

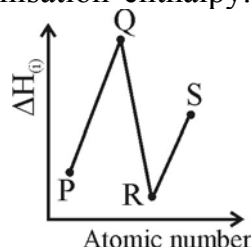
UNIT-3

Classification of elements and periodicity in properties

One mark questions:

1. For the triad of elements A, B and C if the atomic weights of A and C are 7 and 39. Predict the atomic weight of B.
2. "Every eighth element has property similar to the 1st element when placed (arranged) in increasing order of their atomic weight". Name the law for the above statement.
3. Which property of the element was the basis for the classification of elements by Mendeleev?
4. State Mendeleev's periodic law.
5. Name the scientist whose experiment on x-ray spectra of elements led to modern periodic law.
6. State modern periodic law.
7. What is more fundamental property for an atom of an element according to Moseley?
8. Which quantum number corresponds to the period number in the modern periodic table?
9. How many elements are there in the 4th period of long form of periodic table?
10. Write the atomic number of the element unniltrium.
11. Give the IUPAC name of the element whose atomic number is 109?
12. Which one of the following subshell is not filled in the 5th period (5s, 5p, 5d, 4d)?
13. In which period does the lanthanoids appear?
14. In which period does the actinide series of elements appear?
15. Name the series of inner transition element found in the 7th period.
16. How many elements are in lanthanide series?
17. Elements of a group have similar chemical properties. Why?
18. The position of helium is in 18th group of p block and not in 2nd group of s block of long form of periodic table. Justify the statement.
19. To which block of the periodic table do the elements of group-I and II belong?
20. How many groups of elements form p block of the periodic table?
21. What are 'representative elements'?
22. Which group of elements are called 'chalcogens'?
23. Write the general outer electronic configuration of d block elements.
24. Which block of elements are more known for exhibiting paramagnetism and catalytic properties?
25. A metal X forms coloured ions, is paramagnetic and is used as a catalyst. Predict the block to which the metal belongs.

26. Why are d block elements also called transition elements?
27. Write the general outer electronic configuration of f block elements.
28. What are transuranium elements?
29. What is the trend in the metallic character of elements down a group?
30. In bromine molecule (Br_2) the bond distance is 228 pm. What is the covalent radius of bromine?
31. What is covalent radius for a non-metal?
32. Define metallic radius.
33. Arrange the following in the decreasing order of their atomic radius:
- K Be N Na
(Z=19) (Z=4) (Z=7) (Z=11)
34. For noble gases covalent radius cannot be defined. Why?
35. Name a group of non-metals for which covalent radius cannot be defined.
36. Size of the cation is smaller than the parent atom. Give reason.
37. Size of the anion is larger than the parent atom. Give reason.
38. Hydride ion (H^-) is larger than hydrogen atom. Give reason.
39. Mention a species that is isoelectronic with neon.
40. Arrange the following in the increasing order of their ionic radii: F^- , N^{3-} , Na^+ , O^{2-} .
41. $\text{X}^+_{(\text{s})} \longrightarrow \text{X}^{+2}_{(\text{g})} + \text{e}^-$. Correct the equation to represent the 2nd ionisation enthalpy of the element X.
42. Define second ionisation enthalpy.
43. 2nd ionisation enthalpy for an element is higher than the 1st ionisation enthalpy. Give reason.
44. Using the graph, match the ionisation energy of Ar, Na, Ne, Li with positions P, Q, R and S.
45. Define electron gain enthalpy.
46. Why is ionisation enthalpy always positive?
47. Arrange the below elements X, Y, Z in the increasing order of electron gain enthalpy.



Element	Electron gain enthalpy kJ/mol
X	-48
Y	+77
Z	-295

48. What is electronegativity for an atom?
49. "Ability of an atom in a compound to attract the shared electrons to itself". Which periodic property does the above quote represent?
50. On the basis of Pauling scale what is the value of electronegativity of fluorine?
51. How is electronegativity related to non-metallic property of an element?

52. Give reason for the anomalous properties of 2nd period elements when compared to the elements in their respective groups.
53. Mention one property common to all actinoid elements.
54. How are H⁻ and He related?
55. By what name do we know the 17th group elements?
56. Isoelectronic species do not have the same size. Why?
57. Arrange the following in the increasing order of their metallic character: Cu, K, Ge, Br.
58. What is the difference between an amphoteric oxide and a neutral oxide?
59. Give an example for a basic oxide.
60. Give an example for a neutral oxide.
61. Name the element that is diagonally related to beryllium.
62. Why do 17th group elements have high negative electron gain enthalpy?

