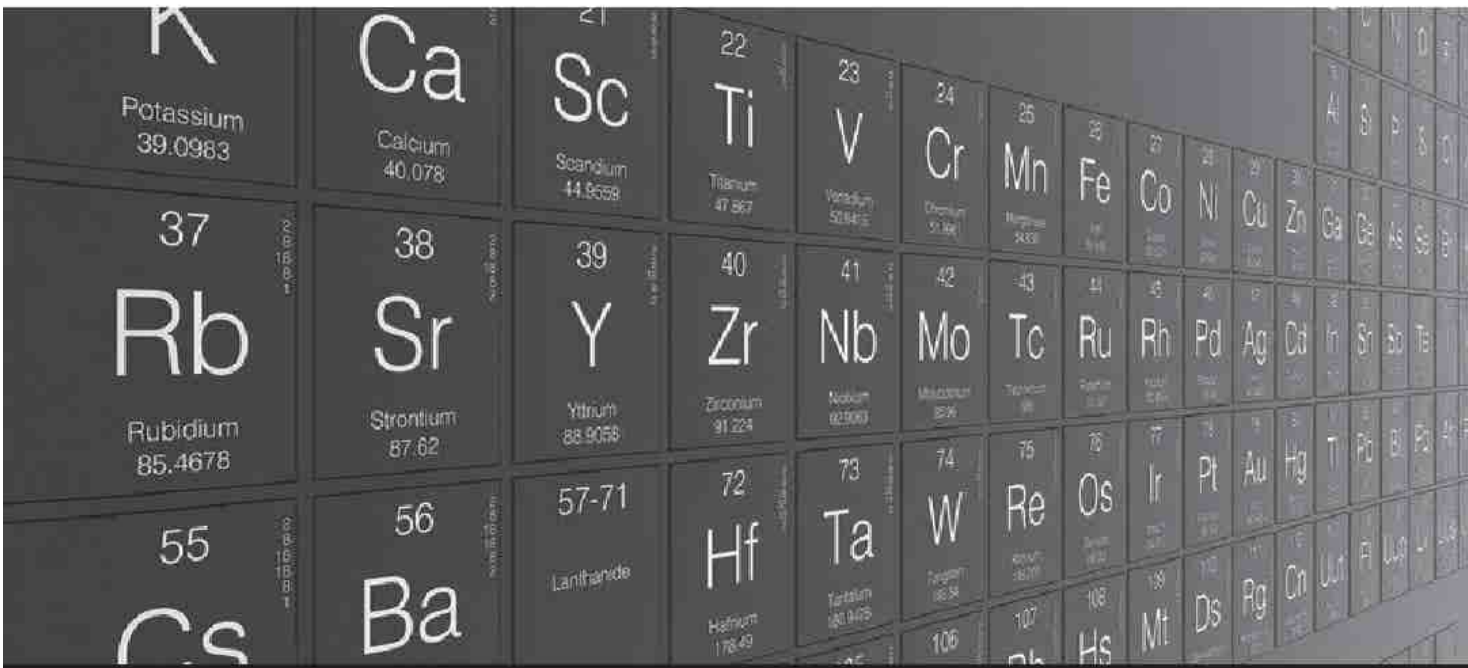
5 Periodic Classification of Elements



Scientists regularly refer to the periodic table to get information about an element, like atomic mass and chemical symbol. The element arrangement also allows scientists to discern trends in element properties, including atomic radius and electronegativity.

Topic Notes

- *Early Attempts at Classification of Elements*
- *Mendeléev's Periodic Table*
- *The Modern Periodic Table*

EARLY ATTEMPTS AT CLASSIFICATION OF ELEMENTS

The number of elements known to us is around 118. But around the year 1800, only 30 elements were known and their properties were also not known much. With the discovery of more elements, scientists gathered more and more information about the properties of these elements and looked for ways to organize them on the basis of similarities in their properties.

The earliest attempt to classify the elements resulted in grouping the then known elements as metals and non-metals. Later further classifications were tried out as our knowledge of elements and their properties increased.

Döbereiner's Triads

In the year 1817, Johann Wolfgang Döbereiner, a German chemist, identified some groups having three elements each which he called 'triads'.

Döbereiner showed that when the three elements in a triad were written in the order of increasing atomic masses, the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements.

Döbereiner's Triads				
Group	**Elements and their Atomic Mass**			**Arithmetic mean of Atomic mass**
A	Lithium (Li)	Sodium (Na)	Potassium (K)	$\frac{6.9 + 39.0}{2} = 22.95$ or 23.0
	6.9	23.0	39.0	
B	Calcium (Ca)	Strontium (Sr)	Barium (Ba)	$\frac{40.0 + 137.0}{2} = 88.5$
	40.0	87.5	137.0	
C	Chlorine (Cl)	Bromine (Br)	Iodine(I)	$\frac{35.02 + 127.0}{2} = 81.0$
	35.0	80.0	127.0	

Example: Consider the triad consisting of lithium (Li), sodium (Na) and potassium (K) with the respective atomic masses 6.9, 23.0 and 39.0. The atomic mass of sodium (23) is the mean of the masses of lithium and potassium.

Achievements of Döbereiner's Triads

This was a great step in predicting atomic mass and properties of middle element. The triads identified by Döbereiner are placed in the same group even in the Modern Periodic Table.

Example 1. What were the limitations of Döbereiner's classification? [NCERT]

Ans. All the elements discovered at that time could not be grouped into triads as Döbereiner could identify only three triads from amongst the elements known at that time.

Take the example of N, P and As. Atomic mass of P (31.0) is not an arithmetic mean of atomic masses of N (14.0) and As (74.9), which is 44.4.

Newlands' Law of Octaves

In 1866, John Newlands, an English scientist, arranged the then known elements in the order of increasing atomic masses. He started with the element having the lowest atomic mass (hydrogen) and ended at thorium which was the 56th element.

He found that every eighth element had properties similar to that of the first. He compared this to the octaves found in music. Therefore, he called it the 'Law of Octaves'. It is known as 'Newlands' Law of Octaves'. In Newlands' Octaves, the properties of lithium and sodium were found to be the same. Sodium is the eighth element after lithium. Similarly, beryllium and magnesium resemble each other.

Newlands' 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	Zm	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	—	—

(1) 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.

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

(3) In order to fit elements into his Table, Newlands adjusted two elements in the same slot, but also put some unlike elements under the same note.

Example:

- Cobalt and nickel are in the same slot and these are placed in the same column as different properties than these elements.
- Iron, which resembles cobalt and nickel in properties, has been placed far away from these elements.

(4) Newlands' Law of Octaves worked well with lighter elements only.

Example 2. Did Döbereiner's triads also exist in the columns of Newlands' Octaves? Compare and find out.

Ans. Yes, Döbereiner's triads also exists in the columns of Newlands' Octaves. For example, Li, Na and K form Döbereiner's triads and they also exist in Newland's octaves under the same note or column.

TOPIC 2

MENDELÉEV'S PERIODIC TABLE

The main credit for classifying elements goes to Dmitri Ivanovich Mendeléev, a Russian chemist. He was the most important contributor to the early development of a 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.

(1) When Mendeléev started his work, 63 elements were known.

(2) He examined the relationship between the atomic masses of the elements and their physical and chemical properties.

(3) Among chemical properties, Mendeléev concentrated on the compounds formed by elements with oxygen and hydrogen.

(4) 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.

(5) He then took 63 cards and on each card he wrote down the properties of one element.

(6) He sorted out the elements with similar properties and pinned the cards together on a wall.

(7) 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.

(8) It was also observed that there occurs a periodic recurrence of elements with similar physical and chemical properties.

Mendeléev Periodic Law: 'The properties of elements are the periodic function of their atomic masses'.

Group	I	II	III	IV	V	VI	VII	VIII
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_3	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
Periods ↓	A B	A B	A B	A B	A B	A B	A B	Transition sries
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453	
4 First series: Second series	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 47.90 As 74.92	Cr 50.94 Se 78.96	Mn 54.94 Br 79.909	Fe Co Ni 55.85 58.93 58.71

series: 85.47	87.62	88.91	91.22	92.91	95.94	99		101.07	102.91	106.4
Second series Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90				
6 First series: Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 18095	W 183.85			Os 190.2	Ir 192.21	Pt 195.09
Second series Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98						

Features of Mendeléev's Periodic Table

(1) Mendeléev's Periodic Table contains vertical columns called 'groups' and horizontal rows called 'periods'.

(2) This table contains 8 groups and 6 periods.

(3) The formula for oxides and hydrides are written at the top of the columns of Mendeléev's periodic table, where the letter 'R' is used to represent any of the elements in the group. For example, the hydride of carbon, CH_4, is written as RH_4 and the oxide CO_2, as RO_2.

Achievements of Mendeléev's Periodic Table

(1) Mendeléev's periodic law predicted the existence of some elements that had not been discovered at that time. Mendeléev left some gaps in his Periodic Table. Mendeléev named them by prefixing a Sanskrit numeral, *Eka* (one) to the name of preceding element in the same group.

For example: Scandium, gallium and germanium, discovered later, have properties similar to Eka-boron, Eka-aluminium and Eka-silicon, respectively.

The properties of Eka-Aluminium predicted by Mendeléev and those of the element, gallium which was discovered later and replaced Eka aluminium, are listed as follows.

Property	Eka-Aluminium (Predicted)	Gallium (Actual)
Atomic Mass	68	69.7
Density	5.9 g/cm^3	5.94 g/cm^3
Melting Point	Low	30.2 °C (Low)
Formula of Chloride	ECl_3	$GaCl_3$
Formula of Oxide	E_2O_3	Ga_2O_3

(2) Mendeléev's periodic table could predict the properties of several elements on the basis of their positions in the periodic table.

(3) It could accommodate noble gases when these gases were discovered in a new group without disturbing the existing order.

Limitations of Mendeléev's Classification

Position of Hydrogen

The electronic configuration of hydrogen resembles that of alkali metals. Like alkali metals, hydrogen combines with halogens, oxygen and sulphur to form compounds having similar formulae. On the other hand, just like halogens, hydrogen also exists as diatomic molecules and it combines with metals and non-metals to form covalent compounds.

Thus, a correct position could not be assigned to hydrogen in the periodic table.

Position of Isotopes

The position of isotopes could not be explained since the elements are arranged according to their atomic masses and isotopes are atoms of the same element having similar chemical properties but different atomic masses.

Compounds of H	Compounds of Na
HCl	NaCl
H_2O	Na_2S
H_2S	Na_2S

Position of isotopes, which were discovered much later, could not be explained as they were placed in the same group.

Wrong Order of Atomic Masses

There were a few instances where Mendeléev had to place an element with a slightly greater atomic mass before an element with a slightly lower atomic mass. The sequence was inverted so that elements with similar properties could be grouped together.

For example, cobalt (atomic mass 58.9) appeared before nickel (atomic mass 58.7).

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

Non-uniform Variation of Atomic Masses

Another problem was that the atomic masses do not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements — especially when we consider the heavier elements.

THE MODERN PERIODIC TABLE

In 1913, Henry Moseley showed that the atomic number of an element is a more fundamental property than its atomic mass. Accordingly, Mendeléev's Periodic Law was modified and atomic number was adopted as the basis of Modern Periodic Table.

Modern Periodic Law: 'Properties of elements are a periodic function of their atomic number.'

Elements, when arranged in order of increasing atomic number, lead us to the classification known as the Modern Periodic Table. Prediction of properties of elements could be made with more precision when elements were arranged on the basis of increasing atomic number.

Note: See the table on the next page.

Features of Modern Periodic Table

The Modern Periodic Table has 18 vertical columns known as 'groups' and 7 horizontal rows known as 'periods'.

Position of Elements in the Modern Periodic Table

In order to find the position of an element in the modern periodic table, the group number and period number of the element is to be found out from its electronic configuration.

Period

(1) The period number of an element is equal to the number of electron shells in its atom.

If an atom has two occupied shells, it will belong to the second period.

(2) The number of elements in a period is fixed by the maximum number of electrons which can be accommodated in the different shells of an atom.

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

Shell Number (n)	Shell	Maximum Number of Electrons
n = 1	K	$2\times(1)^2 = 2$
n = 2	L	$2\times(2)^2 = 8$
n = 3	M	$2\times(3)^2 = 18$

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

(5) If two or more elements have the same number of valence shells, then they belong to the same period of the periodic table.

1^{st} period contains 2 elements and is called very short period.

2^{nd} period contains 8 elements and is called short period.

3^{rd} period contains 8 elements and is called short period.

4^{th} period contains 18 elements and is called long period.

5^{th} period contains 18 elements and is also called long period.

6^{th} period contains 32 elements and is called very long period.

7^{th} period contains rest of the elements and is incomplete.

