23. Write three different chemical reactions showing the conversion of ethanoic acid to sodium ethanoate. Write balanced chemical equation in each case. Write the name of the reactants and the products other than ethanoic acid and sodium ethanoate in each case. *[CBSE (AI) 2016]*

24. (*i*) Name the products obtained on complete combustion of hydrocarbons? How is the gas evolved during combustion tested in the laboratory? Explain in brief.

(*ii*) Write the next higher homologue of:

(*a*) C_3H_6 (*b*) C_5H_8

25. State any three points of differences between ionic and covalent compounds.

26. What happens when

(write chemical equation in each case)

(*a*) ethanol is burnt in air ?

(*b*) ethanol is heated with excess conc. H_2SO_4 at 443 K ?

(*c*) a piece of sodium is dropped into ethanol ? *[CBSE (AI) 2017]*

27. What are hydrocarbons ? Write the general formula of (*i*) saturated hydrocarbons, and (*ii*) unsaturated hydrocarbons and draw the structure of one hydrocarbon of each type. *[CBSE (F) 2017]*

Long Answer Questions [5 marks]

28. What are hydrocarbons? Distinguish alkanes from alkenes and each of them from alkynes, giving one example of each. Draw the structure of each compound cited as example to justify your answer.

29. An organic compound 'A' on heating with another compound 'B' in presence of concentrated sulphuric acid forms a sweet smelling compound 'C':

(*i*) Identify the name of this chemical reaction.

(*ii*) Write a balanced chemical equation for the above chemical reaction.

(*iii*) Write one use of compound 'C'.

(*iv*) Write a balanced chemical equation for the reaction when an acid or a base is added to compound 'C'.

30. Explain the given reactions with the examples: *[NCERT Exemplar]*

(*i*) Hydrogenation reaction (*ii*) Oxidation reaction

(*iii*) Substitution reaction (*iv*) Saponification reaction

(*v*) Esterification reaction

31. Match the reactions given in Column (A) with the names given in Column (B). *[NCERT Exemplar]*

Column A	Column B
(*a*) $CH_3OH + CH_3COOH \xrightarrow{H^+} CH_3COOCH_3 + H_2O$	(*i*) Addition reaction
(*b*) $CH_2=CH_2 + H_2 \xrightarrow{Ni} CH_3—CH_3$	(*ii*) Substitution reaction
(*c*) $CH_4 + Cl_2 \xrightarrow{Sunlight} CH_3Cl + HCl$	(*iii*) Neutralisation reaction
(*d*) $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$	(*iv*) Esterification reaction

32. What is meant by "structural isomers"? Give reason why propane (C_3H_8) cannot exhibit this characteristic. Draw the structures of possible isomers of butane (C_4H_{10}).

33. Esters are sweet-smelling substances and are used in making perfumes. Suggest some activity and the reaction involved for the preparation of an ester with well labeled diagram.

5 PERIODIC CLASSIFICATION OF ELEMENTS

BASIC CONCEPTS – A FLOW CHART

PERIODIC CLASSIFICATION OF ELEMENTS

Earlier Attempts of Element Classification

Döbereiner's Triads (1817)

- Elements with similar properties were arranged into groups of three elements called **triads**.
- He could identify only three triads from the elements known.

Newlands' Law of Octaves (1866)

- Elements were arranged in the order of increasing atomic masses such that properties of the eighth element was the repetition of the properties of first element.
- This law worked well with lighter elements only.

Mendeléev's Periodic Table (1869)

States that the properties of elements are the periodic function of their atomic masses.

Achievements

- Accommodated noble gases which were discovered very late.
- Some gaps were left to accommodate elements to be discovered later.

Limitations

- Could not assign a correct position to hydrogen.
- Position of isotopes could not be explained.
- Wrong order of atomic masses of some elements could not be explained.

Henry Moseley (1913)

Showed that anomalies in arrangement of elements could be removed when the elements were arranged in order of increasing atomic number.

Modern Classification of Elements/Modern Periodic Table

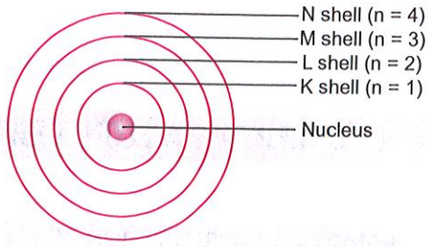
- States that the properties of elements are periodic function of their atomic number.
- Consists of 18 vertical columns called **groups**.
- Consists of 7 horizontal rows called **periods**.
- Atoms of different elements with same number of occupied outer-shells are placed in same period.
- Position of an element tells us about its chemical properties.

Trends in Modern Periodic Table

	Across the period	Down the group
Atomic size	Decreases	Increases
Valency	First increases from 1 to 4 and then decreases to 0.	Remains same
Metallic character (or electropositive character)	Decreases	Increases
Non-metallic character (or electronegative character)	Increases	Decreases

MORE POINTS TO REMEMBER

- Elements with the same number of valence electrons are placed in the same group.
- Elements with the same number of occupied shells are placed in the same period.
- **Electron Distribution in Orbits:** Arrangement of electrons in atomic orbitals is called electronic distribution.



- Electrons that can be accommodated in a shell depends on the formula $2n^2$ where 'n' is the number of the given shell from the nucleus.
- Number of elements in periods of periodic table are calculated as:

  K Shell – $2 \times (1)^2 = 2$, hence the first period has 2 elements.

  L Shell – $2 \times (2)^2 = 8$, hence the second period has 8 elements.

  M Shell – $2 \times (3)^2 = 18$, but the outermost shell can have only 8 electrons, so the third period also has only 8 elements.

- **Atomic Size:** It refers to the radius of an atom. It is the distance between the centre of the nucleus and the outermost shell of an isolated atom.
- **Valency:** It is the combining capacity of an element. It depends on the number of valence electrons of the element.

NCERT Intext Questions

Q. 1. Did Döbereiner's Triads also exist in the columns of Newlands' Octaves?

Ans. Döbereiner's Triads:

Li	Ca	Cl
Na	Sr	Br
K	Ba	I

Döbereiner's Triads also exist in the columns of Newlands' Octaves. For example, lithium (Li), sodium (Na), potassium (K) constitute a Döbereiner's triad. Also, the second column of Newlands' classification has the elements lithium (Li), sodium (Na) and potassium (K).

Q. 2. What were the limitations of Döbereiner's classification?

Ans. Döbereiner's system of classification failed to arrange all the elements in the form of triads having similar chemical properties. Döbereiner could identify only three triads from the elements known at that time.

Q. 3. What were the limitations of Newlands' Law of Octaves?

Ans. (*i*) The Law of Octaves was applicable only up to calcium (*i.e.*, lighter elements) as after calcium, every eighth element did not possess properties similar to that of the first.

(*ii*) Newlands assumed that only 56 elements existed in nature and no more elements would be discovered in the future. After sometime, several new elements were discovered whose properties did not fit into the Law of Octaves.

(*iii*) Newlands adjusted two elements in the same slot, but also put some unlike elements under the same slot. For example, cobalt and nickel are in the same slot and these are placed in the same column as fluorine, chlorine and bromine which have very different properties than these elements. Iron, which resembles cobalt and nickel in properties, has been placed far away from these elements.

Q. 4. Use Mendeléev's Periodic Table to predict the formulae for the oxides of the following elements:

(*i*) K (*ii*) C (*iii*) Al (*iv*) Si (*v*) Ba

Ans. (*i*) The element K is in group I of Mendeléev's Periodic Table in which the general formula of the oxides of elements is R_2O, therefore, the formula of oxide of K will be K_2O.

(*ii*) The element C is in group IV of Mendeléev's periodic table in which the general formula of the oxides of elements is RO_2, therefore, the formula of oxide of C will be CO_2.

(*iii*) The element Al is in group III of Mendeléev's Periodic Table in which the general formula of the oxides of elements is R_2O_3, therefore, the formula of oxide of Al will be Al_2O_3.

(*iv*) The element Si is in group IV of Mendeléev's Periodic Table in which the general formula of the oxides of elements is RO_2, therefore, the formula of oxide of Si will be SiO_2.

(*v*) The element Ba is in group II of Mendeléev's Periodic Table in which the general formula of the oxides of elements is RO, therefore, the formula of oxide of Ba will be BaO.

Q. 5. Besides gallium, which other elements have since been discovered that were left by Mendeléev in his Periodic Table? (*any two*)

Ans. Scandium and Germanium

Q. 6. What were the criteria used by Mendeléev in creating his Periodic Table?

Ans. When Mendeléev started his work, 63 elements were known. He tried putting the elements in order of their atomic masses. He also examined the relationship between the atomic masses of the elements and their physical and chemical properties. Among chemical properties, Mendeléev concentrated on the compounds formed by elements with oxygen and hydrogen. He selected hydrogen and oxygen as they are very reactive and formed compounds with most elements. The formulae of the oxides and hydrides formed by an element were treated as one of the basic properties of an element for its classification. He then took 63 cards and on each card he wrote down the properties of one element. He selected the elements with similar properties and pinned the cards together on a wall. He observed that most of the elements got a place in a Periodic Table and were arranged in the order of their increasing atomic masses.

