BLOOM | BSO Bloom School Olympiad

CLASS 11

Bloom Chemistry Olympiad
Sample Paper

Maximum Time : 60 Minutes **Maximum Marks : 60**

INSTRUCTIONS

1. There are 50 Multiple Choice Questions in this paper divided into two sections :

   Section A 40 MCQs; 1 Mark each

   Section B 10 MCQs; 2 Marks each

2. Each question has Four Options out of which **ONLY ONE** is correct.
3. All questions are compulsory.
4. There is no negative marking.
5. No electric device capable of storing and displaying visual information such as calculator and mobile is allowed during the course of the exam.

Roll No.

Student's Name

Section-A (1 Mark each)

1. In an experiment, it is found that 2.0769 g of pure X produces 3.6769 g of pure X_2O_5. The number of moles of X is

(a) 0.04 (b) 0.06 (c) 0.40 (d) 0.02

2. In which case is the number of molecules of water maximum ?

(a) 0.00224 L of water vapours at 1 atm and 273 K

(b) 0.18 g of water

(c) 18 mL of water

(d) 10^{-3} mole of water

3. Dissolving 120 g of urea (mol. wt. 60) in 1000 g of water gave a solution of density 1.15 g/mL. The molarity of the solution is

(a) 1.78 M (b) 2.00 M (c) 2.05 M (d) 2.22 M

4. If E_A, E_B and E_C represents kinetic energies of an electron, alpha particle and proton respectively and each moving with same de-Broglie wavelength, then choose the correct increasing representation.

(a) $E_A = E_B = E_C$ (b) $E_A > E_B > E_C$ (c) $E_B > E_C > E_A$ (d) $E_A < E_C < E_B$

5. Which of the given statements correctly represents the effect of rise in temperature on the emitted radiations of a hot body?

(a) The radiations move towards shorter wavelengths.

(b) The radiations move towards shorter frequency.

(c) The radiations move towards lower energy.

(d) The frequency of radiations does not change.

6. Energy of an electron is given by

$$E = -2.178 \times 10^{-18}\,\text{J}\left(\frac{Z^2}{n^2}\right)$$

wavelength of light required to excite an electron in an hydrogen atom from level $n = 1$ to $n = 2$ will be ($h = 6.62 \times 10^{-34}$ Js and $c = 3.0 \times 10^{8}\,\text{ms}^{-1}$)

(a) 1.214×10^{-7} m (b) 2.816×10^{-7} m (c) 6.500×10^{-7} m (d) 8.500×10^{-7} m

7. $4d, 5p, 5f$ and $6p$-orbitals are arranged in the order of decreasing energy.

The correct option is

(a) $6p > 5f > 5p > 4d$ (b) $5p > 5f > 4d > 5p$

(c) $5f > 6p > 4d > 5p$ (d) $5f > 6p > 5p > 4d$

8. The electronegativity of the following elements increases in the order

(a) C, N, Si, P (b) N, Si, C, P (c) Si, P, C, N (d) P, Si, N, C

9. Which represents the correct order of first ionisation potential of third period elements?

(a) Na > Mg > Al > Si (b) Na < Mg < Al < Si

(c) Na < Si < Al < Mg (d) Na < Al < Mg < Si

10. In which of the following arrangements, the order is not according to the property indicated after it in bracket?

(a) $Al^{3+} < Mg^{2+} < Na^{+} < F^{-}$ (Increasing ionic size)

(b) B < C < N < O (Increasing first ionisation energy)

(c) I < Br < F < Cl (Increasing electron gain enthalpy)

(d) Li < Na < K < Rb (Increasing metallic radius)

11. The hybridisations of atomic orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ respectively are

(a) sp, sp^3 and sp^2 (b) sp^2, sp^3 and sp

(c) sp, sp^2 and sp^3 (d) sp^2, sp and sp^3

12. Why water is the better solvent medium for most of the synthetic chemical reaction?

(a) Use of water is low in cost

(b) It devoids of any carcinogenic effects

(c) Water has high specific heat capacity

(d) All of the above

13. The table shown below gives the bond dissociation energies (E_{diss}) for single covalent bonds of carbon (C) atoms with elements '*A*', '*B*', '*C*' and '*D*'. Which element has the smallest atoms?

Bond	E_{diss}(kJ mol^{-1})
C—*A*	240
C—*B*	328
C—*C*	276
C—*D*	485

(a) *A* (b) *B* (c) *C* (d) *D*

14. A gas such as CO would be most likely to obey the ideal gas law at

(a) high temperature and low pressure

(b) low temperature and high pressure

(c) high temperature and high pressure

(d) low temperature and low pressure

15. NH_3 gas at 1 atm was connected to a manometer. After sparking in the flask, NH_3 dissociates as

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$

mercury level in the manometer showed a difference of 10.12 cm. Thus, partial pressure of H_2 gas under given condition is

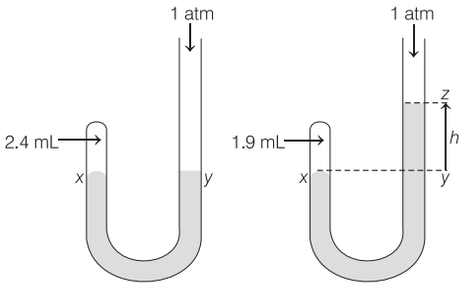
(a) 0.20 atm (b) 0.40 atm (c) 1.20 atm (d) 0.07 atm

16. For two gases *A* and *B*, it is found that $M_A T_B = M_B T_A$

where, M_A and M_B are molar masses of the gases *A* and *B* respectively. For which of the following property this relation holds good?

