CHEMISTRY

BOOKS - PRADEEP CHEMISTRY (HINGLISH)

EQUILIBRIUM

PROBLEM FOR PRACTICE

1. The reaction

$CH_3COOH(l) + C_2H_5OH(l) \Leftrightarrow CH_3COOC_2H_5(l) + H_2O(l)$

was carried out at $27^\circ C$ by taking one mole of each of the reactants. The reaction reached equilibrium when $2/3$ rd of the reactants were consumed. Calculate the free energy change for the reaction $\left(R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}\right)$.

CURIOSITY QUESTIONS

1. A magician took yellow colured solution in one test tube and added a colourless solution Into It and announced the fun of getting red colour. Then he added red coloured solution into it and announced the fun of colour becoming lighter. What chemicals he musthave used and explain how all this might have happened ?

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2. Why tooth decay occurs when we eat too much sweets?

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3. Some reactions yield greater amount of products on heating while some others give lesser amount. Why ?

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4. At $0^{\circ} C$, ice and water are present in equilibrium. What will happen on increasing the pressure ?

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ADVANCED PROBLEMS

1. The degree of dissociation of HI at a particualr temperature is 0.8. Calculate the volume of $2MNa_2S_2O_3$ solution required to neutralise the iodine present in an equilibrium mixture of a reaction when 2 mol each of H_2 and I_2 are heated in a closed vessel of $2L$ capacity and the equilibrium mixture is freezed.

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2. NH_3 is heated at 15 at, from $25^{\circ} C$ to $347^{\circ} C$ assuming volume constant. The new pressure becomes 50 atm at equilibrium of the reaction $2NH_3 \Leftrightarrow N_2 + 3H_2$. Calculate % moles of NH_3 actually decomposed.

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3. An equilibrium mixture at $300K$ contains N_2O_4 and NO_2 at 0.28 and $1.1 atm$, respectively. If the volume of container is doubles, calculate the new equilibrium pressure of two gases.

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4. When 0.15 mol of CO taken in a $2.5L$ flask is maintained at $750K$ along with a catalyst, the following reaction takes place

$CO(g) + 2H_2(g) \Leftrightarrow CH_3OH(g)$

Hydrogen is introduced until the total pressure of the system is 8.5 atm at equilibrium and 0.08 mol of methanol is formed.

Calculate

a. K_p and K_c

b. The final pressure, if the same amount of CO and H_2 as before are used, but with no catalyst so that the reaction does not take place.

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5. For the reaction

$Ag(CN)_2^{\ominus} \Leftrightarrow Ag^{\oplus} + 2CN^{\ominus}$, the K_c at $25\,^{\circ}C$ is 4×10^{-19} Calculate $\left[Ag^{\oplus}\right]$ in solution which was originally $0.1M$ in KCN and $0.03M$ in $AgNO_3$.

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6. A sample of air consisting of N_2 and O_2 was heated to 2500 K until the equilibrium

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

was established the intial composition of air in mole fraction of N_2 and O_2.

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7. At $817^{\circ}C, K_p$ for the reaction between $CO_{2(g)}$ and excess hot graphite (s) is $10atm$.

(a) What are the equilibrium concentration of the gases at $817^{\circ}C$ and a total pressure of $5atm$?

(b) At what total pressure, the gas contains $5\%\ CO_2$ by volume?

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8. The value of K_p is $1 \times 10^{-3} atm^{-1}$ at $25^{\circ}C$ for the reaction: $2NO + Cl_2 \Leftrightarrow 2NOCl$. A flask contains NO at $0.02atm$ and at $25^{\circ}C$. Calculate the mole of Cl_2 that must be added if 1% of the NO is to be converted to $NOCl$ at equilibrium. The volume of the flask is such that $0.2mole$ of gas produce $1atm$ pressure at $25^{\circ}C$. (Ignore probable association of NO to N_2O_2.)

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9. The K_p for the reaction $N_2O_4 \Leftrightarrow 2NO_2$ is $640 mm$ at $775 K$. Calculate the percentage dissociation of N_2O_4 at equilibrium pressure of $160 mm$. At what pressure, the dissociation will be $50\ \%$?

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10. The equilibrium constant of a reaction doubles on increasing the temperature of the reaction from $25\ ^\circ C \rightarrow 35\ ^\circ C$. Calculate enthalpy change of the reaction, assumpting it to be constant in this temperature range.

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11. A mixture in which the mole ratio of H_2 and O_2 is $2:1$ is used to prepare water by the reaction.

$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(g)}$

The total pressure in the container is $0.8 atm$ at $20\ ^\circ C$ before the reaction.

Determine the final pressure at $120^{\circ} C$ after reaction assuming 80% yield of water.

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12. For a hypothetical reaction`P(g) + Q(g) hArr R(g) + S(g) , " a graph between log K and " T^(-1) " is a straight line as hsown in the fig. in which " theta = tan^(-1) 0*5 and OA = 10. " Assuming "Delta H^(@) " is independent of temperature , calculate the equilibrium constant of the reaction at 298 K and 798 K respectively.

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13. 2 mole of an equimolar mixture of alchols ROH and R'OH are taken in! L flask. One mole of acetic acid is added to it. At equilibrium , 80% of acetic acid is found to be reacted and the ratio of $RCOOCH_3$ and $R' COOCH_3$ formed is 3 : 2 , Calculate the equilibrium constant for the esterification of ROH.

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14. The values of K_p and Kp_2 for the reactions $X \Leftrightarrow Y + Z$, (a)

and $A \Leftrightarrow 2B$, (b)

are in the ration of $9:1$. If the degree of dissociation of X and A is equal, then the total pressure at equilibriums (a) and (b) is in the ratio

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15. Formaldehyde polymerizes to form glucose according to the reaction, $6HCHO \rightarrow C_6H_{12}O_6$ The theoretically computed equilibrium constant for this reaction is found to be 6×10^{22} If 1M solution of glucose dissociates according to the above equilibrium, the concentration of formaldehyde in the solution will be :

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TEST YOUR GRIP (MULTIPLE CHOICE QUESTIONS)

1. For reaction,

$PCl_3(g) + Cl_2(g) \Leftrightarrow PCl_5(g)$

the value of K_c at $250\,^{\circ}C$ is 26. The value of K_p at this temperature will be

.

A. $0 \cdot 61$

B. $0 \cdot 57$

C. $0 \cdot 83$

D. $0 \cdot 46$

Answer: A::B::C::D

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2. K_p/K_c for the reaction

$CO(g) + \frac{1}{2}O_2(g) \Leftrightarrow CO_2(g)$ is

A. 1

B. RT

C. $1/\sqrt{RT}$

D. $(RT)^{1/2}$

Answer: A::B::C::D

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3. For the reaction $N_{2(g)} + O_{2(g)} \Leftrightarrow 2NO_{(g)}$, the value of K_c at $800\,^{\circ}C$ is 0.1. When the equilibrium concentrations of both the reactants is 0.5 mol, what is the value of K_p at the same temperature

A. $0 \cdot 5$

B. $0 \cdot 1$

C. $0 \cdot 01$

D. $0 \cdot 025$

Answer: A::B::C::D

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4. In a reversible chemical reaction having two reactants in equilibrium, if the concentration of the reactants are doubled then the equilibrium constant will :

A. Reduced to half its original value

B. Reduced to one fourth of its original value

C. Doubled

D. Constant

Answer: D

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5. The equilibrium constant for a reacton

$N_2(g) + O_2(g) = 2NO(g)$ is 4×10^{-4} at $2000K$. In the presence of catalyst, the equilibrium constant is attained 10 times faster. The equilibrium constant in the presence of catalyst, at $2000K$ is

A. 40×10^{-4}

B. 4×10^{-4}

C. 4×10^{-3}

D. difficult to compute without more data.

Answer: B

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6. For the hypothetic reaction, the equilibrium constant (K) values are given

$A \Leftrightarrow B, K_1 = 2.0$

$B \Leftrightarrow C, K_2 = 4.0$

$C \Leftrightarrow D, K_3 = 3.0$

The equilibrium constant for the reaction

$A \Leftrightarrow D$ is

A. 48

B. 6

C. 12

D. 24

Answer: A::B::C::D

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7. For the reaction $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ at $400K, K_p = 41$

Find the value of K_p for the following reaction :

$$\frac{1}{2}N_2(g) + \frac{3}{2}H_2 \Leftrightarrow NH_3(g)$$

A. $6 \cdot 4$

B. $0 \cdot 02$

C. 50

D. $4 \cdot 6$

Answer: A::D

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8.

K_p for the following reaction will be equal to $3Fe(s) + 4H_2O(g) \Leftrightarrow Fe_3O_4(s) + 4H$

A. $\left(p_{H_2}\right)^4\left(p_{Fe_3O_4}\right)$

B. $\dfrac{p_{H_2}}{p_{H_2O}}$

C. $\dfrac{\left(p_{H_2}\right)^4}{\left(p_{H_2O}\right)^4}$

D. $\dfrac{\left(p_{H_2}\right)\left(p_{Fe_3O_4}\right)}{p_{F_e}}$

Answer: C

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9. a' moles of PCl_5 are heated in a closed container to equilibrate $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$ at a pressure of p atm . If x moles of PCl_5 dissociate at equilibrium , then

A. $0 \cdot 04$

B. $0 \cdot 025$

C. $0 \cdot 02$

D. $0 \cdot 05$

Answer: A

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10. The what manner will increase of pressure affect the following equation ?

$C(s) + H_2O(g) \Leftrightarrow CO(g) + H_2(g)$

A. Shift in the forward direction

B. Shift in the reverse direction

C. Increase in the yield of hydrogen

D. No effect.

Answer: B

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11. Formation of SO_3 take place according to the reaction $2SO_2 + O_2 \Leftrightarrow 2SO_3, \ \Delta H = -45.2$ kcal Which of the following factors favours the formation of SO_3 ?

A. Increase in temperature

B. Increase in pressure

C. Removal of oxygen

D. Increase in volume

Answer: B

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12. Le Chatelier's principle is not applicable to

A. $Fe(s) + S(s) \Leftrightarrow F_eS(s)$

B. $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

C. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

D. $N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

Answer: A::B::C::D

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13. In which one of the following reactions, the yield of the products decreases by in creasing the pressure ?

