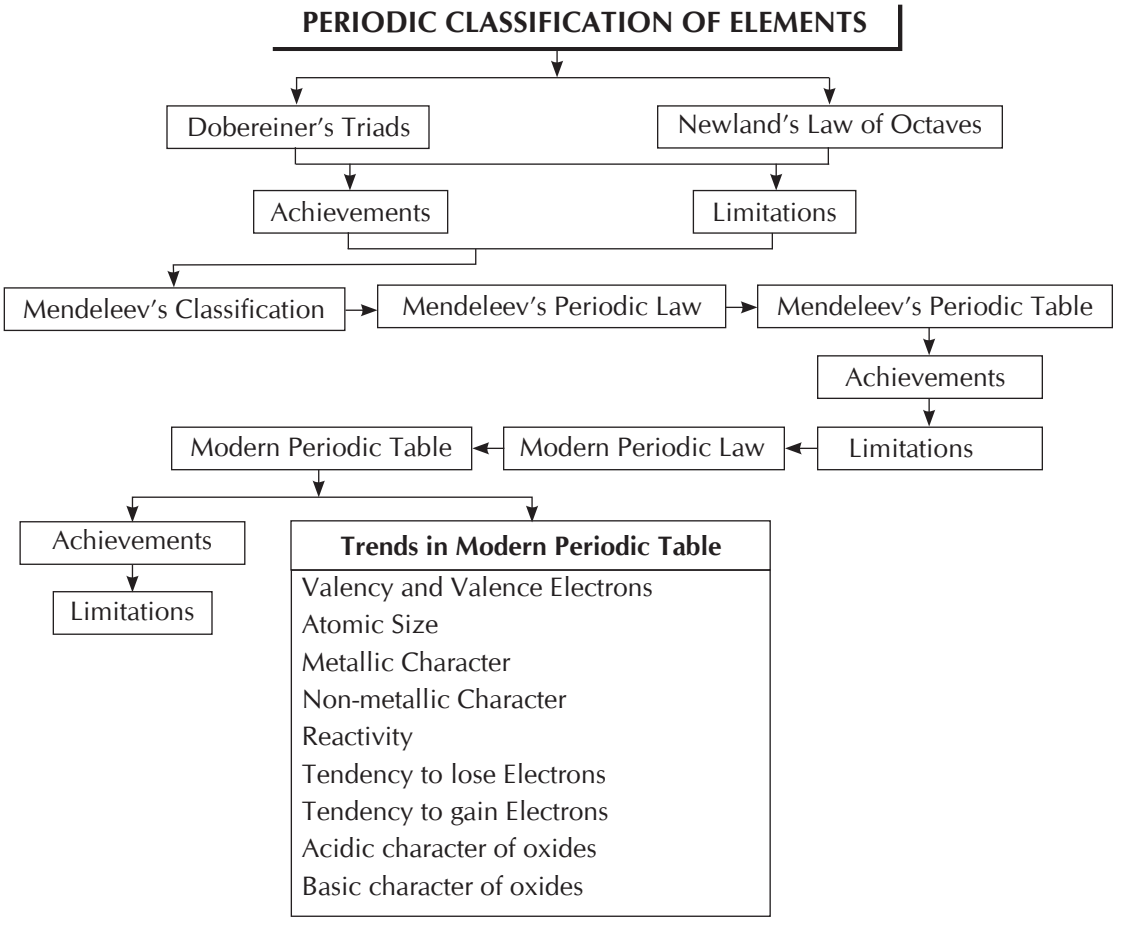
2. Periodic Classification of Elements

TOPICS COVERED

2.1 Early Attempts at the Classification of Elements
2.2 Modern Periodic Table
2.3 Trends in the Modern Periodic Table

CHAPTER MAP



TOPIC 1. Early Attempts at the Classification of Elements

Earlier attempts at classification: In 1803, Dalton published a table of relative atomic weights (now called atomic masses) which formed the important basis of classification at that time. The earliest attempt to classify the elements resulted into metals and non-metals.

Dobereiner's Law of triads: When elements are arranged in a group of three, such that the atomic mass of middle element is the average of the mass of first and third element, they were found to resemble each other, e.g.

Li	Na	K	Ca	Sr	Ba
7	23	39	40.1	87.6	137.3
Atomic mass of Na = $\frac{7+39}{2}$ = 23			Atomic mass of Sr = $\frac{40.1+137.3}{2} = \frac{177.4}{2}$ = 88.7		

Cl	Br	I
35.5	79.9	126.9
Atomic mass of Br = $\frac{126.9 \quad 35.5}{2} = \frac{162.4}{2}$ = 81.2		

Limitations

- He could not classify all the elements discovered at that time. Hence, this system of triads was not found to be useful.
- Only 3 sets of elements forming the triads was found.

Newlands' law of octaves: When elements are arranged in increasing order of their atomic masses, every eighth element resembled with the first, e.g. the properties of Li and Na are found to be similar, Be and Mg resembles each other.

sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	da (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	–	–

Limitations

- It was found that Newlands' law of octaves was applicable only upto calcium. It worked well only with lighter elements.
- It was assumed by Newlands that only 56 elements existed in nature. But many elements were discovered later, whose properties did not fit into the law of octaves.
- Newlands adjusted two elements in the same slot, but also put some elements with different properties under same place, e.g. Co and Ni are in the same slot with H, F, Cl and Br and these do not resemble with H, F,Cl, Br. Iron resembles with Co and Ni but it is placed far away.

Mendeleev's Periodic Law: Properties of elements are periodic function of their atomic masses ie. properties of elements depend upon their atomic masses.

Mendeleev's Periodic Table: He arranged elements on the basis of atomic masses and similarity in chemical properties (formulae of oxides and hydrides).

- Mendeleev's periodic table contains 8 groups and 6 periods.
- It was based on increasing order of atomic masses and on the basis of formulae of oxides and hydrides.
- Each group has been subdivided into A or B, except Group VIII.
- Group VIII consist of three elements in each row, total 9 elements.
- Hydrogen was kept in Group 1. It was the only element in first period.
- Second period had Li, Be, B, C, N, O, F –elements.
- Third period had Na, Mg, Al, Si, P, S, Cl –elements.
- In group I, in the 4^{th}, 5^{th}, 6^{th} period, Cu, Ag, Au were placed in Group IB along with K, Rb, Cs in Group IA.

Mendeleev's Periodic Table

Groups	I		II		III		IV		V		VI		VII		VIII		
Oxide:	R_2O		RO		R_2O_3		RO_2		R_2O_5		RO_3		R_2O_7		RO_4		
Hydride:	RH		RH_2		RH_3		RH_4		RH_3		RH_2		RH				
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 26.98		Si 28.09		P 30.974		S 32.06		Cl 35.453				
4 First series	K 39.102		Ca 40.08		Sc 44.96		Ti 47.90		V 50.94		Cr 50.20		Mn 54.94		Fe 55.85	Co 58.93	Ni 58.71
Second series		Cu 63.54		Zn 65.37	Ga 69.72		Ge 72.59		As 74.92		Se 78.96		Br 79.909				
5 First series	Rb 85.47		Sr 87.62		Y 88.91		Zr 91.22		Nb 92.91		Mo 95.94		Tc 99		Ru 101.07	Rh 102.91	Pd 106.4
Second series		Ag 107.87		Cd 112.40	In 114.82		Sn 118.69		Sb 121.75		Te 127.60		I 126.90				
6 First series	Cs 132.90		Ba 137.34		La 138.91		Hf 178.49		Ta 180.95		W 183.85				Os 190.2	Ir 192.2	Pt 195.09
Second series		Au 196.97		Hg 200.59	Tl 204.37		Pb 207.19		Bi 208.98								

- In group II, in the 4th, 5th, 6th period, Zn, Cd, Hg were placed in Group IIB along with Ca, Sr and Ba in Group IIA.
- In Group IIIB, Sc, Y and La are present, B along with Ga, In, Tl are present in Group IIIA.
- Group IVA has Ge, Sn, Pb and Group IVB has Ti, Zr, Hf.
- Group VA has As, Sb, B, along with Group VB has V, Nb, Ta.
- Group VIA has Se, Te, along with Group VIB has Cr, Mo, W.
- Group VIIA has Br, I with Mn and Tc in Group VIIB.
- Group VIII has

Fe	Co	Ni
Ru	Rh	Pd
Os	Ir	Pt

(9) elements.

Achievements of Mendeleev's Periodic table

- He could classify all the elements discovered at that time.
- He gave preference to similarity in properties over increasing order of atomic masses.
- He left gaps for the undiscovered elements and predicted their properties which made their discovery easier. Scandium, gallium, germanium which were discovered later, have properties as predicted by Mendeleev.
- His periodic table helps in correction of atomic masses of some of the elements in the beginning.
- Noble gases discovered later could be easily adjusted in his periodic table without disturbing the existing order.

Limitations of Mendeleev's Periodic Table

- Position of hydrogen was not justified, because it resembles both with alkali metals (group 1) as well as halogens (group 17).
- Isotopes of an element have different atomic masses but similar chemical properties that posed a challenge to Mendeleev's periodic law.

- Increasing order of atomic masses could not be maintained.
- Some elements having different properties like transition metals were kept along with alkali metals (Group 1) and (Group 2). Transition metals resemble each other but these were kept in different groups.

EXERCISE 2.1

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. Up to which element, the Law of Octaves was found to be applicable?

(*a*) Oxygen (*b*) Calcium

(*c*) Cobalt (*d*) Potassium

2. According to Mendeleev's Periodic Law, the elements were arranged in the periodic table in the order of

(*a*) increasing atomic number (*b*) decreasing atomic number

(*c*) increasing atomic mass (*d*) decreasing atomic mass

3. In Mendeleev's Periodic Table, gaps were left for the elements to be discovered later. Which of the following elements found a place in the perioidc table later?

(*a*) Germanium (*b*) Chlorine

(*c*) Oxygen (*d*) Silicon

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 and 2 two statements are given-one labeled as **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (*a*), (*b*), (*c*) and (*d*) as given below:

(*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

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

(*c*) 'A' is true but 'R' is false.

(*d*) 'A' is false but 'R' is true.

1. Assertion: Increasing order of atomic masses could not be maintained in Mendeleev's periodic table.

Reason: His periodic table helps in correction of atomic masses of some of the elements in the beginning.

2. Assertion: Dobereiner adjusted two elements in the same slot.

Reason: Dobereiner could not classify all the elements in triads. [*CBSE* 2020]

III. Very Short Answer Type Questions (1 Mark)

1. Lithium, sodium and potassium form a Dobereiner's triad. The atomic masses of Li and K are 7 and 39, respectively. Predict the atomic mass of sodium.

2. Why was the system of classification of elements into triads not found suitable?

3. Did Dobereiner's triads also exist in the columns of Newlands' octaves? [*NCERT*]

4. What were the limitations of Dobereiner's classification? [*NCERT*]

5. Besides Gallium, which other elements have since been discovered to fill the gaps left by Mendeleev in his periodic table? [*NCERT*]

6. What were the criteria used by Mendeleev in creating the periodic table? [*Delhi* 2013]

7. Why do you think the noble gases are placed in a separate group in the periodic table? [*Delhi* 2013]

8. Write two reasons responsible for late discovery of noble gases. [*Delhi* 2013]

9. What was the basis of classification of elements by Newlands?

OR

Define Newlands' law of octaves. [*Delhi* 2014]

10. Write the formulae of chlorides of Eka-silicon and Eka-aluminium, the elements predicted by Mendeleev. [*NCERT Exemplar*]

IV. Short Answer Type Questions-I (2 Marks)

1. Elements have been arranged in the following sequence on the basis of their increasing atomic masses: F, Na, Mg, Al, Si, P, S, Cl, K

(*a*) Pick up two sets of elements which have similar properties.

(*b*) The above given sequence represents which law of classification of elements?

