CHEMISTRY

PHYSICAL, INORGANIC, AND ORGANIC CHEMISTRY

IONIC EQUILIBRIUM

Solved Example

1. In which direction will the following equilibria I and II proceed?

$I: H_2SO_4(aq) + NH_3(aq) \Leftrightarrow NH_4^+(aq) + HSO_4^-(aq)$

$II: HCO_3^-(aq) + SO_4^-(aq) \Leftrightarrow HSO_4^-(aq) + CO_3^{2-}(aq)$

A. I forward &II backward

B. I backward & II forward

C. Both forward

D. Both backward

Answer: A

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2. For the given reaction identify the true (T) & false (F) statements

$C_2H_5NH_2 + HI \Leftrightarrow (C_2H_5NH_3)^+\Gamma$

S_1 : HI is bronsted base

S_2HI is bronsted acid

S_3 : HI is arrhenius acid

S_4 : HI is lewis acid

S_5 : HI is arrhenius base

S_6 : HI is lewis base.

A. $TFFFTT$

B. $FTTTFF$

C. $FTTFFF$

D. $TFFFTF$

Answer: C

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3. In the above question identify the true (T) and false (F) statement is Hi is replaced with $C_2H_5NH_2$ in each statement .

A. $TFFFTT$

B. $TFFFFT$

C. $FFTTFF$

D. $FTTTFF$

Answer: B

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4. Ammonium ion is :

A. Lewis acid

B. Lewis base

C. Bronsted acid

D. Bronsted base

Answer: C

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5. In which of the following reactions does NH_3 act as a acid?

A. $NH_3 + H^+ \rightarrow NH_4$

B. $NH_3 + H^+ \rightarrow NH_2^- + H_2$

C. $NH_3 + HCl \rightarrow NH_4Cl$

D. None as NH_3 is a base

Answer: B

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6. Sulphanilic acid is a/an:

A. Arrhenius acid

B. Lewis base

C. Neither (A) or (B)

D. Both (A) and (B)

Answer: D

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7. Find the pH of (a)$10^{-3}MHNO_3$ solution (b)$10^{-4}MH_2SO_4$ solution (Take$\log 2 = 0.3$)

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8. Calcuate pH of $10^{-8}MHCl$ solution at $25^{\circ}C$ (Take $\log 1.05 = 0.02$)

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9. What will be the pH of $5 \times 10^{-6}MBa(OH_2)$ solution of $25^{\circ}C$?

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10. Calculate pH of $10^{-7}MofNaOH$ solution at $25^{\circ}C$ (take log0.618=0.21)`

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11. Calculate pH of mixture of $\left(400mL, \frac{1}{200}MH_2SO_4\right) + \left(400mL. \frac{1}{100}MHCl\right) + (200mLofwater)$

Take $\log 2 = 0.3$

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12. $500mL$ of $10^{-5}MNaOH$ is mixed with $500mL$ of $2.5 \times 10^{-5}M$ of $Ba(OH_2)$,To the resulting solution ,$99L$ water is added ,calculate pH of final solution.Take $\log 0.303 = -0.52$.

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13. Calculate pH of mixture of $\left(400mL, \frac{1}{200}MBa(OH)_2\right) + \left(400mL. \frac{1}{50}MHCl\right) + (200mL \text{of water})$

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14. Calculate pH of (a) $10^{-1}MCH_3COOH(b)10^{-3}CH_3COOH(C)10^{-6}McH_3COOH$ Take $K_a = 2 \times 10^{-5}$ at $25^\circ C$.

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15. Calculate pH of the solution which is $10^{-1}M$ in HCl & $10^{-3}M$ in $CH_3COOH\left[K_a = 2 \times 10^{-5}\right]$.Also calculate $\left[H^+\right]$ form CH_3COOH.

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16. Calculate the pH of a solution obtained by mixing equal volume of $0.02MHOCl \& 0.2MCH_3COOH$ solutions

Given that $K_a(HOCl) = 2 \times 10^{-4}$, $K_a(CH_3COOH) = 2 \times 10^{-5}$

Also calculate $\left[OH^-\right]$, $\left[OCl^-\right]$, $[CH_3COOH]$ at equilibrium .Take $\log 2 = 0.3$

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17. Calculate the concentration of all species of significant concentration present in $0.1MH_2PO_4$ solution $K_{a_1} = 6.2 \times 10^{-8}$, $K_{a_3} = 3.6 \times 10^{-13}$ .Take $0.075 \times 4.075 = (0.555)^2$

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18. Calcualate $pH, [H^+], [OH^-], [CH_3COOH], [SH^-], [H_2S], [S^{2-}]$ in a solution obtained by mixing equal volume of $0.2M H_2S \& 0.02M$ acetic acid .Given that

$K_a(CH_3COOH) = 2 \times 10^{-5}, K_{a_1}(H_2S) = 10^{-7}, K_{a_2}(H_2S) = 10^{-14}$

Take $\log 21 = -1.32, \frac{1}{\sqrt{21}} = 0.218$

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19. Calculate $pH_1, [HS^-], [S^{2-}], [Cl^-]$ in a solution which is $0.1M$ in $HCl \& 0.1M \in H_2S$.Given that $K_{a_1}(H_2S) = 10^{-7}, K_{a_2}(H_2S) = 10^{-14}$ .Also calculate degree of dissociation of H_2S & HS^- in solution.

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20. Calculate degree of hydrolysis K_h and pH of $1M$ urea hydtochloride solution in water K_b (Urea) $= 1.5 \times 10^{-14}$ at $25^\circ C$.Consider urea as a monoacidic base.Take $\log 0.55 = -0.26$

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21. Equal volume of $0.2MNH_4OH$ (or ammonia) are $0.1MH_2SO_4$ are mixed.Calculated pH of final solution.Given :K_b of $NH_3 = 1.8 \times 10^{-5}$ at $25^\circ C$.

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22. If the equilibrium for reaction of HCN with $NaOH$ is 10^{10} then calculate pH of $10^{-3}MNaCN$ solution of $25^\circ C$

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23. Calculate degree of hydrolysis(h) and pH of solution obtained by dissolving 0.1 moles of $CH_3COOHNa$ in water to get $100L$ of solution .Take K_a of acetic acid $= 2 \times 10^{-5}$ at $25^\circ C$.

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24. Calculate pH and degree of hydrolysis fo $10^{-2}MNH_4CN$ solution. Given that K_a of $HCN = 5 \times 10^{-10}$ and K_b of (aq.NH_3) $= 2 \times 10^{-5}$ at $25^\circ C$.

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25. What is the pH of $1MNaPO_4$ solution at $25^\circ C$?

$PO_4^{3-} + H_2O \Leftrightarrow HPO_4^{2-} + OH^-, K_b = 2.4 \times 10^{-2}$

Assume no hydrolysis of HPO_4^{2-} ions.

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26. Calculate the amount of $(NH_4)_2SO_4$ in grams which must be added to $500ml$ of $0.2MNH_3$ to give a solution of $pH = 9.3$ .Given pK_b for $NH_3 = 4.7$.

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27. The pH of a blood stream is maintained by a proper balance of H_2CO_3 and $NaHCO_3$ .What volume of $5MNaHCO_3$ solution should be mixed with $10ml$ of a sample of solution which is $2.5M$ in H_2CO_3 in order to maintain a $pH = 7.4$(Take pK_{a_1} for $H_2CO_3 = 6.7, \log 2 = 0.3$)

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28. Calculate $\left[H^+\right]$ in a $0.20M$ solution of dichloriacetic acid $\left(K_a = 5 \times 10^{-2}\right)$ that also contains $0.1M$ sodium dichloroacetate.Neglect hydrolysis of sodium salt.

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29. Calculate the buffer capacity of $1L$ solution of :

$(i) 0.1MCH_3COOH$ and $0.1MCH_3COONa$

$(ii) 0.2MCH_3COOH$ and $0.2MCH_3COONa$

Given:$pK_a(CH_3COOH) = 4.74$

Which will be a better buffer?

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30. pH of $0.1M$ solution of NaA (sodium salt of weak acid HA) is 8.92 .Calculate pK_a of HA.If a drop $HPh(pK_{\text{in}} = 9.52)$ be added to the above solution.predict whether the pink colour will visible or not the under the medical fact that our eyes can see the pink colour if the mole $\%$ of ionised form of indicated is $25\,\%$ or more.

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31. Find the pH at equivalence points when a soluiton of $0.1M$ acetic acid is titrated with a solution of $0.3MNaOHK_a$ for acetic acid $= 7.5 \times 10^{-6}$

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32. Predict titration curve for titration of $Na(2)CO_3$ & HCl

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33. Calculate K_{sp} of $Fe_4\left[Fe(CN)_6\right]_3$ at a particular temperature where solubility in water =smol//L

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34. You are given $10^{-5}MNaCl$ solution and $10^{-8}MAgNO_3$ solution.They are mixed in $1:1$ volume ratio predict whether $AgCl$ will be precipitated or not ,if solubility product (Ksp) of $AgCl = 10^{-10}$

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35. $100mL$ of a clear saturated solution of Ag_2SO_4 is added to $250mL$ of a clear saturated solution of $PbCrO_4$ .will any precipitate form and if so what ?Given K_{sp} values of $Ag_2SO_4, Ag_2CrO_4, PbCrO_4 \& PbSO_4$ are $1.4 \times 10^{-5}, 2.4 \times 10^{-12}, 2.8 \times 10^{-13}$ and 1.6×10^{-8} respectively.

