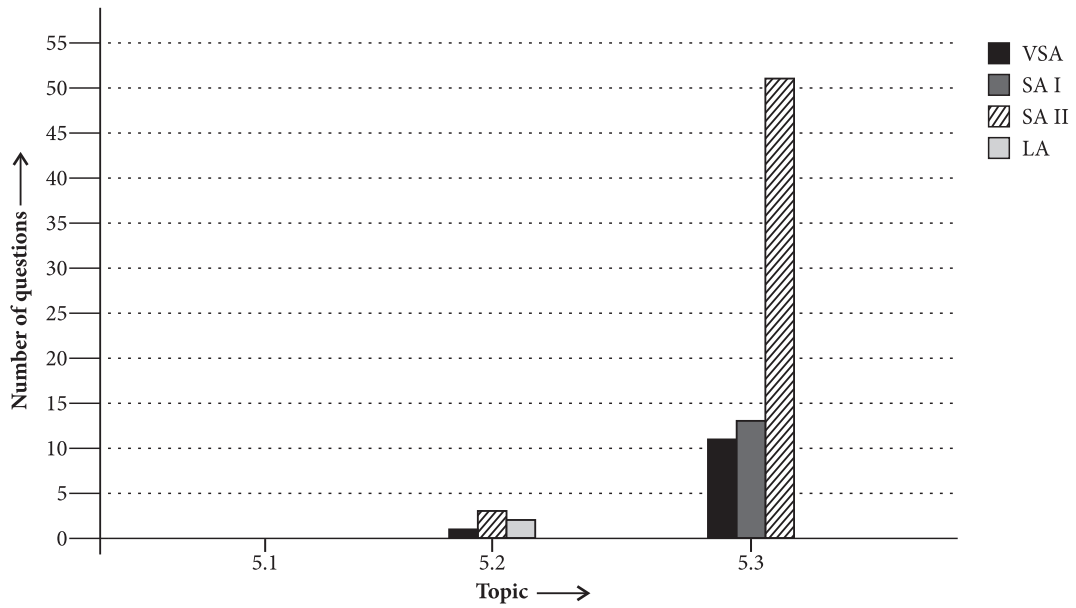
Chapter

5

Periodic Classification of Elements

Topicwise Analysis of Last 10 Years' CBSE Board Questions (2017-2008)



- Maximum weightage is of *Making Order Out of Chaos-The Modern Periodic Table.*
- Maximum VSA, SA I and SA II type questions were asked from Making Order Out of *Chaos-The Modern Periodic Table* .
- Maximum LA type questions were asked from *Mendeleev's Periodic Table.*

QUICK RECAP

- **Need for classification :** It is very difficult to study each and every element individually and also very difficult to know its properties and uses. Therefore, they have been classified into groups on the basis of their similarities in properties.
- **Early attempts at the classification of elements :**
  - **Dobereiner's triads :** According to this law, "when the elements are arranged in groups of three in increasing order of atomic masses, the middle element of a group has the atomic

mass and properties roughly the average of the other two elements." These elements show similarity in their properties.

e.g., :

Elements :	Li	Na	K
Atomic mass :	7	23	39

Average atomic mass of 1st and 3rd elements $= \frac{7+39}{2} = 23$

– **Limitations :** Only a limited number of elements could be arranged in such triads.

▸ **Newland's law of octaves :** It states that when elements are arranged in the order of increasing atomic masses, the properties of the eighth element are the repetition of the properties of the first element like the eighth note on a musical scale. Therefore, Li, Na and K resemble each other.

– **Limitations :** All the elements discovered at that time could not be classified into octaves. This law worked well with lighter elements only.

Mendeleev's periodic table : This table had been designed on the basis of a law called Mendeleev's periodic law which states that the properties of elements are periodic function of their atomic masses.

▸ **Groups :** The vertical columns of the periodic table are called '*groups*'. There are eight groups in this table.

Group →	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4		
Periods ↓	**A B**	**A B**	**A B**	**A B**	**A B**	**A B**	**A B**	**Transition series**		
1	H 1.008									
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998			
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453			
4 First series Second series	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 50.20 Se 78.96	Mn 54.94 Br 79.909	Fe 55.85	Co 58.93	Ni 58.71
5 First series Second series	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.82	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Tc 99 I 126.90	Ru 101.07	Rh 102.91	Pd 106.4
6 First series Second series	Ca 132.90 Au 196.97	Ba 137.34 Hg 200.59	La 138.91 Tl 204.37	Hf 178.49 Pb 207.19	Ta 180.95 Bi 208.98	W 183.85		Os 190.2	Ir 192.2	Pt 195.09

- **Periods :** The horizontal rows of the periodic table are called '*periods*'. There are six periods in this table.
- **Achievements of Mendeleev's periodic table :**
  - He classified all the 63 elements discovered at that time on the basis of similarities in their properties.
  - He left gaps for yet to be discovered elements.
  - He predicted the properties of undiscovered elements and thus, helped in the discovery of these elements later on.
  - He named them by prefixing a Sanskrit numeral eka (one), divi (two), tri (three), etc. to the name of the preceding similar element in the same group, *e.g.*, eka-boron, eka-aluminium, etc.
- **Limitations :**
  - Increasing order of atomic masses could not be maintained in all cases *e.g.*, cobalt with higher atomic mass was placed before nickel. Similarly, tellurium with higher atomic mass was placed before iodine.
  - This table did not provide place for noble gases which were discovered later.
  - There was no separate place for isotopes in Mendeleev's periodic table, although they differ in atomic masses.
  - He could not assign a correct position to hydrogen.

Modern periodic law : This law states that the properties of elements are a periodic function of their atomic numbers. This means that when elements are arranged in increasing order of their atomic numbers the properties of elements are repeated after certain regular intervals. This repetition of properties of elements after certain regular interval is known as '*periodicity in properties*'. This periodicity in properties of elements is due to periodicity in their outer electronic configurations. Infact, elements having similar outer-electronic configurations show similar chemical properties.

Modern periodic table : In the modern periodic table, the elements are arranged in increasing order of their atomic numbers. This table was prepared on the basis of electronic configurations of elements.

- **Position of elements in modern periodic table :** Modern periodic table consists of eighteen columns called '*groups*' and seven horizontal rows called '*periods*'. These groups are numbered from 1-18 and periods are numbered from 1-7.
- **Description of groups :**

Family of Elements	Group
Normal or representative elements	1 and 2 (left) 13 - 18 (right)
Alkali metals	1
Alkaline earth metals	2
Boron family	13
Carbon family	14
Nitrogen family or pnicogens	15
Oxygen family or chalcogens	16
Halogens	17
Inert gases or noble gases	18
Transition elements	3, 4, 5, 6, 7, 8, 9, 10, 11, 12

- **Description of periods :** The number of elements in any period is fixed by the maximum number of electrons that can be accommodated in that particular shell which is given by the formula, '$2n^2$' where 'n' is the number of the given shell starting from the nucleus.

Shell	'n'	Period	No. of Elements
K	1	First	2[$_1$H, $_2$He]
L	2	Second	8[$_3$Li, $_4$Be, $_5$B, $_6$C, $_7$N, $_8$O, $_9$F, $_{10}$Ne]

Metals | Metalloids | Non-metals

The zigzag line separates the metals from the non-metals.

s-block elements (Representative elements) — groups 1–2; *d*-block elements (Transition elements) — groups 3–12; *p*-block elements — groups 13–18 (Representative elements — groups 13–17; Noble gases 0, 18)

Periods (No. of elements)	IA 1	IIA 2	IIIB 3	IVB 4	VB 5	VIB 6	VIIB 7	VIII 8	9	10	IB 11	IIB 12	IIIA 13	IVA 14	VA 15	VIA 16	VIIA 17	0 18
1 (2) ($_1$H-$_2$He)	1 H Smallest atomic size																	2 He Highest ionisation potential
2 (8) ($_3$Li-$_{10}$Ne)	3 Li Lightest solid metal	4 Be											5 B Lightest solid non-metal	6 C Maximum catenation	7 N	8 O	9 F Highest electro negative	10 Ne
3 (8) ($_{11}$Na-$_{18}$Ar)	11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4(18) ($_{19}$K-$_{36}$Kr)	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 Liq. non-metal	36 Kr
5 (18) ($_{37}$Rb-$_{86}$Rn)	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 Most stable element	53 I Sublime on heating	54 Xe
6 (32) ($_{55}$Cs-$_{86}$Rn)	55 Cs Lowest electro-negative; lightest liq. metal	56 Ba	57 La	72 Hf	73 Ta	74 W Highest m.pt., b.pt. metal	75 Re	76 Os Heaviest solid metal	77 Ir	78 Pt (Noble Metals)	79 Au (Noble Metals)	80 Hg Lowest m.pt. metal	81 Tl	82 Pb	83 Bi	84 Po	85 At Heaviest solid non-metal	86 Rn Heaviest gaseous non-metal
7 (32) ($_{87}$Fr-$_{118}$Og)	87 Fr Liquid element of radio-active nature	88 Ra	89 Ac	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

f-block elements (Inner-transition elements)

Lanthanide series →	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 →	90 Th	91 Pa	92 U	93 Np	94 Pu Most poisonous element	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

M	3	Third	8[$_{11}$Na, $_{12}$Mg, $_{13}$Al, $_{14}$Si, $_{15}$P, $_{16}$S, $_{17}$Cl, $_{18}$Ar]
N	4	Fourth	18[$_{19}$K to $_{36}$Kr]
O	5	Fifth	18[$_{37}$Rb to $_{54}$Xe]
P	6	Sixth	32[$_{55}$Cs to $_{86}$Rn]
Q	7	Seventh	32[$_{87}$Fr to $_{118}$Og]

- In order to avoid the periodic table becoming too lengthy, two series of 14-elements each, have been placed at the bottom of the periodic table.
  - First series contains elements of atomic numbers 58–71 called '*Lanthanide series*'.
  - Second series contains elements of atomic numbers 90–103 called '*Actinide series*'.

