

CHAPTER

5

PERIODIC
CLASSIFICATION
OF ELEMENTS

Syllabus

Need for classification, early attempts at classification of elements (Dobereiner's Triads, Newland's Law of Octaves, Mendeleev's Periodic Table); Modern periodic table, gradation in properties, valency, atomic number, metallic and non-metallic properties.

Trend Analysis

List of Concepts	2018	2019		2020	
	OD/D	OD	D	OD	D
Periodic Classification and early attempts	1Q (5M)			1Q (3M)	1Q (5M)
Modern periodic table and gradation in properties	1Q (5 M)	1Q (5 M) 1Q (5 M)	1Q (2 M) 1Q (2 M) 1Q (3 M)	2Q (1M) 1Q (1M) 1Q (3M)	1Q (5M)

TOPIC - 1

Periodic Laws and their Limitations



Revision Notes

- **Need for Periodic Classification:** To make the study of elements easy, elements have been divided into few groups in such a way that elements in the same group have similar properties. Now, study of a large number of elements is reduced to a few groups of elements.
- **Dobereiner's Triads:** When elements are arranged in the order of increasing atomic masses, groups of three elements (known as triads), having similar chemical properties are obtained.

The atomic mass of the middle element of the triad was roughly the average of the atomic masses of the other two elements.

TOPIC - 1

Periodic Laws and their Limitations

TOPIC - 2

Periodic Elements and Periodic Properties

Elements	Atomic Mass
Ca	40.1
Sr	87.6
Ba	137.3

- **Limitation:** Dobereiner could identify only three triads. He was not able to prepare triads of all the known elements.
- **Newland's Law of Octaves:** John Newlands arranged the elements in the order of increasing atomic masses. It states that when the elements are arranged in increasing order of atomic masses, the properties of the eighth element are a kind of repetition of the first, just like notes of music.
- **Table showing Newland's Octaves:**

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 of Newland's law of octaves:**
 - (i) The law was applicable to elements up to calcium (Ca) only.
 - (ii) It contained only 56 elements. Further, it was assumed by Newlands that only 56 elements existed in nature and no more elements would be discovered in the future.
 - (iii) In order to fit elements into the table, Newland adjusted two elements 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 differently away from these elements.
- **Mendeleev's Periodic Table:** Dmitri Ivanovich Mendeleev, a Russian chemist, was the most important contributor to the early development of a periodic table of elements as in this the elements were arranged on the basis of their atomic mass and chemical properties.
- **Characteristics of Mendeleev's Periodic Table:**
 - (i) Mendeleev arranged all the 63 known elements in increasing order of their atomic masses.
 - (ii) The table consists of vertical columns called 'groups' and horizontal rows called 'periods'.
 - (iii) The elements with similar physical and chemical properties came under same groups.
- **Mendeleev's Periodic Law:** The properties of elements are the periodic functions of their atomic masses.
- **Merits of Mendeleev's Periodic Table:**
 - (i) Mendeleev left some blank spaces for undiscovered elements.
 - (ii) Mendeleev predicted the discovery of some elements and named them as eka boron, eka aluminium and eka silicon.
 - (iii) Noble gases discovered later could be placed without disturbing the existing order.
- **Limitations of Mendeleev's periodic table:**
 - (i) **Position of Hydrogen:** He could not assign a correct position to hydrogen as hydrogen resembles alkali metals as well as halogens.
 - (ii) **Position of Isotopes :** Isotopes are placed in same position though they have different atomic masses.
 - (iii) Separation of chemically similar elements while dissimilar elements are placed in the same group.
- **Modern Periodic Table:** Henry Moseley gave a new property of elements, 'atomic numbers' and this was adopted as the basis of Modern Periodic Table.
- **Modern Periodic Law:** Properties of elements are the periodic functions of their atomic numbers.

Periodic Table of Elements

12	34	5	6	7	8	91	01	11	21	31	41	51	61	7	18		
Atomic number																	
1	H		Symbol														
Name																	
Atomic Mass																	
1	C	Solid	Metals													Non-metals	
2	Hg	Liquid	Lanthanoids		Actinoids		Transition		Poor metal		Other non-metals		Noble gases				
3	H	Gas	Alkaline earth metal														
4	Rf	Unknown	Alkali metal														
5	23	22	21	39	38	41	40	42	24	25	26	27	28	29	30		
6	56	57-71	72	73	74	75	76	77	78	79	80	81	82	83	84		
7	87	89-103	104	105	106	107	108	109	110	111	112	113	114	115	116		
Hydrogen		Lithium		Beryllium		Sodium		Magnesium		Calcium		Potassium		Rubidium			
1.0079		6.941		9.0122		22.990		24.305		40.078		39.098		85.468			
Helium		Neon		Fluorine		Oxygen		Nitrogen		Carbon		Boron		Zinc			
4.0026		20.180		18.998		15.999		14.007		12.011		10.811		65.39			
Argon		Chlorine		Sulphur		Phosphorus		Silicon		Aluminum		Iodine		Tellurium			
39.948		35.453		32.065		30.974		28.086		26.982		126.90		127.60			
Krypton		Bromine		Selenium		Arsenic		Germanium		Gallium		Antimony		Bismuth			
83.798		79.904		78.96		74.922		72.64		69.723		121.76		208.98			
Xenon		Cesium		Barium		Lanthanide		Hafnium		Tantalum		Radium		Francium			
131.29		137.33		178.49		180.95		186.21		190.23		192.22		195.08			
Radon		Polonium		Astatine		Oganesson		Livermorium		Tennessine		Oganeson		Oganesson			
(222)		(210)		(210)		(294)		(293)		(294)		(294)		(294)			

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

58	Ce	Cerium	140.12	59	Pr	Praseodymium	140.91	60	Nd	Neodymium	144.24	61	Pm	Promethium	(145)	62	Sm	Samarium	150.36	63	Eu	Europium	151.96	64	Gd	Gadolinium	157.25	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
90	Th	Thorium	232.04	91	Pa	Protactinium	231.04	92	U	Uranium	238.03	93	Np	Neptunium	(237)	94	Pu	Plutonium	(244)	95	Am	Americium	(243)	96	Cm	Curium	(247)	97	Bk	Berkelium	(247)	98	Cf	Californium	(251)	99	Es	Einsteinium	(252)	100	Fm	Fermium	(257)	101	Md	Mendelevium	(258)	102	No	Nobelium	(259)	103	Lr	Lawrencium	(262)



Mnemonics:

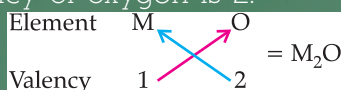
Interpretation: Hydrogen, Helium, Lithium, Beryllium, Boron, Carbon, Nitrogen, Oxygen, Fluorine, Neon, Sodium, Magnesium, Aluminium, Silicon, Phosphorus, Sulphur, Chlorine, Argon, Potassium, Calcium.

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

- A 3**

Solution:

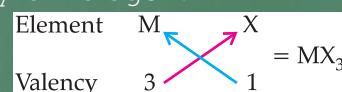
Step I: Valency of oxygen is 2.



So, the molecular formula of oxide of first group elements is M_2O where 2 is the group 1 element and O is oxygen.

Step II : Valency of group 13 elements is 3.

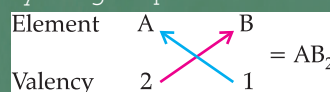
Valency of halogens 1.



So, the molecular formula of halide of group thirteen elements is MX_3 where M is the group 13 element and X is halogen. **1**

Step III: Valency of group 2 elements is + 2

Valency of group 17 elements is 1.



So, the molecular formula is AB_2 . **1**

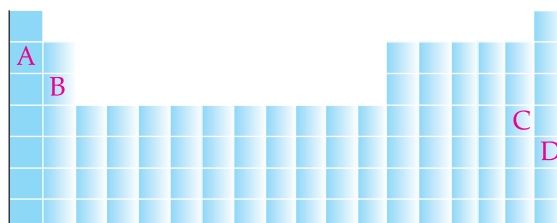
Objective Type Questions

1 mark each

Multiple Choice Questions

Q. 1. 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?

[Board SQP 2020]



- (a) A (b) B
(b) C (d) D

Ans. Correct option : (c)

Explanation: Element C to form an acidic oxide because it lies in non-metal category.

