PACE-IIT & MEDICAL

ANDHERI / BORIVALI / DADAR / CHEMBUR / THANE / MULUND/ NERUL / POWAI

IIT – JEE	**CRASH COURSE (ADV)**	**MARKS: 124**
TIME: 75 MIN.	**TOPIC: CHEMICAL & IONIC EQUILIBRIUM**	**DATE:20/11/18**

SECTION–I (Multiple Choice Questions)

This section contains **06 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONLY ONE** is correct.   **(+3,- 1)**

1. Pure water is added into the following solutions causing a 10% increase in volume of each. The greatest % change in pH would be observed in which case (A), (B), (C) or (D)?
(A) 0.1 M $NaHCO_3$ (B) 0.2 M NaOH
(C) 0.3 M NH_3 – 0.2 M NH_4^+ system   (D) 0.4 M CH_3COONH_4

2. A well is dug in a bed of rock containing fluorspar (CaF_2). If the well contains 20000 L of water, what is the amount of F^- in it? $K_{sp} = 4 \times 10^{-11}$ ($10^{1/3} = 2.15$)
(A) 4.3 mol   (B) 6.8 mol   (C) 8.6 mol   (D) 13.6 mol

3. Ammonia gas at 15 atm is introduced in a rigid vessel at 300 K. At equilibrium the total pressure of the vessel is found to be 40.11 atm at 300ºC. The degree of dissociation of NH_3 will be:
(A) 0.6   (B) 0.4   (C) Unpredictable   (D) None of these

4. For the equilibrium $CuSO_4.5H2O(s) \rightleftharpoons CuSO_4.3H_2O(s) + 2H_2O(g)$
$K_p = 2.25 \times 10^{-4}$ atm^2 and vapour pressure of water is 22.8 Torr at 298 K.
$CuSO_4.5H_2O(s)$ is efflorescent (i.e., loses water) when relative humidity is:
(A) less than 33.3%   (B) less than 50 %   (C) less than 66.6%   (D) above 66.6%

5. What is the minimum pH when $Fe(OH)_3$ starts precipitating from a solution containing 0.1M $FeCl_3$?
K_{sp} of $Fe(OH)_3 = 8 \times 10^{-13}$ M^3
(A) 3.7   (B) 5.7   (C) 10.3   (D) 8.3

6. One mole of N_2O_4 (g) at 300 K is left in a closed container under one atm . It is heated to 600 K when 20 % by mass of N_2O_4 (g) decomposes to NO_2(g). The resultant pressure is:
(A) 1.2 atm   (B) 2.4 atm   (C) 2.0 atm   (D) 1.0 atm

SECTION-II (Multiple Choice Questions)

This section contains **06 multiple choice questions.** Each question has 4 choices (A), (B), (C) and (D) for its answer, out which **ONE OR MORE** is/are correct.   **(+4,- 2)**

7. The equilibrium of which of the following reactions will not be disturbed by the addition of an inert gas at constant volume?
(A) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ (B) $N_2O_4(g) \rightleftharpoons 2NO_2(g)$
(C) $CO_2(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$ (D) $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$

8. K_a values for HA, HB and HD are 10^{-5}, 10^{-7} and 10^{-9} respectively. Which of the following will be correct for decimolar aqueous solutions of NaA, NaB and NaD at 25^0C?
(A) $(pH)_{NaA} < (pH)_{NaB}$ (B) $(pH)_{NaD} < (pH)_{NaB}$
(C) $(pH)_{NaA} < (pH)_{NaD}$ (D) $(pH)_{NaB} = 7$

9. When $NaNO_3$ is heated in a closed vessel, oxygen is liberated and $NaNO_2$ is left behind. At equilibrium,

$$NaNO_3 \text{ (s)} \rightleftharpoons NaNO_2 \text{ (s)} + \frac{1}{2}O_2 \text{ (g)}$$

(A) addition of $NaNO_2$ favours reverse reaction
(B) addition of $NaNO_3$ favours forwards reaction
(C) increasing temperature favours forward reaction
(D) increasing pressure favours reverse reaction

10. Let the colour of the indicator HIn (colourless) will be visible only when its ionised form (pink) is 25% or more in a solution. Suppose HIn ($pK_a = 9.0$) is added to a solution of pH = 9.6 predict what will happen. (Take log 2 = 0.3)
(A) pink colour will be visible
(B) pink colour will not be visible
(C) % of ionised form will be less than 25%
(D) % of ionised form will be more than 25%