Q. 7. Why do you think the noble gases are placed in a separate group?

Ans. Noble gases are very unreactive. So, they are placed in a separate group, *i.e.*, zero group.

Q. 8. How could the Modern Periodic Table remove various anomalies of Mendeléev's Periodic Table?

Ans. With the adoption of atomic number as the basis of classification of elements, some of the anomalies in the Mendeléev's Periodic Table now disappear. These are:

(*i*) Position of hydrogen: The atomic number of hydrogen is 1 and hence, it should occupy the first position in group 1 of the Periodic Table. But, because of its chemical similarity with elements of group 1 and group 17, the position of hydrogen in the Periodic Table is still debated.

(*ii*) Position of isotopes: As the isotopes of an element have the same atomic number, they should occupy the same place in the Periodic Table.

(*iii*) **Position of anomalous pair:** The position of anomalous pair of elements, *i.e.*, pair of elements in which the element with higher atomic mass precedes the element with lower atomic mass is also decided. When these elements are arranged in order of their atomic numbers, they occupy their natural places in the Periodic Table as shown in the following table.

Anomalous pair of elements

	Pair of elements	Atomic weight	Atomic number	Group
(*i*)	Cobalt	58.9	27	9
	Nickel	58.7	28	10
(*ii*)	Tellurium	127.6	52	16
	Iodine	126.9	53	17

Q. 9. Name two elements you would expect to show chemical reactions similar to magnesium. What is the basis of your choice?

Ans. Beryllium (Be) and Calcium (Ca) are the two elements which will show chemical reactions similar to magnesium because Be and Ca belong to the same group (group 2) of the Periodic Table as magnesium (group 2). All of these have same number of electrons (*i.e.*, 2) in their outermost shell.

Q. 10. Name:

(*i*) three elements that have only a single electron in their outermost shells.

(*ii*) two elements that have two electrons in their valence shells.

(*iii*) three elements with completely filled outermost shells.

Ans. (*i*)

Element	Atomic Number	Electronic Configuration
Lithium (Li)	3	2, 1
Sodium (Na)	11	2, 8, 1
Potassium (K)	19	2, 8, 8, 1

(*ii*)

Element	Atomic Number	Electronic Configuration
Beryllium (Be)	4	2, 2
Magnesium (Mg)	12	2, 8, 2

(*iii*)

Element	Atomic Number	Electronic Configuration
Helium (He)	2	2
Neon (Ne)	10	2, 8
Argon (Ar)	18	2, 8, 8

Q. 11. (*i*) Lithium, sodium, potassium are all metals that react with water to liberate hydrogen gas. Is there any similarity in the atoms of these elements?

(*ii*) Helium is an unreactive gas and neon is a gas of extremely low reactivity. What, if anything, do their atoms have in common?

Ans. (*i*) All these metals have one electron in their respective outermost shells.
Also, all these elements of group 1 form basic oxides.

(*ii*) The outermost shells of the atoms of helium and neon are completely filled with electrons.

Q. 12. In the Modern Periodic Table, which are metals among the first ten elements?

Ans. The first ten elements are : H, He, Li, Be, B, C, N, O, F, Ne. Among these, only two elements Li (lithium) and Be (beryllium) are metals.

Q. 13. By considering their position in the Periodic Table, which one of the following elements would you expect to have maximum metallic characteristic?

Ga Ge As Se Be

Ans. Maximum metallic characteristic is found in elements on the extreme left side of the Periodic Table. Out of the above given elements, beryllium (Be) will have the maximum metallic characteristic because it is on the extreme left side in the Periodic Table (group 2).

NCERT Exercises

Q. 1. Which of the following statements is not a correct statement about the trends when going from left to right across the periods of Periodic Table?

(*a*) The elements become less metallic in nature.

(*b*) The number of valence electrons increases.

(*c*) The atoms lose their electrons more easily.

(*d*) The oxides become more acidic.

Ans. (*c*) The atoms lose their electrons more easily.

Q. 2. Element X forms a chloride with the formula XCl_2, which is a solid with a high melting point. X would most likely be in the same group of the Periodic Table as

(*a*) Na (*b*) Mg (*c*) Al (*d*) Si

Ans. The element X forms a chloride XCl_2, therefore, its valency is 2. Out of the given elements Na, Mg, Al and Si, the element of valency 2 is Mg. So, X would most likely be in the same group of the Periodic Table as Mg.

Q. 3. Which element has:

(*a*) two shells, both of which are completely filled with electrons?

(*b*) the electronic configuration 2, 8, 2?

(*c*) a total of three shells, with four electrons in its valence shell?

(*d*) a total of two shells, with three electrons in its valence shell?

(*e*) twice as many electrons in its second shell as in its first shell?

Ans. (*a*) Ne (2, 8) (*b*) Mg (*c*) Si (2, 8, 4)
(*d*) B (2, 3) (*e*) C (2, 4)

Q. 4. (*a*) What property do all elements in the same column of the Periodic Table as boron have in common?

(*b*) What property do all elements in the same column of the Periodic Table as fluorine have in common?

Ans. (*a*) They all have a valency of 3.

(*b*) They all have a valency of 1 because all have 7 valence electrons.

Q. 5. An atom has electronic configuration 2, 8, 7.

(*a*) What is the atomic number of this element?

(*b*) To which of the following elements would it be chemically similar?

(Atomic numbers are given in parentheses)

N (7) F (9) P (15) Ar (18)

Ans. (*a*) The atomic number of this element is obtained by adding all the electrons present in its electronic configuration.

$\therefore$ Atomic number = 2 + 8 + 7 = 17

(*b*) The electronic configuration of the given element = 2, 8, 7

Valence electron in its atom = 7

This element will be chemically similar to that element which has the same valence electron (7). The electronic configuration of the above elements are:

(*i*) N (7) : 2, 5 (5 valence electron) (*ii*) F (9) : 2, 7 (7 valence electron)

(*iii*) P (15) : 2, 8, 5 (5 valence electron) (*iv*) Ar (18) : 2, 8, 8 (8 valence electron)

Clearly, F (9) has 7 valence electrons just like that of the given element. Hence, the given element of atomic number 17 will be chemically similar to the element fluorine (F) of atomic number 9.

Q. 6. The position of three elements A, B and C in the Periodic Table are shown below:

Group 16	Group 17
—	—
—	A
—	—
B	C

(*a*) State whether A is a metal or a non-metal.

(*b*) State whether C is more reactive or less reactive than A.

(*c*) Will C be larger or smaller in size than B?

(*d*) Which type of ion—cation or anion, will be formed by element A?

Ans. (*a*) Metals lie on the left-hand side of the Periodic Table whereas non-metals are found on the right-hand side. The element A is in group 17. Group 17 is on the right side of the Periodic Table. Thus, element A is a non-metal (called halogen).

(*b*) The chemical reactivity of non-metals decreases on going down in a group. In group 17, the chemical reactivity decreases on going down in a group. So, element C is less reactive than A.

(*c*) The atomic size decreases in moving from left to right along a period. So, atom C will be smaller in size than B.

(*d*) The element A of group 17 has 7 valence electrons. So, it will gain one electron to form a negatively charged ion (A^-). The negatively charged ion is called an anion. So, element A will form an anion.

Q. 7. Nitrogen (atomic number 7) and phosphorus (atomic number 15) belong to group 15 of the Periodic Table. Write the electronic configuration of these two elements. Which of these will be more electronegative? Why?

Ans. (*a*) Nitrogen (N) — At. No. = 7,

Electronic configuration = 2, 5.

(*b*) Phosphorous (P) — At. No = 15,

Electronic configuration = 2, 8, 5.

Thus, nitrogen will be more electronegative because its atom has small size due to which the attraction of its nucleus for the incoming electron is more.

Q. 8. How does the electronic configuration of an atom relate to its position in the modern Periodic Table?

Ans. The group number of elements having upto two valence electrons is equal to the number of valence electrons.

The group number of elements having more than two valence electrons is equal to the number of valence electrons plus 10.

For example,

No. of valence electrons	Group number in the Periodic Table
1 2	1 2 Group number = Number of valence electrons
3	3 + 10 = 13
4	4 + 10 = 14
5	5 + 10 = 15
6	6 + 10 = 16
7	7 + 10 = 17
8 (or 2 valence electrons in K shell)	8 + 10 = 18

The number of electron shells in the atom of an element is equal to the period to which that element belongs in the Periodic Table. Also, the number of valence shell electrons increases by one unit as the atomic number increases by one unit on moving from left to right in a period.

