Chapter 7

Classification of Elements and Periodicity in Properties

- **Doberiner's Law of Triads :** According to this law, *"in certain triads (group of three elements) the atomic mass of the central element was the arithmetic mean of the atomic masses of the other two elements."*

  E.g., atomic masses of Li, Na and K are respectively 7, 23 and 39, thus the mean of atomic masses of 1st and 3rd element is

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

  Limitations of Doberiner's Triads: He could identify only a few such triads and so the law could not gain importance. In the triad of Fe, Co, Ni, all the three elements have a nearly equal atomic mass and thus does not follow the above law.
- **Newland's Law of Octaves :** According to this law *"the elements are arranged in such a way that the eighth element starting from a given one has properties which are a repetition of those of the first if arranged in order of increasing atomic weight like the eight note of musical scale."*

  Drawback of newland's law of octaves:
  (i) This law was applicable for lighter elements e.g., H, F and Cl, but fails in the case of heavier elements.
  (ii) According to Newland only 56 elements exists in nature.
  (iii) No space was left for the elements which were unknown at that time.
  (iv) In order to fit new elements into his table Newland adjust two elements in the same column, but put some unlike elements under the same column.
- **Mendeleev's Periodic Table :** According to Mendeleev "*the properties of the elements are a periodic function of their atomic masses.*"
- **Merits of Mendeleev's Periodic Table:** Mendeleev left some gap for new elements which were not discovered at that time e.g., gallium and germanium were not known at that time.One of the strengths of Mendeleev's periodic table was that, when inert gases were discovered they could be placed in a new group without disturbing the existing order.
- **Characteristics of the periodic table :**
  (i) In the periodic table, the elements are arranged in vertical rows called **groups** and horizontal rows called **periods**.
  (ii) There are **eight groups** indicated by Roman Numerals I, II, III, IV, V, VI, VII, VIII. The elements belonging to first seven groups have been divided into **sub-groups** designated as **A** and **B** on the *basis of similarities*. Group VIII consists of nine elements arranged in **three triads**.
  (iii) There are **six periods** (numbered 1, 2, 3, 4, 5 and 6). In order to accomodate more elements, the periods 4, 5, 6 are divided into two halves.
- **Achievements of mendeleev's periodic table**
  (i) The arrangement of elements in groups and periods *made the study of elements quite systematic.*
  (ii) Many gaps were left in this table for undiscovered elements. However, properties of these elements could be predicted in advance from their expected position.
  (iii) Mendeleev corrected the atomic masses of certain elements with the help of their expected positions and properties.
- **Limitations of mendeleev's classification :**
  (i) He could not assign a correct position of hydrogen in his periodic table, as the properties of hydrogen resembles both with alkali metals as well as with halogens.
  (ii) The isotopes of the same element will be given different position if atomic number is taken as basis, which will disturb the symmetry of the periodic table.
  (iii) The atomic masses do not increases in a regular manner in going from one elements to the next.
- **Modern Periodic Law :** This law was given by **Henry Moseley** in 1913. It states, "*Properties of the elements are the periodic function of their atomic numbers*".
- The *cause of periodicity* is the resemblance in properties of the elements is the *repetition of the same valence shell electronic configuration.*
- **Modern Periodic Table**
  (i) The modern periodic table has 18 vertical columns called "*groups*" and seven horizontal rows called "*periods*".
  (ii) The elements belonging to a particular group make a family and usually named after the first member. In a group all the elements contain the same number of valence electrons. e.g., in halogen family all the elements i.e., F, Cl, Br, I have 7 electrons in their valence shell.
  (iii) In a period all the elements contain the same number of shells, but as we move from left to right the number of valence shell electrons increases by one unit. The maximum number of electrons that can be accommodated in a shell can be calculated by the formula $2n^2$ where n is the number of the given shell from the nucleus e.g.
  K shell = $2 \times (1)^2 = 2$
  L shell = $2 \times (2)^2 = 8$
  M shell = $2 \times (3)^2 = 18$
  N shell = $2 \times (4)^2 = 32$
- **Important characteristics of groups in a modern periodic table :**
  (i) The elements present in a group are separated by definite gaps of atomic numbers (8, 8, 18, 18, 32)
  (ii) There are 18 groups in *long form of periodic table*.
  (iii) The elements in a group have the *same valency*.
  (iv) The elements present in a group have *identical chemical properties.*

