Periodic Classification of Elements

CHAPTER 5

EXAM DRILL

ANSWERS

1. Seven horizontal rows which are known as periods.

OR

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

2. 18

3. **(b) :** As M^- has electronic configuration 2, 8. Hence, M has 2, 7 configuration which belongs to fluorine (F). F lies in group 17 and second period of the periodic table.

4. Na > Mg > Al > Si

5. Non-metallic elements are placed on right hand side of the periodic table in groups 13 to 18.

6. Atomic no. 18 means electronic configuration is 2, 8, 8. As the valence shell is completely filled, therefore, it belongs to group 18.

7. **(b)**

OR

(c) : Since K has highest atomic radius, it is easiest for it to lose the valence electron.

8. **(b) :** The element with atomic number 14 is Si which is a metalloid.

9. **Döbereiner's Triads :** Groups of three elements which when arranged in increasing order of atomic masses, the atomic mass of the middle element is roughly the average of the atomic masses of other two elements.

OR

Formula of the halide of group 13 element is AX_3.

10. **(a) :** Both are elements with atomic numbers 11 and 19 belong to group 1.

11. Mg^{2+} has 10 electrons

OR

Atomic number of calcium is 20.

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

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

12. **(b) :** The period number is equal to the number of electron shells around the nucleus.

OR

Element with atomic number 20 has electronic configuration : 2, 8, 8, 2 hence it belongs to 4^{th} period as it has four electron shells.

13. Halogens have the smallest radii in their respective period.

14. **(c) :** The elements can be arranged in different periods and groups as follows :

Period/Group	1	2	13	14	15
2^{nd}	—	Be	—	—	—
3^{rd}	Na	Mg	—	Si	P

As metallic character decreases along a period and increases down a group, so Na is the most metallic element than Mg and Si, P is the least metallic element and among Be and Mg, Mg is more metallic. Hence, increasing order of metallic character is P < Si < Be < Mg < Na.

15. **(a)**

16. **(d) :** Atomic radius increases down the group as electrons are added in new shells.

17. **(i) (d) :** In general, the atomic radii decrease along a period and increase down a group.

Atom	$_{12}Mg$	$_{13}Al$	$_{14}Si$	$_{15}P$
Radius (pm)	160	143	118	110

Thus, Mg has maximum atomic radius.

(ii) (d) : Boron is the first element of group 13, hence it is smallest in size.

(iii) (c) : Effective nuclear charge increases along a period and due to addition of electrons in the same shell it causes the incoming electron to experience more force of attraction by the nucleus. Therefore, the size of the atom decreases.

(iv) (c) : Atomic size decreases across the period. Cl has smaller size than Ar. Argon has larger atomic size as compared to Cl due to the inert nature (it has completely filled outer shell).

(v) (a) : Atomic size decreases from left to right in a period and increases from top to bottom in a group. Thus, the order is F < O < C < Cl < Br.

18. (i) (c) : The element is chlorine ($Z = 17$).

(ii) (a) : The element (sulphur) belongs to third period and its valency is 2.

(iii) (c) : Atomic number of the element = 40 – 20 = 20

Electronic configuration of the element is 2, 8, 8, 2; *i.e.*, the element is calcium which belongs to 4th period and 2nd group of the periodic table.

(iv) (c) : The element is sulphur. Sulphur and oxygen belong to group 16.

(v) (d)

19. (i) (b) : Metallic character or electropositive character increases down a group and decreases along a period. The given elements are Li, Na, Be and Mg respectively. Among these elements, Na is most electropositive.

(ii) (c) : Non-metallic character increases left to right in a period and decreases from top to bottom in a group.

(iii) (a)

(iv) (c)

(v) (a)

20. (i) (b) : *F* is argon which has atomic number 18. It has 18 electrons. K^+ and Cl^- ions also have 18 electrons each.

(ii) (c) : *D* is aluminium which is an element of group 13. Valency of aluminium is 3. Hence, the formula of its oxide will be Al_2O_3.

(iii) (b) : *D* is aluminium, which has the most metallic character among the given elements.