(a) Pressure (b) Density (c) Kinetic energy (d) u_{rms}

17. Given J-tube has 2.4 mL of air at a pressure of 1 atm. On adding mercury, volume of air is reduced to 1.9 mL as shown. Difference in the level of mercury in two columns is



(a) 700 mm (b) 960 mm (c) 900 mm (d) 760 mm

18. Consider the chemical equation, $Na^+(g) + Cl^-(g) \longrightarrow Na^+Cl^-(s)$

For 1 mole of NaCl(*s*), lattice enthalpy $= +788\ kJ\ mol^{-1}$, $\Delta_{hyd}H^\circ = -784\ kJ\ mol^{-1}$

The enthalpy of solution is calculated as

(a) $-4\ kJ\ mol^{-1}$ (b) $-8\ kJ\ mol^{-1}$ (c) $+4\ kJ\ mol^{-1}$ (d) $-6\ kJ\ mol^{-1}$

19. For the reaction, $X_2O_4(l) \longrightarrow 2XO_2(g)$, $\Delta U = 2.1$ kcal, $\Delta S = 20\ cal\ K^{-1}$ at 300 K.

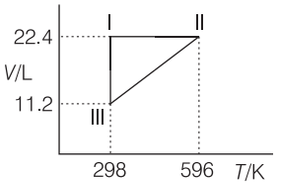
Hence, ΔG is

(a) 2.7 kcal (b) –2.7 kcal (c) 9.3 kcal (d) –9.3 kcal

20. The value of logarithm of equilibrium constant, K_p if the standard free energy change of a reaction is $\Delta G^\circ = -115$ kJ at 298 K will be

(a) 2.303 (b) 13.83 (c) 2.015 (d) 20.15

21. One mole of an ideal gas is put through a series of changes as shown in the figure in which stages I, II and III have been marked. Pressures at the three stages are (in bar)



	I	II	III
(a)	1.106	2.212	1.106
(b)	1.106	1.106	2.212
(c)	2.212	1.106	2.212
(d)	1.106	2.212	2.212

22. Hydrolysis of sucrose gives,

$$\text{Sucrose} + H_2O \rightleftharpoons \text{Glucose} + \text{Fructose}$$

Equilibrium constant (K_C) for the reaction is 2×10^{13} at 300 K. The value of ΔG° at 300 K is

(a) 3.52×10^5 J mol^{-1} (b) 5.12×10^5 J mol^{-1} (c) 7.64×10^4 J mol^{-1} (d) -7.64×10^4 J mol^{-1}

23. The decreasing order of strength of the bases OH^-, NH_2^-, $H—C \equiv C^-$ and $CH_3 — CH_2^-$ is

(a) $CH_3 — CH_2^- > NH_2^- > H — C \equiv C^- > OH^-$ (b) $H — C \equiv C^- > CH_3 — CH_2 > NH_2 > OH^-$

(c) $OH^- > NH_2^- > H — C \equiv C^- > CH_3 — CH_2^-$ (d) $NH_2^- > H — C \equiv C^- > OH — CH_3 — CH_2^-$

24. A buffer solution is prepared in which the conc. NH_3 is 0.30 M and the concentration of NH_4^+ is 0.20 M. If the equilibrium constant, K_b for NH_3 equals 1.8×10^{-5}, what is the pH of this solution?

(a) 8.73 (b) 9.08 (c) 9.44 (d) 11.72

25. The solubility of $BaSO_4$ in water is 2.42×10^{-3} gL^{-1} at 298 K. The value of its solubility product (K_{sp}) will be,

(Given, molar mass of $BaSO_4 = 233$ g mol^{-1})

(a) 1.08×10^{-14} mol^{2}L^{-2} (b) 1.08×10^{-12} mol^{2}L^{-2}

(c) 1.08×10^{-10} mol^{2}L^{-2} (d) 1.08×10^{-8} mol^{2}L^{-2}

26. Identify the species oxidised/reduced in the given reaction,

$$2\,Cu_2O(s) + Cu_2S(s) \longrightarrow 6Cu(s) + SO_2(g)$$

(a) copper is reduced and sulphur is oxidised
(b) copper is oxidised and sulphur is reduced
(c) oxygen is reduced and copper is oxidised
(d) oxygen is oxidised and sulphur is reduced

27. Which of the following reactions is an example of a redox reaction?

(a) $XeF_4 + O_2F_2 \longrightarrow XeF_6 + O_2$ (b) $XeF_2 + PF_5 \longrightarrow [XeF]^+PF_6^-$

(c) $XeF_6 + H_2O \longrightarrow XeOF_4 + 2HF$ (d) $XeF_6 + 2H_2O \longrightarrow XeO_2F_2 + 4HF$

28. Consider the following decomposition reaction.

$$2KClO_3 \longrightarrow 2KCl + 3O_2$$

In the above reaction,

(a) potassium is undergoing oxidation
(b) chlorine is undergoing reduction
(c) oxygen is reduced
(d) None of the species are undergoing oxidation or reduction

29. Hydrogen sulphide is acidic while water is neutral. The reason is

(a) molecular weight of H_2S is more than H_2O
(b) water molecules associate, while H_2S molecules does not
(c) H—S bond is weaker than H—O bond due to the bigger size of S-atom
(d) S-atoms has less affinity for hydrogen atom than O-atm has for it

30. Hydrogen is prepared from H_2O adding

(a) Ca, which acts as reducing agent
(b) Al, which acts as oxidising agent
(c) Ag, which acts as reducing agent
(d) Au, which acts as oxidising agent

31. How many 'mL' of perhydrol is required to produce sufficient oxygen which can be used to completely convert 2L of SO_2 gas?

(a) 10 mL (b) 5 mL (c) 20 mL (d) 30 mL

32. Enzymes that utilise ATP in phosphate transfer require an alkaline earth metal (*M*) as the cofactor *M* is

(a) Mg (b) Ca (c) Sr (d) be

33. Metals form basic hydroxides. Which of the following metal hydroxide is the least basic?

(a) $Mg(OH)_2$ (b) $Ca(OH)_2$ (c) $Sr(OH)_2$ (d) $Ba(OH)_2$

34. The correct order of atomic radii in group 13 elements is

(a) B < Ga < Al < Tl < In
(b) B < Al < Ga < In < Tl
(c) B < Al < In < Ga < Tl
(d) B < Ga < Al < In < Tl

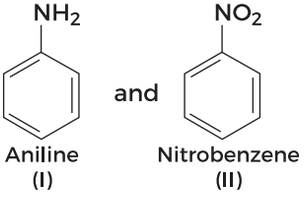
35. Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce, respectively.