Trends in the Modern periodic table : The physical and chemical properties of an element mainly depend upon its outer electronic configuration. Since the outer electronic configuration changes as we go from left to right in a period therefore, within the same period, elements show a gradation both in their physical as well as chemical properties.

These properties which show a regular gradation on moving from top to bottom within the same group or from left to right along a period are called '*atomic properties*'. *e.g.*, valency, atomic size, metallic or non-metallic character, etc.

- **Valency :** Valency is defined as the combining capacity of an element. It depends upon the number of valence electrons (electrons present in outermost shell of the atom).
  - **Variation of valency in a period :** On moving from left to right in a period, the number of valence electrons increases from 1 to 8 although in the first period, it increases from 1 to 2. *e.g.*,

$$\underset{2,8,1}{Na} \longrightarrow \underset{2,8}{Na^+} + e^- \quad \text{(Valency = 1)}$$

$$\underset{2,8,2}{Mg} \longrightarrow \underset{2,8}{Mg^{2+}} + 2e^- \quad \text{(Valency = 2)}$$

$$\underset{2,8,7}{Cl} + e^- \longrightarrow \underset{2,8,8}{Cl^-} \quad \text{(Valency = 8 – 7 = 1)}$$

In other words, in a period, the valency of an element is either equal to the number of electrons in the valence shell or eight minus the number of electrons in the valence shell.

  - **Variation of valency in a group :** All the elements in a group have same number of valence electrons. Therefore, the valency of all the elements in a group is fixed.

e.g., : group 1 elements have valency 1, group 17 elements have valency 1, group 18 elements have valency 0.

- **Atomic size :** If an atom is considered to be a sphere, the atomic size is given by the radius of the sphere, known as *atomic radius*. The atomic radius is defined as the distance between the centre of the nucleus and the outermost shell which contains electrons, in an isolated atom. It is expressed in angstrom (Å) or in picometers (pm).
  - **Variation of atomic radii in a period :** On moving from left to right in a period, the atomic radius decreases due to increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom. Example :

	Li	Be	B	C	N	O	F	Ne
Atomic radius (pm) :	152	111	88	77	75	74	72	160
								Biggest (van der Waals radius)

  - **Variation of atomic radii in a group :** On moving down the group, the atomic radii of elements increase gradually because new shells are being added. This increases the distance between outermost shell and the nucleus so that the atomic size increases in spite of the increase in nuclear charge. Example :

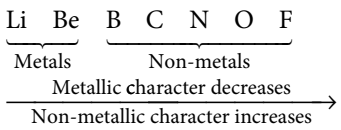
	Li	Na	K	Rb	Cs
Atomic radius (pm) :	152	186	231	246	262

- **Metallic and non-metallic character :** Group 1 to group 12 are metals. Group 13

to 18 consists of non-metals, metalloids and metals.

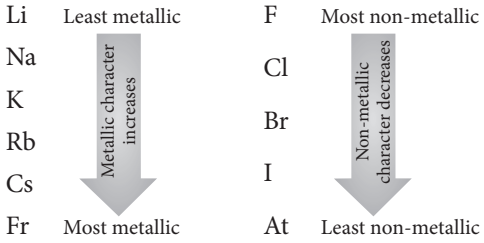
- Metals tend to lose electrons while forming bonds hence, they are electropositive in nature.
- Non-metals tend to form bonds by gaining electrons hence, they are electronegative in nature.
- **Metalloids :** Those elements which resemble both metals and non-metals *i.e.*, border line elements are called metalloids or semi-metals *e.g.*, boron, silicon, germanium, arsenic, tellurium and polonium.
- **Variation in a period :** On moving from left to right in a period, the metallic character decreases whereas the non-metallic character increases.

Example :



- **Variation in a group :** On moving down in a group, the metallic character increases.

  Reversely, on moving down a group, the non-metallic character decreases.



Previous Years' CBSE Board Questions

5.2 Making Order Out of Chaos-Mendeleev's Periodic Table

VSA (1 mark)

1. Why did Mendeleev have gaps in his periodic table? *(1/5, Delhi 2009)*

SA II (3 marks)

2. (a) Which two criteria did Mendeleev use to classify the elements in his periodic table?
(b) State Mendeleev's periodic law.
(c) Why could no fixed position be given to hydrogen in Mendeleev's periodic table? *(3/5, Delhi 2009)*

3. State any three limitations of Mendeleev's classification. *(3/5, Delhi 2009)*

4. What physical and chemical properties of elements were used by Mendeleef in creating his periodic table? List two observations which posed a challenge to Mendeleef's Periodic law. *(Delhi 2008)*

LA (5 marks)

5. On the basis of Mendeleev's periodic table given below, answer the questions that follow the table :

Group →	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**		
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4		
Periods ↓	**A B**	**A B**	**A B**	**A B**	**A B**	**A B**	**A B**	**Transition series**		
1	H 1.008									
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998			
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453			
4 First series Second series	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 50.20 Se 78.96	Mn 54.94 Br 79.909	Fe 55.85	Co 58.93	Ni 58.71
5 First series Second series	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.82	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Tc 99 I 126.90	Ru 101.07	Rh 102.91	Pd 106.4
6 First series Second series	Ca 132.90 Au 196.97	Ba 137.34 Hg 200.59	La 138.91 Tl 204.37	Hf 178.49 Pb 207.19	Ta 180.95 Bi 208.98	W 183.85		Os 190.2	Ir 192.2	Pt 195.09

(a) Name the element which is in
(i) 1st group and 3rd period
(ii) VIIth group and 2nd period.
(b) Suggest the formula for the following :
(i) oxide of nitrogen
(ii) hydride of oxygen
(c) In group VIII of the periodic table, why does cobalt with atomic mass 58.93 appear before nickel having atomic mass 58.71?
(d) Besides gallium, which two other elements have since been discovered for which Mendeleev had left gaps in his Periodic Table?
(e) Using atomic masses of Li, Na and K, find the average atomic mass of Li and K and compare it with the atomic mass of Na. State the conclusion drawn from this activity. *(AI 2008)*

6. (a) Why do we classify elements?
(b) What were the two criteria used by Mendeleev in creating his Periodic Table?
(c) Why did Mendeleev leave some gaps in his Periodic Table?
(d) In Mendeleev's Periodic Table, why was there no mention of noble gases like helium, neon and argon?
(e) Would you place the two isotopes of chlorine, Cl-35 and Cl-37 in different slots because of their different atomic masses or in the same slot because their chemical properties are the same? Justify your answer. *(AI 2008)*

5.3 Making Order Out of Chaos-The Modern Periodic Table

VSA (1 mark)

7. Write the number of vertical columns in the Modern Periodic Table. What are these columns called? *(Delhi 2014, 2013)*

8. Write the number of horizontal rows in the Modern Periodic Table. What are these rows called? *(Delhi 2014)*

9. Write any one difference in the electronic configurations of group 1 and group 2 elements. *(Delhi 2014)*

10. List any two properties of the elements belonging to the first group of the Modern Periodic Table. *(AI 2014)*

11. Write the atomic numbers of two elements '*X*' and '*Y*' having electronic configurations 2, 8, 2 and 2, 8, 6 respectively. *(AI 2014)*

12. The atomic numbers of three elements *A*, *B* and *C* are 12, 18 and 20 respectively. State giving reason, which two elements will show similar properties. *(AI 2014)*

13. State the Modern periodic law of classification of elements. *(Foreign 2014)*

14. Out of the three elements *P*, *Q* and *R* having atomic numbers 11, 17 and 19 respectively, which two elements will show similar properties and why? *(Foreign 2014)*

15. Write the formula used to determine the maximum number of electrons which a shell in an atom can accommodate. *(Foreign 2014)*

16. What is the valency of silicon with atomic number 14? *(Foreign 2010)*

17. How does electronic configuration of atoms change in a period with increase in atomic number? *(1/5, Delhi 2009)*

SA I (2 marks)

18. An element '*X*' has atomic number 13 :
(a) Write its electronic configuration.
(b) State the group to which '*X*' belongs?
(c) Is '*X*' a metal or a non-metal?
(d) Write the formula of its bromide.
(Delhi 2012)

19. How can the valency of an element be determined if its electronic configuration is known? What will be the valency of an element of atomic number 9(nine)?
(Delhi 2012, 2011)

20. Choose from the following :
$_{6}C$, $_{8}O$, $_{10}Ne$, $_{11}Na$, $_{14}Si$
(i) Elements that should be in the same period.
(ii) Elements that should be in the same group.
State reason for your selection in each case.
(AI 2012)

21. An element '*X*' belongs to 3rd period and group 17 of the periodic table. State its (i) electronic configuration, (ii) valency. Justify your answer with reason. *(AI 2012)*

22. Choose from the following :
$_4Be$, $_9F$, $_{19}K$, $_{20}Ca$
(i) The element having one electron in the outermost shell.
(ii) Two elements of the same group.
(Foreign 2012)