Q. 2. Elements P, Q, R and S have atomic numbers 11, 15, 17 and 18 respectively. Which of them are reactive non-metals? [Board SQP 2020]

- (a) P and Q (b) P and R
(c) Q and R (d) R and S

Ans. Correct option : (c)

Explanation: Element Q and R are reactive non-metals because they have great tendency to accept the electrons to occupy the stable state configuration.

Q. 3. Consider the following statements about an element 'X' with number of protons 13. [OD, 2020]

- (A) It forms amphoteric oxide.
(B) Its valency is three.
(C) The formula of its chloride is XCl.

The correct statement(s) is/are:

- (a) only (A) (b) only (B)
(c) (A) and (C) (d) (A), (B) and (C)

Ans. So option (A) and (B) are correct

Q. 4. Upto which element, the Law of Octaves was found to be applicable ?

- (a) Oxygen (b) Calcium
(c) Cobalt (d) Potassium

[NCERT Exemp.]

Ans. Correct option : (b)

Explanation: It was found that the Law of Octaves was applicable only upto calcium, as after calcium every eighth element did not possess properties similar to that of the first.

Q. 5. 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 masses
(d) decreasing atomic masses

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation: Mendeleev arranged the known elements according to increasing order of their atomic masses because according to him, fundamental property of an element was atomic mass.

Q. 6. 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 periodic table later ?

- (a) Germanium (b) Chlorine
(c) Oxygen (d) Silicon

[NCERT Exemp.]

Ans. Correct option : (a)

Explanation: Many gaps for the undiscovered elements were left in the periodic table by Mendeleev. For instance, the elements scandium (Sc), gallium (Ga), and germanium (Ge) were not

known at Mendeleev's time, but he had predicted their existence in advance of their discovery.

Q. 7. What type of oxide would Eka-aluminium form?

- (a) EO_3 (b) E_2O_2
(c) E_2O_3 (d) EO [NCERT Exemp.]

Ans. Correct option : (c)

Explanation: Since, Aluminium forms its oxide as Al_2O_3 . Hence, Formula of oxide is E_2O_3 .

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

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

Q. 1. Assertion (A): Mendeleev arranged element in horizontal rows and vertical columns.

Reason (R): Mendeleev ignored the order of atomic weight thinking that the atomic measurements might be incorrect.

Ans. Correct option : (b)

Explanation: Mendeleev arranged elements in horizontal rows and vertical columns. He ignored the order of atomic weight thinking that the atomic measurements might be incorrect and placed the elements with similar properties. 1

Q. 2. Assertion (A): Mendeleev left the gap under aluminium and silicon and called these Eka-aluminium and Eka-silicon, respectively.

Reason (R): Dobereiner arranged elements on the basis of increasing atomic number.

Ans. Correct option : (c)

Explanation: Dobereiner arranged elements on the basis of increasing atomic weights. 1

Q. 3. Assertion (A): In triad, the three elements have same gaps of atomic masses.

Reason (R): Elements in a triad have similar properties.

Ans. Correct option : (d)

Explanation: In a triad, the atomic mass of the middle element is the mean of the atomic masses of the first and third elements. 1

Q. 4. Assertion (A): According to Mendeleev, periodic properties of elements is a function of their atomic number.

Reason (R): Atomic number is equal to the number of protons.

Ans. Correct option : (d)

Explanation: According to Mendeleev, periodic properties of elements is a function of their atomic masses. 1

C Very Short Answer Type Questions

Q. 1. How many horizontal rows are present in modern periodic table. What are they called?

Ans. There are seven horizontal rows in the modern periodic table. These rows are called periods.

$\frac{1}{2} + \frac{1}{2}$

Q. 2. How many vertical columns are present in modern periodic table. What are they called?

Ans. There are 18 vertical columns in the modern periodic table and these are known as groups.

$\frac{1}{2} + \frac{1}{2}$

Q. 3. State the formula to fill up the maximum number of electrons in a shell.

Ans. $2n^2$, where n is the number of shell. 1

Q. 4. Write the total number of periods in modern periodic table. [R] [Board Term II, 2015]

Ans. The total number of periods in modern periodic table is seven. [CBSE Marking Scheme, 2015] 1

[AI] Q. 5. State one reason that explains the position of Hydrogen in group I?

Ans. Hydrogen should be placed in group I, since it has only one electron in its outermost shell. 1

[AI] Q. 6. Why noble gases are placed in a separate group in modern periodic table?

Ans. It is because they resemble with each other but do not resemble with other group elements. 1



Short Answer Type Questions-I

2 marks each

Q. 1. 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?

[U] [Delhi, 2019]

Ans. Modern periodic table consists of groups and periods. Where number of valence electrons determines the group and number of shells determines the period.

[CBSE Marking Scheme, 2019] 1 + 1 = 2

Q. 2. Write the name, symbol and electronic configuration of an element X whose atomic number is 11. [R] [Delhi 2019]

Ans. Name – Sodium $\frac{1}{2}$
Symbol – Na $\frac{1}{2}$
Electronic configuration – 2, 8, 1 1

[CBSE Marking Scheme, 2019] 2

Q. 3. Can the following groups of elements be classified as Dobereiner'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.

Justify your answer in each case. [C]

Ans. (a) Na, Si, Cl – Average of atomic masses of Na and Cl is not equal to the atomic mass of Si. 1

(b) Be, Mg, Ca – The average of atomic masses of Be and Ca is equal to the atomic mass of Mg.

Atomic mass of Mg =

$$\frac{\text{Atomic mass of Be} + \text{Atomic mass of Ca}}{2}$$

$$= \frac{9 + 40}{2} = \frac{49}{2} = 24.5$$

[CBSE Marking Scheme, 2019] 1

Q. 4. An element 'X' has mass number 35 and 18 number of neutrons. Therefore, Electronic configuration of X = 2, 8, 7. Write atomic number and electronic configuration of 'X'. Also write group number, period number and valency of 'X'.

[AE] [CBSE OD, 2016]

Ans. Atomic number of X = Mass number of X – No of neutrons

$$35 - 18 = 17$$

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

Group number = 17

Period no = 3

Valency = 8 – 7 = 1

2



Short Answer Type Questions-II

3 marks each

Q. 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

[CBSE OD, 2020]

- (i) From the given three categories A, B and C, pick the one which forms Dobereiner's Triads.
 (ii) Why did Mendeleev placed elements of category A, B and C in three different groups?
 (iii) Is Newland law of octaves applicable to all the three categories?

Give reason to justify your answer.

Ans. (i) Category A (Li, Na, K) shows Dobereiner's triads.

(ii) Mendeleev arranged the elements in increasing order of atomic mass and grouped them as per similar chemical property. The elements in A, B and C are similar among themselves but have different chemical properties.

(iii) No, Newland law of Octaves is not applicable because in the three categories every eighth element will not show same property as first. Also, Newland Octaves law is applicable only upto calcium. $1+1+1$

Q. 2. Three elements 'X', 'Y' and 'Z' have atomic numbers 7, 8 and 9 respectively.

(a) State their positions (Group number and period number both) in the Modern Periodic Table.

(b) Arrange these elements in the decreasing order of their atomic radii.

(c) Write the formula of the compound formed when 'X' combines with 'Z'. [CBSE OD 2016/OD 2020]

Ans. (a) X (7) - 2,5 Group 15; Period 2

Y (8) - 2,6 Group 16; Period 2

Z (9) - 2,7 Group 17; Period 2

(b) $X > Y > Z$

(c) XZ_3

Q. 3. 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. [A] [CBSE SQP, 2019]

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

Both X and Y belongs to 3rd period.

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 XY.

[CBSE Marking Scheme, 2019] $1 + \frac{1}{2} + 1 + \frac{1}{2}$

Q. 4. 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 its valency and justify your answer in each case.

[AE] [CBSE SQP, 2018]

Ans. 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. X belongs to 3rd period. 1

(b) X has 6 valence electrons it belongs to group 16. 1

(c) Valency will be 2. To acquire noble gas configuration it will gain 2 electrons. 1

[CBSE Marking Scheme, 2018]

COMMONLY MADE ERROR

- ➔ Usually students get confused with the group and period to which they belong to. They also get confused with the valency.