2. Can the following group of elements be classified as Dobereiner's triads? Explain by giving reasons.

(*a*) Na, Si, Cl (*b*) Be, Mg, Ca [*Delhi* 2019] [*NCERT Exempler*]

3. Write two drawbacks of Mendeleev's periodic table.

4. What were the limitations of Newlands' law of octaves? [*NCERT*]

5. Use Mendeleev's Periodic table to predict the formulae for the oxides of the following elements:

K, C, Al, Si, Ba

V. Short Answer Type Question-II (3 Marks)

1. Study the data of the following three categories A, B and C.

Category	Name of the element	Atomic Mass
A	Li	7
	Na	23
	K	39
B	N	14
	P	31
	As	74
C	B	10.8
	Al	27
	Ga	69.7

(*a*) From the given three categories A, B and C, pick the one which forms Dobereiner's Triads.

(*b*) Why did Mendeleev placed elements of category A, B and C in three different groups?

(*c*) Is Newland law of octaves applicable to all the three categories? Give reason to justify your answer. [*CBSE* 2020]

VI. Long Answer Type Questions (5 Marks)

1. (*a*) Why do we classify elements?

(*b*) What were the two criteria used by Mendeleev in creating 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 mass or in the same slot because their chemical properties are same? Justify your answer. [*Delhi* 2012, 2013, 2015]

2. On the basis of Mendeleev's Periodic table, answer the following questions:

(*a*) Name the element which is in

(*i*) I group and III period. (*ii*) VII group and II period.

(*b*) Suggest the formula of 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?

Answers 2.1

I. 1. (*b*) It was applicable up to Calcium

2. (*c*) Increasing atomic mass

3. (*a*) Germanium found a place below silicon.

II. 1. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.

2. (*d*) 'A' is false but 'R' is true.

III. 1. Atomic mass of sodium = $\frac{7+39}{2} = 23$

2. It is because all the elements discovered at that time could not be classified into triads.

3. Yes, e.g. Li, Na, K is a part of Newlands' law of octaves.

4. (*i*) All the elements could not be classified into triads.

(*ii*) Only three triads could be identified resembling each other.

5. Scandium and Germanium

6. (*i*) Increasing order of atomic mass (*ii*) Formula of oxides and hydrides

7. It is because these are least reactive and resemble each other.

8. (*i*) They are less abundant in nature. (*ii*) They are least reactive.

9. Elements were arranged in increasing order of atomic mass and every 8^{th} element resembled with the first element.

10. $GeCl_4$, $GaCl_3$.

IV. 1. (*a*) (*i*) F, Cl (*ii*) Na, K (*b*) Newlands' law of octaves

2. (*a*) No, because atomic mass of Si = $\frac{58.5}{2} = 29.25$

which is nearly equal to 28 but these elements do not resemble with each other.

(*b*) Yes, atomic mass of Mg = $\frac{9+40}{2} = 24.5$

which is nearly equal to 24 and these three elements resemble with each other.

3. (*i*) Isotopes challenged the basis of Mendeleev's periodic table.

(*ii*) Increasing order of atomic masses could not be maintained in classifying all the elements.

4. (*i*) It was applicable upto Ca, i.e. lighter elements only.

(*ii*) New elements could not fit into Newlands' octaves.

5. K_2O, CO_2, Al_2O_3, SiO_2, BaO

V. 1. (*a*) 'A' forms Dobereiner's Triad.

(*b*) It is because they had different formula of oxides and hydrides.

(*c*) No, it was not applicable to elements after Ca(20) because after Ca every eighth element did not possess similar properties to first.

VI. 1. (*a*) It helps to study the properties of elements in a simpler way by studying the properties of 118 elements by studying properties of 18 groups and 7 periods.

(*b*) (*i*) Increasing order of atomic mass, (*ii*) Formula of oxides and hydrides of elements.

(*c*) These gaps were left for the undiscovered elements.

(*d*) Noble gases were not discovered by that time.

(*e*) They will be placed in same slot due to same properties.

2. (*a*) (*i*) Na belongs to 1st group, IIIrd period. (*ii*) F belongs to VII group, IInd period.

(*b*) (*i*) N_2O_5 (*ii*) H_2O

(*c*) It is because Co, Rh, Ir resemble with each other and Ni, Pd, Pt resembles with each other. Similarity in properties were preferred over increasing order of atomic masses.

IUPAC Periodic Table of the Elements

1																	18
1 **H** hydrogen 1.008 [1.0078, 1.0082]	2		Key:									13	14	15	16	17	2 **He** helium 4.0026
3 **Li** lithium 6.94 [6.938, 6.997]	4 **Be** beryllium 9.0122		atomic number **Symbol** **name** conventional atomic weight standard atomic weight									5 **B** boron 10.81 [10.806, 10.821]	6 **C** carbon 12.011 [12.009, 12.012]	7 **N** nitrogen 14.007 [14.006, 14.008]	8 **O** oxygen 15.999 [15.999, 16.000]	9 **F** fluorine 18.998	10 **Ne** neon 20.180
11 **Na** sodium 22.990	12 **Mg** magnesium 24.305 [24.304, 24.307]	3	4	5	6	7	8	9	10	11	12	13 **Al** aluminium 26.982	14 **Si** silicon 28.085 [28.084, 28.086]	15 **P** phosphorus 30.974	16 **S** sulfur 32.06 [32.059, 32.076]	17 **Cl** chlorine 35.45 [35.446, 35.457]	18 **Ar** argon 39.948
19 **K** potassium 39.098	20 **Ca** calcium 40.078(4)	21 **Sc** scandium 44.956	22 **Ti** titanium 47.867	23 **V** vanadium 50.942	24 **Cr** chromium 51.996	25 **Mn** manganese 54.938	26 **Fe** iron 55.845(2)	27 **Co** cobalt 58.933	28 **Ni** nickel 58.693	29 **Cu** copper 63.546(3)	30 **Zn** zinc 65.38(2)	31 **Ga** gallium 69.723	32 **Ge** germanium 72.630(8)	33 **As** arsenic 74.922	34 **Se** selenium 78.971(8)	35 **Br** bromine 79.904 [79.901, 79.907]	36 **Kr** krypton 83.798(2)
37 **Rb** rubidium 85.468	38 **Sr** strontium 87.62	39 **Y** yttrium 88.906	40 **Zr** zirconium 91.224(2)	41 **Nb** niobium 92.906	42 **Mo** molybdenum 95.95	43 **Tc** technetium	44 **Ru** ruthenium 101.07(2)	45 **Rh** rhodium 102.91	46 **Pd** palladium 106.42	47 **Ag** silver 107.87	48 **Cd** cadmium 112.41	49 **In** indium 114.82	50 **Sn** tin 118.71	51 **Sb** antimony 121.76	52 **Te** tellurium 127.60(3)	53 **I** iodine 126.90	54 **Xe** xenon 131.29
55 **Cs** caesium 132.91	56 **Ba** barium 137.33	57-71 lanthanoids	72 **Hf** hafnium 178.49(2)	73 **Ta** tantalum 180.95	74 **W** tungsten 183.84	75 **Re** rhenium 186.21	76 **Os** osmium 190.23(3)	77 **Ir** iridium 192.22	78 **Pt** platinum 195.08	79 **Au** gold 196.97	80 **Hg** mercury 200.59	81 **Tl** thallium 204.38 [204.38, 204.39]	82 **Pb** lead 207.2	83 **Bi** bismuth 208.98	84 **Po** polonium	85 **At** astatine	86 **Rn** radon
87 **Fr** francium	88 **Ra** radium	89-103 actinoids	104 **Rf** rutherfordium	105 **Db** dubnium	106 **Sg** seaborgium	107 **Bh** bohrium	108 **Hs** hassium	109 **Mt** meitnerium	110 **Ds** darmstadtium	111 **Rg** roentgenium	112 **Cn** copernicium	113 **Nh** nihonium	114 **Fl** flerovium	115 **Mc** moscovium	116 **Lv** livermorium	117 **Ts** tennessine	118 **Og** oganesson

57 **La** lanthanum 138.91	58 **Ce** cerium 140.12	59 **Pr** praseodymium 140.91	60 **Nd** neodymium 144.24	61 **Pm** promethium	62 **Sm** samarium 150.36(2)	63 **Eu** europium 151.96	64 **Gd** gadolinium 157.25(3)	65 **Tb** terbium 158.93	66 **Dy** dysprosium 162.50	67 **Ho** holmium 164.93	68 **Er** erbium 167.26	69 **Tm** thulium 168.93	70 **Yb** ytterbium 173.05	71 **Lu** lutetium 174.97
89 **Ac** actinium	90 **Th** thorium 232.04	91 **Pa** protactinium 231.04	92 **U** uranium 238.03	93 **Np** neptunium	94 **Pu** plutonium	95 **Am** americium	96 **Cm** curium	97 **Bk** berkelium	98 **Cf** californium	99 **Es** einsteinium	100 **Fm** fermium	101 **Md** mendelevium	102 **No** nobelium	103 **Lr** lawrencium

TOPIC 2. Modern Periodic Table

Atomic number: It is equal to the number of protons. It is also equal to number of electrons in a neutral atom.

Henry Moseley showed that atomic number is a more fundamental property than atomic mass of an element ie. properties of elements depend upon atomic number

Modern periodic law: Properties of elements are a periodic function of their atomic number.

Modern periodic table (Features and Advantages)

- It is based on increasing order of atomic numbers.
- It could remove the anomalies of atomic masses, i.e. cobalt has higher atomic mass than nickel but has lower atomic number and hence placed before nickel.
- Prediction of properties of undiscovered elements was more accurate.
- The position of elements was related to their electronic configuration.
- There are 7 periods (horizontal rows) and 18 groups (vertical columns).
- Each period has elements equal to the maximum number of electrons in the shell corresponding to the period, e.g. 1st period has 2 elements because 1st shell has 2 electrons, 2nd period has 8 elements because 2nd shell has 8 electrons. 3rd period has 8 elements although 3rd shell can have 18 electrons (maximum), but if it is the last shell, it cannot have more than 8 electrons. 4th and 5th period have 18 elements each, although they could accommodate 32 electron. This is because if 4th and 5th shell are the outermost shell and electrons are filled in the increasing order of energy they could accomodate a maximum of 18 electrons. 6th and 7th period have 32 elements, each.
- Each group has elements with same number of valence electrons and similar chemical properties but each period have elements with different number of valence electrons and chemical properties.

The electronic configuration of some main group elements are given below:

Group 1								Group 18
H (1) 1	Group 2		Group 13	Group 14	Group 15	Group 16	Group 17	He(2) 2
Li (3) 2, 1	Be (4) 2, 2		B(5) 2, 3	C(6) 2, 4	N(7) 2, 5	O(8) 2, 6	F(9) 2, 7	Ne(10) 2, 8
Na(11) 2, 8, 1	Mg(12) 2, 8, 2	Transition elements	Al(13) 2, 8, 3	Si(14) 2, 8, 4	P(15) 2, 8, 5	S(16) 2, 8, 6	Cl(17) 2, 8, 7	Ar(18) 2, 8, 8
K(19) 2, 8, 8, 1	Ca(20) 2, 8, 8, 2	Group 3 to 12	Ga(31) 2,8,18,3	Ge(32) 2,8,18,4	As(33) 2,8,18,5	Se(34) 2,8,18,6	Br(35) 2,8,18,7	Kr(36) 2,8,18,8

EXERCISE 2.2

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. Which of the following statement(s) about the Modern Periodic Table are incorrect?