23. An element has atomic number 13.
(a) What is the group and period number to which this element belongs?
(b) Is this element a metal or a non-metal? Justify your answer. *(Foreign 2012)*

24. How does the electronic configuration of an atom of an element relate to its position in the Modern Periodic Table? Explain with one example. *(Delhi 2011)*

25. How does the valency of elements vary (i) in going down a group, and (ii) in going from left to right in a period of the periodic table? *(AI 2011)*

26. In the Modern Periodic Table, the element calcium (atomic number = 20) is surrounded by elements with atomic numbers 12, 19, 21 and 38. Which of these elements has physical and chemical properties resembling those of calcium and why? *(AI 2011)*

27. In the periodic table, how does the tendency of atoms to loose electrons change on going from
(i) left to right across a period?
(ii) top to bottom in a group?
(Foreign 2011)

28. What is meant by periodicity of properties of elements? Why are the properties of elements placed in the same group of the periodic table similar? *(Foreign 2011)*

29. Elements magnesium and oxygen respectively belong to group 2 and group 16 of the Modern Periodic Table. If the atomic numbers of magnesium and oxygen are 12 and 8 respectively, draw their electronic configuration and show the process of formation of their compound by transfer of electrons. *(Foreign 2010)*

30. How and why does the atomic size vary as you go :
(i) from left to right along a period?
(ii) down a group? *(2/5, Delhi 2009)*

SA II (3 marks)

31. Write the names given to the vertical columns and horizontal rows in the Modern Periodic Table. How does the metallic character of elements vary on moving down a vertical column? How does the size of atomic radius vary on moving left to right in a horizontal row? Give reason in support of your answer in the above two cases. *(Delhi 2017)*

32. An element *P* (atomic number 20) reacts with an element *Q* (atomic number 17) to form a compound. Answer the following questions giving reason :
Write the position of *P* and *Q* in the Modern Periodic Table and the molecular formula of the compound formed when *P* reacts with *Q*.
(Delhi 2017)

33. Write the number of periods and groups in the Modern Periodic Table. How does the metallic character of elements vary on moving (i) from left to right in a period, and (ii) down a group? Give reason to justify your answer. *(AI 2017)*

34. Na, Mg and Al are the elements of the 3^{rd} periods of the Modern Periodic Table having group number 1, 2 and 13 respectively. Which one of these elements has the (a) highest valency, (b) largest atomic radius, and (c) maximum chemical reactivity? Justify your answer stating the reason for each.
(AI 2017)

35. Calcium is an element with atomic number 20. Stating reason answer each of the following questions :
(i) Is calcium a metal or non-metal?
(ii) Will its atomic radius be larger or smaller than that of potassium with atomic number 19?
(iii) Write the formula of its oxide.
(Delhi 2016)

36. An element *M* with electronic configuration (2, 8, 2) combines separately with $(NO_3)^-$, $(SO_4)^{2-}$ and $(PO_4)^{3-}$ radicals. Write the formula of the three compounds so formed. To which group and period of the Modern Periodic Table does the element *M* belong? Will *M* form covalent or ionic compounds? Give reason to justify your answer.
(Delhi 2016)

37. Name any two elements of group one and write their electronic configurations. What similarity do you observe in their electronic configurations? Write the formula of oxide of any of the aforesaid element.

(Delhi 2016)

38. Two elements *A* and *B* belong to the 3rd period of Modern Periodic Table and are in group 2 and 13 respectively. Compare their following characteristics in tabular form.

(a) Number of electrons in their atoms
(b) Size of their atoms
(c) Their tendencies to loose electrons
(d) The formula of their oxides
(e) Their metallic characters
(f) The formula of their chlorides

(Delhi 2016)

39. An element '*X*' belongs to 3rd period and group 16 of the Modern Periodic Table.

(a) Determine the number of valence electrons and the valency of '*X*'.
(b) Molecular formula of the compound when '*X*' reacts with hydrogen and write its electron dot structure.
(c) Name the element '*X*' and state whether it is metallic or non-metallic.

(AI 2016)

40. An element '*X*' has mass number 35 and number of neutrons 18. Write atomic number and electronic configuration of '*X*'. Also write group number, period number and valency of '*X*'. *(AI 2016)*

41. Three elements '*X*', '*Y*' and '*Z*' have atomic numbers 7, 8 and 9 respectively.

(a) State their positions (group number and period number both) in the Modern Periodic Table.
(b) Arrange these elements in the decreasing order of their atomic radii.
(c) Write the formula of the compound formed when '*X*' combines with '*Z*'.

(AI 2016)

42. The position of eight elements in the Modern Periodic Table is given below where atomic numbers of elements are given in the parenthesis.

Period No.		
2	Li (3)	Be (4)
3	Na (11)	Mg (12)
4	K (19)	Ca (20)
5	Rb (37)	Sr (38)

(i) Write the electronic configuration of Ca.
(ii) Predict the number of valence electrons in Rb.
(iii) What is the number of shells in Sr?
(iv) Predict whether K is a metal or a non-metal?
(v) Which one of these elements has the largest atom in size?
(vi) Arrange Be, Ca, Mg and Rb in the increasing order of the size of their respective atoms. *(AI 2016)*

43. An element '*X*' belongs to 3rd period and group 13 of the Modern Periodic Table.

(a) Determine the valence electrons and the valency of '*X*'.
(b) Molecular formula of the compound formed when '*X*' reacts with an element '*Y*' (atomic number = 8)
(c) Write the name and formula of the compound formed when '*X*' combines with chlorine. *(AI 2016)*

44. State the main aim of classifying elements. Which is the more fundamental property of elements that is used in the development of Modern Periodic Table? Name and state the law based on this fundamental property. On which side of the periodic table one can find metals, non-metals and metalloids?

(Foreign 2016)

45. An element '*X*' (atomic number 20) burns in the presence of oxygen to form a basic oxide.

(a) Identify the element and write its electronic configuration.
(b) State its group number and period number in the Modern Periodic Table.
(c) Write a balanced chemical equation for the reaction when this oxide is dissolved in water. *(Foreign 2016)*

46. An element '*X*' belongs to third period and second group of the Modern Periodic Table.

(a) Write its electronic configuration.
(b) Is it a metal or non-metal? Why?

(c) Write the formula of the compound formed when '*X*' reacts with an element (i) *Y* of electronic configuration 2, 6 and (ii) *Z* of electronic configuration 2, 8, 7. *(Foreign 2016)*

47. The atomic number of an element *X* is 19.
(a) Write its electronic configuration.
(b) To which period of the Modern Periodic Table does it belong and what is its valency?
(c) If '*X*' burns in oxygen to form its oxide, what will be its nature - acidic, basic or neutral?
(d) Write balanced chemical equation for the reaction when this oxide is dissolved in water. *(Foreign 2016)*

48. How does the tendency of the elements to loose electrons change in the Modern Periodic Table in (i) a group, (ii) a period and why? *(Foreign 2016)*

49. How many groups and periods are there in the Modern Periodic Table? How do the atomic size and metallic character of elements vary as we move :
(a) down a group and
(b) from left to right in a period? *(Delhi 2015)*

50. Na, Mg and Al are the elements of the same period of Modern Periodic Table having one, two and three valence electrons respectively. Which of these elements (i) has the largest atomic radius, (ii) is least reactive? Justify your answer stating reason for each case. *(Delhi 2015, AI 2012)*

51. From the following elements :
$_4$Be; $_9$F; $_{19}$K; $_{20}$Ca
(i) Select the element having one electron in the outermost shell.
(ii) Two elements of the same group.

Write the formula and mention the nature of the compound formed by the union of $_{19}$K and element *X* (2, 8, 7). *(Delhi 2015)*

52. Write the number of periods the Modern Periodic Table has. State the changes in valency and metallic character of elements as we move from left to right in a period. Also state the changes, if any, in the valency and atomic size of elements as we move down a group. *(Delhi 2015, 2013)*

53. Two elements '*P*' and '*Q*' belong to the same period of the Modern Periodic Table and are in Group-1 and Group-2 respectively. Compare their following characteristics in tabular form :
(a) The number of electrons in their atoms.
(b) The sizes of their atoms.
(c) Their metallic character.
(d) Their tendencies to loose electrons.
(e) The formula of their oxides.
(f) The formula of their chlorides. *(AI 2015)*

54. Taking the example of an element of atomic number 16, explain how the electronic configuration of the atom of an element relates to its position in the Modern Periodic Table and how valency of an element is calculated on the basis of its atomic number. *(AI 2015)*

55. Given below are some elements of the Modern Periodic Table. Atomic number of the element is given in the parentheses :
A(4), *B*(9), *C*(14), *D*(19), *E*(20)
(a) Select the element that has one electron in the outermost shell. Also write the electronic configuration of this element.
(b) Which two elements amongst these belong to the same group? Give reason for your answer.
(c) Which two elements amongst these belong to the same period? Which one of the two has bigger atomic radius? *(AI 2015)*

56. The atomic number of an element '*X*' is 20.
(i) Determine the position of the element '*X*' in the periodic table.
(ii) Write the formula of the compound formed when '*X*' reacts/combines with another elements '*Y*' (atomic number 8).
(iii) What would be the nature (acidic or basic) of the compound formed? Justify your answer. *(Foreign 2015)*

57. An element '*X*' is placed in the 3rd group and 3rd period of the Modern Periodic Table. Answer the following questions stating reason for your answer in each case :
(a) Write the electronic configuration of the element '*X*'.
(b) Write the formula of the compound formed when the element '*X*' reacts with another element '*Y*' of atomic number 17.