ANSWERING TIPS

- ➔ Understand the basic concepts involved in the separation of periods and groups in the modern periodic table.
 ➔ After writing the electronic configuration, check the number of energy shells which should be equal to the period number.
 ➔ Then check for how many outermost (valence) electrons are there and then write the Group to which it belongs.
 ➔ From the valence electrons we can write the valency of that element.

Q. 5. Write the electronic configuration of two elements P (atomic number 17) and Q (atomic number 19) and determine their group numbers and period numbers in the Modern Periodic Table.

[C] [OD Comptt 31/1 2017]

Ans. Electronic Configuration of 'P' — 2, 8, 7

Group number — 17

Period number — 3rd

Electronic Configuration of 'Q' — 2, 8, 8, 1

Group number — 1

Period number — 4th

[CBSE Marking Scheme, 2017] $1 + 1 + 1$

Q. 6. Consider the following elements (atomic numbers are given in parenthesis)

Ca(20); K(19); F(9); Be(4) [OD Comptt 31/3 2017]

(a) Select:

(i) The elements having one electron in the outermost shell.

(ii) Two elements of the same group. Write the number of this group.

(b) Write the formula of the compound formed by the union of Ca(20) and the element X(2, 8, 7).

[AE] [OD Comptt 31/3 2017]

Ans. (a) (i) K (Potassium — 2, 8, 8, 1)

(ii) Be and Ca in same group because both have same number of valence electrons in their outermost shell. The number of this group is 2.

(b)

Ca	X
Valency 2	1

Thus, the formula of the compound is $Ca_1X_2 = CaX_2$ $1+1+1$

Q. 7. An element P (atomic number 20) reacts with an element Q (atomic number 17) to form a compound. Answer the following questions by 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.

[C] [CBSE, Delhi Set, 2017]

Ans.

Position of P	Group-2	Because it has 2 valence electrons/ 2, 8, 8, 2
	Period-4	Because it has 4 shells/ 2, 8, 8, 2
Position of Q	Group-17	Because it has 7 valence electrons/ 2, 8, 7
	Period-3	Because it has 3 shells/ 2, 8, 7
Formula	PQ ₂	Because valency of P is 2 and that of Q is 1

[CBSE Marking Scheme, 2017] 3

COMMONLY MADE ERROR

- ➔ Students often write vague answer. It seems they are unaware of the concept of calculating group and period of an element.

ANSWERING TIPS

- ➔ Follow the basic rule that the period number is equal to the number of shells in an atom and group number is equal to valence electrons for the first two groups.

Q.8. The atomic number of an element is 20.

- Write its electronic configuration and determine its valency.
- Is it a metal or a non-metal?
- Write the formula of its chloride.
- Is it more reactive or less reactive than Mg (atomic number 12)? Give reason for your answer.

[C] [Foreign Set 31/2/1 2017]

- Ans. (a) X₍₂₀₎ – 2, 8, 8, 2 ½
 Valence electrons- 2
 Hence valency is 2 ½+½
- (b) It is a metal ½
- (c) XCl₂ ½
- (d) It is more reactive than Mg as reactivity increases down the group. Mg- III Period and X₂₀ (Ca)- IV Period. ½

Q. 9. 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.

[Outside Delhi 2017]

- Ans. • X(20) – 2, 8, 8, 2 ½
 • Y(17) – 2, 8, 7
 • XY₂
 • $\ddot{X} + 2\ddot{Y} = X^{2+} [\ddot{Y}]^{2-}$ ½+½
 • Ionic/electrovalent bond. ½

[CBSE Marking Scheme, 2017]

Q. 10. An element 'M' has atomic number 12.

- Write its electronic configuration and valency.
- Is 'M' a metal or a non-metal? Give reason in support of your answer.
- Write the formula and nature (acidic/basic) of the oxide of M. [AE] [Delhi 31/1/2017 Comptt.]

Ans. (i) Electronic Configuration — 2, 8, 2
 Valency — 2.

- (ii) Metal
 There are two electrons in its outermost shell and it easily loses them to form a positive ion.

(iii) M O
 2 2
 M₂O₂ = MO 1+1+1
 It is a basic oxide.

Q. 11. An element 'X' with electronic configuration (2, 8, 2) combines separately with two radicals, (NO₃)⁻ and (SO₄)²⁻.

- Is 'X' a metal or a non-metal? Write the nature of its oxide.
- Write the formula of the compounds of 'X' formed by the combination of these radicals. Are these compounds covalent or electrovalent?

[U] [CBSE OD Comptt. 2017]

Ans. (i) X is a metal. Nature of it is Basic.

(ii) X(NO₃)₂, XSO₄
 These compounds are Ionic/electrovalent. 1+1+1

[AI] Q. 12. State the main aim of classifying elements. Which is more fundamental property of elements that is used in the development of Modern Periodic Table? Name and state the law based on this fundamental property. On which side of the periodic table one can find metals, non-metals and metalloids?

[U] [Borad Term II, Foreign Set I, 2016]

OR

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?

[R] [Board Term II, Delhi II, 2015]

Ans. (i) Aim of Classification: For systematic and simplified study of elements and their compounds. ½

(ii) Basic property: Atomic Number. ½

- (iii) **Modern periodic Law:** The properties of elements are a periodic function of their atomic number. $\frac{1}{2}$
- (iv) Metals are found on the left side and centre of the Modern Periodic Table. $\frac{1}{2}$
- (v) Metalloids are found in a zig-zag manner between the metals and the non-metals. $\frac{1}{2}$
- (vi) Non-metals are found on the right side of the Modern Periodic Table. $\frac{1}{2}$

[CBSE Marking Scheme, 2015]

Q. 13. An element 'X' belong to 3rd period and group 13 of the Modern Periodic Table.

- (a) Determine the valence electrons and the valency of 'X'.

- (b) Molecular formula of the compound formed when 'X' reacts with an element 'Y' (atomic number = 8).
- (c) Write the name and formula of the compound formed when 'X' combines with chlorine.

[CBSE OD, 2016]

- Ans. (a)** Group 13 means valence electrons 3 and valency 3. $\frac{1}{2} + \frac{1}{2}$
- (b) Y (8) – 2, 6 X = 2, 8, 3
Valency – 2 Valency – 3
Compound formed – X_2Y_3/Al_2O_3 1
- (c) X Chlorine Cl
Valency -3 valency -1
Compound formed $XCl_3/AlCl_3$ 1

✓ Long Answer Type Questions

5 marks each

Q. 1. The position of certain elements in the Modern Periodic Table are shown below:

Group →	1	2	3 to 12	13	14	15	16	17	18
↓ Period									
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?

[U] [CBSE SQP 2020]

- Ans. (i)** Element E is Silicon. It will form covalent bond only as it has four electrons in its outermost orbit and need only four more electrons to become stable.
- (ii) Non-metal with valency 2 is B, which is oxygen.
- (iii) Element D is a metal with valency 2. Element D is Magnesium. Due to its low electro negativity, it has a higher tendency to donate electrons.
- (iv) Element F has the largest atomic size. Element F is argon. Argon occupies 3 energy shells compared to elements H and C, which occupies one and two energy shells. Due to this, the atomic radius of argon is the largest.
- (v) Elements H, C and F belong to Group number 18, which means according to their electronic configuration, their octet is complete and thus these elements are stable. They have very low tendency to react with other elements. Group 18 elements belong to noble gas family. 5

- Q. 2. (a) What was the basis of Mendeleev's classification of elements?**
- (b) List two achievements of Mendeleev's Periodic table.
- (c) List any two observations which posed a challenge to Mendeleev's periodic law.

[R] [Comptt. Set I, II, III, 2018]

- Ans. (a)** Atomic mass 1
- (b) (i) He could classify all the 63 elements known at that time.

- (ii) He left gaps for the yet to be discovered elements.
- (iii) He predicted the properties of such elements. (any two) 1×2
- (c) (i) Position of isotopes
- (ii) Irregular increase in atomic masses in going from one element to the next, making the prediction of undiscovered elements difficult.
- (iii) Position of Hydrogen. (any two) 1×2

[CBSE Marking Scheme, 2018]

COMMONLY MADE ERROR

- Students write irrelevant answers. Be specific. Read question carefully and write only what is asked.