Groups

(1) The group number of an element having upto two valence electrons is equal to the number of valence electrons.

(2) The group number of an element having more than 2 valence electrons is equal to the number of valence electrons + 10.

Elements having 1 valence electron are placed in Group 1.

Elements having 2 valence electrons are placed in Group 2.

Elements having 3 valence electrons are placed in Group 13.

Elements having 4 valence electrons are placed in Group 14.

Elements having 5 valence electrons are placed in Group 15.

Elements having 6 valence electrons are placed in Group 16.

Elements having 7 valence electrons are placed in Group 17.

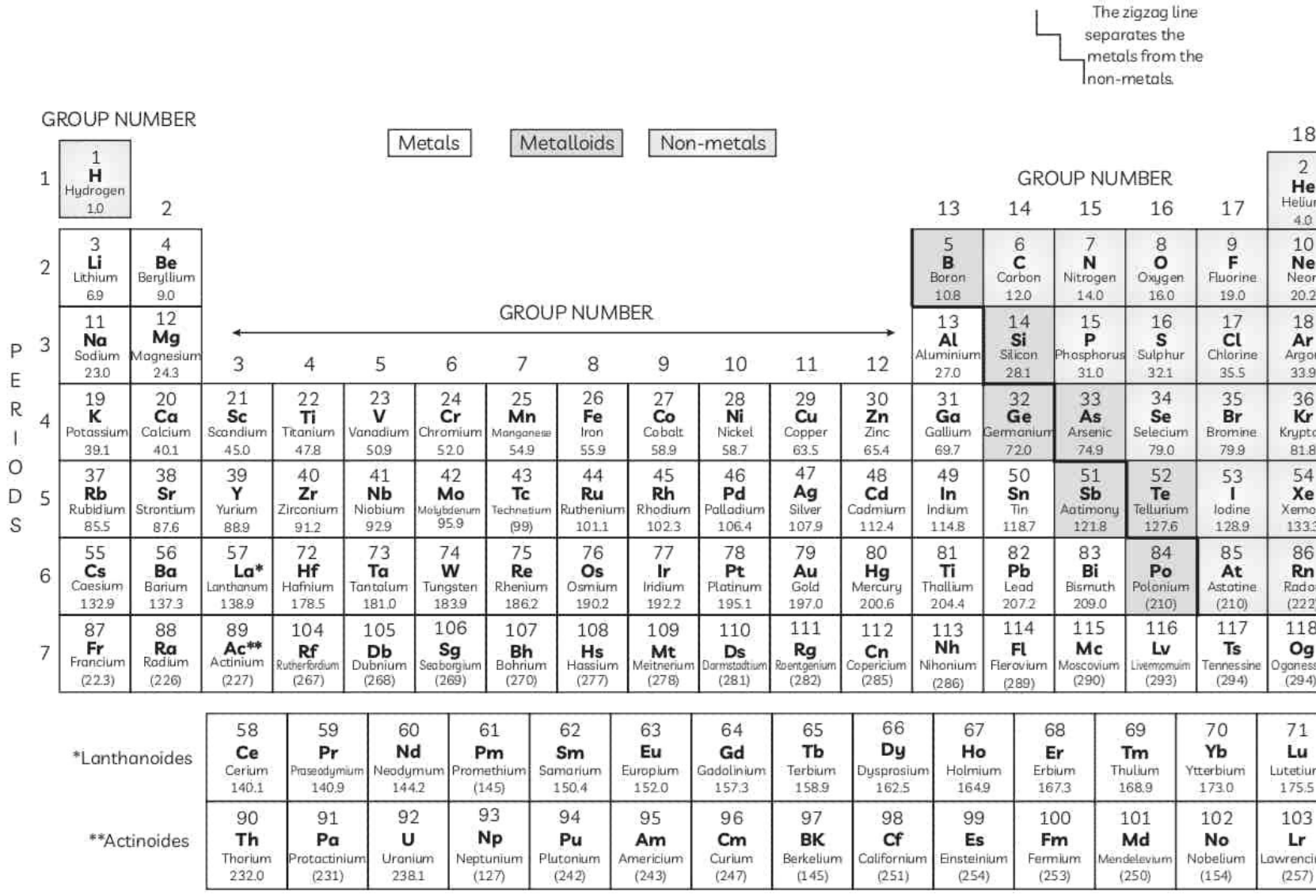
Elements having 8 valence electrons are placed in Group 18.

(3) The elements in a group do not have consecutive atomic numbers.

(4) All the elements in a group have similar electronic configurations and show similar properties. All elements contain the same number of valence electrons. Groups in the Periodic Table signify an identical outer shell electronic configuration.

(5) The number of shells increases as we go down the group.

(6) If two or more elements have the same number of valence electrons, then they belong to the same group of the periodic table.


The zigzag line separates the metals from the non-metals.
GROUP NUMBER
Metals
Metalloids
Non-metals
GROUP NUMBER
PERIODS
1 H Hydrogen 1.0
2 Li Lithium 6.9
Be Beryllium 9.0
Na Sodium 23.0
Mg Magnesium 24.3
K Potassium 39.1
Ca Calcium 40.1
Sc Scandium 45.0
Ti Titanium 47.8
V Vanadium 50.9
Cr Chromium 52.0
Mn Manganese 54.9
Fe Iron 55.9
Co Cobalt 58.9
Ni Nickel 58.7
Cu Copper 63.5
Zn Zinc 65.4
Ga Gallium 69.7
Ge Germanium 72.0
As Arsenic 74.9
Se Selecium 79.0
Br Bromine 79.9
Kr Krypto 81.8
Rb Rubidium 85.5
Sr Strontium 87.6
Y Yurium 88.9
Zr Zirconium 91.2
Nb Niobium 92.9
Mo Molybdenum 95.9
Tc Technetium (99)
Ru Ruthenium 101.1
Rh Rhodium 102.3
Pd Palladium 106.4
Ag Silver 107.9
Cd Cadmium 112.4
In Indium 114.8
Sn Tin 118.7
Sb Aatimony 121.8
Te Tellurium 127.6
I Iodine 128.9
Xe Xeno 133.3
Cs Caesium 132.9
Ba Barium 137.3
La* Lanthanum 138.9
Hf Hafnium 178.5
Ta Tantalum 181.0
W Tungsten 183.9
Re Rhenium 186.2
Os Osmium 190.2
Ir Iridium 192.2
Pt Platinum 195.1
Au Gold 197.0
Hg Mercury 200.6
Tl Thallium 204.4
Pb Lead 207.2
Bi Bismuth 209.0
Po Polonium (210)
At Astatine (210)
Rn Rado (222)
Fr Francium (223)
Ra Radium (226)
Ac** Actinium (227)
Rf Rutherfordium (267)
Db Dubnium (268)
Sg Seaborgium (269)
Bh Bohrium (270)
Hs Hassium (277)
Mt Meitnerium (278)
Ds Darmstadtium (281)
Rg Roentgenium (282)
Cn Copericium (285)
Nh Nihonium (286)
Fl Flerovium (289)
Mc Moscovium (290)
Lv Livermorium (293)
Ts Tennessine (294)
Og Oganess (294)
*Lanthanoides
Ce Cerium 140.1
Pr Praseodymium 140.9
Nd Neodymum 144.2
Pm Promethium (145)
Sm Samarium 150.4
Eu Europium 152.0
Gd Gadolinium 157.3
Tb Terbium 158.9
Dy Dysprosium 162.5
Ho Holmium 164.9
Er Erbium 167.3
Tm Thulium 168.9
Yb Ytterbium 173.0
Lu Lutetiu 175.5
**Actinoides
Th Thorium 232.0
Pa Protactinium (231)
U Uranium 238.1
Np Neptunium (127)
Pu Plutonium (242)
Am Americium (243)
Cm Curium (247)
BK Berkelium (145)
Cf Californium (251)
Es Einsteinium (254)
Fm Fermium (253)
Md Mendelevium (250)
No Nobelium (154)
Lr Lawrenci (257)

A student studied the Modern Periodic Table and tried to find out the names of elements in Group I, their electronic configuration and similarity in their configuration.

If you look at the long form of the Periodic Table, you will find that the elements Li, Be, B, C, N, O, F, and Ne are present in the second period.

[NCERT Activity 5.4, 5.5]

(A) Which of the following statements are incorrect?

(I) The first three elements of Group 1 are H, Li and Na.

(II) Except H, all other elements of Group 1 have one valence electron.

(III) The number of shells remains same on going down the group.

(IV) Groups in the Periodic Table signify an identical outershell electronic configuration.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(B) The number of valence electrons of fluorine and Group number to which it belongs is:

(a) Number of valence electrons = 7, Group Number = 1

(b) Number of valence electrons = 9, Group Number = 7

(c) Number of valence electrons = 1, Group Number = 17

(d) Number of valence electrons = 7, Group Number = 17

(C) Why is the element Be placed in the second period and Al in the third period?

(D) What will be the formula of fluoride of an element E belonging to Group 13 of the Modern Periodic Table?

(E) Assertion (A): All elements in a period have similar properties.

Reason (R): All elements in a group have identical outer shell electronic configuration.

(a) Both (A) and (R) are true and (R) is the 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.

Explanation: Hydrogen has one valence electron, just like other elements of Group 1. As we go down a group, a new shell is added in the atom.

For example, consider the elements Li, Na and K having atomic number 3, 11 and 19 respectively. They belong to group 1 of the Modern periodic table as they have one electron in their valence shell.

Element	Atomic Number	K-shell	L-shell	M-shell	N-shell
Lithium	3	2	1	-	-
Sodium	11	2	8	1	-
Potassium	19	2	8	8	1

As we can see from the above, a new shell is added as we go down a group.

(B) *(d) Number of valence electrons = 7, Group Number = 17*

Explanation: The atomic number of fluorine is 9 and its electronic configuration is (2, 7).

As it has two occupied shells, it is placed in second period and as it has seven valence electrons, it is placed in Group 17 of the Modern periodic table.

(C) *The atomic number of Be is 4 and that of Al is 13.*

The electronic configuration of be is (2, 2) and that of Al is (2, 8, 3).

As Be has two occupied shells and Al has three occupied shells, Be is placed in second period and Al is placed in the third period.

(D) Fluorine has a valency of 1 as it is a halogen and has seven valence electrons. An element E belonging to group 13 has 3 valence electrons and therefore a valency of 3. Therefore, the formula of the compound formed will be EF_3.

(E) *(d) (A) is false, but (R) is true.*

Explanation: Properties of elements are a periodic function of their atomic number as the properties of elements depend upon their electronic configuration. The elements of a period have the same number of occupied shells but different electronic configuration and hence different properties.

However, elements belonging to the same group have identical outer shell electronic configuration and hence they have similar properties.

(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? [NCERT]

Ans. **(A)** The element having two shells, both of which are completely filled will have an electronic configuration of (2, 8). Therefore, the element Neon (Atomic number = 10) has two shells, both of which are completely filled.

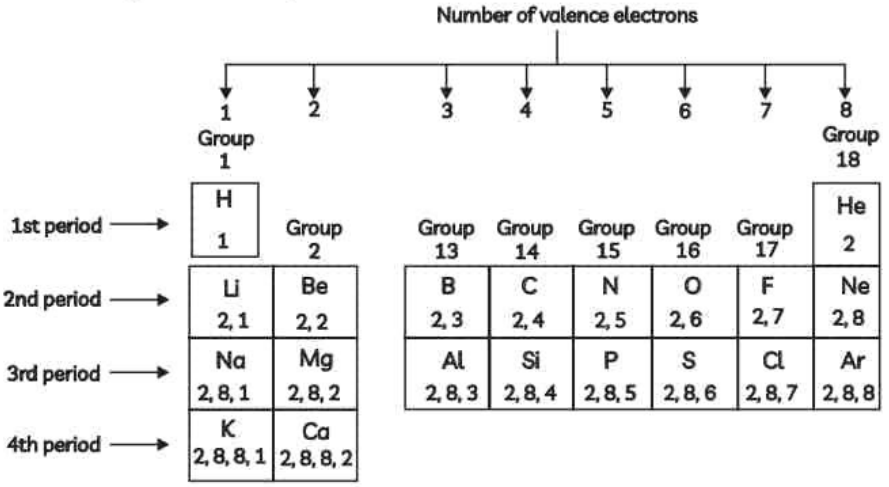
(B) Electronic configuration (2, 8, 2) means that the atomic number of the element is 12, which is that of Magnesium (Mg).

(C) Element having three shells, with four have the electronic configuration 2, 8, 4. Therefore, the atomic number of the element is 14 and the element is silicon which belongs to group 14.

(D) Element having two shells, with three electrons in its valence shell or L shell will have the electronic configuration 2, 3. Therefore, the atomic number of the element is 5 and the element is boron which belongs to group 13.