- **Characteristics of periods :** We know that there are **seven periods** in the modern periodic table.
  (i) In all the elements present in a period, the electrons are filled in the valence shell.
  (ii) As the number of electrons in the valence shell change, there also occurs a change in the chemical properties of the elements present in a period.
- **Merits of modern periodic table over Mendeleev's periodic table :**
  (i) Position of isotopes : All isotopes of the same elements have different atomic masses but same atomic number. Therefore, they occupy the same position in the modern periodic table which they should have because all of them are chemically similar.
  (ii) Anomalous pairs of elements : When elements are arranged in the periodic table according to their atomic numbers the anomaly regarding certain pairs of elements in Mendeleev's periodic table disappears.
  (iii) It explains the periodicity of the properties of the elements and relates them to their electronic configurations.
  (iv) The table is simple, systematic and easy way for remembering the properties of various elements and moreover lanthanides and actinides are placed separately.
- **Classification based on differentiating electron :**
  s-block elements : Those elements of the periodic table in which the last electron enters in s–orbital, are called s-block elements. s-orbital can accommodate a maximum of two electrons. Their general formulae are ns^1 and ns^2 respectively, where n = (1 to 7).
  p-block elements : Those elements of the periodic table in which the last electron gets filled up in the p-orbital, called p-block elements. A p-orbital can accommodate a maximum of six electrons.
  d-block elements : Those elements of the periodic table in which the last electron gets filled up in the d-orbital, called d block elements.
  f-block elements : Those elements of the periodic table in which the last electron gets filled up in the f orbital, called f-block elements. There are 28 f-block elements in the periodic table. The elements from atomic number 58 to 71 are called lanthanides because they come after lanthanum (57). The elements from 90 to 103 are called actinides because they come after actinium (89).
- **Trends in the modern periodic table :**

(i) Valency : The combining capacity of an atom or radical is known as its valency. Valency of an element is defined as the number of hydrogen, chlorine and double the number of oxygen atom with which atom of an element can combine.
Valency in a period : The number of valence electrons increases in a period from 1 to 8 from left to right. It reaches 8 in group 18 elements (noble gases) which show practically no chemical activity under ordinary conditions and their valency is taken as zero.
Valency in a group : All the elements of a group have the same number of valence electrons. Therefore, they all have the same valency.

(ii) Atomic Radii : For an isolated atom atomic radius may be taken as the distance between the centre of nucleus of atom and the outermost shell of electrons.
Variation of atomic radii in a period : In a period there is a gradual increase in the nuclear charge with increase in atomic number. Since valence electrons are added in the same shell since, the electrons in the same shell do not screen each other from the nucleus, the increase in nuclear charge is not neutralised by the extra valence electron. As a result effective nuclear charge increases therefore valence electrons are more and more strongly attracted towards nucleus. This gradually decreases atomic radii across a period.
Variation of atomic radii in a group : In moving down the group the nuclear charge increases with increase in atomic number. However, while going down in a group from one atom to another the number of inner shells also increases, although the number of electrons in the outermost shell remains the same. The effect of increase in the size of the electron cloud (due to increase in number of shells) is more pronounced than the effect of increased nuclear charge. Thus the distance of outermost electron from the nucleus increases as we move down a group. This gradually increases atomic radii along a group.

(iii) Ionization Energy : The minimum amount of energy required to remove an electron from a gaseous atom in its ground state to form a gaseous ion is called ionization energy. It is measured in unit of kJ mol^{-1}.
Variation of ionization energy in a group : Force of attraction between valence electrons and nucleus decreases in a group from top to bottom because of increase in atomic size due to addition of inner shells. As a result, the electron becomes less and less firmly held to nucleus as we move down the group. Ionization energy decreases in a group from top to bottom.
Variation of ionization energy in a period : We know that the force of attraction between valence electron and nucleus increases in a period from left to right due to increase in nuclear charge. As a consequence of this, the ionization energy generally increases in a period from left to right.

(iv) Electron Affinity : It is the energy change when an electron is accepted by an atom in the gaseous state. It corresponds to the process : $X(g) + e^- \longrightarrow X^-(g) + E$
Variation of electron affinity in a group : In a group, the electron affinity decreases on moving from top to bottom.
Variation of electron affinity along a period : On moving across a period, the size of atom decreases and nuclear charge increases. Both of these factors result into greater attraction for incoming electron. Thus electron affinity increases in a period from left to right.

(v) Electronegativity : Electronegativity is relative tendency of a bonded atom to attract the bond-electrons towards itself.
Electronegativity generally decreases in a group from top to bottom.
Electronegativity generally increases in a period from left to right.

(vi) Metallic and Non-Metallic Character : Characteristic properties of a metal. They are electropositive in nature (the tendency to lose electrons), have luster, ductility, malleability and electrical conductance.

Variation of metallic character in a group : Metallic character of elements increases from top to bottom. As we move down in a group atomic size increases therefore distance between valence electrons and nucleus also increase. Thus electrostatic force of attraction on valence electrons decreases and they can be easily removed.