(a) B_2O_3 and H_3BO_3 (b) B_2O_3 and $[BH_4]^-$ (c) H_3BO_3 and B_2O_3 (d) HBO_2 and H_3BO_3

36. Which of the following statement is not correct?

(a) Silicon is extensively used as a semiconductor.
(b) Carborundum is SiC.
(c) Silicon occurs in free state in nature.
(d) Mica contains the element silicon.

37. Consider the following compounds,



Which of the following option is/are true regarding I and II?

(a) I shows + *R* -effect, whereas II shows –*R* -effect
(b) I shows –*R* -effect, whereas II shows + *R* -effect
(c) Both I and II show +*R* -effect
(d) Both I and II show –*R* -effect

38. In which of the following molecule, hyperconjugation is not possible?

(a) $CH_3—CH=CH_2$ (b) $CH_2=CH_2$ (c) $CH_3—\overset{+}{C}(CH_3)_2$ (d) $CH_3—C(CH_3)=C(CH_3)—CH_3$

39. Which of the following distillation is used if the difference in boiling points of two liquids is not much?

(a) Steam distillation (b) Simple distillation

(c) Fractional distillation (d) Distillation under reduced pressure

40. The correct order of increasing (C—O) bond length of CO, CO_3^{2-} and CO_2 is

(a) $CO_3^{2-} < CO_2 < CO$ (b) $CO_2 < CO_3^{2-} < CO$

(c) $CO < CO_3^{2-} < CO_2$ (d) $CO < CO_2 < CO_3^{2-}$

Section-B (2 Marks each)

41. Consider the following statements.

I. Metals comprise more than 78% of all known elements and appear on the left side of the periodic table.

II. Most non-metallic solids are brittle and are neither malleable nor ductile.

III. The elements become more metallic as we go down a group.

IV. The non-metallic character decreases as one goes from left to right across the periodic table.

Choose the option with all correct statements.

(a) I, II and III (b) II, III and IV (c) I and II (d) III and IV

42. Consider the following statement.

I. When O_2 is converted into O_2^{2+} bond order decreases.

II. O_2 molecule is paramagnetic because it contains two unpaired electrons in $\pi^* 2p_x$ and $\pi^* 2p_y$ molecular orbitals.

III. The bond length in NO is greater than in NO^+

Choose the correct statements.

(a) Only I (b) I and II (c) II and III (d) II and IV

43. Match the Column I with Column II and choose the correct option from the codes given below.

	Column I		**Column II**
A.	Mass of H_2 produced when 0.5 mole of zinc reacts with excess of HCl.	1.	3.01×10^{23} molecules
B.	Mass of all atoms of a compound with formula $C_{70}H_{22}$.	2.	6.023×10^{23} molecules
C.	Number of molecules in 35.5 g of Cl_2.	3.	1.43×10^{-21} g
D.	Number of molecules in 64 g of SO_2.	4.	1g

Codes

	A	B	C	D		A	B	C	D
(a)	2	1	4	3	(b)	1	2	3	4
(c)	4	3	1	2	(d)	4	3	2	1

44. Match the elements given in Column I with the properties mentioned in Column II.

	Column I		**Column I**
A.	Li	1.	Strongest monoacidic base
B.	Na	2.	Most negative $E^{\ominus}$ value among alkali metals
C.	Ca	3.	Insoluble oxalate
D.	Ba	4.	$6s^2$ outer electronic configuration

Codes

	A	B	C	D		A	B	C	D
(a)	1	2	3	4	(b)	1	2	4	3
(c)	2	1	3	4	(d)	2	3	1	4

Direction (Q. Nos. 45 & 46) In the following questions, an Assertion (A) is followed by a corresponding Reason (R). Use the following keys to choose the appropriate answer.

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

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

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

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

45. **Assertion** (A) Kjeldahl's method is not applicable to compounds containing nitrogen in the form of nitro and azo groups and nitrogen present in the ring (e.g. pyridine).

Reason (R) Nitrogen of nitro and azo group containing compounds does not change to ammonium sulphate by Kjeldahl's method.

46. **Assertion** (A) Propene reacts with HI in the presence of peroxide to give 1-iodopropane.

Reason (R) 1° free radical is less stable than 2° free radical.

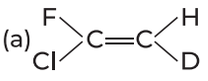
Case-Study

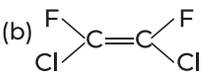
Organic compounds composed of only C and H are called hydrocarbons. Any two carbon atoms of a hydrocarbon may combine through single (—), double (=) or triple (≡) bonds. Depending upon the manner of attachment of carbon atoms, hydrocarbons are classified as alkane, alkenes and alkynes.

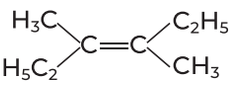
Among them alkenes are highly reactive compounds due to the presence of exposed π-electron cloud in them as these π-electrons are less tightly held between the two carbon atoms. These compounds show electrophilic reactions in which electrophiles attack the losely held π-electrons of alkenes. They show largely, electrophilic addition and substitution reactions.

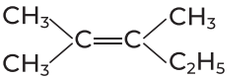
Read the case study and answer the following questions.