Li	Be	B	C	N	O	F	Ne
2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8

Q. 9. In the Modern Periodic Table, calcium (atomic number 20) is surrounded by elements with atomic numbers 12, 19, 21 and 38. Which of these have physical and chemical properties resembling calcium?

Ans. The atomic numbers of three elements which lie in the same group are 12, 20 and 38. So, the elements having atomic numbers 12 and 38 have physical and chemical properties resembling with calcium.

Atomic number	Electronic configuration
12	2, 8, 2
20	2, 8, 8, 2
38	2, 8, 18, 8, 2

Q. 10. Compare and contrast the arrangement of elements in Mendeléev's Periodic Table and the Modern Periodic Table.

Ans.

Mendeléev's Periodic Table	Modern Periodic Table
(*i*) Elements have been arranged in order of their increasing atomic masses.	(*i*) Elements have been arranged in the order of their increasing atomic numbers.
(*ii*) There are only eight vertical columns called groups.	(*ii*) There are eighteen vertical columns, called groups.
(*iii*) Transition elements are arbitrarily placed together in a single group VIII.	(*iii*) Transition elements are placed in the middle of the table.
(*iv*) The inert gases were not known at the time of Mendeléev.	(*iv*) The inert gases have been placed at the end of Periodic Table *i.e.*, Group 18.
(*v*) No proper places are assigned to isotopes of elements.	(*v*) Isotopes of elements are assigned the same place as they have same atomic number.
(*vi*) There are misfit anomalous pair on the basis of atomic masses.	(*vi*) When atomic number is taken as the basis of classification, the misfit anomalous pair have been removed.

VERY SHORT ANSWER QUESTIONS [1 mark]

Q. 1. What was Döbereiner's basis of classifying elements?

Ans. According to Döbereiner, elements having similar properties can be arranged in triads in which atomic mass of the middle element is the mean of the atomic masses of the other two elements.

Q. 2. State Mendeléev's Periodic Law.

Ans. Mendeléev's Periodic Law states that, "The properties of the elements are periodic function of their atomic masses."

Q. 3. State Newlands' Law of Octaves.

Ans. Newlands' Law of Octaves states that "when elements are arranged in order of increasing atomic weights, then every eighth element has properties similar to that of the first element."

Q. 4. What was the drawback of the Law of Octaves?

Ans. Law of Octaves failed to assign the position to the elements with large atomic weights.

Q. 5. Who classified the elements on the basis of fundamental properties of elements like atomic mass?

Ans. Mendeléev.

Q. 6. Define groups.

Ans. The vertical columns in the long form of the Periodic Table are called groups.

Q. 7. What do you understand by periods in the Periodic Table?

Ans. The horizontal rows in the long form of the Periodic Table are called periods.

Q. 8. In how many groups and periods, the Modern Periodic Table of elements is divided?

Ans. 18 groups and 7 periods.

Q. 9. Name the elements present in the first period.

Ans. Hydrogen and helium.

Q. 10. Which period is the longest period in the Modern Periodic Table?

Ans. The sixth period is called the longest period because it has maximum 32 elements.

Q. 11. How many vertical columns are there in the Modern Periodic Table?

Ans. In the Modern Periodic Table, there are 18 vertical columns of elements called groups.

Q. 12. Out of Li, C and N, which forms the most basic oxide and which forms the most acidic oxide?

Ans. Lithium forms the most basic oxide as it is a metal and nitrogen forms the most acidic oxide as it is a non-metal.

Q. 13. A metal M belongs to 13th group in the Modern Periodic Table. Write the valency of the metal.

Ans. Atomic number = 13 (Al)

Electronic configuration = 2, 8, 3

Valency = 3

Q. 14. Find the period and group of the element whose atomic number is 12.

Ans. 3rd period, 2nd group.

Q. 15. Write two reasons responsible for late discovery of noble gases. *[CBSE Delhi 2013]*

Ans. (*i*) They are very less reactive.

(*ii*) They are less abundant in nature.

SHORT ANSWER QUESTIONS–I [2 marks]

Q. 1. The three elements A, B and C with similar properties have atomic masses X, Y and Z respectively. The mass of Y is approximately equal to the average mass of X and Z. What is such an arrangement of elements called as? Give one example of such a set of elements. *[NCERT Exemplar]*

Ans. The arrangement of these elements is known as Döbereiner triad. Example: lithium, sodium and potassium.

Q. 2. Elements have been arranged in the following sequence on the basis of their increasing atomic masses.

F, Na, Mg, Al, Si, P, S, Cl, Ar, K

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

(*b*) The given sequence represents which law of classification of elements? *[NCERT Exemplar]*

Ans. (*a*) (*i*) F and Cl

(*ii*) Na and K

(*b*) Newlands' Law of Octaves

Q. 3. Why did Mendeléev leave some gaps in his Periodic Table?

Ans. Mendeléev left some gaps in his Periodic Table for the elements yet to be discovered. He even predicted the properties of these elements by studying the properties of the neighbouring elements.

Q. 4. State Modern Periodic Law. What is number of groups and periods in the Modern Periodic Table? *[CBSE Delhi (C) 2017]*

Ans. Modern Periodic Law states that the properties of elements are a periodic function of their atomic number.

There are 18 groups and 7 periods in the Modern Periodic Table.

Q. 5. What do you understand by the term periodicity? Does the periodicity in properties is a function of valence electrons? Illustrate.

Ans. When the elements are arranged in order of increasing atomic numbers, elements with similar chemical properties are repeated at definite intervals. This is known as periodicity. Yes, this periodicity is due to the periodicity in the number of electrons in the outermost shell of the atoms of the elements. If elements having the same number of valence electrons are grouped together, the elements falling within each group are similar in chemical properties.

Q. 6. What does each group in the Periodic Table signify?

Ans. Each group in the Periodic Table signifies identical outer shell electronic configuration for the elements constituting that group. For example, each element of group 1 has one electron in its outermost shell.

Q. 7. Why do elements in any given group have similar properties?

Ans. The chemical properties of an atom are largely determined by its valence electrons. In a given group, the number of valence electrons are same, hence they have similar properties.

Q. 8. Why do group 1 elements form unipositive ions?

Ans. Group 1 elements contain 1 electron in their outermost shells. These elements lose this electron easily to attain the 8 electrons in their outermost shell. Hence, they form unipositive ion.

For example,

	K	L	M			K	L
Sodium (Na)	2,	8,	1	$\xrightarrow{-1e^-}$	Na^+	2,	8

Q. 9. Which is smaller?

(*a*) Na^+ or Na **(*b*) Cl or Cl^-**

Ans. (*a*) Na → 2, 8, 1 Na^+ → 2, 8

Na^+ is smaller as it has lesser number of shells than Na.

(*b*) Cl → 2, 8, 7 Cl^- → 2, 8, 8

Cl has greater effective nuclear charge. So, it is smaller than Cl^-.

Q. 10. Why are the elements of group 18 called zero valent?

Ans. Group 18 elements have their outermost shells completely filled and the atoms of these elements have no tendency to gain or lose electrons. Thus, the elements of this group are zero valent and almost unreactive.

Q. 11. Why group 17 elements form uninegative anions?

Ans. Group 17 elements have 7 valence electrons, one electron less than the maximum number of electrons that can be accommodated in the outermost shell. Therefore, it is easier for these elements to gain an electron and form uninegative anions, so as to attain noble gas configuration.

For example,

	K	L			K	L
Fluorine (F)	2,	7	$\xrightarrow{+1e^-}$	F^-	2,	8

Q. 12. Would you place the two isotopes of chlorine, Cl-35 and Cl-37 in different slots because of their different atomic masses or in the same because their chemical properties are the same? Justify your answer.

Ans. In Mendeléev's Periodic Table the two isotopes of chlorine, Cl-35 and Cl-37 would be placed in different slots because they have different atomic masses. But because of their similar chemical properties which is a more reliable property as it is based on the number of valence electrons, they would be placed in the same slot.

Q. 13. How does the metallic character change along the period?

Ans. As we go from left to right in a period, the metallic character decreases, because of the addition of an electron in the same energy shell each time. So, attraction between the nucleus and the electrons in the outermost shell increases. Thus, tendency to lose an electron decreases and metallic character decreases.

Q. 14. What is atomic radius? Why does atomic radius decrease across a period?

Ans. Atomic radius is defined as the distance from the centre of the nucleus of an atom to the outermost shell of electrons. The atomic radius decreases along a period. In moving from left to right across the period, the charge on the nucleus increases by one unit (due to increase in atomic number), but the additional electron goes to the same shell. As a result, outer electrons are pulled in closer to the nucleus. This causes the decrease of atomic size.