(E) Element having twice as many electrons in its second shell (L shell) as in its first shell (K shell) will have the electronic configuration 2, 4. Therefore, the atomic number of the element is 6 and the element is carbon which belongs to group 14.

Arrangement of elements in the modern periodic table on the basis of the electronic configurations of their atoms



Position of Hydrogen: There is an anomaly when it comes to the position of hydrogen because it can be placed either in group 1 or group 17 in the first period.

Hydrogen has been placed at the top of Group I, above the alkali metals because the electronic configuration of hydrogen is similar to those of alkali metals. Both have 1 valence electron each. Since the size of hydrogen atom is much smaller than that of alkali metals, many properties of hydrogen are different from those of alkali metals.

Explanation of the Anomalies of Mendeléev's Classification of Elements

(1) **Explanation of the position of hydrogen:** A unique position has been given to hydrogen. It has been placed at the top left corner in group 1, period 1 because of its unique characteristics.

(2) **Explanation for the position of isotopes:** Since all the isotopes of an element have the same atomic number, they are put at one place in the same group of the periodic table.

(3) **Explanation for the Position of Cobalt and Nickel:** Since the elements are arranged according to their atomic number, and the atomic number of cobalt is 27 while that of nickel is 28, so cobalt with lower atomic number should come first and nickel with higher atomic number should come later.

Comparison of Mendeléev's Periodic table and Modern periodic table

Mendeléev's Periodic Table	Modern Periodic Table
Mendeléev's periodic table is based on atomic mass.	Modern periodic table is based on atomic number.

undiscovered elements.	maintains uniformity.
Noble gases were not placed (as they are not discovered at that time)	Noble gases in a separate group named as group-18.
There are a total of 8 groups and 6 periods	There are a total of 18 groups and 7 periods

Example 5. How could the Modern Periodic Table remove various anomalies of Mendeléev's Periodic Table? [NCERT]

Ans. The Modern Periodic Table is based on grouping elements with similar properties on the basis of their atomic numbers, whereas Mendeléev's periodic table was based on atomic masses. This led to certain anomalies, such as position of hydrogen, position of isotopes and the fact that atomic masses do not increase in a regular manner on moving from one element to the next.

(1) Hydrogen has been allotted a unique position, i.e., it is placed at the top of alkali metals in the first group based on similarity in electronic configuration with alkali metals.

(2) The anomaly regarding position of isotopes of an element have been resolved as isotopes of an element have the same atomic number and so they have been allotted the same position in modern periodic table.

(3) The position of Cobalt and nickel is now justified as atomic number of Cobalt is less than atomic number of nickel and hence it is placed at 9^{th} group whereas Nickel is placed at 10^{th} group.

(4) As the elements have been arranged in the order of increasing atomic number, the number of elements lying between any two elements can easily be predicted.

Trends in the Modern Periodic Table

Valency

The valency of an element is its combining capacity with other atoms in order to attain the nearest inert gas configuration. It is related to the number of valence electrons present in the atom of an element.

Variation along a period: On moving from left to right, the valency increases from 1 to 4 and then decreases to 0 from group 15 to 18 as the valency is determined by the number of valence electrons.

Example: Valency of Na (Z = 11) is 1 as its electronic configuration is 2, 8, 1 and it attains its nearest inert gas configuration by losing one electron.

is (2, 6) and it requires two electrons to attain its nearest inert gas configuration.

Variation along a group: All elements in a group have the same valency as elements in the same group have the same number of valence electrons.

Valency of group 1 elements = Number of valence electrons = 1

Valency of group 2 elements = Number of valence electrons = 2

Valency of group 13 elements = Number of valence electrons = 3

Valency of group 14 elements = Number of valence electrons = 4

Valency of group 15 elements = 8 - Number of valence electrons = 3

Valency of group 16 elements = 8 - Number of valence electrons = 2

Valency of group 17 elements = 8 - Number of valence electrons = 1

Valency of group 18 elements = 8 - Number of valence electrons = 0

Example: Elements Li, Na and K belong to group 1 as they all have one valence electron and hence have valency 1.

Li: 2, 1

Na: 2, 8, 1

K: 2, 8, 8, 1

Elements F, Cl and Br belong to group 17 as they as they all have seven valence electrons and hence have valency 1 (8 – 7).

F: 2, 7

Cl: 2, 8, 7

Br: 2, 8, 8, 7

Example 6. 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** **[NCERT]**

Ans. *(b) Mg*

Explanation: As the formula of chloride of element X is XCl_2, and valency of Cl is 1, it means that valency of X is 2. Since metals combine with halogens to form metal halides, X is a metal with valency 2 and hence occupies group 2 of the periodic table.

Out of the elements given Na belongs to group 1, Mg to group 2, Al to Group 13 and Si to group 14 of the periodic table.

Therefore, correct answer is Mg.

(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? [NCERT]

Ans. To find the elements having similar physical and their electronic configuration.

We observe that the elements Mg and Sr also have two valence electrons just like Ca. Therefore, Calcium will have properties similar to both Mg and Sr.

Element	Atomic Number	K-shell	L-shell	M-shell	N-shell	O-shell
Calcium	20	2	8	8	2	-
Magnesium	12	2	8	2	-	-
Potassium	19	2	8	8	1	-
Scandium	21	2	8	8	3	-
Strontium	38	2	8	18	8	2

Atomic size

The size of an atom refers to the radius of atom and is the distance between the centre of the nucleus and the outermost shell of an isolated atom. It is expressed in picometer.

1 picometer = 10^{-12} m

Variation along a period: On moving from left to right in a period, the size of atoms decreases.

Reason: When we move from left to right in a period, the number of electrons and protons increases. Due to the large positive charge on the nucleus, electrons are pulled more strongly towards the nucleus.

Variation along a group: The size of an atom (radius) increases as we go down in a group

Reason: When going from top to bottom in a group, a new shell is added to the atoms which increases the distance between the valence electrons and the nucleus. So, the effective nuclear charge experienced by the valence electrons decreases.

Metallic and Non-metallic Character

Metals are the elements that have 1, 2 or 3 electrons in their valence shell and lose electrons easily to form positive ions or cations. They are present on the left side and centre of the periodic table. They are called electropositive elements as they have a tendency of losing electrons.

Non-Metals are the elements that have 4, 5, 6 or 7 electrons in their valence shell and gain electrons to form negative ions or anions. They are present on the right side of the periodic table. They are called electronegative elements as they have a tendency of gaining electrons.

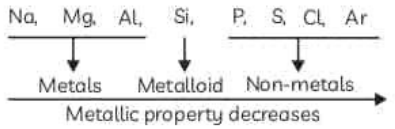
Metalloids: There are some elements known as metalloids that exhibit properties of both metals and non-metals.

In the Modern Periodic Table, a zig-zag line separates metals from non-metals. The border line elements – boron, silicon, germanium, arsenic, antimony, tellurium and polonium – are intermediate in properties and are called metalloids or semi-metals.

Variation along a period: The metallic character decreases and non-metallic character increases as we move from left to right in a period.

Reason: When we move from left to right in a period, the electropositive character of elements decreases, but the electronegative character increases. Due to the large positive charge on the nucleus, electrons are pulled more strongly towards the nucleus.

Example: Consider the elements of 3rd period. The variation of metallic character is shown below:



Variation along a group: The metallic character increases and non-metallic character decreases as we move from top to bottom in a group.

Reason: When we go down a group, the electropositive character of elements increases as the tendency of an atom to lose electrons increases as the effective nuclear charge experienced by the valence electrons decrease. The electronegative character decreases down a group as the tendency to gain electrons decreases.

Example 8. Case Based:

Let us study how the tendency to lose electrons will change in a group and how this tendency will change in a period.

In the periodic table, study the change in the tendency to gain electrons as we go from left to right across a period and as we go down a group.

[NCERT Activity 5.10, 5.11]

(A) Group 1 elements when, arranged in increasing order of their reactivity is:

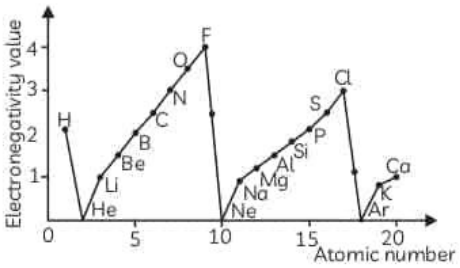
(a) Na < Li < K < Rb < Cs

(b) Cs < Rb < K < Na < Li

(c) Li < Na < K < Rb < Cs

(d) K < Na < Li < Rb < Cs

the first 20 elements is shown below:



Study the graph above and select the correct statement:

(I) The alkali metals are the most electronegative elements in a period.

(II) The electronegativity increases as we go down a group

(III) The electronegativity increases as we move from left to right along a period.

(IV) In a given period, the halogens are the most electronegative elements.

(a) Both (I) and (III)

(b) Both (I) and (IV)

(c) Both (II) and (IV)

(d) Both (III) and (IV)

(C) What happens to tendency to gain electron down the group and why?

(D) Arrange the elements F, Cl, Br and I in increasing order of reactivity.

(E) Assertion (A): The tendency to lose electrons decreases as we go from left to right in a period.

Reason (R): The effective nuclear charge acting on the valence shell electrons increases across a period.

(a) Both (A) and (R) are true and (R) is the 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.

Ans. **(A)** *(c) Li < Na < K < Rb < Cs*

Explanation: The reactivity of a metal depends upon its electropositivity, i.e., its ability to form cations by losing electrons. As we move down a group, a new shell is added in the atom and the outermost electrons are farther away from the nucleus due to which the effective nuclear charge experienced by valence electrons decreases. Therefore, an atom can easily lose down a group. As Li is at the top of Group 1 and Cs is at the bottom of the group, Cs is more reactive than Li and reactivity increases from top to bottom in a group.

(B) *(d) Both (III) and (IV)*

Explanation: As we move from left to right along a period, the electro negativity increases as the ability of atoms to gain electrons increases due to decrease in atomic size. This is due to the increase in effective nuclear charge as electrons are added in the same shell in a period. Since halogens are in group 17, they are the most electronegative elements in a period and alkali elements are the most electro positive elements in a period. The electronegativity decreases as we move from top to bottom in a group which is due to the decrease in the effective nuclear charge experienced by valence electrons due to increase in atomic size.

(C) The tendency to gain electron decreases down a group because as the atomic size increases, the effective nuclear charge experienced by valence electrons decreases as the outermost electrons are farther away from the nucleus.

(D) *I < Br < Cl < F.*

Explanation: The elements F, Cl, Br and I belong to Group 17 of the modern periodic table.

The electronic configuration of F, Cl, Br and I is given below:

Element	Atomic Number	K-shell	L-shell	M-shell	N-shell	O-shell
F	9	2	7	-	-	-
Cl	17	2	8	7	-	-
Br	35	2	8	18	7	-
I	53	2	8	18	18	7

We observe that a new shell is added when we move down the group due to which the effective nuclear charge experienced by the valence electrons decreases and hence reactivity decreases.

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

Example 9. 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 [NCERT]

2^{nd} group of the periodic table. Whereas the elements Ga, Ge, As and Se are placed in 4^{th} period, group 13 to 16 respectively.

As the metals are placed on the left side of the periodic table and non-metals on the right side, we can say that Be is the most metallic of these elements.

Example 10. 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? [NCERT]

Ans. The electronic configuration of the elements is given below:

Element	Atomic Number	K-shell	L-shell	M-shell
Nitrogen	7	2	5	-
Phosphorus	15	2	8	5

Electronegativity is the ability to gain electrons. Nitrogen will be more electronegative than phosphorus as nitrogen has smaller atomic size than phosphorus as it has 2 shells whereas phosphorus has three shells. As the number of shells increases, the distance between the nucleus and valence shell increases due to which it becomes more difficult for an atom to gain electrons.

Chemical Reactivity

The chemical reactivity of an element depends upon the electronic configuration of the atom of the element.

Variation along a period: The chemical reactivity of elements first decreases and then increases when we move from left to right in a period.

Variation along a group: The chemical reactivity of metals increases on going down in a group.

The chemical reactivity of non-metals decreases on going down in a group.

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

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

Ans. (A) Yes, Li, Na and K belong to group 1 of the modern periodic table as atoms of all these metals have one valence electron in their outermost shell.

is 2, 1

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

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

(B) Both He and Ne are inert gases and have a completely filled valence shell which explains their chemical inertness.

Electronic configuration of He (Atomic Number = 2): 2

Electronic configuration of Ne (Atomic Number = 10): 2, 8

Nature of Oxides

Variation along a period: The basic nature of oxides decreases and the acidic nature increases as we move from left to right as metal oxides are basic in nature and oxides of non-metals are acidic in nature.

Variation along a group: There is no change in the nature of oxides as we go down in a group as all elements of the same group have similar chemical nature.