47. Which of the following will not show geometrical isomerism ?

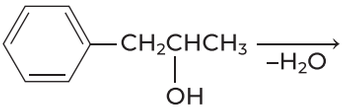
(a) 

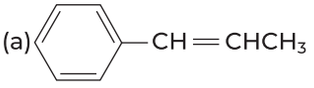
(b) 

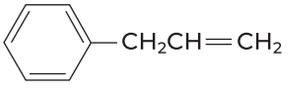
(c) 

(d) 

48. Identify the dehydration product in the following compound?



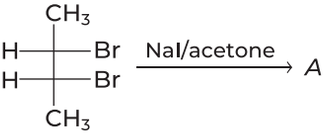
(a) 

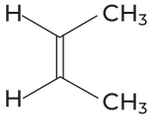
(b) 

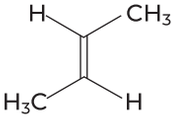
(c) Both (a) and (b)

(d) None of these

49. In the following reaction *'A'* is



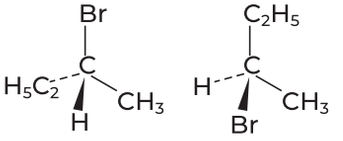
(a) 

(b) 

(c) Both (a) and (b)

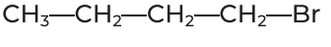
(b) None of these

50. The addition of HBr to 1-butene gives a mixture of products *A*, *B* and *C*.



(*A*)

(*B*)



(*C*)

The mixture consists of

(a) *A* and *B* as major and *C* as minor products

(b) *B* as major, *A* and *C* as minor products

(c) *B* as minor, *A* and *C* as major products

(d) *A* and *B* as minor and *C* as major products

Darken your choice with HB Pencil

1.	Ⓐ Ⓑ Ⓒ Ⓓ	11.	Ⓐ Ⓑ Ⓒ Ⓓ	21.	Ⓐ Ⓑ Ⓒ Ⓓ	31.	Ⓐ Ⓑ Ⓒ Ⓓ	41.	Ⓐ Ⓑ Ⓒ Ⓓ
2.	Ⓐ Ⓑ Ⓒ Ⓓ	12.	Ⓐ Ⓑ Ⓒ Ⓓ	22.	Ⓐ Ⓑ Ⓒ Ⓓ	32.	Ⓐ Ⓑ Ⓒ Ⓓ	42.	Ⓐ Ⓑ Ⓒ Ⓓ
3.	Ⓐ Ⓑ Ⓒ Ⓓ	13.	Ⓐ Ⓑ Ⓒ Ⓓ	23.	Ⓐ Ⓑ Ⓒ Ⓓ	33.	Ⓐ Ⓑ Ⓒ Ⓓ	43.	Ⓐ Ⓑ Ⓒ Ⓓ
4.	Ⓐ Ⓑ Ⓒ Ⓓ	14.	Ⓐ Ⓑ Ⓒ Ⓓ	24.	Ⓐ Ⓑ Ⓒ Ⓓ	34.	Ⓐ Ⓑ Ⓒ Ⓓ	44.	Ⓐ Ⓑ Ⓒ Ⓓ
5.	Ⓐ Ⓑ Ⓒ Ⓓ	15.	Ⓐ Ⓑ Ⓒ Ⓓ	25.	Ⓐ Ⓑ Ⓒ Ⓓ	35.	Ⓐ Ⓑ Ⓒ Ⓓ	45.	Ⓐ Ⓑ Ⓒ Ⓓ
6.	Ⓐ Ⓑ Ⓒ Ⓓ	16.	Ⓐ Ⓑ Ⓒ Ⓓ	26.	Ⓐ Ⓑ Ⓒ Ⓓ	36.	Ⓐ Ⓑ Ⓒ Ⓓ	46.	Ⓐ Ⓑ Ⓒ Ⓓ
7.	Ⓐ Ⓑ Ⓒ Ⓓ	17.	Ⓐ Ⓑ Ⓒ Ⓓ	27.	Ⓐ Ⓑ Ⓒ Ⓓ	37.	Ⓐ Ⓑ Ⓒ Ⓓ	47.	Ⓐ Ⓑ Ⓒ Ⓓ
8.	Ⓐ Ⓑ Ⓒ Ⓓ	18.	Ⓐ Ⓑ Ⓒ Ⓓ	28.	Ⓐ Ⓑ Ⓒ Ⓓ	38.	Ⓐ Ⓑ Ⓒ Ⓓ	48.	Ⓐ Ⓑ Ⓒ Ⓓ
9.	Ⓐ Ⓑ Ⓒ Ⓓ	19.	Ⓐ Ⓑ Ⓒ Ⓓ	29.	Ⓐ Ⓑ Ⓒ Ⓓ	39.	Ⓐ Ⓑ Ⓒ Ⓓ	49.	Ⓐ Ⓑ Ⓒ Ⓓ
10.	Ⓐ Ⓑ Ⓒ Ⓓ	20.	Ⓐ Ⓑ Ⓒ Ⓓ	30.	Ⓐ Ⓑ Ⓒ Ⓓ	40.	Ⓐ Ⓑ Ⓒ Ⓓ	50.	Ⓐ Ⓑ Ⓒ Ⓓ

Hints and Explanations

1. (a) $2X \longrightarrow X_2O_5$

$2X \qquad (2X + 80)$

$\therefore \quad \frac{2X}{2.0769} = \frac{2X + 80}{3.6769}$

$\therefore \quad X(\text{atomic weight of } X) = 51.92\ \text{g/mol}$

$\therefore \quad 2.0709\ \text{g} = \frac{2.0769}{51.92}\ \text{mol } X = 0.04\ \text{mol } X$

2. (c) Number of molecules = mole × Avogadro's number (N_A)

The number of molecules of water in each of the given options is calculated as,

(a) $(V_{(H_2O)g})_{STP} = 0.00224$ L

$$n_{H_2O} = \frac{V}{22.4\,\text{L}} = \frac{0.00224}{22.4} = 0.0001$$

$\therefore$ Number of molecules of water $= 0.0001 \times N_A$

(b) 0.18 g of water

$$n_{H_2O} = \frac{w_{H_2O}}{M_{H_2O}} = \frac{0.18}{18} = 0.01$$

Number of molecules $= 0.01 \times N_A$

(c) 18 mL of water, number of mole $(n_{H_2O}) = \frac{\text{mass of substance in g } (w_{H_2O})}{\text{molar mass in g mol}^{-1}\ (w_{H_2O})}$

$w_{H_2O} = 18\,\text{g/mol}$ [$\because$ Density of water $(d_{H_2O}) = 1\ \text{g L}^{-1}$]

$\therefore \quad n_{H_2O} = \frac{18}{18} = 1$

Number of molecules of water $= 1 \times N_A$

(d) $n_{H_2O} = 10^{-3}$

$\therefore$ Number of molecules of water $= 10^{-3} \times N_A$

Hence, maximum number of molecules are present in 18 mL of water.