Q. 15. Why does the size of the atom increase down the group?

Ans. In moving down a group, the charge on the nucleus increases with increase in atomic number, but at the same time, there is an increase in the energy levels. The number of electrons in the outermost shell, however, remains the same. Since the effect of additional energy levels outweighs the effect of increased nuclear charge and thus the distance of the outermost electron from the nucleus increases on going down the group.

Q. 16. Can the following groups of elements be classified as Döbereiner's triad?

(*a*) Na, Si, Cl **(*b*) Be, Mg, Ca**

Atomic mass of Be 9; Na 23; Mg 24; Si 28; Cl 35; Ca 40

Explain by giving reason. *[NCERT Exemplar]*

Ans. (*a*) No, because all these elements do not have similar properties although the atomic mass of silicon is average of atomic masses of sodium (Na) and chlorine (Cl).

(*b*) Yes, because they have similar properties and the mass of magnesium (Mg) is roughly the average of the atomic masses of Be and Ca.

Q. 17. Write the formulae of chlorides of *Eka*-silicon and *Eka*-aluminium, the elements predicted by Mendeléev. *[NCERT Exemplar]*

Ans. $GeCl_4$, $GaCl_3$

Q. 18. If an element X is placed in group 14, what will be the formula and the nature of bonding of its chloride? *[NCERT Exemplar]*

Ans. The formula will be XCl_4. The element X of group 14 will have 4 valence electrons. So, it shares its 4 electrons and forms covalent bond with 4 chlorine atoms.

Q. 19. The atomic number of an element is 17. To which group and period does this element belong? Determine its valency. *[CBSE Delhi (C) 2017]*

Ans. Electronic configuration: 2, 8, 7

Group: 17

Period: 3

Valency: 8 – 7 = 1

Q. 20. Arrange the following elements in increasing order of their atomic radii:

(*a*) Li, Be, F, N **(*b*) Cl, At, Br, I** *[NCERT Exemplar]*

Ans. (*a*) F < N < Be < Li as the atomic radii decreases along a period.

(*b*) Cl < Br < I < At as the atomic radii increases down a group.

Q. 21. Identify and name the metals out of the following elements whose electronic configurations are given below.

(*a*) 2, 8, 2 **(*b*) 2, 8, 1**

(*c*) 2, 8, 7 **(*d*) 2, 1** *[NCERT Exemplar]*

Ans. (*a*), (*b*) and (*d*) are metals.

(*a*) Magnesium (*b*) Sodium (*d*) Lithium

Q. 22. Arrange the following elements in the increasing order of their metallic character

Mg, Ca, K, Ge, Ga *[NCERT Exemplar]*

Ans. Ge < Ga < Mg < Ca < K

Q. 23. Which group of elements could be placed in Mendeléev's Periodic Table without disturbing the original order? Give reason. *[NCERT Exemplar]*

Ans. Noble gases.

According to the Mendeléev's classification, the properties of elements are the periodic function of their atomic masses and there is a periodic recurrence of elements with similar physical and chemical properties. Noble gases being inert, could be placed in a separate group without disturbing the original order.

Q. 24. (*i*) Why do we classify elements?

(*ii*) In Mendeléev's Periodic Table, why was there no mention of noble gases like Helium, Neon and Argon?

Ans. (*i*) Different elements discovered in different times were found to possess different physical and chemical properties. But, it was difficult to study all the information or properties of these elements. Scientists started discovering some pattern in their properties to classify all the known elements in order to make their study easier. So, elements are classified on the basis of their similarities and dissimilarities in properties.

(*ii*) Noble gases like He, Ne, Ar, etc. were not discovered at the time of Mendeléev. They were discovered later as they are inert and present in extremely low concentrations in our atmosphere. So, after their discovery they were placed in a new group (18) in Modern Periodic Table.

Q. 25. Explain why sodium is more reactive than lithium.

Ans. Sodium is more reactive than lithium because sodium is larger in size. Outermost electrons are less tightly held in sodium than in lithium. As a result, sodium loses its outermost electron more easily than lithium. Hence, it is more reactive than lithium.

Q. 26. Choose from the following. *[CBSE (AI) 2012]*

$_6$C, $_8$O, $_{10}$Ne, $_{11}$Na, $_{14}$Si

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

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

Ans. (*i*) C, O, Ne should be in the same period as these elements contain same number of shells. Similarly, Na and Si should be in the same period.

(*ii*) C and Si should be in the same group as these elements have same number of valence electrons.

SHORT ANSWER QUESTIONS–II [3 marks]

Q. 1. Write the main aim of classifying elements. Name the basic property of elements used in the development of Modern Periodic Table. State the Modern Periodic Law. On which side (part) of the Modern Periodic Table do you find metals, metalloids and non-metals? *[CBSE (F)2016, 2015]*

Ans. Elements are classified for systematic and simplified study of elements and their compounds. The basic property of elements used in the Modern Periodic Table is the atomic number of the elements.

Modern Periodic Law states that "the properties of elements are a periodic function of their atomic number."

Metals are found on the left side and centre of the Modern Periodic Table.

Non-metals are found on the right side of the Modern Periodic Table.

Metalloids are found in a zig-zag manner between the metals and the non-metals.

Q. 2. How does the atomic radius of the elements change on going

(*i*) from left to right in a period, and

(*ii*) down a group

in the Modern Periodic Table? Give reason in support of your answer. *[CBSE Delhi (C) 2017]*

Ans. (*i*) Atomic radius decreases along a period. This is because nuclear charge increases from left to right in a period which tends to pull the electrons closer to the nucleus.

(*ii*) Atomic radius increases down the group because number of shells increases on going down the group.

Q. 3. How many groups and periods are there in the Modern Periodic Table? How do the atomic size and metallic character of elements vary as we move:

(*a*) down a group and

(*b*) from left to right in a period *[CBSE Delhi 2015]*

Ans. There are 18 groups and 7 periods in the Modern Periodic Table.

(*a*)
- Atomic size increases
- Metallic character increases

(*b*)
- Atomic size decreases
- Metallic character decreases

Q. 4. What is periodicity in properties of elements with reference to the Modern Periodic Table ? Why do all the elements of the same group have similar properties ? How does the tendency of elements to gain electrons change as we move from left to right in a period ? State the reason of this change. *[CBSE (AI) 2017]*

Ans. According to the Modern Periodic Table, similar properties of elements are repeated after regular intervals.

All elements in a group have similar properties because of the same number of valence electrons.

Tendency of elements to gain electrons increases along a period due to increase in effective nuclear charge which pulls the electrons towards it.

Q. 5. From the following elements:

$_4$Be; $_9$F; $_{19}$K; $_{20}$Ca

(*i*) Select the element having one electron in the outermost shell.

(*ii*) Two elements of the same group.

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

Ans.

Element	Electronic configuration
Be	2, 2
F	2, 7
K	2, 8, 8, 1
Ca	2, 8, 8, 2

(*i*) K

(*ii*) Be and Ca, as both have same number of valence electrons, *i.e.*, 2.

(*iii*)

$$\underset{(2,8,8,1)}{\overset{K}{}} \quad \underset{(2,8,7)}{\overset{X}{}}$$

$$\downarrow \qquad \downarrow$$

$$K^+ + X^- \longrightarrow KX$$

Ionic or electrovalent bond is formed.

Q. 6. Name any two elements of group one and write their electronic configurations. What similarity do you observe in their electronic configurations? Write the formula of oxide of any of the aforesaid element. *[CBSE Delhi 2016]*

Ans. Two elements of group 1 are Sodium (Na) and potassium (K).

Their electronic configurations: Na = 2,8,1; K = 2,8,8,1

Similarity: Both have one valence electron.

Formula of their oxides: Na_2O; K_2O.

Q. 7. 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*. *[CBSE Delhi 2017]*

Ans. The electronic configuration of *P* is 2, 8, 8, 2.

Group – 2 because it has 2 valence electrons.

Period – 4 because it has 4 shells.

The electronic configuration of Q is 2, 8, 7.

Group – 17 because it has 7 valence electrons so group number is 7 + 10 *i.e.*, 17.

Period – 3 because it has 3 shells.

Formula is PQ_2 because valency of P is 2 and that of Q is 1.

Q. 8. Write the number of periods the Modern Periodic Table has. State the changes in valency and metallic character of elements as we move from left to right in a period. Also state the changes, if any, in the valency and atomic size of elements as we move down a group. *[CBSE Delhi 2015]*

Ans. The Modern Periodic Table has 7 periods. Valency across a period increases from 1 to 4, then decreases from 4 to zero.

Metallic character of elements across a period decreases.

Valency down a group remains the same. Atomic size of elements down a group increases.

Q. 9. The elements $_4$Be, $_{12}$Mg and $_{20}$Ca, each having two valence electrons in their valence shells, are in periods 2, 3 and 4 respectively of the Modern Periodic Table. Answer the following questions associated with these elements, giving reason in each case:

(*a*) In which group should they be?