(*i*) The elements in the Modern Periodic Table are arranged on the basis of their decreasing atomic number

(*ii*) The elements in the Modern Periodic Table are arranged on the basis of their increasing atomic masses

(*iii*) Isotopes are placed in adjoining group(s) in the Periodic Table

(*iv*) The elements in the Modern Periodic Table are arranged on the basis of their increasing atomic number

(*a*) (*i*) only (*b*) (*i*), (*ii*) and (*iii*) (*c*) (*i*), (*ii*) and (*iv*) (*d*) (*iv*) only

2. Which of the following statements about the Modern Periodic Table is correct?

(*a*) It has 18 horizontal rows known as Periods

(*b*) It has 7 vertical columns known as Periods

(*c*) It has 18 vertical columns known as Groups

(*d*) It has 7 horizontal rows known as Groups

3. Which of the given elements A, B, C, D and E with atomic number 2, 3, 7, 10 and 30 respectively belong to the same period?
(*a*) A, B, C (*b*) B, C, D (*c*) A, D, E (*d*) B, D, E
4. Where would you locate the element with electronic configuration 2, 8 in the Modern Periodic Table?
(*a*) Group 8 (*b*) Group 2 (*c*) Group 18 (*d*) Group 10
5. Element 'X' forms a chloride with formula XCl_2, which is a solid with high melting point. 'X' would most likely to be in the same group of the periodic table as:
(*a*) Na, (*b*) Mg, (*c*) Al (*d*) Si **[HOTS]**
6. On the basis of electronic configuration of $^{9}_{5}X$, the group number and period of the element 'X' is:
(*a*) Group 15 period 2 (*b*) Group 13 period 2
(*c*) Group 19 period 5 (*d*) Group 13 period 5 [*CBSE* 2020]
7. An element 'X' with atomic number 11 forms a compound with element 'Y' with atomic number 8. The formula of the compound formed is
(*a*) XY (*b*) X_2Y (*c*) XY_2 (*d*) X_2Y_3 [*CBSE* 2020]
8. An element 'X' is forming an acidic oxide. Its position in modern periodic table will be
(*a*) Group 1 and Period 3 (*b*)Group 2 and Period 3
(*c*) Group 13 and Period 3 (*d*) Group 16 and Period 3 [*CBSE* 2020]
9. Consider the following statements about an element 'X' with number of protons 13.
(A) It forms amphoteric oxide (B) Its valency is three
(C) The formula of its chloride is XCl_3
The correct statements(s) is/are
(*a*) only (A) (*b*) only (B) (*c*) (A) and (C) (*d*) (A), (B) and (C) [*CBSE* 2020]

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 to 4 two statements are given-one labeled as **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (*a*), (*b*), (*c*) and (*d*) as given below:
(*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(*c*) 'A' is true but 'R' is false.
(*d*) 'A' is false but 'R' is true.

1. **Assertion:** $SiCl_4$ is covalent compound
Reason: Si can lose electrons and chlorine can gain electron.
2. **Assertion:** Ionic compounds have high melting point.
Reason: Ionic compounds do not conduct electricity in solid state.
3. **Assertion:** The formula of oxide of nitrogen is N_2O_5. and H_2O is oxide of hydrogen.
Reason: N_2O_5 is acidic oxide H_2O is neutral oxide.
4. **Assertion:** Element with atomic number 118 belongs to group 18.
Reason: Element with atomic number 118 has 8 valence electrons.

III. Very Short Answer Type Questions (1 Mark)

1. State modern periodic law. [*Delhi* 2013, 2014, CBSE 2018]
2. Write the formula which determines the maximum number of electrons that the shell of an atom can accommodate. [*Delhi* 2013, 2014]
3. The electronic configuration of two elements X and Y are 2, 8, 7 and 2, 8, 8, 3 respectively. Write the atomic numbers of X and Y. [*Delhi* 2013]
4. Out of the three elements P, Q and R, having atomic number 11, 17 and 19 respectively, which two elements will show similar properties and why? [*Delhi* 2014]
5. Write the number of horizontal rows in the modern periodic table. What are these rows called? [*Delhi* 2013, 2014]
6. Explain, why the number of elements in the third period are 8.
7. Name the element having electronic configuration 2, 8, 3. What is its valency?
8. P(3), Q(12), R(13), S(20), which two elements have similar chemical properties and why?
9. Where would you locate the element with electronic configuration: 2, 8 in the modern periodic table?
10. Give the number of elements in 2nd and 5th period of modern periodic table. [*Delhi* 2013]
11. A metal 'M' belongs to 13th group in the modern periodic table. Write the valency of the metal.
12. What is the number of valence electrons in the last element of the 3rd period?

13. An element 'X' belongs to the second group of periodic table. What is the formula of its chloride?
14. An element 'B' belongs to the second period and Group 13. Give the formula of its oxide.
15. $^{35}_{17}Cl$ and $^{37}_{17}Cl$ are isotopes of chlorine, would you place them in different slots because their atomic masses are different? Or would you place them in the same position because their chemical properties are the same? [*NCERT*]
16. Is it possible to have an element with atomic number 1.5 placed between hydrogen and helium?
17. If an element 'X' is placed in group 14, what will be the formula and nature of bonding of its chloride? [*NCERT Exemplar*]
18. An element 'A' has atomic number 17. To which group and period does it belong? [*Delhi* 2016]
19. Find the atomic number of the element whose electronic configuration is 2, 8, 5. [*Delhi* 2016]
20. An element 'A' has atomic number 16. To which group and period does it belong? [*Delhi* 2016]
21. Name the scientist who first of all showed that atomic number of an element is a more fundamental property than its atomic mass. [*CBSE* 2018]
22. How many metals are present in second period of periodic table? [*CBSE* 2020]
23. To which group and period should hydrogen be assigned? [*NCERT*]
24. Write the name, symbol and electronic configuration of an element X whose atomic number is 11. [*Delhi* 2019]

IV. Short Answer Type Questions-I (2 Marks)

1. Predict the maximum number of valence electrons possible for the elements in the first period of periodic table. [*Delhi* 2014]
2. Why lithium with atomic number 3 and potassium with atomic number 19 are placed in group one? What will be atomic numbers of first two elements of second group? [*Delhi* 2016]
3. List two anomalies of Mendeleev's periodic table which were solved by modern periodic table law. [*Delhi* 2016]
4. (*a*) Among the following elements identify the one that would form anions:
   K, O, Na, F, Ca, Cl, Hg
   (*b*) Write the electronic configuration of the anions identified above. [*Delhi* 2014, 2015]
5. An element belongs to third period and second group of the periodic table:
   (*a*) State number of valence electrons in it. (*b*) Is it a metal or non-metal?
   (*c*) Name the element. (*d*) Write the formula of its oxide. [*Delhi* 2011, 2015]
6. State the reasons for the following:
   (*a*) The elements of the same group have similar chemical properties.
   (*b*) The elements of the same period have different properties. [*Delhi* 2012]
7. (*a*) State two main characteristics of elements on which modern periodic table is based.
   (*b*) No fixed position can be assigned to hydrogen in the periodic table. Why? [*Delhi* 2012]
8. (*a*) State modern periodic law.
   (*b*) Elements A, B, C and D have atomic numbers 1, 8, 11 and 19 respectively. Choose the odd element and give reason for your answer. [*Delhi* 2012]
9. How it can be proved that the basic structure of the Modern Periodic Table is based on the electronic configuration of atoms of different elements?
10. The electronic configuration of an element is 2,8,4. State its:
    (*a*) Group and period in the Modern Periodic Table.
    (*b*) Name and write its one physical property. [*Delhi* 2019]
11. An element 'X' has atomic number 13.
    (*a*) Write its electronic configuration.
    (*b*) State the group to which 'X' belong.
    (*c*) Is 'X' a metal or non-metal?
    (*d*) Write the formula of its bromide. [*Delhi* 2012]

12. Choose from the following: $_{6}C$, $_{8}O$, $_{10}Ne$, $_{11}Na$, $_{14}Si$

(*a*) Elements that should be placed in the same period.

(*b*) Elements that should be placed in the same group.

State the reason for your selection in each case. [*Delhi* 2016]

V. Short Answer Type Questions-II (3 Marks)

1. The electrons in the atoms of four elements A, B, C and D are distributed in 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 A and D and the molecular formula of compound formed when A and D will combine. [*Delhi* 2014, 2015]

2. (*a*) Predict the following which will form anions and which will form cations:

(*i*) Na (*ii*) Al (*iii*) Cl (*iv*) O

(*b*) Name two elements that are inert.

3. 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]

4. From the elements $^{39}_{19}A$, $^{28}_{14}B$, $^{16}_{8}C$ and $^{40}_{18}D$ identify:

(*a*) the most electropositive element.

(*b*) a noble gas.

(*c*) a metalloid.

(*d*) an element which will gain 2 electrons to attain nearest noble gas configuration.

(*e*) formula of compound formed between A and C.

(*f*) elements belonging to same period. [*CBSE* 2020]

VI. Long Answer Type Question (5 Marks)

1. Name the element which has

(*a*) the electronic configuration 2, 8, 1

(*b*) a total of two shells, with 4 electrons in the valence shell.

(*c*) total of three shells, with 3 electrons in valence shell.

(*d*) One shell which is completely filled with electrons.

(*e*) twice as many electrons in the second shell as in the first shell. [*Delhi* 2016] **[HOTS]**

Answers 2.2

I. 1. (*b*) (*i*), (*ii*), (*iii*) are incorrect statement, only (*iv*) is correct statement.

2. (*c*) It is 18 vertical columns called groups.

3. (*b*) B,C,D because they have same number of shells

	K	L	M	N
A	2			
B	2	1		
C	2	5		
D	2	8		
E	2	8	18	2

4. (*c*) Group 18 because they have 8 valence electrons.

5. (*b*) Mg because its valency is 2 and it forms $MgCl_2$

6. (*b*) 'X' (2, 3) has 3 valence electrons, so it belongs to group 13 and second period because it has 2 shells.

7. (*b*) X(2,8,1), Y(2,6)

X^1 Y^2

X_2Y is formula of compound

8. (*d*) Group 16 and period 3 is sulphur which is non-metal, will form acidic oxide.

9. (*d*) It is Al, having 3 valence electrons. Al_2O_3 is amphoteric oxide. Its valency is 3. The formula for chloride is $AlCl_3$.

II. 1. (*c*) 'A' is true but 'R' is false.

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

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

4. (*b*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.

III. 1. Properties of elements are a periodic function of their atomic number.

2. $2n^2$, where 'n' represents the number of electronic shell.

3. 17 and 21 respectively.

4. P(11): 2, 8, 1, Q(17): 2, 8, 7, R(19): 2, 8, 8, 1
'P' and 'R', because they have the same number of valence electrons.

5. There are 7 horizontal rows. These are called periods.

6. It is because 3rd shell could accommodate a maximum of 18 electrons, but if it is the outermost shell it could not have more than 8 electrons. Therefore, this period has 8 elements.

7. Aluminium, its valency is equal to 3, because it lose 3 electrons to become stable.

8. P(3): 2, 1; Q(12): 2, 8, 2; R(13): 2, 8, 3; S(20): 2, 8, 8, 2
'Q' and 'S' because they have the same number of valence electrons.

9. It belongs to Group 18 and second period of the periodic table.

10. 2nd period has 8 elements, 5th period has 18 elements.

11. 3 **12.** 8 **13.** XCl_2 **14.** B_2O_3

15. They will be placed in the same slot.

16. No, atomic number cannot be in fractions.

17. XCl_4, it has covalent bonding.

18. Its electronic configuration is 2, 8, 7. It belongs to group 17 and 3rd period.

19. Its atomic number is equal to 2 + 8 + 5 = 15.

20. It belongs to group 16 and third (3rd) period.

21. Henry Moseley

22. There are two metals Lithium (Li) and Beryllium (Be) in second period of periodic table.

23. It is placed in Group 1 and first period.

24. Sodium, Na: 2,8,1

IV. 1. 2 valence electrons are present in the last element 'Helium' of 1st period.

2.

	K L M N
Li(3)	2, 1
K(19)	2, 8, 8, 1

Li and K are placed in Group 1 because both have 1 valence electron.
Be(4) and Mg(12) are first two elements of Group 2.

3. (*i*) Position of isotopes were not justified in Mendeleev's periodic table but it is justified in the modern periodic table.
(*ii*) Increasing order of atomic masses could not be followed but increasing order of atomic numbers has been followed.