11. The dissociation of ammonium carbamate may be represented by the equation
$$NH_4CO_2NH_2(s) \rightleftharpoons 2NH_3(g) + CO_2(g), \ \Delta H = +ve$$
The equilibrium will shift from right to left if there is
(A) a decrease in pressure
(B) an increase in temperature
(C) an increase in the concentration of ammonia
(D) an increase in the concentration of carbon dioxide

12. Which of the following mixtures will act as buffer?
(A) H_2CO_3 + NaOH (1.5 : 1 molar ratio)　　(B) H_2CO_3 + NaOH (1.5 : 2 molar ratio)
(C) NH_4OH + HCl (5 : 4 molar ratio)　　(D) NH_4OH + HCl (4 : 5 molar ratio)

SECTION – III　(Paragraph Type)

This section contains **2 multiple choice questions** relating to 1 paragraph. Each question has four choices (A), (B), (C) and (D) out of which **ONLY ONE is correct.**　　　　　**(+3,- 1)**

PARAGRAPH FOR QUE. NOS. 13 & 14.

Strontium fluoride (SrF_2) is a sparingly soluble salt. Let s_1 be its solubility (in mol/lt.) in pure water at 25°C, assuming no hydrolysis of F^- ions. Also, let s_2 be its solubility (in mol/lt.) in 0.1 M NaF solution at 25°C, assuming no hydrolysis of F– ions and no complex formation.
However, it is known that $s_1 : s_2 = 10^6 : 256$. Now, answer the following questions.

13. The K_{sp} value of SrF_2 at 25°C is:
(A) 2.048×10^{-9}　　(B) 1.372×10^{-9}　　(C) 1.864×10^{-9}　　(D) 2.916×10^{-9}

14. The mass of NaF to be added to 100 ml solution of 0.0011 M Sr^{+2} ions to reduce its concentration to 2×10^{-4} M is : [Assume no hydrolysis of F^- ions]
(A) 0.42 g　　(B) 0.063 g　　(C) 0.021 g　　(D) 0.084 g

PARAGRAPH FOR QUE. NOS. 15 & 16.

The pH $\{-\log [H^+]\}$ value for pure water is 7.0, whereas natural rainwater is weakly acidic. This is caused by dissolution of atmospheric carbon dioxide. In many areas, however, rainwater is more acidic. This has several causes some of which are natural and some of which derive from human activity. In the atmosphere, sulphur dioxide and nitrogen monoxide are oxidized to sulphur trioxide and nitrogen dioxide respectively, which react with water to give sulphuric acid and nitric acid. The

resulting so-called "acid rain" has an average pH of 4.5. Values as low as 1.7 have however, been measured. Sulphur dioxide SO_2, is diprotic acid in aqueous solution. At 27°C the acidity constants are

$$SO_2(aq) + H_2O(\ell) \rightleftharpoons HSO_3^-(aq) + H^+(aq) \quad K_{a_1} = \frac{[H^+][HSO_3^-]}{[SO_2]} = 10^{-2}\,M$$

$$HSO_3^-(aq) \rightleftharpoons SO_3^{2-}(aq) + H^+(aq) \quad K_{a_2} = \frac{[SO_3^{2-}][H^+]}{[HSO_3^-]} = 10^{-7}\,M$$

And for equilibrium

$$SO_2(aq) + H_2O(\ell) \rightleftharpoons SO_3^{2-}(aq) + 2H^+(aq)\, K_a = \frac{[SO_3^{2-}][H^+]^2}{[SO_2]} = K_{a_1} \times K_{a_2} = 10^{-9}\,M$$

Also for water $H_2O \rightleftharpoons H^+ + OH^- \quad K_w = [OH^-][H^+] = 10^{-14}$.
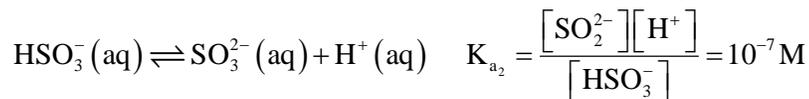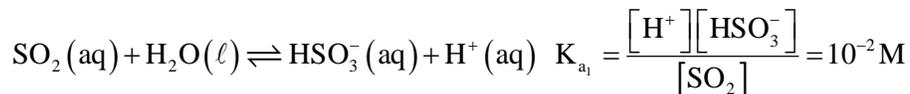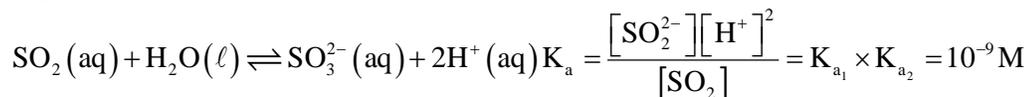
Now answer the following questions (T = 300 K for all questions).