(*b*) Which one of them is least reactive?

(*c*) Which one of them has the largest atomic size? *[CBSE (AI) 2015]*

Ans. (*a*) In group 2, as each element has two valence electrons.

(*b*) Be is least reactive because Be has the least tendency to lose electrons.

(*c*) Ca has the largest atomic size as Ca has the maximum number of shells and atomic size increases down the group.

Q. 10. Given below are some elements of the Modern Periodic Table. Atomic number of the element is given in the parentheses:

A(4), B(9), C(14), D(19), E(20)

(*a*) Select the element that has one electron in the outermost shell. Also write the electronic configuration of this element.

(*b*) Which two elements amongst these belong to the same group? Give reason for your answer.

(*c*) Which two elements amongst these belong to the same period? Which one of the two has bigger atomic radius? *[CBSE (AI) 2015]*

Ans. (*a*) D; the electronic configuration of D(19) is 2, 8,8, 1.

(*b*) A and E belong to the same group as both have the same number of valence electrons, *i.e.*, 2.

(*c*) A, B and D, E.

A has a bigger atomic radius than B and D has a bigger atomic radius than E.

Q. 11. Nitrogen (atomic no. 7) and phosphorous (atomic no. 15) belong to group 15 of the Periodic Table. Write the electronic configuration of these two elements in terms of K, L, M, N shell. Predict whether these are metallic or non-metallic.

Ans.

Element	K	L	M
N (7)	2	5	
P (15)	2	8	5

Both are non-metals as they tend to form bonds by gaining electrons.

Q. 12. Na, Mg and Al are the elements of the same period of Modern Periodic Table having one, two and three valence electrons respectively. Which of these elements (*i*) has the largest atomic radius, (*ii*) is least reactive? Justify your answer stating reason for each case.

[CBSE Delhi 2015]

Ans. (*i*) Na has the largest atomic size because the atomic size decreases from left to right due to the increase in the nuclear charge.

(*ii*) Al is least reactive because the tendency to lose electrons decreases from left to right.

Q. 13. Two elements 'P' and 'Q' belong to the same period of the Modern Periodic Table and are in Group-1 and Group-2 respectively. Compare their following characteristics in tabular form:

(*a*) The number of electrons in their atoms

(*b*) The sizes of their atoms

(*c*) Their metallic characters

(*d*) Their tendencies to lose electrons

(*e*) The formula of their oxides

(*f*) The formula of their chlorides *[CBSE (AI) 2015]*

Ans.

Characteristic		P	Q
(*a*)	Number of electrons in their atoms	Number of electrons is less.	Number of electrons is more.
(*b*)	Sizes of their atoms	P is bigger in size.	Q is smaller in size.
(*c*)	Metallic character	P is more metallic than Q.	Q is less metallic.
(*d*)	Tendencies to lose electrons	P will lose electrons more easily.	Q does not lose electrons easily.
(*e*)	Formula of their oxides	P_2O	QO
(*f*)	Formula of their chlorides	PCl	QCl_2

Q. 14. The position of three elements A, B and C in the Periodic Table is shown below:

Groups → / Periods ↓	1	2	3	4	5	6	7	8
1								
2			B					
3	A	C						

Giving reasons, explain the following:

(*i*) Element A is a metal.

(*ii*) Element C has larger size than element B.

(*iii*) Element B has a valency of 3.

Ans. (*i*) Element A belongs to group 1 of the Periodic Table. So, it has 1 valence electron and it forms unipositive ion by losing its valence electron. Hence, A is a metal.

(*ii*) This is because element C is in third period while element B is in second period. We know that the atomic size increases down the group and decreases along a period.

(*iii*) Element B is in 2nd period and 3rd group hence it has 3 valence electrons. It loses 3 electrons to achieve nearest inert gas configuration. So, its valency is 3.

Q. 15. Identify the elements with the following property and arrange them in increasing order of their reactivity.

(*a*) An element which is a soft and reactive metal.

(*b*) The metal which is an important constituent of limestone.

(*c*) The metal which exists in liquid state at room temperature. *[NCERT Exemplar]*

Ans. (*a*) Na or K (*b*) Ca (*c*) Hg

Reactivity order: Hg < Ca < Na < K

Q. 16. Properties of the elements are given below. Where would you locate the following elements in the Periodic Table?

(*a*) A soft metal stored under kerosene.

(*b*) An element with variable (more than one) valency stored under water.

(*c*) An element which is tetravalent and forms the basis of organic chemistry.

(*d*) An element which is an inert gas with atomic number 2.

(*e*) An element whose thin oxide layer is used to make other elements corrosion resistant by the process of "anodising". *[NCERT Exemplar]*

Ans. (*a*) Sodium (Na) Group 1 and Period 3 or Potassium (K) Group 1 and Period 4

(*b*) Phosphorus (P) Group 15 and Period 3

(*c*) Carbon (C) Group 14 and Period 2

(*d*) Helium (He) Group 18 and Period 1

(*e*) Aluminium (Al) Group 13 and Period 3

Q. 17. The atomic number of an element 'X' is 20.

(*i*) Determine the position of the element 'X' in the periodic table.

(*ii*) Write the formula of the compound formed when 'X' reacts/combines with another element 'Y' (atomic number 8).

(*iii*) What would be the nature (acidic or basic) of the compound formed? Justify your answer. *[CBSE (F) 2015]*

Ans. Electronic configuration : 2, 8, 8, 2

(*i*) 'X' is in the 2nd group and 4th period of the periodic table.

(*ii*) $\underset{(2,8,8,2)}{K} + \underset{(2,6)}{Y} \longrightarrow XY$

(*iii*) The nature of the compound formed is basic because X is a metal and Y is oxygen. The oxides of metals are basic in nature.

Q. 18. The following table shows the position of six elements A, B, C, D, E and F in the Periodic Table.

Groups → / Periods ↓	1	2	3 to 12	13	14	15	16	17	18
2.	A					B			C
3.		D			E				F

Using the above table answer the following questions:

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

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

(*c*) Which element is a non-metal with valency 3?

(*d*) Write a common name for the family of elements C and F.

(*e*) Out of D and E, which one has a bigger atomic radius and why?

Ans. (*a*) E

(*b*) D

(*c*) B

(*d*) The noble gases.

(*e*) D has bigger atomic radius. The atomic radius decreases in moving from left to right along a period. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

Q. 19. The atomic radii of first group elements of the Periodic Table are as follows:

Group 1 elements	Na	Li	Rb	Cs	K
Atomic radius (pm)	186	152	244	262	231

(*i*) Arrange these elements in the increasing order of their atomic radii.

(*ii*) Name the elements which have the smallest and the largest atoms.

(*iii*) How does the atomic size vary as you go down a group?

Ans. (*i*)

Group 1 elements	Li	Na	K	Rb	Cs
Atomic radius (pm)	152	186	231	244	262

(*ii*) The element Li has the smallest atom (atomic radius 152 pm) whereas the element Cs has the largest atom (atomic radius 262 pm).

(*iii*) From this arrangement, we find that the atomic size (or radius) increases down the group.

Q. 20. The elements of the second period of the Periodic Table are given below:

Li, Be, B, C, N, O, F

(*i*) Explain why atomic radius decreases from Li to F.

(*ii*) Identify the most metallic and non-metallic elements among the above elements.

Ans. (*i*) On moving from left to right along a period of the Periodic Table, atomic number increases, *i.e.*, number of protons and electrons increases which ultimately increases the nuclear charge. Hence, the electrons are pulled in closer to the nucleus which leads to contraction of the atom and thus atomic radius decreases.

(*ii*) On moving from left to right in a Periodic Table, metallic character decreases and non-metallic character increases. This is because the capacity to lose electrons from the outermost orbit of an atom (called ionisation energy) decreases. Hence, among the above elements Li being placed on the extreme left side is most metallic and F being placed on the extreme right side is the most non-metallic element.

Q. 21. The atomic numbers of nitrogen, oxygen and fluorine are 7, 8 and 9 respectively. Write the electronic configuration of each element and answer the following questions:

(*a*) Which one of N, O and F is most electronegative and which one is least electronegative?

(*b*) What is the number of valence electrons of F?

(*c*) What is valency of each one of N, O and F?

Ans. Electronic configuration of

Nitrogen : 2, 5

Oxygen : 2, 6

Fluorine : 2, 7

(*a*) Fluorine (F) is the most electronegative and nitrogen (N) is the least electronegative.

(*b*) Fluorine (F) has 7 valence electrons.

(*c*) Valency of nitrogen is 3 and 5, valency of oxygen is 2, valency of fluorine is 1.