4. (*a*) O, F, Cl will form anions.
(*b*) O^{2-}(10) 2, 8
F^-(10) 2, 8
Cl^-(18) 2, 8, 8.

5. (*a*) 2, 8, 2 is the electronic configuration. The number of valence electrons = 2
(*b*) It is a metal
(*c*) Magnesium
(*d*) MgO is the formula of its oxide.

6. (*a*) It is because they have the same number of valence electrons.
(*b*) It is because they differ in the number of valence electrons.

7. (*a*) (*i*) Atomic number, (*ii*) No. of valence electrons

(*b*) It is because hydrogen resembles with Group 1 as well as Group 17 elements, therefore no fixed position can be assigned to it.

8. (*a*) **Modern Periodic Law:** It states that the properties of elements are a periodic function of their atomic number.

(*b*) 'B' with atomic number 8 is an odd element because it has 6 valence electrons whereas others have 1 valence electron.

9. Position of element in periodic table is decided with the help of electronic configuration e.g. group number is decided on the basis of valence electrons e.g., elements having valence electrons 1,2,3,4,5,6,7,8, belong to Group 1, 2, 13, 14, 15, 16, 17 and 18 respectively.

Period is equal to number of shells e.g. 2,8,3 belong to third period.

10. (*a*) It belongs to Group 14, third period.

(*b*) Silicon is the element. It is a metalloid, forms covalent bond. It is a semiconductor.

11. (*a*) 2, 8, 3, (*b*) Group 13, (*c*) Metal, (*d*) $AlBr_3$

12. (*a*) $_{6}C$, $_{8}O$, $_{10}Ne$ belong to the same period because all these have 2 shells.

$_{11}Na$, $_{14}Si$ belong to the same period because both of these have 3 shells.

(*b*) $_{6}C$ and $_{14}Si$ belong to the same group because they have the same number of valence electrons and valency.

V. 1. They belong to third period because these have 3 shells.

A has electronic configuration 2, 8, 1, valence electron 1, valency = 1

D has electronic configuration 2, 8, 7, valence electron 7, valency = 1

Formula: AD or A^+D^-

2. (*a*) Cl and O will form anions

Na and Al will form cations

(*b*) He, Ne are inert.

3. Atomic number of element P = 20

Electronic configuration of element P = 2, 8, 8, 2

Atomic number of element Q = 17

Electronic configuration of element Q = 2, 8, 7

The position of P in the Modern Periodic Table

Period (Number of shells) = 4

Group (Electrons in outer-most shell) = 2

The position of Q in the Modern Periodic Table

Period (Number of shells) = 3

Group (Electrons in outer-most shell) = (10 + 7) = 17

When P reacts with Q, it loses the two valence electrons (valency 2).

These two valence electrons are accepted by two Q atoms (valency 1).

Hence, the formula of the compound formed between P and Q is PQ_2.

4. (*a*) $^{39}_{19}A$ is most electropositive element (*b*) $^{40}_{18}D$ is noble gas

(*c*) $^{28}_{14}B$ is metalloid

(*d*) $^{16}_{8}C$ will gain 2 electrons to attain nearest noble gas configuration

(*e*) A^1 C^2

A_2C

(*f*) $^{28}_{14}B$, $^{40}_{18}D$ belong to same period *i.e.* 3rd period because they have 3 shells

VI. 1. (*a*) Sodium (2, 8, 1) (*b*) Carbon (2, 4) (*c*) Aluminium (2, 8, 3)

(*d*) Helium (2) (*e*) Carbon (2, 4)

TOPIC 3. Trends in the Modern Periodic Table

Valency: Valency increases from left to right till the middle and then decreases in the modern periodic table. Valency remains the same in a group, because valence electrons remains the same.

Atomic size: It goes on increasing down the group, because number of shells goes on increasing and effective nuclear charge decreases.

It decreases from left to right in a period due to increase in effective nuclear charge, because one proton and 1 electron is being added successively, number of shells remains the same, forces of attraction between the nucleus and valence electrons increases.

Metallic and Non-metallic properties: On the right hand side of periodic table, there are non-metals. Metals are on the left and middle region of periodic table. Metalloids are placed on the borderline of metals and non-metals, aligned in a zig-zag manner, e.g. B, Si, Ge, As, Sb, Te and Po are metalloids.

Tendency to lose electrons: Tendency to lose electrons decreases along a period, because atomic size decreases and effective nuclear charge increases. Tendency to lose electrons increases down the group, because atomic size increases and effective nuclear charge decreases. Metallic character decreases along the period, e.g. Na > Mg > Al. Metallic character increases down the group, e.g. K > Na > Li.

Tendency to gain electrons: Tendency to gain electrons increases along a period, ∵ effective nuclear charge increases. So as electronegativity increases, non-metallic character increases, e.g. F > O > N > C. Tendency to gain electrons decreases down the group, ∵ effective nuclear charge decreases. Therefore, electronegativity decreases, non-metallic character decreases, e.g. F > Cl > Br > I.

Reactivity of metals: It increases down the group, because tendency to lose electrons increases, e.g. Li < Na < K. It decreases along a period due to increase in effective nuclear charge, tendency to lose electrons decreases, e.g. Al < Mg < Na.

Reactivity of Non-metals: It decreases down the group, ∵ tendency to gain electrons decreases due to increase in atomic size, e.g. F > Cl > Br > I. Reactivity of non-metals increases along a period due to decrease in atomic size and increase in tendency to gain electrons, e.g. N < O < F.

Basic nature of oxides: It decreases along a period, but increases down the group.

Acidic nature of oxides: It decreases down the group, but increases along a period.

Stability of noble gases: The atoms of Group 18 elements have a very stable arrangement of electrons in their outermost valence shell. This makes them unreactive.

Cations and anions: Metals lose electrons to form +ve ions (cations), non-metals gain electrons to form –ve ions (anions).

- Cations are smaller than neutral atoms due to more effective nuclear charge.
- Anions are bigger than neutral atoms due to less effective nuclear charge.
- Group 1 and Group 2 elements form ionic compounds with Group 16 and Group 17 elements.
- Group 14 elements mostly form covalent compounds.
- Metals are mostly solids, except mercury which is a liquid. Non-metals exist as solids, liquids and in gaseous state, e.g. F_2, Cl_2, H_2, N_2, O_2 are gases; Br_2 is liquid; C, S, P, I_2 are solids.
- Group 18 elements all are gases. Group 17 and 18 elements are all non-metals. Group 1 and Group 2 elements are all metals.
- Metallic character increases down the group due to increase in tendency to lose electrons.
- Metallic character decreases along a period from left to right because tendency to lose electrons decreases.
- Non-metallic character decreases down the group as tendency to gain electrons decreases. It increases along a period due to increase in tendency to gain electrons.

EXERCISE 2.3

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

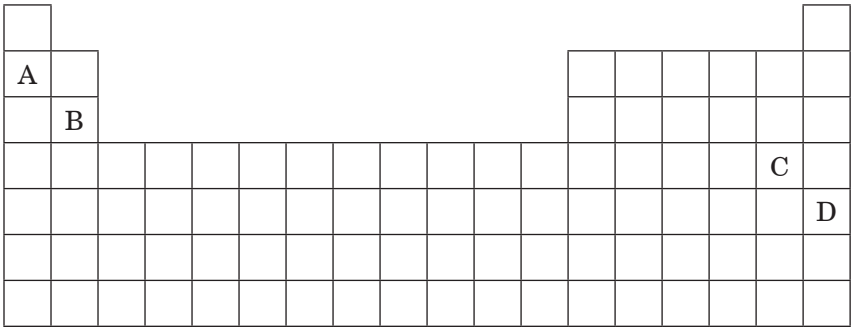
1. Which of the following gives the correct increasing order of the atomic radii of O, F and N?
(*a*) O < F < N (*b*) N < F < O (*c*) O < N < F (*d*) F < O < N

2. Which among the following elements has the largest atomic radii?
(*a*) Na (*b*) Mg (*c*) K (*d*) Ca

3. Which of the following elements would lose an electron easily?
(*a*) Mg (*b*) Na (*c*) K (*d*) Ca

4. Which of the following elements does not lose an electron easily?
(*a*) Na (*b*) F (*c*) Mg (*d*) Al

5. The positions of four elements A, B, C and D in the modern periodic table are shown below. Which element is most likely to form an acidic oxide?



(*a*) A (*b*) B (*c*) C (*d*) D

[*CBSE Sample Paper* 2019-2020]

6. Elements P, Q, R and S have atomic numbers 11, 15, 17 and 18 respectively. Which of them are reactive non-metals?
(*a*) P and Q (*b*) P and R (*c*) Q and R (*d*) R and S

[*CBSE Sample Paper* 2019-2020]

II. Assertion-Reason Type Questions (1 Mark)

For question numbers 1 to 2 two statements are given-one labeled as **Assertion** (A) and the other labeled **Reason** (R). Select the correct answer to these questions from the codes (*a*), (*b*), (*c*) and (*d*) as given below:

(*a*) Both 'A' and 'R' are true and 'R' is correct explanation of the assertion.
(*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.
(*c*) 'A' is true but 'R' is false.
(*d*) 'A' is false but 'R' is true.

1. **Assertion:** X with atomic number 13 is a metal.
Reason: It belongs to group 13 and 3rd period.
2. **Assertion:** Carbon is a metalloid.
Reason: Carbon forms CO_2 which is acidic oxide whereas CO is neutral oxide.

III. Very Short Answer Type Questions (1 Mark)

1. Which is smaller: (*i*) Na^+ or Na, (*ii*) Cl or Cl^-?
2. How does metallic character (electropositive character) varies down the group?
3. Which has smaller size: K(19) or Na(11); B(5) or C(6)?
4. How does valency vary in a (*i*) period on going from left to right, (*ii*) group?
5. On moving from left to right in the second period, what happens to the number of valence electrons?
6. How does atomic size vary from left to right in a periodic table?
7. How does reactivity of metals vary down the group?
8. Give any one difference in the electronic configuration of Group 1 and Group 2 elements.[*Delhi* 2014]
9. Out of Li and K, which one have stronger metallic character and why? [*Delhi* 2016]
10. "Fluorine is more electronegative than iodine". Give reason in support of this.
11. List any two properties of the elements belonging to the first group of modern periodic table.
[*Delhi* 2014]
12. The formula of magnesium oxide is MgO. State the formula of barium nitrate and barium sulphate, if barium belongs to the same group. [*Delhi* 2012]
13. The electronic configuration of two elements 'A' and 'B' are 2, 8, 7 and 2, 8, 8, 2, respectively. Write the atomic number of these elements. What will be the formula of the compound formed and the nature of bond between them, when these elements chemically combine together? [*Delhi* 2012]

14. Which has larger atomic radius, K(19) or Ca(20)? [*Delhi* 2016]

15. What would be nature of oxides formed by the elements on the right hand side of periodic table? [*Delhi* 2014]

16. Arrange the following metals in decreasing order of atomic size:
Ca, Mg, Ba, Be [*Delhi* 2014]

17. How does valency of an element vary across a period? [*CBSE Sample Paper* 2019-2020]

18. Define electropositivity. [*CBSE* 2020]

19. The atomic radii of first group elements are given below:

Group-1 element	Atomic Radii (pm)
Na	86
K	231
Rb	244
Cs	282

State the reason behind the observed trend in the above elements. [*CBSE* 2020]

20. Write the number of valence electrons present in a nitrogen atom $\left({}^{14}_{7}\mathrm{N}\right)$. [*CBSE* 2020]

IV. Short Answer Type Questions-I (2 Marks)

1. How does the valency of an element be determined, if its electronic configuration is known? What will be the valency of an element with atomic number 9? [*Delhi* 2012, 2011]

2. How does the metallic character of elements changes along a period of the periodic table from left to right and why? [*Delhi* 2011]

3. In the periodic table, how does the tendency of an atom to lose electrons changes on moving from (*i*) left to right across a period?, (*ii*) top to bottom in a group? [*Delhi* 2011]

4. What is meant by periodicity of properties of elements? Why are the properties of elements placed in the same group of periodic table similar? [*Delhi* 2011]

5. How does electronegativity of an element change as we go down a group and across a period? Give reason.

6. Which is bigger (*i*) O or F, (*ii*) N or P and why?

7. Calcium is an element with atomic number 20
(*i*) Will it be a metal/non-metal? (*ii*) What will be its valency?
(*iii*) What would be formula of its chloride?
(*iv*) Will it be larger/smaller than K? [*Delhi* 2016]

8. Three elements 'X', 'Y' and 'Z' having atomic numbers 11, 7 and 6 respectively react with oxygen to form their oxides.
(*a*) Arrange these oxides in increasing order of their basic nature.
(*b*) Give reason for your answer.