ANSWERING TIPS

- Do not overlook any part of a question and avoid being in a hurry to conclude the answer.

Q. 3. (a) The modern periodic table has been evolved through the early attempts of Dobereiner, Newland and Mendeleev. List one advantage and one limitation of all the three attempts.

(b) Name the scientist who first of all showed that atomic number of an element is a more fundamental property than its atomic mass.

[R] [Delhi/Outside Delhi, 2018]

Ans. (a) (i) Dobereiner Periodic Table

Advantage: To predict the atomic mass of middle element in each triad.

Limitation: Dobereiner could identify only three triads.

(ii) Newland Periodic table

Advantage: Every eighth element had properties similar to that of first and co-related the properties of elements with their atomic mass.

Limitation: It was only applicable upto Calcium/ only 56 elements and no future element.

(iii) Mendeleev's Periodic Table

Advantage: Elements with similar properties could be grouped. He predicted the existence of new elements that had not been discovered at that time.

Limitation: No fixed position for hydrogen and isotopes. Atomic masses do not increase in a regular manner.

(b) Henry Moseley: Properties of elements are a periodic function of their atomic number. $3 + 1 + 1$

[CBSE Marking Scheme, 2018]



Topper Answer, 2018

Ans.

(a) Dobereiner's method of classification
Advantage: He, for the first time grouped metals on the basis of their similar chemical properties. He could find 3 Dobereiner's Triad which had a special characteristic:-
When arranged in increasing atomic masses, the atomic mass of middle element was equal to average of atomic masses of other two. This.

Li	-	6.9 u
Na	-	23 u
K	-	39.1 u

→ This encouraged others to classify elements on basis of chemical properties and atomic masses.

Disadvantage: He could only place 9 such elements in 3 triads & thus, wasn't efficient for a study of them.

1/2

(b) Newland's law of octaves — Classification of Newland
Advantage: He could place 56 elements known at that time in his classification & also for first time, studied periodic recurrence of properties. In his classification, properties of every 8th element resembled to that of first.

Disadvantage: His system worked only for lighter elements & properties matched only for elements till Calcium. Also, he placed some elements like Co & Ni even in same slot.

(c) Mendeleev's classification
Advantage: He arranged elements on basis of increasing atomic masses & similar formulae for hydrides & oxides. He also left gaps in his tables which encouraged for discovery of new elements like eka-boron, eka-aluminium etc.

COMMONLY MADE ERROR

- ➔ Students get confused with the characteristics, merits and demerits of different periodic classifications.

ANSWERING TIPS

- ➔ Learn and understand the basic concepts of each periodic classification, the person's name who is responsible for that periodic classification and make a list of differences.

- Q. 4. (i) Why do we classify elements ?**
 (ii) What are the two criteria used in the development of Modern Periodic Table ?

- (iii) State the position of (a) metals, (b) non-metals and (c) metalloids in the periodic table.
 (iv) Would you place two isotopes of chlorine; Cl-35 and Cl-37 in different slots of the periodic table because of their different atomic masses or in the same slot because their chemical properties are same ? Justify your answer. U

- Ans.** (i) To study the properties of elements and to keep the elements with similar properties together. 1
 (ii) Chemical properties of elements and atomic number. 1
 (iii) Metals lie on extreme left, metalloids lie in the middle and non-metals lie on the right side. 2
 (iv) They should be placed in the same slot. Since they have same numbers of electrons/atomic number and modern periodic Table is based on atomic number and not on atomic mass. 1

TOPIC - 2

Periodic Elements and Periodic Properties



Revision Notes

- **Position of elements in modern periodic table:**
 - (i) The Modern Periodic Table consists of 18 groups and 7 periods.
 - (ii) Elements present in any one group have the same number of valence electrons. Also, the number of shells increases as we go down the group.

(iii) Elements present in any one period, contain the same number of shells. Also, with increase in atomic number by one unit on moving from left to right, the valence shell electron increases by one unit.

(iv) Each period marks a new electronic shell getting filled.

➤ **Trends in the Modern Periodic Table:**

(i) **Periodicity in Properties:** The properties of elements depend upon the electronic configuration which changes along a period and down a group in the periodic table. The periodicity properties i.e. repetition of properties after a regular interval is due to similarity in electronic configuration.

(ii) **Tendency to lose or gain electron:** Chemical reactivity of an element depends upon the ability of its atoms to donate or accept electrons.

(iii) **Variations of tendency to lose electron down the group:** Tendency to lose electron goes on increasing down the group.

Reason: It is due to the increase in the distance between the valence electrons and the nucleus as the atomic size increases down the group, the force of attraction between the nucleus and the valence electrons decreases, therefore, tendency to lose electron also increases down the group.

(iv) **Variation of tendency to lose electron along a period:** It goes on decreasing generally along a period from left to right with decrease in atomic size.

Reason: Due to decrease in the atomic size, the force of attraction between the valence electrons and the nucleus increases and therefore, electrons cannot be removed easily.

(v) **Variation of tendency to gain electron down the group:** It goes on decreasing down the group in general.

Reason: Due to increase in atomic size, the force of attraction between the nucleus and the electron to be added becomes less.

(vi) **Variation of tendency to gain electron along a period:** It increases left to right in a period.

Reason: It is due to decrease in the atomic size which leads to an increase in the force of attraction between the nucleus and the electron to be added.

➤ **Metallic and non-metallic character:** Group 1 to 12 are metals. Group 13 to 18 comprises non-metals, metalloids and metals.

➤ **Properties of Metals:**

(i) They are malleable.

(ii) They are ductile.

(iii) They are good conductors of heat and electricity.

(iv) They have generally 1 to 3 valence electrons.

(v) They have the same or less number of electrons in their outermost shell than the number of shells.

(vi) They are mostly solids.

➤ **Properties of Non-metals:**

(i) They exist in solid, liquid or gaseous state.

(ii) Non-metals are generally brittle.

(iii) They are non-conductors.

(iv) They have 4 to 8 valence electrons.

➤ **Atomic radii increases down the group.**

Atomic number	Elements	Symbols	Electronic configuration	Valence electrons	Valency
1	Hydrogen	H	(1)	1	1
2	Helium	He	(2)	2	0
3	Lithium	Li	(2, 1)	1	1
4	Beryllium	Be	(2, 2)	2	2
5	Boron	B	(2, 3)	3	3
6	Carbon	C	(2, 4)	4	4
7	Nitrogen	N	(2, 5)	5	3
8	Oxygen	O	(2, 6)	6	2
9	Fluorine	F	(2, 7)	7	1

10	Neon	Ne	(2, 8)	8	0
11	Sodium	Na	(2, 8, 1)	1	1
12	Magnesium	Mg	(2, 8, 2)	2	2
13	Aluminium	Al	(2, 8, 3)	3	3
14	Silicon	Si	(2, 8, 4)	4	4
15	Phosphorus	P	(2, 8, 5)	5	3
16	Sulphur	S	(2, 8, 6)	6	2
17	Chlorine	Cl	(2, 8, 7)	7	1
18	Argon	Ar	(2, 8, 8)	8	0
19	Potassium	K	(2, 8, 8, 1)	1	1
20	Calcium	Ca	(2, 8, 8, 2)	2	2



Mnemonics

Concept: Trends in Atomic Radii:	Concept: gradation in properties
Mnemonics: Display Pic (DP)	Mnemonics: Dear God IskoPoocho: EA IP EN
Interpretation: Decreases across a period	Interpretation: Decrease in groups Increase in periods In case of: E lectron A ffinity, I onization P otential And E lectro N egativity

How is it done on the GREENBOARD?

AI Q. What is meant by 'group' in the modern periodic table? How do the following change on moving from top to bottom in a group?

- (i) Number of valence electrons
- (ii) Number of occupied shells
- (iii) Size of atoms
- (iv) Metallic character of element
- (v) Effective nuclear charge experienced by valence electrons.

Solution:

Step I: Vertical columns of the periodic table are known as groups.