3. (c) Molarity $(M) = \frac{\text{Moles of solute}}{\text{Volume of solution (in L)}}$

Moles of urea $= 120/60 = 2$

Weight of solution = Weight of solvent + Weight of solute

$= 1000 + 120 = 1120$ g

$\Rightarrow \quad \text{Volume} = \frac{1120\ \text{g}}{1.15\ \text{g/mL}} \times \frac{1}{1000\ \text{mL}} = 0.973\ \text{L}$

$\therefore \quad$ Molarity $= 2/0.973 = 2.05$ M

4. (d) As we know that, $\lambda = \frac{h}{mv} = \frac{h}{\sqrt{2m\text{KE}}}$

$\because \quad \lambda \propto \frac{1}{\sqrt{m}}$

Mass of *e*, α and *p* are $m_e < m_p < m_\alpha$.

The correct order is $E_A < E_C < E_B$.

5. (a) The intensities of radiations emitted by hot body depends on temperature. As the temperature is raised, the emitted radiations move towards shorter wavelengths.

It shows that, as the temperature is raised, the maxima of the curve shifts towards shorter wavelengths.

6. (a) Given, $E = -2.178 \times 10^{-18}\,\text{J}\left[\frac{Z^2}{n^2}\right]$

For hydrogen, $Z = 1$

So, $E_1 = -2.178 \times 10^{-18}\,\text{J}\left[\frac{1}{1^2}\right]$

$E_2 = -2.178 \times 10^{-18}\,\text{J}\left[\frac{1}{2^2}\right]$

Now, $E_1 - E_2$

i.e. $\Delta E = 2.178 \times 10^{-18}\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{hc}{\lambda}$

$$2.178 \times 10^{-18}\left(\frac{1}{1^2} - \frac{1}{2^2}\right) = \frac{6.62 \times 10^{-34} \times 3.0 \times 10^8}{\lambda}$$

$\therefore \quad \lambda \approx 1.21 \times 10^{-7}\,\text{m}$

7. (d) The order of energy of orbitals can be calculated from $(n + l)$ rule. The lower the value of $(n + l)$ for an orbital, lower is its energy. If two orbitals have same $(n + l)$ value, the orbital with lower value of *n* has the lower energy.

(a) $6p = 6 + 1 = 7$ (b) $5f = 5 + 3 = 8$ (c) $4d = 4 + 2 = 6$ (d) $5p = 5 + 1 = 6$

$\therefore$ The order of decreasing energy will be $5f > 6p > 5p > 4d$.

8. (c) On moving along a period from left to right in the periodic table, electronegativity increases (due to decrease in size), while on moving downward in a group, electronegativity decreases.

Thus, the correct order of electronegativity is $\underset{(1.8)}{\text{Si}} < \underset{(2.1)}{\text{P}} < \underset{(2.5)}{\text{C}} < \underset{(3.0)}{\text{N}}$.

9. (d) Generally, ionisation potential increases, as we move from left to right in a period. However, the ionisation potential of II A group elements is higher than that of the III A group elements. This is because of the fully-filled *s*-orbitals in II A group elements.

Hence, the correct order of ionisation potential is Na < Al < Mg < Si.

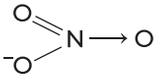
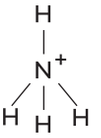
10. (b) IE increases on moving from left to right but, the order of IE_1 of B, C, O and N is as

B < C < N < O.

IE_1 of N ($1s^2, 2s^2, 2p^3$) is more than that of O ($1s^2, 2s^2, 2p^4$) due to the presence of extra stable half-filled $2p$-subshell of N. Thus, the correct order is B < C < N < O.

Rest all arrangements are correct.

11. (d) The hybridisations of atomic orbitals of nitrogen in NO_2^+, NO_3^- and NH_4^+ respectively are sp, sp^2 and sp^3.

Ion	Structure	Hybridisation
NO_2^+	$O=\overset{+}{N}=O$	sp
NO_3^-		sp^2
NH_4^+		sp^3

12. (d) Water is a better solvent medium for most of the synthetic chemical reactions because of following reasons

(i) Use of water is low in cost.

(ii) It devoids of any carcinogenic effect.

(iii) It has high specific heat capacity.

13. (d) Smallest the atom, larger the overlapping hence higher will be the bond dissociation energy.

14. (a) Real gases show ideal behaviour as temperature is increased and pressure is decreased.

15. (a) 1 atm = 76 cm of Hg

$$2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$$

Initial pressure	76	0	0
After dissociation $(76 - 2x)$		x	$3x$

Thus, total pressure $= (76 + 2x)$ cm

Thus, $2x = 10.12$ cm

$$x = \frac{10.12}{2} \text{ cm}$$

Thus, $p_{H_2} = 3x = \left(\frac{10.12}{2}\right) \times 3 = 15.18$ cm

$$= \frac{15.18}{76} \text{ atm} = 0.20 \text{ atm}$$

16. (d) (a) If $p_A = \frac{w_A}{M_A}\frac{RT_A}{V_A}$

$$\frac{M_A}{T_A} = \frac{w_A R}{p_A V_A}$$

Pressure may differ. Hence, $M_A T_B \neq M_B T_A$

(b) Density $(d) = \frac{pM}{RT}$

If p are different then, density would be different.

(c) Kinetic energy $= \frac{3}{2}nRT = \frac{3}{2}\frac{w_A}{M_A}RT_A$

This would be possible only when w_A and w_B are same.