9. Given below are four elements with their atomic numbers:

Element	Atomic Number
A	16
B	11
C	3
D	14

(*a*) Identify the element which belong to same group of Modern Periodic Table.
(*b*) Arrange the given elements in decreasing order of atomic size.
(*c*) Write the formula of the oxide of 'B'.
(*d*) Which of the above element is a metalloid? [*Delhi* 2011]

10. Give reasons for the following:
(*a*) Lithium atom is smaller than sodium atom.
(*b*) Chlorine (Atomic number 17) is more electronegative than sulphur (Atomic number 16). [*Delhi* 2011]

11. Two elements 'M' and 'N' belong to Group I and II respectively and are in the same period of the periodic table. How do the following properties of M and N vary:

(a) size of their atoms (b) their metallic characters

(c) their valencies in forming oxides (d) formulae of their chlorides [*Delhi* 2012]

12. The following table shows elements represented by the letters A, B, C, D, E, F, G and H:

Group	1	2	13	14	15	16	17	18
Element	A	B	C	D	E	F	G	H

(i) Which of the element has the atomic size (a) biggest and (b) smallest?

(ii) Which element has valency (a) 3 and (b) Zero [*Delhi* 2012]

13. What is a metalloid? Name any one of them. [*Delhi* 2011]

14. What is place of metalloid in the periodic table? [*Delhi* 2011]

V. Short Answer Type Questions-II (3 Marks)

1. An element 'X' belongs to 3rd period and group 16 of the modern periodic table.

(i) Determine the number of valence electrons and valency of 'X'.

(ii) Molecular formula of the compound, when 'X' reacts with hydrogen and write its electron dot structure.

(iii) Name the element 'X' and state whether it is metallic or non-metallic. [*Delhi* 2016]

2. An element 'M' with electronic configuration (2, 8, 2) combines separately with NO_3^-, SO_4^{2-} and PO_4^{3-} radicals. Write the formulae of three compounds so formed. To which group and period of modern periodic table, 'M' belongs to? Will 'M' form covalent or ionic compounds? Give reason to justify your answer. [**HOTS**] [*Delhi* 2016]

3. In the following table, the position of six elements A, B, C, D, E and F are given as they are in the modern periodic table as follows:

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

On the basis of above table, answer the following questions: [**HOTS**]

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

(ii) Name the element which is a metal with the valency of 3.

(iii) Name the non-metal with the valency of 3.

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

(v) Write the common name for the family to which the elements D and F belongs to.

4. Based on the group valency of elements, state the formula of the following, giving justification for each.

(i) Oxides of Group 1 elements.

(ii) Halides of the elements of Group 13.

(iii) Compounds formed when an element of group 2 combines with an element of Group 16.

[*Delhi* 2014] [**HOTS**]

5. In the following table, are given eight elements A, B, C, D, E, F, G and H (here letters are not the usual symbols of the elements) of the Modern Periodic Table with atomic numbers of the elements in parenthesis.

Period	Group 1	Group 2
2	A (3)	E (4)
3	B (11)	F (12)
4	C (19)	G (20)
5	D (37)	H (38)

(i) What is the electronic configuration of F?

(ii) What is the number of valence electrons in the atom F?

(iii) What is the number of shells in the atom F?

(iv) Write the order of size of the atoms of E, F, G and H in decreasing order.

(*v*) State whether F is a metal or a non-metal.
(*vi*) Out of the three elements B, E and F, which one has the biggest atomic size?
[*Delhi* 2016] [**HOTS**]

6. Table given below shows a part of the periodic table:

H							He
Li	Be	B	C	N	O	F	Ne
Na	Mg	Al	Si	P	S	Cl	Ar

Using this table, explain why
(*i*) Li and Na are considered as active metals?
(*ii*) Atomic size of Mg is less than that of Na?
(*iii*) Fluorine is more reactive than chlorine? **[HOTS]**

7. What is the position i.e. group number, period number of element, iodine (atomic number 53)? What is the physical state and nature of this element (metal or non metal)? **[HOTS]**

8. Consider the following and answer the questions that follow:

Group 1	Group 2	Group 3
A	B	C
D	E	F
G	H	I

(*i*) Amongst A, D and G, which is not electropositive and why?
(*ii*) Atomic size of H is bigger than B. Why?
(*iii*) Write the formula of compound formed by the element E and fluorine. **[HOTS]**

9. Explain the basic character of oxides of elements down the group and across the period. [*Delhi* 2016]

10. The atomic number of Na and Mg is 11 and 12 respectively and they belong to same period.
(*a*) Which one would have smaller atomic size?
(*b*) Which one would be more electropositive?
(*c*) To which group would each one belongs?

11. Two elements 'P' and 'Q' belong to the same period of the modern periodic table and are in Group 1 and 2 respectively. Compare the following characteristics in tabular form:
(*a*) The number of valence electrons in their atom.
(*b*) Their metallic character
(*c*) The size of their atoms
(*d*) The formulae of their oxides
(*e*) Their tendency to lose electrons
(*f*) The formula of their chloride [*Delhi* 2015]

12. Given below are some elements of modern periodic table. Atomic number of elements are given in parenthesis:
A(4), B(9), C(14), D(19), E(20)
(*a*) Select the element that has one electron in outermost shell. Also write the electronic configuration of this element.
(*b*) Which two elements amongst there belong to the same group? Give reason for your answer.
(*c*) Which two elements amongst there belong to the same period? Which one of the two has bigger atomic radius? [*Delhi* 2015]

13. The elements Be, Mg and Ca are 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 radius. [*Delhi* 2014, 2015]

14. What is meant by 'group' in the modern periodic table? How do the following changes occur 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.

15. 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]

16. Na, Mg and Al are the elements of the 3rd period 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]

17. Two elements X and Y have atomic numbers 12 and 16 respectively. To which period of the modern periodic table do these two elements belong? What type of bond will be formed between them and why? Also give the chemical formula of the compound formed.

18. 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]

19. The electronic configuration of an element 'X' is 2,8,6. To which group and period of the modern periodic table does 'X' belong .State it valency and justify your answer in each case.

20. Based on the group valency of elements write the molecular formula of the following compounds giving justification for each

(*i*) Oxides of first group elements

(*ii*) Halides of group 13 and

(*iii*) Compound formed when an element A of group 2 combines with element B of group 17

[*Delhi* 2019]

21. How is possible valency of element determined with the help of electronic configuration of its atom? Determine the valency of 'X' whose atomic number is 15.

22. The following table shows the position of five elements A, B, C, D and E in the modern periodic table. **3**

Group→ Period↓	1	2	3 to 12	13	14	15	16	17	18
2	A							B	C
3		D				E			

Answer the following giving reasons:

(*i*) Which element is a metal with valency two?

(*ii*) Which element is least reactive?

(*iii*) Out of D and E which element has a smaller atomic radius?

VI. Long Answer Type Questions (5 Marks)

1. 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 the 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 belongs to?

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

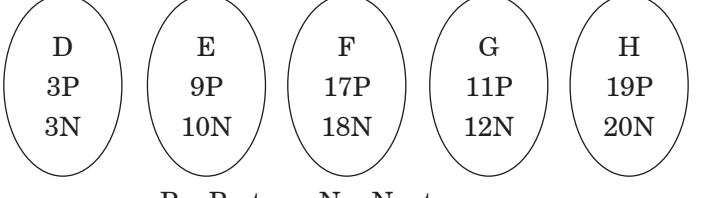
(*iii*) Which two of these elements could definitely be metals?

(*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 are 3 and 7 respectively, then write the formula of the compound formed by the combination of C and G.

[*Delhi* 2010**] [HOTS]**

2. The nucleus of five elements D, E, F, G and H are shown below:



P = Protons, N = Neutrons

(*i*) Identify D and E.
(*ii*) Identify the position of F and H in the periodic table.
(*iii*) What is the cause of similarity among the species D, G, H?
(*iv*) What will be the formula of compound formed between D and E?
(*v*) Which is largest in size among D, E, F, G and H? **[HOTS]**

3. (*i*) Which element can lose electrons most easily in 3rd period and why?
(*ii*) Why does tendency to lose electrons increases down the group?
(*iii*) What happens to the basic character of oxides down the group and why?
(*iv*) What happens to the acidic character of oxides along a period and why?
(*v*) Which group of elements can gain electrons most easily and why?

4. An element X of group 15 exists as a diatomic molecule and combines with hydrogen at 773 K, in the presence of a catalyst to form a compound ammonia, which has a characteristic pungent smell.
(*i*) Identify the element X. How many valence electrons does it have?
(*ii*) Draw the electron dot structure of diatomic molecule of X. What type of bond is formed in it?
(*iii*) Draw the electron dot structure for ammonia and what type of bond is formed in it? **[HOTS]**

5. An element X, which is a yellow solid at room temperature shows catenation and allotropy. X forms two oxides which are also formed during the thermal decomposition of ferrous sulphate crystals and are the major air pollutants.
(*i*) Identify the element X.
(*ii*) Write the electronic configuration of X.
(*iii*) Write the balanced chemical equation for the thermal decomposition of ferrous sulphate crystals.
(*iv*) What would be the nature (acidic/basic) of the oxides formed?
(*v*) Locate the position of the element in the modern periodic table. **[HOTS]**

6. The atomic radius of element of second period are given below:

Second period of elements	B	Be	O	N	Li	F	C
Atomic Radius (pm)	88	111	66	74	152	64	77

(*i*) Arrange these elements in decreasing order of atomic radius.
(*ii*) Are the elements now arranged in the pattern of period in the periodic table?
(*iii*) Name the element which has (*a*) largest (*b*) smallest atomic size.
(*iv*) From the above data, infer how the atomic size or radius of elements changes as we go from left to right in a period.
(*v*) Name one metal, one non-metal and a metalloid from these elements.
(*vi*) Why does atomic radius decrease as we move from left to right in a period?

7. (*a*) How is valency of an element determined if its electronic configuration is known? Determine the valency of an element of atomic no. 9
(*b*) Given below are some elements of modern periodic table. Atomic number of elements are given in parentheses.
A (4), B (9), C (14), D (19), E (20)
(*i*) With the help of electronic configuration, find out which ore of the above elements will have one electron in its outermost shell.
(*ii*) Which two elements belong to the same group? Give reasons for your answer.
(*iii*) Which one of the above element belonging to the fourth period has bigger atomic radius and why?
[*CBSE* 2019]

8. Explain giving justification the trends in the following properties of elements, on moving from left to right in a period, in the Modern Periodic Table.
(*a*) Variation of valency (*b*) Change of atomic radius
(*c*) Metallic to non-metallic character (*d*) Electronegative character
(*e*) Nature of oxides [*CBSE* 2018(C)]

9. (*a*) List any three observations which posed a challange to Mendeleev's periodic table.
(*b*) How does the mettallic character of elements vary on moving from
(*i*) Left to right in a period.
(*ii*) From top to bottom in a group of the Modern periodic table? Give reason for your answer.

10. The position of certain elements in the Modern Periodic Table are shown below:

Group → / ↓Period	1	2	3 to 12	13	14	15	16	17	18
1	G								H
2	A			I			B		C
3		D			E				F

Using the above table answer the following questions giving reasons in each case:

(*i*) Which element will form only covalent compounds?