Step II : (i) The number of valence electrons remains constant when we move down the group.

Step III: (ii) The number of occupied shells increases down the group.

Step IV: (iii) The size of atom increases down the group.

Step V: (iv) The metallic character of elements increases down the group.

Step VI: (v) The effective nuclear charge decreases down the group. $\frac{1}{2} \times 6 = 3$



Objective Type Questions

1 mark each

A Multiple Choice Questions

Q. 1. 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

Ans. Correct option : (d)

Explanation: Group 16 and Period 3. Non- metals form acidic oxides.

Q. 2. 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

[NCERT Exemp.]

Ans. Correct option : (c)

Explanation: Element with electronic configuration 2, 8 has octet configuration, so must be placed in group 18.

Q. 3. Which of the following is the outermost shell for elements of period 2?

- (a) K shell
- (b) L shell
- (c) M shell
- (d) N shell

[NCERT Exemp.]

Ans. Correct option : (b)

Explanation: The elements of 2nd period contain two shells, K and L shell.

Q. 4. Arrange the following elements in the order of their decreasing metallic character: Na, Si, Cl, Mg, Al.

- (a) $\text{Cl} > \text{Si} > \text{Al} > \text{Mg} > \text{Na}$
- (b) $\text{Na} > \text{Mg} > \text{Al} > \text{Si} > \text{Cl}$
- (c) $\text{Na} > \text{Al} > \text{Mg} > \text{Cl} > \text{Si}$
- (d) $\text{Al} > \text{Na} > \text{Si} > \text{Ca} > \text{Mg}$

[NCERT Exemp.]

Ans. Correct option : (b)

Explanation: As we move from left to right in periodic table, metallic characters a decreases and non-metallic characters a increases.

Q. 5. Which of the following elements will form an acidic oxide?

- (a) An element with atomic number 7
- (b) An element with atomic number 3
- (c) An element with atomic number 12
- (d) An element with atomic number 19

[NCERT Exemp.]

Ans. Correct option : (a)

Explanation: Formation of acidic oxides is a characteristic of non-metals. Here, element with atomic number 7 is a non-metal that is nitrogen. Rest three elements are metals and hence it forms basic oxide.

Q. 6. Which of the following set of elements is written in order of their increasing metallic character?

- (a) Be, Mg, Ca
- (b) Na, Li, K
- (c) Mg, Al, Si
- (d) C, O, N

[NCERT Exemp.]

Ans. Correct option : (a)

Explanation: As we move down in a group, metallic nature increases. Be, Mg and Ca belong to same group that is group 2 of Modern Periodic table.

B Assertions and Reasons Type Questions

Directions: In the following questions, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

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

Q. 1. Assertion (A): Sixth and seventh periods in the periodic table contains 14 elements.

Reason (R): In the periodic table, 14 elements of sixth and seventh periods are known as lanthanoids and actinoids.

Ans. Correct option : (d)

Explanation: Sixth period contains 32 elements and seventh period is incomplete and like sixth, the period would have 32 elements.

Q. 2. Assertion (A): Be and Al show some similar properties.

Reason (R): The metallic radius of Be is less than the metallic radius of Al.

Ans. Correct option : (b)

Explanation: Be and Al show diagonal relationship because Be resembles in its properties with Al. Metallic radius of the Be (111 pm) is less than the metallic radius of Al (143 pm). Although smaller size is the reason for the anomalous behaviour of Be but not a reason for its diagonal relation with Al.

Q. 3. Assertion (A): The atomic and ionic radii generally decrease towards right in a period.

Reason (R): The ionisation enthalpy increases on moving towards left in a period.

Ans. Correct option : (c)

Explanation: The ionisation enthalpy increases on moving towards the extreme right element in period and atomic and ionic radii decreases in a period from left to right.

Q. 4. Assertion (A): Smaller the size of an atom, greater is the electronegativity.

Reason (R): Electronegativity refers to the tendency of atom to share electrons with other atom.

Ans. Correct option : (c)

Explanation: Electronegativity refers to the tendency of an atom to attract bonding electrons.

Q. 5. Assertion (A): Noble gases are highly reactive.

Reason (R): Noble gases have stable closed shell electronic configuration.

Ans. Correct option : (d)

Explanation: Inert gases (noble gases) are very less reactive due to stable closed shell electronic configuration like ns^2 , np^6 or ns^2 .

C Very Short Answer Type Questions

Q. 1. How does valency of an element vary across a period? [CBSE SQP, 2020]

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

[CBSE Marking Scheme, 2020] 1

Q. 2. Define electropositivity. [OD 2020]

Ans. Electropositivity is the tendency of an element to lose electrons and form positive ions in a chemical reactions. 1

Q. 3. The atomic radii of first group elements are given below: [OD 2020]

Group I element	Atomic radii (pm)
Na	86
K	231

Rb 244

Cs 282

State the reason behind the observed trend in the above elements. [U]

Ans. In a group, as we move from top to bottom, the number of shells increases. Hence, the atomic radius increases.

Q. 4. State one reason for placing Mg and Ca in the same group of the periodic table.

[Board Term II, 2015]

Ans. Due to the presence of 2 electrons in the valence shell and similar chemical properties.

[CBSE Marking Scheme, 2015] 1

Q. 5. How many elements are in 2nd and 5th period of Modern Periodic table.

Ans. 2nd period has 8 elements, 5th period has 18 elements. $\frac{1}{2} + \frac{1}{2}$

Q. 6. Name any two elements that have two electrons in their valence shell. [U]

Ans. (i) Magnesium: 2, 8, 2 $\frac{1}{2}$

(ii) Calcium : 2, 8, 8, 2. $\frac{1}{2}$

Q. 7. If the atomic number of three element X, Y and Z are 3, 11 and 17 respectively. Which two elements will show similar chemical properties. Justify.

Ans. X and Y will show similar chemical properties as these have same valence electrons.

X = 2, (1)

Y = 2, 8, (1) $\frac{1}{2} + \frac{1}{2}$



Short Answer Type Questions-I

2 marks each

Q. 1. The atomic number of an element is 14. Examine if this element will have metallic properties or not. Give reason to justify your answer. [CBSE 2019]



Topper Answer, 2019

Ans.

Atomic number = 14
electronic configuration = 2, 8, 4
element = Silicon
This element has semi properties of both metals and non-metals,
∴ It is a metalloid.
It has 4 valence electrons due to which it can neither gain nor lose electrons as it would become unstable.
∴ It forms covalent bonds.

Q. 2. 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. [AE] [Delhi 2019]

Ans. (a) Group – 14, Period – 3 $\frac{1}{2} + \frac{1}{2}$

(b) Silicon $\frac{1}{2}$ Non – metallic / poor conductor of electricity $\frac{1}{2}$ (or any other property)

[CBSE Marking Scheme, 2019] 2

Q. 3. 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 its valency. [C]

Ans. 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. X belongs to 3rd period.

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

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

Q. 4. Define the following terms ? (i) Valency, (ii) Atomic size. [R]

Ans. (i) **Valency:** The combining power or the combining capacity of an atom is called its valency.

(ii) **Atomic size:** Atomic size or atomic radius is the distance between the centre of the nucleus and the outermost shell of an isolated atom.



Short Answer Type Questions-II

3 marks each

Q. 1. The following table shows the position of five elements A, B, C, D and E in the modern periodic table.

Group →	1	2	3 to 12	13	14	15	16	17	18
↓ Period									
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?

Ans. (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.

Q. 2. 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? [SQP-2020 Delhi]

Ans. **Atomic Size:** The distance from centre of nucleus to outermost shell of an atom is atomic radius.

Atomic size is measured in Angstroms, where 1 Angstroms = 10^{-10} metres.

Along the period from left to right atomic radius decreases.

Reason: Nuclear charge increases which tends to pull the electrons closer to the nucleus.

Down the group: Atomic radius increases

Reason: Number of shells increases on going down the group.

Q. 3. The atomic number of an element is 14. Examine if this element will have metallic properties or not. Give reason to justify your answer. [CBSE 2019 toppers answer]



Topper Answer, 2019

Ans.

