PART (B): CHEMISTRY

SECTION I: (SINGLE CHOICE QUESTIONS)

This section contains **30 multiple choice questions.** Each question has four choices (1), (2), (3) and (4) out of which **ONLY ONE is correct**

31. In an atom, the maximum number of electrons that can have principal quantum number, n = 3 and spin quantum number, $m_s = -½$ is:
(1) 28 (2) 18 (3) 14 (4) 9

31. (4)
The total number of orbitals with quantum number n is n^2.
For n = 3, the total number of orbitals are 9.
Each orbital is occupied by one electron with $m_s = -½$.
Therefore, the maximum number of electrons that can have principal quantum number, n = 3 and spin quantum number, $m_s = -½$ is 9.

32. The hydrogen like species Li^{2+} is in a spherically symmetrical state S_1 with one radial node. Upon absorbing light the ion undergoes transition to a state S_2. The state S_2 has one radial node and its energy is equal to that of the hydrogen atom in the ground state. The states S_1 and S_2 are respectively:
(1) 2*s* and 2*p* (2) 1*s* and 2*s* (3) 2*s* and 3*s* (4) 2*s* and 3*p*

32. (4)
S_1 is spherically symmetrical so it has to be *s* orbital. Since it has one radial node it cannot be 1*s*, it has to be 2*s* as there are *n*-1 nodes in *s*-orbitals.
S_2 also has one radial node. The number of radial nodes in an orbital is equal to *n*-*l*-1.
The possible orbitals with one radial nodes are 2*s*, 3*p*, 4*d* and 5*f*.
The energy of Li^{2+} in S_2 state is the same as that of hydrogen in the ground state:

$$E_{S_2} = \frac{-13.6 \times Z^2}{n^2} = E_H = -13.6$$

For Li^{2+}, Z = 3

$$E_{S_2} = \frac{-13.6 \times 9}{n^2} = -13.6$$

Therefore, n = 3 and for this value of n there is only one orbital with one radial node *viz*. 3*p*.
Thus S_1 is 2*s* and S_2 is 3*p*.

33. Which of the following statements are **NOT** true for anode rays?
(1) They are deflected by electric and magnetic fields.
(2) Their e/m ratio depends on the gas in the discharge tube used to produce the anode rays.
(3) The e/m ratio of anode rays is constant.
(4) They are produced by the ionization of the gas in the discharge tube.

33. (3)
The e/m ratio of anode rays is not constant.

34. The work function of some metals is listed below.

Metal	Li	W	Pt	Mg
Work function/eV	2.4	4.75	6.3	3.7

The metals which will show the photoelectric effect when light of 300 nm wave length falls on these are:

(1) Li and W (2) W and Pt (3) Mg and Pt (4) Li and Mg

34 (4)

The metal will show photoelectric effect if the energy of the light falling on it is greater than the work function of the metal.

Energy of 300 nm light = $E = h\nu = hc/\lambda$

$= \frac{6.626\times10^{-34}\ js^{-1}\times3\times10^{8}\ ms^{-1}}{300\times10^{-9}\ m} = 6.626\ \times\ 10^{-19}\ J$

$1.6\ \times\ 10^{-19}\ J\ =\ 1\ eV$ Therefore $6.626\ \times\ 10^{-19}\ J\ =\ 4.14\ eV$

The work function of Li and Mg is less than the energy of light falling on it, so they will show photoelectric effect.

35. Assertion (***A***): It is impossible to determine the exact position and exact momentum of an electron simultaneous with great accuracy.

Reason (***R***): The path of an electron in an atom is clearly defined.

(1) ***A*** and ***R*** both are true and ***R*** is the correct explanation of ***A***

(2) ***A*** and ***R*** both are true but ***R*** is not the correct explanation of ***A***

(3) ***A*** is true but ***R*** is false

(4) ***A*** and ***R*** both are false

35. (3)

Path of electron is not definite.

36. 100 mL of PH_3 on heating forms P and H_2. The volume change in the end of reaction is

(1) An increase of 50 mL (2) An increase of 100 mL

(3) An increase of 150 mL (4) A decrease of 50 mL

36. (1)

The reaction is

$2PH_3(g) \rightarrow 2P(s) + 3H_2(g)$

Thus, 2 volumes of PH_3 form 3 volumes of H_2 therefore, 100 mL of PH_3 would form

$\frac{100\text{x}3}{2} = 150mL$.

$\therefore$ increase = 150 – 100 = 50 mL

37. $Na_2SO_4 + BaCl_2 \rightarrow BaSO_4 + 2\ NaCl$

Assume that 500 cm^3 of 0.250M Sodium sulphate is added to an aqueous solution of 15g of Barium chloride. Which reactant is limiting and which is in excess?