(*ii*) Which element is a non-metal with valency 2?

(*iii*) Which element is a metal with valency 2?

(*iv*) Out of H, C and F which has largest atomic size?

(*v*) To which family does H, C and F belong? [*CBSE* 2020]

11. Define atomic size. Give its unit of measurement. In the modern periodic table what trend is observed in the atomic radius in a group and a period and why is it so? [*CBSE* 2020]

Answers 2.3

I. 1. (*d*) F < O < N ∵ Number of protons and electrons are decreasing, so effective nuclear charge decreases, and atomic size increases.

2. (*c*) K (2,8,8,1) is largest due to least effective nuclear charge as it has 19 protons and 19 electrons and four shells.

3. (*c*) 'K' because it has largest atomic size, least effective nuclear charge, therefore, can lose electron easily.

4. (*b*) 'F' is non-metal, it cannot lose electron easily. It can gain electron easily to become stable.

5. (*c*) C is non-metal, it will form acidic oxide

6. (*c*) Q (2, 8, 5) and R (2, 8,7) are reactive non-metals (Phosphorus and Chlorine)

II. 1. (*b*) Both 'A' and 'R' are true but 'R' is not correct explanation of the assertion.

2. (*d*) 'A' is false but 'R' is true.

III. 1. (*i*) Na^+, (*ii*) Cl

2. It increases down the group.

3. Na(11) is smaller in size than K(19), C(6) is smaller in size than B(5).

4. (*i*) In a period, valency first increases till the middle and then it decreases.
(*ii*) In a group, it remains the same.

5. Valence electrons keeps on increasing from left to right in the second period.

6. Atomic size decreases along a period from left to right in the periodic table.

7. It increases down the group.

8. Group 1 elements have 1 valence electron and are more reactive than Group 2 elements which have two valence electrons.

9. 'K', because it can lose electrons easily due to larger size and less effective nuclear charge.

10. 'F' is smaller in size than I, therefore the tendency to gain electrons is more due to more effective nuclear charge.

11. (*i*) They should have valency equal to 1 and form monovalent positive ions.
(*ii*) They are highly reactive soft metals.

12. $Ba(NO_3)_2$, $BaSO_4$

13. A has atomic number '17', 'B' has atomic number '20'.
BA_2 is the formula of the compound. The bond formed between A and B will be ionic bond.

14. K(19) is larger than Ca(20).

15. Acidic

16. Ba > Ca > Mg > Be

17. The valency of an element first increases and then decreases across a period.

18. It is defined as measure of tendency to lose electrons. The greater the tendency to lose electrons, more will be electropositivity.

19. Atomic radii increases down the group because number of shells go on increasing, effective nuclear charge decreases, distance between nucleus and valence shell increases.

20. It has 5 valence electrons.

IV. 1. Valency is equal to the number of valence electrons when valence electrons are from 1 to 4 or 8 – no. of valence electrons when valence electrons are from 5 to 8.

F(9): 2, 7; It can gain 1 electron to become stable, so its valency = 1.

2. It decreases due to decrease in atomic size and decrease in tendency to lose electrons.

3. (*i*) It decreases due to increase in effective nuclear charge.

(*ii*) It increases due to decrease in effective nuclear charge.

4. The repetition of similar properties of elements after a certain interval of elements is called periodicity of properties.

Elements of the same group have same number of valence electrons, same valency and therefore posses similar chemical properties.

5. Electronegativity decreases down the group due to increase in atomic size and decrease in effective nuclear charge.

Electronegativity increases along a period due to decrease in atomic size and increase in effective nuclear charge.

6. O is bigger in size than F due to less effective nuclear charge.

P is bigger in size than N due to more number of shells.

7. (*i*) It is a metal. (*ii*) Its valency is equal to 2.

(*iii*) $CaCl_2$ is the formula of its chloride. (*iv*) It will be smaller than K.

8. X(11): 2, 8, 1; Y(7): 2, 5; Z(6): 2, 4

(*a*) Y < Z < X

(*b*) 'X' is metallic in nature, therefore it will form basic oxide. 'Y' and 'Z' are non-metals will form acidic oxides. 'Y' will form more acidic oxide than 'Z' because it is more non-metallic in nature.

9. (*a*) 'B' and 'C' belong to same group. (*b*) B > D > A > C

(*c*) B_2O (*d*) 'D' is a metalloid.

10. (*a*) It is because Li(2, 1) has two shells whereas Na(2, 8, 1) has three shells.

(*b*) Chlorine is smaller in size and has more effective nuclear charge than sulphur, therefore it is more electronegative.

11. (*a*) Size of 'N' is smaller than 'M'.

(*b*) 'M' is more metallic than 'N'.

(*c*) Valency of 'M' is 1 and valency of 'N' is 2.

(*d*) MCl and NCl_2 are the formulae of their chlorides.

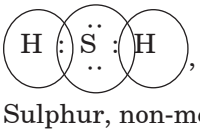
12. (*i*) (*a*) 'A' is biggest in size (*b*) 'G' is smallest in size

(*ii*) (*a*) 'C' has valency 3. (*b*) H has zero valency

13. The element which resembles both with metals and non-metals is called a metalloid, e.g. Boron, Silicon.

14. They are placed between metals and non-metals in a zig-zag manner.

V. 1. (*i*) The element is S(16)—2, 8, 6, The number of valence electrons—6, Valency—2.

(*ii*) 

, H_2S

(*iii*) Sulphur, non-metallic.

2. $Mg(NO_3)_2$, $MgSO_4$, $Mg_3(PO_4)_2$

It belongs to Group 2, 3rd period of the periodic table.

It will form ionic compounds because it can lose 2 electrons easily to form Mg^{2+} ions.

3. (*i*) E, (*ii*) B, (*iii*) C, (*iv*) B, ∵ It has more number of shells, (*v*) Noble gases

4. (*i*) Group 1 elements can lose one electron to become stable, so its valency is equal to 1, M_2O.

(*ii*) Group 13 elements have valency equal to 3, MCl_3.

(*iii*) Group 2 elements have valency equal to 2, Group 16 elements have 6 valence electrons.

Thus, formula of oxide: M^{2+} O^{2-} → MO

$\therefore$ valency = 2

5. (*i*) F(12) 2, 8, 2; (*ii*) 2; (*iii*) 3;
(*iv*) H > G > F > E; (*v*) F is a metal;
(*vi*) B has biggest atomic size.

6. (*i*) Li and Na can lose electrons easily due to their large size and hence are more reactive.
(*ii*) Mg has more effective nuclear charge than Na.
(*iii*) Fluorine can gain electrons more easily than chlorine, due to smaller atomic size.

7. I(53): 2, 8, 18, 18, 7
It belongs to group 17, 5th period.
It is a solid. It is a non-metal.

8. (*i*) 'A' is not electropositive because it is hydrogen which is considered as a non-metal.
(*ii*) 'H' has more number of shells than 'B', therefore it has bigger atomic size.
(*iii*) EF_2 is the formula of fluoride of 'E'.

9. Basic character of oxides increases from top to bottom in a group because metallic character increases down the group due to increase in tendency to lose electrons.
Basic character of oxide decreases along a period from left to right because the atomic size decreases, tendency to lose electrons decreases, metallic character decreases.

10. (*a*) Magnesium has smaller size than Na.
(*b*) Na is more electropositive than Mg.
(*c*) Na belongs to Group 1, Mg belongs to Group 2.

11.

Property	P	Q
(*a*) Valence electrons	1	2
(*b*) Size	Bigger	Smaller
(*c*) Metallic character	More metallic	Less metallic
(*d*) Tendency to lose electrons	More	Less
(*e*) Formula of oxide	P_2O	QO
(*f*) Formula of Chloride	PCl	QCl_2

12. (*a*) D(19) has one valence electron. Its electronic configuration is 2, 8, 8, 1.
(*b*) A(4), E(20) belong to same group because they have same number of valence electrons.
(*c*) A and B belong to same period, A is bigger than 'B'.
D and E also belong to same period, 'D' is bigger than E.

13. (*i*) They belong to Group 2 because they have 2 valence electrons.
(*ii*) Be is the least reactive element due to smallest size and least tendency to lose electrons.
(*iii*) Ca has largest radius because it has the most, four shells (2, 8, 8, 2).

14. The vertical columns of periodic table are called **Groups.**
(*i*) Number of valence electrons remains the same.
(*ii*) Number of occupied shells goes on increasing.
(*iii*) Size of atoms increases down the group.
(*iv*) Metallic character of elements increases down the group.
(*v*) Effective nuclear charge decreases.

15. In the Modern Periodic Table, there are 18 vertical columns known as Groups and 7 horizontal rows known as Periods.
Metallic character: It is defined as the tendency of an atom to lose electrons.

Across the period *i.e.*, from left to right: Metallic character decreases.

Down the group *i.e.*, from top to bottom: Metallic character increases.

Reason: Across the period, the effective nuclear charge increases, thus decreasing its atomic radius. This favours the increase of electronegativity and therefore the tendency to lose electrons is less. This accounts for the decrease in the metallic character along the period.

But as we move down the group the number of shells keep on increasing and therefore the atomic size increases. This means that the electronegativity decreases. This enhances the ability to lose electrons and therefore the metallic character increases down the group.

16. Given are the three elements Na, Mg and Al belonging to group 1 , 2 and 13 respectively.

The electronic configurations of the three elements are as follows:

Element Name	Symbol	Atomic Number	Electronic Configuration
Sodium	Na	11	2, 8, 1
Magnesium	Mg	12	2, 8, 2
Aluminium	Al	13	2, 8, 3

(*a*) The element having the highest valency signifies the maximum number of electrons present in the valence shell of an atom. Hence, as per the given electronic configurations, the element having highest valency is aluminium (Al).

(*b*) As we move across the period, *i.e.*, from left to right the atomic radius decreases. Therefore the element having the largest atomic radius will be sodium (Na).

(*c*) The given three elements are metals. So, the chemical reactivity of a metal is determined by its metallic character which is the tendency of an atom to lose its electrons. We know that the metallic character of element decreases across the period, *i.e.*, from left to right. So, the element having highest chemical reactivity is sodium (Na).

17. Electronic configuration of X: 2,8,2, Y: 2,8,6

Both X and Y belong to 3rd period because they have 3 shells.

Ionic bond will be formed.

Reason: X will lose 2 electrons and Y will gain 2 electrons to complete their octet and become stable.

Formula is $(X^{2+})\left(:\underset{\cdot\cdot}{\overset{\cdot\cdot}{Y}}:^{2-}\right)$

18. In the Modern Periodic Table, there are 18 vertical columns known as Groups and 7 horizontal rows known as Periods.

As we move down the group, the electrostatic attraction between the nucleus and the outer-most electron decreases due to increase in the distance between them. This happens because, on moving down the group, a new shell is added. So the valence electrons can be easily lost by the element. As we know, metallic character is characterised by the ease of loss of electrons, thereby, metallic character increases on moving down the group in the Modern Periodic Table.

When we move across a period, the number of electrons in the same shell increases. This leads to greater electrostatic attraction between the nucleus and the outer-most electron. This increased attraction pulls the outer-most electron closer to the nucleus, thereby decreasing the atomic size.

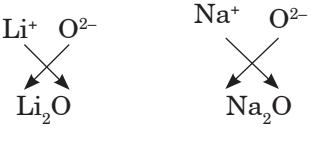
19. X – 2, 8, 6

(*a*) Since 'X' has three energy shells and period number of an element is equal to the number of energy shells. So, X belongs to 3rd period.

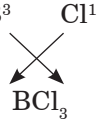
(*b*) X has 6 valence electrons so, it belongs to group 16.

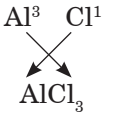
(*c*) Valency will be 2. To acquire noble gas configuration it will gain 2 electrons.

20. (*i*) Group 1 elements have valency equal to 1.



