (Boron Family):

(i) This group includes Boron (B), Aluminum (Al), Gallium (Ga), Indium (In) and Thallium (Ti).
(ii) Their valence shell contains three electrons.
(iii) On reaction, they lose three electrons and form a trivalent positive ion except for Boron.

Group IV A (Carbon Family):

(i) This group includes Carbon (C), Silicon (Si), Germanium (Ge), Tin (Sn) and Lead (Pb).
(ii) Their valence shell contains four electrons.
(iii) C, Si and Ge form a covalent bond, whereas Sn and Pb exhibit variable valence 2 and 4.
(iv) Carbon is a nonmetal, whereas Silicon, Germanium are metalloids and Tin and Lead are metals.

Group V A (Nitrogen Family):

(i) This group includes Nitrogen (N), Phosphorus (P), Arsenic (As), Antimony (Sb) and Bismuth (Bi).
(ii) Their valence shell contains five electrons.
(iii) They show large variations in their properties as we go down the group.
(iv) Except Nitrogen all exist in allotropic form.

Group VI A (Oxygen Family):

(i) This group includes Oxygen(O), Sulphur (S), Selenium (Se), Tellurium (Te) and Polonium (Po).
(ii) Their valance shell contains six elements.
(iii) All of these elements exist in allotropic forms.
(iv) Oxygen and sulphur are nonmetals, polonium is metal and all others are metalloids.

Group VII A (Halogen Family):

(i) This group includes Fluorine (F), Chlorine (Cl), Bromine (Br), Iodine (I) and Astatine (At).
(ii) Their valence shell contains seven electrons.

(iii) Except arsenic (metal) all are nonmetals.

(iv) Fluorine and chlorine are gases, bromine is liquid and iodine is solid at room temperature.

Group VIII A (Inert or Nobel gases):

(i) This group include Helium (He), Neon (Ne), Argon (Ar), Krypton (Kr) Xenon (Xe) and Radon (Rn).

(ii) Their valence shell contain eight electrons except for Helium which contains two electrons.

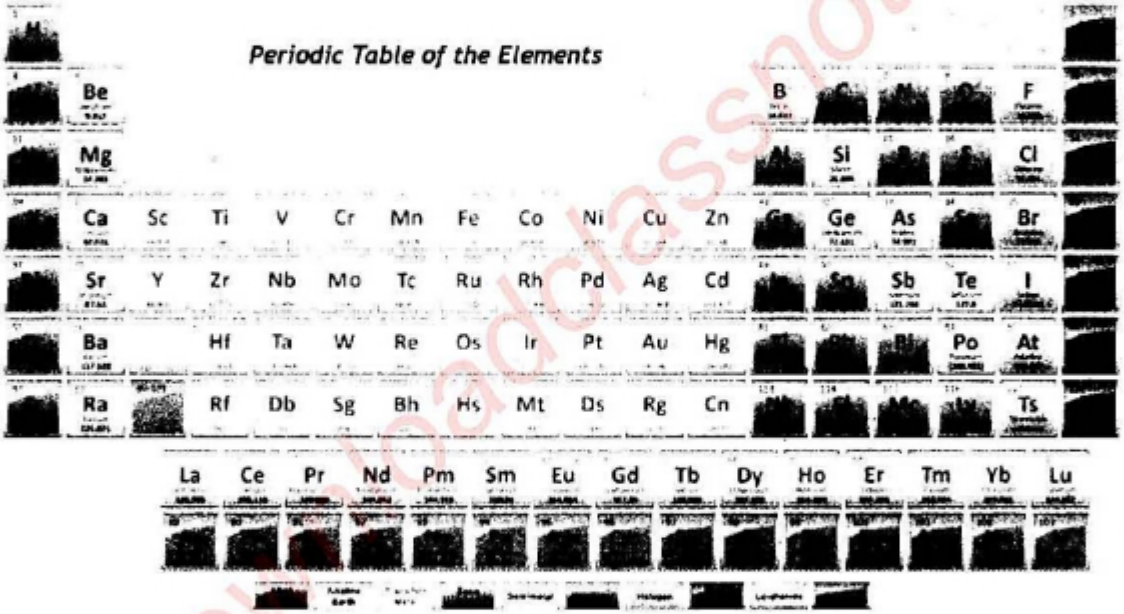
Group IB to VIII B (Transition Elements):

(i) These groups are metals.

(ii) In chemical reactions they show variable valences.