A. $2SO_2(g) + O_2 \Leftrightarrow 2SO_3(g)$

B. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

C. $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

D. $N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

Answer: A::C

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14. What would happen to a reversible dissociation reaction at equilibrium when an inert gas is added while the pressure remains unchanged ?

A. Less of the product will be formed

B. More of the product will be formed

C. More of thereactants will be fromed

D. It remains unaffected.

Answer: B

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15. The supply of oxygen to the tissues by blood (haemoglobin) can be examined by

A. Boyle's law

B. Le chatelier's principle

C. Dalton's law

D. Charles'law

Answer: B

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CONCEPTUAL QUESTIONS

1. In a chemical reaction under equilibrium , there is no change in moler conertration of products and reactants. Does the reaction stop?

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2. Reaction between ethyl acetate and water attains a state of equilibrium in an open vessel but not the decomposition of $CaCO_3$. Explain.

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3. If concentration are expressed in moles L^{-1} and pressure in atmospheres, what is the ratio of $K_p \text{to} K_c$ for the reaction, $2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$ at $25\,^\circ C$?

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4. The value of equlibrium constant depends on what?

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5. The equilibrium constant for the reactions

$N_2 + O_2 \Leftrightarrow 2NO$ and $(ii) 2NO + O_2 \Leftrightarrow 2NO_2$ are K_1 and K_2 respectively, then what will be the equilibrium constant for the reaction

$N_2 + 2O_2 \Leftrightarrow 2NO_2$

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6. For the reactions, $N_{2(g)} + 3H_{2(g)} \Leftrightarrow 2NH_{3(g)}$. At $400K$, $K_p = 41 atm^{-2}$. Find the value of K_p for each of the following reactions at the same temperature:

(i) $2NH_{3(g)} \Leftrightarrow N_{2(g)} + 3H_{2(g)}$,

(ii) $\frac{1}{2}N_{2(g)} + \frac{3}{2}H_{2(g)} \Leftrightarrow NH_{3(g)}$,

(iii) $2N_{2(g)} + 6H_{2(g)} \Leftrightarrow 4NH_{3(g)}$

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7. The equilibrium $H_2O(l) \Leftrightarrow H_2O(v)$ is attained in a closed container at $40^\circ C$. The aqueous tension of water at $40 ^\circ C$ is 23 mm . What is K_p for the said equilibrium ?

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8. The concentration quotient of a reversible reaction is Q, and the equilibrium constant is K. What do youconclude if (i) $Q = K(ii)Q > K(iii)Q < K$?

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9. What does the equilibrium constant K less than 1 indicate ?

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10. What quantiative information can you obtain from the value of the equilibrium constant?

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11. In which one of the following reactions, the yield of the product will be maximum ?

$2A + B \Leftrightarrow C, K = 10^{-5}, C + 2D \Leftrightarrow E, K = 10^{5}, D + 3B \Leftrightarrow f, K = 10^{3}$.

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12. For the reaction $H_2 + I_2 \Leftrightarrow 2HI$, if intially 25 mL of H_2 and 20 mL of I_2 are present ia a container in a container and at equilibrium, 30 mL of HI is foprmed , then calculate equilibrium constant.

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13.

$\Delta_r G^\circ = -RT$ In K. For the same reaction at the same temperature using K_c and

are found to be different . Why ?

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14. What happence to the equilibrium $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$, if nitrogen gas is added to it (i)at constant volume(ii) at constant pressure ? Give reasons.

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15. What two changes on the equilibrium, $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g), \Delta H = -92.4 \text{ kJ}$. can keepitsstate undisturbed ?

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16. The following system is equilibrium : $SO_2Cl_2 + Heat \Leftrightarrow SO_2 + Cl_2$ What will happen to the temperature of the system if some Cl_2 gas is added at equilibrium

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17. Areaction $A(g) + B(g) \leftrightarrow 2C(g)$ is an equlibrium at a certain temperature. Can we increases the amount of products by (i) adding catayst (ii) increasing pressure?

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18. $2N_2O(g) + O_2(g) \Leftrightarrow 4No(g), \Delta H > 0$

What will be the effect on equilibrium when

(i) Volume of the vessel increases ? (ii) Temperature decreases ?

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19. Some process are given below. What happens to the process if it is subjected to a change given in the barckets ?

(ii) Dissolution of $Ice \overset{M.pt}{\Leftrightarrow}$ Water (Pressure is increased)

(ii) Dissolution of NaOH in water (Temperature is increased)

(iii) $N_2(g) + O_2(g) \Leftrightarrow 2NO(g) - 180 \cdot 7kJ$ (pressure is increased and temperature is decreased).

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20. What is the effect of the reduction of the volume of the system for the equilibrium

$2C(s) + O_2(g) \Leftrightarrow 2CO(g)$?

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21. In the direction , $N_2 + 3H_2 \Leftrightarrow 2NH_3$ at equilibrium , helium gas is injected into the vessel without disturbing the overall pressure of the system. What will be the effect on the equilibrium ?

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NCERT QUESTIONS AND EXERCISES WITH ANSWERS

1. A liquid is in equilibrium with its vapour in a sealed container at a fixed temperature. The volume of the container is suddenly increased.

a. what is the initial effect of the change on vapour pressure?

b. How do rates of evaporation and condensation change initially?

c. What happens when equilibrium is restored finally and what will be the final vapour pressure?

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2. What is K_c for the following equilibrium concentration of each substance is:

$\left[SO_2\right] = 0.60M$, $\left[O_2\right] = 0.82M$ and $\left[SO_3\right] = 1.90M$?

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

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3. At a certain temperature and a total pressure of 10^5 Pa, iodine vaour contain 40% by volume of iodine atmos $\left[I_2(g) \Leftrightarrow 2I(g)\right]$. Calculate K_p for the equilibrium.

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4. Write the expression for the equilibrium constant K_c for each of the following reactions:

a. $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g)$

b. $2Cu\left(NO_3\right)_2(s) \Leftrightarrow 2CuO(s) + 4NO_2(g) + O_2(g)$

c. $CH_3COOC_2H_5(aq) + H_2O(1) \Leftrightarrow CH_3COOH(aq) + C_2H_5OH(aq)$

d. $Fe^{3+}(aq) + 3OH^{\ominus}(aq) \Leftrightarrow Fe(OH)_3(s)$

e. $I_2(s) + 5F_2 \Leftrightarrow 2IF_5$

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5. Find out the value of K_c for each of the following equilibrium from the value of K_p:

a. $2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g), K_p = 1.8 \times 10^{-2}$ at $500K$

b. $CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g), K_p = 167$ at $1073K$

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6. For the following equilibrium, $K_c = 6.3 \times 10^{14} at 1000K$

$NO(g) + O_3(g) \Leftrightarrow NO_2(g) + O_2(g)$

Both the forward and reverse reactions in the equilibrium are elementary bimolecular reactions. What is K_c, for the reverse reaction?

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7. Explain why pure liquids and solids can ignored while writing the equilibrium constant expression?

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8. Reaction between nitrogen and oxygen takes place as following:

$2N_{2(g)} + O_2 \Leftrightarrow 2N_2O_{(g)}$

If a mixture of $0.482 \text{mole} N_2$ and 0.933mole of O_2 is placed in a reaction vessel of volume $10 litre$ and allowed to form N_2O at a temperature for which $K_c = 2.0 \times 10^{-37} litre mol^{-1}$. Determine the composition of equilibrium mixture.

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9. Nitric oxide reacts with bromine and gives nitrosyl-bromide as per reaction given below:

$2NO_{(g)} + Br_{2(g)} \Leftrightarrow 2NOBr_{(g)}.$

When 0.087mole of NO and 0.0437mole of Br_2 are mixed in a closed container at constant temperature, 0.0518mole of $NOBr$ is obtained at equilibrium. Calculate equilibrium amount of nitric oxide and bromine.

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10. At $450K$, $K_p = 2.0 \times 10^{10} /$ bar for the given reaction at equilibrium.

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

What is K_c at this temperature?

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11. A sample of $HI(g)$ is placed in flask at a pressure of $0.2 atm$. At equilibrium. The partial pressure of $HI(g)$ is $0.04 atm$. What is K_p for the given equilibrium?

$2HI(g) \Leftrightarrow H_2(g) + I_2(g)$

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12. A mixture of $1.57 mol$ of N_2, $1.92 mol$ of H_2 and $8.13 mol$ of NH_3 is introduced into a $20L$ reaction vessel at $500K$. At this temperature, the equilibrium constant K_c for the reaction $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ is 1.7×10^2. Is the reaction mixture at equilibrium? If not, what is the direction of the net reaction?

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13. The equilibrium constant expression for a gas reaction is :

$$K_c = \frac{\left[NH_3\right]^4 \left[O_2\right]^5}{[NO]^4 \left[H_2O\right]^6}$$

Write the balanced chemical equation corresponding to this expression.

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14. One mole of H_2O and one mole of CO are taken in a $10 litre$ vessel and heated to $725K$. At equilibrium, $40 percent$ of water (by mass) reacts with carbon monoxide according to the equation,

$H_2O_{(g)} + CO_{(g)} \Leftrightarrow H_{2(g)} + CO_{2(g)}$

Calculate the equilibrium constant for the reaction.

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15. At $700K$ equilibrium constant for the reaction, $H_{2(g)} + I_{2(g)} \Leftrightarrow 2HI_{(g)}$ is 54.8. If $0.5 mollitre^{-1}$ of $HI_{(g)}$ is present at equilibrium at $700K$, what are the concentrations of $H_{2(g)}$ and $I_{2(g)}$, assuming that we initially started with $HI_{(g)}$ and allowed it to reach equilibrium at $700K$.

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16. What is the equilibrium concentration of each of the substance in the equilibrium when the initial concentration of ICl was $0.78M$?

$2ICl(g) \Leftrightarrow I_2(g) + Cl_2(g), K_c = 0.14$

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17. $K_p = 0.04atm$ at $899K$ for the equilibrium shown below. What is the equilibrium concentration of C_2H_6 when it is placed in a flask at $4.0atm$ pressure and allowed to come to equilibrium?