(*ii*) Group 13 elements have 3 valence electrons, valency equal to 3





(*iii*) 

$\therefore$ A has valency equal to 2 and B has valency equal to 1.

21. Valency is equal to number of valence electrons or 8–valence electrons. X has electronic configuration 2, 8, 5.

Its valency is equal to 3 because it can gain 3 electrons to become stable.

22. (*i*) D, As it is on the left side of the table in group 2.

(*ii*) C, as it is in the group 18/ Noble gas.

(*iii*) E, as we move from left to right across a period, atomic radius decreases.

VI. 1. (*i*) They belong to the same period but different groups. 'G' belongs to Group 17. A and B belong to Group 1 and 2, $\because$ their oxides are basic. 'C' belongs to Group 13 due to 3 valence electrons. 'D' belongs to Group 14. E and F belong to group 15 and 16, respectively. 'H' belongs to group 18.

(*ii*) B and F will form an ionic compound.

(*iii*) A and B are metals.

(*iv*) G, H are gases at room temperature.

(*v*) CG_3

2. (*i*) 'D' is lithium, E is fluorine.

(*ii*) F belongs to group 17, 3rd period.

H belongs to group 1, 4th period.

(*iii*) They have the same number of valence electrons, D(3) 2, 1; G(11) 2, 8, 1; H(19) 2, 8, 8, 1.

(*iv*) DE is the formula of the compound.

(*v*) H is largest in size due to the presence of four shells.

3. (*i*) Na, it is due to larger atomic size and least effective nuclear charge.

(*ii*) It is due to increase in atomic size and decrease in effective nuclear charge.

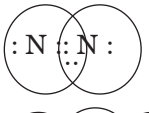
(*iii*) Basic character of oxides increases down the group due to increase in metallic character.

(*iv*) Acidic character of oxides increases along a period due to increase in non-metallic character.

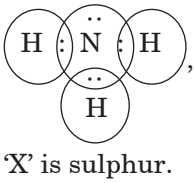
(*v*) Group 17 elements, due to smaller atomic size and more effective nuclear charge.

4. (*i*) 'X' is nitrogen. It has 5 valence electrons.

$$N_2(g) + 3H_2(g) \xrightarrow[773\ K]{Fe} 2NH_3(g)$$

(*ii*) 

:N≡N:, It forms a triple covalent bond.

(*iii*) 

, It forms a single covalent bond.

5. (*i*) 'X' is sulphur. (*ii*) S(16): 2, 8, 6

(*iii*) $2FeSO_4(s) \xrightarrow{heat} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

(*iv*) SO_2 and SO_3 are acidic oxides and major air pollutants whereas Fe_2O_3 is a basic oxide.

(v) It belongs to group 16 and 3rd period.

6. (*i*)

Li	Be	B	C	N	O	F
152	111	88	77	74	66	64

(*ii*) Yes, the elements are arranged in the pattern of a period (2^{nd} period in the periodic table).

(*iii*) (*a*) Li is largest in size.

(*b*) F is smallest in size.

(*iv*) Atomic radius decreases from left to right in a period.

(*v*) Metal–Li/Be, Non-Metal-C/N/O/F, Metalloid-Boron.

(*vi*) Atomic size decreases as we move from left to right in a period because effective nuclear charge increases as one electron and one proton is added successively and number of shells remains the same.

7. (*a*) Valency is equal to number of valence electrons or 8— number of valence electrons.

F (9): 2,7

Its valency is equal 1 because it will become stable on gaining one electron.

(*b*) (*i*) A (4): 2,2 D (19): 2,8,8,1
B (9): 2,7 E (20): 2,8,8,2
C (14): 2,8,4
'D' has one valence electron.

(*ii*) 'A' and 'E' belong to same group because they have same number of valence electrons.

(*iii*) 'D' has larger atomic radius than 'E' because it has 19 protons which attract 19 electrons which is there less strongly than 20 protons can attract 20 electrons as in E.

8. (*a*) Valency increases from left to right till middle, then decreases because valence electrons goes on increasing.

(*b*) Atomic radius decreases due to increase in effective nuclear change.

(*c*) Metallic character decreases, non-metallic character increases due to increase in tendency to gain electrons as atomic size decreases, effective nuclear change increases.

(*d*) Electronegative character increases due to increase in effective nuclear change.

(*e*) Acidic character of oxides increases, basic character of oxides decreases because metallic character decreases and non-metallic character increases.

9. (*a*) (*i*) Increasing order of atomic mass could not be followed.

(*ii*) Isotopes cannot occupy different positions as they have same chemical properties but different atomic mass.

(*iii*) Position of hydrogen was not justified.

(*b*) (*i*) Metallic character decreases from left to right in a period because tendency to lose electrons decreases as effective nuclear charge increases.

(*ii*) Metallic character increases down the group from top to bottom because tendency to lose electron increases due to increase in atomic size and decrease in effective nuclear charge.

10. (*i*) E will form only covalent compounds.

(*ii*) B is non-metal with valency 2.

(*iii*) D is metal with valency 2.

(*iv*) 'F' has largest atomic radius.

(*v*) It belongs to noble gases.

11. Atomic size is the distance between centre of nucleus and valence shell.
Its unit of measurement is picometre (10^{-12} m) denoted by pm.
Atomic radius increases down the group due to increase in number of shells and decrease in effective nuclear charge.
Atomic radius decreases along a period from left to right because effective nuclear charge increases but number of shells remain the same.

CASE STUDY QUESTIONS

1. Around the year 1800, only 30 elements were known. Dobereiner in 1817 and Newlands in 1866 tried to arrange the then known elements and framed laws which were rejected by the scientists. Even after the rejection of the proposed laws, many scientists continued to search for a pattern that correlated the properties of elements with their atomic masses.

The main credit for classifying elements goes to Mendeleev for his most important contribution to the early development of a Periodic table of elements wherein he arranged the elements on the basis of their

fundamental property, the atomic mass and also on the similarity of chemical properties. The formulae of their hydrides and oxides were treated as basic criteria for the classification of the elements.

However, Mendeleev's classification also had some limitations as it could not assign the position to isotopes. He also left some gaps in the periodic table.

(*i*) According to Mendeleev's Periodic Law properties of elements are periodic function of

(*a*) atomic mass (*b*) atomic number

(*c*) number of protons (*d*) number of electrons

(*ii*) Why did Mendeleev leave some gaps in the Periodic table?

(*a*) For elements to be discovered (*b*) For isotopes

(*c*) For isobars (*d*) None of these

(*iii*) If the letter 'R' was used to represent any of the elements in the group, then the hydride and oxide of carbon would respectively be represented as

(*a*) RH_4, RO (*b*) RH_4, RO_2 (*c*) RH_2, RO_2 (*d*) RH_2, RO

(*iv*) Isotopes are:

(*a*) Atoms of an element with similar chemical properties but different atomic masses.

(*b*) Atoms of different elements with similar chemical properties but different atomic masses.

(*c*) Atoms of an element with different chemical properties but same atomic masses.

(*d*) Atoms of different elements with different chemical properties but same atomic masses.

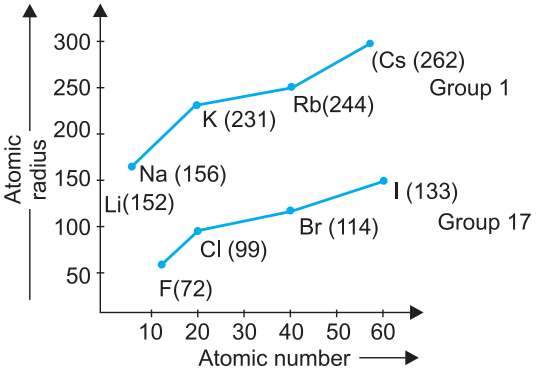
(*v*) How many groups and periods are there in Mandeleev's periodic table?

(*a*) 6 group, 8 period (*b*) 18 group, 7 period

(*c*) 7 group, 18 period (*d*) 8 group, 6 period

Ans. (*i*) (*a*) (*ii*) (*a*) (*iii*) (*b*) (*iv*) (*a*) (*v*) (*d*)

2. Modern periodic table has 18 vertical columns known as groups and 7 horizontal rows known as periods. First period contains 2 elements second and third period contain 8 elements. 4th and 5th period contains 18 elements and 6th and 7th period contains 32 elements. The graph is plotted between atomic number and atomic radius of group 17 and group 1 elements.



(*i*) Which group elements will have largest atomic size?

(*a*) Group 1 (*b*) Group 2 (c) Group 3 (*d*) Group 18

(*ii*) Which group elements will gain electrons to form negative ions?

(*a*) Group 1 (*b*) Group 2 (*c*) Group 17 (*d*) Group 18

(*iii*) Which element in group 17 has smallest size?

(*a*) Flourine (*b*) Bromine (*c*) Chlorine (*d*) Iodine

(*iv*) What happens to atomic radii in a group from top to bottom?

(*a*) Increases (*b*) Decreases

(*c*) First decreases then increases (*d*) Number of shells remains the same

(*v*) Atomic size decreases from left to right in a period because

(*a*) Effective nuclear charge increases

(*b*) Number of shells remains the same

(*c*) Force of attraction between the nucleus and valence electrons increases

(*d*) All of these

Ans. (*i*) (*a*) (*ii*) (*c*) (*iii*) (*a*) (*iv*) (*a*) (*v*) (*d*)

3.

Atom (Period II)	Li	Be	B	C	N	O	F
Electronegativity	1.0	1.5	2.0	2.5	3.0	3.5	4.0
Atom (Period III)	Na	Mg	Al	S.	P	S	Cl
Electronegativity	0.9	1.2	1.5	1.8	2.1	2.5	3.0

Atom Group 1	**Electronegativity**	**Atom Group 17**	**Electronegativity**
Li	1.0	F	4.0
Na	0.9	Cl	3.0
K	0.8	Br	2.8
Rb	0.8	I	2.5
Cs	0.7	At	2.2

(*i*) Which element has highest electronegativity?

(*a*) C (*b*) N (*c*) O (*d*) F

(*ii*) How electronegativity varies in a period?

(*a*) Increases from left to right (*b*) Decreases from left to right

(*c*) First increases then decreases (*d*) Vary independently

(*iii*) How electronegativity varies in a period?

(*a*) Increases down the group

(*b*) Decreasing down the group

(*c*) First increases then decreases down the group

(*d*) Vary independently

(*iv*) Which of the following has least electronegativity?

(*a*) Li, (*b*) Be, (*c*) O, (*d*) N

(*v*) What happens to tendency to gain electron in a period?

(*a*) Increases, (*b*) Decreases, (*c*) Remaining same, (*d*) First increases then decreases.