Example 12. 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. [NCERT]

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

Explanation: On moving from left to right along a period, the metallic character decreases. This is because when we move from left to right in a period, the tendency to lose electrons decreases as the effective nuclear charge on the valence electrons increases.

However, the number of valence electrons increases and the non-metallic character also increases because of the increase in the electronegativity. Further, oxides of non-metals are acidic whereas metal oxides are basic in nature.

Example 13. The position of three elements A, B and C in the Periodic Table are shown below:

Group 16	Group 17
-	-
-	A
-	-
B	C

(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? [NCERT]

Ans. **(A)** Since A belongs to group 17 and the number of valence electrons is 7, it has a valency of 1 it will gain one electron to complete its octet. Therefore, A is a non-metal.

(B) C is less reactive than A because as we move down in a group, the reactivity of non-metals decreases. This is because, as we move in a group, the atomic size increases as a new shell is added due to which the distance between the nucleus and valence electrons increases and hence electronegativity decreases.

(C) C is smaller in size than B because B and C both are placed in the same period and the size decreases as one moves from left to right in a period due to increase in effective nuclear charge.

(D) A will form anion because it is a non-metal and will gain one electron to complete its octet.

(1) It is based on the atomic number of elements which is the most fundamental property of elements.

(2) It helps us understand why elements in a group show similar properties but elements in different groups show different properties.

(3) It explains the reasons for the periodicity in properties of elements.

(4) The modern periodic table tells us why the properties of elements are repeated after 2, 8, 18 and 32 elements.

(5) There are no anomalies in the arrangement of elements in the modern periodic table.

Advantages of the Periodic Table

(1) The periodic table has made the study of chemistry systematic and easy.

(2) It is easier to remember the properties of an element if its position in the periodic table is known.

(3) The type of compounds formed by an element can be predicted by knowing its position in the periodic table.

(4) A periodic table chart is used as a teaching aid in chemistry in schools and colleges.

OBJECTIVE Type Questions

[1 mark]

Multiple Choice Questions

1. Which of the following statement(s) about the modern periodic table are incorrect?

(I) The elements in the modern periodic table are arranged on the basis of their decreasing atomic numbers.

(II) The elements in the modern periodic table are arranged on the basis of their increasing atomic masses.

(III) Isotopes are placed in adjoining group(s) in the periodic table.

(IV) The elements in the modern periodic table are arranged on the basis of their increasing atomic number.

(a) Only (I) **(b) (I), (II) and (III)**

(c) (I), (II) and (IV) **(d) Only (IV)**

[CBSE 2014]

Ans. *(b) (I), (II) and (III)*

Explanation: The modern periodic table is a tabular arrangement of elements in increasing order of their atomic number, which is why

only (III) is correct.

2. **Which of the following statements about the modern periodic table is correct?**

(a) It has 18 horizontal rows known as periods.

(b) It has 7 vertical columns rows known as periods.

(c) It has 18 vertical columns known as groups.

(d) It has 7 horizontal rows known as groups.

[CBSE 2014]

3. **An element *X* is forming acidic oxide. Its most probable position in the modern periodic table is:**

(a) Group 1 and Period 3

(b) Group 16 and Period 3

(c) Group 17 and Period 3

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

4. **Which of the given elements A, B, C, D and E with atomic number 2, 3, 7, 10 and 30 respectively belong to the same period?**

(a) A, B, C **(b) B, C, D**

(c) A, D, E **(d) B, D, E**

[NCERT Exemplar]

5. **On the basis of electronic configuration of X^{9}_{5}, the group number and period of the element 'X' is:**

(a) Group 15 period 2

(b) Group 13 period 2

(c) Group 9 period 5

(d) Group 13 period 5 **[CBSE 2020]**

Ans. *(b) Group 13 period 2*

Explanation: From X^{9}_{5}, we can have the information as :

X — element

5 — Atomic number

9 — Mass number

Electronic configuration of *X* is 2, 3.

Group number is found out on the basis of valance electrons. Valence electrons are 3 so group number is 10 + 3 = 13.

Period can be found out by knowing the number of shells. Since number of shells are 2 so it belongs to period 2.

6. **The elements A, B, C, D and E have atomic number 9, 11, 17, 12 and 13 respectively. Which of these belong to the same group?**

(a) A and B **(b) B and D**

(c) A and C **(d) D and E** **[NCERT]**

7. **An element 'X' with atomic number 11 forms a compound with element 'Y' with atomic number 8. The formula of the compound formed is:**

(a) *XY* **(b) X_2Y**

(c) XY_2 **(d) X_2Y_3** **[CBSE 2020]**

Ans. *(b) X_2Y*

Element	Atomic Number	Electronic Configulation	Valence Electron
X	11	2, 8, 1	1
Y	8	2, 6	6

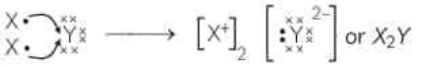
Element *X* can lose one electron and has the configuration like that of Neon.

$$X \longrightarrow X^{+} + e^{-}$$

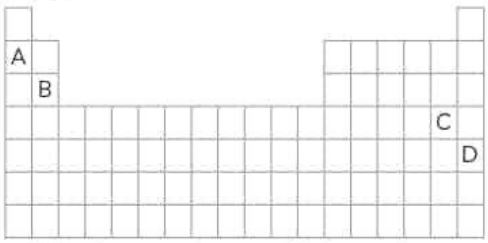
Element *Y* can gain two electrons to acquire noble gas configuration like that of Neon:

$$Y + 2e^{-} \longrightarrow Y^{2-}$$

Or we can write



8. **The positions of four elements *A*, *B*, *C* and *D* in the modern periodic table are shown below.**



Which element is most likely to form an acidic oxide?

(a) *A* **(b) *B***

(c) *C* **(d) *D***

9. **In Mendeléev's periodic table, gaps were left for the elements to be discovered later. Which of the following element found a place in the periodic table later?**

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

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

10. **Elements *P*, *Q*, *R* and *S* have atomic numbers 11, 15, 17 and 18 respectively. Which of them are reactive non-metals?**

(a) *P* and *Q* **(b) *P* and *R***

(c) *Q* and *R* **(d) *R* and *S***

[CBSE Marking Scheme 2019]

11. An element which is an essential constituent of all organic compounds belongs to:

(a) Group 1 (b) Group 14

(c) Group 15 (d) Group 16

[NCERT Exemplar]

12. According to Mendeléev'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

Ans. *(c) Increasing atomic masses*

Explanation: The Mendeléev's periodic law is an arrangement of elements in increasing order of their atomic masses as Mendeléev's periodic law states that, the physical and chemical properties of elements are a periodic function of their atomic masses.

13. 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]

14. Which of the following gives the correct increasing order of the atomic radii of O, F and N?

(a) O, F, N (b) N, F, O

(c) O, N, F (d) F, O, N

[CBSE 2014]

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

(a) Cl > Si > Al > Mg > Na

(b) Na > Mg > Al > Si > Cl

(c) Na > Al > Mg > Cl > Si

(d) Al > Na > Si > Ca > Mg

16. Which among the following elements has the largest atomic radii?

(a) Na (b) Mg

(c) K (d) Ca

[NCERT Exemplar]

Ans. *(c) K*

Explanation: Na and Mg belong to the same period, whereas Na and K are in the same group. In a group from top to bottom, the in a period from left to right. Hence, the order would be K > Na > Mg and K > Ca > Mg.

Related Theory

- *Atomic radius represents the distance from the nucleus to the outer shell of an element.*
- *Trend of the atomic radius in the periodic table:*
  (1) decreases going from left to right of a period
  (2) increases going down a group.

17. The electronic configurations of three elements X, Y and Z are:

X : 2 Y : 2, 8, 7 Z : 2, 8, 2

Which of the following is correct regarding these elements?

(a) X is a metal

(b) Y is a metal

(c) Z is a non-metal

(d) Y is a non-metal and Z is a metal

Ans. *(d) Y is a non-metal and Z is a metal.*

Explanation: Element Y has 1 less electron to complete its octet which is a property of non-metals. On the other hand, element Z has 2 extra electrons to become stable which is a property of metals.

18. Which of the following elements would lose an electron easily?

(a) Mg (b) Na

(c) K (d) Ca [NCERT]

19. Which of the following elements does not lose an electron easily?

(a) Na (b) F

(c) Mg (d) Al

[NCERT Exemplar]

Ans. *(b) F*

Explanation: Flourine has 7 electrons in the outermost orbit. Its atom size is the smallest too. Since it is the most electronegative element, it does not lose an electron easily.

Sodium has one valence electron, magnesium has 2 valence electrons, and aluminium has 3 valence electrons. All these metals lose electrons easily.

Related Theory

- *Metals can easily lose electrons and exhibit electropositive nature, whereas non-metals have a tendency to accept electrons and exhibit electronegative nature. Na, Al and Mg are metals, whereas F is a non-metal.*

20. What type of oxide would Eka-aluminium form?

(c) E_2O_3 (d) EO

[NCERT Exemplar]

21. **The element with atomic number 14 is hard and forms acidic oxide and a covalent halide. To which of the following categories does the element belong?**

(a) Metal

(b) Metalloid

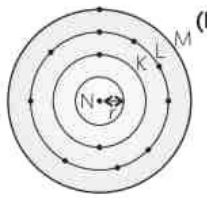
(c) Non-metal

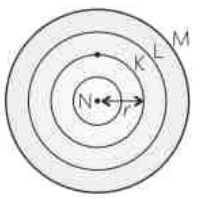
(d) Left-hand side element **[CBSE 2020]**

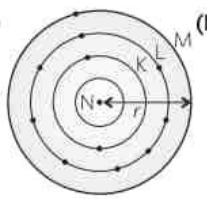
Ans. *(b) Metalloid*

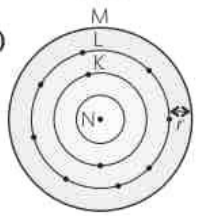
Explanation: Atomic number 14 (electronic configuration of 2,8,4) is for silicon element, which is a metalloid and exhibit properties of both metal and non-metal. It has 4 electrons in its valence shell, so it tends to form covalent acidic oxide.

22. **Which one of the following depicts the correct representation of atomic radius (r) of an atom?**

(I) 

(II) 

(III) 

(IV) 

(a) (I) and (II) **(b) (II) and (III)**

(c) (III) and (IV) **(d) (I) and (IV)** **[NCERT]**

Ans. *(b) (II) and (III)*

Explanation: The distance between the centre of the nucleus and the outermost shell is known as atomic radius.

23. **Which one of the following does not increase while moving down the group of the periodic table?**

(a) Atomic radius

(b) Metallic character

(c) Valence

(d) Number of shells in an element

[CBSE 2013]

the periodic table, the size of the atom:

(a) increases

(b) decreases

(c) does not change appreciably

(d) first decreases and then increases

[NCERT Exemplar]

Ans. *(b) decreases*

Explanation: As we move from left to right in the period of periodic table, the number of shell remains same but atomic number increases. So, the increase in nuclear charge which tends to pull electrons closer to the nuclers and reduces the size of the atoms.

Related Theory

The size of atom of an inert gas is bigger than that of the preceding halogen atom. The greater size of the inert gas atom in a period is due to the structural stability of its outermost shell consisting of an octet of electrons.

25. **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 Exemplar]

Ans. *(a) Be, Mg, Ca*

Explanation: As we move down in a group, the metallic nature of elements increases. Be, Mg and Ca are present in the same group (group 2 of the modern periodic table). Thus, Ca has the highest metallic character.

26. **An element X makes an oxide with the formula X_2O_3. This element will be in the same group as:**

(a) Na **(b) Mg**

(c) Al **(d) Cl** **[Diksha]**

Ans. *(c) Al*

Explanation: The answer is Al (aluminium). The element Al is in group III of Mendeléev's periodic table, in which the general formula of the oxides of elements is X_2O_3.

27. **The two pairs of elements placed by Newlands in one slot are:**

(a) Co, Ni and Ce, La

(b) Be, Mg and Co, Ni

(c) F, Cl and Ce, La

(d) Zn, Sr and Be, Mg

elements is: N < P < As < Sb < Bi. Identify the most electronegative among these elements.

(a) N (b) P

(c) Sb (d) Bi

Ans. *(a) N*

Explanation: The less metallic an element, the more electro negative it will be. Since electronegativity is the ability of an atom to gain electrons, whereas metallic character is related to the ability of atoms to lose electrons. As N is the least metallic of the given elements, it will be the most electronegative.

29. **Four elements P, Q, R and S have number of valence electrons 2, 3, 5 and 7 respectively. A student noted down the Group number in Modern Periodic Table and their valency as:**

	Element	Number of Valence Electrons	Group Number	Valency
(a)	P	2	12	2
(b)	Q	3	3	3
(c)	R	5	15	5
(d)	S	7	17	1

Select the row containing the correct group number and valency.

