Solution

CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES WS 1

Class 11 - Chemistry

Section A

1. **(c)** The same vertical column or group.
   Explanation: 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. This is because the properties of elements are repeating after a regular interval.
2. **(a)** Atomic weight
   Explanation: Mendeleev's used atomic weight as the basis of classification of elements in the periodic table. He arranged 63 elements known at that time in the periodic table on the basis of the order of their increasing atomic weights and he placed elements with similar nature in same group.
3. **(b)** Eka-germanium and Eka-silicon
   Explanation: Mendeleev left the gap under aluminium and a gap under silicon, are called as Eka-aluminium and Eka-silicon, respectively.
4. **(c)** atomic masses
   Explanation: atomic masses
5. **(c)** P, As, Sb
   Explanation: P, As, Sb
6. **(b)** periodic variation in electronic configurations.
   Explanation: Modern Periodic law states that the physical and chemical properties of elements are the periodic functions of their atomic numbers. It implies that the chemical and physical properties of the elements and any variations in these properties can easily be predicted *via* the outermost electronic configuration.
7. **(a)** 1 to 18
   Explanation: The groups are numbered from 1 to 18; where group 1 is alkali metal group and group 18 is for the noble gases.
8. **(b)** The horizontal rows are called periods and the vertical columns, groups.
   Explanation: In the modern periodic table, the elements are arranged in the increasing order of their atomic number. It contains 7 horizontal rows called periods and 18 vertical columns called groups.
9. **(a)** 7th period and 14th group
   Explanation: Elements with atomic numbers Z = (87 - 114) are placed in the 7th period.
   Thus, the element with Z= 114 (Flerovium) is placed in the 7th period and 14th group of the modern periodic table.
10. **(b)** atomic numbers
    Explanation: atomic numbers
11. **(b)** principal quantum number
    Explanation: In the modern periodic table, each period indicates the value of principal quantum number (n). It also implies the number of shells or orbits.
12. **(b)** periods, groups
    Explanation: The horizontal rows (which Mendeleev’s called series) are called periods and the verticcal columns, groups.

13.

(d) F< Cl < Br < I

Explanation: In a group moving from top to bottom the number of shells increases. So the atomic size increases. Although the effective nuclear charge increases but its effect is negligible in comparison to the effect of the increasing number of shells. Therefore the correct trend is F< Cl < Br < I.

14.

(d) 110

Explanation: un = 1 nil = 0 So 110 = ununnilium.

15.

(d) Ubn and unbinilium

Explanation: Atomic number (Z) = 120

IUPAC name = Unbinilium

Symbol = Ubn

16.

(b) 109

Explanation: un = 1

nil = 0

enn = 9

So, atomic number = 109

17. **(a)** 18, 7

Explanation: 18, 7

18.

(d) 7

Explanation: Sept is for 7.

Numerical	0	1	2	3	4	5	6	7	8	9
roots	nil	un	bi	tri	quad	pent	hex	sept	oct	en

19.

(d) 106

Explanation: un = 1 Nil = 0 Hex = 6. So, 106 = uninilhexium.

20.

(d) Gallium

Explanation: Gallium

21.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation: Mendeleef's periodic table was based purely on the basis of atomic masses and atomic numbers are the number of protons in the nucleus.

22.

(b) Both A and R are true but R is not the correct explanation of A.

Explanation: Name of ununbium is 112 according to IUPAC nomenclature and not merely because of its Latin meaning.

23.

(c) 2,6,10,14

Explanation: The number of columns in different blocks of elements in the periodic table is in accordance with the Aufbau principle which also gives the linear order of blocks (as atomic number increases) in the periodic table. Therefore, the number of columns for

i. s -block elements = 2
ii. p - block elements = 6
iii. d- block elements = 10
iv. f - block elements = 14

24.

(d) Mendeleev's arranged elements in order of their increasing atomic number

Explanation: Mendeleev arranged elements in horizontal rows and vertical columns of table in the order of their increasing atomic weights.

25.

(d) Gallium and Germanium respectively

Explanation: Mendeleev arranged the elements according to their atomic weights. He corrected the atomic weights of a few existing elements to explain their chemical and physical behaviour. Moreover, he felt that few elements are still to be discovered, so he left empty spaces for them in his periodic table. Two such elements whose properties he predicted; and were later discovered are Gallium and Germanium respectively.