$C_2H_6(g) \Leftrightarrow C_2H_4(g) + H_2(g)$

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18. Ethyl accetate is formed by the reaction between ethanol and acetic acid and the equilibrium is represented as :

$CH_3COOH(l) + C_2H_5OH(l) \Leftrightarrow CH_3COOC_2H_5(l) + H_2O(l)$.

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19. A sample of pure PCl_5 was introduced into an evacuated vessel at $473K$. After equilibrium was attained,concentration of PCl_5 was found to be $0.5 \times 10^{-1} mollitre^{-1}$. If value of K_c is $8.3 \times 10^{-3} mollitre^{-1}$. What are the concentrations of PCl_3 and Cl_2 at equilibrium ?

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20. One of the reaction that takes plece in producing steel from iron ore is the reduction of iron(II) oxide by carbon monoxide to give iron metal and CO_2.

$FeO(s) + CO(g) \Leftrightarrow Fe(s) + CO_2(g), K_p = 0.265$ atm at $1050K$

What are the equilibrium partial pressure of CO and CO_2 at $1050K$ if the partical pressure are: $p_{CO} = 1.4 atm$ and $p_{CO_2} = 0.80 atm$?

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21. Equilibrium constant, K_c for the reaction, $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ at $500K$ is $0 \cdot 061$. At a particular time, the analysis shows that composition of the reaction mixture is $3 \cdot 0$ mol $L^{-1}N_2, 2 \cdot 0$ mol $L^{-1}H_2$ and $5 \cdot 0$mol $L^{-1}NH_3$. Is the reaction at equilibrium ? If not , in which direction does the reaction tend to reach equilibrium ?

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22. Bromine monochloride, $(BrCl)$ decomposes into bromine and chlorine and reaches the equilibrium.

$2BrCl_{(g)} \Leftrightarrow Br_{2(g)} + Cl_{2(g)}$

For which $K_c = 32$ at $500K$. If initially pure $BrCl$ is present at a concentration of $3.30 \times 10^{-3} mollitre^{-1}$, what is its molar concentration in the mixture at equilibrium?

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23. At $1127K$ and $1atm$ pressure, a gaseous mixture of CO and CO_2 in equilibrium with solid carbon has $90.55\% CO$ by mass:

$C_{(s)} + CO_{2(g)} \Leftrightarrow 2CO_{(g)}$

Calculate K_c for the reaction at the above temperature.

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24. Calculate $(a)\Delta G^{\Theta}$ and (b) the equilibrium constant for the formation of NO_2 from NO and O_2 at 298 K

$NO(g) + 1/2O_2(g) \Leftrightarrow NO_2(g)$ where

$\Delta_f G^{\Theta}\left(NO_2\right) = 52.0kJ/mol, \Delta_f G^{\Theta}(NO) = 87.0kJ/mol, \Delta_f G^{\Theta}\left(O_2\right) = 0kJ/mol.$

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25. Does the number of moles of reaction products increase , decrease or remain same when each of the folllowing equilibria is subjected to a decrease by increasing the volume ?

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26. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction the reaction to go into forward of backward direction.

a. $COCl_2(g) \Leftrightarrow CO(g) + Cl_2(g)$

b. $CH_4(g) + 2S_2(g) \Leftrightarrow CS_2(g) + 2H_2S(g)$

c. $CO_2(g) + C(s) \Leftrightarrow 2CO(g)$

d. $2H_2(g) + CO(g) \Leftrightarrow CH_3OH(g)$

e. $CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$

f. $4NH_3(g) + 5O_2(g) \Leftrightarrow 4NO(g) + 6H_2O(g)$

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27. The equilibrium constant for the following reaction is 1.6×10^5 at $1024K$

$H_2(g) + Br_2(g) \Leftrightarrow 2HBr(g)$

find the equilibrium pressure of all gases if 10.0 bar of HBr is introduced into a sealed container at $1024K$.

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28. Dihydrogen gas is obtained from natural gas by partial oxidation with steam as per following endothermic reaction:

$CH_4(g) + H_2O(g) \Leftrightarrow CO(g) + 3H_2(g)$

a. Write an expression for K_(p) for the above reaction.

b. How will the value of K_(p) and composition of equilibrium mixture be affected by

i. Increasing the pressure

ii. Increasing the temperature

iii. Using a catalyst?

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29. Decribe the effect of:

a. Addition of H_2

b. Addition of CH_3OH

c. Removal of CO

d. Removal of CH_3OH

on the equilibrium of the reaction:

$2H_2(g) + CO(g) \Leftrightarrow CH_3OH(g)$

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30. At $473K$, equilibrium constant K_c for decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3}. If decomposition is depicted as,

$PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)\Delta_r H^{\Theta} = 124.0kJmol^{-1}$

a. Write an expression for K_c for the reaction.

b. What is the value of K_c for the reverse reaction at the same temperature?

c. What would be the effect on K_c if

i. More PCl_5 is added

ii. Pressure is increased

iii. The temperature is increased?

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31. Dihydrogen gas used in Haber's process is produced by reacting methane from natural gas with high temperature steam. The first stage of the two 2 stage reaction involves the formation of CO and H_2. In second stage, CO formed in first stage is reacted with more steam in water gas shift reaction,

$CO(g) + H_2O(g) \Leftrightarrow CO_2(g) + H_2(g)$

If a reaction vessel at $400\,^{\circ}C$ is charged with an equimolar mixture of CO and steam such that $p_{CO} = p_{H_2O} = 4.0$ bar, what will be the partial pressure of H_2 at equilibrium? $K_p = 0.1$ at $400\,^{\circ}C$.

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32. Predict which of the following reaction will have appreciable concentration of reactants and product :

$(a) Cl_2(g) \Leftrightarrow 2Cl(g), K_c = 5 \times 10^{-39}$

(b) $Cl_2(g) = 2NO(g) \Leftrightarrow 2NOCl(g), K_c = 3 \cdot 7 \times 10^8$

(c) $Cl_2(g) + 2NO_2(g) \Leftrightarrow 2NO_2Cl(g), K_c = 1 \cdot 8$

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33. The value of

K_c for the reaction , $3O_2(g) \Leftrightarrow 2O_3(g)$, is $2 \cdot 0 \times 10^{-50}$ at $25\,^\circ C$. If the equilibri

K_c for the reaction , $3O_2(g) \Leftrightarrow 2O_3(g)$, is $2 \cdot 0 \times 10^{-50}$ at $25^\circ C$. If t

What is the concentration of O_3 ?

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34. The reaction , $CO(g) + 3H_2(g) \Leftrightarrow CH_4(g) + H_2O(g)$, is at equilibrium at 1300 K in a 1 L flask. It also contains 0*30 mol of CO, 0*10 mol of H_2 and $0 \cdot 02$ mol of H_2O and an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. The equilibrium constant, K_c, for the reaction at the given temperature is $3 \cdot 90$.

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ADDITIONAL QUESTIONS (VERY SHORT ANSWER QUESTIONS)

1. Which measurable property becomes constant in water $\Leftrightarrow watervapour$ equilibrium at constant temperature.

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2. Give one example of everyday life in which there is gas solution equilibrium .

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3. Give one example of a reversible reaction taking place in aqueous solution.

Watch Video Solution

4. Write the reversible reaction taking place between ferric ions and thiocyanate ions and write the colour of each reactant and product.

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5. What will be

K_p for the reaction $2NOCl(g) \rightarrow 2NO(g) + Cl_2(g)$ at 1000 K? K_c at 1000 K is $3 \cdot$

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6. Under what condition, a reversible process becomes irreverible?

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7. What is the effect on equilibrium and on the value of equilibrium constant on adding catalyst ?

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8. If the equilibrium constant for a reaction is $4 \cdot 0$, what will be the equilibrium constant for the reverse reaction.

A. 1

B. 4

C. 0.25

D. 25

Answer: C

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9. Write the expression for equilibrium constant K_p for the reaction,

$3Fe(s) + 4H_2O(g) \Leftrightarrow Fe_3O_4(s) + 4H_2(g)$.

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10. What is van't Hoff reaction isotherm ?

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11. What happens to the disociation of PCl_5 in a closed vassel if helium gas is introduced into it at the same temperature ?

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12. What happens when potassium ferrocyanide solution is added to a ferric salt solution?

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13. $N_2 + 3H_2 \Leftrightarrow 2NH_3$ in this equilibrium system if the pressure is increased at $25^\circ C$ then the value of K will

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14. What are the conditions for getting maximum yield of NH_3 by Haber's process?

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ADDITIONAL QUESTIONS (SHORT ANSWER QUESTIONS)

1. What do you understand by term 'Equilibrium' ? Explain physical equilibrium with one suitable example.

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2. Give one example of each of the following equilibria :

(i) Solid - Liquid Equilibria (ii) Liquid - Gas Equilibrium (iii) Solid - Solutions Equilibrium

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3. Define the terms ' Vapour pressure and 'Solubility'.

Watch Video Solution

4. Define Henry Law. Why the gas fizzes out when a soda water bottle is opened ?

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5. What do you understand by Reversible and Irreversible reactions? Illustrate your answer with two examples of each. Under what conditions a reversible reaction becomes irreversible ?

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6. What do you understand by chemical equilibrium? Explain with one suitable example.

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7. List any four important characteristics of a chemical equilibrium.

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8. State and explain the Law of Mass Action.

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9. State and explain the 'Law of Chemical Equilibrium.'

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10. Derive a general expression for the equilibrium constant.

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11. What do you understand by K_c and K_p ? Derive a relationship between them.

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12. K_p and K_c are related by $K_p = K_c(RT)^{\Delta n}$. Under what practical condition/s, $K_p = K_c$?

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13. Characteristics of Equilibrium constant continued..

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14. Discuss the effect of temperature of the equilibrium constant. How does it change for (a) exothermi reaction (b) endothermic reaction © reaction having zero heat of reaction ?

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15. Define 'Homogeneous Equlibria and Heterogeneous Equilibria'. Give two examples of each of them.

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16. Applying the law of chemical equilibrium, explain why vapour pressure of water is constant at constant temperature.

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17. Why strictly speaking equilibrium constant has no units ?

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18. How does the magnitude of equilibrium constant give an idea of the relative amounts of the reactants and products ?

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19. Write the relationship between standard free energy change and equilibrium constant of a reaction. Express it in the exponential form. Using this relation how does $+$ or $- sign of \Delta G$ decided the extent of reaction in the forward direction?