Atomic number = 14
 electronic configuration = 2, 8, 4
 element = Silicon
 This element has semi properties of both metals and non-metals,
 ∴ It is a metalloid.
 It has 4 valence electrons due to which it can neither gain nor lose electrons as it would become unstable.
 ∴ It forms covalent bonds.

Q. 4. Define groups in the Modern Periodic Table. How do valency, atomic size and metallic character vary in a group? [2019]



Topper Answer, 2019

Ans.

Q. 4. ① The vertical columns present in the modern periodic table having elements with similar valencies and chemical properties are called Groups.

② For eg. Alkali metals Group 1

H	- Hydrogen
Li	Lithium
Na	Sodium
K	Potassium

Rb	Rubidium
Cs	Cesium
Fr	Francium

③ Valency

As we move down a group, valency remains same.
eg. all alkali metals are monovalent.

④ Atomic size

Atomic size is the distance from the centre of nucleus to the last shell.

As we move down a group, the atomic size increases as number of shells increase.

eg. $H \rightarrow 1$
 $Li \rightarrow 2, 1$
 $Na \rightarrow 2, 8, 1$ etc.

⑤ Metallic character

As we go down a group, the chemical reactivity of metals ~~decreases~~ increases as it is easier for a bigger atom to lose electrons due to weaker electrostatic forces. eg. Francium is more metallic than Lithium.

But in non-metals, it decreases as it is easier for a smaller atom on top to gain electrons due to strong electrostatic forces than a bigger atom.
eg. Fluorine is more non-metallic than Astatine.

Q. 4. 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.

[A] [Delhi Comptt. 31/1/1 2017]

Ans. (i) Atomic radius decreases. $\frac{1}{2}$

Reason: Nuclear charge increases which tends to pull the electrons closer to the nucleus. 1

(ii) Atomic radius increases. $\frac{1}{2}$

Reason: Number of shells increases on going down the group. 1

[CBSE Marking Scheme, 2017]

Q. 5. 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.

[R] [Delhi 31/1/1 2017]

Ans. Vertical Column — Groups $\frac{1}{2}$

Horizontal Rows — Periods $\frac{1}{2}$

(i) Metallic character increases.

Reason: Ability to lose electrons increases on moving down the group due to increase in distance between the nucleus and the valence electrons/

Ans. decrease in the attraction between the nucleus and the valence electrons. 1

(ii) Atomic radius decreases.

Reason: 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. 1

[CBSE Marking Scheme, 2017]

Detailed Answer:

In the modern periodic table, there are 18 vertical columns known as Groups and 7 horizontal rows known as Periods.

Metallic character increases on moving down a group in the Modern Periodic table. As we move down the group, the electrostatic attraction between the nucleus and the outermost 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 electron can be easily lost by the element, thereby metallic character increases on moving down a group.

The size of atomic radius decreases on moving left to right in a horizontal row. 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 outermost electron. This increased attraction pulls the outermost electron closer to the nucleus, thereby decreasing the atomic size.

Q. 6. 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. [U] [SA-II, OD, Set-I, 2017]



Topper Answer, 2017

(a) Highest valency

Na $\frac{K}{2}, \frac{L}{8}, \frac{M}{1}$, Mg $\frac{K}{2}, \frac{L}{8}, \frac{M}{2}$, Al $\frac{K}{2}, \frac{L}{8}, \frac{M}{3}$

Clearly, highest valency is 3 i.e. of aluminium as it can lose its 3 valence electrons to become 'Al³⁺'

(b) largest atomic radius → Sodium (Na)

Reason → Because atomic size decreases along a period from left to right. Since Na is present at most left side, it has more atomic radius.

(c) Maximum chemical reactivity → Na (Sodium)

Reason → Since all three are metals, chemical reactivity means ability to lose electrons. Since ability to lose electrons decreases along a period, Na would be most metallic and hence chemically most reactive.

Q. 7. 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 OD 2017]

Ans. • Repetition of similar properties of elements after regular intervals. 1
• Because of the same number of valence electrons.
• It increases due to increase in effective nuclear charge which pulls the electrons towards it.

[CBSE Marking Scheme, 2017]

Q. 8. 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 OD 2017]

Ans. • Periods – 7, Groups – 18

- Metallic character decreases along the period because effective nuclear charge increases on the valence electrons hence decrease in tendency to lose electrons.
- Metallic character increases down a group because effective nuclear charge experienced by valence electrons decrease, hence tendency to lose electron decreases.

[CBSE Marking Scheme, 2017]



Topper Answer, 2017

Ans.

9. Modern Periodic Table has 7 periods and 18 groups.

(i) Metallic character decreases on moving from left to right in a period.
Reason: Along the period, from left to right, the effective nuclear charge increases due to increase in no. of protons due to which force of attraction between nucleus & valence electrons increases and ability to lose electrons (i.e. metallic character) decreases.

(ii) Metallic character increases down a group.
Reason: Because atomic size increases down a group, the force of attraction between nucleus & valence electron decrease & electrons losing tendency increases. Therefore metallic character increases.

Q. 9. How does the tendency of the elements to lose electrons change in the Modern Periodic Table in (i) a group, (ii) a period and why?

[Board Term II, Foreign Set III, 2016]

Ans. (i) Increases down a group. $\frac{1}{2}$

Reason: At each succeeding element down a group, the number of shells increases, so the distance of the valence shell from the nucleus increases, the effective nuclear force of attraction decreases on the last shell, so it becomes easy for the atom to lose electrons. 1

(ii) Decreases in a period from left to right. $\frac{1}{2}$

Reason: As the effective nuclear charge on the valence electron increases, the attraction between the valence electron and nucleus increases, so it becomes difficult to lose electrons.

[CBSE Marking Scheme, 2016] 1

Q. 10. (i) Name the element with atomic number 17.

(ii) To which period does it belong?

(iii) To which group does it belong?

(iv) Write its electronic configuration.

[Board Term II, Delhi, 2016]

Ans. (i) Chlorine $\frac{1}{2}$

(ii) 3rd period 1

- (iii) 17th group 1
(iv) 2, 8, 7. [CBSE Marking Scheme, 2016] ½

Q. 11. 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:

- (i) Number of electrons in their atoms
(ii) Size of their atoms
(iii) Their tendencies to lose electrons
(iv) The formula of their oxides
(v) Their metallic character
(vi) The formula of their chlorides.

[C] [Board Term II, Delhi Set III, 2016]

Ans.	Sr. No.	Characteristics	A	B
	(i)	Number of electrons in their atoms	12	13
	(ii)	Size of their atoms	Bigger	Smaller
	(iii)	Their tendencies to lose electrons	More	Less
	(iv)	The formula of their oxides	AO	B ₂ O ₃
	(v)	Their metallic character	More metallic	Less metallic
	(vi)	The formula of their chlorides	ACl ₂	BCl ₃

[CBSE Marking Scheme, 2016] 6 × ½ = 3

Q. 12. 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 for any of the above said element. [R] [Board Term II, Delhi Set II, 2016]

- Ans. (i) Two elements of group 1 are Na, K / Sodium, potassium. 2 × ½
Electronic configurations Na = 2,8,1; K = 2,8,8,1 2 × ½
(ii) **Similarity:** Both have one valence electron / One electron in outermost shell. ½
(iii) **Oxide** – Na₂O / K₂O. ½

[CBSE Marking Scheme, 2016]

Q. 13. 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'.

[U] [Board Term II, O.D. Set I, 2016]

- Ans. Atomic number of X = Mass number of X – No. of neutrons ½
= 35 – 18 = 17 ½
Therefore, Electronic configuration of
X = 2, 8, 7 ½
Group number = 17 ½
Period = 3
Valency = 8 – 7 = 1 ½ + ½

[CBSE Marking Scheme, 2016]

Q. 14. 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.	Elements	
2	Li(3)	Be(4)
3	Na(11)	Mg(12)
4	K(19)	Ca(20)
5	Rb(37)	Sr(38)

- (i) State 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.