(1) Limiting - $BaCl_2$, Excess- Na_2SO_4

(2) Limiting - Na_2SO_4, Excess - $BaCl_2$

(3) Both are in exact molar ratio

(4) Would be decided by the quantity of the product formed

37. (1)

500 cm^3 of 0.25 M $Na_2SO_4 = \frac{0.25}{1000} \times 500$

= 0.125 mole

$15g\ BaCl_2 = \frac{15}{208}$ = 0.072 moles

$BaCl_2$ is a limiting reagent.

38. In Haber's process, 30 L of dihydrogen and 30 L of dinitrogen were taken for reaction which yielded only 50% of the expected product. What will be the composition of the gaseous mixture under the same conditions in the end?

(1) 20 L NH_3 , 25 L N_2 and 20 L H_2 (2) 10 L NH_3 , 25 L N_2 and 15 L H_2

(3) 20 L NH_3 , 10 L N_2 and 30 L H_2 (4) 20 L NH_3 , 25 L N_2 and 15 L H_2

38. (2)

According to Gay Lussac's law of gaseous volumes, the gases combine or are produced in a chemical reaction in a simple ratio. In Haber's process the reaction is

$3H_2 + N_2 \rightarrow 2NH_3$

The ratio of volumes of NH_3 : N_2 : H_2 in the reaction = 2:1:3

So 30 L of dihydrogen will react with 10 L of dinitrogen to form 20 L of ammonia.

Since only 50% of expected product is formed, volume of ammonia formed is 10L.

Therefore,Volume of dinitrogen that has reacted = 10/2 = 5L.

Volume of dinitrogen remaining = (30 – 5) L =25 L

Volume of dihydrogen that has reacted = $(10/2)\times 3 = 15L.$

Volume of dinitrogen remaining = (30 – 15)L = 15L

The composition of the reaction mixture at the end is $10L\ NH_3,\ 25L\ N_2 and\ 15L\ H_2$.

39. How many Moles of HCl will be present in 100ml of a solution of specific gravity 1.08, containing 20% HCl by mass?

(1) 0.5 (2) 0.6 (3) 0.8 (4) 0.12

39. (2)

Mass of HCl in 100 ml solution = 100×1.08 = 108 g

Mass of HCl = $\frac{20}{100}\times 108 = 21.6g$

No. of Moles of HCl = $\frac{21.6}{36.5} = 0.6$

40. 1.25 g of an impure metal, which is monovalent in nature was dissolved in dilute HNO_3 and the solution so formed on treatment with $BaCl_2$ solution precipitated 1.33 g of dry chloride of the metal. The percentage purity of metal if atomic mass of metal is 108, is:

(1) 80% (2) 40% (3) 20% (4) 20%

40. (1)

Since the metal is monovalent, the reactions are

$$\underset{108g}{M} \xrightarrow{HNO_3} MNO_3 \xrightarrow{BaCl_2} \underset{108+35.5}{MCl} = 143.5$$

Use this stoichiometry to find the mass of M in 1.33 g of the chloride of the metal.

1.33 g of metal chloride contains = 108 gm pure metal

$\therefore$ 1.25 g will contain = $\frac{108\times 1.25}{1.33} = 101.5g$

Percentage purity= $\frac{101.5\times 100}{108} = 80\%$

41. Which of the following is the correct order of size of the following ions?

(1) $Li^+ > Be^{2+} > Na^+ > Mg^{2+}$ (2) $Na^+ > Li^+ > Mg^{2+} > Be^{2+}$

(3) $Li^+ > Na^+ > Mg^{2+} > Be^{2+}$ (4) $Mg^{2+} > Be^{2+} > Li^+ > Na^+$

41. (2)

Ionic radius increases from top to bottom in a group while it decreases from left to right in a period. Na and Li belong to group 1 while Mg and Be belong to group 2.
Thus $Na^+ > Li^+$ while $Mg^{2+} > Be^{2+}$.
Li and Be belong to period 2 while Na and Mg belong to period 3. Thus the correct order is (2).

42. A, B and C are the oxides of the elements x, y, z respectively. x, y and z are in the same period of the periodic table. A gives an aqueous solution which is acidic in nature. B react with both strong acids and strong alkalis C gives an aqueous solution which is strongly alkaline.
Which of the following statements is/are true?
(i) The three are metals
(ii) The electronegativity decreases in the order x, y and z
(iii) The atomic radius decreases in the order x, y and z
(iv) x, y and z could be phosphorus, Aluminum and sodium respectively.
(1) i, ii, iii only correct (2) i, iii only correct
(3) ii, iv only correct (4) ii, iii, iv only correct

42. (3)

43. Which of the following options represents Increasing order of electron affinity of N, O, Cl and Al?
(1) O < N < Al < Cl (2) N < Al < O < Cl
(3) Cl < N < O < Al (4) N < O < Cl < Al

43. (2)
Because electron affinity increases in moving from left to right in a period because effective nuclear charge increase.