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20. What is the effect of adding a catalyst on a reaction which is (a) in equilibrium (b) not in equilibrium ?

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21. What is the effect of adding 1 mole of He (g) to a flask containing SO_2, O_2 and SO_3 in equilibrium at constant temperature ?

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22. For the reaction at equilibrium , $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g) + Heat,$ indicate the direction in which the equilibrium will shift when the following changes are made :

(i) Temperature of the system is decreased

(ii) Total pressure is decreased

(iii) Volume of the container is increased (iv) A catalyst is added.

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23. Consider the following reaction

$N_2O_4(g) \Leftrightarrow 2NO_2(g) \Delta H = 58.6KJ$

What will be the effect of the following changes on the concentration of N_2O_4 at equilibrium?

(i) Increasing the pressure (ii) Increasing the temperature

(iii) Increasing the volume

(iv) Adding more $NO_2(g)$ to the system without changing temperature and pressure (v) Adding catalyst.

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24. What will be the effect of increased pressure on the following equilibria ?

(i)$H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

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

(iii) $2SO_2(g) + O_2 \Leftrightarrow 2SO_2(g)$,

(iv) $2O_3(g) \Leftrightarrow 3O_2(g)$

(v)$N_2O_4(g) \Leftrightarrow 2NO_2(g)$

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25. Using Le chatelier's principle , predict the effect of

(i) decreasing the temperature and (ii) increasing the pressure on each of the following equilibria :

A. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)Heat$ B. $N_2(g) + O_2 \Leftrightarrow 2NO(g) + Heat$

C. $H_2O(g) + Heat \Leftrightarrow H_2(g) + \frac{1}{2}O_2(g)$ D. $2CO(g) + O_2(g) \Leftrightarrow 2CO_2(g) + Heat$

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26. In the reaction equilibrium , $A + B \Leftrightarrow C + D$, what will happen to concentration of A, B and D if the concentration of C is increased ?

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27. Mention at least three ways which the concentration of SO_3 can be increased after the equilibrium is establish in the reaction : $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3 + Heat$

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28. Why does manufacture of ammonia by Haber's process require higher pressure, low temperature , use of catalyst and pure gases ?

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ANALYTICAL QUESTIONS AND PROBLEMS WITH ANSWER/SOLUTIONS (Questions)

1. Why is there a fizz when a soda water bottle is opened?

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2. For an exothermic reaction, what happens to the equilibrium constant if temperature is raised?

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3. The equilibrium constant of a reaction is 2×10^{-3} at $25^{\circ} C$ and 2×10^{-2} at $50^{\circ} C$. Is the reaction exothermic or endothermic ?

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4. Why is equilibrium constant related to standard free energy change and not free energy change ?

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5. The following reaction has attained equilibrium

$CO(g) + 2H_2(g) \Leftrightarrow CH_3OH(g). \Delta H^\circ = -92.0 KJmol^{-1}$

What will happen if

(i) Volume of the reaction vessel is suddenly reduced to half?

(ii) the partial pressure of hydrogen is suddenly doubled?

(iii) an inert gas is added to the system at constant volume.

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6. Why does ice melt showly at higher altitudes?

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7. Show that degree of dissociation (α) for the dissociation of PCl_5 into PCl_3 and Cl_2 at pressure P is given by $\alpha = \left[\frac{kp}{P + kp}\right]^{1/2}$

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8. At temperature T, a compound $AB_2(g)$ dissociation according to the reaction, $2AB_2(g) \Leftrightarrow 2AB(g) + B_2(g)$ with degree of dissociation, α, which is small compared to unity . Deduce the expression for α in terms of the equilibrium constant K_p and the total pressure P.

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9. Prove that the pressure necessary to obtain 50% dissociation of PCl_5 at 500 K is numerically three times the value of K_p.

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ANALYTICAL QUESTIONS AND PROBLEMS WITH ANSWER/SOLUTIONS (PROBLEMS)

1. The equilibrium constant of the reaction $A_2(g) + B_2(g) \Leftrightarrow 2AB(g)$ at $100\,^\circ C$ is 50. If a one litre flask containing one mole of A_2 is connected to a two litre flask containing two moles of B_2, how many moles of AB will be formed at $373K$?

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2. A mixture of SO_3, SO_2 and O_2 gases is maintained in a $10L$ flask at a temperature at which the equilibrium constant for the reaction is 100:

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

a. If the number of moles of SO_2 and SO_3 in the flask are equal. How many moles of O_2 are present?

b. If the number of moles of SO_3 in flask is twice the number of moles of SO_2, how many moles of oxygen are present?

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3. The equilibrium constant K_p of the reaction: $2SO_2 + O_2 \Leftrightarrow 2SO_3$ is $900atm^{-1}$ at $800K$. A mixture constaining SO_3 and O_2 having initial pressure of 1 atm and 2 atm respectively, is heated at constant volume to equilibriate. Calculate the partial pressure of each gas at $800K$ at equilibrium.

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4. When sulphur in the form of S_8 is heated at $900K$, the initial pressure of 1 atm falls by 10% at equilibrium. This is because of conversion of some S_8 to S_2. Find the value of equilibrium constant for this reaction.

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5. K_c for $CO(g) + H_2O(g) \Leftrightarrow CO_2(g) + H_2(g)$ at $986\,^{\circ}C$ is 0.63. A mixture of 1 mol $H_2O(g)$ and 3 mol $CO_2(g)$ is allowed to react to come to an equilibrium. The equilibrium pressure is 2.0 atm.

a. Hoe many moles of H_2 are present at equilibrium ?

b. Calculate partial pressure of each gas at equilibrium.

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6. Calculate the percent dissociation of $H_2S(g)$ if $0.1 mol$ of H_2S is kept in $0.4L$ vessel at $1000K$. For the reaction:

$2H_2S(g) \Leftrightarrow 2H_2(g) + S_2(g)$

The value of K_c is 1.0×10^{-6}

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7. At some temperature and under a pressure of 4 atm, PCl_5 is 10% dissociated. Calculated the pressure at which PCl_5 will be 20% dissociated temperature remaining same.

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8. An equilibrium mixture $CO(g) + H_2O(g) \Leftrightarrow CO_2(g) + H_2(g)$ present in a vessel of one litre capacity at 1000 K was found to contain$0 \cdot 4$mole of CO, $0 \cdot 3$mole of H_2O, $0 \cdot 2$ mole of CO_2 and $0 \cdot 6$ mole of H_2. If it is desired to increase the concentration of CO to $0 \cdot 6$mole by adding CO_2 into the vessel , how many moles of it must be added into equilibrium mixture at constant temperature in order to get this change ?

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9. At $540K, 0.10mol$ of PCl_5 is heated in a $8L$ flask. The pressure of equilibrium mixture is found to be $1.0atm$. Calculate K_p and K_c for the reaction.

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10. When $3.06g$ of solid NH_4HS is introduced into a two-litre evacuated flask at $27^\circ C, 30\%$ of the solid decomposes into gaseous ammonia and hydrogen sulphide. (i) Calculate K_c and K_p for the reaction at $27^\circ C$. (ii)

What would happen to the equilibrium when more solid NH_4HS is introduced into the flask?

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11. For the reaction

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g), K_p = 1 \cdot 16$ atm . If $20 \cdot 0$ g of $CaCO_3$ is heated

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g), K_p = 1 \cdot 16$ atm . If $20 \cdot 0$ g of CaC

would remain unreached at equilibrium ? (Mol. wt. of $CaCO_3 = 100$, R

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12. Solid Ammonium carbamate dissociates as:

$NH_2COONH_4(s) \Leftrightarrow 2NH_3(g) + CO_2(g)$.

In a closed vessel, solid ammonium carbonate is in equilibrium with its dissociation products. At equilibrium, ammonia is added such that the partial pressure of NH_3 at new equilibrium now equals the original total pressure. Calculate the ratio of total pressure at new equilibrium to that of original total pressure. Also find the partial pressure of ammonia gas added.

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13. Some solid NH_4HS is placed in flask containing 0.5 atm of NH_3. What would be the pressure of NH_3 and H_2S when equilibrium is reached.

$NH_4HS(g) \Leftrightarrow NH_3(g) + H_2S(g), K_p = 0.11$

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14. The degree of dissociation of N_2O_4 into NO_2 at 1 atm $40\,^\circ C$ is 0.310. Calculate its K_p at $40\,^\circ C$. Also report the degree of dissociation at 10 atm pressure at same temperature.

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15. When α - D glucose is dissolved in water, it undergoes a partial converion to β - D glucose to exhibit mutarotation. This conversion stops when 63.6% of glucose is in β form. Assuming that equilibrium has been attained, calculate K_c for mutarotation.

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16. At $77^\circ C$ and one atmospheric pressure , N_2O_4 is 70% dissociated into NO_2 What will be the volume occupied by the mixture under these conditions if we start with 10 g of N_2O_4 ?

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17. 0.1 mole of $N_{2O_4(g)}$ was sealed in a tude under one atmospheric conditions at $25^\circ C$ Calculate the number of moles of $NO_2(g)$ preesent , if the equilibrium $N_2O_4(g) \Leftrightarrow 2NO_2(g)\left(K_P = 0.14\right)$ is reached after some time :

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18. The degree of dissociation is 0.4 at $400K$ and 1.0 atm for the gaseous reaction

$PCl_5 \Leftrightarrow PCl_3 + Cl_2$

assuming ideal behaviour of all gases, calculate the density of equilibrium mixture at $400K$ and 1.0 atm (relative atomic mass of P is 31.0 and of Cl is 35.5).

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19. One mole of H_2, two moles of I_2 and three moles of HI are injected in a litre flask. What will be the concentration of H_2, I_2 and HI at equilibrium at $490\,^{\circ}C$?

The equiibrium constant for the reaction at $490\,^{\circ}$ is 45.9

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20. A mixtue of H_2 and I_2 (vapour) in molecular proportion of 2: 3 was heated at $449\,^\circ C$ till the reaction $H_2 + I_2 \Leftrightarrow 2HI$ reached equilibrium state . Calculate the percentage of iodine converted into $HI\left(K_c \text{at} 440\,^\circ C \text{ is } 0 \cdot 02\right)$.