30. **Consider the elements Li, Be, B, C, N, O and F.**

(I) The most electropositive element is F.

(II) The most electronegative element is F.

(III) The only metalloid is B.

(IV) The smallest atomic size is of Li.

Read the statements given above and select the incorrect statements:

(a) Both (I) and (III)

(b) Both (I) and (IV)

(c) Both (II) and (III)

(d) Both (II) and (IV)

Ans. *(b) Both (I) and (IV)*

Explanation: Let us arrange the given elements according to their atomic number:

Li < Be < B < C < N < O < F.

All the above elements have two occupied shells and are therefore placed in second group of the periodic table.

The most electropositive element is Li and the most electronegative element is F. This is because the tendency to lose electrons decreases as we go from left to right along a period. Also, as we go from left to right along atomic size decreases because of the increase in effective nuclear charge experienced by the valence electrons. The only metalloid is B.

31. **Out of the elements F, Cl, Br and I, which is the most electronegative element?**

(a) F **(b) Cl**

(c) Br **(d) I**

Ans. *(a) F*

Explanation: The electronegativity decreases as we move down a group because the ability to gain electrons decreases down a group. This is because of the decrease in the effective nuclear charge experienced by the valence electrons since a new shell is added in each group.

Since F, Cl, Br and I have 2, 3, 4 and 5 shells respectively, F is the most electronegative of these elements.

Assertion-Reason Questions

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

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

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

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

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

32. **Assertion (A) : Potassium has a bigger atomic radius than lithium.**

Reason (R) : Atomic radius decreases along a period. [Diksha]

33. **Assertion (A): Chemical properties of the elements belonging to the same group are the same.**

Reason (R) : Elements belonging to the same group possess the same number of valence electrons.

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

34. **Assertion (A): Nitrogen is a non-metal.**

Reason (R) : Nitrogen has 5 valence electrons.

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

Explanation: Non-metals are the elements which form negative ions by gaining electrons.

K L

Electronic configuration of N = 2 5

achieve the same configuration as that of the inert gas neon.

$$N + 3e^- \longrightarrow N^{3-}$$

35. **Assertion (A) : Newland's law of Octaves worked well with lighter elements only.**

Reason (R) : Newland assumed that only 56 elements existed in nature.

36. **Assertion (A): A correct position could not be assigned to hydrogen in the Mendeléev's periodic table.**

Reason (R) : Mendeléev Periodic Law states that 'the properties of elements are the periodic function of their atomic numbers'.

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

Explanation: A correct position could not be assigned to hydrogen in the periodic table. The electronic configuration of hydrogen resembles that of alkali metals. Like alkali metals, hydrogen combines with halogens, oxygen and sulphur to form compounds having similar formulae.

On the other hand, just like halogens, hydrogen also exists as diatomic molecules and it combines with metals and non-metals to form covalent compounds.

Moreover, Mendeléev Periodic Law states that 'the properties of elements are the periodic function of their atomic masses'.

37. **Assertion (A) : The elements Sodium (Na), Magnesium (Mg), Aluminium (Al) belong to the same group in Modern Periodic Table.**

Reason (R) : Atoms of different elements with the same number of occupied shells are placed in the same period.

38. **Assertion (A) : Calcium (Atomic No. 20) is more metallic than Potassium (Atomic No. 19).**

Reason (R) : The tendency to lose electrons decreases as we move from left to right in a period.

Explanation: Potassium (Atomic No. 19) is more metallic than Calcium (Atomic No. 20) as the tendency to lose electrons decreases as we move from left to right in a period.

The electronic configuration of Potassium is 2, 8, 8, 1 and that of Calcium is 2, 8, 8, 2. Therefore, the effective nuclear charge acting on the valence electrons of Calcium will be more than that of Potassium.

Very Short Answer Type Questions

39. **State the common characteristic of the following elements:**

Boron, Silicon, Germanium and Arsenic

[CBSE 2020]

40. **State the Periodic Law on which the Modern Periodic Table is based. [CBSE 2020]**

Ans. Periodic Law on which the Modern Periodic Table is based is termed as Modern Periodic Law. According to Modern Periodic Law—The properties of elements are a periodic function of their atomic numbers.

Related Theory

➥ *Modern Periodic Table or Long form of Periodic table was prepared by Henry Moseley and is based on electronic configuration of elements. The elements are arranged in increasing order of their atomic numbers. Modern Periodic Table consists of 18 vertical columns called 7 horizontal rows called periods.*

41. **How many metals are present in second period of periodic table? [CBSE 2020]**

42. **The atomic radii of three elements A, B and C of a periodic table are 186 pm, 104 pm and 143 pm respectively. Giving a reason, arrange these elements in the increasing order of atomic numbers in the period.**

Ans. Since atomic size decreases along a period and the atomic number increases. So, the element with smaller radii, has the highest atomic number.

Hence, B has the highest atomic number followed by C and A

i.e. A < C < B

Explanation: The atomic size is the distance between the centre of the nucleus and the outermost shell of an isolated atom. The atomic radius is measured in picometre, (1 pm = 10^{-12} m).

left to right along a period. This is due to:
As the atomic number increases, the nuclear charge increases. Increase in nuclear charge tends to pull the electrons closer to the nucleur and reduce the size of the atom.

43. Consider the following :

$_{20}Ca$, $_{8}O$, $_{16}S$, $_{4}Be$

Which of the above elements would you expect to be in group 2 of the Modern Periodic table?

Ans. Consider the electronic configuration of elements:

Ca: 2, 8, 8, 2

O: 2, 6

S: 2, 8, 6

Be: 2, 2

As Ca and Be all have the same number of valence electrons (2), they belong to group 2 of the Modern Periodic Table.

44. Define electropositivity. [CBSE 2020]

Ans. Electropositivity is the ability metals to lose electron to form positive ions.

Explanation: Metals have 1, 2, 3 valence electrons and have a strong tendency to lose these to form positive ions, so metal are called electropositive elements.

$$Na \longrightarrow Na^{+} + e^{-}$$
2, 8, 1 2, 8

$$Al \longrightarrow Al^{3+} + 3e^{-}$$
2, 8, 3 2, 8

$$Mg \longrightarrow Mg^{2+} + 2$$
2, 8, 2 2, 8

as we move down in a group in the periodic table, atomic size increases. As a result, force of attraction between the nucleus and valence electrons decreases.

45. Write two reasons responsible for the late discovery of noble gases [CBSE 2015]

Ans. The two reasons for the late discovery of noble gases are:

(1) Their low concentration in atmosphere.

(2) Their chemical inertness or very less reactivity.

46. What were the criteria used by Mendeléev in creasting has periodic table [CBSE 2013]

Ans. The criteria used by Mendeléev in creating his periodic table were the relationship between the atomic masses of the elements and their physical and chemical properties and formulae of the hydrides and oxides formed by an element.

COMPETENCY BASED Questions (CBQs)

[1, 4 & 5 marks]

47. *Sulphur is a multivalent non-metal, abundant, tasteless and and odorless. In its native form sulphur is a yellow crystalline solid. In nature it occurs as the pure element or as sulphide and sulphate minerals.Sulphur dioxide or sulphur dioxide is the chemical compound with the formula SO_2. It is a toxic gas responsible for the smell of burnt matches. It is released naturally by volcanic activity and is produced as a by-product of copper extraction and the burning of fossil fuels contaminated with sulphur compounds.*

Identify the group and period of the Modern Periodic Table to which Sulphur belongs. Write any two properties exhibited by sulphur.

Ans. The atomic number of sulphur is 16. It's electronic configuration is (2, 8, 6). It belongs to group 16 and period 3 of the Modern Periodic Table.

Two properties exhibited by sulphur are allotropy and catenation.

48. *Around the year 1800, only 30 elements were known. Dobereiner in 1817 and Newlands*

elements and framed laws which were rejected by the scientists. Even after the rejection of the proposed laws, many scientists continued to search for a pattern that correlated the properties of elements with their atomic masses.

The main credit for classifying elements goes to Mendeléev for his most important contribution to the early development of a Periodic table of elements wherein he arranged the elements on the basis of their fundamental property, the atomic mass and also on the similarity of chemical properties. The formulae of their hydrides and oxides were treated as basic criteria for the classification of the elements.

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

(A) State Mendeléev's Periodic Law.

(B) Why did Mendeléev leave some gaps in the Periodic table?

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

(a) RH_4, RO (b) RH_4, RO_2

(c) RH_2, RO_2 (d) RH_2, RO

(D) Isotopes are:

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

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

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

(d) Atoms of different elements with different chemical properties but same atomic masses. [CBSE 2020]

Ans. (A) **Mendeléev's Periodic Law:** It states that the properties of elements are the periodic function of their atomic masses.

Related Theory

➥ *Mendeléev concluded that when elements are arranged in order of increasing atomic masses, similar properties of element repented after a definite gap of atomic masses. This repetition of similar properties after a definite gap of atomic masses is also called periodicity in properties.*

chemical properties but different atomic masses.

Explanation: Isotopes are the atoms of some element which have same atomic number but different mass number. They have same atomic number, same number of protons, same number of electrons and, same number of valence electrons. Valence electrons are responsible for the chemical properties of an element. Since isotopes of an element have same number of valence electrons. So they will have similar chemical properties.

Related Theory

➥ *Isotopes of chlorine are Cl–35 and Cl–37:*

Element	Cl-35	Cl-37
Atomic mass	*35*	*37*
Atomic number	*17*	*17*
Number of neutron	*18*	*20*
Number of protons	*17*	*17*
Number of electrons	*17*	*17*
Number of electrons	*K L M*	*K L M*
Electronic configuration	*2 8 1*	*2 8 7*
Valence electrons	*7*	*7*

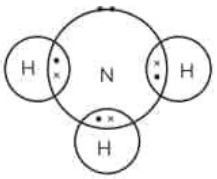
Hence, isotopes of chlorine Cl–35 and Cl–37 will have similar chemical properties.

49. *Recently, two persons died in a major ammonia gas leakage at the Indian Farmers Fertilizer Cooperative Limited (IFFCO) unit at Prayagraj. The experts point out that ammonia is stored for industrial use in liquid form under high pressure or in gaseous form at low temperature, as was the case in the IFFCO unit where the accident took place. Ammonia is critical in the manufacturing of fertilizers, and is one of the largest-volume synthetic chemicals produced in the world.*

What type of bond is present in ammonia molecule? Will a solution of ammonia be

electricity?

Ans. Ammonia molecule NH_3 is formed by the sharing of electrons between nitrogen and hydrogen atoms as shown below:



As electron pairs are shared between the three hydrogen atoms and the nitrogen atom, a solution of ammonia in water will be a poor conductor of electricity as there are no charged particles present in an ammonia molecule.

50. *The following table shows a part of the periodic table in which the elements are arranged according to their atomic numbers. (The letters given here are not the chemical symbols of the elements):*

a	b		c	d	e	f	g	h
3	4		5	6	7	8	9	10
i	j		k	l	m	n	o	p
11	12		13	14	15	16	17	18

(A) Which element has a bigger atom, a or f?

(B) Which element has a higher valency, k or o?

(C) Which element is more metallic, i or k?

(D) Select a letter which represents a non-metal of valency 2.

Ans. (A) a (size decreases from left to right in a period).

(C) i (metallic character decreases from left to right in a period).

Explanation:

Element	Atomic Number	Electronic Configuration
i	11	2, 8, 1
k	13	2, 8, 3

i has to lose only one electron to acquire metallic character whereas k has to lose 3 electrons which requires a lot of energy as compared to i element so element i is more metallic.

51. *When Sam was walking along the street, he saw several beautiful and colourful signages. In the signage industry, neon signs are electric tubes that contain rarefied neon or other gases. They are the most common use for neon lighting, which was first demonstrated in a modern form in December 1910 by Georges Claude at the Paris Motor Show.*

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 Exemplar]

Ans. *(c) Group 18*

Explanation: The element with electronic configuration 2, 8 has octet configuration, so it must be an inert gas, *i.e.*, neon, which is placed in group 18.

Related Theory

Group 18 in the modern periodic table has noble gases (inert gases). Helium (He), neon (Ne), argon (Ar), krypton (Kr), xenon (Xe) and radon (Rn) are present in group 18. The members of the group have eight electrons in their outermost orbit (except helium which has two electrons). Thus, they have a stable electronic configuration. These gases are chemically un-reactive, i.e., they don't react with other elements to form compounds.