Two Marks questions:

1. Mention one merit and one drawback of Mendeleev's periodic table.
2. What was the name given by Mendeleev to the element if existed and had properties similar to that of the aluminium? What is the present name of the element?
3. What observation made by Moseley showed that atomic number and not atomic mass is more fundamental property of an element?
4. With respect to long form of periodic table what are groups and periods?
5. How many groups and periods are present in the long form of periodic table?
6. How many elements are there in 2nd period? Justify your answer.
7. Which is the i) shortest ii) longest period in the long form of periodic table?
8. What are the subshells filled in i) 2nd period ii) 4th period?
9. Hydrogen is placed separately at the top of the long form periodic table. Justify its position giving two reasons.
10. The electronic configuration of an element is [Ar] 3d⁷ 4s². To which block and period does it belong?
11. Write the electronic configuration of the element with atomic number 118. Predict the group the element belongs to.
12. Mention any two differences in the properties of metals and non-metals.
13. What are metalloids? Give an example.
14. Determination of size of an atom cannot be precise. Give reason.
15. How does atomic radius vary along a period and down a group in the periodic table.
16. Explain why atomic size decreases along a period and increases down a group.

17. Given: a) F, Cl, Br b) N, O, F : For which one of these set of elements does the atomic radius increase? Justify your answer.
18. What are isoelectronic species? Give example.
19. Which among the following has i)largest ii)smallest ionic radii: Na^+ , Al^{+3} , Mg^{+2} , F^- ?
20. Define ionisation enthalpy. Give its SI unit.
21. Compare the 1st and 2nd ionisation enthalpies of magnesium with reason.
22. Which group of elements have maximum value for ionisation enthalpy. Give reason.
23. Draw a graph showing the variation of ionisation enthalpy with atomic number for the elements Li, Be, B and C.
24. How does ionisation enthalpy vary along a period? Give reason.
25. How does ionisation enthalpy vary down a group? Give reason.
26. Ionisation enthalpy of boron is less than that of beryllium. Give reason.
27. Why is ionisation enthalpy of oxygen less than that of nitrogen?
28. Ionisation enthalpy of aluminium is less than that of magnesium. Justify the statement.
29. Give two differences between ionisation enthalpy and electron gain enthalpy for an element.
30. How does electron gain enthalpy vary along a period? Give reason.
31. How does electron gain enthalpy vary down the group? Explain.
32. Between flourine and chlorine which one of these has low electron gain enthalpy. Give reason.
33. Which among the following has the most positive and the most negative electron gain enthalpy: O, Ar, Na, S?
34. How does electronegativity vary along a period? Give reason.
35. How does electronegativity vary down a group? Give reason.
36. Name any two periodic properties that increases along a period.
37. Name any two periodic properties that decreases down a group.
38. Arrange the elements in the following two sets in the increasing order of their electronegativity values: a) [Cl, F, I, Br] b) [S, Cl, Al, Na]
39. Which one of these is possible: BF_4^- or BF_6^{+3} . Justify your answer. (atomic number of boron = 5)
40. Why is the chemical reactivity of elements at the two extremes (except noble gases) of the periodic table very high?
41. Why are the elements placed in the extreme left of the periodic table most metallic?
42. Mention two factors on which ionisation enthalpy depends.

43. Mention one exception (anomaly) each found in the variation of i) ionisation enthalpy in the 2nd period ii) electron gain enthalpy in the 16th period.
44. Classify these into acidic, basic, amphoteric and neutral oxide: CO, Na₂O, Cl₂O₇, Al₂O₃.

Four Marks:

1. a) What is the valence of 2nd group elements?
 b) Using the table given below, evolve the formulae of i) aluminium oxide, ii) aluminium nitride, iii) aluminium fluoride:

Group No.	13	15	16	17
Element	Al	N	O	F

2. a) When is a cation and an anion is formed from an atom?
 b) Arrange H⁺, H⁻, H in decreasing order of their size.
 c) What does the energy absorbed in the reaction represent?

$$X_{(g)} \longrightarrow X_{(g)}^{+} + e^{-}$$
3. What does ionisation enthalpy, electron gain enthalpy and electronegativity measure for an atom? Which one of these is not a measurable quantity?
4. Given:

Element	Electronic configuration
P	1s ² 2s ²
Q	1s ² 2s ² 2p ⁶ 3s ² 3p ¹
R	1s ² 2s ² 2p ⁶ 3s ¹
S	1s ² 2s ² 2p ⁴

- i) Arrange P, Q, R, S in decreasing order of their atomic radii.
 ii) Which one among these is a chalcogen?
 iii) Which one among these has more positive electron gain enthalpy?
 iv) Give the formula of the oxide formed from R and S.
5. Mention any two characteristic properties each for s and p block elements.
6. How does metallic and non-metallic character vary along a period and down a group. Give reasons.
7. Given the outer electronic configurations of A and B as 3s² and 3s² 3p⁵.
 a) Locate their position in the periodic table (group and period)
 b) Which one of these has i) larger atomic size ii) higher ionisation energy