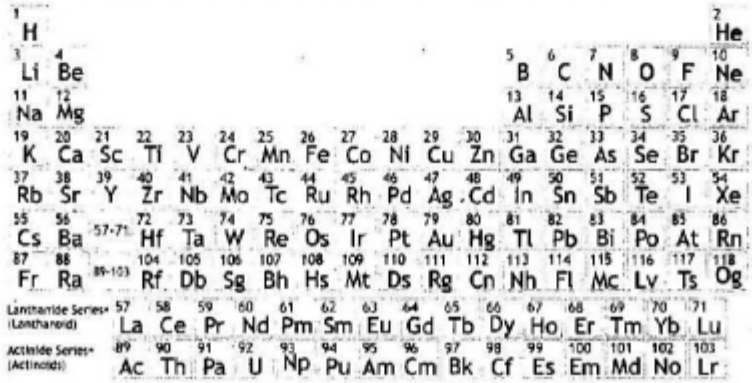
(iii) Their valence shells are incomplete.

Q.10 ***Look at the given periodic table carefully and answer the following questions:***

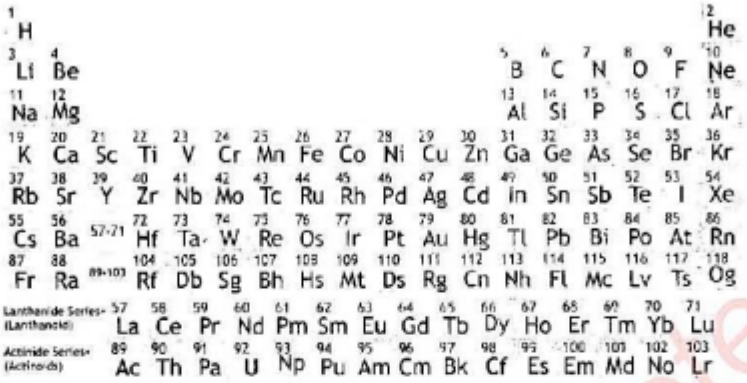


(i) ***Identify and list down the solids, liquids and gases at room temperature from the given periodic table.***

Ans: ***List of Gases:*** The gaseous element group; hydrogen (H), nitrogen (N), oxygen (O), fluorine (F), chlorine (Cl) and noble gases helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe), radon (Rn) are gases at standard temperature and pressure (STP).



List of Liquids: The only liquid elements at standard temperature and pressure are bromine (Br) and mercury (Hg). Although, elements caesium (Cs), rubidium (Rb), Francium (Fr) and Gallium (Ga) become liquid at or just above room temperature.



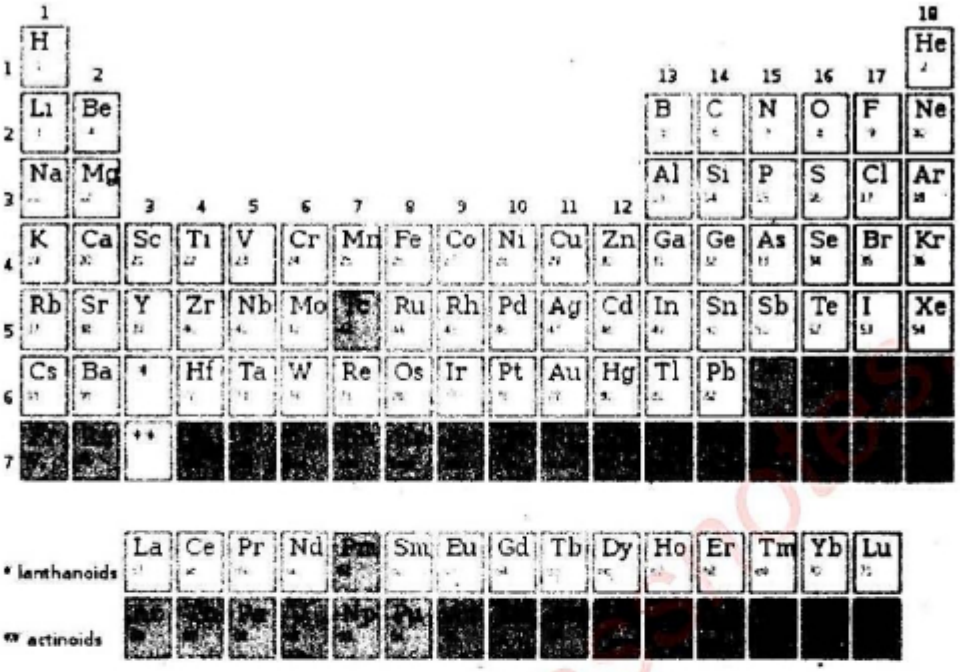
List of Solids: 86 elements of the periodic table are solids.