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Competition Focus (Jee(Main and advanced)/Medical Entrance) I. MULTIPLE CHOICE QUESTIONS (with one correct answer)

1. The vapour pressure of a liquid in a closed container depends upon

A. depandes upon the amount of the liquid taken s

B. Keeps on increasing continously as more and more liquid evaporates

C. has a constant value depending only on the nature of the liquid

D. had a constant value at constant temperature

Answer: D

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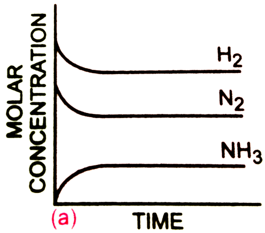
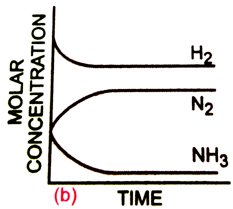
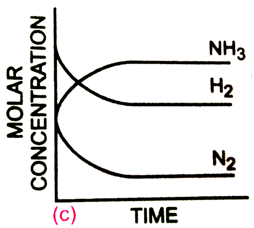
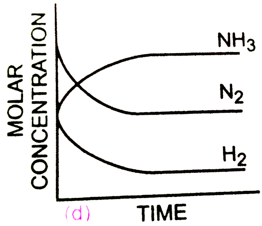
2. For the synthesis of ammonia by the reaction $N_2 + 3H_2 \Leftrightarrow 2NH_3$ in the Haber's process ,the attainment of equilibrium is correctly predicated bt the curve

A. 

B. 

C. 

D. 

Answer: A

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3. For the reversible reaction

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

at $500\,^\circ C$, the value of K_p is 1.44×10^{-5} when the partial pressure is measured in atmosphere. The corresponding value of K_c with concentration in mol L^{-1} is

A. $1 \cdot 44 \times 10^{-5} / (0 \cdot 082 \times 500)^{-2}$

B. $1 \cdot 44 \times 10^{-5} / (8 \cdot 314 \times 773)^{-2}$

C. $1 \cdot 44 \times 10^{-5} / (0 \cdot 082 \times 773)^{2}$

D. $1 \cdot 44 \times 10^{-5} / (0 \cdot 082 \times 7773)^{-2}$

Answer: D

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4. The temperature at which K_c and K_p will have the same value for the equilibrium ,

$N_2O_4(g) \Leftrightarrow 2NO_2(g)$ is

A. 0 K

B. 273 K

C. 1 K

D. 12.18 K

Answer: D

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5. The pressure at which equilibrium constant in terms of pressures is found to be equal to that in terms of mole fraction for the equilibrium,

$PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

A. 10 atm

B. 1 atm

C. $0 \cdot 1$atm

D. 2 atm

Answer: B

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6. White solid balls of naphthalene $\left(C_{10}H_8\right)$ used as moth balls were kept in a closed container at room temperature $\left(27^\circ C\right)$. The vapour pressure above the balls was found to be 0.10 mm Hg. The value of K_c for the sublimation equilibrium ,

$C_{10}H_8(s) \Leftrightarrow C_{10}H_8(v)$ is

A. $1 \cdot 32 \times 10^{-4}$

B. $5 \cdot 36 \times 10^{-6}$

C. $3 \cdot 4 \times 10^{-7}$

D. $0 \cdot 10$

Answer: B

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7. For the reaction, $SO_2(g) + \frac{1}{2}O_2(g) \Leftrightarrow SO_3(g)$, If $K_p = K_c(RT)^x$ where the symbols have usual meaning then, the value of x is (assuming ideality).

A. 1

B. -1

C. $-\frac{1}{2}$

D. $\frac{1}{2}$

Answer: C

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8. For the reaction

$CO(g) + CI_2(g) \Leftrightarrow COCI_2(g)$

K_p/K_c is equal to

A. $\sqrt{RT}$

B. RT

C. $\frac{1}{RT}$

D. $1 \cdot 0$

Answer: C

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9. The equilibrium constant K_p for the reaction $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$ changes if:

A. total pressure

B. temperature

C. catalyst

D. amount of H_2 and I_2 present

Answer: B

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10. Given : $2N_2O(g) \Leftrightarrow 2N_2(g) + O_2(g), K = 3 \cdot 5 \times 10^{33}$

$2NO_2(g) \Leftrightarrow N_2(g) + 2O_2(g), K = 6 \cdot 7 \times 10^{16}$

$2NO(g) \Leftrightarrow N_2(g) + O_2(g), K = 2 \cdot 2 \times 10^{30}$

$2N_2O_5(g) \Leftrightarrow 2N_2(g) + 5O_2(g), K + 1 \cdot 2 \times 10^{34}$

Which oxide of nitrogen is most stable ?

A. N_2O

B. NO_2

C. NO

D. N_2O_5

Answer: B

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11. The equilibrium constant for the reaction

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

at temperature T is 4×10^{-4}.

The value of K_c for the reaction

$NO(g) \Leftrightarrow \frac{1}{2}N_2(g) + \frac{1}{2}O_2(g)$

at the same temperature is

A. $50 \cdot 0$

B. $0 \cdot 02$

C. $2 \cdot 5 \times 10^2$

D. 4×10^{-4}

Answer: A

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12. If the equilibrium constant for

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$ is K , the equilibrium

constant for $\frac{1}{2}N_2(g) + \frac{1}{2}O_2(g) \Leftrightarrow NO(g)$ will be

A. $\frac{1}{2}K$

B. K

C. K^2

D. $K^{1/2}$

Answer: D

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13. Consider the following gaseous equilibria with equilibrium constant $K_1 \text{and} K_2$ respectively.

$SO_2(g) + \frac{1}{2}O_2(g) \rightarrow SO_3(g), 2SO_3(g) \rightarrow 2SO_2(g) + O_2(g)$

The equilibrium constant are related as :

A. $K_1^2 = \frac{1}{K_2}$

B. $2k_1 = K_2^2$

C. $K_2 = \frac{2}{K_1^2}$

D. $K_2^2 = \frac{1}{K_1}$

Answer: A

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14. The following equilibria are given by :

$N_2 + 3H_2 \Leftrightarrow 2NH_3, K_1$

$N_2 + O_2 \Leftrightarrow 2NO, K_2$

$H_2 + \frac{1}{2}O_2 \Leftrightarrow H_2O, K_3$

The equilibrium constant of the reaction $2NH_3 + \frac{5}{2}O_2 \Leftrightarrow 2NO + 3H_2O$ in terms of K_1, K_2 and K_3 is

A. $K_1K_3^3/k_2$

B. $K_2K_3^3/K_1$

C. K_2K_3/K_1

D. $K_2^3K_3/K_1$

Answer: B

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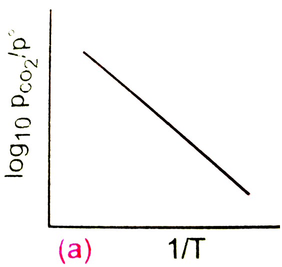
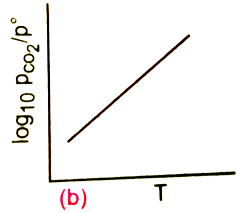
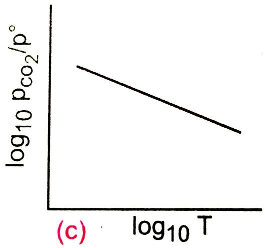
15. For the chemical equilibrium,

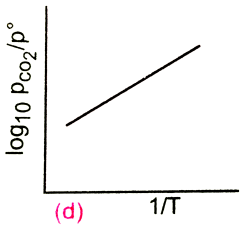
$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$

$\Delta_r H^\ominus$ can be determined from which one of the following plots?

A. 

B. 

C. 

D. 

Answer: A

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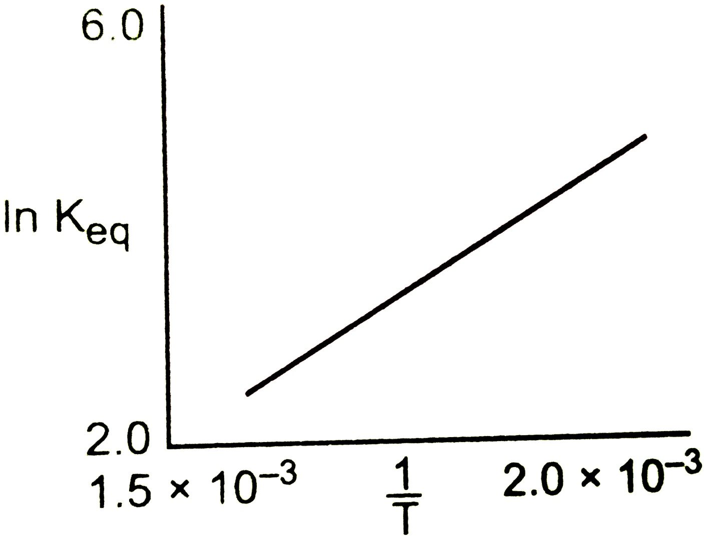
16. A schematic plot of In K_{eq} versus inverse of temperature for a reaction is shown below :



The reaction must be

A. exothermic

B. endothermic

C. one with negliable enthalpy change

D. highly spontaneous at ordianary temperature

Answer: A

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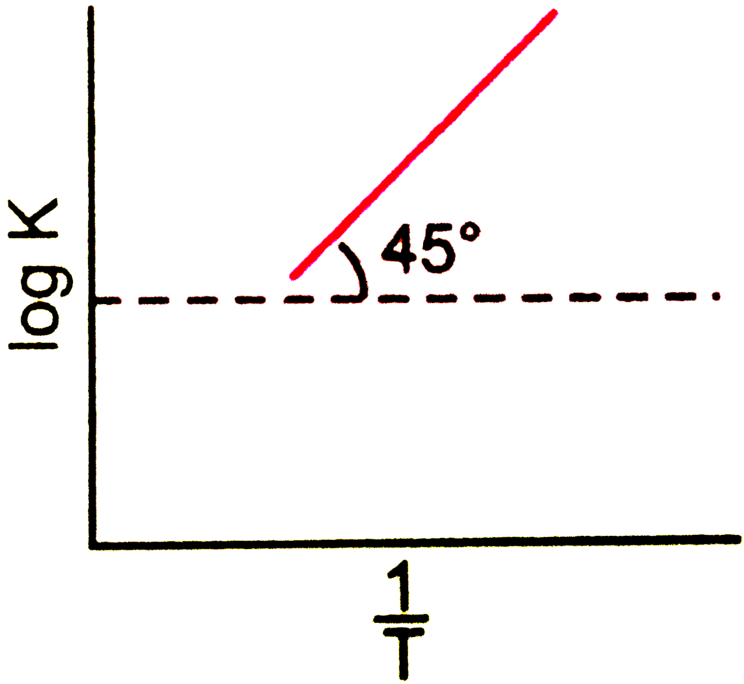
17. The variation of equilibrium constant (K) with temperature (T) was stupied by plotting log K versus 1/T The plot obtained is shown iin the Fig . Hence, enthalpy change $\left(\Delta H^{\circ}\right)$ of the reaction is