Variation of metallic character in a period : Metallic character of elements decreases in a period from left to right. As we move from left to right in a period atomic size decreases. Thus electrostatic force of attraction increases for valence electrons thereby decreasing electropositive character.

Exercise 1

DIRECTIONS : This section contains multiple choice questions. Each question has 4 choices (1), (2), (3) and (4) out of which only one is correct.

1. The early attempt to classify elements as metals and non-metals was made by
   (1) Mendeleev (2) Lother Meyer
   (3) Lavoisier (4) Henry Moseley
2. Newlands could classify elements only upto
   (1) copper (2) chlorine
   (3) calcium (4) chromium
3. Mendeleev classified elements in
   (1) increasing order of atomic groups
   (2) eight periods and eight groups
   (3) seven periods and eight groups
   (4) eight periods and seven groups
4. The long form of periodic table consists of
   (1) seven periods and eight groups
   (2) seven periods and eighteen groups
   (3) eight periods and eighteen groups
   (4) eighteen periods and eight groups
5. All the members in a group in long form of periodic table have the same
   (1) valence
   (2) number of valence electrons
   (3) chemical properties
   (4) All of these
6. An element 'M' has an atomic number 9 and its atomic mass 19. The ion of M will be represented by
   (1) M (2) M^{2+}
   (3) M^{-} (4) M^{2-}
7. The element with smallest size in group 13 is
   (1) beryllium (2) carbon
   (3) aluminium (4) boron
8. Which of the following properties generally decrease along a period?
   (1) Atomic size
   (2) Non-metallic character
   (3) Metallic character
   (4) Both (1) and (3)
9. The elements with atomic numbers 2, 10, 18, 36, 54 and 86 are all
   (1) halogen (2) noble gases
   (3) noble metals (4) light metals
10. The number of elements in the third period of periodic table is
    (1) 2 (2) 8
    (3) 18 (4) 32
11. Which of these choices is not a family of elements?
    (1) Halogens (2) Metals
    (3) Inert gases (4) All of these
12. The element which has least tendency to lose electron is
    (1) H (2) Li
    (3) He (4) Ne
13. The most metallic element in the fourth period is
    (1) Ca (2) K
    (3) S (4) P
14. The elements of group sixteen are called
    (1) halogens (2) chalcogens
    (3) pnicogens (4) noble gases
15. Which of the following is correct set of Dobereiner Triads?
    (1) Na, Si, Cl (2) Be, Mg, Ca
    (3) F, Cl, I (4) Li, Na, Be
16. The metal which is hard and has high m.p. and used in electric bulbs is
    (1) Ni (2) Pt
    (3) Fe (4) W
17. The lightest liquid metal is
    (1) Hg (2) Ga
    (3) Cs (4) Fr
18. Which is not true about noble gases?
    (1) They are non-metallic in nature
    (2) They exist in atomic form
    (3) They are radioactive in nature
    (4) Xenon is the most reactive among them
19. Elements of which group form anions most readily?
    (1) Oxygen family (2) Nitrogen family
    (3) Halogens (4) Alkali metals
20. Which of the following is not a representative element?
    (1) Fe (2) K
    (3) Ba (4) N
21. On moving horizontally across a period, the number of electrons in the outermost shell increases from ..... to ..... .
    (1) 2, 8 (2) 2, 18
    (3) 1, 8 (4) 1, 18
22. Which one of the following is most electropositive element?
    (1) Sodium (2) Calcium
    (3) Aluminium (4) Silicon
23. As you move down the group, the alkali metals become
    (1) brighter (2) hotter
    (3) more reactive (4) less reactive
24. Which is a metalloid?
    (1) Pb (2) Sb
    (3) Bi (4) Zn
25. The scientific who made maximum contribution towards periodic table was
    (1) Chadwick (2) Rutherford
    (3) Dalton (4) Mendeleev

26. In the modern periodic table, the period indicates the value of
(1) atomic number (2) atomic mass
(3) main energy level (4) atomic size

27. Which of the following elements A, B, C, D and E with atomic number 3, 11, 15, 18 and 19 respectively belong to the same group?
(1) A, B, C (2) B, C, D
(3) A, D, E (4) A, B, E

28. Which one of the following elements have maximum number of valence electrons?
(1) Na (2) Al
(3) Si (4) P

29. Which of the following elements does not lose an electron easily?
(1) Na (2) F
(3) Mg (4) Al

30. Which of the following set of elements is written in order of their increasing metallic character?
(1) Be, Mg, Ca (2) Na, Li, K
(3) Mg, Al, Si (4) C, O, N

31. Which one among the following has the highest first ionisation energy ?
(1) Carbon (2) Fluorine
(3) Nitrogen (4) Oxygen