Lithium, Yttrium, Neodymium, Thorium, Beryllium, Zirconium, Promethium, Protactinium, Boron, Niobium, Samarium, Uranium, Carbon, Molybdenum, Europium, Neptunium, Sodium, Technetium, Gadolinium, Plutonium, Magnesium, Ruthenium, Terbium, Americium, Aluminum, Rhodium, Dysprosium, Curium, Silicon, Palladium, Holmium, Berkelium, Phosphorus, Silver, Erbium, Californium, Sulphur, Cadmium, Thulium, Einsteinium, Potassium, Indium, Ytterbium, Nickel, Calcium, Tin, Gold, Copper, Scandium, Antimony, Thallium, Zinc, Titanium, Tellurium, Lead, Gallium, Vanadium, Iodine, Bismuth, Germanium, Chromium, Cesium, Polonium, Arsenic, Manganese, Barium, Astatine, Selenium, Iron, Lanthanum, Francium, Rubidium, Cobalt, Cerium, Radium, Lutetium, Strontium, Praseodymium, Actinium, Hafnium, Tantalum, Tungsten, Rhenium, Osmium, Iridium, Platinum.

(ii) Identify and name the artificial elements from the periodic table given above.

Ans: ***Artificial Elements:*** The following elements do not occur naturally on Earth. All are transuranium elements and have atomic numbers of 95 and higher. Americium, Curium, Berkelium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium, Rutherfordium, Dubnium, Seaborgium, Bohrium, Hassium, Meibierium, Dannstadtium, Roentgenium, Copernicium, Nihonium, Flerovium, Moscovium, Livermorium, Tennessine, Oganesson. All elements with atomic numbers 1 through 94 occur naturally at least in trace quantities, but the following elements are often produced through synthesis. Technetium, promethium, astatine, neptunium, and plutonium were discovered through synthesis before being found in nature.

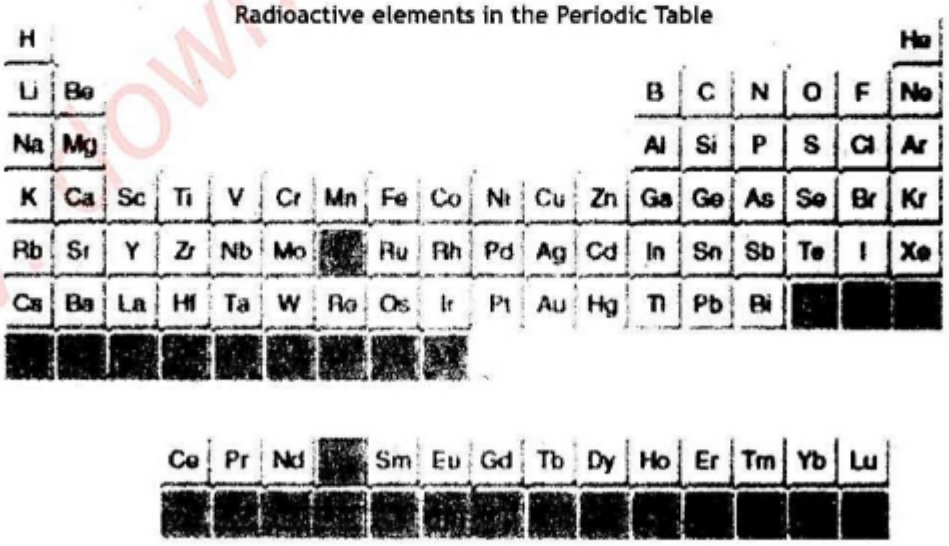
Technetium, Promethium, Polonium, Astatine, Francium, Actinium, Protactinium, Neptunium, Plutonium.



(iii) ***Identify and list down the radioactive elements.***

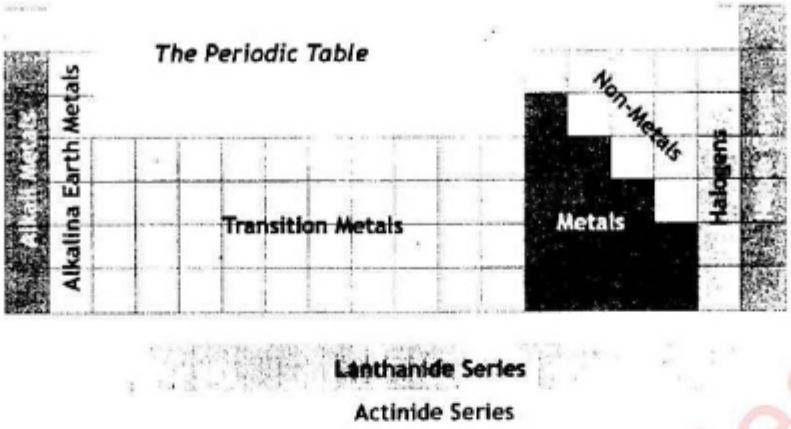
Ans: Technetium, Promethium, Polonium, Astatine, Radon, Francium, Radium, Actinium, Thorium, Protactinium, Uranium, Neptunium, Plutonium, Americium, Curium, Berkelium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium, Rutherfordium, Dubnium, Seaborgium, Bohrium, Hassium,
Meitnerium, Darmstadtium, Roentgenium, Copernicium, Nihonium, Fleroviurn, Moscovium, Livermorium, Tennessine, Oganesson.