A. $+2 cal$

B. $-2 cal$

C. $+4.606 cal$

D. $-4.606 cal$

Answer: D

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18. In the preparation of CaO from $CaCO_3$ using the equilibrium,

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$

K_p is expressed as

$$\log K_p = 7.282 - \frac{8500}{T}$$

For complete decomposition of $CaCO_3$, the temperature in celsius to be used is:

A. 1167

B. 894

C. 8500

D. 850

Answer: B

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19. For a given exothermic reaction , K_p and k'_p are the equilibrium constants at temperatures T_1 and T_2 respectively. Assuming that heat of reaction is constant in temperature range between T_1 and T_2 , it is readily observed that

A. $K_p > K_p{}'$

B. $K_p < K'_p$

C. $K_p = K'_p$

D. $K_p = \frac{1}{K'_p}$

Answer: A

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20. If the value of equilibrium constant for a particular reaction is 1.6×10^{12} , then art equilibrium the system will contain

A. mostly products

B. similar amounts of reactants and products

C. all reactants

D. mostly reactants

Answer: A

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21. An aqueous solution contains 0.10 M H_2S and 0.20 M HCl. If the equilibrium constants for the formation of HS from HS is 1.0×10^{-7} and that of S^{2-}? from HS^- ions is 1.2×10^{-7} then the concentration of S^{2-} ions in aqueous solution is

A. 5×10^{-8}

B. 3×10^{-20}

C. 6×10^{-21}

D. 5×10^{-19}

Answer: B

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22. The following equilibrium constants are given :

$N_2 + 3H_3 \Leftrightarrow 2NH_3, K_1$

$N_2 + O_2 \Leftrightarrow 2NO, K_2$

$H_2 + \frac{1}{2}O_2 \Leftrightarrow H_2O, K_3$

The equilibrium constant for the oxidation of NH_3 by oxygen to give NO is :

A. K_1K_2/K_3

B. $K_2K_3^3/K_1$

C. $K_2K_3^2/K_1$

D. $K_2^2K_3/K_1$

Answer: B

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23. The dissociation constants for acetic acid and HCN at $25\,^{\circ}C$ are 1.5×10^{-5} and 4.5×10^{-10}, respectively. The equilibrium constant for the equilibirum $CN^{-} + CH_3COOH \Leftrightarrow HCN + CH_3COO^{-}$ would be

A. 3.0×10^{-5}

B. 3.0×10^{-4}

C. 3.0×10^{4}

D. 3.0×10^{5}

Answer: C

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24. Consider the following reactions in which all the reactants and the products are in gasous state

$2PQ \Leftrightarrow P_2 + Q_2, K_1 = 2.5 \times 10^{5}$

$PQ + \frac{1}{2}R_2 \Leftrightarrow PQR, K_2 = 5 \times 10^{-3}$

The value of K_3 for the equilibrium

$1/2P_2 + 1/2Q_2 + 1/2R_2 \Leftrightarrow PQR,$ is

A. 2.5×10^{-3}

B. 2.5×10^{3}

C. 1.0×10^{-5}

D. 5×10^{3}

Answer: C

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25. Partial pressure of O_2 in the reaction

$1/2P_2 + 1/2Q_2 + 1/2R_2 \Leftrightarrow PQR,$

A. K_p

B. $\sqrt{K_p}$

C. $\sqrt[3]{K_p}$

D. $2K_p$

Answer: A

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26. Mercurous chloride , Hg_2Cl_2, in a saturated solution has the equilibrium called solubility equilibrium . The equilibrium constant for this solubility equilibrium will be

A. $\left[Hg^+\right]\left[Cl^-\right]$

B. $\left[Hg^+\right]^2\left[Cl^-\right]^2$

C. $\left[Hg_2^{2.+}\right]\left[Cl^-\right]^2$

D. $2\left[Hg^+\right] \times 2\left[Cl^-\right]$

Answer: C

Watch Video Solution

27. In a reaction $A + 2B \Leftrightarrow 2C$, 2.0 moles of $'A'$ 3 moles of 'B' and 2.0 moles of 'C' are placed in a 2.0 L flask and the equilibrium concentration of 'C' is 0.5 mol/ L . The equilibrium constant (K) for the reaction is

A. 0.073

B. 0.147

C. 0.05

D. 0.026

Answer: C

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28. 500 ml vessel contains 1.5 M each of A, B, C and D at equlibrium. If 0.5 M each of C and D are taken out, the value of K_c for $A + B \Leftrightarrow C + D$ will be

A. 1.0

B. 1/9

C. $4/9$

D. $8/9$

Answer: A

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29. When two reactants, A and B are mixed to give products C and D, the reaction quotient Q, at the initial stages of the reaction.

A. is zero

B. decreases with time

C. is independent of time

D. increases with time.

Answer: D

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30. 9.2 grams of $N_2O_{4(g)}$ is taken in a closed one litre vessel and heated till the following equilibrium is reached $N_2O_{4(g)} \Leftrightarrow 2NO_{2(g)}$. At equilibrium, $50\% N_2O_{4(g)}$ is dissociated. What is the equilibrium constant (in mol $litre^{-1}$) (Molecular weight of $N_2O_4 = 92$) ?

A. 0.1

B. 0.2

C. 0.4

D. 2

Answer: B

Watch Video Solution

31. Calculate the partial pressure of carbon monoxide from the following data :

$$CaCO_3 \overset{\Delta}{\Leftrightarrow} CaO(s) + CO_2 \uparrow, K(p) = 8 \times 10^{-2}$$

$$CO_2(g) + C(s) \Leftrightarrow 2CO(g), K_p = 2$$

A. $0 \cdot 2$

B. $0 \cdot 4$

C. $1 \cdot 6$

D. 4

Answer: B

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32. The equilibrium:

$P_4(g) + 6Cl_2(g) \Leftrightarrow 4PCl_3(g)$

is attained by mixing equal moles of P_4 and Cl_2 in an evacuated vessel. Then at equilibrium:

A. $[Cl_2] > [PCl_3]$

B. $[Cl_2] > [P_4]$

C. $[P_4] > [Cl_2]$

D. $[PCl_3] < [P_4]$

Answer: C

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33. An amount of solid NH_4HS is placed in a flask already containing ammonia gas at a certain temperature and 0.50 atm pressure.Ammonium hydrogen sulphide decomposes to yield NH_3 and H_2S gases in the flask.When the decomposition reaction reaches equilibrium, the total pressure in the flask rises to 0.84 atm ? The equilibrium constant for NH_4HS decomposition at this temperature is :

A. 0.30

B. $0 \cdot 18$

C. $0 \cdot 17$

D. $0 \cdot 11$

Answer: D

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34. $A + B \Leftrightarrow C + D$. If finally the concentrations of A an d B are both equal but at equilibrium concentration of D will be twice of that of A then what will be the equilibrium constant of reaction.

A. $4/9$

B. $0 \cdot 18$

C. $0 \cdot 17$

D. $0 \cdot 11$

Answer: D

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35. The equilibrium constant at $298K$ for a reaction, $A + B \Leftrightarrow C + D$ is 100. If the initial concentrations of all the four species were 1M each, then equilibirum concentration of D (in molL^{-1}) will be

A. $0 \cdot 182$

B. $0 \cdot 818$

C. $1 \cdot 818$

D. $1 \cdot 182$

Answer: C

Watch Video Solution

36. $NH_4COONH_2(s) \Leftrightarrow 2NH_3(g) + CO_2(g)$ If equilibrium pressure is 3 atm for the above reaction, then K_p for the reaction is

A. 4

B. 27

C. $4/27$

D. $1/27$

Answer: A

Watch Video Solution

37. The equilibrium pressure for the reaction $MSO_4.2H_2O(s) \Leftrightarrow MSO_4(s) + 2H_2O(g)$ is $\pi/4$atm at 400 K . The K_p for the given is

A. $\pi^2/4$

B. $\pi/6$

C. $\pi^2/16$

D. $\dfrac{\pi}{16}$

Answer: C

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38. For the reaction

$H_2(g) + CO(g) \Leftrightarrow CO(g) + H_2O(g)$, if the initial concentration of $[H_2] = [CO_2]$ and x moles /litres of hydrogen is consummed at equilibrium , the correct expression of K_p is :

A. $\dfrac{x^2}{(1 - x)^2}$

B. $\dfrac{(1 + x)^2}{(1 - x)^2}$

C. $\dfrac{x^2}{(2 + x)^2}$

D. $\dfrac{x^2}{(1 - x)^2}$

Answer: A

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39. A mixture of nitrogen and hydrogen in the ratio of $1:3$ reach equilibrium with ammonia, when 50% of the mixture has reacted. If the total pressure is P, the partial pressure of ammonia in the equilibrium mixture was :

A. $P/2$

B. $P/3$

C. $P/4$

D. $P/6$

Answer: B

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40. For the reaction, $H_2 + I_2 \Leftrightarrow 2HI, K = 47.6$. If the initial number of moles of each reactant and product is 1 mole then at equilibrium

A. $\left[I_2\right] = \left[H_2\right], \left[I_2\right] > [HI]$

B. $\left[I_2\right] < \left[H_2\right], \left[I_2\right] = [HI]$

C. $\left[I_2\right] = \left[H_2\right], \left[I_2\right] < [HI]$

D. $\left[I_2\right] > \left[H_2\right], \left[I_2\right] = [HI]$

Answer: C

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41. The equilibrium constant $\left(K_p\right)$ for the decomposition of gaseous H_2O