32. Element A belongs to Group VII in p-block and element B belongs to Group I in s-block of the periodic table. Out of the following assumptions, the correct one is :
(1) A and B are metals
(2) A and B are non-metals
(3) A is a metal and B is a non-metal
(4) A is a non-metal and B is a metal

33. Which of the following statement(s) about the Modern Periodic Table is/are incorrect ?
(i) The elements in the Modern Periodic Table are arranged on the basis of their decreasing atomic number
(ii) The elements in the Modern Periodic Table are arranged on the basis of their increasing atomic masses
(iii) Isotopes are placed in adjoining group(s) in the Periodic Table
(iv) The elements in the Modern Periodic Table are arranged on the basis of their increasing atomic number
(1) (i) only (2) (i), (ii) and (iii)
(3) (i), (ii) and (iv) (4) (iv) only

34. Which of the given elements A, B, C, D and E with atomic number 2, 3, 7, 10 and 30 respectively belong to the same period?
(1) A, B, C (2) B, C, D
(3) A, D, E (4) B, D, E

35. An element which is an essential constituent of all organic compounds belongs to
(1) group 1 (2) group 14
(3) group 15 (4) group 16

36. Which of the following gives the correct increasing order of the atomic radii of O, F and N ?
(1) O, F, N (2) N, F, O
(3) O, N, F (4) F, O, N

37. Which of the following are the characteristics of isotopes of an element?
(i) Isotopes of an element have same atomic masses
(ii) Isotopes of an element have same atomic number
(iii) Isotopes of an element show same physical properties
(iv) Isotopes of an element show same chemical properties
(1) (i), (iii) and (iv) (2) (ii), (iii) and (iv)
(3) (ii) and (iii) (4) (ii) and (iv)

38. Arrange the following elements in the order of their increasing non-metallic character
Li, O, C, Be, F
(1) F < O < C < Be < Li (2) Li < Be < C < O< F
(3) F < O < C < Be < Li (4) F < O < Be < C < Li

39. The element with atomic number 14 is hard and forms acidic oxide and a covalent halide. To which of the following categories does the element belong?
(1) Metal (2) Metalloid
(3) Non-metal (4) Left-hand side element

40. Which of the following properties donot match elements of halogen family ?
(1) They have seven electrons in their valence shell
(2) They are diatomic in their molecular form
(3) They are highly reactive chemically
(4) They are metallic in nature

41. Which of the following sets of elements belongs to halogen family ?
(1) 1, 12, 30, 4, 62 (2) 37, 19, 3, 55
(3) 9, 17, 35, 53 (4) 12, 20, 56, 88

42. Which of the following is not isoelectronic with O^{2-} ?
(1) N^{3-} (2) Na^{+}
(3) F^{-} (4) Ti^{+}

43. The correct order of the increasing radii of the elements Na, Si, Al and P is :
(1) Si, Al, P, Na (2) Al, Si, P, Na
(3) P, Si, Al, Na (4) Al, P, Si, Na

44. According to Mendeleev's periodic classification, the electronic configuration of hydrogen atom resembles that of alkali metals, which are given below as :
$H = 1s^1$, $Li = 2s^1$, $Na = 3s^1$, $K = 4s^1$
On the other hand like halogens, hydrogen also exist as diatomic molecules, such as : H_2, Cl_2, Br_2, I_2, etc.
On the basis of above information hydrogen can be placed with :
(1) Alkali metals (2) Halogens
(3) Both (1) and (2) (4) None of these

45. Hydrogen has three isotopes ^1H, ^2H and ^3H respectively. On what is the basis of these elements were placed in modern periodic table ?
(1) Atomic mass (2) Atomic number
(3) Both (1) and (2) (4) We can't say

46. Look at the group-1 of the modern periodic table as given below :

(Group -1)

3^{Li}
11^{Na}
19^{K}
37^{Rb}
55^{Cs}
87^{Fr}

What is common between them ?
(1) All are alkali metals
(2) All have one valence electron
(3) Both (1) and (2)
(4) None of these

47. Consider the following elements of third period of modern periodic table :

Period III elements	Na	Mg	Al	Si	P	S	Cl	Ne
Atomic Number	11	12	13	14	15	16	17	18

How does valency vary in a period on going from left to right ?
(1) Increases
(2) Decreases
(3) Remains constant
(4) First increases then decreases

48. Examine the following elements :
N, O, F, Ne
P, S, Cl, Ar
Br, Kr
I, Xe
In modern periodic table, on which side these elements are placed
(1) Top left side (2) Bottom left side
(3) Top right side (4) Middle side