52. *Atoms of eight elements A, B, C, D, E, F, G and H have the same number of electron shells but different number of electrons in their outermost shells. It was found that elements A and G combine to form an ionic compound. This ionic compound is added in a small amount to almost all vegetables and dishes during cooking. Oxides of elements A and B are basic in nature while those of elements E and F are acidic. The oxide of element D is, however, almost neutral.*

Based on the above information, answer the following questions:

(A) To which group or period of the periodic table do these elements belong?

formed by a combination of elements B and F?

(C) Which two of these elements could definitely be metals and which would be non metals?

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

Ans. (B) The compound between B and F will be ionic in nature.

(D) Element H will be found in gaseous state at room temperature as it is the 8th element of the group so it would have 8 electrons in its outermost shell which is the electronic configuration of a nobel gas.

Related Theory

- *Sodium chloride is used in almost all vegetables and dishes during cooking. It means A is sodium and G is chlorine.*
- *Metals are one present on the left hand side of modern periodic table and non-metals on the right hand side. As we know oxides of metals are basic in nature and oxides of non-metals form acidic oxide. The elements given one.*

A	B	C	D	E	F	G	H
Na	Mg	Al	Si	P	S	Cl	Ar

53. *Analyse the following table given below and answer the questions that follow:*

Given alongside is a part of the periodic table. As we move vertically downward from Li to Fr:

Li	Be
Na	
K	
Rb	
Cs	
Fr	Ra

(A) Which among the following has larger size of atoms?

(a) Li (b) Na

(c) Cs (d) Fr

(B) Which one of the following does not increase while moving down in group of the periodic table?

(a) Atomic radius

(b) Metallic character

(c) Valence

(d) Number of shells in an element

whose magnitude change while going from top to bottom in a group of the periodic table. In what manner do they change?

(D) Rewrite the following statement after correction, if necessary:

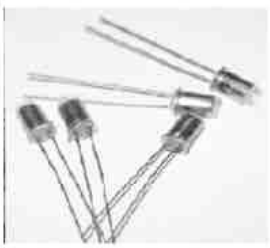
"Groups have elements with consecutive atomic numbers"

Ans. (A) *(d) Fr*

Explanation: Fr has greater atomic size as the atomic size increases gradually from lithium to francium.

(D) Periods have elements with consecutive atomic numbers.

54. *In addition to its applications in electronic devices, germanium is used as a component of alloys and in phosphors for fluorescent lamps. Because germanium is transparent to infrared radiation, it is employed in equipment used for detecting and measuring such radiation, such as windows and lenses.Silicon is used in building and construction, able to bond materials such as concrete, glass, granite, steel and plastics, enabling them to work better and last longer. Solar cells made out of silicon currently provide a combination of high effciency, low cost, and long lifetime.*



Three elements B, Si and Ge are:

(a) Metals

(b) Non-metals

(c) Metalloids

(d) Metal, non-metal and metalloid respectively [NCERT Exemplar]

Explanation: The elements boron (B), silicon (Si) and germanium (Ge) exhibit intermediate properties of metals and non-metals, therefore, they are called as metalloids. These elements are placed in between metals and non-metals diagonally as a zigzag line to separate them.

Related Theory

- *A few other elements are arsenic (As), antimony (Sb), tellurium (Te), polonium (Po) and astatine (At).*

55. *Analyse the following table given below and answer the questions that follow:*

The atomic radii of the element of second period are given below:

Second Period Element	*B*	*Be*	*O*	*N*	*Li*	*F*	*C*
Atomic Radii (pm)	*88*	*111*	*66*	*74*	*152*	*64*	*77*

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

(B) Why does atomic radius decreases as we move from left to right in a period?

(C) Which is not true about the noble gases?

(a) They are non metallic in nature

(b) They exist in atomic form

(c) They are radioactive in nature

(d) Xenon is the most reactive among these

(D) 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 [SQP]

Ans. (A) Elements in decreasing order of their atomic radii

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

(C) *(c) They are radioactive in nature.*

Explanation: Noble gases are inert and are not radioactive in nature.

Related Theory

- *Noble gases cannot lose or gain or shore electrons as their outermost shell is complete.*
- *He has 2 electrons in its K shell, which is completely filled as K shell can accommodate maximum 2 electrons whereas Ne has 8 electrons in its L shell and its octet is complete so they exist in atomic form.*

56. *A student tried to assign a correct position to hydrogen in Mendeléev's Periodic Table by the halogen family.*

Another student wondered where she would place the isotopes of chlorine, Cl-35 and Cl-37 as they were atoms of the same element.

[NCERT Activity 5.1, 5.2]

(A) No fixed position could be given to hydrogen in the Mendeléev's Periodic Table as:

(I) Electronic configuration of hydrogen resembles that of alkali metals.

(II) Hydrogen combines with metals and non-metals to form ionic compounds.

(III) Hydrogen exists as diatomic molecules just like alkali metals.

(IV) Hydrogen combines with halogens, oxygen and sulphur to form compounds having similar formulae as alkali metals.

(a) Both (I) and (II)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (III) and (IV)

(B) The formula of hydrides of elements belonging to a Group of Mendeelev's Periodic Table is RH_2. The Group Number to which the element belongs is:

(a) Group IV (b) Group V

(c) Group VI (d) Group VII

(C) The formula of oxides and hydrides of elements belonging to different Groups of the Mendeléev's Periodic Table is given below:

	Group No.	Formula of Oxides	Formula of Hydrides
(a)	I	RO	RH
(b)	II	RO	RH_2
(c)	III	R_2O_3	RH_3
(d)	V	R_2O_5	RH_3

**The letter 'R' is used to represent any of the elements in the group.*

Select the row containing incorrect information.

(D) Select the correct statement regarding position of isotopes in Mendeléev's Periodic Table:

(a) Mendeléev left some gaps in his periodic table for the isotopes.

Mendeléev had proposed his periodic classification of elements.

(c) Mendeléev placed both the isotopes of chlorine (Cl-35 and Cl-37) under the same slot as they had same chemical properties.

(d) Mendeléev placed both the isotopes of chlorine (Cl-35 and Cl-37) in different slots as they had different masses.

(E) Mendeléev left some gaps in his Periodic Table as he predicted the existence of some elements that had not been discovered at that time. Which of the following elements discovered later, have properties similar to Eka-boron?

(a) Gallium

(b) Germanium

(c) Caesium

(d) Scandium

Ans. (A) *(c) Both (I) and (IV)*

Explanation: As Mendeléev's periodic table was based on atomic mass, no fixed position could be assigned to hydrogen. However, it has one valence electron just like alkali metals Li, Na, K etc. Moreover, hydrogen combines with halogens, oxygen and sulphur just like alkali metals do.

However, hydrogen combines with metals and non-metals to form covalent bonds by sharing of electrons and exists as diatomic molecules like halogens.

(C) *(a) Group No.: 1, Formula of oxides; RO, Formula of Hydrides; RH*

Explanation: The formula of hydrides and oxides of elements belonging to group I of Mendeléev's table is R_2O and RH respectively. For example, formula of oxide and hydride of element Li will be Li_2O and LiH respectively.

57. *We all have heard about the damage being done to the Taj Mahal and our environment due to high levels of oxides of certain elements in the atmosphere. Acid rain is caused by a chemical reaction that begins when these oxides are released into the air. These substances can rise very high into the atmosphere, where they mix and react with water, oxygen, and other chemicals to form more acidic pollutants, known as acid rain.*

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 Exemplar]

Ans. *(a) An element with atomic number 7*

Explanation: Non-metals form acidic oxides. The element with atomic number 7 is a non-metal (nitrogen). Rest three elements with atomic numbers, 3 (Li), 12 (Mg) and19 (K) are metals and hence, form basic oxides.

58. *Atomic radii of the elements of the second period are given below:*

Period II : B Be O N Li C 152 77
elements :
Atomic : 88 111 66 74
radius (pm)

Atomic radii of first group elements are given below and arrange them in an increasing order.

Group 1 : Na Li Rb Cs K
Elements 6
Atomic : 186 152 244 262 231
Radius (pm) **[NCERT Activity 5.7, 5.8]**

(A) Select the incorrect statements:

(I) The atomic radius decreases in moving from left to right along a period.

(II) The atomic radius increases in moving from left to right along a period

(III) As we move from left to right along a period, there is an increase in nuclear charge which tends to pull the electrons closer to the nucleus.

(IV) As we move from left to right along a period, there is a decrease in nuclear charge which tends to pull the electrons away from the nucleus.

(a) Both (I) and (III)

(b) Both (II) and (III)

(d) Both (II) and (IV)

(B) Two students recorded their observations on variation of atomic radii of first group elements as given below:

	First Student	Second Student
(a)	Li has the smallest atomic radii	Na has the smallest atomic radii
(b)	Atomic radius of Rb > Cs	Atomic radius of Cs > Rb
(c)	Cs has the biggest atomic radius	Li has the smallest atomic radius
(d)	Atomic radius of K > Na	Atomic radius of Na > K

Select the row containing the correct observation by both students.

(C) The atomic size of Na is greater than Li because:

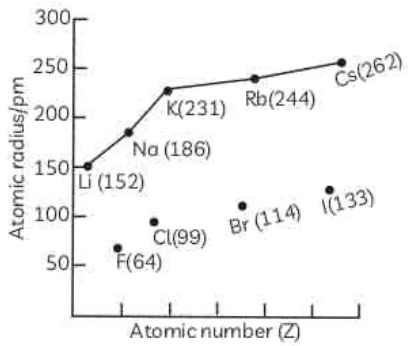
(a) Na has three shells, whereas Li has two shells in its atom

(b) The atomic number of Na is greater than Li

(c) As we go down a group, distance between outermost electrons and nucleus decreases.

(d) The mass of Na atom is greater than Li atom

(D) The graph of variation of atomic radius with atomic number for alkali metals and halogens is shown below:



Select the correct observation:

(a) Na has a bigger atomic radius than Li due to decrease in nuclear charge

(b) F has a smaller atomic radius than Li due to increase in nuclear charge

(c) Elements of Group 1 have the biggest atomic size in their respective periods of Modern Periodic Table and have identical electronic configuration.

(d) Elements of Group 17 have the biggest atomic size in their respective periods.

(E) The correct increasing order of the atomic radii of the elements Mg, Si and Cl is:

(a) Mg > Si > Cl (b) Si < Cl < Mg

(c) Cl < Si < Mg (d) Cl < Mg < Si

Ans. (A) *(d) Both (II) and (IV)*

Explanation: As we move from left to right along a period we see that the atomic radius 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.

(B) *(c) First student: Cs has the biggest atomic radius, Second student: Li has the smallest atomic radius.*

Explanation: The atomic radius and hence the atomic size increases as we move down a group. This is because a new shell is added as we move down the group. This increases the distance between the nucleus and the valence shell.

As Cs lies at the bottom of group 1, and Li lies at the top, Cs has the biggest atomic radius among Group 1 elements.

(D) *(b) F has a smaller atomic radius than Li due to increase in nuclear charge*

Explanation: Both F and Li lie in the second period as they have two occupied shells. However, as the effective nuclear charge is more in the case of F as compared to Li, F has a smaller atomic radius than Li.

The atomic radius decreases in moving from left to right along a period and it increases in going from top to bottom along a group.

59. *Chemists have always looked for ways of arranging the elements to reflect the similarities between their properties. The earliest attempt to classify the elements was in 1789, when Antoine Lavoisier grouped the elements based on their properties into gases, non-metals, metals and earths. Several other attempts were made to group elements together over the coming decades. In 1829, Johann Döbereiner recognised triads of elements with chemically similar properties, such as lithium, sodium and*

the middle element could be predicted from the properties of the other two. It was not until a more accurate list of the atomic mass of the elements became available at a conference in Karlsruhe, Germany in 1860 that real progress was made towards the discovery of the modern periodic table.

(A) Which of the following elements form Döbereiner's triads?

(a) Li, Na, K (b) Ca, Sr, Ba

(c) F, Cl, Br (d) Cl, Br, I

(B) Given below are four statements on Dobereiner's triads:

(I) One triad identified by Dobereiner was (Ca, Na, Ba)

(II) The triads identified by Döbereiner had three elements each.

(III) The atomic mass of the middle element was roughly equal to the atomic masses of the other two elements.

(IV) Dobereiner could identify only three triads from the elements known at that time.

Identify the incorrect statements.

(a) Both (I) and (III)

(b) Both (II) and (III)

(c) Both (I) and (IV)

(d) Both (II) and (IV)

(C) A & B are two elements having similar properties which obey the law of octaves. How many elements are there in between A and B?

(a) 5 (b) 6

(c) 7 (d) 8

(D) Which of the following is not a limitation of Newland's law of octaves:

(a) The elements fluorine, chlorine and bromine are placed in the same column (musical note).

(b) Newlands' Law of Octaves worked well with lighter elements only.

(c) Newlands assumed that only 56 elements existed in nature and no more elements would be discovered in the future.

