SECTION –I – (STRAIGHT OBJECTIVE TYPE)

This section contains 7 multiple choice questions. Each question has 4 choices (A), (B), (C) and (D), out of which **ONLY ONE** is correct.

1. To prepare a buffer solution of pH = 4.04, amount of Barium acetate to be added to 100mL of 0.1 M acetic acid solution [$pK_b(CH_3COO^-) = 9.26$ is:

   (A) 0.05 mole (B) 0.025 mole

   (C) 0.1 mole (D) 0.005 mole

2. $pOH = 7 - 0.5\ pK_a + 0.5pK_b$ is true for aqueous solution containing which pair of cation and anion :

   (A) $C_6H_5NH_3^+, CH_3COO^-$ (B) NH_4^+, F^-

   (C) Both (A) and (B) (D) None of these

3. N_2 and H_2 are taken in 1: 3 molar ratio in a closed vessel to attain the following equilibrium

   $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. Find k_p for reaction at total pressure of 2P if P_{N_2} at equilibrium is $\frac{P}{3}$

   (A) $\frac{1}{3P^2}$ (B) $\frac{4}{3P^2}$

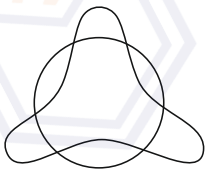
   (C) $\frac{4P^2}{3}$ (D) None

4. SO_2 and CH_4 are introduced in a vessel in the molar ratio 1 : 2. The ratio of molecules of two gases present in the container when their rate of effusion becomes equal is :

   (A) 1 : 2 (B) 2 : 1

   (C) 4 : 1 (D) 1 : 4

5. The wave motion of electron in a Bohr's orbit of hydrogen is as shown in diagram. The potential energy of electron in the given orbit of hydrogen atom is :



   (A) –3.4 eV (B) +3.4 eV

   (C) –3.02 eV (D) –1.51 eV

6. Select the most ionic and most covalent compounds respectively from the following

   $CrO_5, Mn_2O_7, PbO, P_4O_{10}, SnO_2$

   (A) CrO_5, Mn_2O_7 (B) PbO, Mn_2O_7

   (C) CrO_5, P_4O_{10} (D) SnO_2, CrO_5

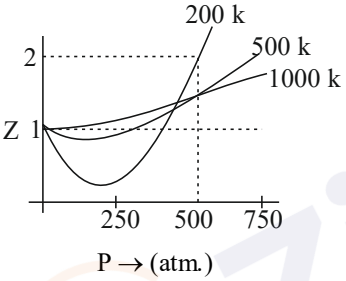
7. In which of the following sets the central atom of each member involves sp^3 hybridisation?

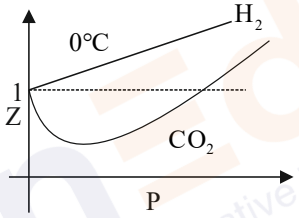
   (A) IO_4^-, ICl_4^-, IF_4^+ (B) XeO_3, XeO_4, XeF_4

   (C) $SO_3, SO_3^{2-}, SO_4^{2-}$ (D) PCl_4^+, BF_4^-, ClO_4^-

Paragraph for Question Nos. (8 to 11)

Sketch shows the plot of Z v/s P of a hypothetical gas for one mole at three distinct temperature.





Boyle's temperature is the temperature at which a gas shows ideal behaviour over a pressure range in the Low pressure region. Boyle's temperature $(T_b) = \frac{a}{Rb}$. If a plot is obtained at temperature well below Boyle's temperature then the curve will show negative deviation in low pressure region and positive deviation in the high pressure region. Near critical temperature, the curve is more likely as CO_2 and the temperature well above critical temperature curve is more like H_2 at $0°C$ as shown above. At high pressure suppose all the constant temperature curve varies linearly with pressure according to the following equation

$$Z = 1 + \frac{Pb}{RT} (R = 2 cal\, mol^{-1} K^{-1})$$

8. Which of the following is correct?

(A) $\frac{a}{b} < 0.4$ k cal mol^{-1} (B) $0.4k\, cal\ mol^{-1} < \frac{a}{b} < 2k$ cal mol^{-1}

(C) $\frac{a}{b} < 0.4k$ cal mol^{-1} (D) $\frac{a}{b} = 1K$ Cal mol^{-1}

9. For 500K plot value of Z changes from 2 to 2.2 if pressure is varied from 1000 atm to 1200 atm (high pressure) then the value of $\frac{b}{RT}$ will be

(A) $10^{-3} atm^{-1}$ (B) $2 \times 10^{-3} atm^{-1}$

(C) $5 \times 10^{-4} atm^{-1}$ (D) $10^{-4} atm^{-1}$

10. As shown in the figure at 200K and 500 atm value of compressibility factor is 2 (approx). Then volume of the gas at this point will be