Radioactive elements in the Periodic Table



(iv) ***Identify alkali, alkaline, transition metals.***

Ans:



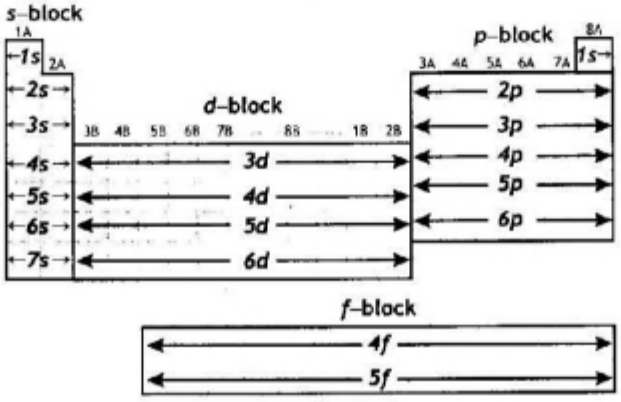
(v) ***Identify and list down metalloids, lanthanide and actinide.***

Ans: ***Metalloids:*** Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium, Polonium, Tennessine.
Lanthanide: Lanthanum, Cerium, Praseodymium, Neodymium, Promethium, Samarium, Europium, Gadolinium, Terbium, Dysprosium, Holmium, Erbium, Thulium, Ytterbium, Lutetium.
Actinide: Actinium, Thorium, Protactinium, Uranium, Neptunium, Plutonium, Americium, Curium, Berkelium, Californium, Einsteinium, Fermium, Mendelevium, Nobelium, Lawrencium.

1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
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
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
55 Cs	56 Ba	57-71	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
87 Fr	88 Ra	89-103	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
Lanthanide Series* (Lanthanoid)			57 La	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	
Actinide Series* (Actinoid)			89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr	

Q.11 ***Determine the demarcation of the periodic table in s, p, d and f blocks.***

Ans: ***Demarcation of Periodic Table in s, p, d and f Blocks:*** The periodic table has been divided into four blocks, s, p, d, and f based on electronic configuration.



Noble Gases: They are colourless, unreactive and diamagnetic. They are placed in zero group. Their electronic configuration is ns^2, np^6 which are exceptionally stable.

Representative Elements: It includes metals and nonmetals. Some are diamagnetic and some are paramagnetic and marked as s block and p block elements.

(i) **s-block Elements:** In s block elements electrons occupy in ns orbital. The elements of group IA and IIA are s block elements. Their electronic configuration varies ns^1 to ns^2.

(ii) **p-Block Elements:** In p block elements electrons begin to fill ns^1 to np^5. Elements of group IIIA to VII and zero group are also p block elements.

d-Block Elements (Outer Transition Elements): The elements exhibit a common oxidation state. In these elements electron fills in (n-1)d-orbital. d-block elements consist of three series.

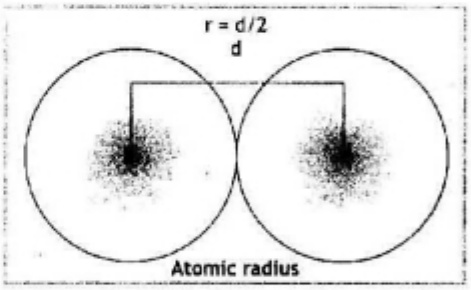
f-Block Elements (Inner Transition Elements): The elements in which inner f-orbital filled are called f block elements. They exhibit electronic configuration $(n-2)f^{(0-14)}(n-1)d^{(0-1)}ns^2$. There are two series called Lanthanides and Actinides.

Q.12 ***Define periodicity of properties.***

Ans: **Periodicity of Properties:** Periodicity means "Repetition of something after the final interval". The Periodicity of properties means that elements are arranged in an order where properties of elements repeat after some period.

Q.13 ***Write a note on atomic radii. OR What is the trend of atomic radius in a group?***

Ans: **Atomic Size and Atomic Radius:** Atoms are so small that it is impossible to see atoms even with a powerful optical microscope. The size of a single atom therefore cannot be directly measured. however, techniques have been developed which can measure the distance between the centres of two bonded atoms of any elements. Half of this distance is considered to be the radius of the atom. It is measured in Angstrom unit (A) $1A = 10^{-8}$ cm.