(iv) (c) : Valency of *E* is 4. Hence, the formula of the chloride will be ECl_4.

(v) (d) : *E* is silicon which is a metalloid.

21. (i) XF_4

(ii) It is a covalent compound.

The diagram shows that an atom of *X* shares four pairs of electrons with four atoms of fluorine to form the molecule XF_4. Sharing of electrons is a characteristic of covalent compounds.

OR

Electronic configuration of element *A* is 2(*K*), 8(*L*), 4(*M*). As the number of occupied shells is 3, therefore, element *A* belongs to third period. As maximum number of electrons which can be accommodated in any of the above shells is 8, therefore, third period is likely to have 8 elements. They are Na, Mg, Al, Si, P, S, Cl, Ar.

22. (i) $Z = 20$ = proton number = number of electrons

Electronic configuration of *Y* : 2, 8, 8, 2

(ii) It is easier for an atom of element *Y* to lose the two valence electrons to achieve an electronic configuration similar to argon (2, 8, 8). Hence, an atom of element *Y* will form a positive ion with charge equal to its group number, *i.e.*, 2. The symbol of the ion is Y^{2+}.

23. Atomic number of *A* = 20

∴ Electronic configuration of *A* = 2, 8, 8, 2

Atomic number of *B* = 17

∴ Electronic configuration of *B* = 2, 8, 7

As *A* contains 4 shells, it belongs to 4th period and due to presence of two valence electrons, it belongs to 2nd group.

Similarly, *B* contains 3 shells and 7 valence electrons thus, it belongs to 3rd period and 17th (10 + 7) group.

The molecular formula of compound formed when *A* reacts with *B* will be :

Element A B

Valency 2 1 $\Rightarrow AB_2$

OR

Electronic configurations of *A* and *B* are :

$_{19}A$: K L M N : 2, 8, 8, 1 ; $_{17}B$: K L M : 2, 8, 7

The compound formed will be *AB* or KCl as potassium has atomic number 19 and chlorine has atomic number 17. The compound is ionic in nature.

$K - 1e^- \longrightarrow K^+$; $Cl + 1e^- \longrightarrow Cl^-$

$K^+ + Cl^- \longrightarrow KCl$

$K^{\times} + \cdot\underset{\cdot\cdot}{\overset{\cdot\cdot}{Cl}}: \longrightarrow K^+ [:\underset{\cdot\cdot}{\overset{\cdot\cdot}{Cl}}:]^-$ or K^+Cl^-

Since, K loses electron to from cation and Cl accepts electron to form anion, the bond formed will be ionic.

24. When elements are arranged in increasing order of their atomic numbers, elements with similar chemical properties are repeated at definite intervals. This is known as periodicity of properties of elements.

Elements placed in the same group of the periodic table have similar properties because they have same number of outermost electrons and hence, show same valency. Thus, they all will form similar type of compounds.

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

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

(i) Atomic number of K (potassium) is 19 so, it is placed before Ca (20) in the same period. On moving from left to right in a period, the atomic radius decreases.

Hence, atomic radius of Ca will be smaller than that of K.

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

26. (a) As the element '*X*' belongs to 3rd period so, it will have three energy shells. Moreover, it belongs to 16th group, so it will have six valence electrons.

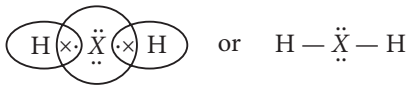
∴ Electronic configuration of *X* = 2, 8, 6

Thus, valence electrons = 6

and valency = 8 – 6 = 2

(b) Molecular formula of the compound formed when *X* reacts with hydrogen = H_2X

The electron dot structure is as :



27. (a) From the formula E_2O, it is clear that the valency of element *E* is one. This means that it has only one electron in its valence shell.

(b) Chlorine is a monovalent element. Since the valency of the element *E* is also one, thus, the formula of the chloride of the element *E* is *E*Cl.

(c) Element *E* belongs to group 1.

OR

(i) All the elements have the same number of electrons in their outermost shell, *i.e.*, valence shell. Hence, these elements will be present in the same group of the periodic table and their valencies will be the same.