44. Which one of the following elements has the highest ionization energy?
(1) [Ne] $3s^2\ 3p^1$ (2) [Ne] $3s^2\ 3p^2$ (3) [Ne] $3s^2\ 3p^3$ (4) [Ne] $3d^{10}\ 4s^2\ 4p^2$

44. (3)
Because in outermost shell 5 electron are present which require more energy to remove.

45. For alkali metals, which one of the following trends is ***incorrect***?
(1) Hydration energy Li > Na > K > Rb (2) Atomic size Li < Na < K < Rb
(3) Ionization energy Li > Na > K > Rb (4) Density Li < Na < K < Rb

45. (4)
Correct option is (4) is density because density is mass/volume so it should be Li > K > Na > Rb.

46. What could be the general formula of oxide of an element E having atomic number 119 (element is only hypothetical since it is not discovered yet)?
(1) E_2O (2) EO (3) E_3O (4) EO_2

46. (1)
E would belong to group I (alkali metal) considering into magic number
Outermost electronic configuration = $8S^1$
Valency of the element (E) =1
Formula of the oxide = E_2O

47. The electron affinity of chlorine is 3.7eV. How much energy is released when 2g of chlorine is completely converted to Cl^- ion in a gaseous state?
(1) 42.8 Kcal (2) 4.08 Kcal (3) 3.25 Kcal (4) 4.8 Kcal

47. (4)
$Cl + e \rightarrow Cl^- + 3.7eu$

35.5g 3.7′ 23.06KCal

\ Energy released for conversion of 2g gaseous chlorine into Cl^- ions

$= \frac{3.7' 23.06}{35.5}' 2 = 4.8\,\text{Kcal}$

48. The electronic configurations of four elements are given below. Which of these does not belong to the same family as others?

(1) [Xe] $4f^{14}\ 5d^{10}\ 6s^2$ (2) [Kr]$4d^{10}5s^2$

(3) [Ne]$3s^2 3p^5$ (4) [Ar]$3d^{10}4s^2$

48. (3)

Option 3 represents a p-block element, remaining all are d-block elements

49. The species having pyramidal shape is

(1) SO_3 (2) BrF_3 (3) SiO_3^{2-} (4) SOF_2

49. (4)

In SOF_2 the central atom is S (at. No. 16)

According to VSEPR theory, there are total number of 5 electron pairs around S [4 bond pairs $(3\sigma \text{ and } 1\pi)$ for two S−F single bonds and one S=O double bond) +1 lone pair].

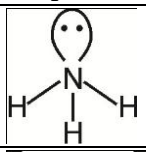
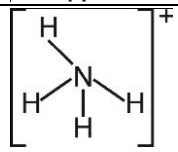
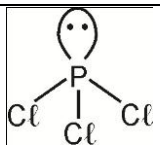
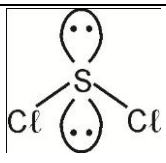
Thus lone pair-bond pair repulsions result in pyramidal shape of the molecule.

(AB_3E type of molecule where B are σ bond pairs and E is lone pair)

50. In which of the following bond angle is maximum?

(1) NH_3 (2) NH_4^+ (3) PCl_3 (4) SCl_2

50. (2)

Molecules	Hybridization	Shape	bp	ip
NH_3	sp^3		3	1
NH_4^+	sp^3		4	0
PCl_3	sp^3		3	1
SCl_2	sp^3		2	2

Based on VSEPR, the electronic repulsions follow the order

Lp – lp > lp – bp > bp – bp – bp

In NH_4^+ there is no lone pair present and hence electron repulsions are minimum.

Thus bond angles are maximum

51. Which of the following statements is not correct while considering Kinetic Theory of Gases?

(1) At any particular time, different particles of gases have different speeds.

(2) The distribution of speeds also changes with time
(3) Every collision changes the velocity of gaseous molecules
(4) At different times a particle may have different Kinetic Energy

51. (2)

Though the speed of molecules of a gas are continuously changing the distribution of speed remains constant with time.

52. For which of the following can we not draw a stable Lewis structure?

(1) PCl_5 (2) OCl_6
(3) SF_6 (4) All of these have a stable Lewis structure

52. (2)

Oxygen cannot expand its octet

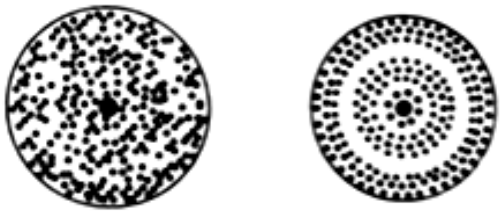
53. Which of the following oxides is expected to exhibit paramagnetic behavior?

