Exercise-1

Marked Questions may have for Revision Questions.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Development of Periodic Table & Modern Periodic Table

A-1. Explain the following :
(i) Why argon (atomic mass = 39.94) has been placed before potassium (atomic mass = 39.10) in the Modern periodic table ?
(ii) There are only 14 lanthanides and only 14 actinides in Modern periodic table.

A-2. Why the third period of Modern periodic table contains 8 elements and not 18?

Section (B) : Shielding Effect & Z_{eff}

B-1. Tell the relation between effective nuclear charge (Z_{eff}), atomic number (Z) and shielding constant (σ). Explain it qualitatively.

B-2. Which orbital electrons are known to shield the nuclear charge improperly ? Does this generate some irregularity in properties of elements ?

Section (C) : Oxidation states & Inert pair effect

C-1. Pb^{4+} compounds are very good oxidising agents. Explain.

C-2. Arrange the following in correct order of stability :
(i) Ga^{+}, In^{+}, Tl^{+} (ii) As^{+5}, Sb^{+5}, Bi^{+5}

Section (D) : Atomic and Ionic radius

D-1. Explain why cations are smaller and anions larger in radii than their parent atoms ?

D-2. The atomic radii of palladium and platinum are nearly same. Why ?

D-3. In the ionic compound KF, the K^{+} and F^{-} ions are found to have practically identical radii, about 1.34 Å each. What can you predict about the relative atomic radii of K & F ?

Section (E) : Ionisation energy

E-1. Why second ionization enthalpy is always higher than the first ionisation enthalpy for every element ?

E-2. The first ionization enthalpy of carbon is greater than that of boron, whereas the reverse is true for second ionization enthalpy. Explain.

E-3. Among the elements B, Al, C and Si, (i) which element has the highest first ionisation enthalpy ?
(ii) which element has the most metallic character ?
Justify your answer in each case.

Section (F) : Electron gain enthalpy

F-1. Be and Ne have positive values of electron gain enthalpy against the general trend in their period in Modern periodic table. Explain.

F-2. Nitrogen has positive electron gain enthalpy whereas oxygen has negative. However, oxygen has lower ionisation enthalpy than nitrogen. Explain.

Section (G) : Electronegativity

G-1. Among alkali metals, which element do you expect to be least electronegative ?

G-2. Explain the following according to Modern periodic table :
(a) Electronegativity of elements increase on moving from left to right in a period.
(b) Ionisation enthalpy decrease in a group from top to bottom.

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Development of Periodic Table & Modern Periodic Table

A-1. The period number in the long form of the periodic table is equal to :
(A) magnetic quantum number of any element of the period.
(B) atomic number of any element of the period.
(C) maximum Principal quantum number of any element of the period.
(D) maximum Azimuthal quantum number of any element of the period.

A-2. Which one of the following statements related to the modern periodic table is **incorrect** :
(A) The p-block has 6 columns, because a maximum of 6 electrons can occupy all the orbitals in a p-subshell.
(B) The d-block has 8 columns, because a maximum of 8 electrons can occupy all the orbitals in a d-subshell.
(C) Each block contains a number of columns equal to the number of electrons that can occupy that subshell.
(D) The block indicates value of Azimuthal quantum number (ℓ) for the last subshell that received electrons in building up the electronic configuration.

A-3. The elements in which electrons are progressively filled in 4f-orbital are called :
(A) actinoids (B) transition elements (C) lanthanoids (D) halogens

A-4. Which of the following statements is not correct regarding hydrogen :
(A) It resembles halogens in some properties.
(B) It resembles alkali metals in some properties.
(C) It can be placed in 17^{th} group of Modern periodic table.
(D) It cannot be placed in 1^{st} group of Modern periodic table.

A-5. Atomic number of Ag is 47. In the same group, the atomic numbers of elements placed above and below Ag in Long form of periodic table will be :
(A) 29, 65 (B) 39, 79 (C) 29, 79 (D) 39, 65

A-6. In modern periodic table, the element with atomic number Z = 118 will be :
(A) Uuo; Ununoctium; alkaline earth metal (B) Uno; Unniloctium; transition metal
(C) Uno; Unniloctium; alkali metal (D) Uuo; Ununoctium; noble gas

Section (B) : Shielding Effect & Z_{eff}

B-1. The order of screening effect of electrons of s, p, d and f orbitals of a given shell of an atom on its outer shell electrons is :
(A) s > p > d > f (B) f > d > p > s (C) p < d < s > f (D) f > p > s > d

B-2. Which of the following is generally true regarding effective nuclear charge (Z_{eff}) :
(A) It increases on moving left to right in a period.
(B) It remains almost constant on moving top to bottom in a group.
(C) For isoelectronic species, as Z increases, Z_{eff} decreases.
(D) Both (A) and (B).

B-3. Among following species which of them have maximum Z_{eff}.
(A) Sn (B) Sn^{4+} (C) In (D) In^{+}

B-4. From the given set of species, point out the species from each set having highest Z_{eff}

	(a) O^{2-}, F^{-}, Na^{+}			(b) Li, Be, Na			(c) He, Li^{+}, H^{-}		
	a	b	c				a	b	c
(A)	Na^{+}	Be	Li^{+}	(B)	O^{2-}	Li	H^{-}		
(C)	F^{-}	Na	He	(D)	Na^{+}	Be	He		

Section (C) : Oxidation states & Inert pair effect

C-1. The atomic number of an element which can not show the oxidation state of +3 is-
(A) 13 (B) 32 (C) 33 (D) 17

C-2. The most common oxidation state of an element is –2. The number of electrons present in its outer most shell is -
(A) 2 (B) 4 (C) 6 (D) 8

C-3. Most stable oxidation state of gold is :
(A) + 1 (B) +3 (C) +2 (D) zero

C-4. Which can have both +ve and –ve oxidation states in their compounds
(A) F (B) I (C) Na (D) Al

C-5. The oxidation state of nitrogen varies from :
(A) –3 to + 5 (B) 0 to +5 (C) –3 to 1 (D) +3 to +5

C-6. Which metal exhibtis more than one oxidation states in their compounds
(A) Na (B) Mg (C) Al (D) Fe

C-7. Electrons of which subshell do not participate in bonding due to inert pair effect ?
(A) 6s (B) 6p (C) 5d (D) 4f