(c) Will the oxide of this element be acidic or basic ? *(Foreign 2015)*

58. Four elements *P, Q, R* and *S* belong to the third period of the Modern Periodic Table and have respectively 1, 3, 5 and 7 electrons in their outermost shells. Write the electronic configurations of *Q* and *R* and determine their valencies. Write the molecular formula of the compound formed when *P* and *S* combine. *(Foreign 2015)*

59. In the following table, the positions of six elements *A, B, C, D, E* and *F* are given as they are in the Modern Periodic Table :

Group → / Period ↓	1	2	3-12	13	14	15	16	17	18
2	*A*			*B*		*C*			*D*
3					*E*				*F*

On the basis of the above table, answer the following questions :

(i) Name the element which forms only covalent compounds.

(ii) Name the element which is a metal with valency three.

(iii) Name the element which is a non-metal with valency three.

(iv) Out of *B* and *C*, whose atomic radius is bigger and why?

(v) Write the common name for the family to which the elements *D* and *F* belong. *(Foreign 2015)*

60. Based on the group valency of elements state the formula for the following giving justification for each :

(i) Oxides of 1st group elements,

(ii) Halides of the elements of group-13, and

(iii) Compounds formed when an element of group-2 combines with an element of group-16. *(Delhi 2014)*

61. (a) Define the following terms :
(i) Valency; (ii) Atomic size

(b) How do the valency and the atomic size of the elements vary while going from left to right along a period in the Modern Periodic Table? *(Delhi 2014)*

62. Consider two elements *X* (atomic number 17) and *Y* (atomic number 20).

(i) Write the positions of these elements in the Modern Periodic Table giving justification.

(ii) Write the formula of the compound formed by the combination of *X* and *Y*.

(iii) Draw the electron-dot structure of the compound formed and state the nature of the bond formed between the two elements. *(Delhi 2014)*

63. Consider two elements '*A*' (Atomic number 17) and '*B*' (Atomic number 19).

(i) Write the positions of these elements in the Modern Periodic Table giving justification.

(ii) Write the formula of the compound formed when '*A*' combines with '*B*'.

(iii) Draw the electron dot structure of the compound and state the nature of the bond formed between the two elements. *(Delhi 2014)*

64. The electrons in the atoms of four elements *A*, *B*, *C* and *D* are distributed in the three shells having 1, 3, 5 and 7 electrons in the outermost shell respectively. State the period in which these elements can be placed in the Modern Periodic Table. Write the electronic configuration of the atoms of *A* and *D* and the molecular formula of the compound formed when *A* and *D* combine. *(AI 2014)*

65. Study the following table in which positions of six elements *A*, *B*, *C*, *D*, *E* and *F* are shown as they are in the Modern Periodic Table :

On the basis of the above table, answer the following questions :

Group → / Period ↓	1	2	3-12	13	14	15	16	17	18
2	*A*					*B*			*C*
3				*D*	*E*				*F*

(i) Name the element which forms only covalent compounds.

(ii) Name the element which is a metal with valency three.

(iii) Name the element which is a non-metal with valency three.

(iv) Out of *D* and *E*, which is bigger in size and why?
(v) Write the common name for the family to which the elements *C* and *F* belong.
(AI 2014)

66. What is meant by 'group' in the Modern Periodic Table? How do the following change on moving from top to bottom in a group?
(i) Number of valence electrons.
(ii) Number of occupied shells.
(iii) Size of atoms.
(iv) Metallic character of elements.
(v) Effective nuclear charge experienced by valence electrons. *(AI 2014)*

67. The elements Be, Mg and Ca each having two electrons in their outermost shells are in periods 2, 3 and 4 respectively of the Modern Periodic Table. Answer the following questions, giving justification in each case :
(i) Write the group to which these elements belong.
(ii) Name the least reactive element.
(iii) Name the element having largest atomic radius. *(AI 2014)*

68. What are groups and periods in the periodic table? Two elements *X* and *Y* belong to group 1 and 2 respectively and are in the same period of the periodic table. How do the following properties of *X* and *Y* vary?
(i) Size of their atoms.
(ii) Their metallic character.
(iii) Their valencies in forming oxides.
(iv) Molecular formula of their chlorides.
(Foreign 2014)

69. Write the number of groups and periods in the Modern Periodic Table. Mention the criteria of placing elements in the (i) same group and (ii) same period. Illustrate your answer with an example for each case.
(Foreign 2014, Delhi 2013C)

70. Study the following table in which positions of six elements *A*, *B*, *C*, *D*, *E* and *F* are shown as they are in the Modern Periodic Table :

Group → / Period ↓	1	2	3-12	13	14	15	16	17	18
2		*A*					*B*		*C*
3	*D*				*E*				*F*

On the basis of the above table, answer the following questions :
(i) Name the element which will form only covalent compounds.
(ii) Which element is a metal with valency one?
(iii) Which element is a non-metal with valency two?
(iv) Out of *D* and *E*, which has a bigger atomic radius and why?
(v) Write the formula of the compound formed when *B* combines with *D*.
(Foreign 2014)

71. The electronic configuration of an element is 2, 8, 8, 1.
(i) State its group number and period number in the Modern Periodic Table.
(ii) State whether this element is a metal or a non-metal.
Give reason for the justification of your answer in each case. *(Foreign 2014)*

72. Given below are some elements of the Modern Periodic Table :
$_4$Be, $_9$F, $_{14}$Si, $_{19}$K, $_{20}$Ca
(i) Select the element that has one electron in the outermost shell and write its electronic configuration.
(ii) Select two elements that belong to the same group. Give reasons for your answer.
(iii) Select two elements that belong to the same period. Which one of the two has bigger atomic size? *(Delhi 2013)*

73. An element '*X*' belongs to the third period and group one of the Modern Periodic Table. Find (i) the number of its valence electrons (ii) its valency, and (iii) whether *X* is a metal or a non-metal. State reasons to justify your answer in each case. *(Delhi 2013C)*

74. F, Cl and Br are the elements each having seven valence electrons. Which of these (i) has the largest atomic radius, (ii) is most reactive? Justify your answer stating reason for each. *(Delhi 2012)*

75. (a) How many periods are there in the Modern Periodic Table of elements?

(b) How do atomic radius, valency and metallic character vary down a group?

(c) How do the atomic size and metallic character of elements vary as we move from left to right in a period?

(Foreign 2012)

76. The atomic number of an element is 16. Predict

(i) the number of valence electrons in its atom

(ii) its valency

(iii) its group number

(iv) whether it is a metal or a non-metal

(v) the nature of oxide formed by it

(vi) the formula of its chloride. *(AI 2011)*

77. The positions of three elements *A*, *B* and *C* in the periodic table are indicated below :

Group 16	Group 17	
–	–	(First period)
–	*A*	(Second period)
–	–	(Third period)
B	*C*	(Fourth period)

(a) State whether element *C* would be a metal or a non-metal? Why?

(b) Which is the more active element *A* or *C*? Why?

(c) Which type of ion (cation or anion) will be formed by the element *C*? Why?

(Foreign 2011)

78. Atoms of eight elements *A*, *B*, *C*, *D*, *E*, *F*, *G* and *H* have the same number of electronic shells but different number of electrons in their outermost shell. It was found that elements *A* and *G* combine to form an ionic compound. This compound is added in a small amount to almost all vegetable dishes during cooking. Oxides of elements *A* and *B* are basic in nature while those of *E* and *F* are acidic. The oxide of *D* is almost neutral. Based on the above information answer the following questions :

(i) To which group or period of the periodic table do the listed elements belong?

(ii) What would be the nature of compound formed by a combination of elements *B* and *F*?

(iii) Which two of these elements could definitely be metals?

(iv) Which one of the eight elements is most likely to be found in gaseous state at room temperature?

(v) If the number of electrons in the outermost shell of elements *C* and *G* be 3 and 7 respectively, write the formula of the compound formed by the combination of *C* and *G*. *(Delhi 2010)*

79. In the following table six elements *A*, *B*, *C*, *D*, *E* and *F* (here letters are not the usual symbols of the elements) of the Modern Periodic Table with atomic number 3 to 18 are given :

3 *A*	4	5	6	7	8 *E*	9	10 *G*
11 *B*	12 *C*	13	14 *D*	15	16	17 *F*	18

(a) Which of these (i) a noble gas, (ii) a halogen?

(b) If *B* combines with *F*, what would be the formula of the compound formed?

(c) Write the electronic configurations of *C* and *E*. *(Foreign 2010)*

80. (a) What is meant by periodicity in properties of elements with reference to the periodic table?

(b) Why do all the elements of the same group have similar properties?

(c) How will the tendency to gain electrons change as we go from left to right across a period? Why? *(AI 2009)*

81. (a) What are 'groups' and 'periods' in the 'periodic table'?

(b) Two elements *M* and *N* belong to groups I and II respectively and are in the same period of the periodic table. How do the following properties of *M* and *N* vary?

(i) Sizes of their atoms.

(ii) Their metallic characters.

(iii) Their valencies in forming oxides.

(iv) Molecular formula of their chlorides.

(Foreign 2009)

Detailed Solutions

1. Mendeleev placed elements with similar properties one below the other leaving gaps for elements which could match with other elements of that group but had not been discovered by that time.