$H_2O(g) \Leftrightarrow H_2(g) + \frac{1}{2}O_2(g)$

is related to the degree of dissociation α at a total pressure P by

A. $K_p = \frac{\alpha^3 p^{1/2}}{(1+\alpha)(2+\alpha)^{1/2}}$

B. $K_p = \frac{\alpha^3 p^{3/2}}{(1-\alpha)(2+\alpha)}$

C. $K_p = \frac{\alpha^{3/2} p^2}{(1-\alpha)(2+\alpha)^{1/2}}$

D. $K_p = \frac{\alpha^{3/2} p^{1/2}}{(1-\alpha)(2+\alpha)^{1/2}}$

Answer: D

Watch Video Solution

42. a' moles of PCl_5 are heated in a closed container to equilibrate $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$ at a pressure of p atm . If x moles of PCl_5 dissociate at equilibrium , then

A. $\frac{x}{a} = \left(\frac{K_p}{p}\right)^{1/2}$

B. $\frac{x}{a} = \frac{K_p}{K_p + p}$

C. $\frac{x}{a} = \left(\frac{K_p}{K_p + p}\right)^{1/2}$

D. $\frac{x}{a} = \left(\frac{K_p + p}{K_p}\right)^{1/2}$

Answer: C

Watch Video Solution

43. If the concentration of OH^- ions in the reaction

$Fe(OH)_3(s) \Leftrightarrow Fe^{3+}(aq.) + 3OH^-(aq.)$

is decreased by $1/4$ times, then the equilibrium concentration of Fe^{3+} will increase by

A. 8 times

B. 16 times

C. 64 times

D. 4 times

Answer: C

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44. The dissociation equilibrium of a gas AB_2 can be represented as, $2AB_2(g) \Leftrightarrow 2AB(g) + B_2(g)$. The degree of disssociation is 'x' and is small compared to 1. The expression relating the degree of dissociation (x) with equilibrium constant k_p and total pressure P is

A. $\left(2K_p/P\right)$

B. $\left(2K_p/P\right)^{1/3}$

C. $\left(2K_p/P\right)^{1/2}$

D. $\left(K_p/P\right)$

Answer: B

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45. Equimolar concentrations of H_2 and I_2 are heated to equilibrium in a 2 L flask. At equilibrium, the forward and backward rate constants are found to be equal. What percentage of initial concentration of H_2 has reached at equilibrium ?

A. 33%

B. 66%

C. 50%

D. 40%

Answer: C

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46. 5 moles of $SO_2$and 5 moles of O_2 are allowed to react .At equilibrium , it was foumnd that 60% of SO_2 is used up .If the pressure of the equilibrium mixture is one aatmosphere, the parital pressure of O_2 is :

A. $0 \cdot 52$ atm

B. $0 \cdot 21$ atm

C. $0 \cdot 41$atm

D. $0 \cdot 82$ atm

Answer: C

Watch Video Solution

47. Consider thr reaction where $K_p = 0.497$at 500K

$PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

If the htree gasses are mixed in a right container so that the partial pressure of each gas in initially 1 atm ,then which is correct observation ?

A. More PCl_5 will be produced

B. More PCl_3 will be produced

C. Equilibrium will be established when 50% of the reaction is complete

D. None of the above

Answer: A

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48. The reaction,

$2A(g) + B(g) \Leftrightarrow 3C(g) + D(g)$

is begun with the concentration of A and B both at an intial value of 1.00 M. When equilibrium is reached, the concentration of D is measured and found to be 0.25 M. The value for the equilibrium constant for this reaction is given by the expression:

A. $\left[(0 \cdot 75)^3(0 \cdot 25)\right] \div \left[(1.00)^2(1.00)\right]$

B. $\left[(0 \cdot 75)^3(0 \cdot 25)\right] \div \left[(0 \cdot 50)^2(0 \cdot 75)\right]$

C. $\left[(0 \cdot 75)^3(0 \cdot 25)\right] \div \left[(0 \cdot 50)^2(0 \cdot 75)\right]$

D. $\left[(0 \cdot 75)^3(0 \cdot 25)\right] \div \left[(0 \cdot 75)^2(0 \cdot 25)\right]$

Answer: B

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49. For the reaction, $AB(g) \Leftrightarrow A(g) + B(g)$, AB is 33% dissociated at a total pressure of 'p' Therefore, 'p' is related to K_p by one of the following options

A. $P = K_p$

B. $P = 3K_p$

C. $P = 4K_p$

D. $P = 8K_p$

Answer: D

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50. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted to CO on addition of graphite. Calculate the value of K, if the total pressure at equilibrium is 0.8 atm.

A. 3 atm

B. $0 \cdot 3$atm

C. $0 \cdot 18atm$

D. $1 \cdot 8$ atm

Answer: D

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51. For the reaction $C(s) + CO_2(g) \rightarrow 2CO(g), k_p = 63$ atm at 100 K. If at equilibrium $p_{CO} = 10p_{CO_2}$ then the total pressure of the gases at equilibrium is

A. $6 \cdot 3$ atm

B. $6 \cdot 93$ atm

C. $0 \cdot 63$atm

D. $0 \cdot 693$ atm

Answer: B

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52. In the reaction $AB(g) \Leftrightarrow A(g) + B(g)$ at $30^{\circ} C, k_p$ for the dissociation equilibrium is $2.56 \times 10^{-2} atm$. If the total pressure at equilibrium is 1 atm, then the percentage dissociation of AB is

A. 0.87

B. 0.13

C. $43 \cdot 5 \%$

D. 0.06

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53. A 20 litre container at 400 K contains $CO_2(g)$ at pressure $0.4 atm$ and an excess of SrO (neglect the volume of slid SrO). The volume of the container is now decreased by moving the movable piston fitted in the container . The maximum volume of the container, when pressure of CO_2 attains its maximum value, will be

[Given that : $SrCO_3(s) \Leftrightarrow SrO(s) + CO_2(g), Kp = 1.6atm$]

A. 5 litre

B. 10 litre

C. 4 litre

D. 2 litre

Answer: A

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54. Which of the following statement is correct for a reversible process in a state of equilibrium ?

A. $\Delta G^\circ = -2 \cdot 30RT\log K$

B. $\Delta G^\circ = 2 \cdot 30RT\log K$

C. $\Delta G = -2 \cdot 30R\log K$

D. $\Delta G = 230RT\log K$

Answer: A

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55. The standard Gibbs energy change at $300K$ for the reaction $2A \Leftrightarrow B + C$ is 2494. $2J$. At a given time, the composition of the reaction mixture is $[A] = \frac{1}{2}, [B] = 2$ and $[C] = \frac{1}{2}$. The reaction proceeds in the $(R = 8.314JK/\text{mole} = 2.718)$

A. Forward direction because $Q > K_c$

B. Reverse direction because $Q > K_c$

C. Forward direction because $Q < K_c$

D. Reverse direction because $Q < K_c$

Answer: B

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56. Choose the equilibrium that is not influenced by pressure

A. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

B. $CO_2(g) + 3H_2(g) \Leftrightarrow CH_4(g) + H_2O(g)$

C. $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

D. $2HI(g) \Leftrightarrow H_2(g) + I_2(g)$

Answer: D

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57. The reaction , $SO_2 + Cl_2 \Leftrightarrow SO_2Cl_2$ is exothermic and reversible . A mixture of $SO_2(g), Cl_2 \Leftrightarrow SO_2Cl_2(g)$ is at equilibrium in a closed container . Now a certain quantity of extra SO_2 is introduced into the container , the volume remaining the same. Which of the following is / are/ true ?

A. The pressure inside the container will not change

B. The temperature will not change

C. The temperature will increases

D. The temperature will decrease.

Answer: C

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58. Consider the following equilibrium in a closed container

$N_2O_4(g) \Leftrightarrow 2NO_2(g)$

At a fixed temperature, the volume of the reaction container is halved. For this change, which of the following statements hold true regarding the equilibrium constant (K_p) and degree of dissociation (α)?

A. neither $K_p \text{nor} \alpha$ changes

B. both K_p and α change

C. K_p changes but α does not change

D. K_p does not change but α changes

Answer: D

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59. Given reaction is $2X_{(gas)} + Y_{(gas)} \Leftrightarrow 2Z_{(gas)} + 80$ Kcal

Which combination of pressure and temperature gives the highest yield of Z at equilibrium ?

A. 1000 atm and $200\ ^{\circ}C$

B. 500 atm and $500\ ^{\circ}C$

C. 500 atm and $200\ ^{\circ}C$

D. 500 atm and $100\ ^{\circ}$

Answer: A

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60. The following two reactions:

i. $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

(ii) $COCl_2(g) \Leftrightarrow CO(g) + Cl_2(g)$

are simultaneously in equilibrium in a container at constant volume. A few moles of $CO(g)$ are later introduced into the vessel. After some time, the new equilibrium concentration of

A. PCl_5 will increases

B. PCl_5 will remain unaffected

C. Cl_2 will increases

D. PCl_5 will decreases

Answer: B

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61. At equilibrium of the reaction

$2X(g) + Y(g) \Leftrightarrow X_2Y(g)$

the number of moles of X_2Y at equilibrium is affected by the

A. temperature and pressure

B. temperature only

C. pressure only

D. temperature , pressure and catalyst used

Answer: A

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62. To an equilibrium mixture of

$2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

some helium , an inert gas, is added at constant volume. The addition of helium causes the total pressure to double . Which of the following is true ?