26. The German Chemist, Johann Dobereiner in early 1829 was the first to classify the elements according to the properties of elements.He took the triads of three elements and arrange them in increasing order of their atomic mass.
27. Eka-aluminium and eka-silicon names were given to gallium and germanium by Mendeleev. He thought that gallium (Ga) and germanium (Ge) will have similar properties as that of aluminium and silicon respectively.
28. Mendeleev predicted the existence of gallium and germanium. He named them as Eka-Aluminium and Eka-Silicon.
    He described some of their general physical properties. These elements were discovered later.
29. Dobereiner took the triads of three elements and arranged them in increasing order of their atomic mass. The atomic mass of the middle element was the arithmetic mean of other two elements. Also the properties of the middle element were in between those of the other two members. Dobereiner's relationship is known as the law of triads.
30. Mendeleev took the basis of atomic weight of elements. According to Mendeleev's Periodic law 'The properties of the elements are periodic function of their atomic weights (A)'.
31. Dobereiner took the triads of three elements and arranged them in increasing order of their atomic mass. The atomic mass of the middle element was the arithmetic mean of other two elements.
    Therefore, Atomic mass of Y = $\frac{atomic\ mass\ of\ X + atomic\ mass\ of\ Z}{2} = \frac{7+39}{2}$ = 23
32. According to modern periodic law, The physical and chemical properties of the elements are periodic functions of their atomic numbers (Z).
33. Elements in the same period have the same value for the quantum number n. Both Al and Si belong to third period with n = 3.
34. **Periodicity:** The periodic repetition of the elements with similar properties after certain regular interval when atoms are arranged in increasing order of atomic number is called periodicity.
    Cause of periodicity: The periodic repetition of the properties is due to the recurrence of the similar valence shell configuration after certain regular interval and gradual addition of an electron into the successive elements .
35. There are 118 elements in periodic table. Out of which 114 elements are known at present.
36. In 1978 IUPAC Commission on the Nomenclature of Inorganic Chemistry decided that it is necessary to have a systematic naming for the elements with atomic number greater than 100 ($Z > 100$), even for those which had not been discovered.
    Here, 0 = nil and 1= un root is used to write the IUPAC name of element with Z =110.
    IUPAC name of element with Z=110 = Ununnilium (Uun);
    Official name Darmstadtium; Symbol: Ds.
37. The roots for 1, 2 and 0 are un, bi, and nil, respectively. Hence, the symbol and the name respectively are Ubn and unbinilium.

Section B

38. The basic theme of organisation of elements in the periodic table is to classify the elements in periods and groups according to their properties. This systematic arrangement makes the study of elements and their compounds, simple to understand and easy to interpert.
39. In his period table, Mendeleev used the periodicity in atomic weight as the basis of classification of elements. He did stick with the idea of atomic weight, and used it to classify elements into groups and periods. He went further when based on his research he corrected atomic weights of exisiting elements and even kept spaces of elements that he felt should exit but not found at that time such as gallium, germanium etc.
40. According to Mendeleev the physical and chemical properties of elements are periodic function of atomic mass. He 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. He treated formulae of hydrides and oxides as one of the basic criteria for categorization.
41. In the beginning of eighteenth century, only 31 elements were known but by 1865, the number had became more than double i.e. 63. At present, 118 elements are known to us. Efforts are still continuing to synthesize new elements. With such a large number of elements, it became very difficult to study each element and its innumerable compounds individually. So, scientist felt the need of

some simple methods to systematise the study of properties of different elements and their compounds. The need gave rise to the classification of elements into various groups having similar properties and led to the formulation of periodic table. Thus, "periodic table is an arrangement of elements with similar properties placed together."