2. (a) Two criteria used by Mendeleev to classify elements are :

(i) Atomic mass

(ii) Similarity in chemical properties

(b) Mendeleev's periodic law states that the properties of elements are the periodic function of their atomic masses.

(c) There is no fixed position given to hydrogen in Mendeleev's periodic table because properties of hydrogen resemble both to alkali metals and to halogens.

3. Three limitations of Mendeleev's classification are :

(i) The position of isotopes could not be explained.

Isotopes are the atoms of the same element having similar chemical properties but different atomic masses. If the elements are arranged according to their atomic masses, the isotopes should be placed in different groups. But isotopes were not given separate places in Mendeleev's periodic table.

(ii) Wrong order of atomic masses of some elements could not be explained.

When certain elements were put in their correct groups on the basis of their chemical properties, it was found in some cases that the element with higher atomic mass comes first and the element with lower atomic mass comes later.

e.g., cobalt (at. wt. = 58.9) comes before nickel (at. wt. = 58.7).

(iii) There is no fixed position given to hydrogen in Mendeleev's periodic table because properties of hydrogen resemble both to alkali metals and to halogens.

4. Atomic masses and similarity in physical and chemical properties are the points used by Mendeleef in creating his periodic table.

The two observations that posed a challenge in Mendeleef periodic law are :

(i) Increasing order of atomic weights could not be maintained while matching chemical properties.

(ii) Isotopes have different atomic masses but have similar chemical properties.

5. (a) (i) Sodium (Na) belongs to 1^{st} group and 3^{rd} period.

(ii) Fluorine (F) belongs to VII^{th} group and 2^{nd} period.

(b) (i) Oxide of nitrogen will have the formula N_2O_5.

(ii) Hydride of oxygen will have the formula H_2O.

(c) In the Mendeleev's periodic table (which is based on the increasing atomic masses) cobalt (atomic wt. 58.93) appears before nickel (atomic wt. 58.71) because cobalt resembles with rhodium (Rh) and iridium (Ir) whereas nickel (Ni) resembles with palladium (Pd) and platinum (Pt) in properties.

(d) Besides gallium, germanium and scandium are the two elements which have been discovered for which Mendeleev had left gaps in his periodic table.

(e) Atomic mass of Li = 6.939
Atomic mass of Na = 22.99
Atomic mass of K = 39.102

$$\text{Average atomic mass of Li and K} = \frac{6.939 + 39.102}{2}$$
$$= 23.0205 \ (\approx \text{at. mass of Na } \textit{i.e.}, 22.99)$$

Thus, the atomic mass of Na is average of the atomic masses of Li and K and these elements resemble each other. The calculated average mass of Na is close to its actual mass.

6. (a) We classify elements so as to study the properties of elements conveniently.

(b) *Refer to answer 2 (a).*

(c) *Refer to answer 1.*

(d) In Mendeleev's periodic table, there was no mention of noble gases like helium, neon and argon because they were not discovered at that time.

(e) Two isotopes of chlorine Cl-35 and Cl-37 should be kept in the same slot as they have same chemical properties.

7. There are 18 vertical columns in the Modern periodic table which are called groups.

8. There are seven horizontal rows of elements in the Modern periodic table which are known as periods.

9. Group 1 elements have one electron in their outermost shell while group 2 elements have two electrons in their outermost shell.

10. Two properties of the elements belonging to the first group :
(i) As the elements belong to group 1, so they have one electron in their outermost shell hence, valency of these elements is one.
(ii) Alkali metals (group 1 elements) are electropositive in nature.

11. Electronic configuration of X = 2, 8, 2
$\therefore$ Atomic number = 2 + 8 + 2 = 12
Similarly,
Electronic configuration of Y = 2, 8, 6
$\therefore$ Atomic number = 2 + 8 + 6 = 16

12. Atomic number of A = 12
$\therefore$ Electronic configuration = 2, 8, 2
Similarly, for B(18) = 2, 8, 8
for C(20) = 2, 8, 8, 2
As elements A and C contain two valence electrons in their outermost shell (group-2) they will show similar properties.

13. Modern periodic law states that the physical and chemical properties of elements are the periodic function of their atomic numbers.

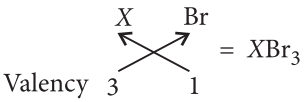
14. Atomic number of P = 11
Electronic configuration of P = 2, 8, 1
Electronic configuration of Q(17) = 2, 8, 7
and for R(19) = 2, 8, 8, 1
Thus, from electronic configurations of P and R, it is observed that they belong to group 1 as both have one valence electron and have valency equal to 1. Thus, P and R will have similar properties.

15. The maximum number of electrons that can be accommodated in a shell, is given by the formula $2n^2$, where 'n' is the number of the shell.

16. Atomic number of silicon = 14
Electronic configuration = 2, 8, 4
As silicon (Si) contains four electrons in its outermost shell, its valency will be four.

17. One electron each is added successively to the same valence shell as we move from left to right in the period. Due to this increase in valence electrons, the electronic configuration of atoms changes with increase in atomic number.

18. X has atomic number = 13
(a) Electronic configuration of X = 2, 8, 3
(b) As X contains 3 valence electrons in its outermost shell, it belongs to group 13.
(c) X is a metal as it contains 3 valence electrons which can be lost easily.
(d) Formula of X with bromine will be



$= XBr_3$

19. Valency of an element is determined by the number of electrons present in its outermost shell. For elements having outermost electrons 1 to 4, valencies are equivalent to their respective valence electrons.
For elements having outermost electrons 5 to 8, valency is calculated as;
Valency = 8 – (Number of valence electrons)
For element having atomic number = 9
Electronic configuration = 2, 7
Valency = 8 – 7 = 1

20. The electronic configurations of the given elements are :
$_6C$ = 2, 4
$_8O$ = 2, 6
$_{10}Ne$ = 2, 8
$_{11}Na$ = 2, 8, 1
$_{14}Si$ = 2, 8, 4
(i) $_6C$, $_8O$, $_{10}Ne$, all contain two shells hence, they belong to same period *i.e.*, second period.
$_{11}Na$, $_{14}Si$ both contain three shells hence, they belong to third period.
($_6C$, $_8O$, $_{10}Ne$) $\Rightarrow$ period number 2
($_{11}Na$, $_{14}Si$) $\Rightarrow$ period number 3
(ii) $_6C$ and $_{14}Si$ belong to the same group as they both contain 4 electrons in their outermost shell. Thus, $_6C$ and $_{14}Si$ belong to group 14.

21. As element X belongs to group 17, it will have 7 electrons in its outermost shell. Moreover, X belongs to period number 3 so, it will have 3 shells.
(i) Electronic configuration of X = 2, 8, 7
(ii) Valency of element X
= 8 – (Number of valence electrons)
= 8 – 7 = 1

22. The electronic configurations of the given elements are :

$_4$Be = 2, 2
$_9$F = 2, 7
$_{19}$K = 2, 8, 8, 1
$_{20}$Ca = 2, 8, 8, 2

(i) Potassium (K) has one electron in its outermost shell.
(ii) Be and Ca have two electrons in their outermost shells hence, they belong to same group.

23. Atomic number of element = 13
Thus, its electronic configuration = 2, 8, 3
(a) From the electronic configuration, it can be easily seen that there are 3 electrons in the outermost shell which indicates that it belongs to group number 10 + 3 = 13.
Moreover, the element has 3 shells in which electrons are filled thus, it belongs to period number 3.
(b) As the element contains 3 valence electrons which can be easily lost thus, it is a metal.

24. Electronic configuration of an element decides its position in Modern periodic table.
Lets take an example of sodium (Na).
Atomic number of sodium = 11
Thus, electronic configuration of Na = 2, 8, 1
As Na contains 1 electron in its outermost shell, it belongs to group 1. Sodium contains 3 shells so, it belongs to period number 3.
Thus, we can conclude that
Group number = Number of valence electrons
(When valence electrons are 1 and 2)
and group number = 10 + valence electrons
(When valence electrons are 3 and above)
Period number = Number of shells in which electrons are filled.

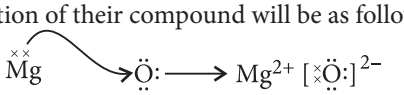
25. (i) When we go down the group the valency of elements remains same.
(ii) When we move along the period from left to right, the valency of elements first increases and then decreases.

26. From the given data, the electronic configuration of different elements can be written as :
Calcium (20) = 2, 8, 8, 2
Element with atomic number 12 = 2, 8, 2
Element with atomic number 19 = 2, 8, 8, 1
Element with atomic number 21 = 2, 8, 8, 3
Element with atomic number 38 = 2, 8, 18, 8, 2
It can be easily seen that elements with atomic numbers 12 and 38 have two electrons in their outermost shell thus, they belong to same group as that of calcium. So, they will show the physical and chemical properties resembling those of calcium.

27. (i) Tendency of atoms to loose electrons decreases from left to right in a period due to increase in effective nuclear charge.
(ii) Tendency of atoms to loose electrons increases down the group due to increase in atomic radii.

28. When elements are arranged in increasing order of their atomic numbers, elements with similar chemical properties are repeated at definite intervals. This is known as periodicity of properties of elements.
Elements placed in the same group of the periodic table have similar properties because they have same number of outermost electrons and hence, show same valency. Thus, they all will form similar type of compounds.