(d) In order to fit elements into his Table, Newlands adjusted cobalt and nickel in the same slot.

properties of elements.

	Observation	Dobereiner's Triad	Newland's law
(a)	Properties of Be and Mg were found to be similar	Yes	No
(b)	Properties of Ba and Ca were found to be similar	Yes	Yes
(c)	Properties of Cl and Br were found to be similar	No	Yes
(d)	Properties of Li and Na were found to be similar	Yes	Yes

Select the option containing the correct observation.

Ans. (B) *(a) Both (I) and (III)*

Explanation: Dobereiner's triads consisted of three elements having similar properties. He could identify only three triads out of the elements discovered at that time. They were (Li, Na, K), (Ca, Sr, Ba) and (Cl, Br, I).

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

(D) *(a) The elements fluorine, chlorine and bromine are placed in the same column (musical note).*

Explanation: The elements fluorine, chlorine and bromine are placed in the same column (musical note) as they have similar properties and are known as halogens. Even in the modern periodic table, they are placed in the same group, group 17.

(E) *(d) Observation: Properties of Li and Na were found to be similar, Döberimer's Triads: Yes, Newlands' Law: Yes.*

Explanation: Both Be and Mg were placed under the same note in Newland's law, but were not part of Döbereiner's triads.

Döbereiner's Triads

60. *Valency of an element is the combining capacity of an atom of the element. The valency of an element is related to how many electrons are in the outer shell. The chemical formula for a substance shows how many atoms of each element are present in a molecule, or the proportion of atoms of each element. The formula can be worked out using the valency.*

be predicted knowing the valency of the constituting atoms. Knowledge of valency is useful in calculating equivalent weight of elements, writing down chemical equations and in checking the structures of molecules. Some elements show variable valency and the valency determines the properties of elements. The table below gives atomic number of five elements written as P, Q, R, S and T, which are not their real chemical symbols.

Element	Atomic Number
P	*4*
Q	*9*
R	*14*
S	*18*
T	*20*

(A) **The valency and group number in Modern Periodic Table of four elements are given below :**

	Element	Valency	Group Number
(a)	P	2	12
(b)	Q	2	7
(c)	R	4	4
(d)	S	0	18

Select the option containing the correct valency and group number.

(B) **The electronic configuration of the element T is:**

	K-shell	L-shell	M-shell	N-shell
(a)	2	8	10	
(b)	2	10	8	
(c)	2	8	8	2
(d)	2	8	9	1

(C) **The valency of elements:**

(a) **Decreases as we go down a group**

(b) **Remains same in a group**

(c) **Increases as we go down a group**

(d) **First increases and then decreases as we go down a group**

(D) **As per the table given above, the element(s) which will form only covalent bonds is:**

(III) S (IV) Q

(a) **Only (I)**

(b) **Only (II)**

(c) **Both (I) and (IV)**

(d) **Both (II) and (III)**

(E) **Select the incorrect statement:**

(a) **Valency of elements of second period is 2.**

(b) **Valency of an element is determined by the number of valence electrons present in the outermost shell of its atom.**

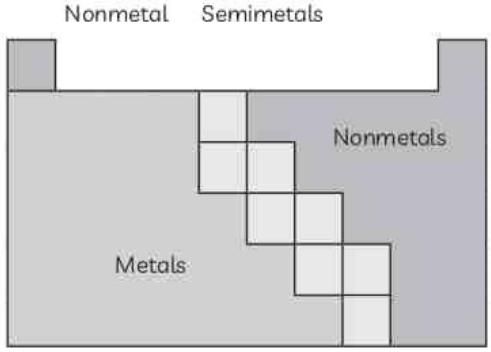
(c) **Valency of metals is equal to the number of valence electrons.**

(d) **Valency of elements of Group 18 of Modern Periodic Table is 0.**

Ans. (C) *(b) Remains same in a group*

Explanation: The valency of elements is equal to the number of valence electrons in case of metals and (8 – valence electrons) for non-metals. Moreover, all elements belonging to the same group have same outer shell electronic configuration. Therefore, valency of elements remains same in a group.

61. *The elements can be classified as metals, nonmetals, or metalloids. In the Modern Periodic Table, a zig-zag line separates metals from non-metals.*



The metals are to the left of the line (except for hydrogen, which is a nonmetal), the nonmetals are to the right of the line, and the elements immediately adjacent to the line are the metalloids.

Ionization energy is the minimum amount of energy required to remove the most loosely bound electron of an isolated neutral gaseous

$X(g) + \text{energy} \longrightarrow X^+(g) + e^-$

where X is any atom or molecule, X^+ is the ion with one electron removed, and e^- is the removed electron.

Since the metals are further to the left on the periodic table, they have low ionization energies.

(A) Which of the following elements is not a metalloid?

(a) Si (b) Ge

(c) As (d) Ar

(B) An element A (atomic number 17) reacts with an element B (atomic number 14) to form a tetravalent halide.

Select the option which gives the correct nature of elements A and B :

	Element A	Element B
(a)	Metal	Non-metal
(b)	Non-metal	Non-metal
(c)	Non-metal	Metalloid
(d)	Metalloid	Metalloid

(C) Four statements are given below.

(I) The metalloids are placed in Groups 13 – 16 in the Modern Periodic Table

(II) Boron is the only metalloid in group 13 of the Modern Periodic Table.

(III) Group 14 of the Modern Periodic Table contains only metalloids.

(IV) Group 17 of the Modern Periodic Table contains both metalloids and non-metals

Select the correct statement(s):

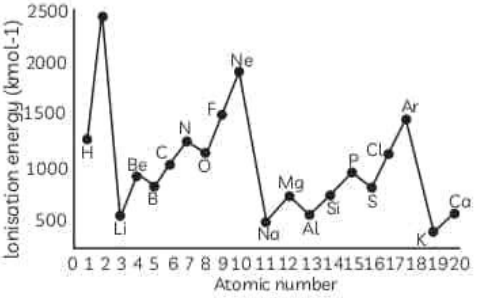
(a) (I), (II) and (III)

(b) Both (I) and (III)

(c) Both (II) and (IV)

(d) (I), (II) and (IV)

(D) Variation of ionization energy of elements with atomic number upto atomic number 20 is given below:



From the graph we can conclude that the tendency to lose electrons:

(a) Increases as we go down the group

(b) Decreases as we go down the group

(c) Remains constant in a group

(d) No definite conclusion can be made

(E) The metalloid which is the second most abundant element on earth's crust after oxygen and is widely used in electronics is:

(a) B (b) Ge

(c) Si (d) As

Ans. (A) *(d) Ar*

Explanation: The metalloids are B, Si, Ge, As, Te and Po. Ar (Argon) is a noble gas having atomic number 18.

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

62. From the elements Li, K, Mg, C, Al, S identify the:

(A) elements belonging to the same group.

(B) element which has the tendency to lose two electrons.

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

(D) most metallic element.

(E) element that forms acidic oxide.

(F) element that belongs to group 13.

[CBSE 2020]

Ans. (A) Li, K (B) Mg (C) C (D) K

(E) S (strongly acidic, C (weakly acidic)(F) Al

Explanation:

Element	Atomic Number	Number of Protons	Number of Electrons	Electronic Configuration	Number of Valence Electrons
Li	3	3	3	2, 1	1

Mg	12	12	12	2, 8, 2	2
C	6	6	6	2, 4	4
Al	13	13	13	2, 8, 3	3
D	16	16	16	2, 8, 6	6

(A) All the elements in any group of the periodic table have identical or valence shell electronic configuration *i.e.* the same number of valence electrons. Li and K belong to group 1 as both of them have one electron in the outermost shell though the number of filled shells have increased from 2 to 4.

(B) Elements having 1, 2 or 3 electrons in their respective valence shells have a tendency to lose electrons to form positive ions. So they are metals and are called electropositive element.

Magnesium has 2 electrons in its outer most shell so it has tendency to lose 2 electrons.

(C) C has four valence electrons so it is difficult for *C* to lose or gain 4 electrons to become C^{4+} or C^{4-} ions, so it prefers sharing of electrons.

(D) Most metallic element is K since it has to lose only one electron to form electropositive element $K \longrightarrow K^{+} + e^{-}$

(E) As we move across a period from left to right, metallic character decreases and non-metallic character increases.

(F) Al belongs to group 13 as number of valence electrons are 3 so the group number is (10 + 3) = 13.

63. The position of three elements *A*, *B* and *C* in the Modern periodic table is as follows:

Group→ Period↓	1	2	13	14	15	16	17	
1								
2								
3								

(A) Write formula of compound formed between:

(i) B and A (ii) B and C

(B) Is any of the three elements a metal? Give reason to justify your answer.

[CBSE 2020]

64. 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]

65. 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? [CBSE 2019]

Ans. The Modern Periodic table consists of 18 vertical columns or 'groups' and 7 horizontal rows or 'periods'.

As we move from left to right along a period, we observe that the elements have the same number of valence shells but the number of valence electrons increases by one unit.

Similarly, as we move down a group, we observe that elements have the same number of valence electrons but the number of shells increases by one.

This proves that the Modern Periodic Table is based on electronic configuration of atoms of elements.

66. 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. [CBSE 2019]

Ans. (A) As the number of valence electrons in the given element is 4, it belongs to Group 14 of the Modern Periodic Table.

As the number of occupied shells is 3 (since electrons are filled in K, L and M shells), the element belongs to third period.

(B) The given element is Silicon (atomic symbol: Si). Its physical property is:

(ii) It is a semi-conductor

(iii) It exhibits allotropy

(iv) It has a metallic luster

(Any 1 of 4 points can be written to get full marks)

Related Theory

- *Allotropy is the property exhibited by certain elements to exist in different physical forms due to difference in arrangement of atoms.*
- *Graphite and diamond are the two allotropes of carbon*

67. 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.

Explain by giving reason. [NCERT Exemplar]

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

Ans. Eka-silicon is identified as germanium (Ge), which is placed in group 4 of Mendeléev's periodic table. The valency of germanium is 4, so the chemical formula of its chloride must be $GeCl_4$.

Eka-aluminium was later identified as gallium (Ga). It is placed in group 3 of Mendeléev's periodic table. Hence, the valence of gallium is 3 and the formula of chloride would be $GaCl_3$.

69. 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]

70. 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.

Ans. Electronic configuration of X: 2, 8, 2, Y: 2, 8, 6 Both X and Y belong to 3rd period.

Ionic bond will be formed.

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

Formula is XY.

Give reasons for your answer.

(A) X has 12 protons and 12 electrons

(B) Y has 12 protons and 10 electrons

[NCERT Exemplar]

72. 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. What is the nature of the bond formed?

[CBSE 2012]

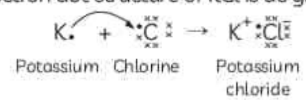
Ans. The electronic configuration of element A with atomic number 19 would be 2, 8, 8, 1. Since it has only one valence electron, it must be a metal that is potassium.

The electronic configuration of element B would be 2, 8, 7 with 7 valence electrons. So, it must be a non-metal that is chlorine.

A metal and a non-metal usually combine through ionic bond because metals have a tendency to lose electrons and form cations, whereas non-metals can accept electrons to form anions.

Potassium and chlorine will form potassium chloride (KCl).

The electron dot structure of KCl is as given below:



73. An element X has mass number 35 and the number of neutrons is 18. Identify the group number and period of X. [Diksha]

Ans. Mass no. = Sum of protons + Sum of neutrons

35 = Sum of protons + 18

Sum of protons = 35 – 18

Sum of protons = 17

Hence, we can say that the atomic number of element X is 17.

Its electronic configuration will be 2, 8, 7.

Thus it is clear that element X belongs to the 3rd Period and the 17th Group.

74. List the limitations of Newlands' Law of Octaves.

Ans. Limitations of Newlands' Law of Octaves:

(1) It was not applicable for all the elements. It was applicable only till calcium, as after calcium every eighth element did not possess properties similar to that of the first.

elements existed in nature and no more elements would be discovered in the future. But, later on, several new elements were discovered, whose properties did not fit into the Law of Octaves.

(3) Cobalt and nickel are placed in the group of halogens with the elements fluorine and chlorine (F, Cl) which have different properties and it was not explained for the same.

(4) Placing of iron far away from cobalt and nickel, which have similar properties as iron, could also not be explained.

Thus, Newlands' Law of Octaves worked well with lighter elements only.

75. **Answer the following:**

(A) Name any three halogens.

(B) Mention the group to which they belong and their valency.

(C) What type of compounds will they form with elements of group 1?

76. **An element 'X' (Atomic number = 19) 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.

77. **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	P	31
	As	74
C	B	10.8
	Al	27
	Ga	69.7

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

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

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

78. **An element belongs to third period and second group of the periodic table:**

(A) State the number of valence electrons in it.

(B) Is it a metal or a non-metal?