Q. 22. Four elements P, Q, R and S belong to the third period of the Modern Periodic Table and have respectively 1, 3, 5 and 7 electrons in their outermost shells. Write the electronic configurations of Q and R and determine their valencies. Write the molecular formula of the compound formed when P and S combine. *[CBSE (F) 2015]*

Ans. Electronic configuration of Q : 2, 8, 3

Valency of Q : 3

Electronic configuration of R: 2, 8, 5

Valency of R: 8 – 5 = 3

$$\underset{2,8,1}{P} + \underset{2,8,7}{S} \longrightarrow PS$$

Q. 23. Consider the following elements:

Li, Cl, Br, Na, K, I

(*i*) Arrange the elements according to the groups to which they belong in the Periodic Table.

(*ii*) What are the common properties on the basis of which the elements have been grouped together?

Ans. (*i*) Li, Na and K are grouped together in the periodic table and belong to group I. They are grouped together because all of them have one electron in their valence shell. Rest of the elements Cl, Br and I are grouped together in the periodic table and belong to group 17.

(*ii*) The elements of group 1 are called alkali metals because they react with water to liberate H_2 gas and form alkalis. The elements of group 17 are monovalent non-metals. They form acidic oxides and are called halogens.

Q. 24. 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. *[CBSE (Delhi) 2017]*

Ans. Vertical columns – Groups

Horizontal rows – Period

Metallic character increases on moving down a vertical column. This is because ability to lose electrons increases on moving down the group due to increase in distance between the nucleus and the valence electrons.

Atomic radius decreases on moving left to right across a period because the nuclear charge increases on moving from left to right across a period resulting in increase in the attraction between the nucleus and the valence electrons.

Q. 25. Atomic number is considered to be a more appropriate parameter than atomic mass for classification of elements in a periodic table. Why? *[CBSE (F) 2017]*

How does metallic character of elements vary on moving from

(*i*) left to right in a period?

(*ii*) from top to bottom in a group?

Give reasons for your answers.

Ans. The properties of elements depend upon valence electrons in the atom which in turn depends on the total number of electrons, *i.e.*, atomic number. Therefore, atomic number is a more appropriate parameter than atomic mass for classification of elements.

(*i*) On moving from left to right in a period, the metallic character decreases. This is due to an increase in nuclear charge which tends to pull the electrons closer to the nucleus and reduces the size of the atom.

(*ii*) On moving from top to bottom in a group, metallic character increases. This is because new shells are being added as we go down the group. This increases the distance between the valence shell and the nucleus.

Q. 26. Two elements with symbol X (atomic no. 16) and Y (atomic no. 12) are placed in the III period of the Modern Periodic Table.

(*i*) Which amongst the two has more metallic character?

(*ii*) Calculate the valency of each element.

(*iii*) Element 'Y' is smaller than 'X' in terms of atomic size. Is the statement true, justify?

Ans. (*i*) Y

(*ii*) 2 each

(*iii*) False, same period but Y lies in group 2 and X in group 16. So, as we move from left to right size decreases with increase in nuclear charge.

Q. 27. Taking the example of an element of atomic number 16, explain how the electronic configuration of the atom of an element relates to its position in the Modern Periodic Table and how valency of an element is calculated on the basis of its atomic number. *[CBSE (AI) 2015]*

Ans. Atomic number of the element = 16

Electronic configuration = 2, 8, 6

Period number = Number of shells

The atom of the element has three shells. So, the period number is 3.

The atom of the element has six valence electrons. So, the group number of the element will be 16 (6 + 10).

Valency = 8 – number of valence electrons (> 5) or number of valence electrons (<5)

Q. 28. Calcium is an element with atomic number 20. Stating reason answer each of the following questions:

(*i*) Is calcium a metal or non-metal?

(*ii*) Will its atomic radius be larger or smaller than that of potassium with atomic number 19?

(*iii*) Write the formula of its oxide. *[CBSE Delhi 2016]*

Ans. (*i*) Calcium is a metal since it has two electrons in its outermost shell which it can lose easily.

(*ii*) K(19) is placed before Ca(20) in the same period (fourth period). Since the atomic radius decreases along a period, the atomic radius of calcium is smaller than that of potassium.

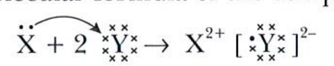
(*iii*) The formula of oxide of calcium is CaO, because the valency of calcium as well as that of oxygen is 2.

Q. 29. Write the electronic configuration of two elements X and Y whose atomic numbers are 20 and 17 respectively. Write the molecular formula of the compound formed when element X reacts with element Y. Draw electron-dot structure of the product and also state the nature of the bond formed between both the elements. *[CBSE (AI) 2017]*

Ans. X(20) – 2, 8, 8, 2

Y(17) – 2, 8, 7

The molecular formula of the compound is XY_2.



Ionic or electrovalent bond is formed.

LONG ANSWER QUESTIONS [5 marks]

Q. 1. (*a*) How do you calculate the valency of an element from its electronic configuration?

(*b*) What is the valency of magnesium with atomic number 12 and sulphur with atomic number 16?

(*c*) How does the valency vary in a period on going from left to right?

(*d*) How does the valency vary in going down a group?

Ans. (*a*) The valency of an element is determined by the number of valence electrons present in the outermost shell of its atom. The number of electrons lost or gained (or shared) by one atom of an element to achieve the nearest inert gas electron configuration, gives us the valency of the element.

(*b*) (*i*) Atomic number of magnesium = 12

Electronic configuration is 2, 8, 2.

A magnesium atom can lose its 2 valence electrons to achieve the inert gas electronic configuration of neon (2, 8).

Therefore, valency of magnesium = 2.

(*ii*) The atomic number of sulphur = 16.

Electronic configuration = 2, 8, 6.

A sulphur atom cannot lose 6 electrons to achieve inert gas electronic configuration due to energy consideration. It can gain 2 electrons to achieve the nearest inert gas electronic configuration of argon (2, 8, 8).

Thus, the valency of sulphur = 2.

(*c*) On going from left to right along a period (short period), the valency of elements increases from 1 to 4 and then decreases to 0 (zero).

Third period	Na	Mg	Al	Si	P	S	Cl	Ar
Valency	1	2	3	4	3	2	1	0

(*d*) All the elements in a group have the same valency.

Q. 2. An element placed in 2nd Group and 3rd Period of the Periodic Table, burns in presence of oxygen to form a basic oxide.

(*a*) Identify the element.

(*b*) Write the electronic configuration.

(*c*) Write a balanced equation when it burns in the presence of air.

(*d*) Write a balanced equation when this oxide is dissolved in water.

(*e*) Draw the electron dot structure for the formation of this oxide. *[NCERT Exemplar]*

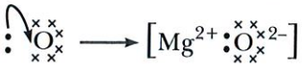
Ans. (*a*) Magnesium (Mg)

(*b*) K L M

2 8 2

(*c*) $2Mg(s) + O_2(g) \longrightarrow 2MgO(s)$

(*d*) $MgO(s) + H_2O(l) \longrightarrow Mg(OH)_2\ (aq)$

(*e*) 

Q. 3. Atomic number of a few elements are given below:

10, 20, 7, 14

(*a*) Identify the elements.

(*b*) Identify the Group number of these elements in the Periodic Table.

(*c*) Identify the Periods of these elements in the Periodic Table.

(*d*) What would be the electronic configuration for each of these elements?

(*e*) Determine the valency of these elements. *[NCERT Exemplar]*

Ans. (*a*) Elements — Neon (Ne), Calcium (Ca), Nitrogen (N), Silicon (Si)

(*b*) Group — 18, 2, 15, 14

(*c*) Period — 2, 4, 2, 3

(*d*) Electronic configuration— (2, 8); (2, 8, 8, 2); (2, 5); (2, 8, 4)

(*e*) Valency — 0, 2, 3, 4

Q. 4. Mendeléev predicted the existence of certain elements not known at that time and named two of them as *Eka*-silicon and *Eka*-aluminium.

(*a*) Name the elements which have taken the place of these elements.

(*b*) Mention the Group and the Period of these elements in the Modern Periodic Table.

(*c*) Classify these elements as metals, non-metals or metalloids.

(*d*) How many valence electrons are present in each one of them? *[NCERT Exemplar]*

Ans. (*a*) Germanium (Ge) and Gallium (Ga)

(*b*) Group 14; Period 4 and Group 13; Period 4

(*c*) Ge — Metalloid; Ga — Metal

(*d*) Ga — 3; Ge — 4

Q. 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.

(*a*) Identify the element X.

(*b*) Write the electronic configuration of X.

(*c*) Write the balanced chemical equation for the thermal decomposition of ferrous sulphate crystals.

(*d*) What would be the nature (acidic/basic) of oxides formed?