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36. Calcuate solubility of silver oxalate in $10^{-2}M$ potassium oxalate solution.Given that K_{sp} of silver oxalate $= 10^{-10}$.

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37. Calculate similtaneous solubility of silver thiocyanate and silver bromids in water .Given that K_{sp} of silver thiocyanate=10^{-12} and K_{sp} of silver bromids $= 5 \times 10^{-13}$ respcectively.

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38. what must be the concentration of aqueous of NH_3 which must be added to a solution containing $4 \times 10^{-3}MAg^{+}$ and $0.001MNaCl$ to prevent the precipitaion of $AgCl$.

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39. The solubility of $Pb(OH)_2$ in water is 6.7×10^{-6}M. Calculate the solubility of $Pb(OH)_2$ in a buffer solution of $pH = 8$.

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40. Calculate solubility of MnS in a buffer solution of given pH. K_{sp} of MnS and $K_{a_1}\&K_{a_2}$ for H_2S are given .

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41. $2M$ solution of Na_2CO_3 is boiled in a closed container with excess of CaF_2 .Very little amount of $CaCO_3$ and NaF are formed.If the solubility product (K_{sp}) of $CaCO_3$ is x and molar solubility of CaF_1 is y.Find the molar concentration of F^- in resulting solution after equilibrium is attained.

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42. What $\left[H_3O^+\right]$ must be maintained in a satured H_2S solutions of precipitate Pb^{2+} but not Zn^{2+} form a solution in which each ion is present at a concentration of $0.01M$?

(K_(sp)ofH_(2)S $= 1.1 \times 10^{-22}$, K_{sp} of $ZnS = 1.0 \times 10^{-21}$, $\sqrt{11} = 3.3$)

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Solved Example Miscellaneous Solved Problems

1. Which of the following is the strongest base?

A. $C_2H_5^-$

B. C_2H_5COO

C. $C_2H_6O^-$

D. OH^-

Answer: A

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2. Calculate the pH of solution obtained by mixing $10mL$ of $0.1MHCl$ and $40mL$ of $0.2MH_2SO_4$ take $\log 3.4 = 0.53$

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3. A solution of HCl has a HCl has a $pH = 5$ if one mL of it is dilluted to 1 litre what will be pH of resulting solution.

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4. Calculate the pH of a solution which contains $100mL$ of $0.1MHCl$ and $9.9mL$ of $1.0MNaOH$.

Take $\frac{1}{1099} = 9.1 \times 10 \times 10^{-4}$& $\log 9.1 = 0.96$.

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5. Calculate the pH of $0.001MHOCl$ having $25\,\%$ dissocation .Also calculate dissocation constant of the acid ,Take $\log 2 = 0.3$

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6. Calcualte $\left[H^+\right]$ in a solution containing $0.1MHCOOH$ and $0.1MHCON$. K_a for $HCOOH$ and $HOCN$ are 1.8×10^{-4} and 3.3×10^{-4}.Take $\sqrt{50} = 7.14$

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7. A solution contains $0.1MH_2S$ and $0.3MHCl$ .Calculate the conc.of S^{2-} and HS^- ions is solutions.Given K_{a_1} and K_{a_2} are $10^{-7}$and 1.3×10^{-13} respectively.

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8. $20mL$ of $0.2MNaOH$ are added to $50mL$ of $0.2M$ acetic acid $\left(K_a = 1.85 \times 10^{-5}\right)$

Take $\log 2 = 0.3, \log 3 = 0.48$

(1) What is pH of solution?

(2) Calculate volume of $0.2MNaOH$ required to make the pH of origin acetic acid solution.4.74.

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9. Calculate the amount of NH_3 and NH_4CI required to prepare a buffer solution of pH 9.0 when total concentration of buffering reagents is $0.6molL^{-1}$. $(pK_bf \text{ or } NH_3 = 4.7, \log 2 = 0.30)$

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10. The solubility product of SrF_2 in water is 8×10^{-10}. Calculate its solubility in $0.1M$ NaF aqueous solution.

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11. A solution contains a mixture of $Ag^{+}(0.10M)$ and $Hg_2^{2+}(0.10M)$ which are to be separated by selective precipitation. Calculate the miximum concentreation of iodide ion at which one of them gets precipitated almost completely. What % of that metal ion is precipitated ? $\left(K_{SP}ofAgI = 8.5 \times 10^{-17} \text{ and } K_{SP} \text{ of } Hg_2I_2 = 2.5 \times 10^{-26}\right)$

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12. Calculate solubility of $BasO_4$ when $CaSO_4$ and $BasO_4$ are dissolved in water simultaneously K_{sp} of $CaSO_4 = p$. K_{sp} of $BasO_4 = q$ and simultaneous solubility of $CaSO_4$ is b mol/litre.

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13. What $\left[H^{+}\right]$ must be maintained in a saturated $H_2S(0.1)M$ to precipitate CdS but not ZnS if $\left[Cd^{2+}\right] = \left[Zn^{2+}\right] = 0.1$ initially?

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Board Level Exercise

1. How does the degree of ionization (assuming lt lt 1)` of a weak electroyte vary with concentration ? Give exact relationship.

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2. In the reaction $SnCl_4 + 2Cl^- \rightarrow [SnCl_6]^{2-}$ which is Lewis acid and which one is base?

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3. What happens to the ionic product of water if some acid is added into water?

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4. What are pH and pOH value of the neutral solution at a temperature at which $K_W = 10^{-13}$?

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5. NaCl solution is added to a saturated solution of $PbCl_2$. What will happen to the concentration of Pb^{+2} ions?

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6. Which of the followings are Lewis acids: H_2O, BF_3, $H^{\oplus}$ and NH_4?

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7. Write the expression for comparison of realtive strengths of two weak in terms of their ionization constants.

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8. What happens to the pH if a few drops of acid are added to the CH_3COOH solution?

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9. At half neutralisation of weal acid with a strong base,what is the relationship between pH and dissocaition constant (K_a) of weak acid ?

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10. What happens to the solubility of $AgCl$ in water if $NaCl$ solution is added is to ?

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11. What will be the pH of $1MNaNO_3$ solution at $25^\circ C$? Explain.

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12. What is the effect of temperature on ionic porduct of water and why?

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13. What is the diffrerence between ionic product and solubility product?

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14. Why common salt is added to precipitate out soap form the solution during its manufacturing ?

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15. What is pH of our blood? Why does it remain almost constant inspite the varity of food and species we eat ?

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16. why is ammonia termed as a base through it does not contain OH^- ions?

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17. Two sparingly soluble salts AB and XYZ have the same soubility product. Which salt will be more soluble?

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18. Calcuate the pH value of (assume $100\,\%$ ionization)

(i) 10^{-2} molar HNO_3 solution

(ii) $0.03MHCl$ solution $(\log 3 = 0.4771)$

(iii) $0.0005MH_2SO_4$ solution

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Exercise 1

1. Select polybasic Arrhenius acids form the following : $H_3PO_2, H_3PO_3, H_3BO_3, HCOOH, (COOH)_2$

b Write conjugate acids of $SO_4^{2-}, RNH_2, NH_2^-, C_2H_5OC_2H_5, F^-$

c Write conjugate base of $HNO_2, OH^-, H_2CO_3, HClO_4$

d Write conjugate acid and conjugate base of following amphoteric species:

$HS^-, NH_3. C_2H_5OH, H_2O$

e Classify the following into Lewis base :$H^+, FeCl_3, (CH_3)_3N, F, CH_2$

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2. Common upon H_2O as an Arrhenius acid/base ,Bronsted-Lowry acid/base and Lewis acid /base.

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3. At $-50^{\circ}C$ liquid NH_3 has ionic product is 10^{-30} .How many amide $\left(NH_2^-\right)$ ions are present per mm.^{3} in pure liqudi NH_3? (Take $N_A = 6 \times 10^{23}$)

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4. What is the ionisation constant of $HOCl$ if K_b of $Ocl^- = 4 \times 10^{-10}$?

Also find its pK_a.

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5. Calcutate pH of following solutions:

(i) 0.001 M HNO_3,(ii) 0.005m H_2SO_4 ,(iii) 0.01 M KOH

(iv) 10^{-6} M NaOH, (v)0.0008 M $Ba(OH)_2$

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6. Calculate the pH of the resulting solution formed by mixing the following solutions:

(a) $20ml$ of $0.2M$ $Ba(OH)_2 + 30mL$ of $0.1M$ HCl

(b) $2mL$ of 0.1 M $HCl + 10ml$ of 0.01 M KOH

(c) $10mL$ of 0.1 M $H_2SO_4 + 10mL$ of $0.1MKOH.$

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7. Acetic acid gets $1.3\,\%$ ionised in its decimolar solution.What is be the ionisation constant of acetic acid?

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8. Calculate the pH of $500mL$ Solution of $1MBOH\left(K_b = 2.5 \times 10^{-5}\right)$

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9. What is the $pH$of $0.01MH_2S$ solution ? Also determine $\left[HS^-\right]$ & $\left[S^{2-}\right]$ Given: For H_2S, $K_{a_1} = 9 \times 10^{-8}$, $K_{a_2} = 1.2 \times 10^{-13}$

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10. Upon passing 0.01 moles HCl gas through $100mL$ of $0.05M$ Formic acid solution $\left(K_a = 1.8 \times 10^{-4}\right)$ determine change in pH of solution and $\left[HCOO^-\right]$ in resulting solution.

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11. Calculate $\left[H^+\right], \left[HCOO^-\right]$ and $\left[OCN^-\right]$ in a solution that contains 0.1 M HCOOH $\left(K_a = 2.4 \times 10^{-4}\right)$ and $0.1MHOCN\left(K_a = 4 \times 10^{-4}\right)$.