42. i. In Mendeleev table, the elements were arranged in vertical columns, and horizontal rows. The vertical columns were called groups and the horizontal rows were called periods.
    ii. There were in all eight groups. Group I to VIII. The group numbers were indicated by Roman numerals. Group VIII occupy three triads of the elements each i.e. in all nine elements.
    iii. There were seven periods to accommodate more elements the period 4, 5, 6 and 7 were divided into two halves. The first half of the elements were placed in the upper left corner and the second half in the lower right corner of each box.
43. In Mendeleev's periodic law, physical and chemical properties of elements are periodic functions of their atomic weights whereas the Modern Periodic Law uses atomic numbers as the measure of the periodicity.
44. The sixth period corresponds to sixth shell. The orbitals present in this shell are 6s, 4f, 5p, and 6d. The maximum number of electrons which can be present in these sub-shell is 2 + 14 + 6 + 10 = 32. Since the number of elements in a period corresponds to the number of electrons in the shells, therefore, sixth period should have a maximum of 32 elements.
45. Modem periodic law states that physical and chemical properties of the elements are a periodic function of their atomic numbers. If the elements are arranged in the order of their increasing atomic number, after a regular interval, elements with similar properties are repeated.
46. General characteristics of the long form of Periodic table :-
    i. There are in all 18 vertical columns i.e. 18 groups in the long form periodic table.
    ii. There are seven horizontal rows called periods. Elements across the period are arranged with increasing electrons in the same shell.
    iii. The elements of groups 1, 2 and 13 to 17 are called main group elements.
    iv. The elements of group 3 to 12 are called transition elements.
    v. The f-block elements are only called the inner transition elements. The elements of the 6 and that of the 7 periods of Group 3 are placed separately called f- block elements. These are also known as inner transition elements.
47. In the present set up of the long form of the periodic table accommodate 118 elements. The long form of periodic table or modern periodic table consist of 7 periods (i.e., principal quantum number, n = 7) and four blocks (s, p, d and f-block elements). Therefore, the maximum number of elements which can be accommodated in the present set up of the long form of the periodic table in accordance with Aufbau principle is
    $1s^2$, $2s^2$, $2p^6$, $3s^2$,$3p^6$, $4s^2$, $3d^{10}$, $4p^6$, $5s^2$, $4d^{10}$, $5p^6$, $6s^2$, $5d^{10}$, $6p^6$, $7s^2$, $5f^{14}$, $6d^{10}$, $7p^6$ = 118.
48. i. Potassium, K (Z= 19)
    ii. Strontium, Sr (Z = 38)
    iii. Ruthenium, Ru (Z =44)
    iv. Praseodymium, Pr (Z = 59)
    v. Xenon, Xe(Z = 54)
49. The element is chlorine (Cl) with atomic number (Z) = 17.
50. For Z = 114, the electronic configuration is [Rn] $5f^{14}$ $6d^{10}$ $7s^2$ $7p^2$. The outermost electronic configuration provides the information that the element lies in the 7^{th} period and belongs to the carbon family i.e. Group 14.
51. In the "long form" of the Periodic Table of the elements, horizontal rows are called periods and the vertical columns are called groups.
52. A recently discovered element was first named as eka-mercury.
    Atomic number = Z = 112
    IUPAC name : Ununbium (Uub)
    IUPAC symbol : Cn
    IUPAC official name : Copernicium
    Electronic configuration of Copernicium = [Rn] $5f^{14}$ $6d^{10}$ $7s^2$
53. i. Lawrencium (Lr) with atomic number (Z) 103.
    ii. Seaborgium (Sg) with atomic number (Z) 106.
54. The roots 2, 7, 5, 9 and 0 are referred as bi, hept, pent, enn and nil respectively. Therefore, their names and symbol are

Z(Atomic number)	Name	Symbol
122	Unbibium	Ubb

127	Unbiseptium	Ubs
135	Untripentium	Utp
149	Unquadennium	Uqe
150	Unpentnilium	Upn

Section C

55. State True or False:

    (i) **(b)** False
    Explanation: False

    (ii) **(a)** True
    Explanation: True

    (iii) **(b)** False
    Explanation: False

56. Dobereiner arranged certain elements with similar properties in groups of three in such a way that the atomic weight of the middle element was nearly the same as the average atomic weights of the first and third elements.
    For example:

Triad:	lithium	Sodium	potassium
Atomic mass:	7	23	39

    Atomic mass of Na = $\frac{39+7}{2}$ = 23

Chlorine	Bromine	Iodine
35.5	80	127

    Atomic mass of Br = $\frac{127+35.5}{2}$ = 81.25

57. i. In general, as the size of atom or multiplicity of bond increases, bond dissociation energy increases but bond dissociation energy of F_2 is less than that of Cl_2 because of the small size of F. Thus, the correct order is

    $\underset{155}{F_2} < \underset{242}{Cl_2} < \underset{494}{O_2} < \underset{941\ kJ/mol}{N_2}$

    ii. Electropositive character means tendency to give an electron to form cation. It varies directly with atomic radii. Thus, the correct order is Mg > Fe > Cu.

    iii. In HNO_3, N is in contact with three electronegative O atoms each of which share two electrons and hence acquire -2 charge.

    Thus, the increasing order of valency of nitrogen is HNO_2<NO_2<HNO_3

58. Dobereiner arranged certain elements with similar properties in groups of three in such a way that the atomic weight of the middle element was nearly the same as the average atomic weights of the first and third elements.
    For example:

Triad	lithium	sodium	potassium
Atomic mass:	7	23	39

    Atomic mass of Na = $\frac{39+7}{2} = 23$

Chlorine	Bromine	Iodine
35.5	80	127

    Atomic mass of Br = $\frac{127+35.5}{2} = 81.25$

59. First period is the shortest period of the periodic table. It contains 2 elements, $_1$H and $_2$He.

    Second and third periods contain 8 elements each called short periods. The second period contain elements $_3$Li to $_{10}$Ne and $_{11}$Na to $_{18}$Ar.

    Fourth and fifth period contains 18 elements each namely $_{19}$K to $_{36}$Kr and $_{37}$Rb to $_{54}$Xe and are long periods.

    Sixth period contains 32 elements from $_{55}$Cs to $_{86}$Rn and is the longest period.

    Seventh period is incomplete period. It has all other elements starting with $_{87}$Fr onwards. Elements from 93 onwards are purely synthetic and are called trans–uranium elements and their properties have not been studied properly yet.

60. No, the maximum number of elements which can be accommodated in the present setup of the long form of the periodic table is 118. Thereafter, filling of 8s-orbital shell begin which will accommodate only two electrons
After 8s-orbitals, the filling of 5g-orbitals will begin. Since we do not have any provision for g-block elements, therefore, an element with atomic number 126, if discovered, cannot be accommodated in the present setup of the long form of periodic table.

Section D

61. Fill in the blanks:
    (i) 1. Newland
    (ii) 1. 118
    (iii) 1. Groups
    (iv) 1. Periods
    (v) 1. Atomic numbers

62. The Russian chemist, Dmitri Mendeleev (1869) proposed that when elements are arranged in increasing order of their atomic weight, element having similar properties, reoccurs at regular intervals. On this basis he gave a law, called the Mendeleev's periodic law, which state that "the physical and chemical properties o f the element are the periodic function of their atomic weight".
The repetation o f properties o f elements after certain regular intervals is called periodicity of properties

I	II	III	IV	V	VI	VII	VIII		
H 1.01									
Li 6.94	Be 9.01	B 10.8	C 12.0	N 14.0	O 16.0	F 19.0			
Na 23.0	Mg 24.3	Al 27.0	Si 28.1	P 31.0	S 32.1	Cl 35.5			
K 39.1	Ca 40.1		Ti 47.9	V 50.9	Cr 52.0	Mn 54.9	Fe 55.9	Co 58.9	Ni 58.7
Cu 63.5	Zn 65.4			As 74.9	Se 79.0	Br 79.9			
Rb 85.5	Sr 87.6	Y 88.9	Zr 91.2	Nb 92.9	Mo 95.9		Ru 101	Rh 103	Pd 106
Ag 108	Cd 112	In 115	Sn 119	Sb 122	Te 128	I 127			
Ce 133	Ba 137	La 139		Ta 181	W 184		Os 194	Ir 192	Pt 195
Au 197	Hg 201	Ti 204	Pb 207	Bi 209					
			Th 232		U 238				

i. • Among chemical properties, Mendeleev considered mainly the properties of compound of elements with oxygen and hydrogen (i.e. properties of their oxides and halides.
ii. • Reason for the selection o f these compounds as the basis of classification are the high reactivity of hydrogen and oxygen and formation of large number of compounds by these elements.
iii. • Mendeleev arranged the elements then known in increasing order of their atomic weight and generated a table called periodic table.
Note At some place of periodic table, he had ignored the increasing order of atomic weight.