[A] [Board Term II, O.D. Set III, 2016]

- Ans. (i) Ca = 2, 8, 8, 2 ½
(ii) Valence electrons in Rb = 1 ½
(iii) Five ½
(iv) Metal ½
(v) Rb is biggest in size ½
(vi) Be < Mg < Ca < Rb. ½

[CBSE Marking Scheme, 2016]

Q. 15. Four elements A, B, C and D have atomic numbers 12, 13, 14 and 15 respectively.

Answer the following questions giving reasons:

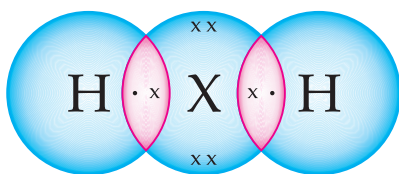
- (i) What is the number of valence electrons and valency of D?
(ii) Which of them will have largest atomic radii?
(iii) Which of these elements will form the most basic oxide? [AE] [Board Term II, SQP, 2016]

- Ans. (i) Valence electrons in 'D' = 5 and Valency of 'D' = 3. 1
(ii) 'A' will have largest atomic radii because atomic radius decreases across a period from left to right. 1
(iii) 'A' will form the most basic oxide as it is most metallic. [CBSE Marking Scheme, 2016] 1

Q. 16. 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 OD 2016]

- Ans. (a) Electronic Configuration of X - 2,8,6
Valence electrons - 6
Valency = 8 - 6 = 2
(b) Formula with hydrogen- H₂X or H₂S



(c) Sulphur; Non-metal

Q. 17. An element 'M' with electronic configuration (2, 8, 2) combines separately with $(\text{NO}_3)^-$, $(\text{SO}_4)^{2-}$ and $(\text{PO}_4)^{3-}$ radicals. Write the formula of the three compounds so formed. To which group and period of the Modern Periodic Table does the elements 'M' belong? Will 'M' form covalent or ionic compounds? Give reason to justify your answer.

[CBSE Delhi 2016]

Ans. The electronic configuration (2, 8, 2) of the element 'M' suggests that it belongs to group 2 and period 3 of the Modern Periodic Table and its valency is 2. The chemical formula of the compounds are:
 $\text{M}(\text{NO}_3)_2$ / $\text{Mg}(\text{NO}_3)_2$; MSO_4 / MgSO_4 ; $\text{M}_3(\text{PO}_4)_2$
 'M' will form ionic compounds by losing two electrons

Q. 18. In the following table, the positions of six elements A, B, C, D, E and F are given as they are in the Modern Periodic Table:

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

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

- Name the element which forms only covalent compounds.
- Name the element which is a metal with valency three.
- Name the element which is a non-metal with valency three.
- Out of B and C, whose atomic radius is bigger and why?
- Write the common name for the family to which the elements D and F belong.

[AE] [Board Term II, Delhi Set III, 2015]

Ans. (i) E $\frac{1}{2}$
 (ii) B $\frac{1}{2}$

- C $\frac{1}{2}$
- B, because atomic radius decreases from left to right due to increase in the nuclear charge. 1
- Noble gases. $\frac{1}{2}$

[AI] Q. 19. The elements ${}_4\text{Be}$, ${}_{12}\text{Mg}$ and ${}_{20}\text{Ca}$ 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,

- In which group should they be?
- Which one of them is least reactive?
- Which one of them has the largest atomic size?

[U] [Board Term II, O.D. Set-I, 2015]

Ans. (i) They all belong to group 2 because all three have 2 electrons in their outermost shell.

(ii) Be is least reactive because it has 2 shells and due to more nuclear charge it is not easy to take electrons from it.

(iii) Ca is the element having largest atomic radius because it has 4 shells. 1+1+1

[CBSE Marking Scheme, 2015]

COMMONLY MADE ERROR

- ➔ Usually students get confused with element arranged in groups and periods in the periodic table and their periodic properties.

ANSWERING TIPS

- ➔ Basically students should understand the basic concept of how the elements are arranged in the periodic table, across the period and down the group, their electronic configurations, stability, reactivity, family and other properties. Then they should recollect the element in the modern periodic table and answer the questions.



Long Answer Type Questions

5 marks each

[AI] Q. 1. (a) List any three observations which posed a challenge to Mendeleev's Periodic Law.
 (b) How does the metallic character of elements vary on moving from
 (i) left to right in a period,
 (ii) From top to bottom in a period of the Modern Periodic Table? Given reason for your answer.

[R] [Board Outside Delhi, Set-I, 2019]

Ans. (a) (i) No fixed position of H in the periodic table. 1
 (ii) Position of isotopes not clear. 1
 (iii) Atomic mass does not increase in a regular manner. (or any other) 1
 (b) (i) Left to right metallic character decreases $\frac{1}{2}$

Reason: Effective nuclear charge increases / tendency to lose electrons decrease / electropositivity decreases (any one reason) $\frac{1}{2}$

- (ii) Top to bottom metallic character increases $\frac{1}{2}$
Reason: Size of atom increase / tendency to lose electron increases (any one reason) $\frac{1}{2}$

[CBSE Marking Scheme, 2019]

AIQ. 2. 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 respectively in their outermost shells. Write the group numbers in which these elements are placed in the Modern Periodic Table. configuration of the atoms of B and D and the molecular formula of the compound formed when B and D combine.

[A] [Board Outside Delhi, Set-I, 2019]

Ans.	A	B	C	D
	1	3	5	7
• Group no.	1 st	13 th	15 th	17 th
				$\frac{1}{2} \times 4$
• B = 2, 8, 3				D = 2, 8, 7
• BD ₃				1 + 1

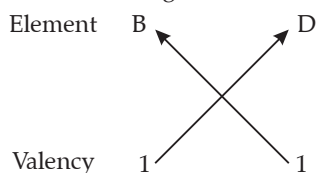
[CBSE Marking Scheme, 2019] 1

Detailed Answer:

Elements	Valence electrons	Period	Group
A	1	3	1
B	3	3	3
C	5	3	5
D	7	3	7

Electronic configuration of B: 2, 8, 3

Electronic configuration of D: 2, 8, 7



So, the molecular formula will be BD₃. 5

Q. 3. 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:

- Variation of valency.
- Change of atomic radius.
- Metallic to non-metallic character.
- Electronegative character.
- Nature of oxides.

[R] + [U] [Comptt. Set I, II, III, 2018]

Ans. (a) Valency first increases, then decreases
(b) Decreases
(c) Increase

- Increases
- Change from basic to acidic

[CBSE Marking Scheme, 2018] 5

Detailed Answer:

- Valency is the combining capacity of an element. Valence electrons are the number of electrons in the outermost shell. Valency and valence electrons are same till the number of outermost electrons is 4, but when it goes beyond 4, then the outermost electrons are subtracted from 8 and valency is determined. Thus valency first increases along the period and then decreases.
- Along the period, from left to right effective nuclear charge increases as the number of protons increase, due to which force of attraction between nucleus and the valence electron increases therefore, atomic radius decreases.
- Along the period, from left to right effective nuclear charge increases as the number of protons increases, due to which force of attraction between nucleus and the valence electron increases thus, it becomes difficult to lose electron across the period and metallic to non-metallic character increases.
- Along the period, from left to right effective nuclear charge increases as the number of protons increases, due to which force of attraction between nucleus and the valence electron increases. Hence the electron from the outermost orbit is difficult to remove, atomic size decreases therefore electronegativity increases.
- Along the period, from left to right effective nuclear charge increases as the number of protons increases, due to which force of attraction between nucleus and the valence electron increases, hence the electron from the outermost orbit is difficult to remove. Therefore, across the period the metallic to non-metallic character increases. So nature of oxide formation across the period changes from basic to acidic.

COMMONLY MADE ERROR

- ➡ Usually students get confused with variation in periodic properties across the period and down the group.

ANSWERING TIPS

- ➡ Students should understand the basic concept of how the elements are arranged in the periodic table, across the period and down the group, their electronic configurations etc. Then they should learn the variation of periodic properties and how it varies.



Visual Case-based Questions

4 marks each

Q. 1. Read the passage and answer any four questions from (a) to (e).

Mendeleev was a Russian chemist, who contributed the most for the development of periodic table of elements wherein the elements were arranged on the basis of their fundamental property, the atomic mass and also on the similarity of chemical properties. Only 63 elements were known at his time. He arranged the 63 elements in the increasing order of their atomic masses and found that there was a periodic recurrence of elements with similar physical and chemical properties. He observed that elements with similar properties fall in the same vertical column. These vertical columns are called groups and horizontal rows of elements are called periods. Mendeleev predicted the existence of certain elements not known at that time and named two of them as Eka-silicon and Eka-aluminium.