C-8. Thallium shows different oxidation states because :
(A) of its high reactivity (B) of inert pair of electrons
(C) of its amphoteric nature (D) its is a transition metal

C-9. In which of the following elements, + 3 oxidation state is more stable than + 5 ?
(A) P (B) As (C) N (D) Bi

C-10. Which of the following is correct order of stability :
(A) $Tl^{3+} > Bi^{3+}$ (B) $PbO_2 > PbO$ (C) $BiI_5 < BiF_5$ (D) $Sn^{2+} = Ge^{2+}$

Section (D) : Atomic and Ionic radius

D-1. Select correct statement about radius of an atom :
(A) Values of Vander waal's radii is larger than those of covalent radii because the Vander waal's forces are much weaker than the forces operating between atoms in a covalently bonded molecule.
(B) The metallic radii is smaller than the Vander waal's radii, since the bonding forces in the metallic crystal lattice are much stronger than the Vander waal's forces.
(C) Both (A) & (B)
(D) None of these

D-2. Match the correct atomic radius with the element :

S.No.	Element	Code	Atomic radius (pm)
(i)	Be	(p)	74
(ii)	C	(q)	88
(iii)	O	(r)	111
(iv)	B	(s)	77
(v)	N	(t)	66

(A) (i) – r, (ii) – q, (iii) – t, (iv) – s, (v) – p (B) (i) – t, (ii) – s, (iii) – r, (iv) – p, (v) – q
(C) (i) – r, (ii) – s, (iii) – t, (iv) – q, (v) – p (D) (i) – t, (ii) – p, (iii) – r, (iv) – s, (v) – q

D-3. Choose the correct order of atomic radii of Fluorine and Neon (in pm) out of the options given below :
(A) 72, 160 (B) 160, 160 (C) 72, 72 (D) 160, 72

D-4. The size of isoelectronic species O^{-2}, F^- and Na^+ is affected by :
(A) nuclear charge (Z)
(B) valence principal quantum number (n)
(C) electron-electron interaction in the outer orbitals
(D) none of the factors because their size is the same.

D-5. Which of the following order of atomic / ionic radius is not correct ?
(A) F < Cl < Br < I (B) $Y^{3+} > Sr^{2+} > Rb^+$ (C) Nb ≈ Ta (D) Li > Be > B

Section (E) : Ionisation energy

E-1. Which one of the following statements is incorrect in relation to ionisation enthalpy ?
(A) Ionization enthalpy increases for each successive electron.
(B) The greatest increase in ionization enthalpy is experienced on removal of electron from core of noble gas configuration.
(C) End of valence electrons is marked by a big jump in ionization enthalpy.
(D) Removal of electron from orbitals bearing lower n value is easier than from orbitals having higher n value.

E-2. The first ionisation enthalpies (in eV) of N & O are respectively given by :
(A) 14.6, 13.6 (B) 13.6, 14.6 (C) 13.6, 13.6 (D) 14.6, 14.6

E-3. The first ionisation enthalpies of Na, Mg, Al and Si are in the order :
(A) Na < Mg > Al < Si (B) Na > Mg > Al > Si (C) Na < Mg < Al < Si (D) Na > Mg > Al < Si

E-4. Which represents alkali metals (i.e. 1st group metals) based on $(IE)_1$ and $(IE)_2$ values (in kJ/mol) ?

		$(IE)_1$	$(IE)_2$			$(IE)_1$	$(IE)_2$
(A)	X	500	1000	(B)	Y	600	2000
(C)	Z	550	7500	(D)	M	700	1400

E-5. Which of the following relation is correct with respect to first (I) and second (II) ionization enthalpies of potassium and calcium ?
(A) $I_{Ca} > II_K$ (B) $I_K > I_{Ca}$ (C) $II_{Ca} > II_K$ (D) $II_K > II_{Ca}$

Section (F) : Electron gain enthalpy

F-1. Among halogens, the correct order of amount of energy released in electron gain (electron gain enthalpy) is:
(A) F > Cl > Br > I (B) F < Cl < Br < I (C) F < Cl > Br > I (D) Cl > Br > F > I

F-2. Which of the following will have the most negative electron gain enthalpy and which the least negative ? F, P, S, Cl.
(A) P, Cl (B) Cl, F (C) Cl, S (D) Cl, P

F-3. The order of electron gain enthalpy (magnitude) of O, S and Se is :
(A) O > S > Se (B) S > Se > O (C) Se > S > O (D) S > O > Se

F-4. Electronic configurations of four elements A, B, C and D are given below :
(i) $1s^2 2s^2 2p^6$ (ii) $1s^2 2s^2 2p^4$ (iii) $1s^2 2s^2 2p^6 3s^1$ (iv) $1s^2 2s^2 2p^5$
Which of the following is the correct order of increasing tendency to gain electron :
(A) (i) < (iii) < (ii) < (iv) (B) (i) < (ii) < (iii) < (iv) (C) (iv) < (ii) < (iii) < (i) (D) (iv) < (i) < (ii) < (iii)

F-5. Which of the following statement is correct ?
(A) Electron gain enthalpy may be positive for some elements.
(B) Second electron gain enthalpy always remains positive for all the elements.
(C) $\Delta_{eg}H(K^+) = -$ IE (K)
(D) All of these

Section (G) : Electronegativity

G-1. Which of the following is affected by the stable electron configuration of an atom ?
(a) Electronegativity (b) Ionisation enthalpy (c) Electron gain enthalpy
Correct answer is :
(A) only electronegativity (B) only ionisation enthalpy
(C) both electron gain enthalpy and ionisation enthalpy (D) all of the above

G-2. The electronegativity values of C, N, O and F on Pauling scale :
(A) decrease from carbon to fluorine.
(B) increase from carbon to fluorine.
(C) increase upto oxygen and then decrease upto fluorine.
(D) decrease from carbon to nitrogen and then increase continuously.