Scheme of valuation with complete answers

One mark questions:

Qn.No.	Value points	Marks allotted
1	23	1
2	Law of octaves	1
3	Atomic weight or atomic mass	1
4	Properties of the elements are periodic functions of their atomic weight	1
5	Moseley or Henry Moseley	1
6	Physical and chemical properties or properties of the elements are periodic functions of their atomic numbers	1
7	Atomic number	1
8	Principal quantum number	1
9	18	1
10	103	1
11	Unnilennium	1
12	5d	1
13	6 th period or 6	1
14	7 th period or 7	1
15	Actinoids or actinide series	1
16	14	1
17	Similar outermost electronic configuration or same number and same distribution of electrons in their outermost orbital	1
18	It has completely filled value shell ($1s^2$) and has properties characteristic of noble gases	1
19	s block	1
20	6	1
21	s and p block	1
22	16 th group or 16	1
23	$(n-1) d^{1-10} ns^{0-2}$	1
24	d – block	1
25	d – block	1
26	They act as a bridge between chemically most active metals of s-block and less active elements of groups 13 and 14.	1
27	$(n-2) f^{1-14} (n-1) d^{0-1} ns^2$	1
28	Elements appearing after uranium	1
29	Metallic character increases	1
30	114 pm	1
31	It is one half the distance between two atoms bonded by a single covalent bond	1
32	It is half the internuclear distance separating the metal cores in the metallic crystal	1

33	$K > Na > Be > N$	1
34	They are monoatomic gases	1
35	Noble gases	1
36	It has fewer electrons and nuclear charge remains same	1
37	It has more electrons and effective nuclear charge decreases	1
38	In H^- due to more number of electrons the effect of nuclear charge is less	1
39	Na^+ (or Mg^{+2} , Al^{+3} or any other)	1
40	$Na^+ < F^- < O^{-2} < N^{-3}$	1
41	$X_{(g)}^+ \longrightarrow X_{(g)}^{+2} + e^-$	1
42	It is the energy required to remove the 2 nd most loosely bound electron	1
43	It is more difficult to remove an electron from a positively charged ion than from a neutral atom	1
44	$P = Li, Q = Ne, R = Na, S = Ar$	1
45	It is the enthalpy change that occurs when an electron is added to a neutral gaseous atom	1
46	It is an endothermic process or energy is always absorbed to remove an electron	1
47	$Y < X < Z$	1
48	It is the ability of an atom in a compound to attract the shared electrons to itself	1
49	Electronegativity	1
50	4	1
51	Electronegativity \propto non-metallic character	1
52	Same size, large charge / radius ratio, high electronegativity (any two)	1
53	Radioactivity	1
54	Isoelectronic	1
55	Halogens	1
56	They have different nuclear charge	1
57	$Br < Ge < Cu < K$	1
58	Amphoteric oxide has both acidic and basic character. But a neutral oxide is neither acidic nor basic.	1
59	Na_2O	1
60	CO	1
61	Aluminium	1
62	By gaining one electron they attain noble gas configuration	1

Two mark questions:

Qn.No.	Value points	Marks allotted
1	i) Position of some elements do not fit in with the scheme of classification or element of lower atomic weight are placed before the element with high atomic weight.	1
	ii) He correctly predicted the existence of few elements.	1
2	Eka-aluminium	1
	Gallium	1
3	The regularities in the x-ray spectra of elements could be accounted if a plot of $\sqrt{\nu}$ (ν is the frequency of x-rays emitted) versus atomic number and not atomic mass was done.	1
	or	1
	A graph of $\sqrt{\nu}$ versus atomic number and not atomic mass could explain the characteristics of x-ray spectra of elements.	1
		1
4	The vertical column of elements are called groups.	1
	The horizontal rows of elements are called periods.	1
5	18 groups and 7 periods	1+1
6	8 elements	1
	In the 2 nd period ($n = 2$) the sub-shells filled are 2s and 2p only	1
7	1 st period	1
	6 th period	1
8	i) 2s and 2p	1
	ii) 4s, 3d and 4p	1
9	i) It has only one electron in 1 st orbital and hence could be placed in I group	1
	ii) It can also gain one electron to achieve a noble gas configuration like 17 group elements and hence can be placed in 17 group.	1
10	Block – d	1
	Period – 4	1
11	$1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^6 5s^2 4d^{10} 5p^6 6s^2 4f^{14} 5d^{10} 6p^6 7s^2 5f^{14} 6d^{10} 7p^6$ or [Rn] $7s^2 5f^{14} 6d^{10} 7p^6$	1
	18 group or noble gas group	1
12	Metals	Non-metals
	1. Have high melting point	Have low melting point.
	2. Good conductor of heat and electricity	Bad conductor of heat and electricity
	3. Malleable and ductile	Not malleable and ductile
13	Elements that show properties similar to both metals and non-metals	1
	Silicon (or any other)	1
14	i) Atom is very small	1
	ii) Electron cloud of the atom does not have a sharp boundary	1