29. Atomic number of magnesium = 12
$\therefore$ Electronic configuration = 2, 8, 2
Valency of magnesium (Mg) = 2
Similarly, for oxygen (O) atomic number = 8
Electronic configuration = 2, 6
Valency of oxygen = 8 – 6 = 2
Formation of their compound will be as follows :



30. (i) As we go from left to right across the period, the atomic size of the elements decreases. At each successive element, there is addition of one electron in the same shell due to which there is an increase in nuclear charge. Thus, there is an increase in attraction between nucleus and the valence electrons which results in decreasing atomic size.
(ii) On moving down the group, the atomic size increases due to addition of new shell at each successive element.

31. In Modern periodic table, there are 18 vertical columns called groups and 7 horizontal rows called periods.
The elements which have a greater tendency to loose electrons are more metallic thus, the metallic

character of elements increases down the group as their tendency to loose electrons increases.

Atomic radius decreases as we move from left to right in a horizontal row. At each successive element, the electron enters to the same shell due to which there is increase in nuclear charge and the electrons are pulled with greater attractive force. Hence, the atomic size decreases.

32. Atomic number of $P = 20$

$\therefore$ Electronic configuration of $P = 2, 8, 8, 2$

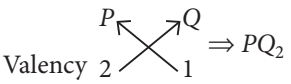
Atomic number of $Q = 17$

$\therefore$ Electronic configuration of $Q = 2, 8, 7$

As P contains 4 shells, it belongs to 4^{th} period and due to presence of two valence electrons, it belongs to 2^{nd} group.

Similarly, Q contains 3 shells and 7 valence electrons thus, it belongs to 3^{rd} period and 17^{th} (10 + 7) group.

The molecular formula of compound formed when P reacts with Q will be :



$\Rightarrow PQ_2$

33. In the Modern periodic table, there are 18 vertical columns called groups and 7 horizontal rows called periods.

Trend of metallic character :

(i) Along the period from left to right : Metallic character of elements decreases as we move from left to right in a period. Metallic character depends on the electropositive character (tendency to loose electrons) of the elements. As we go across the period from left to right, one electron is added to same shell at every stage which increases the effective nuclear charge and hence, valence electrons becomes more and more closer to the nucleus. Due to this, the tendency of atoms to loose valence electrons and form positive ions decreases. Hence, electropositive character decreases resulting in decrease of metallic character.

(ii) Down the group : Metallic character of elements increases on moving down the group as the electropositive character increases down the group.

34. Period number of Na, Mg and Al = 3

Group number of Na, Mg and Al are 1, 2 and 13 respectively.

(a) Aluminium (Al) will show highest valency of +3 as it belongs to group number 13 (valency = 13 – 10 = 3). Moreover, along the period from left to right valency first increases to maximum (+4) and then decreases.

(b) Sodium (Na) will have the largest atomic radius because as we move along the period from left to right, the atomic radius decreases.

(c) Sodium (Na) will have maximum chemical reactivity because as we move along the period from left to right, chemical reactivity decreases.

35. Given that, atomic number of calcium is 20.

So, its electronic configuration = 2, 8, 8, 2

(i) As, it has 2 valence electrons in the outermost shell which can be easily lost, so it is a metal.

(ii) Atomic number of K (potassium) is 19 so, it is placed before Ca(20) in the same period.

On moving from left to right in a period, the atomic radius decreases.

Hence, atomic radius of Ca(20) will be smaller than that of K(19).

(iii) The valency of calcium as well as oxygen is 2 thus, the formula of the oxide will be CaO.

36. Electronic configuration of M is 2, 8, 2 which shows that it belongs to group 2 and period 3 of the Modern periodic table.

As it has 2 valence electrons, so the valency of element M will be 2.

The chemical formulae of the compounds formed will be

$M(NO_3)_2$, MSO_4, $M_3(PO_4)_2$

As M has two valence electrons, it can easily loose these electrons to attain a noble gas configuration. Hence, M will form ionic compounds.

37. Two elements of group 1 are sodium (Na) and potassium (K).

Electronic configuration of Na (11) = 2, 8, 1

Electronic configuration of K (19) = 2, 8, 8, 1

From the electronic configuration, we observe that both (Na and K) have one electron in outermost shell due to which they have valency equal to one.

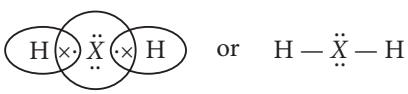
Thus, formula of their oxides are, Na_2O and K_2O.

38. Electronic configuration of A = 2, 8, 2 *i.e.*, Mg

Electronic configuration of B = 2, 8, 3 *i.e.*, Al

Characteristics		*A*	*B*
(a)	No. of electrons in their atoms	12	13
(b)	Size of their atoms	Bigger	Smaller
(c)	Tendency to loose electrons	More	Less
(d)	Formula of their oxides	*A*O	B_2O_3
(e)	Metallic character	More	Less
(f)	Formula of their chlorides	ACl_2	BCl_3

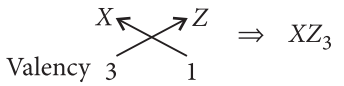
39. (a) As the element '*X*' belongs to 3rd period so, it will have three energy shells. Moreover, it belongs to 16th group, so it will have six valence electrons.
∴ Electronic configuration of *X* = 2, 8, 6
Thus, valence electrons = 6
and valency = 8 – 6 = 2
(b) Molecular formula of the compound formed when *X* reacts with hydrogen = H_2X
The electron dot structure is as :



(c) The element *X* is sulphur and it is a non-metal.

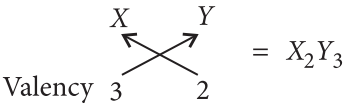
40. Mass number of *X* = 35
Number of neutrons = 18
∴ Number of electrons = Number of protons
= (Mass number – Number of neutrons)
= 35 – 18 = 17
Number of electrons of *X* = Atomic number of *X* = 17
Thus, electronic configuration of *X* = 2, 8, 7
As it has 7 electrons in the outermost shell, so it belongs to 17th group. Moreover the electrons are present in three shells, so it belongs to 3rd period.
Valency of *X* = 8 – 7 = 1

41. (a) For element *X* of atomic number 7, the electronic configuration is 2, 5 so it has 5 valence electrons and hence, it belongs to group 15. As seven electrons are filled in two shells so, it belongs to 2nd period.
Similarly, for *Y*(8), electronic configuration = 2, 6
Period number = 2, Group number = 16
and for *Z*(9) = 2, 7
Period number = 2, Group number = 17
(b) As size of the atoms decreases on moving from left to right in a period so, the order of atomic radii will be : *X* > *Y* > *Z*
(c) Formula of the compound when *X* combines with *Z* :

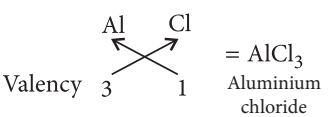


42. (i) Atomic number of Ca = 20
∴ Electronic configuration = 2, 8, 8, 2
(ii) Rb (37), electronic configuration = 2, 8, 18, 8, 1
Thus, number of valence electrons = 1
(iii) As Sr (38) belongs to period number 5 so, it will have 5 shells.
(iv) As K(19) = 2, 8, 8, 1
So, it has 1 valence electron which can be easily lost to attain the noble gas configuration. Hence, potassium (K) is a metal.
(v) Size of the atom increases down the group and decreases from left to right along a period. Thus, Rb (37) will be the largest atom among given elements.
(vi) Increasing order of atomic size is
Be < Mg < Ca < Rb

43. (a) As *X* belongs to group 13 so, it will have three valence electrons and valency of *X* will be 3.
(b) Atomic number of *Y* = 8
∴ Electronic configuration = 2, 6
Valency of *Y* = 8 – 6 = 2
Molecular formula of the compound when *X* reacts with element *Y* :



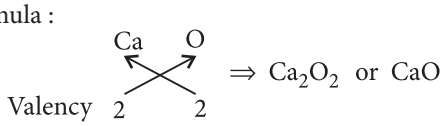
(c) As *X* belongs to 3rd period and group number 13, so it will be aluminium (Al).
For chlorine (17), electronic configuration = 2, 8, 7
∴ Valency of Cl = 8 – 7 = 1
∴ Formula of the compound :



44. The main aim of classifying elements is the prediction of their properties with more precision (systematic study of known elements).

– When the elements are arranged on the basis of increasing atomic number then it is easier to predict their properties. This led to the development of Modern periodic table.
– Modern periodic law states that the properties of elements are periodic function of their atomic numbers.
– In Modern periodic table, the metals like sodium and magnesium are towards left hand side while the non-metals like sulphur and chlorine are found on the right hand side. Elements like silicon, germanium, etc. which lie along the border line (group 13 to group16) are semi-metals or metalloids because they exhibit some properties of both metals and non-metals.

45. (a) Atomic number of element *X* is 20 so, it is calcium (Ca).
Electronic configuration of Ca = 2, 8, 8, 2
(b) As calcium has two valence electrons in its outermost shell, so it belongs to group 2.
Moreover, it has four shells which indicates that it belongs to period number 4.
(c) Calcium forms a basic oxide having the formula :

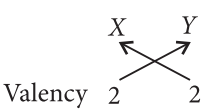


$\Rightarrow Ca_2O_2$ or CaO

When calcium oxide is treated with water then calcium hydroxide is formed.