G-3. Correct order of electronegativity of N, P, C and Si on Pauling scale is :
(A) N > P > C > Si (B) C > Si > N > P (C) N < P < C < Si (D) N > C > P > Si

G-4. The correct order of electronegativity on Pauling scale is :
(A) F > Cl > O > S (B) Li > Na > K > Rb > Cs
(C) Be < B < N < C (D) Both (A) and (B)

G-5. Which of the following is most electronegative element.
(A) Li (B) Mg (C) H (D) Na

PART - III : MATCH THE COLUMNS

Section (A) : Development of Periodic Table & Modern Periodic Table

1. Match the column.

	Column-I (Atomic number)		Column-II
(A)	57	(p)	is d-Block or p-Block element
(B)	17	(q)	is 4^{th} period element
(C)	19	(r)	is violates Aufbou's principle element
(D)	29	(s)	is non metal
		(t)	is s-Block element

Section (E) : Ionisation energy

2. Match the column.

	Column-I		Column-II
(A)	$O(g) + e^- \longrightarrow O^-(g)$	(p)	Positive Electron gain enthalpy
(B)	$O^-(g) + e^- \longrightarrow O^{2-}(g)$	(q)	Negative Electron gain enthalpy
(C)	$Na^-(g) \longrightarrow Na(g) + e^-$	(r)	Exothermic
(D)	$Mg^+(g) + e^- \longrightarrow Mg(g)$	(s)	Endothermic

Exercise-2

Marked Questions may have for Revision Questions.

PART - I : ONLY ONE OPTION CORRECT TYPE

1. The statement that is **not** correct for periodic classification of elements in Modern periodic table is :
(A) The properties of elements are periodic function of their atomic numbers.
(B) Non-metallic elements are less in number than metallic elements.
(C) For transition elements, the 3d-orbitals are filled with electrons after 3p-orbitals and before 4s-orbitals.
(D) The first ionisation enthalpies of elements generally increase with increase in atomic number as we go along a period.

2. Which of the following is true about the element $_{33}As$ according to Modern periodic table :
(A) It is a 5^{th} period element. (B) It is a p-block element.
(C) It belongs to 16^{th} group. (D) It is one among typical elements.

3. Which of the following contains atomic number of only s-block
(A) 55,12,18,53 (B) 13,33,54,83 (C) 3, 20, 55, 87 (D) 22,33,55,66

4. Screening effect is not observed in :
(A) He^+ (B) Li^{2+} (C) Be^{3+} (D) In all cases

5. Which of the following have higher Z_{eff} than Fluorine.
(A) Cl (B) O (C) F^- (D) none of these

6. The oxidation number that iron does not exhibit in its common compounds or in its elemental state is :
(A) 0 (B) +1 (C) +2 (D) +3

7. Which of the following can show +7 oxidation state?
(A) Mn (B) F (C) In (D) N

8. Which of following does not exist :
(A) TlI_3 (B) PbF_4 (C) Both (A) and (B) (D) None of these

9. Elements of which period show maximum inert pair effect :
(A) 3 (B) 4 (C) 5 (D) 6

10. When the following five anions are arranged in order of decreasing ionic radius, the correct sequence is:
(A) Se^{2-}, I^-, Br^-, O^{2-}, F^- (B) I^-, Se^{2-}, Br^-, F^-, O^{2-}
(C) Se^{2-}, I^-, Br^-, F^-, O^{2-} (D) I^-, Se^{2-}, Br^-, O^{2-}, F^-

11. In which of the following compounds, manganese shows maximum radius ?
(A) MnO_2 (B) $KMnO_4$ (C) MnO (D) $K_3[Mn(CN)_6]$

12. Which of the following is the correct order of ionisation enthalpy ?
(1) $Be^+ > Be$ (2) $Be > Be^+$ (3) C > Be (4) B > Be
(A) 2, 3 (B) 3, 4 (C) 1, 3 (D) 1, 4

13. Considering the elements B, Al, Mg, and K, the correct order of their metallic character is :
(A) B > Al > Mg > K (B) Al > Mg > B > K (C) Mg > Al > K > B (D) K > Mg > Al > B

14. Fluorine has the highest electronegativity among the ns^2np^5 group on the Pauling scale, but the electron affinity of fluorine is less than that of chlorine because :
(A) the atomic number of fluorine is less than that of chlorine.
(B) fluorine being the first member of the family behaves in an unusual manner.
(C) chlorine can accommodate an electron better than fluorine by utilising its vacant 3d–orbital.
(D) small size, high electron density and an increased electron repulsion makes addition of an electron to fluorine less favourable than that in the case of chlorine in isolated stage.

15. Which one of the following arrangements represents the correct order of electron gain enthalpy (with negative sign) of the given atomic species ?
(A) Cl < F < S < O (B) O < S < F < Cl (C) S < O < Cl < F (D) F < Cl < O < S

16. Which of the following statement is incorrect ?
(A) The tendency to attract bonded pair of electron in case of hybrid orbitals follow the order: $sp > sp^2 > sp^3$
(B) Alkali metals generally have negative value of electron gain enthalpy.
(C) $Cs^+(g)$ releases more energy upon gain of an electron than Cl(g).
(D) The electronegativity values for 2p-series elements is less than that for 3p-series elements on account of small size and high inter electronic repulsions.

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. Identify the group (in Modern Periodic Table) and valency of a hypothetical element having atomic number 119. If group number is x and valency is y. Give the the value of x + y.

2. An element belonging to 3d series of modern periodic table has spin magnetic moment = 5.92 B.M. in +3 oxidation state. Determine the atomic number of element.

3. An element has atomic number 29. It belongs to x period and y group. Give value of 2x + y :

4. How many of the following have greater Z_{eff} than Silicon atom :
(i) Na (ii) Mg (iii) Al (iv) P (v) Cl
(vi) S (vii) N (viii) O (ix) F

5. The most stable oxidation state of chromium is +n, Give the value of 'n'.

6. How many of the following compounds are found to exist?
(i) BiF_5 (ii) $T\ell I_3$ (iii) PbO_2 (iv) $SnCl_2$
(v) $T\ell_2O_3$ (vi) PbI_4 (vii) As_2O_3

7. The Lanthanides are characterized by the uniform [+n] oxidation state shown by all the Lanthanides . What is the value of 'n'

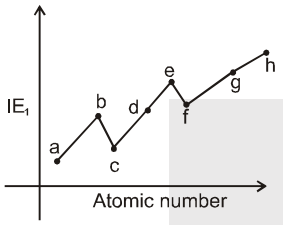
8. Highest oxidation states shown by Chromium & Manganese are +x & +y respectively. Give the value of x + y ?