(d) $u_{rms} = \sqrt{\frac{3RT}{M}}$

$$u_A = \sqrt{\frac{3RT_A}{M_A}}$$

$$u_B = \sqrt{\frac{3RT_B}{M_B}}$$

Thus if, $u_A = u_B$, then $M_A T_B = M_B T_A$.

17. (b) Atmospheric pressure = 760 mm of Hg

Since, $p_1V_1 = p_2V_2$, at constant temperature

$$\therefore \quad p_2 = \frac{p_1V_1}{V_2} = \frac{760 \times 24}{1.9} = 960 \text{ mm of Hg}$$

18. (c) Given : $\Delta_{lattice}H^\circ = +788$ kJ/mol

$$\Delta_{hyd}H^\circ = -784 \text{ kJ/mol}$$

$$\because \quad \Delta_{sol}H^\circ = \Delta_{lattice}H^\circ + \Delta_{hyd}H^\circ$$

$$\therefore \quad \Delta_{sol}H^\circ = +788 \text{ kJ mol}^{-1} - 784 \text{ kJ mol}^{-1} = +4 \text{ kJ mol}^{-1}$$

19. (b) As we know that, $\Delta H = \Delta U + \Delta n_g RT$

where, ΔU = change in internal energy

Δn_g = number of moles of gaseous products – number of moles of gaseous reactants = 2 – 0 = 2

R = gas constant = 2 cal

But, $\Delta U = 2.1$ kcal

$$= 2.1 \times 10^3 \text{ cal} \quad [\because 1 \text{ kcal} = 10^3 \text{ cal}]$$

$$\therefore \quad \Delta H = (2.1 \times 10^3) + (2 \times 2 \times 300) = 3300 \text{ cal}$$

Now, $\Delta G = \Delta H - T\Delta S$

$$\Rightarrow \quad \Delta G = (3300) - (300 \times 20)$$

$$\Rightarrow \quad \Delta G = -2700 \text{ cal}$$

$$\therefore \quad \Delta G = -2.7 \text{ kcal}$$

20. (d) Given,

$$\Delta G^\circ = -115 \times 10^3 \text{ J}$$

$$T = 298 \text{ K}, R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$$

$$\because \quad -\Delta G^\circ = 2.303 RT \log_{10} K_p$$

$$\therefore -(-115 \times 10^3) = 2.303 \times 8.314 \times 298 \log_{10} K_p$$

$$\log_{10} K_p = \frac{115000}{2.303 \times 8.314 \times 298} = 20.15$$

21. (d) At stage I :

$$p_I = \frac{nRT}{V} = \frac{1 \times 0.0831 \times 298}{22.4} = 1.106 \text{ bar}$$

In stage II, temperature is doubled.

$\therefore \quad p_{II} = 2.212 \text{ bar}$

In state III, volume is halved.

$\therefore \quad p_{III} = 2.212 \text{ bar}$

22. (d) Sucrose $+ H_2O \longrightarrow$ Glucose + Fructose

We know that, $R = 8.314 \text{ J mol}^{-1}\text{K}^{-1}$

Given, $T = 300 \text{ K}; K_C = 2 \times 10^{13}$

$\because \quad \Delta G^\circ = -RT \ln K_C$ or $-2.303\, RT \log K_C$

$\therefore \quad \Delta G^\circ = -2.303 \times 8.314 \text{ J mol}^{-1} \text{ K}^{-1} \times 300 \text{ K} \times \log (2 \times 10^{13})$

$\Rightarrow \quad \Delta G^\circ = -7.64 \times 10^4 \text{ J mol}^{-1}$

23. (a) The conjugate acids of the given bases are H—OH, NH_3, H — C ≡ C — H and CH_3 — CH_3.

Their acidic character follows the trend, H — OH > CH ≡ CH > NH_3 > CH_3 — CH_3.

Since, a strong acid has a weak conjugate base.

Hence, the strength of bases will be, CH_3 — CH_2^- > NH_2^- > H — C ≡ C^- > OH^-.

24. (c) Given, conc. of NH_3 (base) = 0.30 M

Conc. of NH_4^+ (salt) = 0.20 M

$$K_b = 1.8 \times 10^{-5}$$

$\because \quad \text{pOH} = \text{p}K_b + \log \frac{[\text{salt}]}{[\text{base}]}$

$\Rightarrow \quad 4.74 + \log \frac{0.20}{0.30} = 4.74 + (0.301 - 0.477)$

$= 4.74 - 0.176 = 4.56$

$\Rightarrow \quad \text{pH} = 14 - 4.56 = 9.44$

25. (c) For a general reaction,

$$A_xB_y \rightleftharpoons xA^{y+} + yB^{x-}$$

Solubility product $(K_{sp}) = [A^{y+}]^x \ [B^{x-}]^y$

For $BaSO_4$ (binary solute giving two ions)

$$BaSO_4(s) \rightleftharpoons \underset{S}{Ba^{2+}}(aq) + \underset{S}{SO_4^{2-}}(aq)$$

$\therefore \quad K_{sp} = [Ba^{2+}] \ [SO_4^{2-}]$

$= (S)\ (S) = S^2$ ...(i) [where, S = Solubility]

Given, $S = 2.42 \times 10^{-3} \text{ g L}^{-1}$

Molar mass of $BaSO_4$ = 233 g mol^{-1}

$\therefore$ Solubility of $BaSO_4$,

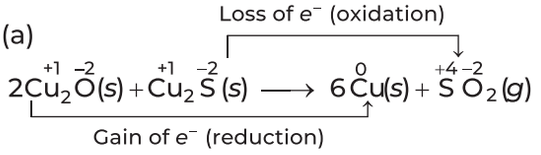
$$(S) = \frac{2.42 \times 10^{-3}}{233} \text{ mol } L^{-1} = 1.04 \times 10^{-5} \text{ mol } L^{-1}$$

On substituting the value of S in Eq. (i), we get

$$K_{sp} = (1.04 \times 10^{-5} \text{ mol } L^{-1})^2$$

$$= 1.08 \times 10^{-10} \text{ mol}^2 \text{ } L^{-2}$$

26. (a)



Thus, copper is reduced and sulphur is oxidised.