15. The solubility of sulphur dioxide gas is 24.63 litre in 1 litre of water at partial pressure of 1 atm. Then the concentration of SO_2 in water saturated with SO_2 gas (the change in volume caused by dissolution of SO_2 may be ignored) (R = 0.0821 litre atm.mol^{-1} K^{-1}) is
(A) 1.2 M   (B) 1M   (C) 0.5 M   (D) 2 M

16. The pH of 0.01 M aqueous solution of sodium sulphite will be :
(A) 8.5   (B) 9   (C) 4.5   (D) 9.5

PARAGRAPH FOR QUE. NOS. 17 & 18.

Equilibrium constants are given (in atm) for the following reactions at 0° C:
$SrCl_2 . 6H_2O(s) \rightleftharpoons SrCl_2 . 2H_2O(s) + 4H_2O(g)$ $K_p = 5 \times 10^{-12}$
$Na_2HPO_4 .12 H_2O(s) \rightleftharpoons Na_2HPO_4 . 7 H_2O(s) + 5H_2O(g)$ $K_p = 2.43 \times 10^{-13}$
$Na_2SO_4 .10H_2O(s) \rightleftharpoons Na_2SO_4(s) + 10 H_2O(g)$ $K_p = 1.024 \times 10^{-27}$
The vapor pressure of water at 0°C is 4.56 torr.
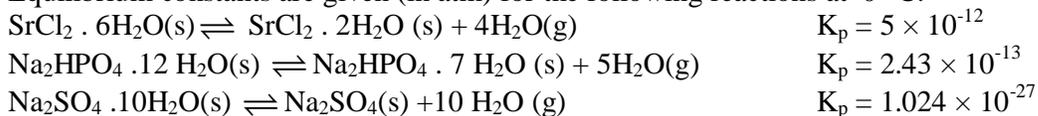
17. Which is the most effective drying agent at 0°C?
(A) $SrCl_2. 2H_2O$ (B) $Na_2HPO_4.7 H_2O$ (C) Na_2SO_4 (D) all equally

18. At what relative humidities will $Na_2SO_4.10 H_2O$ be efflorescent (release moisture) when exposed to air at 0°C?
(A) above 33.33%   (B) below 33.33 %   (C) above 66.66%   (D) below 66.66%

SECTION – IV   (Integer Answer Type)

This section contains **08** questions. The answer to each of the questions is a **single digit integer,** ranging from 0 to 9. The correct digit below the question number in the ORS is TO be bubbled.

(+4, 0)

19. Calculate pH of a resultant solution of 25 mL of 0.1M HCl, 50 mL of 0.02M HNO_3 and 25 ml of 0.1M NaOH.

20. Calculate pH of a resultant solution of 0.1M HA $\left(K_a = 10^{-6}\right)$ and 0.45M HB$\left(K_a = 2 \times 10^{-6}\right)$ g 25°C

21. Calculate the ratio of sodium formate and formic acid $\left(K_a = 2 \times 10^{-4}\right)$ in a buffer solution of pH = 4.3

22. A certain weak acid has $K_a = 10^{-5}$. If the equilibrium constant for its reaction with a strong base is represented as $y \times 10^y$ then find the value of y.

23. A solution is saturated in $SrCO_3$ and SrF_2. The CO_3^{2-} was found to be 10^{-3} mol/L. If the concentration of F^- in solution is represented as $y \times 10^{-2}$ M then what is the value of y?
[Given: $K_{sp}(SrCO_3) = 2.5 \times 10^{-10}; K_{sp}(SrF_2) = 10^{-10}$]

24. If 50% of CO_2 converts to CO at the following equilibrium:
$$\frac{1}{2}C(s) + \frac{1}{2}CO_2(g) \rightleftharpoons CO(g)$$
And the equilibrium pressure is 12 atm. Calculate K_p.

25. For the reaction
$$A(g) \rightleftharpoons B(g); K_C = 10$$
$$B(g) \rightleftharpoons C(g); K_C = 2$$
$$C(g) \rightleftharpoons D(g); K_C = 0.01$$
Calculate K_C for the reaction $D(g) \rightleftharpoons A(g)$.