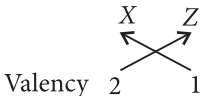
$$CaO + H_2O \longrightarrow \underset{\text{Calcium hydroxide}}{Ca(OH)_2}$$

46. Third period indicates that it has three shells while group 2 indicates that it has two valence electrons in its outermost shell.
Thus, *X* must be magnesium (Mg).
(a) Electronic configuration = 2, 8, 2
(b) As *X* has two valence electrons in its outermost shell which can be easily lost to form a noble gas configuration, so it will be a metal.
(c) (i) Electronic configuration of *Y* = 2, 6
Hence, valency of *Y* = 8 – 6 = 2
Formula of compound formed when *X* reacts with *Y* is



$\Rightarrow X_2Y_2$ or XY

(ii) Electronic configuration of *Z* = 2, 8, 7
Hence, valency of *Z* = 8 – 7 = 1
Formula of compound formed when *X* reacts with *Z* is



$\Rightarrow XZ_2$

47. Atomic number of *X* = 19
(a) Electronic configuration of *X* = 2, 8, 8, 1
(b) *X* has four shells so, the period number of *X* = 4. Moreover, it has one electron in its outermost shell, so the valency of *X* will be equal to one.
(c) Electronic configuration of *X* shows that it is a metal and metals form basic oxides.
(d) When oxide of *X* is dissolved in water then its hydroxide will be formed.

$$X_2O + H_2O \longrightarrow 2XOH$$

48. (i) Tendency of the elements to loose electrons increases down the group. The reason being that at each succeeding element down a group, the number of shells increases. So, the distance of the valence shell from the nucleus increases due to which the effective nuclear charge decreases on the last shell of electrons. So, it becomes easier for the atom to loose electrons.
(ii) Tendency of the elements to loose electrons decreases in a period from left to right. The reason being that as the electron enters to the same shell at each successive element so, the effective nuclear charge on the valence shell electron increases, the attraction between the valence electrons and nucleus increases so, it becomes difficult to loose electrons.

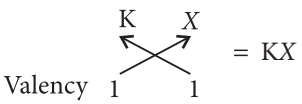
49. There are 18 groups and 7 periods in the Modern periodic table.
– Atomic size increases down the group, while moving from left to right in a period it decreases.
– Metallic character of elements increases down the group while moving from left to right in a period it decreases.

50. Na, Mg and Al belong to same period of Modern periodic table.

	Na	Mg	Al
Valence electrons	1	2	3

(i) Sodium (Na) will have the largest atomic radius because as we move from left to right in a period, atomic size decreases due to increase in effective nuclear charge which pulls the outermost electrons more closer to the nucleus.
(ii) Aluminium (Al) is least reactive because on moving from left to right in the periodic table the nuclear charge increases, so the valence electrons are pulled more closer to the nucleus. Therefore, the tendency to loose electrons decreases and hence, reactivity decreases.

51. *Refer to answer 22.*
Thus, formula of compound when K combines with *X* is



As K has one electron in its outermost shell, so it transfers this electron to outermost shell of *X* and hence, an ionic compound is formed.

52. There are 7 periods in the Modern periodic table.
As we move along the period from left to right then valency of the elements first increases from 1 to 4 and then decreases to 0.
On moving from left to right in a period the metallic character of elements decreases as the electropositive character of elements decreases across the period.
On moving down the group, the valency of the elements remains the same while atomic size increases. This is due to addition of new shell of electrons at every successive step.

53. The given characteristics can be tabulated as follows :

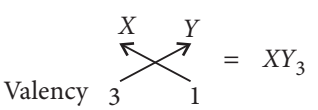
Characteristics		**Group 1** ***P***	**Group 2** ***Q***
(a)	No. of electrons in their atoms	3 11 19 37 55	4 12 20 38 56 (it can be any pair)
(b)	Sizes of atoms	Bigger	Smaller
(c)	Metallic character	More	Less
(d)	Tendency to lose electrons	More	Less
(e)	Formula of their oxides	P_2O	QO
(f)	Formula of their chlorides	PCl	QCl_2

54. Atomic number of the element = 16
Thus, electronic configuration = 2, 8, 6
Since, this element contains 3 shells hence, it belongs to period number 3.
As the element has 6 valence electrons, group number = 10 + 6 = 16
The valency of an element is determined by the number of electrons present in the outermost shell.
∴ Valency of the element = 8 – valence electrons
= 8 – 6 = 2

55. The electronic configuration of the given elements will be as follows :
A(4) = 2, 2
B(9) = 2, 7
C(14) = 2, 8, 4
D(19) = 2, 8, 8, 1
E(20) = 2, 8, 8, 2
(a) Element *D* will have one electron in its outermost shell.
(b) Elements *A* and *E* will belong to same group as both of them have same electrons in their outermost shells.
(c) *A* and *B* belong to period number 2 (two shells).
D and *E* belong to period number 4 (four shells).

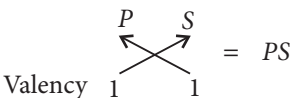
56. *Refer to answer 45.*

57. *X* is placed in 3rd group (IIIA) and 3rd period of the Modern periodic table then it must be aluminium (Al).
As it belongs to 3rd group so it will have 3 electrons in its outermost shell.
Also it belongs to 3rd period, so it will have 3 shells.
(a) Electronic configuration of *X* = 2, 8, 3
(b) Atomic number of *Y* = 17
Electronic configuration = 2, 8, 7
Valency of *Y* = 8 – 7 = 1
∴ Formula of compound formed when *X* reacts with *Y* :



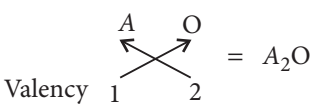
(c) Al_2O_3 is amphoteric in nature *i.e.*, acidic as well as basic oxide.

58. *P, Q, R* and *S* all belong to 3rd period so, all of them will have 3 shells and the number of electrons in their outermost shell is 1, 3, 5 and 7 respectively.
∴ Electronic configuration of *Q* = 2, 8, 3 and its valency = 3
Similarly, electronic configuration of *R* = 2, 8, 5 and its valency = 8 – 5 = 3
Electronic configuration of *P* = 2, 8, 1
Thus, valency of *P* = 1
Electronic configuration of *S* = 2, 8, 7
Thus, valency of *S* = 8 – 7 = 1
Molecular formula of the compound :

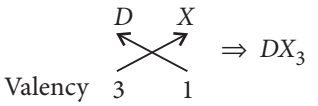


59. (i) Element *E* will form only covalent compounds because it has 4 electrons in the outermost shell so, it can neither loose nor gain 4 electrons, hence *E* forms compounds by sharing of electrons.
(ii) Element *B* is a metal having valency 3 as it belongs to group 13.
(iii) *C* is a non-metal with valency (8 – 5 =) 3.
(iv) Out of *B* and *C, B* will be bigger in size because as we move along the period from left to right, the atomic radius decreases due to addition of electrons in the same shell at each successive element. Hence, nucleus pulls electrons more towards the centre.
(v) *D* and *F* belong to group 18 and are called noble gases.

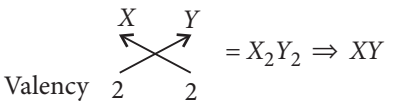
60. (i) Oxides of group 1 elements :
Let the element be *A*.
As *A* belongs to group 1 of the periodic table, it will have valency = 1.
So, chemical formula of its oxide will be



(ii) Halides of the element of group-13 :
Let the element be *D*.
As *D* belongs to group 13, it will have valency = 3
Halide *X* has the valency = 1
So, chemical formula will be

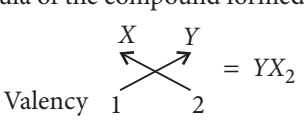


(iii) Compounds formed when element of group-2 combines with an element of group-16 :
Let the group-2 element be *X* and group-16 element be *Y*.
Valency of *X* = 2
Valency of *Y* = 2
Chemical formula of the compound will be

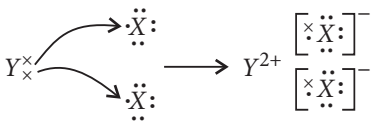


61. (a) (i) Valency : It is defined as the combining capacity of the element which is determined by the number of valence electrons present in the outermost shell of its atom.
(ii) Atomic size : It is defined as the distance between the centre of the nucleus and the outermost shell of an isolated atom.
(b) On moving from left to right in the period, the valency of elements increases from 1 to 4 and then decreases to 0.
This is because the elements in a period do not have the same number of valence electrons hence, they do not show same valency.
The atomic size decreases on moving from left to right along a period due to increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

62. Atomic number of *X* = 17
∴ Electronic configuration of *X* = 2, 8, 7
Atomic number of *Y* = 20
∴ Electronic configuration of *Y* = 2, 8, 8, 2
(i) From the electronic configurations, we can easily observe that *X* contains 3 shells so, it belongs to period 3 and it contains 7 electrons in the outermost shell so, it belongs to group-17. Similarly for *Y*, it has 4 shells which implies that it belongs to period 4 and *Y* contains two electrons in the outermost shell so, it belongs to group-2.
(ii) Valency of *X* = 1
Valency of *Y* = 2
Thus, formula of the compound formed will be

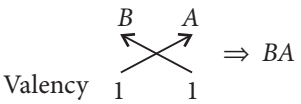


(iii) Electron dot structure of the compound will be

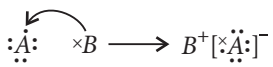


As two electrons present in the outermost shell of *Y* are donated to two different atoms of *X* thus, it will be an ionic bond (formed by the complete transfer of electrons).