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12. What is $\left[HS^{-}\right] \& \left[S^{2-}\right]$ in solution of $0.01MHCl$ and $0.1MH_2S$? (Given that for H_2S, $K_{a_1} = 10^{-7}$ and $K_{a_2} = 10^{-14}$)

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13. Which of the following ions or compounds in a solution tend to produce an acidic ,a base or a neutral solution ?

(a)$C_2H_5O^{-}$, $(b)Cu^{2-}(c)SO_3^{2-}(d)F^{-}(e)NH_4^{+}$

$CH_3COOHNa(g)KNO_3(h)NaOCl(i)Na_2CO_3$, $(j)ZnCl_2$

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14. Calculate the pH of $0.2M$ sodium butyrate, (K_a for butyric acid is 2.0×10^{-5})

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15. A $0.25M$ solution of pyridinium chloride $C_5H_5NH^+Cl^-$ was found to have a pH of 2.75 What is K_b for pyridine, C_5H_5N?

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16. Calcuate the $pH of 0.1M na_3A$ of solution (salt of tribasic acid H_3A) Assume only first step hydrolysis be significant.Given , K_{a_1}, $K_{a_2}\&K_{a_3}$ For H_3A are 10^{-4}, $10^{-7}\&10^{-9}$ respectively.

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17. What is the pH of $m/20KNC_8H_4O_4$ solution .Given :$H_2C_8O_4$ is a diabasic acid with $pK_{a_1}\&pK_{a_2}$ as $2.94\&5.44$ respectively.

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Part Ii Only One Option Correct Type

1. an acid with molecular formula $C_7H_6O_3$ forms three types of sodium salt i.e., $C_7H_5O_3Na$, $C_7H_4O_3Na_2$ and $C_7H_3O_3Na_3$. The basicity of the acid:

A. one

B. Two

C. Three

D. Six

Answer:

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2. In the following reaction $HC_2O_4^-(aq) + PO_4^{3-}(aq) \Leftrightarrow HPO_4^{-2}(aq) + C_2O_4^{2-}(aq)$, which are the two Bronsted bases?

A. $HC_2O_4^-$ and PO_4^{3-}

B. $HPO_4^{2-} + C_2O_4^{2-}$

C. $HC_2O_4^-$ and HPO_4^{2-}

D. PO_4^{3-} and $C_2O_4^{2-}$

Answer:

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3. The following equilibrium is established when $HC1O_4$ is dissolved in weak acid HF,

$HF + HClO_4 \Leftrightarrow ClO_4^- + H_2F^+$

Which of the following is correct set of conjugate acid base pair?

A. HF and $HCIO_4$

B. HF and CIO_4^-

C. HF and H_2F

D. $HCIO_4$ & H_2F^+

Answer:

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4. Which of the following correctly explains the nature of boric acid in aqueous medium :

A. $H_3BO_3 \xrightarrow{H_2O} H_3O^+ + H_2BO_3^-$

B. $H_3BO_3 \xrightarrow{2H_2O} 2H_3O^+ + HBO_3^{2-}$

C. $H_3BO_3 \xrightarrow{3H_2O} 3H_3O^+ + BO_3^{3-}$

D. $H_3BO_3 \xrightarrow{H_2O} B(OH)_4^- + H^+$

Answer:

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5. In the reaction : $Ni^{2+} + 6H_2O \rightarrow \left[Ni(H_2O)_6\right]^{2+}$

A. Ni^{2+} behave like a Lewis acid

B. H_2O behaves like a Lewis base

C. Above cannot be called an acid-base reaction

D. Both (A) and (B)

Answer:

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6. Which of the following expression is not true ?

A. $[H^+] = [OH^-] = \sqrt{K_W}$ for a neutral solution at all temperatures.

B. $[H^+] > \sqrt{K_W} = [OH^-] < \sqrt{K_W}$ for an acidic solution.

C. $[H^+] < \sqrt{K_W} = [OH^-] > \sqrt{K_W}$ for an alkaline solution.

D. $[H^+] = [OH^-] = 10^{-7}$ for a neutral solution at all temperatures.

Answer:

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7. pOH of H_2O is 7.0 at $298K$. If water is heated at $350K$, which of the following statement should be true?

A. pOH will decrease

B. pOH will increases

C. pOHwill remain 7.

D. Both (A) and (B)

Answer:

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8. K_w of H_2O at 373 K is 1×10^{-12} Identify which of the following is/are correct?

A. $pH + pOH = 12$ for every aqueous solutions.

B. pH of H_2O is 6.

C. α_{H_2O} has increased from its value at 298K

D. H_2O is acidic.

Answer:

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9. In pure liquid of $HCOOH$, concentration of $HCOO^- = 10^{-3}M$ at $27^\circ C$. What is the self- ionisation constant $(K = [HCOOH^{2+}][HCOO^-])$

A. 10^{-3}

B. 10^3

C. 10^6

D. 10^{-6}

Answer:

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10. Given, $HF + H_2O \xrightarrow{K_a} H_3O^+ + F^-$

$F^- + H_2O \xrightarrow{K_b} HF + OH^-$

Which relation is correct ?

A. $K_b = \frac{1}{K_a}$

B. K_a, K_b, K_w

C. $K_a . K_b . K_w = 1$

D. $\frac{K_a}{K_b} = K_w$

Answer:

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11. k_{b_1} of N_2H_4 is 4×10^{-6} .Then what is the acid dissociation constant of $N_2H_5^+$ and $N_2H_6^+$ respectively?

A. data insufficient 4×10^{-6}

B. data insufficient 2.5×10^{-8}

C. 2.5×10^{-9} Data insufficient

D. $2.5 \times 10^{-9}, 4 \times 10^{-6}$

Answer:

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12. In water, the acid $HCIO_4$, HCI, H_2SO_4 and HNO_3 exhibit the same strength as they are completely ionised in water (a base). This is called ..... of the solvent water.

A. Strength

B. Capacity

C. Buffer effect

D. Levelling effect

Answer:

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13. The $\left[OH^{-}\right]$ in $100mL$ of $0.016MHCl(aq)$ is

A. $6.25 \times 10^{-12}M$

B. $3 \times 10^{-10}M$

C. $6.25 \times 10^{-13}M$

D. $1.6 \times 10^{-3}M$

Answer:

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14. How many moles of $NaOH$ must be removed from 1 litre of aqueous solution to change its pH from 12 to 11

A. 0.009

B. 0.01

C. 0.09

D. 0.1

Answer:

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15. Which statement/relationship is correct ?

A. pH of aqueous solutions of $0.1MHNO_3, 0.1MHCl.0.1MHI$ at $25^\circ C$ is not equal .

B. For a dilute solution $pH = -\log \frac{1}{[H^+]}$

C. At $25^\circ C$ the pH of pure water is 7.

D. The value of pK_W at $25^\circ C$ is 7.

Answer:

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16. $10^{-6} MHCl$ is diluted to 100 times. Its pH is:

A. 6

B. 8

C. 6.98

D. 7.02

Answer:

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17. On adding $0.04g$ solid $NaOH$ to a $100mL$, $\frac{M}{200}Ba(OH)_2$ solution, determine change in pH:

A. 0

B. $+0.3$

C. -0.3

D. $+0.7$

Answer:

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18. Upon mixing equal volume of a strong acid solution (HA) and a strong base (BOH) solution pH of resulting solution:

A. may be less than 7

B. may be greater than 7

C. will be equal to 7

D. Both (A)&(B)

Answer:

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19. Which of the following solutions will have pH close to 1.0 ?

A. $100mLofM/10HCl + 100mLofM/10NaOH$

B. $55mLofM/10HCl + 45mLofM/10NaOH$

C. $10mLofM/10HCl + 90mLofM/10NaOH$

D. $75mLofM/5HCl + 25mLofM/5NaOH$

Answer:

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20. The ratio of dissociaiton constant of two weak acids HA and HB is $4:1$ .AT what initial molar concentration ratio of two acid solution,the two will have same pH in separate solutions.Assume negligible association of both acids in their solutions.