In the periodic table, that atomic radius increases from top to bottom within a group due to an increase in atomic number. This is because of the addition of an extra shell of electrons in each period, however, as the atomic number increases from left to right, the atomic radius decrease. This gradual decrease in the radius is due to an increase in the positive charge in the nucleus. As the positive nuclear charge increases, the negatively charged electrons in the shells are pulled closer to the nucleus. Thus, the size of the outermost shell becomes gradually smaller. This effect is quite remarkable in the elements of longer periods in which "d" and "f" subshells are involved. For example, the gradual decrease in the size of Lanthanides is significant and called Lanthanide Contraction.

Atomic radii decrease in period

2nd Periods elements	^3Li	^4Be	^5B	^6C	^7N	^8O	^9F	^{10}Ne
Atomic radii (pm)	152	113	88	77	75	73	71	69

Atomic radii increases in period

1st group elements	Atomic radii (pm)
^3Li	152
^{11}Na	186
^{19}K	227
^{37}Rb	248
^{55}Cs	265

Q.14 Write a note on ionization energy.

Ans: ***Ionization Energy:*** The ionization energy is the amount of energy required to remove an electron from a gaseous state and measured in joule/mole. The ionization energy depends upon the atomic size and nuclear charge. The higher ionization energy means the removal of an electron is more difficult. For example, the ionization energy of hydrogen is 1312KJ/mole.

$$H(g) + Energy \longrightarrow H^+ + e^- \quad (I.E = +1312KJ/mole)$$

If we move from left to right in periods the value of ionization energy increases. It is because the size of atoms reduces and electrons are held strongly by the electrostatic force of the nucleus. Due to this elements on the left side have less ionization energy which is shown in the following table.

Ionization energy increases in a period

Increase in ionization Energy of Elements in Periods of Periodic Table

Elements of second periods	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}N
Ionization Energy(KJ/mol)	520	899	801	1086	1402	1314	1681	2081

As we move down the group ionization energy decreases from top to bottom. Due to additions of shells, a decrease in Ionization energy is shown in the following table.
These shells reduce the electrostatic force between electrons of the valence shell and nucleus.

Ionization Energy Decreases in group

Elements of second periods	Ionization Energy(KJ/mol)
^{3}Li	520
^{11}Na	496
^{19}K	419
^{37}Rb	403
^{55}Cs	377

Q.15 Write a note on electron affinity.

Ans: ***Electron Affinity:*** The electron affinity is the amount of energy released when an electron is added to the outermost shell of a gaseous atom. It is also calculated in K J/mol. Affinity means attraction, therefore electron affinity means the tendency to accept an electron to form an anion. For example,the electron affinity of fluorine is –328 KJ/mol.

$$F + e \longrightarrow F^- \qquad \Delta H = -328 \text{ KJ/mol}$$

In a period electron affinity increases from left to right due to decrease of atomic size because when size of atom increases the attraction between nucleus and incoming electron increases and more energy released.

Electron Affinity Increases in Period

Elements of second periods	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F	^{10}N
Ionization Energy(KJ/mol)	–60	0	–29	–122	0	–141	–328	0

In a group electron affinity values decrease from top to bottom, because the size of the atom increases.

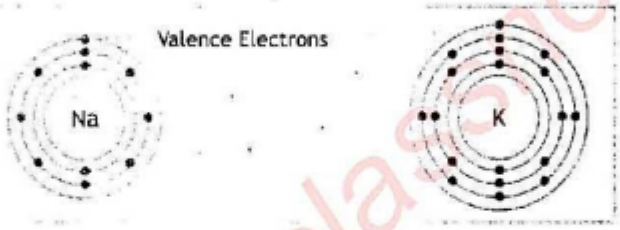
Electron Affinity decreases in Groups

Elements of 17th Group	Electron Affinity(KJ/mol)
^{9}F	–328
^{17}Cl	–349
^{35}Br	–325
^{53}I	–295

Down the group attraction of incoming electron and Nucleus decreases and less energy released. As the size of iodine is bigger than bromine its electron affinity is less than bromine. The decrease of electron affinity is shown in the above table.

Q.16 ***Define shielding effect. OR Why do bigger size atoms have more shielding effects?***

Ans: ***Shielding Effect:*** The shielding effect is defined as a reduction in the effective nuclear charge on the electron cloud, due to a difference in the attractive forces on the electrons in an atom. The electrons present between the nucleus and valence shell of the atom reduce the nuclear charge of electron present in the outermost shell. As a result valence electron experience less nuclear charge than the actual charge. Therefore "electrons present in the inner shells shield the force of attraction of nucleus felt by the valence shell electrons is called shielding effect." The shielding effect increases down the group in the periodic table and remains the same in the period from left to right. For example, the shielding effect in the potassium atom is more than the sodium atom.