(*e*) Locate the position of the element in the Modern Periodic Table. *[NCERT Exemplar]*

Ans. (*a*) Element X is sulphur (atomic no. 16)

(*b*) K L M

2 8 6

(*c*) $2FeSO_4(s) \xrightarrow{\text{Heat}} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

(*d*) Acidic

(*e*) 3rd period, group 16

Q. 6. An element X of group 15 exists as diatomic molecule and combines with hydrogen at 773 K in presence of the catalyst to form a compound, ammonia which has a characteristic pungent smell.

(*a*) Identify the element X. How many valence electrons does it have?

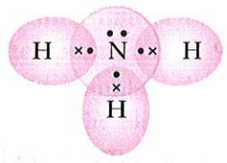
(*b*) Draw the electron dot structure of the diatomic molecule of X. What type of bond is formed in it?

(*c*) Draw the electron dot structure for ammonia. What type of bond is formed in it? *[NCERT Exemplar]*

Ans. (*a*) Nitrogen (atomic no. 7)

Electronic configuration: 2, 5; it has 5 valence electrons.

(*b*)  Triple covalent bonds

(*c*)  3 Single covalent bonds

Q. 7. Give an account of the process adopted by Mendeléev for the classification of elements. How did he arrive at "Periodic Law"? *[NCERT Exemplar]*

Ans. (*i*) When Mendeléev started his work, 63 elements were known. He studied the compounds of these elements with oxygen and hydrogen. He selected hydrogen and oxygen as they are very reactive and formed compounds with most elements. The formulae of the hydrides and oxides formed by an element were treated as one of the basic properties of an element for its classification.

(*ii*) Elements with similar properties were arranged in a group.

(*iii*) Mendeléev observed that elements were automatically arranged in the order of increasing atomic masses.

Q. 8. The atomic number of an element 'X' is 19.

(*a*) Write its electronic configuration.

(*b*) To which period of the Modern Periodic Table does it belong and what is its valency?

(*c*) If 'X' burns in oxygen to form its oxide, what will be its nature – acidic, basic or neutral?

(*d*) Write balanced chemical equation for the reaction when this oxide is dissolved in water.

[CBSE (F) 2016]

Ans. (*a*) Configuration of X (19) = 2,8,8,1.

(*b*) It belongs to fourth period and its valency is 1.

(*c*) Basic oxide (X_2O)

(*d*) $X_2O + H_2O \longrightarrow 2XOH$

Q. 9. (*a*) How does the atomic radius change as you go

(*i*) from left to right in a period?

(*ii*) down a group in the periodic table?

(*b*) Two elements X and Y have atomic numbers 12 and 16 respectively. Write the electronic configuration for these elements. To which period of the Modern Periodic Table do these two elements belong? What type of bond will be formed between them and why?

Ans. (*a*) (*i*) Atomic radius decreases.

(*ii*) Atomic radius increases.

(*b*) Atomic number of element X = 12

Electronic configuration = 2 8 2

K L M

Atomic number of element Y = 16

Electronic configuration = 2 8 6

K L M

The period number of an element is equal to the number of electron shells in its atom. These two elements have 3 electron shells, therefore they belong to 3rd period.

They will form ionic bond because X is a metal and Y is a non-metal. X loses two electrons which will be gained by Y.

Q. 10. (*a*) How would the tendency to lose electrons change as you go

(*i*) from left to right across a period?

(*ii*) down a group?

(*b*) An element X (2, 8, 2) combines separately with $(NO_3)^-$, $(SO_4)^{2-}$ and $(PO_4)^{3-}$ radicals. Write the formulae of the three compounds so formed. To which group of the periodic table does the element 'X' belong? Will it form covalent or ionic compound? Why? *[CBSE Delhi 2016]*

Ans. (*a*) (*i*) Tendency to lose electrons decreases.

(*ii*) Increases.

(*b*) The three compounds are $X(NO_3)_2$, XSO_4 and $X_3(PO_4)_2$.

Valence electrons of element X is 2. Therefore, element X belongs to group 2. It will form ionic compounds because X loses 2 electrons to achieve the electronic configuration of inert gas and forms a positively charged ion.

Q. 11. The position of eight elements in the Modern Periodic Table is given below where atomic numbers of elements are given in the parenthesis.

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

(*i*) Write the electronic configuration of Ca.

(*ii*) Predict the number of valence electrons in Rb.

(*iii*) What is the number of shells in Sr?

(*iv*) Predict whether K is a metal or a non-metal.

(*v*) Which one of these elements has the largest atom in size?

(*vi*) Arrange Be, Ca, Mg and Rb in the increasing order of the size of their respective atoms.

[CBSE (AI) 2016]

Ans. (*i*) Electronic configuration of Ca – 2, 8, 8, 2

(*ii*) Valence electrons in Rb is 1.

(*iii*) Five

(*iv*) Metal

(*v*) Rb is biggest in size.

(*vi*) Be < Mg < Ca < Rb

Q. 12. 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 which can also be extracted from sea water. This compound is added in a small amount to almost all vegetable dishes during cooking. Oxides of elements A and B are basic in nature while those of E and F are acidic. The oxide of D is almost neutral. Based on the above information, answer the following questions:

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

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

(*iii*) Which two of these elements could definitely be metals and which are likely to be non-metals?

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

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

(*vi*) Which one of the eight elements is likely to be a noble gas?

(*vii*) Which one of the eight elements would have the largest atomic radius?

(*viii*) Which one of these eight elements is likely to be a semi-metal or metalloid?

Ans. (*i*) Third period

Group—1, 2, 13, 14, 15, 16, 17, 18 respectively.

(*ii*) Nature of compound: Electrovalent/ionic

(*iii*) Metals—A and B; Non-metals—E, F, G

(*iv*) G/H

(*v*) CG_3

(*vi*) H

(*vii*) A

(*viii*) D

Q. 13. Atoms of seven elements A, B, C, D, E, F and G have a different number of electronic shells but have the same number of electrons in their outermost shells. The elements A and C combine with chlorine to form an acid and common salt respectively. The oxide of element A is liquid at room temperature and is a neutral substance, while the oxides of the remaining six elements are basic in nature. Based on the above information answer the following questions:

(*i*) What could the element A be?

(*ii*) Will elements A to G belong to the same period or same group of the periodic table?

(*iii*) Write the formula of the compound formed by the reaction of the element A with oxygen.

(*iv*) Show the formation of the compound by a combination of element C with chlorine with the help of electronic structure.

(*v*) What would be the ratio of number of combining atoms in a compound formed by the combination of element A with carbon?

(*vi*) Which one of the given elements is likely to have the smallest atomic radius?

Ans. (*i*) Hydrogen

(*ii*) Same group

(*iii*) A_2O/H_2O

(*iv*) $C \cdot + \cdot\ddot{Cl}: \longrightarrow C^+ [:\ddot{Cl}:]^-$

(*v*) 4 : 1

(*vi*) A

Q. 14. In the following table, six elements A, B, C, D, E and F of the modern periodic table with atomic numbers 3 to 18 are given:

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

(*a*) Which of these is (*i*) Noble gas (*ii*) halogen?

(*b*) Which of these is the most active metal in 3rd period?

(*c*) Identify the most electronegative element in the third period.

(*d*) In the compound between B and F what type of bond will be formed?

(*e*) What would be the nature of oxide formed by C? *[CBSE Sample Paper 2016]*

Ans. (*a*) Noble gas – G

Halogen – F

(*b*) Most active metal – B

(*c*) Most electronegative in 3rd period – F

(*d*) Ionic bond

(*e*) Oxide formed by C would be basic.

HOTS (Higher Order Thinking Skills)

Q. 1. Using the part of the Periodic Table given below, answer the questions that follow:

Groups → / Periods ↓	1	2	13	14	15	16	17	18
1	H							He
2	Li	Be	B	C	N	O	F	Ne
3	Na	Mg	Al	Si	P	S	Cl	Ar
4	K	Ca						

(*i*) Na has physical and chemical properties similar to which element (s) and why?

(*ii*) Write the electronic configuration of N and P. Which one of these will be more electronegative and why?

(*iii*) State a chemical property common to fluorine and chlorine.

Ans. (*i*) Lithium and potassium, due to same number of valence electrons.

(*ii*) N ⟶ 2, 5

P ⟶ 2, 8, 5

N is more electronegative element as electronegativity decreases on moving down the group.

(*iii*) Both fluorine and chlorine form their hydracids on reacting with hydrogen.

$H_2 + F_2 \longrightarrow 2HF$

$H_2 + Cl_2 \longrightarrow 2HCl$

Q. 2. Is it possible to have an element with atomic number 2.5?

Ans. No, because the atomic numbers of elements are always in whole numbers.