15	It decreases along a period It increases down a group	1 1
16	i) Along a period the electron is added to same valence shell and effective nuclear charge increases. ii) Down a group the electron is added to a new shell and effective nuclear charge decreases.	1 1
17	Set a The elements belong to a group and down the group the atomic size increases.	1 1
18	Species containing same number of electrons. E.g.: Na^+ , Mg^{+2}	1 1
19	F^- Al^{+3}	1 1
20	It is the energy required to remove an electron from an isolated gaseous atom in its ground state. kJ mol^{-1} or kJ	1 1
21	1 st ionisation enthalpy of magnesium is less than the 2 nd . More energy is required to remove an electron from Mg^+ than from Mg	1 1
22	Noble gases or 18 group. They have a very stable electronic configuration.	1 1
23	<p>Graph-1 Position of elements-1</p>	1+1
24	It increases. Increase in nuclear charge outweighs (or is more prominent) the shielding effect	1 1
25	It decreases. Increase in shielding effect outweighs the increase in nuclear charge.	1 1
26	In Beryllium electron is removed from 2s electron which is closer to the nucleus. In boron the electron is removed from 2p orbital which is far away from the nucleus and is also shielded by 2s electrons.	1 1
27	In nitrogen the three 2p electrons are in different atomic orbitals. In oxygen, two of the four 2p electrons occupy the same 2p orbital resulting in electron-electron repulsion.	1 1
28	In magnesium the electron has to be removed from 3s orbital which is closer to the nucleus. In aluminium the electron has to be removed from 3p orbital which is far from the nucleus and is also well shielded by 3s electrons.	1 1

29	Ionisation enthalpy	Electron gain enthalpy	1
	Its always positive	It may be positive, negative or zero	
	It measures the hold of the nucleus on its electron.	It measures the affinity of an atom to add an electron.	
30	It increases or it becomes more negative. Effective nuclear charge increases.		1
			1
31	It decreases or it becomes less negative. Size of the atom increases and effective nuclear charge decreases.		1
			1
32	Fluorine The electron is added to 2p orbital which is small and experiences more repulsion from other electrons.		1
			1
33	Ar O		1
			1
34	It increases Atomic radius decreases		1
			1
35	It decreases Atomic radius increases		1
			1
36	Ionisation enthalpy and electronegativity		2
37	Electron gain enthalpy and electronegativity		2
38	I < Br < F < Cl Na < Al < S < Cl		1
			1
39	[BF ₄] ⁻ Boron has only 4 valence orbitals.		1
			1
40	Towards the left, ionisation energy is the least and atoms have the tendency to lose the electron. Towards the right, electron gain enthalpy is more negative and hence atoms have tendency to gain an electron.		1
			1
41	The elements have low ionisation enthalpy and have high tendency to form cations.		1
			1
42	Attraction of electrons towards the nucleus. Repulsion of electrons from each other.		1
			1
43	Beryllium and Boron or oxygen and nitrogen Oxygen and sulphur		1
			1
44	CO- neutral, Na ₂ O – basic, Al ₂ O ₃ – amphoteric, Cl ₂ O ₇ – acidic		2

Any other suitable answer to be considered as value point.

Four mark questions:

Qn.No.	Value points	Marks allotted
1	a) 2 b) i) Al_2O_3 ii) AlN iii) AlF_3	1 1 1 1
2	When an atom loses an electron and when an atom gains an electron. $\text{H}^- > \text{H} > \text{H}^+$ 1 st ionisation enthalpy	2 1 1
3	Ionisation energy measures tendency of an atom to lose an electron. Electron gain enthalpy measures tendency of an atom to gain an electron. Electronegativity measures the ability of an atom in a compound to attract shared electrons. Electronegativity	1 1 1 1
4	$\text{Q} > \text{R} > \text{P} > \text{S}$ S Q R_2S	1 1 1 1
5	s block : They are metals and form basic oxides. p block : They are non-metals and form acidic oxides.	2 2
6	Metallic character increases down a group. Ionisation energy decreases. Non-metallic character increases along a period. Electron gain enthalpy increases.	1 1 1 1
7	A: 2 nd group, 3 rd period ; B: 17 th group, 3 rd period i) A ii) B	2 2