9. If internuclear distance between A atoms in A_2 is 10Å and between B atoms in B_2 is 6Å, then calculate internuclear distance between A and B in Å. [Electronegativity difference between A and B has negligible value].

10. Report atomic number of the element having largest size among the following :
Ni, Cu, Zn

11. How many of following atoms have maximum ionization energy than boron.
(i) Be (ii) N (iii) P (iv) Ga (v) S (vi) Mg

12.



Where a, b, c, d, e, f, g, h are 3rd period elements. If difference between atomic number of elements b and e is x and difference between atomic number of elements c and f is y. What is the value of x – y.

13. Values of IE_1, IE_2, IE_3 of an element are 9.3, 18.2 and 553.8 eV. Predict group number in Modern Periodic Table.

14. $A^-(g) \rightarrow A^{2+}(g)$ $\Delta H = 1100$ KJ/mol
$A(g) \rightarrow A^{2+}(g)$ $\Delta H = 1200$ KJ/mol
Electron gain enthalphy of A is $P \times 10^2$ KJ/mol. What is the value of P ?

15. The electron gain enthalpy of a hypothetical element 'A' is –3 eV per atom. How much energy in kCal is released when 10 g of 'A' are completely converted to A^- ions in gaseous state ?
(Take : 1 eV per atom = 23 kCal mol^{-1}, Molar mass of A = 30 g)

16. What is atomic number of element which have maximum electron affinity in Modern Periodic table.

17. How many of the following elements are more electronegative than Boron.
(i) H (ii) Li (iii) Be (iv) C (v) N (vi) O (vii) F

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. The group in modern periodic table in which all the elements do not have same number of electrons in their outermost shell is (considering upto 6th period) :
(A) 13th (B) 11th (C) 9th (D) 18th

2. Element corresponding to which of these/this atomic number belongs to p-block in Modern Periodic Table :
(A) 19 (B) 35 (C) 53 (D) 83

3. Which of the following have greater Z_{eff} than Zn :
(A) Cu^+ (B) Cu^{2+} (C) Fe^{3+} (D) Zn^{2+}

4. Which of the following is/are correct regarding oxidation state of elements in their compounds :
(A) All d-Block elements show multiple oxidation state.
(B) All p-Block elements show multiple oxidation state.
(C) All s-Block elements show single oxidation state.
(D) Some of 18 group elements can show multiple oxidation state.

5. Which of the following elements have + 3 as most popular oxidation state?
(A) Al (B) Xe (C) Cu (D) Sc

6. Which of the following show non-zero multiple oxidation state ?
(A) S (B) O (C) Zn (D) H

7. Which of the following pairs of elements show similar set of oxidation state ?
(A) O^{16}, O^{18} (B) Na, K (C) C, Be (D) Zn, Rb

8. Which of the following elements have their lower oxidation state as more stable oxidation state.
(A) O (B) Pb (C) Tℓ (D) Bi

9. Which is/are the correct order/s of atomic radius ?
(A) Li < B < Be (C) Be < B < Li (C) Li > Be > B (D) N > O > F

10. Which is/are the correct order/s of atomic radius ?
(A) Mn > Fe > Co (B) Mn ≈ Fe ≈ Co (C) Sc > Ti > V (D) Zn < Cu < Ni

11. Which of the following orders is(are) correct for size :
(A) Al ≈ Ga (B) $Te^{2-} > I^- > Cs^+ > Ba^{2+}$
(C) $Cr^{3+} < Cr^{6+}$ (D) Pd ≈ Pt

12. The ionic radii depends upon in the following factors :
(A) Charge on cation
(B) Charge on anion
(C) Shell number of valence shell electron(s) of the ion.
(D) Effective nuclear charge

13. Which of the following statements is/are correct ?
(A) The second ionization enthalpy of oxygen element is greater than that of fluorine element.
(B) The third ionization enthalpy of phosphorus is greater than that of aluminium.
(C) The first ionization enthalpy of aluminium is slightly greater than that of gallium.
(D) The second ionization enthalpy of copper is greater than that of zinc.

14. Which of the following elements will gain one electron more readily in comparison to other elements of their group ?
(A) S(g) (B) N(g) (C) O(g) (D) Cl (g)

15. Which of the following is/are correct order/s of electron affinity.
(A) N < C < O < F (B) P < Si < S < Cl (C) Si < P < S < Cl (D) C < N < O < F

16. Which of the following is correct order of electronegativity :
(A) Cs > Rb > Na (B) Li < Be < B (C) C < N < O (D) Cl > F > Br

17. Choose the correct statement(s) :
(A) In general more the ionisation energy more will be electronegativity.
(B) Electronegativity increase means metallic character increases.
(C) In general lower will be the ionisation energy, easier will be to remove electron.
(D) Electron affinity of S is less than that of Cl.

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

In the modern periodic table, elements are arranged in order of increasing atomic numbers which is related to the electronic configuration. Depending upon the type of orbitals receiving the last electron, the elements in the periodic table have been divided into four blocks, viz, s, p, d and f. The modern periodic table consists of 7 periods and 18 groups. Each period begins with the filling of a new energy shell. In accordance with the Arfbau principle, the seven periods (1 to 7) have 2, 8, 8, 18, 18, 32 and 32 elements respectively. The seventh period is still incomplete. To avoid the periodic table being too long, the two series of f-block elements, called lanthanoids and actinoids are placed at the bottom of the main body of the periodic table.
Now answer the following five questions :

1. The element with atomic number 57 belongs to :
(A) s-block (B) p-block (C) d-block (D) f-block

2. The last element of the p-block in 6th period is represented by the outermost electronic configuration :
(A) $7s^2 7p^6$ (B) $5f^{14} 6d^{10} 7s^2 7p^0$ (C) $4f^{14} 5d^{10} 6s^2 6p^6$ (D) $4f^{14} 5d^{10} 6s^2 6p^4$

3. Which of the elements, whose atomic numbers are given below, cannot be accommodated in the present set up of the long form of the periodic table ?
(A) 107 (B) 118 (C) 126 (D) 102

4. The electronic configuration of the element which is just above the element with atomic number 43 in the same group is _____:
(A) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$ (B) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^3 4p^6$
(C) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^2$ (D) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2$