63. Atomic number of *A* = 17
Electronic configuration of *A* = 2, 8, 7
Atomic number of *B* = 19
Electronic configuration of *B* = 2, 8, 8, 1
(i) From the electronic configuration of *A*, it can be easily observed that *A* contains three shells which indicates that it belongs to period 3. Moreover, it has seven valence electrons in its outermost shell which indicates that it belongs to group 17.
Similarly for *B*, it has 4 shells so, it belongs to period 4 and it has one electron in outermost shell so, it belongs to group 1.
(ii) The molecular formula of the compound when *A* combines with *B* will be



As *A* contains 7 electrons in the outermost shell so, it is an electronegative element that is why *A* is placed after *B*.
(iii) The electron dot structure will be



The one electron present in the outermost shell of *B* gets transferred to the outermost shell of *A* and hence, ionic bond is formed.

64. *Refer to answer 58.*

65. (i) Element *E* will form only covalent compounds because it has 4 electrons in the outermost shell so, it can neither loose nor gain 4 electrons, hence *E* forms compounds by sharing of electrons.
(ii) Element *D* is a metal having valency 3 as it belongs to group 13.
(iii) *B* is a non-metal with valency (8 – 5 =) 3.
(iv) Out of *D* and *E*, *D* will be bigger in size because as we move from left to right in a period there is addition of extra electron in the same shell due to which electrons are pulled more closer to the nucleus.
(v) *C* and *F* belong to group 18 and are called noble gases.

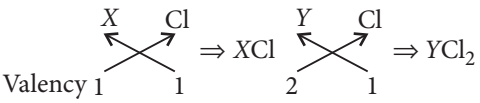
66. The vertical columns in the Modern periodic table are called groups. There are total 18 groups in the Modern periodic table.
(i) In a particular group, the number of valence electrons remains the same.
(ii) On moving down the group, there is addition of an extra shell successively. Hence, number of occupied shells increases.
(iii) Due to addition of extra shells down the group, the size of the atoms *i.e.,* the distance between nucleus and the outermost shell also increases.
(iv) Down the group as atomic size increases, the outermost electron is pulled by nucleus to lesser extent and hence, tendency to loose electrons increases i.e., metallic character increases.
(v) Effective nuclear charge experienced by valence electrons decreases down the group due to increase in size of atoms.

67. (i) As Be, Mg and Ca have two electrons in their outermost shell so, they all belong to group 2.
(ii) Be will be least reactive element, as down the group the reactivity of the elements increases. Be being smaller in size as compared to others will have less tendency to loose electrons and hence, is less reactive.
(iii) As we move down the group, atomic radius increases hence, calcium will have the largest atomic radius.

68. The horizontal rows of elements in the periodic table are called periods. There are seven periods in the long form of periodic table.
The vertical columns in a periodic table are called groups. There are 18 groups in the long form of periodic table.
X belongs to group-1 while *Y* belongs to group-2 of the same period hence, valency of *X* will be 1 and valency of *Y* will be 2.
(i) As we move along the period from left to right the size of the atoms decreases. Hence, *X* will be bigger than *Y*.
(ii) Across the period from left to right, the metallic character decreases. Hence, *X* is more metallic than *Y*.

(iii) The valency of X in its oxide will be 1 and that of Y in its oxide will be 2.

(iv) Molecular formula of their chlorides will be



69. There are 18 groups and 7 periods in the Modern periodic table.

(i) For elements to be in the same group, they should have same number of electrons in their outermost shells. For example, sodium and potassium have one electron in their outermost shells, so they belong to same group *i.e.*, group 1.

(ii) For elements to be in the same period, they should have same number of shells.

For example, magnesium (12) and aluminium (13) contain three shells so, they belong to period 3.

Mg (12) = 2, 8, 2
Al (13) = 2, 8, 3
] Both have three shells

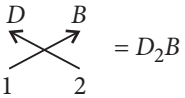
70. (i) Element E will form only covalent compounds.

(ii) Element D is a metal with valency one as it belongs to group 1.

(iii) Element B is a non-metal with valency 2 as it belongs to group 16 (valency = 8 – 6 = 2).

(iv) Out of D and E, D will have bigger atomic radius because as we move along the period from left to right there is decrease in atomic radius.

(v) Valency of B = 2
Valency of D = 1



71. Electronic configuration of element = 2, 8, 8, 1

(i) It contains one electron in its outermost shell thus, it belongs to group 1. Moreover, the element has 4 shells, so it belongs to period 4.

(ii) As the element contains one electron in its outermost shell which can be easily lost hence, it acts as a metal.

72. (i), (ii) *Refer to answer 22.*

(iii) Be and F belong to the same period (period 2). K and Ca belong to the same period (period 4). Among Be and F, Be will be bigger in size and among K and Ca, K will be bigger in size.

73. As element X belongs to group 1, thus it will have one electron in its outermost shell. Moreover, it belongs to period 3 which implies that X has 3 shells.

(i) Electronic configuration of X will be 2, 8, 1
Hence, number of valence electrons = 1

(ii) Valency of X will be 1.

(iii) As X contains 1 valence electron which can be easily lost hence, it is a metal.

74. (i) F, Cl and Br all have seven valence electrons so, they belong to the same group. On moving down the group, the atomic size of the elements increases due to addition of extra shell at each successive element. Due to this the average distance between nucleus and outermost electrons increases. Thus, Br is largest in size among F, Cl and Br.

(ii) Fluorine is the most reactive element because the chemical reactivity of non-metals decreases on going down a group as the size of the atoms goes on increasing. Hence, the attraction of incoming electrons decreases. Therefore, the tendency of atoms to gain electrons decreases due to which their reactivity decreases.

75. *Refer to answer 49.*

Valency remains the same in a group, as the number of valence electrons are same. Valency first increases from 1 to 4 in a period and then decreases to 0.

76. Atomic number of element (E) = 16
∴ Electronic configuration = 2, 8, 6

(i) Number of valence electrons in the atom = 6

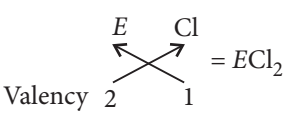
(ii) Valency = 8 – 6 = 2

(iii) As there are 6 valence electrons thus, its group number is 10 + 6 = 16

(iv) This element is a non-metal.

(v) The nature of oxide formed by this element is acidic.

(vi) The formula of the chloride of non-metal 'E' will be



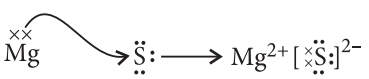
77. (a) C belongs to group 17 and hence, it will have 7 valence electrons in the outermost shell and has a tendency to gain electrons thus, it is a non-metal.

(b) Among *A* and *C*, *A* will be more reactive as the reactivity decreases down the group. So, *A* has more tendency to gain electrons.
(c) *C* will form negatively charged ion which is known as anion because group 17 elements have seven electrons in their outermost shell so, they have strong tendency to gain an electron to attain the noble gas configuration.

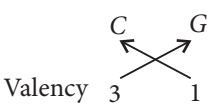
78. Eight elements *A, B, C, D, E, F, G* and *H* have same number of electronic shells. So, they belong to the same period.
The biggest hint in the question is that the compound formed when *A* and *G* combine is used in almost all vegetable dishes which is NaCl.
Thus, *A* = Na and *B* = Cl
(i) These elements belongs to period number 3.
Group :

1	2	13	14	15	16	17	18
A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Na	Mg	Al	Si	P	S	Cl	Ar

(ii) The compound formed by the combination of *B* and *F i.e.*, Mg and S will be ionic in nature as the bond will be formed by complete transfer of electrons.

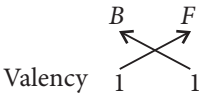


(iii) *A* and *B i.e.*, sodium and magnesium will definitely be metals.
(iv) *G i.e.*, Cl (chlorine) is found as gaseous diatomic (Cl_2) molecule at room temperature.
(v) Number of electrons in outermost shell of *C* = 3
Number of electrons in outermost shell of *G* = 7
∴ Valency of *C* = 3
Valency of *G* = 8 – 7 = 1
Thus, the formula of the compound will be



$\Rightarrow$ CG_3 (*i.e.* $AlCl_3$)

79. (a) (i) Noble gas = *G*
(ii) Halogen = *F*
(b) *B*(11) = 2, 8, 1
F(17) = 2, 8, 7
Valency of *B* = 1
Valency of *F* = 8 – 7 = 1
Formula of the compound formed :



(c) Electronic configuration of *C*(12) = 2, 8, 2
Electronic configuration of *E*(8) = 2, 6

80. (a), (b) *Refer to answer 28.*
(c) endency to gain electrons increases as we go from left to right in a period due to addition of extra electron in the same shell at each successive element. Hence, tendency to attain a noble gas configuration also increases. Moreover, as the number of electrons increases in outermost shell there is an increase in effective nuclear charge due to which tendency to gain electrons increases.

81. (a) *Refer to answer 68.*
(b)

Properties		***M* (Group I)**	***N* (group II)**
(i)	Sizes	Bigger	Smaller
(ii)	Metallic character	More	Less
(iii)	Valencies in forming oxides	+1 (M_2O)	+2 (NO)
(iv)	Molecular formula of chlorides	*M* Cl 1 1 $\Rightarrow$ MCl	*N* Cl 2 1 $\Rightarrow$ NCl_2