27. (a) The reaction in which oxidation and reduction occur simultaneously are termed as redox reaction.

$$(X)eF_4 + O_2(F_2) \longrightarrow XeF_6 + O_2$$

Since, Xe undergoes oxidation while O undergoes reduction. So, it is an example of redox reaction.

28. (b) $2KClO_3 \longrightarrow 2KCl + 3O_2$

(a) The oxidation number of K does not change, thus K undergoes neither reduction nor oxidation.

(b) The oxidation number of chlorine decreases from +5 in $KClO_3$ to –1 in KCl, hence Cl undergoes reduction.

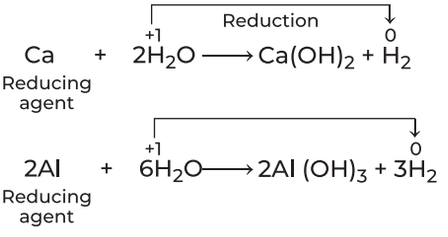
(c) Since, oxidation number of oxygen increases from –2 in $KClO_3$ to 0 in O_2, so oxygen is oxidised.

(d) This statement is not correct because Cl is undergoing reduction and O is undergoing oxidation.

Therefore, statement (b) is true about the given reaction.

29. (c) Hydrogen sulphide is acidic because H—S bond is weaker than H—O bond due to larger size of S-atom.

30. (a) H_2 can be prepared H_2O by adding Ca.



31. (a) Perhydrol means 30% solution of H_2O_2.

H_2O_2 decomposes as, $2H_2O_2 \longrightarrow 2H_2O + O_2$

Volume strength of 30% H_2O_2 solution is 100 that means 1 mL of this solution on decomposition gives 100 mL oxygen.

$$SO_2 + \frac{1}{2}O_2 \longrightarrow SO_3$$

1 L 1/2 L 1 L

2 L 1 L 2 L

Since, 100 mL of oxygen is obtained by = 1 mL of H_2O_2

$\therefore$1000 mL of oxygen will be obtained by $= \frac{1}{100} \times 1000$ mL of H_2O_2

$= 10$ mL of H_2O_2

32. (a) All enzymes that utilise ATP in phosphate transfer require magnesium as the cofactor. The cofactor are required by the enzyme for their efficient activity.

33. (a) The basic nature of hydroxides of alkaline earth metal depends on the solubility in water. More is the solubility, more is the basicity. Solubility of hydroxides depends on lattice energy and hydration energy.

$$\Delta H_{solution} = \Delta H_{lattice\ energy} + \Delta H_{hydration\ energy}$$

The magnitude of hydration energy remains almost same whereas lattice energy decreases down the group leading to more negative values for $\Delta H_{solution}$ down the group.

More negative $\Delta H_{solution}$, more is solubility of compounds.

Hence, $Be(OH)_2$ and $Mg(OH)_2$ have less negative values for $\Delta H_{solution}$ therefore, least basic.

Thus, option (a) is correct.

34. (d) The atomic radii as well as ionic radii increases on moving down the group 13 elements because of the successive addition of one extra shell of electrons.

However, there is an anomaly in case of atomic radius. Atomic radius of Ga is lesser as compared to that of Al. Gallium (Ga) with electronic configuration, $[Ar]_{18}3d^{10}4s^24p^1$ has extra *d*-electrons which do not screen the nucleus effectively. Consequently, electrons of Ga are more attracted by nucleus.

Thus, the increasing order of atomic radii of the group 13 elements is

B (85 pm) < Ga (135 pm) < Al (143 pm) < In (167 pm) < Tl (170 pm).

35. (a) Diborane (B_2H_6) reacts independently with O_2 and H_2O to produce B_2O_3 and H_3BO_3 respectively. Diborane is a colourless, highly toxic gas, having boiling point 180 K. Because of its inflammable nature. It catches fire spontaneously when exposed to air and burns in oxygen releasing an enormous amount of energy as

$$B_2H_6 + 3O_2 \longrightarrow B_2O_3 + 3H_2O + 1976\ kJ/mol$$

It gets hydrolysed readily to give boric acid.

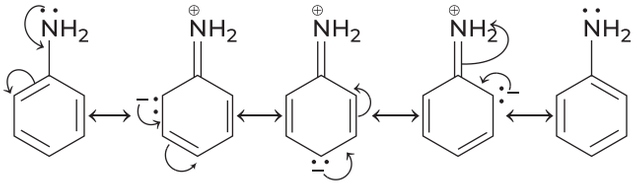
$$\underset{\text{Borane}}{B_2H_6} + 6H_2O \longrightarrow \underset{\text{Orthoboric acid}}{2H_3BO_3} + \underset{\text{Dihydrogen}}{6H_2}\uparrow$$

36. (c) Silicon occurs in combined state in nature as silica, SiO_2 and silicates.

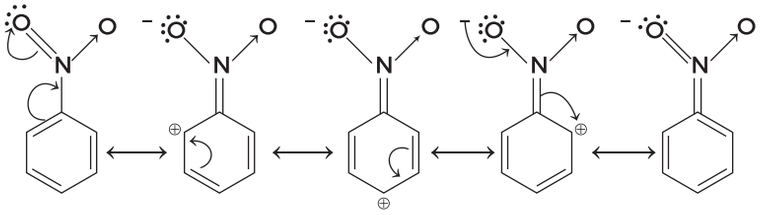
Rest of the given statements are correct.

37. (a) Aniline (I) shows +*R* -effect, whereas nitrobenzene (II) shows –*R* -effect. In +*R* -effect, the transfer of electrons is away from an atom or substituent group attached to the conjugated system. This electron displacement make certain positions in the molecule of high electron densities.