49. Observe the following periodic table :

H 1							He 2
Li 2, 1	Be 2, 2		B 2, 3	C 2, 4	Y 2, 5	O 2, 6	F 2, 7	Ne 2, 8
Na 2, 8, 1	Ag 2, 8, 2		Al 2, 8, 3	Z 2, 8, 4	P 2, 8, 5	S 2, 8, 6	Cl 2, 8, 7	Ar 2, 8, 8
K 2, 8, 8, 1	X 2, 8, 8, 2							

Arrange the following elements X, Y, Z in increasing order of their valencies :
(1) X > Z > Y (2) Y > Z > X
(3) Z > Y > X (4) X > Y > Z

50. Consider the oxides of the third period :

Na_2O	MgO	Al_2O_3	SiO_2	P_2O_3, P_2O_5	SO_2 SO_3	Cl_2O_7

Which of the following will behave as strongest acid when dissolved in water?
(1) Cl_2O_7 (2) SO_3
(3) SiO_2 (4) P_2O_3

51. Which fact is not valid for Dobereiner's triads?
(1) The atomic weight of middle element is roughly average of the other two elements
(2) The properties of middle element is roughly average of the other two elements
(3) The elements of triads belong to the same group of modern periodic table
(4) The elements of triads have same valency electrons.

52. Which of the following statements is **incorrect** from the point of view of modern periodic table ?
(1) Elements are arranged in the order of increasing atomic number
(2) There are eighteen vertical columns called groups
(3) Transition elements fit in the middle of long periods
(4) Noble gases are arbitrarily placed in eighteenth group

53. Elements A, B, C, D have same number of valence electrons. Their melting points are 458°K, 370°K, 525°K and 245°K respectively. Arrange the elements in increasing order of their atomic numbers.
(1) A < B < C < D (2) C < A < B < D
(3) D < C < A < B (4) B < D < A < C

54. The elements A, B, C, D get their outer shell progressively filled with electrons. Arrange the elements in increasing order of their ionization potentials.
(1) D < C < B < A (2) C < B < A < D
(3) A < B < C < D (4) B < A < D < C

Exercise 2

Matching Based MCQ

DIRECTIONS (Qs. 1 to 6) : Match Column-I with Column-II and select the correct answer using the codes given below the columns.

1.

Column I (Name of element)	**Column II (Group of element)**
(A) Nitrogen	(p) 15
(B) Aluminium	(q) 16
(C) Chlorine	(r) 17
(D) Oxygen	(s) 13
(E) Copper	(t) 11

(1) A–(p); B–(s); C–(r); D–(q); E–(t)
(2) A–(s); B–(p); C–(r); D–(q); E–(t)
(3) A–(p); B–(s); C–(q); D–(r); E–(t)
(4) A–(p); B–(s); C–(r); D–(t); E–(q)

2.

Column I (Name of element)	**Column II (Periods of element)**
(A) Hydrogen	(p) 3
(B) Sodium	(q) 4
(C) Calcium	(r) 6
(D) Barium	(s) 1
(E) Iodine	(t) 5

(1) A–(p); B–(s); C–(q); D–(r) ;E–(t)
(2) A–(s); B–(p); C–(q); D–(r) ;E–(t)
(3) A–(s); B–(q); C–(p); D–(r); E–(t)
(4) A–(s); B–(p); C–(q); D–(t); E–(r)

3.

Column I		Column II	
(A)	Element with largest size in second period	(p)	boron
(B)	Element with smallest size in group 13	(q)	fluorine
(C)	Element with maximum non-metallic character	(r)	bromine
(D)	Element with smallest size in fourth period	(s)	lithium
(E)	Element with most metallic character in group 14	(t)	lead

(1) A–(s); B–(p); C–(q); D–(t);E–(r)
(2) A–(p); B–(s); C–(q); D–(r);E–(t)
(3) A–(s); B–(q); C–(p); D–(r);E–(t)
(4) A–(s); B–(p); C–(q); D–(r);E–(t)

4.

Column I		Column II	
(A)	Newland law of octaves	(p)	Atomic mass vs Atomic volume
(B)	Mendeleev	(q)	Li, Na, K
(C)	Electronic configuration	(r)	One to seven groups sub-divided into group A and B
(D)	Lother Meyer	(s)	Periodic repetition of properties of elements
(E)	Dobereiner's triad	(t)	Only 56 elements known

(1) A–(t); B–(s); C–(r); D–(p) ;E–(q)
(2) A–(t); B–(r); C–(s); D–(p) ;E – (q)
(3) A–(t); B–(r); C–(s); D–(q) ;E – (p)
(4) A–(r); B–(t); C–(s); D–(p) ;E – (q)

5.