A. $2:1$

B. $1:2$

C. $4:1$

D. $1:4$

Answer:

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21. At $25^\circ C K_b$ for $BOH = 1.0 \times 10^{-12}.0.01M$ solution of BOH has $\left[OH^-\right]$:

A. $1.0 \times 10^{-6} M$

B. $1.0 \times 10^{-7} M$

C. $1.0 \times 10^{-5} M$

D. $2.0 \times 10^{-6} M$

Answer:

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22. K_a for formic acid and acetic acid are 2.1×10^{-4} and 1.1×10^{-5} respectively. The relative strength of acids is:

A. $10:1$

B. $1:10$

C. $1:\sqrt{10}$

D. $\sqrt{10}:1$

Answer:

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23. K_a for monobasic acid ,whose $0.1M$ solution has pH of 4.5 is :

A. 10^{-10}

B. 10^{-8}

C. $\sqrt{10} \times 10^{-4}$

D. $\sqrt{10} \times 10^{-6}$

Answer:

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24. For 10^{-4} M BOH (weak base) ,$K_b = 5 \times 10^{-5}$):

A. $\alpha = 0.707$

B. $\left[OH^-\right] = 5 \times 10^{-5} M$

C. $pH = 9.85$

D. All of these

Answer:

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25. For, $H_3PO_4 + H_2O \Leftrightarrow H_3O^+ + H_2PO_4^-$, K_{a_1}

$H_2PO_4 + H_2O \Leftrightarrow H_3O^+ + HPO_4^{2-}$, K_{a_2}

$HPO_4^{2-} + H_2O \Leftrightarrow H_3O^+ + PO_4^{3-}$, K_{a_3}

The correct order of K_a values is:

A. $K_{a_1} > K_{a_2} > K_{a_3}$

B. $K_{a_1} < K_{a_2} < K_{a_3}$

C. $K_{a_1} > K_{a_2} > K_{a_3}$

D. $K_{a_1} < K_{a_2} > K_{a_3}$

Answer:

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26. In a $0.2M$ aqueous solution of Ethylene diamine $(H_2NCH_2CH_2NH_2)$:

Given $K_{b_1} = 8 \times 10^{-5}$ & $K_{b_2} = 2.7 \times 10^{-8}$

A. $\left[OH^-\right] = 2 \times 10^{-2}M$

B. $\left[C_2N_2H_{10}^{2+}\right] = 2.7 \times 10^{-8}M$

C. Both (A) and (B)

D. None of these

Answer:

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27. The dissociation constant of acetic acid at a given temperature is 1.69×10^{-5}.The degree of dissociation of 0.01 M acetic acid in presence of 0.01 M HCl is equal to :

A. 1.69×10^{-7}

B. 1.69×10^{-5}

C. 1.69×10^{-3}

D. 2.9×10^{-2}

Answer:

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28. In above question concentration of Triethyl ammonium ion $[C_6NH_{16}]^+$ in resulting solution will be :

A. $100K_b$

B. $200K_b$

C. $10K_b$

D. K_b

Answer:

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29. Consider an aqueous solution 0.1 M each in HOCN, HCOOH, $(COOH)_2$ and H_3PO_4 for HOCN, we can write $K_a(HOCN) = \frac{[H^+][OCN^-]}{[HOCN]}$, $[H^+]$ in the expression refers to:

A. H^+ ions released by $HOCN$

B. Sum of H^+ ions released by all monoprotic acids

C. Sum of H^+ ions released only the first dissociation of all the acids

D. Overall H^+ ion concentration in the solution.

Answer:

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30. What are $[H^{\oplus}]$, $[A^{\Theta}$, and $[B^{\Theta}]$ in a solution that is $0.3MHA$ and $0.1MHB$? K_a for HA and HB are 1.38×10^{-4} and 1.05×10^{-10}, respectively.

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31. pH of solution obtained by mixing equal volumes of $0.1M$ Triethyl amine $\left(K_b = 6.4 \times 10^{-5}\right)$ & $\frac{4}{45}MNH_4OH\left(K_b = 1.8 \times 10^{-5}\right)$ will be :

A. 11.3

B. 10.3

C. 12.3

D. 11.45

Answer:

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32. In a solution containing $0.1MHCl \& 0.1MH_3PO_4$ (having dissociation constants $K_{a_1}, K_{a_2}, K_{a_3}$) assuming $\alpha << 1$ for H_3PO_4,

A. $pH = 1$

B. $\alpha_{H_3PO_4} = 10K_{a_1}$

C. $\left[HPO_4^{2-}\right] = 10K_{a_1}K_{a_2}$

D. All of these

Answer:

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33. For a solution obtained by mixing equal volumes of $0.02MKOH$ solution $\&0.2MB$ (weak diacidic base),$K_{b_1} = 10^{-7}\&K_{b_2} = 10^{-14}$) solution:

A. $pH = 12$

B. $\left[BH^+\right] = 10^{-6}M$

C. $\left[BH_2^{2+}\right] = 10^{-18}M$

D. All of these

Answer:

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34. A pair of salts are given in a solution each is 0.1 M in concentration. Which solution has a higher pH ?

A. $NaCN$ and $NaOBr$

B. NaF and $NaOCl$

C. NaF and $NaOBr$

D. $NaCN$ and $NaOCl$

Answer:

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35. Aqueous solution of NH_4Cl is ..... in nature due to behaviour of....ion in solution:

A. acidic,NH_4

B. alkalline ,NH_4

C. acidic, Cl^-

D. alkalline, Cl^-

Answer:

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36. The pH of a solution obtained by mixing 100mL of 0.3M CH_3COOH with 100mL of 0.2 M NaOH would be:

(pK_a for $CH_3COOH = 4.74$)

A. 4.74

B. 8.87

C. 9.10

D. 8.57

Answer:

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37. The sodium salt of a certain weak monobasic organic acid is hydrolysed to an extent of 3% in its 0.1 M solution at $25^{\circ}C$.Given that the ionic product of water is 10^{-14} at this temperature , what is the dissociation constant of the acid ?

A. $\approx 1 \times 10^{-10}$

B. $\approx 1 \times 10^{-9}$

C. 3.33×10^{-9}

D. 3.33×10^{-10}

Answer:

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38. The pH of $0.1M$ solution of the following salts decreases in the order

A. $NaCl < NH_4Cl < NaCN < HCl$

B. $HCl < NH_4Cl < NaCl < NaCN$

C. $NaCN < NH_4Cl < NaCl < HCl$

D. $HCl < NaCl < NaCN < NH_4Cl$

Answer:

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39. The degree of hydrrolysis of a salt of weak acid and weak base in its $0.1M$ solultion is found to be $50\,\%$. If the molarity of the solution is $0.2M$, the percentage hydrolysis of the salt should be:

A. $100\,\%$

B. $50\,\%$

C. $25\,\%$

D. None of these

Answer:

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40. Select the correct statement regarding above solution.

A. Anion will undergo hydrolysis producing OH^- & solution is expected to be basic.

B. Anion will not undergo hydrolysis & solution is expected to be basic

C. Cation will undergo hydrolysis producting H_3O^+ & solution is expected to be acidic.

D. Cation will undergo hydrolysis producing OH^- & solution is expected to be acidic.

Answer:

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41. pH of $0.1MNa_2HPO_4$ and $0.2MNaH_2PO_4$ are respectively: (pK_a for H_3PO_4 are $2.12, 7.21$ and 12.0 for respective dissociation to HPO_4^{2-}, HPO_4^- and PO_4^{3-}):

A. $4.7, 9.6$

B. $9.6, 4.7$

C. $9.3, 4.4$

D. $4.4, 9.3$

Answer:

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42. The pH of which salt solution is independent of its concentration ?

$1(CH_3COO)C_5H_5NH2Na_2PO_43.\ Na_2HPO_44.\ NH_4CN$

A. $1, 2, 3, 4$

B. $1, 4$

C. $2, 3$

D. $1, 2, 3$

Answer:

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Exercise 2 Part I Only One Correct Type

1. Boric acid H_3BO_3 is a:

A. Arrhenius acid

B. Bronsted acid

C. Lewis acid

D. Both (B)&(C)

Answer:

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2. The self ionisation constant for pure formic acid $K = \left[HCOOH_2^+\right]\left[HCOO^-\right]$ has been estimated as 10^{-6} at room temperature .The density of formic acid is $1.15g/cm^3$ .What percentage of formic acid molecules in pure fomic acid are converted to formation ion?

A. $0.002\ \%$

B. $0.004\ \%$

C. $0.006\ \%$

D. $0.008\ \%$

Answer:

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3. Calculate K for the reaction, $A^- + H_3^+O \Leftrightarrow HA + H_2O$

if K_a value for the acid HA is 1.0×10^{-6}.

A. 1×10^{-6}

B. 1×10^{8}

C. 1×10^{-8}

D. 1×10^{5}

Answer:

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4. 10 mL of a strong acid solution of $pH = 2.000$ are mixed with 990mL of another strong acid solution of $pH = 4.000$. The pH of the resulting solution will be:

A. 3

B. 3.3

C. 3.7

D. Molecular formula of both strogn acids should be known to answer above question.

Answer:

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5. $\%$ dissociation of a $0.024M$ solution of a weak acid $HA\left(K_a = 2 \times 10^{-3}\right)$ is :

A. $0.25\ \%$

B. $\approx 29\ \%$

C. $25\ \%$

D. $\approx 0.29\ \%$

Answer:

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6. For a weak base $BOH, K_b = 10^{-4}$ .Calculate pH of $10^{-4}BOH$ solution. (Take $\log 6.2 = 0.79$)

A. 10

B. 9.79

C. 8

D. None of these

Answer:

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7. What concentration of OH^- ions will reduce NH_4^+ ion to $2 \times 10^{-5}M$ in $0.4M$ solution of NH_4OH? $K(b)(NH_4OH) = 1.8 \times 10^{-5}$

A. $0.36M$

B. $0.036M$

C. $2 \times 10^{-5}M$

D. None of these

Answer:

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8. Ratio of $[HA^+]$ in $1L$ of $0.1MH_3A$ solution $[K_{a_1} = 10^{-5}, K_{a_2} = 10^{-8} K_{a_3} = 10^{-11}]$& upon addition of 0.1mole HCl to it will be :

A. 10

B. 100

C. 1000

D. $10,000$

Answer:

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9. Calculate the $pH$of a 0.15 M aqueous solutions of $AlCl_3$

Given :

$[Al(H_2O)_6]^{3+}(aq) + H_2O(l) \Leftrightarrow [(AlH_2O)_5OH]^{2+}(aq), K_a = 1.5 \times 10^{-5}$

A. 2.82

B. 5

C. 9

D. 11.18

Answer:

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10. Calcualte $\left[OH^{-}\right]$ & $\left[H_2C_2O_4\right]$ in a $0.005MNa_2C_2O_4$ solution.Given : $K_{a_1}\&K_{a_2}$ for oxalic acid are $5.6\times10^{-2}\&\ 5.4\times10^{-5}$Take $\sqrt{\frac{1}{108}}=0.096$

A. $\left[OH^{-}\right]=9.6\times10^{-7}M$

B. $\left[H_2C_2O_4\right]=\frac{5}{28}\times10^{-12}M$

C. Both (A) and (B)

D. None of these

Answer:

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Part Ii Single And Double Value Integer Type

1. If an acid-base reaction $HA(aq) + B^-(aq) \Leftrightarrow HB(aq) + A^-(aq)$ has $K_{aq} = 10^{-4}$.how many of the following statements are true?