(ii) In a group, atomic radii of elements increase as we move from top to bottom. Hence, using the given data of atomic radii, the order of these elements from top to bottom would be *A*, *B* and *C*. We know that the atomic number of elements increases as we go down a group of the periodic table. Thus, element *C* will have the highest atomic number.

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

The elements which have a greater tendency to lose electrons are more metallic thus, the metallic character of elements increases down the group as their tendency to lose electrons increases.

Atomic radius increases as we move down the group. At each successive element, the electron enters to the new shell due to which there is decrease in nuclear charge. Hence, the atomic size increases.

29. (a) For element *X* with atomic number 7, the electronic configuration is 2, 5 so it has 5 valence electrons and hence, it belongs to group 15. As seven electrons are filled in two shells so, it belongs to 2^{nd} period.

Similarly, for *Y* (8), electronic configuration = 2, 6

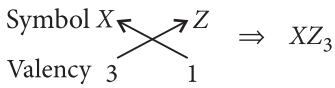
Period number = 2, Group number = 16

and for *Z* (9) = 2, 7

Period number = 2, Group number = 17

(b) As size of the atoms decreases on moving from left to right in a period so, the order of atomic radii will be : $X > Y > Z$

(c) Formula of the compound when *X* combines with *Z* :



30. (a) Because Li and Na have only one valence electron which they can lose easily to complete their octet and thus, show high reactivity.

(b) In a period, nuclear charge increases which leads to increased attraction between nucleus and the valence shell electrons, resulting in decrease in atomic size.

(c) The reactivity of non-metals depends upon the tendency to gain electrons. Since fluorine is smaller in size and have more effective nuclear charge as compared to chlorine, therefore, it accepts the electron more easily than chlorine and thus fluorine is more reactive than chlorine.

31. (a) Mendeleev's periodic table does not explain the position of isotopes. Isotopes are the atoms of the same element having different atomic masses. Therefore, according to Mendeleev's classification these should be placed at different places depending upon their atomic masses. For example, isotopes of hydrogen with atomic masses 1, 2 and 3 should be placed at three places. However, isotopes have not been given separate places in the modern periodic table because of their similar properties.

(b) Potassium (K) will have stronger metallic character than lithium (Li) because as we move from top to bottom in a group, the size increases which increases the ease of liberation of electrons. Therefore, electropositive or metallic character increases.

32. (i) *P* : 10 + 4 = 14 (group - 14)
Q : 10 + 8 = 18 (group - 18)
R : 1 (group - 1)
S : 10 + 7 = 17 (group - 17)

(ii) *P* - Period - 2 *Q* - Period - 2
R - Period - 3 *S* - Period - 3

(iii) *Q* is a noble gas, *R* is an alkali metal, *S* is a halogen.

33. (a) *X* has four shells so, the period number of *X* = 4. Moreover, it has one electron in its outermost shell, so the valency of *X* will be equal to one.

(b) Electronic configuration of *X* shows that it is a metal and metals form basic oxides.

(c) When oxide of *X* is dissolved in water then its hydroxide will be formed.

$X_2O + H_2O \longrightarrow 2XOH$

34. (a) Na is bigger than Mg because on moving from left to right in a period, the atomic number of elements increases which means that the number of protons and electrons in the atom increases. The extra electrons being added to the same shell. Due to this increased nuclear charge, the electrons are attracted closer to the nucleus and thus, the atomic size decreases across a period.

(b) (i) Most metallic element is Na. On moving from left to right in a period the nuclear charge increases thus, the valence electrons are pulled in more strongly by the nucleus and it becomes more and more difficult for the atoms to lose electrons so tendency of atoms to lose electrons (*i.e.,* metallic character) decreases on moving from left to right in a period.

(ii) Most non-metallic element in period 3 is Cl.

Due to increased nuclear charge, it becomes easier for the atoms to gain electrons across a period. So, the tendency to gain electrons (*i.e.,* non-metallic character) increases on moving from left to right in a period.