Column I		Column II	
(A)	Electronegativity	(p)	Isotopes
(B)	Lanthanides	(q)	increases along a period
(C)	Transition elements	(r)	*f*-group of elements
(D)	Ionisation energy	(s)	*d*-group of elements
(E)	Elements of same atomic number but different mass number	(t)	decreases along a group

(1) A–(q); B–(r); C–(s); D–(p) ;E–(t)
(2) A–(r); B–(q); C–(s); D–(t); E–(p)
(3) A–(q); B–(r); C–(s); D–(t) ;E–(p)
(4) A–(q); B–(s); C–(r); D–(t); E–(q)

6.

Column I		Column II	
(A)	's' block elements	(p)	Cr
(B)	'p' block elements	(q)	Na
(C)	'd' block elements	(r)	Ce
(D)	'f' block elements	(s)	Si

(1) A – (s); B – (q); C – (p); D – (r)
(2) A – (q); B – (s); C – (r); D – (p)
(3) A – (q); B – (p); C – (s); D – (r)
(4) A – (q); B – (s); C – (p); D – (r)

Statement Based MCQ

7. With reference to the chemical element with atomic number 17, consider the following statements:
   (a) It belongs to second period in the periodic table of chemical elements.
   (b) It forms anion with unit negative charge.
   Which of the statement(s) given above is/are correct ?
   (1) (a) only (2) (b) only
   (3) Both (a) and (b) (4) Neither (a) nor (b)
8. Consider the following statements:
   (a) Atomic radii decreases across a row of the periodic table when we move from left to right.
   (b) Atomic radii increases down the column as we move from top to bottom.
   (c) Although the order of elements is based on atomic numbers, vertical families share similar chemical properties.
   Which of the statement(s) given above is/are correct?
   (1) (a) and (b) (2) (a) and (c)
   (3) (b) and (c) (4) All are correct
9. Consider the following statements:
   (a) The elements silicon, germanium and arsenic are called metalloids.
   (b) Metalloids have properties quite different from those of metals and non-metals.
   Which of these statement(s) is/are correct ?
   (1) (a) only (2) (b) only
   (3) Both (a) and (b) (4) Neither (a) nor (b)
10. Consider the following statements:
   (a) Metals will be found on the right side of the periodic table.
   (b) The element P, S and O belong to the same period.

   Which of these statement(s) is/are correct ?
   (1) (a) only (2) (b) only
   (3) Both (a) and (b) (4) Neither (a) nor (b)
11. Consider the following statements:
   (a) Fluorine has the highest electron affinity in the periodic table.
   (b) Noble gases are placed extremely left in periodic table.
   (c) Magnesium is more metallic in nature than sodium.
   Which of these statement(s) is/are correct ?
   (1) (a) and (b) (2) (a) and (c)
   (3) Only (a) (4) Only (b)
12. Consider the following statements:
   (a) As Z (atomic number) increases, atomic orbitals become smaller and more stable.
   (b) The number of shells increases in a given period from left to right in the periodic table.
   Which of these statement(s) is/are correct ?
   (1) (a) only (2) (b) only
   (3) Both (a) and (b) (4) Neither (a) nor (b)
13. Consider the following statements:
   (a) The discovery of inert gases later on did not disturb Mendeleev's arrangement.
   (b) In the present periodic table, periodicity in the properties of elements is related to the periodicity in their electronic configurations.
   Which of these statement(s) is/are correct ?
   (1) (a) only (2) (b) only
   (3) Both (a) and (b) (4) Neither (a) nor (b)
14. Consider the following statements:
   (a) There are 16 groups and 7 periods in the modern periodic table.
   (b) Electro-positive character decreases on moving down a group.
   (c) Electro-negativity in a period increases right from the alkali metal to the inert gas element.
   Which of these statement(s) is/are correct ?
   (1) (a) and (b) (2) (a) and (c)
   (3) All are correct (4) All are incorrect

Passage Based MCQ

DIRECTIONS (Qs. 15 to 23) : Read the passage(s) given below and answer the questions that follow.

PASSAGE - 1

The following diagram shows a part of the periodic table containing first three periods in which five elements have been represented by the letters a, b, c, d and e (which are not their chemical symbols) :

1							18
a	2	13	14	15	16	17	
		b					c
d						e	

15. Select the letter which represents an alkali metal.
(1) (a) (2) (b)
(3) (c) (4) (d)

16. Select the letter which represents a noble gas.
(1) (a) (2) (b)
(3) (c) (4) (d)

17. Select the letter which represents a halogen.
(1) (b) (2) (c)
(3) (d) (4) (e)

18. What type of bond is formed between a and e ?
(1) Ionic bond
(2) Covalent bond
(3) Polar covalent bond
(4) Metallic bond

19. What type of bond is formed between d and e ?
(1) Ionic bond
(2) Covalent bond
(3) Polar covalent bond
(4) Metallic bond

PASSAGE - 2

The following table shows the position of six elements A, B, C, D, E and F in the periodic table.