5. The elements with atomic numbers 35, 53 and 85 are all _____ :
(A) noble gases (B) halogens (C) heavy metals (D) light metals

Comprehension # 2

It is not possible to measure the atomic radius precisely since the electron cloud surrounding the atom does not have a sharp boundary. One practical approach to estimate the size of an atom of a non-metallic element is to measure the distance between two atoms when they are bound together by a single bond in a covalent molecule and then dividing by two. For metals we define the term "metallic radius" which is taken as half the internuclear distance separating the metal cores in the metallic crystal. The van der waal's radius represents the over all size of the atoms which includes its valence shell in a non bonded situation. It is the half of the distance between two similar atoms in separate molecules in a solid. The atomic radius decreases across a period and increases down the group. Same trends are observed in case of ionic radius. Ionic radius of the species having same number of electrons depends on the number of protons in their nuclei. Sometimes, atomic and ionic radii give unexpected trends due to poor shielding of nuclear charge by d- and f-orbital electrons.
Now answer the following three questions :

6. Which of the following relations is correct, if considered for the same element :
(A) $r_{Vanderwaal} > r_{Covalent} > r_{Metallic}$ (B) $r_{Covalent} > r_{Metallic} > r_{Vanderwaal}$
(C) $r_{Vanderwaal} > r_{Metallic} > r_{Covalent}$ (D) $r_{Metallic} > r_{Covalent} > r_{Vanderwaa}$

7. K^+, Cl^-, Ca^{2+}, S^{2-} ions are isoelectronic. The decreasing order of their size is :
(A) $Ca^{2+} > K^+ > Cl^- > S^{2-}$ (B) $S^{2-} > Cl^- > K^+ > Ca^{2+}$
(C) $K^+ > Cl^- > Ca^{2+} > S^{2-}$ (D) $S^{2-} > Cl^- > Ca^{2+} > K^+$

8. Select the INCORRECT option regarding atomic/ionic sizes :
(A) Zn > Cu (B) $Pb^{2+} > Pb^{4+}$ (C) $Zr \approx Hf$ (D) $N^{3-} < Al^{3+}$

Comprehension # 3

The periodicity is related to the electronic configuration. That is, all chemical and physical properties are a manifestation of the electronic configuration of the elements.
The atomic and ionic radii generally decrease in a period from left to right. As a consequence, the ionization enthalpies generally increase and electron gain enthalpies become more negative across a period. In other words, the ionization enthalpy of the extreme left element in a period is the least and the electron gain enthalpy of the element on the extreme right is the highest negative. This results into high chemical reactivity at the two extremes and the lowest in the centre. Similarly down the group, the increase in atomic and ionic radii result in gradual decrease in ionization enthalpies and a regular decrease (with exception in some third period elements) in electron gain enthalpies in the case of main group elements.
The loss and gain of electrons can be co-related with the reducing and oxidising behaviour, and also with metallic and non-metallic character respectively, of the elements.

9. The correct order of the metallic character is :
(A) Al > Mg > Na > Si (B) Na > Mg < Al > Si
(C) Na > Mg > Al > Si (D) Al > Mg > Si > Na

10. Considering the elements B, C, N, F, and Si, the correct order of their non-metallic character is :
(A) B > C > Si > N > F (B) Si > C > B > N > F
(C) F > N > C > B > Si (D) F > N > C > Si > B

11. Which of the following statement is correct ?
(A) Ionisation enthalpies of elements decrease along a period and increase along a group in Modern periodic table.
(B) In the 3rd period of Modern periodic table, the two most reactive elements are sodium and fluorine.
(C) Fluorine has the least negative electron gain enthalpy among all halogens.
(D) Ionisation enthalpy of Pb is greater than that of Sn.

Comprehension # 4

Answer Q.12, Q.13 and Q.14 by appropriately matching the information given in the three columns of the following table.

Column-1		Column-2		Column-3	
(I)	Graphite	(i)	d-block elements	(P)	Liquid
(II)	Transition elements	(ii)	Group-16	(Q)	$6s^2 6p^4$
(III)	Amalgam	(iii)	Allotropicity	(R)	Lubricant
(IV)	Polonium	(iv)	Mercury	(S)	Variable oxidation number.

12. For given content is column-1, the correct combination is :
(A) (I), (iii), R (B) (II), (iv), R (C) (II), (iii), S (D) (IV), (iv), Q

13. For iron the correct combination is :
(A) (III), (iv), Q (B) (II), (i), S (C) (IV), (i), Q (D) (I), (ii), P

14. The incorrect combination is :
(A) (III), (iv), P (B) (III), (i), S (C) (II), (ii), S (D) (IV), (ii), Q

Exercise-3

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

1. The incorrect statement among the following is : **[JEE- 1997(Cancelled), 2/200]**
(A) the first ionization energy of Al is less than first ionization energy of Mg.
(B) the second ionization energy of Mg is greater than second ionization energy of Na.
(C) the first ionization energy of Na is less than first ionization energy of Mg.
(D) the third ionization energy of Mg is greater than third ionization energy of Al.

2. Arrange the following ions in order of their increasing size : Li^+, Mg^{2+}, K^+, Al^{3+}**.** **[JEE-1997, 1/100]**

3. Fill in the blanks :
Compounds that formally contain Pb^{4+} are easily reduced to Pb^{2+}. The stability of the lower oxidation state is due to .....

4. **Assertion** : F atom has a less negative electron affinity than Cl atom. **[JEE-1998, 2/200]**
Reason : Additional electrons are repelled more effectively by 3p electrons in Cl atom than by 2p electrons in F atom.
(A) Both Assertion and Reason are true, and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true, but Reason is not correct explanation of Assertion.
(C) Assertion is true but Reason is false.
(D) Assertion is false but Reason is true.

5. Ionic radii of : **[JEE-1999, 3/200]**
(A) $Ti^{4+} < Mn^{7+}$ (B) $^{35}Cl^- < {}^{37}Cl^-$ (C) $K^+ > Cl^-$ (D) $P^{3+} > P^{5+}$

6. The correct order of radii is : **[JEE-2000, 1/35]**
(A) N < Be < B (B) $F^- < O^{2-} < N^{3-}$ (C) Na < Li < K (D) $Fe^{3+} < Fe^{2+} < Fe^{+4}$

7. **Assertion :** The first ionization energy of Be is greater than that of B.
Reason : 2p orbital is lower in energy than 2s. **[JEE-2000, 1/35]**
(A) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.
(B) Both Assertion and Reason are true but Reason is not correct explanation of Assertion.
(C) Assertion is true but Reason is false.
(D) Assertion is false but Reason is true.