(i) HB is stronger acid than HA

(ii) HA is stronger acid than HB

(iii) HA and HB have the same acidic strength

(iv) B^- stronger base than A^-

(v) A^- is stronger base than B^-

(vi) B^- and HB are conjugate acid-base pair

(vii) A^- is the conjugate base of acid HA.

(viii)HA can beHSO_4^- and HB can be $HCOOH$.

A^- can be F^- and B^- can be CN^-

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2. What is pOH of an aqueous solution with $\left[H^{+}\right]=10^{-2}M$ and $K_{w}=2\times10^{-12}$? Report your answer after dividing by 2 and round it off to the nearest whole number .

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3. Determine $pK_{a}(H_{2}O)+pK_{a}(H_{3}O)$.

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4. What volume (in L) of water must be added to $1L$ of $0.1M$ solution of B (weak organic monoacidic base.:Ionisation constant $=10^{-5}$) to triple the $\%$ ionisation of base?

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5. For a solution of weak triprotic acid $H_3A\left(K_{a_1} > > K_{a_2}, K_{a_3} : K_{a_2} = 10^{-8}, K_{a_3} = 10^{-13}, \left[A^{3-}\right] = 10^{-17}M\right.$ .Determine pH of solutions. Report your answer as 0 if you find data insufficient.

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6. Calculate the ratio of concentration of $HCOO^- \& OCN^-$ ions in a solution containing $0.1MHCOOH\left(K_a = 1.8 \times 10^{-4}\right)$ and $0.1MHOCN\left(K_{a_1} = 4 \times 10^{-4}\right)$ .if simplest ratio is $a:b$ reprot your answer as $(a+b)$.

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7. If the equilibrium constant for the reaction of weak acid HA with strong base is 10^9, then pH of $0.1M$ Na A is:

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8. Calculate the changes in pH of $0.1MNaHA$ solution after diluting it to ten times the original volume.(Given that for $H_3A: K_{a_1} = 10^{-4}, K_{a_2} = 10^{-7}, K_{a_3} = 10^{-11}$)

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Part Iii One Or More Than One Option Correct Type

1. Which statement(s) is /are correct?

A. All Bronised bases are also Lewis bases.

B. All Bronised acids are not Lewis acid

C. All cations are acids and anions are bases.

D. All Bronsted bases are also Arrnehius bases.

Answer:

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2. For pure water

A. pK_w increses with decreases in temperature

B. $[H_2O]$ decreases with increase in temperature

C. α_{H_2O} increases with decrease in temperature

D. Both pH and pOH decrease with rise in temperature

Answer:

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3. One litre of a strong acid solution contains 10^{-5} moles of H^+ ions.Then:

A. $pOH = 9$

B. Percentage ionisation of water in solution in $1.8 \times 10^{-9}\ \%$

C. Number of OH^- ions per mL of solution 6.022×10^{15}

D. $\left[H^+\right]_{\text{from}H_2O} = 10^{-9}M$

Answer:

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4. $0.1MCH_3COOH$ is diluted at $25^\circ C\left(K_a = 1.8 \times 10^{-5}\right)$, then which of the following will be correct ?

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5. If $K_{a_1} > K_{a_2}$ of H_2SO_4 are 10^{-2} and 10^{-6} respectively then:

A. K_{a_1} and K_{a_2} because it is easy to abstract H^+ from H_2SO_4 and less easy to abstract H^+ from HSO_4^-

B. K_{a_1} and K_{a_2} may be measured in acetic acid.

C. K_{a_1} and K_{a_2} are measured in H_2O.

D. the H^+ ion conc of $0.01MH_2SO_4$ will less than $0.02M$.

Answer:

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6. When $0.1 m\text{mole}$ of solid $NaOH$ is added in $1L$ of $0.1M NH_3(aq)$ then which statement is going to be wrong?

$\left(K_b = 2 \times 10^{-5}, \log 2 = 0.3\right)$

A. degree of dissociation of NH_3 approaches to zero.

B. change in pH by adding $NaOH$ would be 1.85.

C. in solution $\left[Na^+\right] = 0.1M$, $\left[NH_3\right] = 0.1M$, $\left[OH^-\right] = 0.2M$

D. on addition of OH^-, K_b of NH_3 does not changes.

Answer:

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7. Which of the following solutions added to 1L of a 0.01 M CH_3COOH solution will cause no change in the degree of dissociation of

CH_3COOH and pH of the solution ?

$\left(K_a = 1.6 \times 10^{-5} \text{ for } CH_3COOH\right)$

A. $0.6mMHCOOH\left(K_a = 8 \times 10^{-4}\right)$

B. $0.1MCH_3COONa$

C. $0.4mMHCl$

D. $0.01MCH_3COOH$

Answer:

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8. To $1L$ of a $1.6 \times 10^{-3}M$ aqueous solution of ethylene diamine $\left(K_{b_1} = 8 \times 10^{-5}, K_{b_2} = 2.7 \times 10^{-8}\right), 5 \times 10^{-4}$ mole of $Ba(OH)_2$ is added.Then:

A. $pH_f - pH_i = 0.5$

B. $\alpha_i - \alpha_f = 0.12$

C. $\frac{\left[C_2N_2H_{10}^{2+}\right]}{\left[C_2N_2H_{10}^{2+}\right]_f} = 0.128$

D. $\frac{\left[C_2N_2H_9^{+}\right]_i}{\left[C_2N_2H_9^{2+}\right]_f} = 0.128$

Answer:

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9. Equal volumes of following solutions are mixed. In which case the pH of resulting solution will be average value of pH of two solutions?

A. Aqueous HCl of $pH = 2$ aqueous $NaOH$ of $pH = 12$

B. Aqueous HCl of $pH = 2$, aqueous HCl of $pH = 4$.

C. Aqueous HCl of $pH = 2$ aqueous $NaOH$ of $pH = 10$

D. Aqueous CH_3COOH of $pH = 5$ aqueous NH_3 of $pH = 9$. $[K_a(CH_3COOH) = K_b(NH_3)]$

Answer:

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10. The correct relationship between the pH of isolomar solution of $Na_2O(pH_1)$, $Na_2S(pH_2)$, $Na_2Se(pH_3)$ and $Na_2Te(pH_4)$ is:

A. $pH > pH_2$

B. $pH_2 < pH_4$

C. $pH_2 < pH_3$

D. $pH_3 > pH_4$

Answer:

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11. For a $0.072MNaSO_4$ solution,select the incorrect option(s):$(K_{a_1}$ and K_{a_2} of $H_2SO_4 = \infty$ & $1.2 \times 10^{-2})$

A. $pH = 1.62$

B. $pH = 7.39$

C. Degree of hydrolysis $h = \frac{1}{\sqrt{6}}$

D. $h = 3.4 \times 10^{-6}$

Answer:

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Part Iv Comprehension

1. pH calculation upon dilute of strong acid solution is generally done by equating n_H in original solution & diluted solution.However . If strong acid solution is very dilute then H^+ from water are also to be considered take $\log 3.7 = 0.568$ and answer the following questions.

A 1 litres solution of $pH = 4$(solution of a strong acid) is added to the $7/3$ litres of water.What is the $pH$of resulting solution?

A. 4.52

B. 4.365

C. 4.4

D. 4.432

Answer:

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2. pH calculation upon dilute of strong acid solution is generally done by equating n_H in original solution & diluted solution.However . If strong acid solution is very dilute then H^+ from water are also to be considered take $\log 3.7 = 0.568$ and answer the following questions.

A 1 litre solution of $pH = 6$ (solution of a strong acid) is added to the $7/3$ litres of water.What is the pH of resulting solution? Neglect the common ion effect on H_2O.

A. 6.4

B. 6.52

C. 6.365

D. 6.432

Answer:

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3. Consider a solution of CH_3COONH_4 which is a salt weak acid and weak base.

The equilibrium involved in the solutions are :

$CH_3COO^- + H_2O \Leftrightarrow CH_3COOH + OH^-$ .....(i)

$NH_4^+ + H_2 \Leftrightarrow NH_4OH + H^+$ .....(ii)

$H^+ + OH^- \Leftrightarrow H_2O$ .....(iii)

If we add these reactions, then the net reaction is :

$CH_3COO^- + H_2^+ + H_2O \Leftrightarrow CH_3COOH + NH_4OH$ .....(iv)

Both CH_3COO^- and NH_4^+ get hydrolysed independently and their hydrolysis depends on :

(a) their initial concentration

(b) The value of K_h which is $\frac{K_w}{K_a}$ for CH_3COO^- and $\frac{K_w}{K_b}$ for NH_4^+.

Since both of the ions were produced form the salt, their initial

concertration are same. Therefore, unless and until the value of $\frac{K_w}{K_a}$ or K_a and K_b is same, the degree of hydrogen of ions can't be same.