(1) CO_2 (2) ClO_2 (3) SO_2 (4) SiO_2

53. (2)

ClO_2 is an odd electron molecule.
Total number of valence electrons in chlorine dioxide are
23 [7(Cl) + 2 x 8 (O)].
Thus one electron is always unpaired and is responsible for paramagnetism.

54. The probability density plots of 1*s* and 2*s* orbitals are given in figure:



The density of dots in a region represents the probability density of finding electrons in the region.
On the basis of above diagram which of the following statement is incorrect?

(1) 1*s* and 2*s* oritals are spherical in shape
(2) The probability density of finding the electron is maximum near the nucleus
(3) The probability density of finding the electron at a given distance is equal in all directions
(4) The probability density of electrons for 2*s* orbital decreases uniformly as distance from the nucleus increases

54. (4)

The probability density of electrons for 2*s* orbital is high near the nucleus. It becomes zero after certain distance. It increase again to certain maximum value and then decreases uniformly.

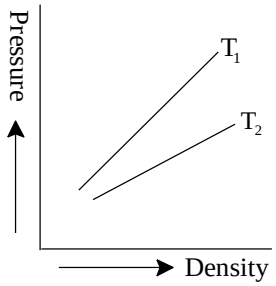
55. Select the incorrect statement:

(1) The region where the probability density function reduces to zero is called nodal surface or node
(2) Boundary surface diagram of an orbital covers about 90% probability of finding electron in covered space
(3) *n s* orbital has $(n - 1)$ spherical nodes
(4) Total number of nodes in an orbital is $(n - l - 1)$

55. (4)

An orbital has '*l*' angular and $(n - l - 1)$ spherical nodes.
Hence, total nodes are the sum, i.e., $(n - 1)$.

56. Which of the following options is true for the given graphs of pressure versus density for an ideal gas at two temperatures T_1 and T_2?



(1) $T_1 > T_2$ (2) $T_1 = T_2$
(3) $T_1 < T_2$ (4) Density is not related to the temperature

56. (1)

Higher the temperature, higher the pressure (as shown in graph) – Acc. to Gay-Lussac's law

57. One litre of gas A at two atmospheric pressure and two litre of gas B at three atmospheric pressure are mixed in a four litre flask to form an ideal gas mixture. What will be the final pressure of the gaseous mixture if the gasses initially and finally were at the same temperature?

(1) 2.5 atm (2) 2.0 atm (3) 1.5 atm (4) 1.0 atm

57. (2)

$pV = nRT$

$n_1 = \frac{p_1V_1}{RT_1}$ & $n2 = \frac{p_2V_2}{RT_2}$

Acc. to Dalton's Law of partial pressure-

p total = $(n_1+n_2)\ \frac{RT}{V}$

$\Rightarrow$ p total = $\frac{(p_1V_1 + p_2V_2)}{\cancel{RT}} \times \frac{\cancel{RT}}{V}$

$\Rightarrow$ p total = $\frac{(1\times 2)+(2\times 3)}{4} = 2.0\,atm$

58. Which of the following statements is incorrect?

(1) Gases tend to deviate from ideal behavior due to intermolecular attractions
(2) Finite size of molecules is responsible for deviation from ideal behavior
(3) Gases tend to show ideal behavior under low pressure and high temperature conditions
(4) Kinetic theory of gases describes the deviation of gases from ideal behavior

58. (4)

59. A cylinder has capacity of 20L and contains gas at 10 atm. Air is filled in the balloon at one atmospheric pressure and volumes 1 lit. Approximately, how many such balloons can be filled by this cylinder

(1) 200 (2) 20 (3) 180 (4) 190

59. (3)

The cylinder can only fill balloons till its pressure drops to 1 atm

60. Decreasing order of mean square velocity of molecules of H_2, O_2, N_2 and HBr at STP is

(1) $H_2 > N_2 > O_2 > HBr$ (2) $HBr > O_2 > N_2 > H_2$
(3) $HBr > H_2 > O_2 > N_2$ (4) $N_2 > O_2 > H_2 > HBr$

60. (1)

Acc. to the formula $\boxed{v_{rms} = \sqrt{\frac{3RT}{M}}}$ i.e. $v_{rms} \alpha \frac{1}{\sqrt{M}}$ & mole mass of $H_2 = 2$, $N_2 = 28$, $O_2 = 32$, HBr = 82

So, lesser the molecular mass, more the v_{rms} .