8. The set representing the correct order of first ionization potential is : **[JEE-2001, 1/35]**
(A) K > Na > Li (B) Be > Mg > Ca (C) B > C > N (D) Ge > Si > C

9. Identify the least stable ion amongst the following : **[JEE-2002, 3/90]**
(A) Li^- (B) Be^- (C) B^- (D) C^-

11. Among the following, the number of elements showing only one non-zero oxidation state is : **[JEE 2010, 3/163]**

O, Cl, F, N, P, Sn, Tl, Na, T I

PART - II : JEE (MAIN) ONLINE PROBLEMS (PREVIOUS YEARS)

1. Which of the following series correctly represents relation between the elements from X to Y ?
$X \rightarrow Y$ **[JEE(Main) 2014 Online (11-04-14), 4/120]**
(1) $_3Li \rightarrow {}_{19}K$ Ionization enthalpy increses (2) $_9F \rightarrow {}_{35}Br$ Electron gain enthalpy
(3) $_6C \rightarrow {}_{32}Ge$ Atomic radii increases (4) $_{18}Ar \rightarrow {}_{54}Xe$ Noble character increases

2. Similarity in chemical properties of the atoms of elements in a group of the periodic table is most closely related to : **[JEE(Main) 2014 Online (12-04-14), 4/120]**
(1) atomic numbers (2) atomic masses
(3) number of principal energy levels (4) number of valence electrons

3. Which of the following arrangements represents the increasing order (smallest to largest) of ionic radii of the given species O^{2-}, S^{2-}, N^{3-}, P^{3-} ? **[JEE(Main) 2014 Online (15-04-14), 4/120]**
(1) $O^{2-} < N^{3-} < S^{2-} < P^{3-}$ (2) $O^{2-} < P^{3-} < N^{3-} < S^{2-}$
(3) $N^{3-} < O^{2-} < P^{3-} < S^{2-}$ (4) $N^{3-} < S^{2-} < O^{2-} < P^{3-}$

4. Which one of the following has largest ionic radius ? **[JEE(Main) 2014 Online (19-04-14), 4/120]**
(1) Li^+ (2) O_2^{2-} (3) B^{3+} (4) F^-

5. In the long form of the periodic table, the valence shell electronic configuration of $5s^25p^4$ corresponds to the element present in : **[JEE(Main) 2015 Online (10-04-15), 4/120]**
(1) Group 17 and period 6 (2) Group 17 and period 5
(3) Group 16 and period 6 (4) Group 16 and period 5

6. The following statements concern elements in the periodic table. Which of the following is true? **[JEE(Main) 2016 Online (10-04-16), 4/120]**
(1) The Group 13 elements are all metals.
(2) All the elements in Group 17 are gases.
(3) Elements of Group 16 have lower ionization enthalpy values compared to those of Group 15 in the corresponding periods.
(4) For Group 15 elements, the stability of +5 oxidation state increases down the group.

7. Consider the following ionization enthalpies of two elements 'A' and 'B'

Element	Ionization enthalpy (kJ/mol)		
	1^{st}	2^{nd}	3^{rd}
A	899	1757	14847
B	737	1450	7731

Which of the following statements is correct ? **[JEE(Main) 2017 Online (08-04-17), 4/120]**
(1) Both 'A' and 'B' belong to group-1 where 'B' comes below 'A'.
(2) Both 'A' and 'B' belong to group-2 where 'A' comes below 'B'.
(3) Both 'A' and 'B' belong to group-2 where 'B' comes below 'A'.
(4) Both 'A' and 'B' belong to group-1 where 'A' comes below 'B'.

8. The electronic configuration with the highest ionization enthalpy is :
[JEE(Main) 2017 Online (09-04-17), 4/120]
(1) [Ne] $3s^2\ 3p^1$ (2) [Ne] $3s^2\ 3p^2$ (3) [Ne] $3s^2\ 3p^3$ (4) [Ar] $3d^{10}\ 4s^2\ 4p^3$

9. For Na^+, Mg^{2+}, F^- and O^{2-} ; the correct order of increasing ionic radii is :
[JEE(Main) 2019 Online (15-04-18), 4/120]
(1) $O^{2-} < F^- < Na^+ < Mg^{2+}$ (2) $Na^+ < Mg^{2+} < F^- < O^{2-}$
(3) $Mg^{2+} < Na^+ < F^- < O^{2-}$ (4) $Mg^{2+} < O^{2-} < Na^+ < F^-$

10. The correct order of electron affinity is : **[JEE(Main) 2019 Online (15-04-18), 4/120]**
(1) F > Cl > O (2) F > O > Cl (3) Cl > F > O (4) O > F > Cl

11. Aluminium is usually found in +3 oxidation state. In contrast, thalium exists in +1 and +3 oxidation states. This is due to : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) inert pair effect (2) lanthanoid contraction
(3) diagonal relationship (4) lattice effect

12. In general, the properties that decrease and increase down a group in the periodic table, respectively, are : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) atomic radius and electronegativity
(2) electronegativity and atomic radius
(3) electron gain enthalpy and electronegativity
(4) electronegativity and electron gain enthalpy

13. When the first electron gain enthalpy (Δ_{eg} H) of oxygen is –141 kJ/mol, its second electron gain enthalpy is : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) almost the same as that of the first (2) negative, but less negative than the first
(3) a more negative value than the first (4) a positive value

14. The effect of lanthanoid contraction in the lanthanoid series of elements by an and large means :
[JEE(Main) 2019 Online (10-01-19), 4/120]
(1) increase in atomic radii and decrease in ionic radii
(2) decrease in both atomic and ionic radii
(3) increase in both atomic and ionic radii
(4) decrease in atomic radii and increase in ionic radii

15. The electronegativity of aluminium is similar to : **[JEE(Main) 2019 Online (10-01-19), 4/120]**
(1) Lithium (2) Carbon (3) Boron (4) Beryllium