To explain why we assume that degree of hydrolysis of cation and anion is same, we needed to now look at the third reaction i.e.,combination of H^+ and OH^- ions. It is obvious that this reaction happens only because one reaction produced H^+ ion and the other prodcued OH^- ions. We can also note that this reaction causes both the hydrolysis reaction to occur more since their product ions are being consumed. Keep this in mind that the equilibrium which has smaller value of the equilibrium constant is affected more by the common ion effect. For the same reason if for any reson a reaction is made to occur to a greater extent by the consumption of any of the prodcut ion, the reaction with the smaller value of equilibrium constant tends to get affected more.

Therefore, we conclude that firstly the hydroylsis of both the ions occurs more in the presence of each other (due to consumption of the product ions) than in each other's absence. Secondly,the hydroylsis of the ion which occurs to a lesser extent (due to smaller value of K_h)is affected more than the one whole K_h is greater. Hence we can see that the degree of hydroylsis of both the ions would be close to each other when they are

getting hyderolysed in the presence of each other.

In the hydrolysis of salt weak acid and weak base :

A. degree of hydrolysis of cation and anion is different

B. degree of hydrolysis of cation and anion is same

C. degree of hydrolysis of cation and anion is different and they can never be assumed same.

D. degree of hydrolysis of cation and anion is different but they are very close to each other when they are gettign hydrolysis in the presence of each other.

Answer:

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4. Consider a solution of CH_3COONH_4 which is a salt weak acid and weak base.

The equilibrium involved in the solutions are :

$CH_3COO^- + H_2O \Leftrightarrow CH_3COOH + OH^- \quad .....(i)$

$NH_4^+ + H_2 \Leftrightarrow NH_4OH + H^+ \quad .....(ii)$

$H^+ + OH^- \Leftrightarrow H_2O \quad .....(iii)$

If we add these reactions, then the net reaction is :

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Both CH_3COO^- and NH_4^+ get hydrolysed independently and their hydrolysis depends on :

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Since both of the ions were produced form the salt, their initial concertration are same. Therefore, unless and until the value of $\frac{K_w}{K_a}$ or K_a and K_b is same, the degree of hydrogen of ions can't be same.

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For 0.1 M CH_3COONH_4 salt solution given, $K_a(CH_3COOH) = K_b(NH_4OH) = 2 \times 10^{-5}$.

In the case : degree of hydrolysis of cation and anion are :

A. exactly same

B. slightly different

C. can't say

D. different but can be take approximatly same.

Answer:

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5. The pH of basic buffer mixtures is given by : $pH = pK_a + \log\left(\frac{[\text{Base}]}{[\text{Salt}]}\right)$, whereas pH of acidic buffer mixtures is given by: $pH = pK_a + \log\left(\frac{[\text{Salt}]}{[\text{Acid}]}\right)$. Addition of little acid or base although shows no appreciable change for all practical purpose, but since the ratio $\frac{[\text{Base}]}{[\text{Salt}]}$ or $\frac{[\text{Salt}]}{[\text{Acid}]}$ change, a slight decrease or increase in pH results in.

A solution containing 0.2 mole of dichloroacetic acid $\left(K_a = 5 \times 10^{-2}\right)$ and 0.1 mole sodium dichloroacetate in one litre solution has $\left[H^+\right]$:

A. $0.05M$

B. $0.025M$

C. $0.10M$

D. $0.005M$

Answer:

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6. The Ph of basic buffer mixtures is given by : $Ph = Pk_a + \log \frac{[\text{Base}]}{[\text{Salt}]}$ whereas Ph of acidic buffer mixtures is given by : Ph $= pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$. Addition of little acid or base although shows no appreciable change in Ph for all practical purposes, but sicne the ratio $\frac{[\text{Base}]}{[\text{Salt}]}$ or $\frac{[\text{Salt}]}{[\text{Acid}]}$ changes, a slight decrease or increase in pH results.

The volume of 0.2 m NaOH needed to prepare a buffer of pH 4.74 with 50 mL of 0.2 m acetic acid pH_b of $CH_3COO^- = 9.26$ is :

A. $50mL$

B. $25mL$

C. $20mL$

D. $10mL$

Answer:

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7. The Ph of basic buffer mixtures is given by : $Ph = Pk_a + \log \frac{[\text{Base}]}{[\text{Salt}]}$ whereas Ph of acidic buffer mixtures is given by : Ph $= pK_a + \log \frac{[\text{Salt}]}{[\text{Acid}]}$. Addition of little acid or base although shows no appreciable change in Ph for all practical purposes, but sicne the ratio $\frac{[\text{Base}]}{[\text{Salt}]}$ or $\frac{[\text{Salt}]}{[\text{Acid}]}$ changes, a slight decrease or increase in pH results.

The ratio of pH of solution (I) containing 1 mole to pH of solution (II) containing 1 mole of CH_3COONa and 1 mole of acetic in one litre is :

A. $1:2$

B. $2:1$

C. $1:3$

D. $3:1$

Answer:

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Exercise 3 Part 1

1. Will the pH of water be same at $4^{\circ} C$ and $25^{\circ} C$? Explain.

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2. A weak acid HX has the dissociation constant $1 \times 10^{-5} M$. It forms a salt NaX on reaction with alkali. The percentage hydrolysis of $0.1M$ solution of NaX is

A. $0.0001\ \%$

B. $0.01\ \%$

C. $0.1\ \%$

D. $0.15\ \%$

Answer:

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3. The dissociation constant of a substitude benzoic acid at $25^{\circ}C$ is 1.0×10^{-4}. The pH of a $0.01M$ solution of its sodium salt is

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4. Amonst the following, the total number of compounds whose aqueous solution turns red litmus paper blue is:

KCN K_2SO_4 $(NH_4)_2C_2O_4$ $NaCI$
$Zn(NO_3)_2$ $FeCI_3$ K_2CO_3 NH_4NO_3
$LiCN$

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Exercise 3 Part 2 Jee Main

1. Species acting as both Bronsted acid and base is:

A. HSO_4^-

B. Na_2CO_3

C. NH_3

D. OH^-

Answer:

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2. Which one of the following statements is not true?

A. the conjugate base of $H_2PO_4^-$ is HPO_4^{2-}

B. $pH + pOH = 14$ for all aqueous solutions at $25^\circ C$.

C. The pH of $1 \times 10^{-8} MHCl$ is 8.

D. $96,500$ coulombs of electrcity when passed through a $CuSO_4$ solution deposities 1 gram equivalent of copper at the cathode.

Answer:

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3. When rain is accompained by a thunderstorm, the collected rain water will have a pH:

A. Slightly lower than that of rain water without thunderstrom

B. uninfluenced by occurrenance of thunderstrom

C. which depends on the amount of dust in air .

D.

Answer:

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4. The conjugate base of $H_2PO_4^-$ is :

A. PO_4^{3-}

B. P_2O_5

C. H_3PO_4

D. HPO_4^{2-}

Answer:

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5. The conjugate base of OH^- is :

A. O_2

B. H_2O

C. O^-

D. O^{2-}

Answer:

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6. Hydrogen ion concentration in mol/L in a solution of $pH = 5.4$ will be:

A. 3.98×10^{8}

B. 3.88×10^{6}

C. 3.68×10^{-6}

D. 3.98×10^{-6}

Answer:

Watch Video Solution

7. The first and second dissociation constants of an acid H_2A are 1.0×10^{-5} and 5.0×10^{-10} respectively. The overall dissociation constant of the acids wil be:

A. 5.0×10^{-16}

B. 0.2×10^{5}

C. 5.0×10^{-5}

D. 5.0×10^{15}

Answer:

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8. The pK_a of a weak acid, HA, is 4.80. The pK_b of a weak base, BOH, is 4.78. The pH of an aqueous solution of the corresponding salt, BA, will be:

A. 4.79

B. 7.01

C. 9.22

D. 9.58

Answer:

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9. Three reactions involving $H_2PO_4^-$ are given below

$I.\ H_3PO_4 + H_2O \rightarrow H_3O^+ + H_2PO_4^-$

$II.\ H_2PO_4^- + H_2O \rightarrow HPO_4^{2-} + H_3O^+$

$III.\ H_2PO_4^- + OH^- \rightarrow H_3PO_4 + O^{2+}$

In which of the above does $H_2PO_4^-$ act as an acid?

A. ii only

B. I and ii

C. iii only

D. I only

Answer:

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10. In aqueous solution the ionization constants for carbonic acid are:

$K_1 = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$

Select the correct statement for a saturated $0.034M$ solution of the carbonic acid.

A. The concentration of CO_3^{2-} is $0.034M$

B. The concentration of CO_3^{2-} is greater than that of HCO_3^-

C. The concentration of H^+ and HCO_3^- are approximately equal.

D. The concentration of H^+ is double that of CO_3^{2-}

Answer:

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11. The pH of a 0.1 molar solution of the acid HQ is 3. The value of the ionisation constant, K_a of the acid is

A. 3×10^{-1}

B. 1×10^{-3}

C. 41×10^{-5}

D. 1×10^{-7}

Answer:

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12. How many litres of water must be added to $1L$ of an aqueous solution of HCl with a pH of 1 to create an aqueous solution with pH of 2?