Group / Periods	1	2	3 to 12	13	14	15	16	17	18
2	A					B			C
3		D			E				F

Using the above table answer the following questions:

20. Which element will form only covalent compounds?
(1) A (2) B
(3) C (4) D

21. Which element is a metal with valency 2 ?
(1) C (2) D
(3) E (4) F

22. Which element is a non-metal with valency of 3 ?
(1) A (2) B
(3) C (4) D

23. Write a common name for the family of elements C and F
(1) Chalcogens (2) Halogens
(3) Noble gases (4) Alkaline earth metals

Assertion Reason Based MCQ

DIRECTIONS (Qs. 24 to 27) : Following questions consist of two statements, one labelled as the **'Assertion'** and the other as **'Reason'**. You are to examine these two statements carefully and select the answer to these items using the code given below.

Code :
(1) Both A and R are individually true and R is the correct explanation of A:
(2) Both A and R are individually true but R is not the correct explanation of A.
(3) A is true but R is false
(4) A is false but R is true.

24. **Assertion :** In group 1 of alkali metals, the element cesium (Cs) has the maximum size.
Reason : The atomic size increases down the group.

25. **Assertion :** Chlorine is the most reactive member of the halogen family.
Reason : Size of chlorine is more than that of fluorine.

26. **Assertion :** In a triad, the three elements present have same gaps of atomic masses.
Reason : Elements in a triad have similar properties.

27. **Assertion :** According to Mendeleev, periodic properties of elements is a function of their atomic number.
Reason : Atomic number is equal to the number of protons.

Definition Based MCQ

28. Electron affinity is
(1) energy change when an electron is accepted by an atom in the gaseous state
(2) energy required to remove an electron from neutral gaseous atom
(3) energy change when an electron is accepted by an atom in the solid state.
(4) energy change when an electron is accepted by an atom in the liquid state.

29. Ionisation energy is
(1) amount of energy required to remove an electron from a gaseous atom in its ground state.
(2) amount of energy required to remove an electron from a gaseous atom in its excited state.
(3) energy change when an electron is accepted by an atom in the gaseous state
(4) energy change when an electron is accepted by an atom in the solid state.

30. s-block elements are
(1) those elements in which last electron enters in p-orbital.
(2) those elements in which last electron enters in d-orbital.
(3) those elements in which last electron enters in f-orbital.
(4) those elements in which last electron enters in s-orbital.

31. Electronegativity is
(1) relative tendency of bonded atom to repel the bond-electrons
(2) relative tendency of bonded atom to attract the bond-electrons
(3) relative tendency of non-bonded atom to repel the bond-electrons
(4) relative tendency of non-bonded atom to attract the bond-electrons

Feature Based MCQ

32. On the basis of following features identify correct option
    I. These elements majorly forms acidic oxides
    II. These elements are majorly non-metals.
    (1) s-block elements
    (2) p-block elements
    (3) d-block elements
    (4) f-block elements

33. On the basis of following features identify correct option
    I. All elements of this group are gases
    II. All elements are chemically inert under ordinary conditions.
    (1) Group 18 (2) Group 17
    (3) Group 14 (4) Group 16

34. On the basis of following features identify correct option
    I. This property of elements decreases in a group from top to bottom
    II. This property of elements increases in a period from left to right
    (1) Electron affinity (2) Electronegativity
    (3) Both (1) and (2) (4) Neither (1) nor (2)

35. On the basis of following features identify correct option
    I. Gaps were left for undiscovered elements
    II. No correct position of hydrogen
    III. The isotopes of same element will be given different position
    (1) Mendeleev's periodic table
    (2) Modern periodic table
    (3) Newland's arrangement of elements
    (4) Both (1) and (2)

Hints & SOLUTIONS

Exercise 1

1. **(3)** **2.** **(3)**

3. **(3)** Mendeleev's periodic table consists of eight groups only while modern periodic table consist of eighteen groups.

4. **(2)**

5. **(4)** Because of the presence of same number of valence electrons the elements of same group have similar chemical properties.

6. **(3)** The electronic configuration of M is 2, 7. It needs one electron to complete its octet. It has a strong tendency to gain 1 electron and so its ion will be M^-.

7. **(4)** In group 13, boron is above aluminium. Rest of elements not belong to group 13.

8. **(4)** As atomic size decreases along a period valence electrons becomes more firmly held with nucleus. Thus more amount of energy is required to remove valance electrons which reduces metallic character

9. **(2)** All these are noble gases with completely filled outermost shell.

10. **(2)**

11. **(2)** A family of elements consists of elements present in a group of the periodic table.

12. **(3)**

13. **(2)** The fourth period contains elements with atomic number 19 to 36. K (Z = 19) is the first member and so it is most metallic.