26. Calculate K_P for the reaction $A(g) \rightleftharpoons B(s) + 2C(g); K_C = 0.2$ at 305 K.

SECTION - V (Matrix Match Type)

This section **1** Question. Each question has four statements Given in **Column - I** and four statements in **Column – II**. Any given statement in **Column – I** can have correct matching with one or more statement (s) given in **column II**.   **(+8, 0)**

27. (Use $\log 1.8 = 0.26$, Ka of formic acid $= 1.8 \times 10^{-4}$, Ka of acetic acid $= 1.8 \times 10^{-5}$, K_b of ammonia $= 1.8 \times 10^{-5}$, Ka_1 of $H_2S = 10^{-7}$ and Ka_2 of $H_2S = 10^{-14}$, for the following matchings)
Match the entries of column II for which the equality of inequality given in the column I are satisfied.

Column – I	Column - II
(A) 10^{-5} M HCl solution $>$ 0.1 M H_2S solution	(P) α_{water} (degree of dissociation of water)
(B) CH_3COOH solution at pH equal to 4.74 $= NH_4OH$ solution at pH equal to 9.26	(Q) $[OH^-]$
(C) 0.1M CH_3COOH solution $= 1.0$M HCOOH solution	(R) α (degree of dissociation of electrolytes)
(D) 0.1 M of a weak acid $HA_1 (Ka = 10^{-5})$ solution < 0.01M of a weak acid $HA_2 (Ka = 10^{-6})$ solution	(S) pH

(A) $A - P, Q, R, S; B - P, R; C - R; D - P, Q, S.$
(B) $A - R, S; B - P; C - P, R; D - P, S.$
(C) $A - P, Q; B - R; C - P; D - Q.$
(D) $A - P, S; B - R; C - Q, R; D - Q, R, S.$

28.

	Column – I		**Column - II**
(A)	AgBr	(P)	Solubility in water is more than expectation.
(B)	AgCN	(Q)	Solubility in acidic solution is more than that in pure water.
(C)	$Fe(OH)_3$	(R)	Solubility in strongly basic solution is more than that in pure water.
(D)	$Zn(OH)_2$	(S)	Solubility decreases in presence of common anion.

(A) $A-R; B-P,R; C-R; D-P,$. (B) $A-S; B-P,Q; C-Q,S; D-Q,R$.

(C) $A-P; B-R; C-R; D-Q$. (D) $A-Q; B-S; C-Q; D-P$.

29. Match the following

List – I (Reaction) **List – II (units of equilibrium constant)**

(A) $N_2^{(g)} + O_2^{(g)} \rightleftharpoons 2NO^{(g)}$ (P) $K_c = mole/L$

(B) $N_2^{(g)} + 3H_2^{(g)} \rightleftharpoons 2NH_3^{(g)}$ (Q) No unit

(C) $PCl_5^{(g)} \rightleftharpoons PCl_3^{(g)} + Cl_2^{(g)}$ (R) $k_p = atm^{-2}$

(D) $A_{(\ell)} \rightleftharpoons B_{(g)}$ (S) $K_p = atm$

(A) $A-Q; B-R; C-P,S; D-P,S$. (B) $A-Q; B-R; C-P; D-S$.

(C) $A-S; B-Q; C-P,R; D-P,S$. (D) $A-R; B-Q; C-P,S; D-S$.

30. For the reaction $2NH_3(g) \rightleftharpoons 3H_2(g) + N_2(g), \Delta H = +ve$

	Column – I		**Column – II**
(A)	K_{eq}	(P)	Increases with temperature.
(B)	Degree of dissociation	(Q)	Decreases with temperature.
(C)	No. of moles of H_2	(R)	Increases with pressure.
(D)	No. of moles of NH_3	(S)	Decreases with pressure.

(A) $A-Q; B-Q,R; C-Q,R; D-P,S$. (B) $A-P; B-P,S; C-P,S; D-Q,R$.

(C) $A-R; B-P,S; C-Q,R; D-P,S$. (D) $A-S; B-Q,R; C-Q,R; D-P,S$.

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1.	(B)	2.	(C)	3.	(B)	4.	(B)	5.	(C)
6.	(B)	7.	(ABCD)	8.	(AC)	9.	(CD)	10.	(AD)
11.	(CD)	12.	(ABC)	13.	(A)	14.	(C)	15.	(B)
16.	(D)	17.	(A)	18.	(B)	19.	(2)	20.	(3)
21.	(4)	22.	(9)	23.	(2)	24.	(4)	25.	(5)
26.	(5)	27.	(A)	28.	(B)	29.	(A)	30.	(B)