A. $0.1L$

B. $0.9L$

C. $2.0L$

D. $9.0L$

Answer:

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Exercise 1 Part 1

1. Calculate the pH of a given mixtures.

(a) $(4gCH_3COOH + 6gCH_3COONa)$ in 100 mL of mixture, (K_a for $CH_3COOH = 1.8 \times 10^{-5}$)

(b) 5 mL of $0.1MBOH + 250$ mL of $0.1MBCI$, (K_a for $MOH = 1.8 \times 10^{-5}$)

(c) (0.25 mole of $CH_3COOH + 0.35$ mole of $CH_{3COOH = 3.6 \times 10^{-4}}$

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2. Calculate the pH of $0.5L$ of a$0.2MNH_4Cl - 0.2MNH_3$ buffer before and after addition of (a)0.05 mole of $NaOH$ and (b) 0.05 mole of HCl. Assume that the volume remains constant.[Given:$pK_a$of $NH_3 = 4.74$]

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3. An environment chemist needs a carbonate buffer of $pH = 10$ to study the effects of the acidification of limestones rich solis.How many grams of

Na_2CO_3 must be added to $1.5L$ of freshly prepared $0.2MNaHCO_3$ to make the buffer.? For H_2CO_3, $K_{a_1} = 4.7 \times 10^{-7}$, $K_{a_2} = 4.7 \times 10^{-11}$

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4. A small quantity of phenolphthalein (an acid indicator) is added a decimolar solution of Sodium butyrate.Calculate the ratio of the ration of the coloured form of the indicator. K_a for butyric acid $= 1.5 \times 10^{-5}$, K for the indicator $= 3.075 \times 10^{10}$ and $K_W = 10^{-14}$ .Take $\log 1.23 = 0.09$.

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5. A base type indicator B differs in colour from its conjugate acid. $\left(BH^+\right)$ .Acidic form is red in colour while basic form is blue in colour. Human eye can sense blue colour distincity when ratio of blue form concentration to red form cocnentration is $\frac{a}{b}$. or more.However ,red colour can be sensed by human eye distinctly when ratio of red form concentration of blue form concentration is $\frac{c}{d}$ or more. Determine the

pH range of solution in which human eyes will be unable to observe distinct red or distinctly blue colour.Take ionisation of B as K_{eq}.

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6. Calculate the pH of the following mixtures. Given K_a of $CH_3COOH = 2 \times 10^{-5}$ and K_b of $NH_4OH = 2 \times 10^{-5}$

(a) $50mL$ of $0.10MNaOH + 50mL$ of $0.10MHCl$.

(b) $50mL$ of $0.10MNaOH + 50mL$ of $0.10MCH_3COOH$

(c)=$50mL$of $0.05MNaOH + 50mL$ of $0.10MCH_3COOH$

(d) $50mLof0.10MNH_4OH + 50mLof0.05MHCl$

(e) $50mLof0.10MNH_4OH + 50mL$ of $0.10MHCl$.

(f) $50mL$ of $0.05MNH_4OH + 50mL$ of $0.05MCH_3COOH$.

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7. $50mL$ of $0.05M$ Propane $-1,2-$ diamine solution is titrated with $0.1MHCl$ solution at $25^\circ C$. Detemine the pH of solution obtained by adding following volumes of HCl solution.

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Exercise 1 Part 2 Only One Option Correct Type

1. Which may be added to one litre of water to act a buffer?

A. One mole of CH_3COOH and one mole of HCl

B. One mole of $NH(4)OH$ and one mole of $NaOH$.

C. One mole of NH_4Cl and one mole of HCl

D. One mole of $CH_3COOH$and 0.5mole of $NaOH$.

Answer:

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2. The pH of an acidic buffer solution & a basic buffer solution at $25^\circ C$ is

:

A. $> 7, < 7$

B. $< 7, > 7$

C. $= 7, = 7$

D. Dependent upon K_a&K_(b)` of acid & base respectively.

Answer:

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3. Fear or exitement, generally cause one to breathe rapidaly and it results in the decrease of concentration of CO_2 in blood. In what way it will change pH of blood ?

A. pH will significantly increase

B. pH will significant decrease

C. No significant change in pH

D. pH will 7

Answer:

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4. pH of a mixture containing $0.10MX^-$ and $0.20MHX$ is: $\left[pK_b\left(X^-\right) = 4\right]$

A. $4 + \log 2$

B. $4 - \log 2$

C. $10 + \log 2$

D. $10 - \log 2$

Answer:

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5. K_a for HCN is $5 \times 10 \wedge (-10)$ at $25^\circ C$. For maintaining a constant pH of 9.0, the volume of $5MKCN$ solution required to be added to

$10mL$ of $2MHCN$ solution is

A. $4mL$

B. $8mL$

C. $2mL$

D. $10mL$

Answer:

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6. The composition of an acidic buffer mixture made up of HA and NaA of total molarity 0.29 having $pH = 4.4$ and $K_a = 1.8 \times 10^{-5}$ in terms of concentration of salt and acid respectively is:

A. $0.09M$ and $0.2M$

B. $0.2M$ and $0.09M$

C. $0.1M$ and 0.19m`

D. $0.19M$ and $0.1M$

Answer:

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7. The pH of a solution resulting from the addition of $12.5mL$ of $0.1MHCl$ to $50mL$ of a solution containing 0.15M CH_3COOH & $0.2M$ CH_3COONa will be (Given : pK_a of $CH_3COOH = 4.74$)

A. 4.74

B. < 4.74

C. > 4.74

D. > 9.26

Answer:

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8. What $\%$ of the carbon in the $H_2CO_3 - HCO_3^-$ buffer should be in the form of HCO_3^- so as to have a neutral solution? $\left(K_a = 4 \times 10^{-7}\right)$

A. $20\ \%$

B. $40\ \%$

C. $60\ \%$

D. $80\ \%$

Answer:

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9. Buffer capacity of a buffer solution is x, the volume of $1MNaOH$ added to $100mL$ of this solution if the change of pH by 1 is

A. $0.1xmL$

B. $10xmL$

C. $4100xmL$

D. xmL

Answer:

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10. A certain indicator (an organic dye) has $pK_a = 5$. For which of the following titrations may it be suitable

A. acetic acid against $NaOH$

B. aniline hydrochloride against $NaOH$

C. sodium carbonate against HCl

D. barium hydroxide against oxalic acid

Answer:

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11. The best indicator for detection of end point in titration of a weak acid and a strong base is

A. Methyl orange (3 to 4)

B. Methyl red (5 to 6)

C. Bromothymol blue (6 to 7.5)

D. Phenolphthalein (8 to 9.6)

Answer:

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12. At $pH < 3.1$, the indicator methyl red is coloured red ,at $pH > 6.3$, it is yellow and at the intermediate values of the pH ,it is orange .What will the colour of indicator be in a $0.1M$ solution of NH_4Br? Take $pK_b(NH_4OH) = 4.74$.

A. Red

B. Yellow

C. Orange

D. $pH = 3.1$ so colour cannot be predicted

Answer:

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13. Upon titrating $50mL$ of $1.96\,\%\,(w/v)H_2SO_4$ with a KOH solution (containing $11.2gKOH$ per litre of solution on adding $50mLKOH$ solution.

A. Equivalent point has been just reached.

B. Equivalent point has been crossed

C. pH of resulting solution $= 1$

D. pH of resulting solution $= 7$

Answer:

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14. $100mL$ of $0.2M$ benzoic acid $(pk_a = 4.2)$ is titrated using $0.2MNaOH$ pH after $50mL$ and $100mL$ of $NaOH$ have been added are :

A. $2.1, 8.1$

B. $4.2, 7$

C. $4.2, 8.1$

D. $4.2, 8.5$

Answer:

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15. Which of the following solutions have different pH?

$100mL$ of $0.2m$ $HCl + 100mL$ of $0.4M$ NH_3

$50mL$ of $0.1M$ HCl $+50mL$ of $03.2MNH(3)$

$10mLof0.3$ M $HCl + 100mLof0.6MNH_3$

A. I &ii

B. ii & iii

C. I & iii

D. all will have same pH.

Answer:

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16. Upon titrating a solution of weak monoprotic acid with a weak monoacidic base solution at equivalent point:

A. pH in general weak would increase if both solution are first diluted to 10 times the original volume & then titration is carries out

B. pH in general would decrease if both solution are first diluted to 10 times the original volume & then titration is carried out.

C. pH in general would remain same $(=7)$ if both solutions are first diluted to 10 times the original volumes & then titration is carried out

D. pH in general coule be less than , greater then or equal to 7if both solutions are first diluted to10 times the original volume & then titration is carried out.

Answer:

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17. The total number of different kind of buffers obtained during the titration of H_3PO_4 with $NaOH$ are:

A. 3

B. 1

C. 2

D. Zero

Answer:

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18. What will be the pH at the equivalence point during the titration of a $100mL0.2M$ solution of $CH_3\mathbb{C}ONa$ with $0.2M$ solution of HCl? $K_a = 2 \times 10^{-5}$

A. $3 - \log\sqrt{2}$

B. $3 + \log\sqrt{2}$

C. $3 - \log 2$

D. $3 + \log 2$

Answer:

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Part 1 Only One Option Correct Type

1. To prepare a buffer of pH 8.26, amount of $(NH_4)_2SO_4$ to be added into 500mL of $0.01MNH_4OH$ solution $\left[pK_a\left(NH_4^+\right) = 9.26\right]$ is:

A. 0.05mole

B. 0.025mole

C. 0.10mole

D. 0.005mole

Answer:

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2. 50 mL of 0.1 M NaOH is added to 60 mL of 0.15 M H_3PO_4 solution $\left(K_1, K_2 \text{ and } K_3 \text{ for } H_3PO_4 \text{ are } 10^{-3}, 10^{-8} \text{ and } 10^{-13}\right.$

respectively). The pH of the mixture would be about (log 2=0.3) :

A. 3.1

B. 5.5

C. 4.1

D. 6.5

Answer:

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3. An acid-base indicator which is a weak acid has a pK_{In} value =5.45. At what concentration ratio of sodium acetate to acctic acid would the indicator show a colour half-way between those of its acid and conjugate base forms ?