Q. 3. An element 'X' has mass number 35 and number of neutrons 18. Write atomic number and electronic configuration of 'X'. Also write group number, period number and valency of 'X'. *[CBSE (AI) 2016]*

Ans. Atomic number of X = Mass number of X – Number of neutrons

= 35 – 18 = 17

Therefore, electronic configuration of X = 2, 8, 7

Group number = 17

Period number = 3

Valency = 8 – 7 = 1

Q. 4. Three elements A, B and C have 3, 4 and 2 electrons respectively in their outermost shell. Give the group number to which they belong in the Modern Periodic Table. Also, give their valencies. *[NCERT Exemplar]*

Ans.

Element	Group Number	Valency
A	13	3
B	14	4
C	2	2

Q. 5. Compare the radii of two species X and Y. Give reasons for your answer.

(*a*) X has 12 protons and 12 electrons

(*b*) Y has 12 protons and 10 electrons *[NCERT Exemplar*

Ans. Radii of Y is less than X because Y is cation of X.

Q. 6. Write the formula of the product formed when the element A (atomic number 19 combines with the element B (atomic number 17). Draw its electronic dot structure. Wha is the nature of the bond formed? *[NCERT Exemplar*

Ans. AB $A^{\bullet} + \times\underset{\times\times}{\overset{\times\times}{\underset{\times\times}{B}}}\times \longrightarrow A^{+} - B^{-}$

Ionic Bond

A = K (Potassium)

B = Cl (Chlorine)

Q. 7. An element X (atomic number 17) reacts with an element Y (atomic number 20) to form a divalent halide.

(*a*) Where in the Periodic Table are elements X and Y placed?

(*b*) Classify X and Y as metal (s), non-metal (s) or metalloid (s).

(*c*) What will be the nature of oxide of element Y? Identify the nature of bonding in the compound formed.

(*d*) Draw the electron dot structure of the divalent halide. *[NCERT Exemplar*

Ans. (*a*) X belongs to Group 17 and 3rd period

Y belongs to Group 2 and 4th period

(*b*) X—Non-metal and Y—Metal

(*c*) Basic oxide; Ionic bonding

(*d*) $Y^{\times}_{\times} + \cdot\underset{\cdot\cdot}{\overset{\cdot\cdot}{X}}\cdot \cdot\underset{\cdot\cdot}{\overset{\cdot\cdot}{X}}\cdot \longrightarrow [Y^{2+}(\cdot\underset{\cdot\cdot}{\overset{\cdot\cdot}{X}}\cdot)_2]$

Q. 8. (*i*) Electropositive nature of the element(s) increases down the group and decreases across the period

(*ii*) Electronegativity of the element decreases down the group and increases across the period

(*iii*) Atomic size increases down the group and decreases across a period (left to right)

(*iv*) Metallic character increases down the group and decreases across a period.

On the basis of the above trends of the Periodic Table, answer the following about the elements with atomic numbers 3 to 9.

(*a*) Name the most electropositive element among them.

(*b*) Name the most electronegative element.

(*c*) Name the element with smallest atomic size.

(*d*) Name the element which is a metalloid.

(*e*) Name the element which shows maximum valency. *[NCERT Exemplar*

Ans. (*a*) Lithium (*b*) Fluorine

(*c*) Fluorine (*d*) Boron

(*e*) Carbon

Q. 9. In the following table, the positions of six elements A, B, C, D, E and F are given as they are in the Modern Periodic Table:

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

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

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

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

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

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

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

[CBSE (F) 2015]

Ans. (*i*) E

(*ii*) B

(*iii*) C

(*iv*) B, because atomic radius decreases from left to right due to increase in the nuclear charge.

(*v*) Noble gases

Q. 10. Two elements 'A' and 'B' belong to the 3rd period of Modern periodic table and are in group 2 and 13 respectively. Compare their following characteristics in tabular form :

(*a*) Number of electrons in their atoms

(*b*) Size of their atoms

(*c*) Their tendencies to lose electrons

(*d*) The formula of their oxides

(*e*) Their metallic character

(*f*) The formula of their chlorides

[CBSE Delhi 2016]

Ans.

	Characteristic	A	B
(*a*)	Number of electrons in their atoms	4 or 12 or 20	5 or 13 or 21
(*b*)	Size of their atoms	Bigger	Smaller
(*c*)	Their tendencies to lose electrons	More	Less
(*d*)	The formula of their oxides	AO	B_2O_3
(*e*)	Their metallic character	More metallic	Less metallic
(*f*)	The formula of their chlorides	ACl_2	BCl_3

Proficiency Exercise

Very Short Answer Questions [1 mark]

1. The atomic number of an element is 12. State whether its oxide is acidic or basic.
2. State the basis of classification of elements in the Modern Periodic Table.
3. Two elements X and Y have atomic numbers 10 and 14 respectively. Identify the group numbers of these elements in the periodic table.
4. List any two properties of the elements belonging to the first group of the Modern Periodic Table.
5. Why are isotopes of an element having different atomic masses placed at the same position in the Periodic Table?

Short Answer Questions–I [2 marks]

6. Write two elements for each of the following: (*i*) Alkali metals, (*ii*) Noble gases.
7. Account for the following:
   (*a*) Cations are smaller in size than the corresponding atom.
   (*b*) The noble gases were discovered very late.
8. The electronic configuration of four elements A, B, C and D is given as follows:
   A – 2, 8 B – 2, 8, 1 C – 2, 8, 2 D – 2, 8, 8
   (*a*) Which of them belong to the same period? Name the period.
   (*b*) Which of them belong to the same group? Name the group.
9. In Mendeléev's Periodic Table the elements were arranged in the increasing order of their atomic masses. However, cobalt with atomic mass of 58.93 amu was placed before nickel having an atomic mass of 58.71 amu. Give reason for the same. *[NCERT Exemplar]*
10. Write two points of differences between Mendeléev's Periodic Table and the Modern Periodic Table.
11. "Hydrogen occupies a unique position in Modern Periodic Table." Justify the statement. *[NCERT Exemplar]*

Short Answer Questions–II [3 marks]

12. 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. *[CBSE (AI) 2017]*
13. Four elements A, B, C and D have atomic numbers 12, 13, 14 and 15 respectively.
    Answer the following questions giving reasons:
    (*a*) What is the number of valence electrons and valency of D?
    (*b*) Which of them will have largest atomic radii?
    (*c*) Which of these elements will form the most basic oxide? *[CBSE Sample Paper 2016]*
14. An element A on combining with O_2 produces an oxide A_2O which is basic in nature.
    (*a*) How many electrons must be there in the outermost shell of the element A?
    (*b*) To which group of periodic table it belongs?
    (*c*) Identify whether it is a metal or non-metal.
15. An element 'X' belongs to 3rd period and group 16 of the Modern Periodic Table.
    (*a*) Determine the number of valence electrons and the valency of 'X'.
    (*b*) Molecular formula of the compound when 'X' reacts with hydrogen and write its electron dot structure.
    (*c*) Name the element 'X' and state whether it is metallic or non-metallic. *[CBSE (AI) 2016]*
16. An element 'X' (Atomic number = 20) burns in the presence of oxygen to form a basic oxide.
    (*a*) Identify the element and write its electronic configuration.
    (*b*) State its group number and period number in the Modern Periodic Table.
    (*c*) Write a balanced chemical equation for the reaction when this oxide is dissolved in water. *[CBSE (F) 2016]*
17. How does the tendency of the elements to lose electrons change in the Modern Periodic Table in (*a*) a group, (*b*) a period and why? *[CBSE (F) 2016]*

Long Answer Questions [5 marks]

18. The elements of a period of the periodic table are given below in order from left to right with one of its element missing:
    Na Mg Al Si S Cl Ar
    (*a*) To which period do these elements belong?
    (*b*) One element of this period is missing. Which is the missing element and where should it be placed?
    (*c*) Which one of these elements in this period shows the property of catenation?
    (*d*) Which one of these elements is least reactive?
    (*e*) Identify the halogen from this period.
19. The position of some elements A, B, C, D, E, F and G in the Modern Periodic Table is given as under:

Groups → / Periods ↓	16	17	18
1			A
2	B	C	D
3	E	F	G

    (*a*) In which group are inert elements placed?
    (*b*) What type of ions would B, C, E and F form?
    (*c*) Which elements would have chemical properties similar to C?
    (*d*) How many shells would A have?
    (*e*) What is the similarity between A and D?
    (*f*) Identify the most abundant element in the earth's crust.
20. (*a*) The following is a list of the electron distributions of atoms of unknown elements.

Element	Electron distribution
A	2, 5
B	2, 8, 4
C	2, 8, 8, 2
D	2, 8, 18, 8
E	2, 8, 18, 8, 1
F	2, 8, 18, 18, 7

    Choose an element from the list for each of the following descriptions.
    (*i*) It is a noble gas.
    (*ii*) It is a soft metal with a low density.
    (*iii*) It has a giant covalent structure similar to diamond.
    (*iv*) It can form a negative ion of the type X^{3-}.
    (*b*) How does electronic configurations of atoms change in a period with increase in atomic number?