Q.17 ***Write a note on electronegativity.***

Ans: ***Electronegativity:*** The ability of an atom to attract the shared pair of electrons towards itself in a molecule is called electronegativity. The trend of electronegativity is the same as ionization energy and electron affinity. It increases from left to right in a period due to an increase in nuclear charge which decreases the distance from nucleus to shared electron pair. It increases the power to attract the shared pair of electrons.

Electronegativity Increases in periods

Elements of second periods	^{3}Li	^{4}Be	^{5}B	^{6}C	^{7}N	^{8}O	^{9}F
Electronegativity	1.0	1.6	2.0	2.6	3.0	3.4	4.0

In group, electronegativity decreases because the size of atom increases and attraction for shared electron pair decreases: for example in the following table electronegativity of halogens are given.

Electronegativity decreases in group

Elements	Electronegativity
^{9}F	4.0
^{17}Cl	3.2
^{35}Br	3.0
^{53}I	2.7

Q.18 ***Justify that periodicity of properties dependent upon the number of protons in an atom?***

Ans: Atomic mass depends upon the number of protons and neutrons in the nucleus. On the other hand, the atomic number implies the number of electrons in the extranuclear part of the number of protons in the nucleus.

Since the nucleus is deep-seated in an atom and is also shielded by electrons in the

extranuclear part, therefore, the atomic mass has little effect on the chemical properties of the elements. Electrons are exposed to the environment. Hence, they can interact with the reagent. As a result, the physical and chemical properties of the elements depend upon their atomic numbers rather than the atomic masses.

Q.19 ***Explain the similarity of chemical and physical properties of elements in the same family.***

Ans: The chemical properties depend on the number of valence shell electrons since these electrons participate in chemical bond formation with other elements. The elements are arranged in the periodic table in such a way that the elements having the same number of electrons in the valence shell are grouped together.

Therefore the chemical properties of the elements present in the same group are similar. For example, the halogens (Group VII) made up of fluorine, chlorine, bromine, iodine and astatine. Since they all have seven electrons in the valence shell they are therefore called halogens. All halogens exhibit similar chemical properties. It is true for all other groups.

The physical properties like melting point, boiling point partially depend on the valence shell and it also depends on the type of interactions between the atoms of the element. Thus to some extent, it shows similarity along with a group.

Q.20 ***Identify that which halogens exist as gases, liquid and solid?***

Ans: Ongoing down the column, the halogens become heavier and this with more electrons. These two factors must be accounted for to explain the change in physical state (F_2 and Cl_2 are gases, Br_2 is a liquid, and I_2 is a solid at room temperature). As the mass increases, the number of electrons increases, too. This, in turns, makes intermolecular interactions (van der Waals forces in these cases) more and more significant and stronger.

For this reason, the magnitude of the intermolecular interactions increases on passing from F_2 to I_2. Therefore, more energy is required to take molecules apart and, subsequently, their melting points and boiling points increase on going down the halogen column.

Q.21 ***Why Alkaline earth metals show irregular melting and boiling point?***

Ans: There is a general decrease in melting point going down group II. However, if we include magnesium, we will see that its melting point is lower than the melting point of calcium, the next element down. If we include magnesium, there is no obvious trend in melting points.

There does not appear to be a trend in boiling points going down the group. Again magnesium is an anomaly. If we exclude it, the boiling points decrease from beryllium to strontium, then increase to radium.

There does not seem to be a satisfactory explanation for the anomalous melting and boiling points of magnesium. One explanation involves the different packing structures for the metal atoms:

- beryllium and magnesium have a hexagonal close-packed structure
- calcium and strontium have a face-centred cubic structure
- barium and radium have a body-centred cubic structure.

Unfortunately, these differences cannot properly explain what is going on.

Q.22 ***Why ionization energy, electron affinity and electronegativity exhibit the same trend in the period and groups?***

Ans: Periodic trends are specific patterns that are present in the periodic table that illustrate different

aspects of a certain element, including its size and its electronic properties. Major periodic trends include electronegativity, ionization energy, electron affinity, atomic radius, melting point, and metallic character. Periodic trends, arising from the arrangement of the periodic table, provide chemists with an invaluable tool to quickly predict an element's properties. These trends exist because of the similar atomic structure of the elements within their respective group families or periods, and because of the periodic nature of the elements.

Q.23 ***Determine the location of families on the periodic table.***

Ans: Elements may be categorized according to element families. Knowing how to identify families, which elements are included, and their properties help predict the behaviour of unknown elements and their chemical reactions.