(C) Name the element.

(D) Write the formula of its oxide.

[CBSE 2015, 11]

Ans. (A) As the element belongs to the second group of the periodic table, it has 2 valence electrons.

(B) It is a metal since it can lose its valence electrons and form a cation.

(C) Element belonging to third period has three occupied shells (K, L and M) and as it belongs to group 2, it has 2 electrons in the M shell. Its electronic configuration is 2, 8, 2 and atomic number is 12. The element is therefore magnesium (Mg).

(D) Formula of its oxide is MgO, as it has a valency of 2.

SHORT ANSWER Type-II Questions (SA-II)

[3 marks]

79. **Answer the following:**

(A) Why do elements in a group show similar property?

(B) An element M is in the third group of the periodic table. Write the formulae of its chloride and oxide.

Ans. (A) All the elements present in a group have same electronic configuration of the atoms. The physical and chemical properties of elements depend on the number of valence electrons. Elements present in the same group have the same number of valence

the same group have similar physical and chemical properties.

Explanation: Elements in the two groups are:

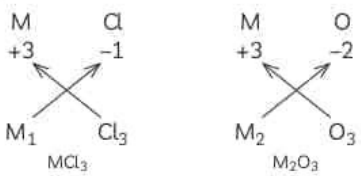
Group I	Group II
(3) Li 2, Q 1	(4) Be 2, 2
(11) Na 2, 8, 1	(12) Mg 2, 8, 2
(19) K 2, 8, 8, 1	(20) Ca 2, 8, 8, 2

Elements in group I have same number of valence electrons, so have same properties.

(B) Element M is in the third group, therefore it will have a valency of 3.

Its chloride and oxide are MCl_3 and M_2O_3 respectively. (∵ O and Cl have valencies of −2 and −1 respectively).

Explanation:



80. Why is atomic number considered to be a more appropriate parameter than atomic mass for the classification of elements in a periodic table? How does the metallic character of elements vary as we move (i) from left to right in a period, and (ii) top to bottom in a group in the modern periodic table? Give reasons to justify your answers.
[CBSE 2017]

number 20. Stating reason answer each of the following questions:

(A) Is calcium a metal or non-metal?

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

(C) Write the formula of its oxide.
[CBSE 2016]

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

Ans. Eka-silicon is identified as germanium (Ge), which is placed in group 4 of Mendeléev's periodic table. The valency of germanium is 4, so the chemical formula of its chloride must be $GeCl_4$.

Eka-aluminium was later identified as gallium (Ga). It is placed in group 3 of Mendeléev's periodic table. Hence, the valence of gallium is 3 and the formula of chloride would be $GaCl_3$.

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

(I) 2, 8, 2 **(II) 2, 8, 1**

(III) 2, 8, 7 **(IV) 2, 1**
[NCERT Exemplar]

Ans. Elements having 1 to 3 valence electrons are usually metals, whereas elements with 4 or more valence electrons are usually non-metals or metalloids.

The following elements whose electronic configurations are given below:

Electronic Configuration	Number of Valence Electrons	Metal/Non-metal	Atomic Number	Name of the Element
(I) 2, 8, 2	2	Metal	2 + 8 + 2 = 12	Magnesium
(II) 2, 8, 1	1	Metal	2 + 8 + 1 = 11	Sodium
(III) 2, 8, 7	7	Non-metal	2 + 8 + 7 = 17	Chlorine
(IV) 2, 1	1	Metal	2 + 1 = 3	Lithium

Thus, elements (a), (b) and (d) are metals, while (c) is a non-metal.

84. Out of lithium and potassium, which one has stronger metallic character and why?
[Diksha]

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

Ans. Magnesium (Mg) belongs to group 2, known as alkaline earth family. The two other elements belonging to the same group are Calcium (Ca) and Strontium (Sr) which are expected to show chemical reactions similar to Magnesium (Mg). The basis of choice is the electronic distribution in the valence shell of these elements. All of them have two valence electrons each.

due to valence electrons, they show same chemical reactions.

	K	L	M	N	O
Mg (Z = 12)	2	8	2	-	-
Ca (Z = 20)	2	8	8	2	-
Sr (Z = 38)	2	8	18	8	2

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? [NCERT]

LONG ANSWER Type Questions (LA)

[5 marks]

87. 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 resent in each one of them? [NCERT]

Ans. (A) The two elements that have taken the place of eka-silicon and eka-aluminium are germanium (Ge) and gallium (Ga), respectively.

(B) Germanium is placed in group 14 and period 4 in the modern periodic table.

Gallium is placed in group 13 and period 4 in the modern periodic table.

(C) Germanium (Ge) is a metalloid. gallium (Ga) is a metal.

(D) Valence electrons in germanium (Ge) are 4. Valence electrons in gallium (Ga) are 3.

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

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

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

(A) Which element will form only covalent compounds?

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

(C) Which element is a metal with valency 2?

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

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

89. 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]

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

91. "Atomic number of an element is considered to be a more appropriate parameter than its atomic mass for a chemist." Take the example of the element *X* (atomic number 13) to justify this statement. [CBSE 2019]

Ans. The electronic configuration of element *X* having atomic number 13 is: 2, 8, 3

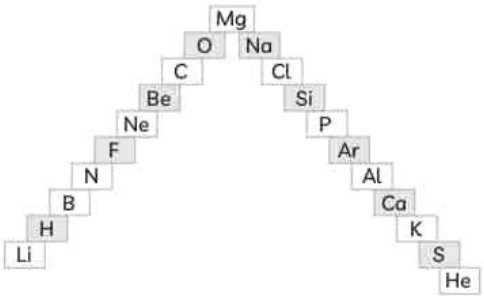
It is a metal having valency = 3 (number of valence electrons). It is electropositive in nature and can form X^{3+} ions.

It is placed in 3^{rd} period and 13^{th} group of the Modern Periodic table.

Therefore, atomic number of an element is a more fundamental property and prediction of properties of elements could be made more accurately when elements were arranged on the basis of increasing atomic number.

92. (A) **In this ladder (figure), symbols of elements are jumbled up. Rearrange these symbols of elements in the increasing order of their atomic numbers in the periodic table.**

(B) **Arrange them in the order of their group also.**



[NCERT Exemplar]

93. **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 char-acteristic pungent smell.**

(A) Identify 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 and what type of bond is formed in it? [NCERT Exemplar]

94. **Based on the group valency of element write the molecular formula of the following compounds giving justification for each:**

(A) Oxide of first group element.

(B) Halide of the element of group thirteen, and

(C) Compound formed when an element, , A of group 2 combines with element, B of group seventeen. [CBSE 2019]

95. **Two elements A and B have atomic numbers 11 and 19 respectively.**

(A) State their position in the modern periodic table.

(B) Arrange them in the increasing order of their atomic radius?

(C) What is the nature of their oxides? [Diksha]

96. **Explain giving justification the trends in the following properties of elements, on moving from left to right in a period, in the Modern periodic Table.**

(A) Variation of valency.

(B) Change of atomic radius.

(C) Metallic to non-metallic character.

(D) Electronegative character.

(E) Nature of oxides. [CBSE 2018]

97. **Give reasons for the following:**

(A) K atom is bigger than Na atom even though both these elements belong to the same group.

(B) The metallic character of elements increases as we move down a group.

(C) Mg atom is smaller than Na even though these elements belong to the same period. [Diksha]

98. **(A) What was the basis of Mendeléev classification of elements?**

(B) List two achievements of Mendeléev periodic tables.

(C) List any two observations which posed a challenge to Mendeléev periodic law. [CBSE 2018]

Ans. (A) Atomic Mass of elements was the basis of Mendeléev's classification of elements.

(B) Achievements of Mendeléev's periodic table:

(1) Mendeléev's periodic law predicted the existence of some elements that had not been discovered at that time. He therefore left some gaps in his Periodic Table

(2) Mendeléev's periodic table could predict the properties of several elements on the basis of their positions in the periodic table.

(3) It could accommodate noble gases when these gases were discovered in a new group without disturbing the existing order.

(Any 2 of 3 points can be written to get full marks)

to Mendeléev's periodic law:

(1) The position of isotopes could not be explained since the elements are arranged according to their atomic masses.

(2) Wrong order of atomic masses of some elements could not be explained. For example, cobalt (atomic mass 58.9) appeared before nickel (atomic mass 58.7).

(3) A correct position could not be assigned to hydrogen in the periodic table.

(4) The atomic masses do not increase in a regular manner in going from one element to the next.

(Any 2 of 4 points can be written to get full marks)

99. **The electronic configurations of four elements *A*, *B*, *C* and *D* are as follows:**

***A* – (2, 8, 7); *B* – (2, 8, 1); *C* – (2, 8, 2); *D* – (2, 8, 8, 2)**

(A) Which amongst these elements will form acidic oxide and why?

(B) Which amongst these elements has the smallest atomic radius and why?

(C) Out of these select those two elements which have same valency and form compounds by ionic bonds.

[CBSE 2017]

100. **(A) Why do we classify elements?**

(B) What were the two criteria used by Mendeléev in creating his periodic table?

(C) Why did Mendeléev leave some gaps in his periodic table?

there no mention of noble gases like helium, neon and argon?

(E) Would you place the two isotopes of chlorine, Cl-35 and Cl-37 in different slots because of their different atomic masses or in the same slot because their chemical properties are the same? Justify your answer. **[Diksha]**

Ans. (A) Elements are classified to systematize their study and make the understanding of properties of elements and compounds simpler.

(B) The two main guiding factors for Mendeléev in the classification of the then known elements were:

(1) increasing atomic masses, and

(2) grouping together of elements having similar properties.

(C) These gaps were left for the elements which had not been discovered at that time. Mendeléev thought that these elements would be discovered later on in the future.

The modern periodic table does not have any gaps because new elements were discovered later on, which were placed correctly in the gaps left by Mendeléev.

(D) Noble gases were not known at that time. So, there was no group of noble gases in Mendeléev's original periodic table.

(E) Both the isotopes of chlorine, Cl-35 and Cl-37, have the same atomic number of 17. Therefore, they have same chemical properties. Hence, both of them can be put at one place in the same group of the periodic table.

VERY SHORT ANSWER Type Questions

[1 mark]

1. List any two properties of the elements belonging to the first group of the modern periodic table.

Ans.

Elements belonging to the first group are:
Metals [Alkali]
Have valency 1

[CBSE Topper 2014]

SHORT ANSWER Type-I Questions (SA-I)

[2 marks]

2. 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'.

Ans.

mass number = 35
no of ~~mass~~ neutrons = 18.
atomic number of X = 17
electronic configuration = 2, 8, 7
(i) group number: 17
(ii) Period number: 3
(iii) valency of X: 1

[CBSE Topper 2016]

SHORT ANSWER Type-I Questions (SA-II)

[3 marks]

3. 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 Ga.
(ii) Predict the number of valence electrons in Rb.
(iii) What is the number of shells in Cr?
(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, Ga, Mg and Rb in the increasing order of the size of their respective atoms.

Ans.

(i) Electronic configuration of calcium: 2, 8, 8, 2
(ii) Valence electrons in Rb: 1
(iii) number of shells in Sr: 5
(iv) ~~Be~~ (iv) metal
(v) Rb
(vi) Be, Mg, Ca, Rb.

[CBSE Topper 2016]

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.

Ans.

(a) Highest valency

	K	L	M
Na	2	8	1
Mg	2	8	2
Al	2	8	3

Clearly, highest valency is 3 i.e of aluminium as it can lose its 3 valence electrons to become Al^{3+}

(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.

[CBSE Topper 2017]

LONG ANSWER Type Questions (LA)

[5 marks]

5. (a) Define groups in the Modern Periodic Table. How do valency, atomic size and metallic character vary in a group?

(b) The atomic number of an element is 14. Examine if this element will have metallic properties or not. Give reason to justify your answer.

Ans.

① The vertical columns present in the modern a) 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

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and Mendeleev. List one advantage and one limitation of all the three attempts.

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

(iii) State Modern periodic law.

Ans.

(i) Döbereiner's method of classification

Advantage: He, for the first time grouped metals on the basis of their similar chemical properties. He could find 3 Döbereiner's Triads 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.

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.

(ii) 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 in same slot.

(iii) Mendeleev's classification

Advantage: He arranged elements on basis of increasing atomic masses & similar formulas for hydrides & oxides. He also left gaps in his tables which encouraged for discovery of new elements like eka-boron, eka-aluminium etc.

Disadvantage: He placed some elements with more atomic mass prior to ones having less atomic mass for similarity of properties but couldn't justify it.

Ex: He placed 'Te' (127.6u) before 'I' (126.9 u).

(b) Henry Moseley showed atomic no. as a more fundamental property.

(c) Modern Periodic Law states that "properties of elements are periodic function of their atomic number".

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