(c) Silicon has four valence electrons in its outermost shell.

	K	*L*	*M*
Si (14) :	2	8	4

(d) Cl has higher atomic mass than Al. On moving from left to right in a period, atomic number increases, thus, atomic mass increases.

OR

(a) The electronic configurations of the given elements are :

$_4$Be = 2, 2

$_9$F = 2, 7

$_{19}$K = 2, 8, 8, 1

$_{20}$Ca = 2, 8, 8, 2

(i) Potassium (K) has one electron in its outermost shell.

(ii) Be and Ca have two electrons in their outermost shells hence, they belong to the same group.

(b) The horizontal rows of elements in the periodic table are called periods. There are seven periods in the long form of periodic table. The vertical columns in a periodic table are called groups. There are 18 groups in the long form of periodic table.

X belongs to group 1 while *Y* belongs to group 2 of the same period hence, valency of *X* will be 1 and valency of *Y* will be 2.

(i) As we move along the period from left to right, the size of the atoms decreases. Hence, *X* will be bigger than *Y*.

(ii) Across the period from left to right, the metallic character decreases. Hence, *X* is more metallic than *Y*.

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

35. (i) Third period

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

(ii) Nature of compound : Electrovalent/ionic

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

(iv) *GH*

(v) CG_3

36. (i) Elements in a period have same number of shells. Thus, elements *A* and *B* with two shells belong to second period while elements *C* and *D* which have three shells belong to third period.

(ii) Elements in a group have same number of valence electrons. Thus, elements *A* and *C* or *B* and *D* belong to the same group.

(iii) Elements having all shells completely filled belong to group 18 (noble gases). Thus, elements *B* and *D* belong to 18th group.

(iv) Because of bigger size and weaker forces of attraction of the nucleus on the valence electron, element *C* (2,8,1) is more reactive than element *A*.

(v) *B* being a noble gas does not form compounds. But element *A* has only one electron in the valence shell which it can lose very easily. Therefore, element *A* forms more number of compounds than *B*.

OR

(a) (i) The element *G* (atomic number 10) has the electronic configuration 2, 8. Thus, its outermost shell is completely filled. So, it is a noble gas.

(ii) The element *F* (atomic number 17) is a member of halogen family.

(iii) The elements *A* and *B* both are alkali metals.

(iv) The element *D* (atomic number 14) has the electronic configuration 2, 8, 4. So, its valency is 4.

(b) The element *A* (atomic number 3) has the electronic configuration 2, 1. The element *F* (atomic number 17) has the electronic configuration 2, 8, 7. So, the element *A* has to lose one electron, and the element *F* has to gain one electron to attain stable electronic configurations. By doing so, *A* becomes a positive ion, and *F* becomes a negative ion.

$A \rightarrow A^+ + e^-$

$F + e^- \rightarrow F^-$

These positive and negative ions combine to give a compound *AF*.

$A^+ + F^- \rightarrow A^+F^- \rightarrow AF$

So, the formula of compound is *AF*.

(c) *D* has atomic number 14. So, the electronic configuration of *D* is 2, 8, 4.

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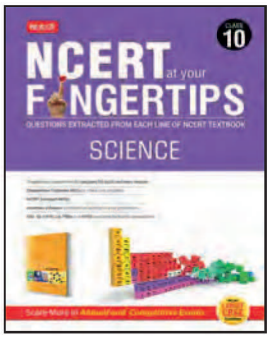