An element family is a set of elements sharing common properties. Elements are classified into families because the three main categories of elements (metals, nonmetals, and semimetals) are very broad. The characteristics of the elements in these families are determined primarily by the number of electrons in the outer energy shell. Element groups, on the other hand, are collections of elements categorized according to similar properties. Because element properties are largely determined by the behaviour of valence electrons, families and groups may be the same. However, there are different ways of categorizing elements into families. Many chemists and chemistry textbooks recognize five main families:

5 Element Families:

(i) Alkali metals (ii) Alkaline earth metals (iii) Transition metals
(iv) Halogens (v) Noble gases

9 Element Families: Another common method of categorization recognizes nine element families:

(i) Alkali Metals: Group 1 (IA)- 1 valence electron
(ii) Alkaline Earth Metals: Group 2 (IIA)- 2 valence electrons
(iii) Transition Metals: Groups 3-12- d and f block metals have 2 valence electrons
(iv) Boron Group or Earth Metals: Group 13 (IIIA)- 3 valence electrons
(v) Carbon Group: Group 14 (IVA)- 4 valence electrons
(vi) Nitrogen Group: Group 15 (VA)- 5 valence electrons
(vii) Oxygen Group: Group 16 (VIA)- 6 valence electrons
(viii) Halogens: Group 17 (VIIA)- 7 valence electrons
(ix) Noble Gases: Group 18 (VIIIA)- 8 valence electrons

Recognizing Families on the Periodic Table:

Columns of the periodic table typically mark groups or families. Three systems have been used to number families and groups:

(i) The older IUPAC system used Roman numerals together with letters to distinguish between the left (A) and right (B) side of the periodic table.
(ii) The CAS system used letters to differentiate main group (A) and transition (B) elements.
(iii) The modern IUPAC system uses Arabic numbers 1-18, simply numbering the columns of the periodic table from left to right.

Many periodic tables include both Roman and Arabic numbers. The Arabic numbering system is the most widely accepted today.

Differences

1. ***Write four differences between Metals and Non–metals.***

Ans:

Metals	*Non–metals*
All metals except mercury are solids with high melting and boiling points.	About half of the nonmetals are gases. nonmetals have low melting and boiling points.
Metals are lustrous (shiny). They can be polished.	Nonmetals are non lustrous. They can not be polished.
Metals are malleable and ductile - they can be changed into sheets and wires.	They are neither malleable nor ductile. They are brittle. (Broken into pieces).
They have relatively high densities.	They usually have low densities.
Examples: iron, nickel, cobalt etc.	Examples: carbon, sulphur, oxygen etc.

2. ***Write four differences between Metals and Metalloids.***

Ans:

Metals	*Metalloids*
Metals form basic oxides.	Metalloids form amphoteric oxides.
Metals are good conductors of heat and electricity.	Metalloids are semiconductors.
Metals are hard.	Metalloids are brittle.
Examples: sodium, calcium, copper etc.	Examples: boron, silicon, astatine etc.

3. ***Write four differences between Group IA and Group IIA elements.***

Ans:

Group IA Elements	*Group IIA Elements*
They are also called alkali metals or Lithium family.	They are also called alkali metals or Lithium family.
Their valence shells have one electron only.	Their valence shells have only two electrons.
They form univalent positive ions (M^+)	They form divalent positive ions (M^{2+})
They are highly reactive metals.	They are less reactive metals.
Examples; lithium, sodium, potassium etc.	Examples; beryllium, magnesium, calcium.

4. ***Write four differences between Normal elements & Transition elements.***

Ans:

Normal elements	*Transition elements*
s and p block elements are called normal or representative elements.	d and f block elements are called transition elements.
s block elements are electropositive and p block elements are electronegative.	Properties of transition elements are intermediate between s and p block elements.
Their inner shells are complete.	Their inner shells (penultimate) or next to the outermost shell are incomplete.
Their valencies are usually constant.	They have variable valencies.

5. ***Differentiate between periods and groups.***

Ans: ***The differences between periods and groups are as follows:***

Periods	*Groups*
Horizontal rows of periodic table are called periods.	Vertical columns of periodic table are called groups.
In a period from left to right, elements change their characters gradually.	In a group from top to bottom elements have same characters.
Size of the atoms decrease from left to right in period.	Size of the atom increases from top to bottom in a group.
Valency of elements increases first up to group IV an then decreases up to Group O.	Valency of elements remains same in a group.

Reasons

1. ***Why Boron in group III-A is a metalloid?***

Ans: Boron (B) is metalloid in the III-A group due to an increase in atomic volume. Boron shows some properties of metals and some properties of non-metals.

2. ***Why do Carbon and Tin exist in the allotropic form in IV-A?***

Ans: Carbon and Tin exist in the allotropic form in the IV-A group, due to the increase in atomic radii and volume, the addition of a new shell takes place.