This effect in aniline is shown as



–R -effect is observed when the transfer of electrons is toward the atom or substituent group is attached to the conjugated system, e.g. in nitrobenzene this electron displacement can be depicted as.



38. (b) Hyperconjugation is not possible in $H_2C{=}CH_2$ because it does not contain alkyl group directly attached to an atom of unsaturated system. As a result, delocalisation of σ-electrons of C—H bond does not occur.

39. (c) Fractional distillation is used when the difference in boiling points of two liquids is not much. Simple distillation cannot be used to separate them because the vapours of such liquids are formed within the same temperature range and are condensed simultaneously.

40. (d)

	Bond between (C—O)
CO	triple
CO_3^{2-}	bonds are equivalent and are between double bond and single bond due to resonance.
CO_2	double

$$\text{Bond length} \propto \frac{1}{\text{number of bonds}}$$

Thus, $CO < CO_2 < CO_3^{2-}$

41. (a) Statements I, II and III are correct, while the statement IV is incorrect.

It's correct form is as follows :

The non-metallic character increases as one goes from left to right across the periodic table.

42. (c) Statements II and III are correct while statement I is incorrect. It's correct form is as follows :

When O_2 is converted into O_2^{2+} bond order increases, i.e. it increases from 2 to 3.

43. (c) The correct match is A - 4, B - 3, C - 1, D - 2.

A. $Zn + 2HCl \longrightarrow ZnCl_2 + H_2$

1 mole of Zn produces 2 g of H_2

0.5 mole of Zn will produce 1 g of H_2.

B. $C_{70}H_{22} = 70 \times 12 + 22 \times 1 = 862$

Molar mass $= 862$

Mass of atoms $= \frac{862}{6.023 \times 10^{23}} = 1.43 \times 10^{-21}$ g

C. 70 g of $Cl_2 = 6.023 \times 10^{23}$ molecules

35.5 g of $Cl_2 = 3.01 \times 10^{23}$ molecules

D. Molar mass of $SO_2 = 64$ g $= 1$ mole

64 g of $SO_2 = 6.023 \times 10^{23}$ molecules.

44. (c) The correct match is A-2, B-1, C-3, D-4.

A. Li—Most negative $E^{\ominus}$ among alkali metals

[Due to very high hydration energy, the resulting $E^{\ominus}$ is most negative].

B. Na—Strongest monoacidic base

[Alkalies are more acidic than alkaline earth metals. LiOH has covalent character].

C. Ca—Insoluble oxalate

[Calcium oxalate is insoluble in water]

D. Ba—Insoluble sulphate

[Hydration energy decreases as size of cation increases].

$6s^2$ outer electronic configuration

$_{56}Ba = 1s^2, 2s^2, 2p^6, 3s^2, 3p^6, 3d^{10}, 4s^2, 4p^6, 4d^{10}, 5s^2, 5p^6, 6s^2$

45. (a) Kjeldahl's method is not applicable to compounds containing nitrogen in the form of nitro and azo groups and nitrogen present in the ring (e.g. pyridine) because nitrogen of these compounds does not change to ammonium sulphate under these conditions.

Thus, both (A) and (R) are correct and (R) is the correct explanation of (A).

46. (b) When propene reacts with HI in the presence of peroxide, it shows anti-Markovnikov's addition.

Thus, 1-iodopropane is obtained as major product.

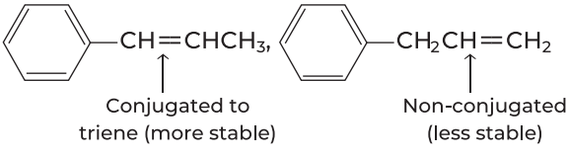
$$\underset{\text{Propene}}{CH_3—CH=CH_2} + HI \xrightarrow{\text{Peroxide}} \underset{\text{1-iodopropane}}{CH_3—CH_2—CH_2I}$$

It is also true that, 2° free radical is more stable than 1° free radical but it is not the reason of the given assertion.

Thus, both (A) and (R) are correct but (R) is not the correct explanation for (A).

47. (d) In option (d), a carbon with double bond has two same functional groups (CH_3) attached. The rotation around carbon will not produce a new compound. Hence, geometrical isomerism is not possible.

48. (a)

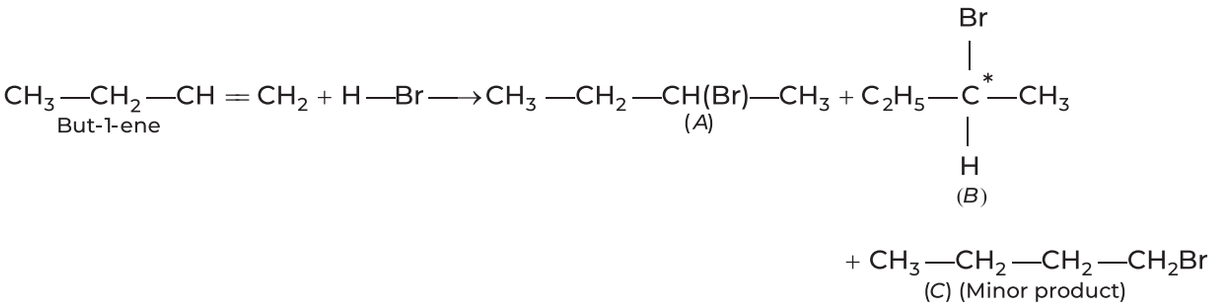


49. (b) Addition to the alkene and elimination of two bromine atoms from the dibromide are predominantly of two bromine atoms from the dibromide are predominantly trans.

$$Cis + Br_2 \rightleftharpoons d \text{ and } l,$$

$$trans + Br_2 \rightleftharpoons meso$$

50. (a) The alkene is unsymmetrical, hence will follow Markownikoff's rule to give major product.



Since, *B* contains, a chiral carbon, it exists in two enantiomers (*A* and *B*) which are mirror images of each other.