Ans. (*i*) (*d*) (*ii*) (*a*) (*iii*) (*b*) (*iv*) (*a*) (*v*) (*a*)

QUICK REVISION NOTES

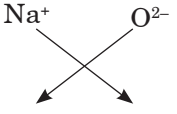
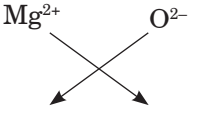
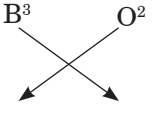
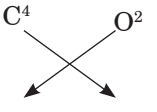
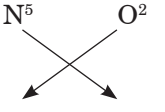
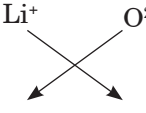
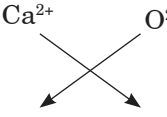
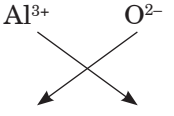
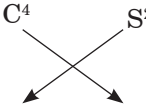
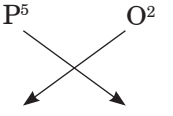
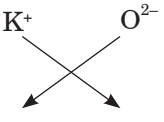
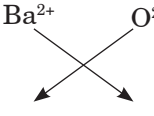
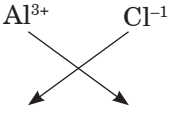
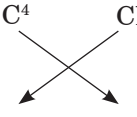
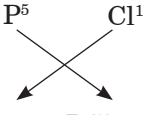
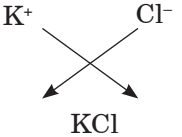
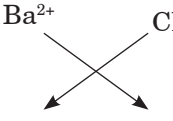
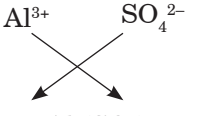
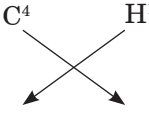
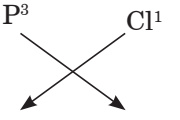
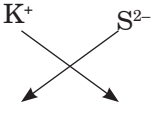
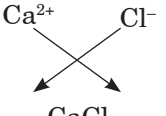
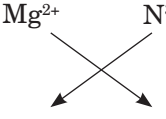
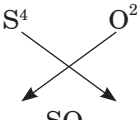
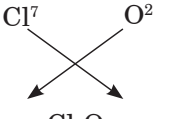
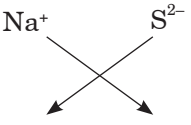
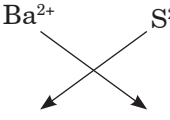
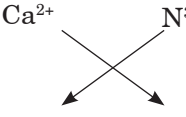
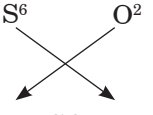
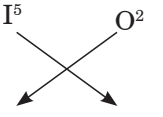
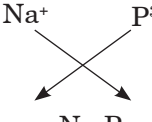
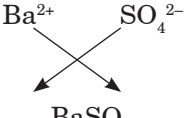
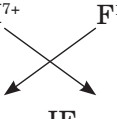
- *Periodic Table*: It is a table in which elements are classified on the basis of similarity in properties.
- Classification is essential so that the properties of elements can be studied conveniently.
- The first attempt of classification was done by Dobereiner in a group of three elements called triads. He could not classify all the elements discovered at that time.
- Newlands arranged elements in the increasing order of their atomic masses. He found that every 8th element resembles with the first like the notes in music, every 8th note is same as the first. He could not classify all the elements.
- Mendeleev classified all the 63 elements discovered till 1869 in the Mendeleev's periodic table based on increasing order of their atomic masses and formulae of their hydrides and oxides.
- Mendeleev kept on modifying his periodic table till isotopes were discovered. After the discovery of isotopes, the basis of his periodic table was rejected.
- Modern periodic law was the basis of modern periodic table in which elements were arranged in increasing order of their atomic number.

- Modern periodic table (long form of periodic table) could overcome most of the shortcomings of Mendeleev's periodic table.
- The horizontal rows of periodic table are called periods. There are 7 periods in modern periodic table.
- The vertical columns of periodic table are called groups. There are 18 groups in the long form of periodic table.
- The elements show *periodicity*, i.e. repetition of similar properties after a definite interval.
- The similar elements are arranged in a group.
- A heavy zig-zag line separates metals from non-metals, with non-metals to the right (except for hydrogen) and metals on the left and middle of the periodic table.
- Metalloids which resemble metals as well as non-metals are on the border line of metals and non-metals and arranged in a zig-zag manner.
- There are 118 elements discovered so far, which are classified into 18 groups and 7 periods.
- First period has 2, second and third period have 8, fourth and fifth period have 18, sixth and 7th period have 32 elements.
- Group 1 elements are called alkali metals, Group 2 elements are called alkaline earth metals, Group 13-Boron family, Group 14-Carbon family, Group 15-Nitrogen family, Group 16-Oxygen family, Group 17-Halogens and Group 18 elements are called Noble gases.
- Group 3 to Group 12 elements are called transition metals.
- Elements with atomic numbers from 58 to 71 are called lanthanoids. It is kept at the bottom of the periodic table in a separate row.
- Elements with atomic numbers from 90 to 103 are called actinoids, kept in the last row in the periodic table, below lanthanoids.
- Atomic size goes on increasing down the group whereas it goes on decreasing along the period from left to right.
- Properties of elements depend upon the number of valence electrons.
- In a group, all the elements have the same number of valence electrons, i.e. same valency.
- Valency is equal to the number of valence electrons or 8-number of valence electrons.
- Valency is number of electrons lost or gained or shared by atoms of elements, so as to become stable like noble gases.
- Valency in a period first increases till middle, then decreases.
- Tendency to lose electrons increases down the group.
- Tendency to lose electrons decreases along a period, from left to right.
- Tendency to gain electrons decreases down the group.
- Tendency to gain electrons increases along a period, from left to right.
- Metallic character increases down the group.
- Metallic character decreases along a period, from left to right.
- Non-metallic character increases along a period, from left to right.
- Non-metallic character decreases down the group.
- Group 18 elements have a very stable electronic configuration in their outermost shell. Their valency is zero because they do not have any tendency to lose/gain or share electrons. This makes them unreactive.
- Elements of 1st period have electrons in first shell only, 2nd period has 2 shells (orbits), 3rd period has 3 shells (K, L, M), 4th period has 4 shells (K, L, M, N) and so on.
- Over 80% of the elements are metals and remaining are non-metals.
- Metals and non-metals differ in their properties.
- Hydrogen is a non-metal but kept in Group 1 because it can form H^+ ion like alkali metals (Group 1 elements).
- The elements after Uranium (92) are man-made or synthetic elements. Tc(43), Pm(61), At(85) and Fr(87) are also man-made elements.
- Across a period, there is a change from metallic to non-metallic character, e.g. in 3rd period, Na, Mg, Al are metals, Si is metalloid, while P, S, Cl, Ar are non-metals.
- Group 1 metals are the most reactive, because they can lose electrons easily to form positive ions.
- Group 17 elements (non-metals) are also considered most reactive, because they can gain an electron easily to become stable and form negative ions.
- Metals are good reducing agents, because they can lose electrons.

- Non-metals are good oxidising agents, because they can gain electrons easily.
- Cations are positively charged whereas anions are negatively charged.
- Elements having 1, 2 or 3 valence electrons are mostly metals. Those elements having 4 to 8 valence electrons are non-metals.
- Elements can go from metallic to non-metallic nature in a period.
- Melting and boiling points rises till the middle of the period, then fall to very low values towards the right.
- Oxides of metals are basic, while oxides of non-metals are acidic. Al_2O_3 and ZnO are amphoteric oxide. Some non-metallic oxides are also neutral e.g. NO, CO, N_2O.
- Reactivity decreases along metals in a period, then increases across non-metals. Noble gases are the least reactive elements.

IMPORTANT FORMULAE

Criss-Cross Method

IMPORTANT ELEMENTS

Electronic Configuration of Elements

	K	L	M	N
H(1)	1			
He(2)	2			
Li(3)	2,	1		
Be(4)	2,	2		
B(5)	2,	3		
C(6)	2,	4		
N(7)	2,	5		
O(8)	2,	6		
F(9)	2,	7		
Ne(10)	2,	8		
Na(11)	2,	8,	1	
Mg(12)	2,	8,	2	
Al(13)	2,	8,	3	
Si(14)	2,	8,	4	
P(15)	2,	8,	5	
S(16)	2,	8,	6	
Cl(17)	2,	8,	7	
Ar(18)	2,	8,	8	
K(19)	2,	8,	8,	1
Ca(20)	2,	8,	8,	2

COMMON ERRORS

Errors	Corrections
• Many students get confused and think atomic number of an element is equal to the total number of electrons and think that sum of the number of electrons and protons is equal to the atomic mass.	☞ Students should learn and understand the definitions of atomic number and atomic mass properly. Atomic number is always equal to the number of protons present in an atom and atomic mass is the sum of mass of protons and neutrons present in the nucleus of the atom.
• Many students get confused among groups and periods.	☞ Although the table itself is called the periodic table, elements in the same group (or column) are often more similar than those in the same period (row).
• Many students consider metalloids to show half of the properties of metals only and none of them to show any non-metallic character and also get confused with their arrangement in the periodic table.	☞ Students should properly understand the definition of the metalloids. Metalloids are the elements that show properties of both metals as well as non-metals. Even though metalloids are also termed as semi metals but some of the properties of metalloids also resemble to that of non-metals, like the formation of borides, tellurides, etc. Metalloids are located in a zig zag manner in the middle region of the periodic table.
• Many students make mistakes in understanding the trend of atomic size in the periodic table and usually consider that non-metals have always bigger atomic size than metals.	☞ Students should understand the phenomena of effective nuclear charge and the effect of addition of orbits (or shells) properly and do not confuse with the effect of metallic and non-metallic character for atomic size or radius.
• Many students fail to understand why helium is a noble element, even when it does not have complete octet of electrons.	☞ Students should properly learn the rules of filling up of electrons in orbitals in an atom and should learn that in helium only one shell is there which can occupy the electrons and based on the rule, it can accommodate a maximum of 2 electrons and that is why it is a noble (unreactive) element.

• Students usually make mistakes while listing the electronic configuration of elements.	☞ Learn all the rules for deciding the filling up of electrons in the orbits of atoms of elements.
• Many students get confused in the number of valence electrons and valency of halogens. Students should properly learn that valency is necessarily not equal to the number of valence electrons. For halogens behaving as anions (like in NaCl), the valency is of Cl^- ion is equal to 8–no. of valence electrons (7), i.e. 1.	☞ Students should properly understand the arrangement of elements in groups and periods in the modern periodic table, based on their electronic configuration.
• Many students do not understand the placement of *lanthanoids* and *actinoids* and accidentally neglect them altogether.	☞ Lanthanoids and actinoids are kept separately at the bottom because they resemble with each other but they do not resemble with the other group elements.

ASSIGNMENT

Total Marks : 20

I. Multiple Choice Questions (1 Mark)

Choose the correct answer from the given options.

1. An element 'X' with atomic number 12 forms a compound with element 'Y' with atomic number 17. The formula of the compound is

(*a*) XY (*b*) XY_2

(*c*) X_2Y (*d*) X_2Y_3 [*CBSE* 2020]

2. An element 'X' is forming acidic oxide. Its most probable position in the modern periodic table is

(*a*) Group 1 and Period 3 (*b*) Group 16 and Period 3

(*c*) Group 17 and Period 3 (*d*) Group 2 and Period 3 [*CBSE* 2020]

II. Assertion-Reason Type Questions (1 Mark)

Note: Use instructions as given in topical exercises of the chapter.

1. Assertion: A. 'X' has mass no. 35, number of neutrons are 18.
Reason: X belongs to Group 17 and 3rd period, it is non-metal

2. Assertion: Out of A(4), B(9), C(14), D(19), E(20), D(19) has one valence electron.
Reason: Valency of A(4) and E(20) are equal to 2.

III. Very Short Answer Type Questions (1 Mark)

1. If the atomic mass of 'Na' is 23 and 'K' is 39, calculate atomic mass of Li, if these elements form Dobereiners' triads.

2. An element belongs to Group 15, 2nd period. Write down the formula of its oxide and hydride.

IV. Short Answer Type Questions-I (2 Marks)

1. How does tendency to lose electrons change in a period and why?

2. How does ionic size vary down the group and along a period from left to right? Why?

3. What is a metalloid and where are they positioned in the periodic table?

V. Short Answer Type Question-II (3 Marks)

1. From the elements Li, K, Mg, C, Al and S identity

(*a*) the case elements belonging to the same group.

(*b*) element which has the tendency to lose two electrons

(*c*) element which prefers sharing of electrons to complete its octet.

(*d*) most metallic element

(*e*) element that forms acidic oxide

(*f*) element that belongs to group 13 [*CBSE* 2020]

VI. Long Answer Type Question (5 Marks)

1. Answer the following questions based on elements with atomic number 3 to 9.

(*a*) Name the element which has smallest atomic radius.

(*b*) Name the element which shows maximum valency.

(*c*) Name the element which is metalloid.

(*d*) Name the element which is most electropositive.

(*e*) Write the chemical formula of a compound formed when the element with atomic number 6 and 8 react together.