$[pK_a$ of acetic acid =4.75, log 2=0.3]

A. $4:1$

B. $6:1$

C. $5:1$

D. $3:1$

Answer:

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4. A weak acid HA after teratment with 12 mL of $0.1M$ strong base BOH has a pH of 5. At the end point, the volume of same base required is $26.6mL$. K_a of acid is:

A. 1.8×10^{-5}

B. 8×10^{-6}

C. 1.8×10^{-8}

D. 8×10^{-5}

Answer:

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5. $50mL$ of $0.05MNa_2CO_3$ is titrated against $0.1MHCl$,pH of the solution will be [Given :For H_2CO_3 ,$pK_a = 6.35, pK_a = 10.33$]

A. 6.35

B. 6.526

C. 8.34

D. 6.173

Answer:

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Part 2 Single And Double Value Integer Type

1. $1M$benzoic acid $(pK_a = 4.2)$ and $1MC_6H_5COONa$ solutions are given separately. What is the volume of benzoic acid required to prepare a $93mL$ buffer solution of $pH = 4.5$?

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2. An NH_4^+ buffer is supposed to keep the pH of the solution constant within$0.3pH$ unit during the reaction

$CH_3COOH_3(aq) + 2H_2O(aq) \rightarrow CH_3COO^-(aq) + H_3O^+(aq) + CH_3O$

If this solution had initial concentration : $\left[NH_4^+\right]_{10} = 0.1M, [NH_3]_0 = 0.06M, [CH_3COOH_3]_0 = 0.02M$

determine the magnitude of pH change as a result of reaction.

Multiply the magnitude by 10 & add 1 if it is a satisfactory buffer, otherwise subtract 1.Report the answer rounding it off to the nearest whole number.

$\left[K_bNH_3 = 1.8 \times 10^{-6}\right]$

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3. End point//equivalence point of how many of the following titrations cannot be detected with the indicators given against them?

	Titration	Indicator
i	$KOH + HCN$	Methyl orange
ii	$NaOH + HF$	Hin$\left(K_{\text{In}} = 3 \times 10^{-4}\right)$
iii	$HNO_3 + Sr(OH)_2$	Phenol red
iv	$HClO_4 +$ Aniline	Methyl red
v	$HCl +$ Dimethyl amine	Hin$\left(K_{\text{In}} = 5 \times 10^{-5}\right)$
v	$Ba(OH)_2 + HNO_2$	Phenolphthalein
vii	$NaH_2PO_2 + H_2SO_4$	$InOH\left(K_{\text{In}} = 3 \times 10^{-5}\right)$
$viii$	Pyridine+Benzoic acid	Phenol red
ix	$KH_3BO_3 + HI$	Methyl red

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4. Ram can see the purple colour of an acidic indicator below $pH = 5.5$ only and the blue colour only above $pH = 8.50$ .How many times that of acidic form, must the concentration of the basic form at least be for Ram to see the end point of titration of HCl with $NaOH$?

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5. A $0.252g$ sample of unknown organic base is dissolved in water and titrated with a $0.14MHCl$ solution .After then addition of $20mL$ of acid

,a pH of 10.7 is recorded. The equivalence point is reached when a total of $40mL$ of HCl is added . If the base and acid combine in $1:1$ molar ratio, then 'a' g is the molar mass of the organic base of 'b' is the ioniation constant of base .Report your answer as $\frac{a}{1000b}$.

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Partiii One Or More Than One Options Correct Type

1. A buffer solution can be prepared from a mixture of

A. Sodium acetate and acetic acid inwater

B. Sodium acetate and hydrochloric acid

C. Ammonia and ammonium chloride in water

D. Ammonia and sodium hydroxide in water

Answer:

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2. Aniline behaves as a weak base. When $0.1M, 50mL$ solution sample of aniline was mixed with $0.2M, 12.5mL$ of solution of HCl ,the pH of resulting solution was 8.Then :

A. pH of $0.01M$ solution of anillinium chloride is 5.

B. pH of original solution of anilline is 3.5.

C. Upon adding the same aniline sample to the above mixture, pH of resulting solution becomes 8.48.

D. Upon adding the same HCl sample to the above mixture pH of resulting solution becomes 4.59.

Answer:

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3. Which of the following mixtures will act as buffer?

A. $H_2CO_3 + NaOH(1.5:1\text{molar ratio})$

B. $H_2CO_3 + NaOH (1.5 : 2 \text{molar ratio})$

C. $NH_4OH + HCl (5 : 4 \text{molar ratio})$

D. $NH_4OH + HCl (4 : 5 \text{molar ratio})$

Answer:

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4. Choose the correct statement(s) about buffer capacity during titration of NH_4OH with HCl:

A. Buffer capacity during titration first increases then decreases

B. Buffer capacity reaches to maximum at equivalence point.

C. Buffer capacity will increase if concentration of NH_4OH increases.

D. Buffer capacity value will remain same if strong acid HCl is replace by H_2SO_4 of equal $[H_2O]$

Answer:

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5. Let the colour of the indicator Hin (coloueless) 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 then $25\,\%$

D. $\%$ of ionised form will be more in $25\,\%$

Answer:

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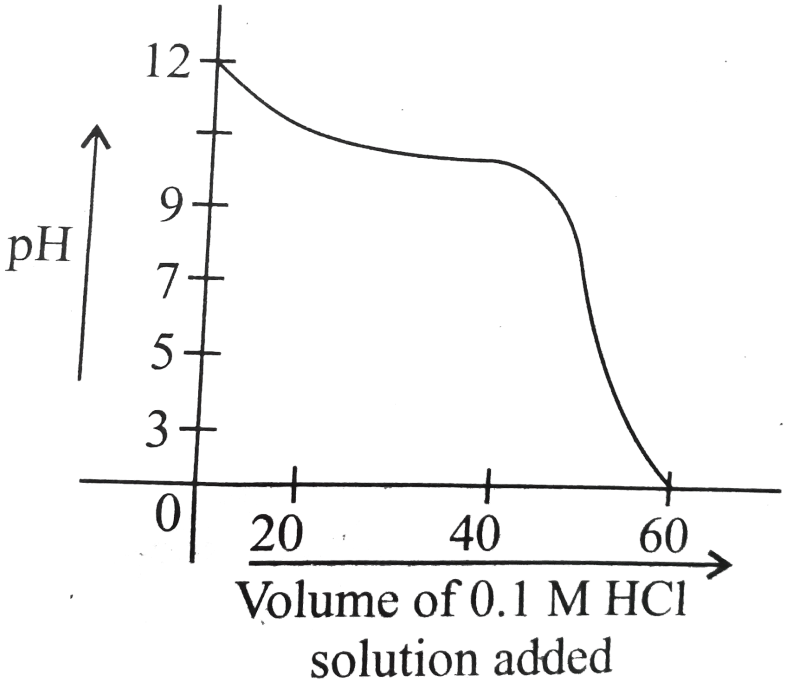
6. When weak base solution $(50mLof0.1NNH_4OH)$ is titrated with strong acid $(0.1NHCI)$, the pH of the solution initially decrease fast

and then decreases slowely till near the equivalence point (as shown in figure). Which of the following is//are correct.



A. The initial fast decrement in pH is due to fast consumption of free OH^- ions by HCl

B. The slow decreases of pH is due to formation of an acidic buffer solution after addition of someHCl

C. The slope of shown pH graph (magnitude only) will be minimum when $25mL$ of $0.1MHCl$ is added.

D. The slow decreases of pH is due to formation of a basic buffer solution after addition of some HCl.

Answer:

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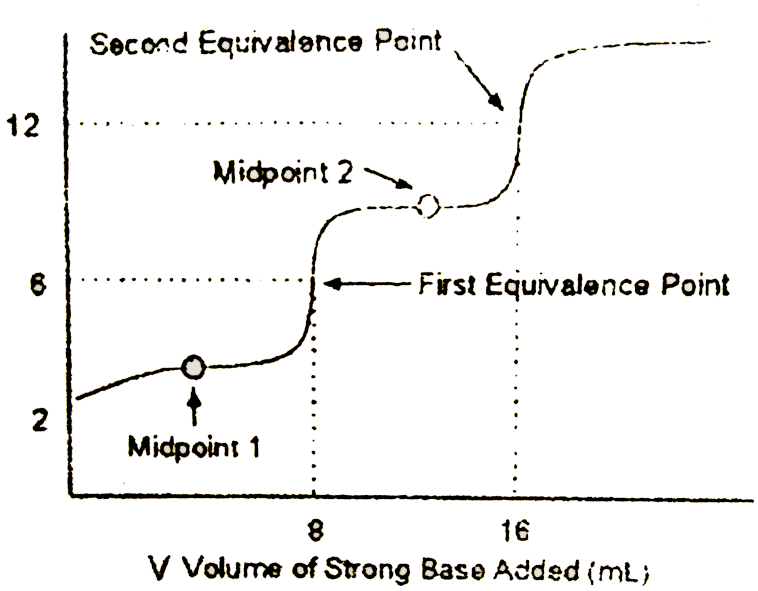
7. A solution of a substances is titrated against a strong base (or acid) ,volume V of strong base (or acid) is plotted against pH of the solution

(as shown in figure) .The substances could be :



A. Na_2CO_3

B. Ethylene diamine

C. $H_2C_2O_2$

D. $CH_2(COOH)_2$

Answer:

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