16. The correct order of the atomic radii of C, Cs, Al, and S is:
[JEE(Main) 2019 Online (11-01-19), 4/120]
(1) C < S < Al <Cs (2) S < C < Al < Cs (3) S < C < Cs < Al (4) C < S < Cs < Al

17. The correct option with respect to the Pauling, electronegativity values of the elements is :
[JEE(Main) 2019 Online (11-01-19), 4/120]
(1) Te > Se (2) Ga < Ge (3) Si < Al (4) P > S

18. The element with Z = 120 (not yet discovered) will be an/a :
[JEE(Main) 2019 Online (12-01-19), 4/120]
(1) transition metal (2) alkali metal
(3) alkaline earth metal (4) inner-transition metal

19. The size of the iso-electronic species Cl^-, Ar and Ca^{2+} is affected by :
[JEE(Main) 2019 Online (08-04-19)S1, 4/120]
(1) Nuclear charge (2) Principal quantum number of valence shell
(3) azimuthal quantum number of valence shell (4) electron-electron interaction in the outer orbitals

20. The IUPAC symbol for the element with atomic number 119 would be :
[JEE(Main) 2019 Online (08-04-19)S2, 4/120]
(1) une (2) unh (3) uun (4) uue

21. The element having greatest difference between its first and second ionization energies, is :
[JEE(Main) 2019 Online (09-04-19)S1, 4/120]
(1) Ba (2) K (3) Ca (4) Sc

22. The isoelectronic set of ions is :

[JEE(Main) 2019 Online (10-04-19)S1, 4/120]

(1) F^- , Li^+ , Na^+ and Mg^{2+} (2) Li^+ , Na^+ , O^2 – and F^-
(3) N^{3-} , Li^+ , Mg^{2+} and O^2 (4) N^{3-} , O^{2-} , F^- and Na^+

23. The group number, number of valence electrons and valency of an element with atomic number 15, respectively, are :

[JEE(Main) 2019 Online (12-04-19)S1, 4/120]

(1) 16,5 and 2 (2) 15,5 and 3 (3) 15,6 and 2 (4) 16,6 and 3

24. The pair that has similar atomic radii is :

[JEE(Main) 2019 Online (12-04-19)S2, 4/120]

(1) Ti and Hf (2) Mo and W (3) Sc and Ni (4) Mn and Re

25. In comparison to boron, beryllium has :

[JEE(Main) 2019 Online (12-04-19)S2, 4/120]

(1) greater nuclear charge and lesser first ionization enthalpy.
(2) lesser nuclear charge and lesser first ionization enthalpy
(3) lesser nuclear charge and greater first ionization enthalpy
(4) greater nuclear charge and greater first ionization enthalpy

26. The electron gain enthalpy (in kJ/mol) of fluorine, chlorine, bromine and iodine, respectively are :

[JEE(Main) 2020 Online (07-01-20)S1, 4/100]

(1) –296, –325, –333 and –349 (2) –333, –349, –325 and –296
(3) –349, –333, –325 and –296 (4) –333, –325, –349 and –296

27. Within each pair of element F & Cl, S & Se, and Li & Na, respectively, the elements that release more energy upon an electron gain are : **[JEE(Main) 2020 Online (07-01-20)S2, 4/100]**

(1) Cl, S and Li (2) F, S and Li
(3) F, Se and Na (4) Cl, Se and Na

28. The first ionization energy (in kJ/mol) of Na, Mg, Al and Si respectively, are :

[JEE(Main) 2020 Online (08-01-20)S1, 4/100]

(1) 496, 577, 737, 786 (2) 786, 737, 577, 496
(3) 496, 577, 786, 737 (4) 496, 737, 577, 786

29. The increasing order of the atomic radii of the following elements is :

[JEE(Main) 2020 Online (08-01-20)S2, 4/100]

(a) C (b) O (c) F (d) Cl (e) Br

(1) (a) < (b) < (c) < (d) < (e) (2) (c) < (b) < (a) < (d) < (e)
(3) (b) < (c) < (d) < (a) < (e) (4) (d) < (c) < (b) < (a) < (e)

30. The acidic, basic and amphoteric oxides, respectively, are :

[JEE(Main) 2020 Online (09-01-20)S1, 4/100]

(1) Na_2O, SO_3, Al_2O_3 (2) N_2O_3, Li_2O, Al_2O_3
(3) Cl_2O, CaO, P_4O_{10} (4) MgO, Cl_2O, Al_2O_3

Answers

EXERCISE - 1

PART – I

A-1. (i) In modern periodic table, elements have been placed in order of their increasing atomic numbers. The atomic number of argon is 18 and that of potassium is 19. Thus, argon has been placed before potassium.
(ii) In lanthanides and actinides, the differentiating electron enters to (n – 2) f-subshell. The maximum capacity of f-subshell is of 14 electrons. Thus, there are only 14 lanthanides ($4f^{1-14}$) and only 14 actinides ($5f^{1-14}$).

A-2. In the modern periodic table, each period starts with the filling of a new principal energy level. Thus, the third period begins with the filling of principal quantum number, n = 3. When n = 3, ℓ = 0, 1, 2. But according to Aufbau principle, the electrons are added to different orbitals in order of their increasing energies. Now, the energy of 3d-subshell is higher than that of 4s-subshell. Therefore, in third period, electrons can be filled in only 3s & 3p-subshells, whose energies increase in the order: 3s < 3p. Now, s-subshell has one and p-subshell has three orbitals. Hence, in all, there are 4 (1 + 3) orbitals that can be filled in this period. Since according to Pauli's exclusion principle, each orbital, at the maximum, can accommodate two electrons. Therefore, 4 orbitals, at the maximum, can have 8 electrons and hence, fourth period has 8 elements.

B-1. $Z_{eff} = Z - \sigma$

B-2. d- and f-orbital electrons are known for poor shielding of nuclear charge, because of their scattered structure. This poor shielding generates some irregularities in properties like atomic radii and ionisation enthalpy of d-block elements, f-block elements and group-13 elements.

C-1. Pb^{4+} is less stable than Pb^{2+} due to inert pair effect. So, Pb^{4+} compounds are very good oxidising agents.