- (a) Mendeleev arranged the periodic table on the basis of their fundamental property:
- Atomic mass
 - Atomic number
 - Number of neutrons
 - Valence electrons
- (b) Eka aluminium and eka silicon were later replaced respectively as :
- Germanium and gallium
 - Gallium and scandium
 - Gallium and germanium
 - Germanium and scandium
- (c) The elements eka aluminium and eka silicon discovered by Mendeleev later found place in periodic table. Both of these elements belong to :
- Period 2
 - Group 13
 - Group 14
 - Period 4
- (d) Mendeleev's periodic table has :
- 8 groups and 7 periods
 - 7 groups and 8 periods
 - 7 groups and 7 periods
 - 8 groups and 8 periods
- (e) How do we classify these newly discovered elements (eka-aluminium and eka-silicon)?
- Metals
 - Non metals
 - Metalloids
 - Inert gases

Ans. (a) (i) atomic mass

(b) (iii) Gallium and germanium

(c) (iv) Period 4

(d) (i) 8 groups and 7 periods

(e) (iii) metalloids 1+1+1+1

Q. 2. Using the given part of the periodic table, answer any four questions from (a) to (e).

Group →	1	2	13	14	15	16	17	18
Period ↓								

3	X		B	C	D	E		
4	Y							
5	Z							

(a) Which of these elements have smallest atomic size?

- B
- C
- D
- E

(b) Write valency of element E.

- 1
- 3
- 2
- 0

(c) Identify the elements which have similar chemical properties as the element X.

- Y and Z.
- Y and B
- All Y, Z and B
- None of the above

(d) The number of period that the modern periodic table has

- Seven
- Eight
- Seventeen
- Eighteen

(e) Which of them will have largest atomic radii:

- E
- X
- C
- D

Ans. (a) (iv) Element: E

(b) (iii) 2

(c) (i) Y and Z

(d) (ii) Seven

(e) (ii) Atomic radii decrease across a period, so A will have largest atomic radius. 1+1+1+1

Q. 3. Read the passage and answer any four questions from (a) to (e).

Atoms of eight elements A, B, C, D, E, F, G and H have the same number of electronic shells but are different in their outermost shells. It was found that elements A and G combine to form an ionic compound which can also be extracted from sea water. Oxides of the elements A and B are basic in nature while those of E and F are acidic. The oxide of elements D is almost neutral.

(a) Which of the following is likely to be halogen?

- D
- G
- H
- A

(b) Which one of the following elements is likely to be a noble gas?

- A
- H
- D
- F

(c) Which two elements amongst these are likely to be the non-metals?

- A and G
- D and F
- E and F
- A and B

(d) Which one of the following will have largest atomic radii?

- A
- H
- G
- B

(e) To which period the listed elements belong?

- (i) 2nd (ii) 7th
(iii) 8th (iv) 3rd

Ans. (a) (ii) G

(b) (ii) H

(c) (iii) E and F

(d) (i) A

(e) (iv) 3rd 1+1+1+1

Q. 4. From the following part of the periodic table, answer any four from (a) to (e):

1	2	13	14	15	16	17
Lithium			Carbon		Oxygen	Fluorine
X			P			Q
Y						R
Z						T

(a) Which is the most reactive metal ?

- (i) Lithium (ii) X
(iii) Y (iv) Z

(b) Name the family of fluorine Q, R, T:

(i) Alkali metals

(ii) Noble gas

(iii) Halogens

(iv) Alkaline metals

(c) Which of the following element belongs to group 2?

- (i) Sodium (ii) Magnesium
(iii) Aluminium (iv) Carbon

(d) Which other element is likely to present in the group in which fluorine is present:

- (i) Neon (ii) Aluminium
(iii) Chlorine (iv) None of the above

(e) Name the element P placed below Carbon in group 14:

- (i) Aluminium (ii) Silicon
(iii) Phosphorus (iv) Sulphur

Ans. (a) (iv) Z

(b) (iii) Halogens

(c) (i) Magnesium

(d) (iii) Chlorine

(e) (ii) Silicon

1+1+1+1



Know the Terms

- **Groups:** The 18 vertical columns in modern periodic table are known as groups.
- **Periods:** 7 horizontal rows in modern periodic table are called periods.
- **Periodicity:** 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.
- **Atomic Radius:** Atomic radius is defined as the distance from the centre of the nucleus of an atom to the outermost shell of electrons.
- **Covalent Radii:** It is defined as half of the distance between the centre of nuclei of two atoms (bond length) bonded by a single covalent bond *e.g.*, bond length in case of H—H is 74 pm.
- **Covalent radius:** It can be measured in case of diatomic molecules of non-metals.
- **Metallic Radii:** It is defined as half of the internuclear distance between the two metal ions in a metallic crystal.
- **Metalloids:** Those elements which resemble both metals and non-metals are called metalloids. They are also called semi-metals. *e.g.*, Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium and Polonium.
- **Isotopes:** Elements which have same atomic number but different mass number are called isotopes.

SELF ASSESSMENT TEST - 1

Maximum Time: 1 hour

MM: 25

- Q. 1. Write two reasons responsible for late discovery of noble gases. 1
- Q. 2. The atomic masses of Lithium and potassium are 7 and 39 respectively. If Lithium, sodium and potassium forms Dobereiner's triad, what will be the atomic mass of sodium. 1
- Q. 3. Name the scientist who first of all showed that atomic number of an element is a more fundamental property than its atomic mass? 1

Q. 4. Directions :

For question numbers 14-16, two statements are given- one labelled Assertion (A) and the other labelled 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 the correct explanation of the assertion.
 (c) A is true but R is false.
 (d) A is false but R is true

Assertion: According to Mendeleev's periodic law, the properties of elements is the periodic function of their atomic numbers.

Reason : Mendeleev's periodic law could not explain the phenomena of anomalous pair. 1

- Q. 5. (a) What were the limitations of Dobereiner's triad? 1
 (b) Why did Mendeleev leave some gaps in his periodic table? 2
- Q. 6. In the following table, six elements represented as A, B, C, D, E and F of the Modern Periodic Table with atomic numbers 3 to 18 are given: 2

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

Study the table and answer the questions followed:

Which of these (A to F) represents:

- (a) Noble Gas and Halogen.
 (b) If B combines with F, what will be the formula?
- Q. 7. Mention any two trends exhibited by elements when we go from left to right across the period of periodic table. 2
- Q. 8. 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 for any of the above said element. 3
- Q. 9. State the main aim of classifying elements. Which is more fundamental property of elements that is used in the development of Modern Periodic Table? Name and state the law based on this fundamental property. On which side of the periodic table one can find metals, non-metals and metalloids? 3
- Q. 10. Using the given part of the periodic table, answer any four questions given below with reason: (Any 4)

Group → Period ↓	1	2	13	14	15	16	17	18
3	X		B	C	D	E		
4	Y							
5	Z							

- (a) Which of these elements have smallest atomic size? 1
- (i) B (ii) C
 (iii) D (iv) E

- (b) Write valency of element E. 1
- | | |
|---------|--------|
| (i) 1 | (ii) 3 |
| (iii) 2 | (iv) 0 |
- (c) Identify the elements which have similar chemical properties as the element X 1
- | | |
|----------------------|------------------------|
| (i) Y and Z | (ii) Y and B |
| (iii) All Y, Z and B | (iv) None of the above |
- (d) The number of period that the modern periodic table has : 1
- | | |
|-----------------|---------------|
| (i) Eight | (ii) Seven |
| (iii) Seventeen | (iv) Eighteen |
- (e) Which of them will have largest atomic radii: 1
- | | |
|---------|--------|
| (i) E | (ii) X |
| (iii) C | (iv) D |

Q. 11. The Electronic configuration of element 'X' is 2, 8, 8, 2. 5

- (a) State the period and group of modern periodic table to which it belongs.
 (b) What will be its valency?
 (c) Is it a metal or non-metal?
 (d) Write the formula of its oxide.

Justify all the answers given.