The periodic table, generated by Mendeleev's had the following features

i. In this periodic table, there were eight vertical columns, named as groups. These were represented by Roman numerals I to VIII. Each group is divided into sub-groups A and B except the VIII group which had nine elements arranged in three rows as triads i.e. in the group of three
ii. In this table, there were six horizontal rows, named as periods which were further divided into 12 series.

63. The periodic table, generated by Mendeleev's had the following features

i. In this periodic table, there were eight vertical columns, named as groups. These were represented by Roman numerals I to VIII. Each group is divided into sub-groups A and B except the VIII group which had nine elements arranged in three rows as triads i.e. in the group of three.
ii. In this table, there were six horizontal rows, named as periods which were further divided into 12 series.

The long form of periodic table is better then Mendeleev's periodic table in the following ways

i. Long form of periodic table removed the anomalies of inversions that existed in the Mendeleev's periodic table, e.g., potassium with atomic number 19 is placed after argon with atomic number 18. Similarly, cobalt with atomic number 27 is placed before nickel with atomic number 28.

ii. In long form table same position is alloted to each isotope of an element as all the isotopes of an element have same atomic number.
iii. Other anomalies of Mendeleev's periodic table like grouping of dissimilar elements together and similar elements separately has also been removed by long form periodic table.
iv. Long form of periodic table also explains the cause of periodicity on the basis of electronic configuration. Further it relates the position o f an element in the periodic table with its electronic configuration.
v. Long form of periodic table provides an easier way to remember all the elements and their properties by just knowing their atomic numbers and electronic configurations.

64. The Demerits of Mendeleev periodic table that need improvement are discussed below:

i. It could not explain the position of hydrogen as it has resemblance with both alkali metals and halogen group elements.
ii. It failed to explain the position of isotopes as they have different atomic masses. For example, hydrogen isotopes with atomic masses 1,2 and 3 should be placed at three places. However, isotopes have not been given separate places in the periodic table because of their similar properties.
iii. The atomic mass of elements is not increases in regular manner which is basic property of his periodic table. For example, he placed cobalt before nickle but atomic mass of Co is more than Ni.
iv. In certain pair of elements law of atomic weight is not obeyed as he tried to place elements with similar properties together. For example Ar has atomic mass 39.9 but K has atomic mass 39 but Ar placed before K and iodine with lower atomic weight than that of tellurium (Group VI) was placed in Group VII along with fluorine, chlorine, bromine because of similarities in properties.
v. He failed to explain the cause of periodicity among elements.

65. **Main features of long form of periodic table:**

i. **Groups.** The vertical columns in the periodic table are known as groups. There are 18 groups in the long form of periodic table. Each group having the same electronic configuration in the outermost shell.
ii. **Periods.** There are 7 periods in the long form of periodic table.
iii. It is denoted by n which means highest principal quantum number.
iv. **Lanthanoids.** Group of 14 elements in the sixth period. They are placed after Lanthanum.
v. **Actinides.** Group of 14 elements in the seventh period after actinium. Both Lanthanoids and actinoids are placed in separate panel at the bottom of the periodic table.

Advantages of long form of periodic table :

i. It gives a suitable link between the position of element and its electronic configuration.
ii. The elements in the same group have similar properties due to their outer- most (valence shell) configuration. Thus it gives is a logical classification.
iii. Justified positions are provided to transition and inner transition elements.
iv. It makes the study of elements systematic and simple.

66. Modern Periodic Table is better than Mendeleev's periodic table because:

- This table is based on more fundamental property i.e. atomic number.
- The position of hydrogen has been justified.
- It correlates position of the elements with their electron configurations clearly.
- Complete separation of metals and nonmetals has been achieved.
- The completion of each period is more logical i.e. as the atomic number increases, the energy shells gradually filled up to an inert gas configuration is reached.
- Due to separation of two subgroups, dissimilar elements are not placed together.