3. ***Metals have usually low values of ionization potential.***

Ans: ***Values of ionization potential:*** Metals are electropositive; it means that they have a tendency to lose electrons. They can lose their outer electron(s) easily, so they usually have low values of ionization potential.

4. ***Ionization energy decreases on going down the group.***

Ans: ***Ionization energy decreases:*** On going down the group the ionization energy decreases because new shells are being added and the atomic size is constantly increasing. The nucleus can not hold the valence electrons tightly, so the ionization energy decreases from top to bottom in a group.

5. ***The ionization energy increases on going across the period.***

Ans: ***Ionization energy increases:*** On going across the group, the ionization energy increases because the nuclear charge is increasing within the same shell. The nucleus can hold the valence electrons tightly, so the ionization energy increases from left to right in a period.

6. ***Group IA elements are called alkali metals.***

Ans: ***Alkali metals:*** Group IA elements are called alkali metals as they form alkalis when they dissolve in water, e.g. sodium hydroxide, potassium hydroxide.

7. ***The atomic size of atoms increases on going down a group.***

Ans: ***Atomic size of atoms increases:*** New shells are constantly being added to the atoms on going down a group. That decrease the attraction between nucleus and valence electrons so the atomic size of atoms increases.

Summary

- The 19th century is considered a milestone in the systematic arrangement of elements in the Periodic Table.
- Dobereiner arranged element in Triads.
- Newland put forward the Law of Octaves.
- Mendeleev published periodic law with groups and rows.
- Moseley stated his law as "the physical and chemical properties of elements are the periodic function of their atomic numbers"
- There are a total of eight groups and seven periods in the modern periodic table.
- Physical and Chemical properties change from left to right in a period. Elements of a period show different properties because the electronic configuration continuously changes within a period.
- The subgroups are divided on the basis of their similar properties as A and B and placed together in a periodic table.
- The elements of subgroup A are called Main or Representative Elements.
- The elements of subgroup B are called Transition Elements. The group number indicates the total number of electrons in the valence shell of the element.
- The atomic size increases down a group but decreases along the period.
- Ionization energy decreases down a group but increases along a period.
- Electronegativity decreases down a group but increases along a period.
- Electron affinity decreases down a group but increases along a period.
- The Shielding effect increases down the group in the periodic table and remains the same in the period.

Solution of Textbook Exercise

SECTION-A: MULTIPLE CHOICE QUESTIONS

Tick Mark (✓) the correct answer:

See "Multiple Choice Questions (M.C.Qs)" - 1 to 10

SECTION-B: SHORT QUESTIONS:

1. Distinguish between periods and groups.

Ans: See "Differences" - Q.5

2. Describe the trend of electronegativity within a group and period with the help of examples.

Ans: See "Short & Detailed Answer Questions" - Q.17

3. Explain the similarity of chemical and physical properties of elements in the same family.

Ans: See "Short & Detailed Answer Questions" - Q.19

4. Justify that periodicity of properties dependent upon the number of protons in an atom?

Ans: See "Short & Detailed Answer Questions" - Q.18

5. Identify that which halogens exist as gases, liquid and solid?

Ans: See "Short & Detailed Answer Questions" - Q.20

6. Why Alkaline earth metals show irregular melting and boiling point?

Ans: See "Short & Detailed Answer Questions" - Q.21

7. Why ionization energy, electron affinity and electronegativity exhibit the same trend in the period and groups?

Ans: See "Short & Detailed Answer Questions" - Q.22

SECTION-C: DETAILED QUESTIONS

1. ***Discuss in detail the long form of the periodic table.***

Ans: See "Short & Detailed Answer Questions" - Q.6

2. ***Determine the demarcation of the periodic table into s, p, d and f blocks.***

Ans: See "Short & Detailed Answer Questions" - Q.11

3. ***Identify the electronic configuration of the following elements.***
Na, Ca, F, Si

Ans: Electronic Configuration of Sodium (Na): $1s^2 2s^2 2p^6 3s^1$

Electronic Configuration of Calcium (Ca): $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2$

Electronic Configuration of Fluorine (F): $1s^2 2s^2 2p^5$

Electronic Configuration of Silicon (Si): $1s^2 2s^2 2p^6 3s^2 3p^2$

4. ***Determine the location of families on the periodic table.***

Ans: See "Short & Detailed Answer Questions" - Q.23

5. ***Discuss that Mendeleev periodic law provides a base for the modern periodic table.***

Ans: See "Short & Detailed Answer Questions" - Q.3

6. ***Explain how the shielding effect influences the periodic trends?***

Ans: See "Short & Detailed Answer Questions" - Q.16