14. **(2)** Elements of oxygen family are known as chalcogens.

15. **(2)**

16. **(4)** Tungsten (W) is used in electric bulbs.

17. **(3)** Cs is a metal. It is liquid at room temperature. It is lighter than Hg (also a liquid metal).

18. **(3)** Only Radon (Rn) is radioactive whereas other noble gases (i.e., He, Ne, Ar, Kr, Xe) are non-radioactive.

19. **(3)** Halogens are most electronegative elements i.e., they are likely to form anions most readily.

20. **(1)** Fe is a transition element.

21. **(3)**

22. **(1)** Alkali metals are most electropositive in their respective period. i.e. they have maximum tendency to lose electron and form a cation.

23. **(3)** **24.** **(2)** **25.** **(4)**

26. **(3)**

27. **(4)** A(Z = 3); B(Z = 11) and E(Z = 19) are all alkali metals.

28. **(4)** P is in group 5 and has 5 valence electron. Number of valence electrons in Na, Al and Si are 1, 3 and 4.

29. **(2)** F has a tendency to gain an electron.

30. **(1)** Metallic character increases as we move down a group.

31. **(2)** The increasing order of the first ionisation potential along 2^{nd} period is C < N < O < F.

As we move from left towards right of periodic table there is increase in nuclear charge and increase in ionisation energy since the size decreases.

$\therefore$ F has the highest first ionisation energy.

32. **(4)** Element A belong to halogens (Group VII) group and is a non-metal. While element B belongs to alkali metal group (Group I) and is a metal.

33. **(2)** **34.** **(2)** **35.** **(2)**

36. **(4)** **37.** **(4)**

38. **(2)** Non-metallic character increases on moving from left to right in a period.

39. **(2)**

40. **(4)** The members of the halogen family are non-metallic in nature. However, iodine and astatine are crystalline solids and have lustre just like metals.

41. **(3)** The element with atomic number (Z = 9) is Fluorine (F). It is a halogen. The rest of the elements also belong to the same group since they have definite gaps of atomic numbers as is expected in a group.

Elements: 9, 17, 35, 53
Gap : 8, 18, 18

42. **(4)** Isoelectronic species have same number of electrons. N^{3-}, Na^{+} and F^{-} all have ten electrons just like O^{2-}. However, Ti^{+} (Z = 22) has twenty one (21) electrons.

43. **(3)** All the elements belong to third period. The atomic radii decrease along a period. The correct decreasing order is :
Na, Al, Si, P. The correct increasing order is the reverse.

44. **(3)** **45.** **(2)** **46.** **(3)**

47. **(4)**

48. **(3)** Given elements are of Group 15, 16, 17 and 18 of Modern periodic table.

49. **(3)** **50.** **(1)** **51.** **(2)**

52. **(4)**

53. **(2)** A, B, C and D belongs to same group as they have same number of electrons in valence shell. As we move down in a group atomic number increases and electrostatic force of attraction between nucleus and valence electrons decreases. Thus on moving down in a group melting point decreases.

54. **(1)**

Exercise 2

1. **(1)** **2.** **(2)** **3.** **(4)**

4. **(2)** **5.** **(3)** **6.** **(4)**

7. **(2)** The chemical element with atomic number 17 is chlorine. It belongs to third period in the periodic table and forms anion with unit negative charge (Cl^{-}).

8. **(4)** **9.** **(3)** **10.** **(4)**

11. **(3)** Noble gases are placed extremely right in periodic table. Sodium is more metallic than magnesium as it is more electropositive and has low ionisation energy.

12. **(1)** **13.** **(3)** **14.** **(4)**

15. **(4)** **16.** **(3)** **17.** **(4)**

18. **(3)** The type of bond formed between *a* and *e* is polar covalent bond. (Note a is hydrogen and e is halogen).

19. **(1)** The type of bond formed between d and e is ionic (d is alkali metal and e is halogen).

20. **(2)** B is a non metal thus only forms covalent compounds.

21. **(2)** **22.** **(2)** **23.** **(3)**

24. **(1)** Reason is the correct explanation for assertion. In fact, the last element francium (Fr) is expected to have maximum size. But it is unstable being a radioactive element. Its exact size is not known.

25. **(4)** Fluorine is the most reactive element belonging to halogen-family and not chlorine. Fluorine is placed above chlorine in the periodic table.

26. **(4)** In a triad, the atomic mass of the middle element is the mean of the atomic masses of the first and third elements.

27. **(4)** According to Mendeleev, periodic properties of elements is a function of their atomic masses.

28. **(1)** **29.** **(1)** **30.** **(4)**

31. **(2)** **32.** **(2)** **33.** **(1)**

34. **(3)** **35.** **(1)**