(A) 0.01 L (B) 0.09 L

(C) 0.65 L (D) 0.657 L

11. In the very high pressure region if Z v/s P is plotted at 1200 K for the above gas then it will have greatest slope.

(A) True (B) False

(C) Can't say (D) Not related to the paragraph

Multiple Correct

12. Solid ammonium carbamate, $NH_4CO_2NH_2(s)$, dissociates into ammonia and carbon dioxide when it evaporates as shown by

$$NH_4CO_2NH_2(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$$

At $25°C$, the total pressure of the gases in equilibrium with the solid is 0.116 atm. If 0.1 atm of CO_2 is introduced after equilibrium is reached then:

(A) Final pressure of CO_2 will be less than 0.1 atm

(B) Final pressure of CO_2 will be more than 0.1 atm

(C) Pressure of NH_3 will decrease due to addition of CO_2

(D) Pressure of NH_3 will increase due to addition of CO_2

13. Choose the correct option (s)

(A) At low pressure (nearly 1 atm), compressibility factor for H_2 gas is greater than 1 at 273K

(B) Compressibility factor for a vander Wall's gas at its critical condition is less than 1.

(C) Boyle's temperature of a gas is lesser than its critical temperature

(D) vander Waal's constant 'a' for NH_3 is greater than that of CH_4

14. Select the correct statement (s) :

(A) The value of spin only magnetic moment of Co^{3+} ion(inBM) $= \sqrt{24}$

(B) The number of radial nodes in a 3p-orbital = 1

(C) The number of electrons with (m = 0) in Mn^{2+} ion $= 11$

(D) The orbital angular momentum for the unpaired electron in $V^{4+} = \dfrac{\sqrt{6}h}{4\pi}$

15. Which charge for the N_2 molecule would give a bond order of 2.5?

(A) +1 (B) +2

(C) −1 (D) −2

Matrix Match Type

16. Match the effect of addition of 0.1 M KOH to 0.1M, 50ml H_3PO_4. Ka_1, Ka_2, Ka_3 are the I, II, III ionisation constant of H_3PO_4 :

Column- I	**Column-II**
(1) 75 ml of KOH	(p) $pH = P^{Ka_1}$
(2) 25 ml of KOH	(q) $pH = P^{Ka_2}$
(3) 150 ml of KOH	(r) $pH = \dfrac{P^{Ka_2} + P^{Ka_3}}{2}$
(4) 100 ml of KOH	(s) $pH = 7 + \dfrac{1}{2}[P^{Ka_3} + \log C]$
	(t) $pOH = 7 - \dfrac{1}{2}[P^{Ka_3} + \log C]$

(A) $1 \to q, 2 \to p, 3 \to st, 4 \to r$ (B) $1 \to r, 2 \to p, 3 \to st, 4 \to q$

(C) $1 \to st, 2 \to p, 3 \to r, 4 \to q$ (D) $1 \to q, 2 \to p, 3 \to r, 4 \to st$

Integer Type

17. Calculate the hydrogen ion concentration (in mol/dm^3) in a solution containing 0.04 mole of acetic acid and 0.05 mole of sodium acetate in 500mL of solution. Dissociation constant for acetic acid is 1.75×10^{-5}. Report your answer after multiplying by 2×10^6.

18. For given simultaneous reaction:

$X(s) \rightleftharpoons A(g) + B(s) + C(g)$ $\quad K_{P_1} = 500$ atm

$Y(s) \rightleftharpoons D(g) + A(g) + E(s)$ $\quad K_{P_2} = 2000$ atm

If total pressure = x, then write your answer after dividing by 25.

19. How many of the following compounds have significant involvement of d orbital in p bonding ?
$H_3PO_2, BCl_3 H_2S_4O_6, XeO_4, XeOF_4, SF_6, NH_4Cl, ClO_2, NO_2$

20. How many of the following statements are correct?
(i) Among sp^3d, sp^3d^2 and sp^3d^3 hybridisation, the maximum number of $90°$ angles between bond pair-bond pair of electrons is observed in sp^3d^2 hybridisation.
(ii) Among SP_4, CH_4 and XeF_4, , interatomic bond angle of $109°28'$ is observed only in SF_4
(iii) Among N_2F_4, N_2F_2 and N_2, the largest N-N bond length is found in N_2F_4
(iv) Among $NF_3, NO_3^-, BF_3H_3O^+$ and $NH_3, [NF_3\ H_3O^+]$ and $[BF_3, NO_3^-]$ are isostructural pairs
(v) Among NH_3, PH_3, AsH_3 and SbH_3, SbH_3 has smallest bond angle.
(vi) Among $SbCl_3$, and $SbBr_3$ and SbI_3, SbI_3 has the largest bond angle

21. The bond order of the underlined species : $\underline{NO}HSO_4$ is :

ANSWER KEY

1. (B)	2. (C)	3. (B)	4. (B)	5. (C)	6. (B)	7. (D)
8. (B)	9. (A)	10. (B)	11. (B)	12. (B,C)	13. (A,B,C)	14. (A,B,C)
15. (A,C)	16. (A)	17. (28)	18. (4)	19. (6)	20. (5)	21. (3)