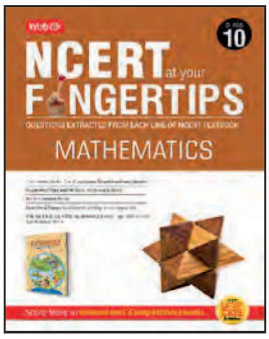

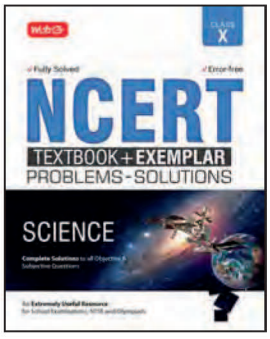

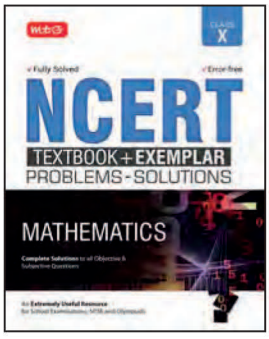

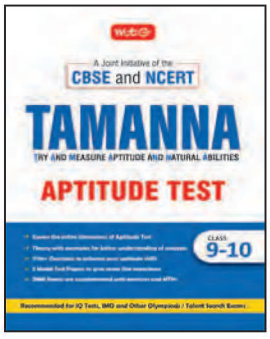

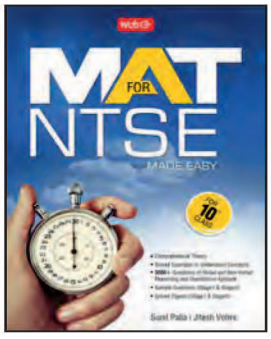

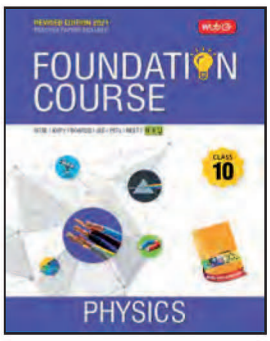

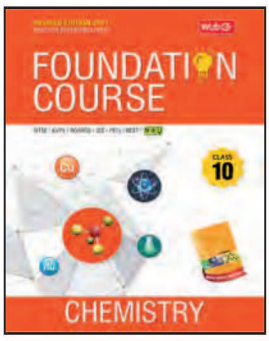

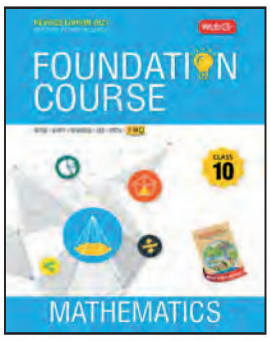

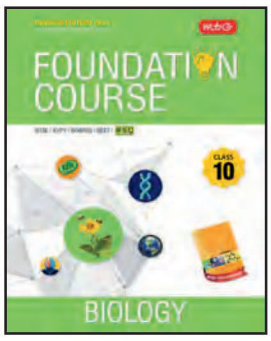

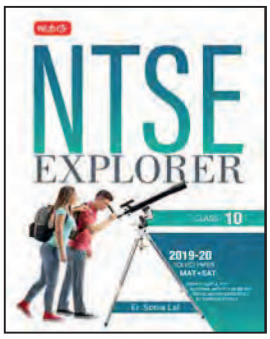

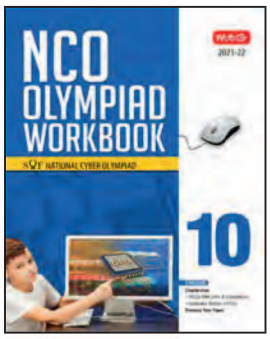

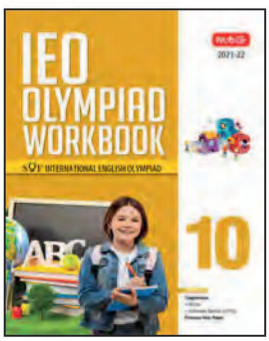

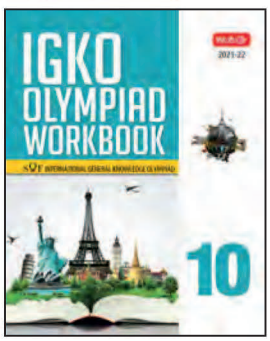

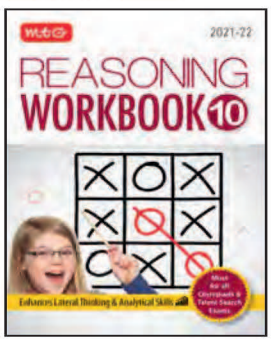

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