C-2. (i) $Ga^{+} < In^{+} < Tl^{+}$ (ii) $As^{+5} > Sb^{+5} > Bi^{+5}$

D-1. The ionic radius of a cation is always smaller than the parent atom because the **loss of one or more electrons increases the effective nuclear charge (Z_{eff})**. As a result, the **force of attraction of nucleus for the remaining electrons increases and hence the electron cloud contracts** and ionic radii decreases.
In contrast, the ionic radius of an anion is always larger than its parent atom because the **addition of one or more electrons decreases the effective nuclear charge (Z_{eff}).** As a result, the **force of attraction of the nucleus for the remaining electrons decreases and hence electron cloud expands** and the ionic radii increases.

D-2. Due to lanthanide contraction (poor shielding of nuclear charge by 4f-electrons), atomic radii of 4d and 5d elements are nearly same.

D-3. Atomic radius of K is larger than F because the size of cation is smaller than its parent atom while size of anion is bigger than its parent atom. Thus, atomic radii of K will be greater than 1.34 Å while atomic radii of F will be less than 1.34 Å.

E-1. Electron is more tightly bound by the nucleus in an cation (i.e. M^{+}) as the number of proton remains the same as in neutral atom whereas number of electron is one less than the proton. This increases the attraction between the valence shell electrons and the nucleus (Z_{eff} increases). So, second ionization enthalpy is always higher than the first ionisation enthalpy for every element.

E-2. Carbon has higher IE_1 because of smaller atomic size and greater Z_{eff}. Removal of second electron from stable $1s^2\ 2s^2$ configuration in case of B^{+} requires greater energy. So, B has greater IE_2.

E-3. (i) C (ii) Al

F-1. In Be, the extra electron is to be added in 2p orbital because 2s orbital is completely filled and in Ne, it is to be added to a noble gas configuration. Since full-filled orbitals and noble gas configuration are more stable, reluctancy in accepting the electron is found. So, they have positive values of electron gain enthalpy.

F-2. Nitrogen has stable half filled configuration $2s^2\ 2p^3$. So removal of one electron will require more energy than oxygen. Similarly, in nitrogen, addition of one electron will require energy (endothermic) while in oxygen, addition of one electron will release energy (exothermic).

G-1. Caesium (Cs).

G-2. (a) On moving left to right in a period, tendency of an atom to attract the shared electron pair towards itself increases due to increasing Z_{eff}. So, electronegativity of elements increase on moving from left to right in a period.
(b) On moving top to bottom in a group, size increases due to addition of extra shells. So, attraction of nucleus outermost electron decreases. So, ionisation enthalpy decrease in a group from top to bottom.

PART - II

A-1.	(C)	**A-2.**	(B)	**A-3.**	(C)	**A-4.**	(D)	**A-5.**	(C)
A-6.	(D)	**B-1.**	(A)	**B-2.**	(D)	**B-3.**	(B)	**B-4.**	(A)
C-1.	(B)	**C-2.**	(C)	**C-3.**	(D)	**C-4.**	(B)	**C-5.**	(A)
C-6.	(D)	**C-7.**	(A)	**C-8.**	(B)	**C-9.**	(D)	**C-10.**	(C)
D-1.	(C)	**D-2.**	(C)	**D-3.**	(A)	**D-4.**	(A)	**D-5.**	(B)
E-1.	(D)	**E-2.**	(A)	**E-3.**	(A)	**E-4.**	(C)	**E-5.**	(D)
F-1.	(C)	**F-2.**	(D)	**F-3.**	(B)	**F-4.**	(A)	**F-5.**	(D)
G-1.	(C)	**G-2.**	(B)	**G-3.**	(D)	**G-4.**	(B)	**G-5.**	(C)

PART - III

1. (A - p,r) ; (B - p,s) ; (C - q,t) ; (D - p,q,r)

2. (A - q,r) ; (B - p,s) ; (C - s) ; (D - q,r)

EXERCISE – 2

PART - I

1.	(C)	**2.**	(B)	**3.**	(C)	**4.**	(D)	**5.**	(D)
6.	(B)	**7.**	(A)	**8.**	(D)	**9.**	(D)	**10.**	(D)
11.	(C)	**12.**	(C)	**13.**	(D)	**14.**	(D)	**15.**	(B)
16.	(D)								

PART - II

1.	2	**2.**	26	**3.**	19	**4.**	6 (except i, ii, iii)	**5.**	3
6.	6 (except (vi))	**7.**	3	**8.**	13	**9.**	8	**10.**	30
11.	2 (i, ii)	**12.**	0	**13.**	2	**14.**	1	**15.**	23
16.	17	**17.**	5 (except ii, iii)						

PART - III

1.	(CD)	**2.**	(BCD)	**3.**	(ABCD)	**4.**	(CD)	**5.**	(AD)
6.	(ABD)	**7.**	(AB)	**8.**	(ABCD)	**9.**	(CD)	**10.**	(BC)
11.	(ABD)	**12.**	(ABCD)	**13.**	(ABD)	**14.**	(AD)	**15.**	(AB)
16.	(BC)	**17.**	(ACD)						

PART - IV

1.	(C)	**2.**	(C)	**3.**	(C)	**4.**	(A)	**5.**	(B)
6.	(C)	**7.**	(B)	**8.**	(D)	**9.**	(C)	**10.**	(C)
11.	(D)	**12.**	(A)	**13.**	(B)	**14.**	(C)		

EXERCISE – 3

PART - I

1.	(B)	**2.**	$Al^{3+} < Mg^{2+} < Li^{+} < K^{+}$			**3.**	Inert Pair Effect		
4.	(C)	**5.**	(D)	**6.**	(B)	**7.**	(C)	**8.**	(B)
9.	(B)	**11.**	2						

PART - II

1.	(3)	**2.**	(4)	**3.**	(1)	**4.**	(2)	**5.**	(4)
6.	(3)	**7.**	(3)	**8.**	(3)	**9.**	(3)	**10.**	(3)
11.	(1)	**12.**	(2)	**13.**	(4)	**14.**	(2)	**15.**	(4)
16.	(1)	**17.**	(2)	**18.**	(3)	**19.**	(1)	**20.**	(4)
21.	(2)	**22.**	(4)	**23.**	(2)	**24.**	(2)	**25.**	(3)
26.	(2)	**27.**	(1)	**28.**	(4)	**29.**	(2)	**30.**	(2)