A. The concentration of the three gases is unchanged

B. The concentration of sulphur trioxide increases

C. The number of moles of sulphur trioxide increases

D. The concentration of sulphur dioxide increases

Answer: A

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63. The equilibrium of the reaction $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ will be shifted to the right when:

A. by increasing the concentration of NH_3

B. by decreasing the pressure

C. by decreasing the pressure

D. by decreasing the concentration of $N_2(g)$ and H_2 (g)

Answer: D

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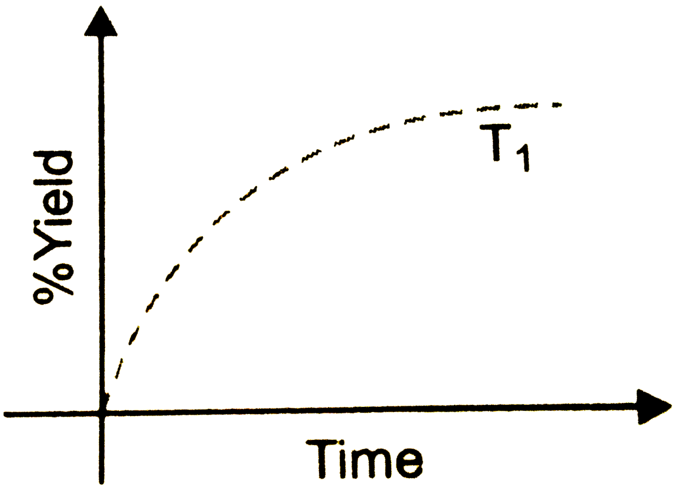
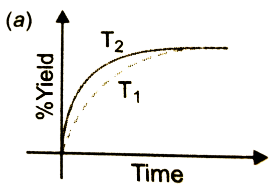
64. The % yield of ammonia as a function as a function of time in the reaction

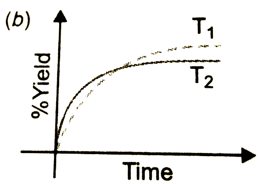
$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g), \Delta H < 0$ at $\left(P, T_1\right)$ is given below



If this reaction is cnducted at $\left(P, T_2\right)$ with $T_2 > T_1\right)$ the % yield of ammonia as a function of time is



A.



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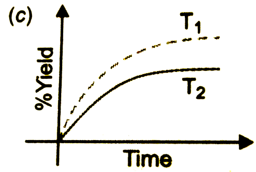
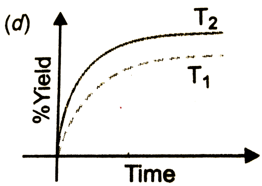
C. 

D. 

Answer: B

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65. In which one of the following the increase of presure favours the backward reaction?

A. Formation of equilibrium ammonia from $N_2(g)$ and $H_2(g)$

B. Decomposition equilibrium of HI (g) to $H_2(g)$ and $I_2(g)$

C. Synthesis of SO_3 (g) by contact process

D. Production of 'syngas' by coal gasification

Answer: D

View Text Solution

66. Consider the reaction equilibrium

$\text{Ice}_{(\text{Greater volume})} \Leftrightarrow \text{Water}_{(\text{Lesser volume})} - 2\text{kcal}$

The favourable conditions for forward reaction are

A. low temperature , high pressure and excess of ice

B. low temperature ,low pressure and excess of ice

C. high temperature , low pressure and excess

D. high temperature , high pressure and excess of ice

Answer: D

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67. Which one of the following condition will favour maximum formation of the product in the reaction. $A_2(g) + B_2(g) \Leftrightarrow X_2(g) \Delta_r H = -X$ kJ ?

A. Low temperature and high pressure

B. Low temperature and low pressure

C. High temperature and high pressure

D. High temperature and low pressure

Answer: A

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68. A mixture of NO_2 and N_2O_4 has a vapor density of 38.3 at 300 K. What is the number of moles of NO_2 in 100 g of themixture ?

A. $0 \cdot 043$

B. $4 \cdot 4$

C. $3 \cdot 4$

D. $0 \cdot 437$

Answer: D

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69. Ammonium carbamate when heated to $200^{\circ} C$ gives a mixture of NH_3 and CO_2 vapours with a density of $16 \cdot 0$. What is the degree of disociation of ammonium carbamate ?

A. $3/2$

B. $1/2$

C. 2

D. 1

Answer: D

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70. The vapour density of fully dissociated NH_4Cl would be

A. double than that of NH_4Cl

B. half than that of NH_4Cl

C. same as that of NH_4Cl

D. determined by the amount of solid NH_4Cl taken

Answer: B

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71. N_2O_4 is 10% dissociated at a total pressure P_1 and 20% dissociated at a total pressure P_2. $Thenratio'$ $\frac{P_1}{P_2}$ is

A. $\frac{1}{2}$

B. $\frac{2}{1}$

C. $\frac{1}{4}$

D. $\frac{4}{1}$

Answer: D

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72. At equilibrium of the reaction ,

$N_2O_4(g) \Leftrightarrow 2NO_2(g)$

the observed molecular weight of $N_{92})O_4$ is 80g mol^{-1} at 350K. The percentage dissociation of $N_2O_4(g)$ at 350K is

A. 0.1

B. 0.15

C. 0.2

D. 0.18

Answer: B

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73. The values of K_{p_1} and K_{p_2} for the reactions

$X \Leftrightarrow Y + Z$ ....(i)

and $A \Leftrightarrow 2B$ ...(ii)

are in ratio of 9 : 1. If degree of dissociation of X and A be equal, then total presure at equilibrium (i) and (ii) are in the ratio.

A. $3:1$

B. $1:9$

C. $36:1$

D. $1:1$

Answer: C

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74. 3 moles of A and 4 moles of B are mixed together and allowed to come into equilibrium according to the following reaction

$A(g) + 4B(g) \Leftrightarrow 2C(g) + 3D(g)$

When equilirium is reached , there is 1 mole of C. The equilibrium extent of the reaction is

A. $1/4$

B. $1/3$

C. $1/2$

D. 1

Answer: C

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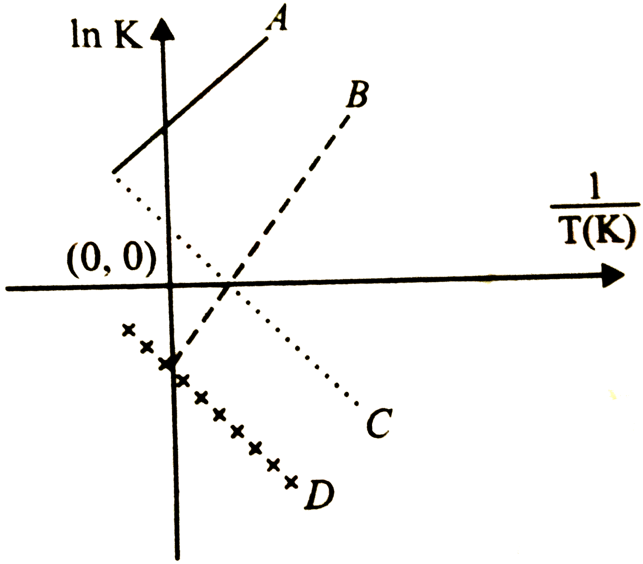
75. Which of the following lines correctly show the temperature dependence of equilibrium constant K, for an exothermic reaction ?



A. A and B

B. B and C

C. C and D

D. A and D

Answer: A

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Competition Focus (Jee(Main and advanced)/Medical Entrance) II. MULTIPLE CHOICE QUESTIONS (with one or More One correct answer)

1. Which of the following are reversible reactions ?

A. $AgNO_3(aq) + NaCl(aq) \rightarrow$

$AgCl(s) + NaNO_3(aq)$

B. $KNO_3(aq) + NaCl(aq) \rightarrow$

$KCl(aq) + NaNO_3$

C. $BaCl_2(aq) + Na_2SO_4 \rightarrow$

$BaSO_4(s) + 2NaCl(aq)$

D. $AgCl(s) + Water \rightarrow Ag^+(aq) + Cl^-(aq)$

Answer: B::D

View Text Solution

2. Which of the following statement are wrong ?

A. Equilibrium constant of a reaction is doubled if the equilibrium concentration of the products become double

B. If a reaction mixture is compressed to half the volume, equilibrium constant is halved

C. Equilibrium , constant increases of tempertature

D. Equilibrium concentrations increase in the presence of a catalyst .

Answer: A::B::C::D

View Text Solution

3. The equilibrium

$SO_2CI_2(g) \Leftrightarrow SO_2(g) + CI_2(g)$

is attained at $25\,^{\circ}C$ in a closed container and inert gas helium is introduced. Which of the following statement (s) is/are correct ?

(1).concentrations of SO_2, CI_2 and SO_2CI_2 change

(2). More chlorine is formed

(3).Concentration of SO_2 is reduced

(4).More SO_2CI_2 is formed

A. Concentration of SO_2, Cl_2 and SO_2Cl_2 change

B. More chlorine is formed

C. Concentration of SO_2 is reduced

D. More SO_2Cl_2 is formed

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4. For the reaction,

$PCl_{5(g)} \Leftrightarrow PCl_{3(g)} + Cl_{2(g)}$, the forward reaction at constant temperature is favoured by:

A. introducing an inert gas at constant volume

B. introducing PCl_5 at constant volume.

C. introducing an inert gas at constant pressure

D. increasing the volume of the container

Answer: B::C::D

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5. The equilibrium: $2Cu^{1} \Leftrightarrow Cu^{0} + Cu^{u}$ in aqueous medium at $25^{\circ} C$ shifts towards the left in the presence of

A. NO^{-}

B. Cl^{-}

C. SCN^{-}

D. CN^{-}

Answer: B::C::D

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6. The thermal dissociation of equilibrium of $CaCo_3(s)$ is studied under different conditions

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$

For this equilibrium, the correct statement (s) is/are

A. ΔH is dependent on T

B. K is independent of the itial amount of $CaCO_3$

C. K is indepdent of the pressure of CO_2 at a given T

D. ΔH is independent of the catalyst , ifany

Answer: A::B::D

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Competition Focus (Jee(Main and advanced)/Medical Entrance) III. MULTIPLE CHOICE QUESTIONS (Based on the given Passage/Comprehension)

1. The expression for the reaction quotient , Q, is similar to that for equilibrim constant , Q, is similar to that for equilibrium constant K. The value of Q for the given composition of a reaction mixture helps us to know whether the reaction will move forward or backward or remain in equilibrium . It also helps to predict the effect of pressure on the direction of the gaseous reaction .In certain reactions, addition of inert gas also favours either the formation of reactants or products . The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation , d In $K_p/dT = \Delta H^\circ/RT^2$ where enthaply change, ΔH° , is taken as constant in the small temperature range.

The equilibrium constant for the reaction between $CH_4(g)$ and $H_2S(g)$ to form $CS_2(g)$ and $H_2(g)$, at 1173 K is $3 \cdot 6$. For the following composition of the reaction mixture , decide which of the following option is correct ?

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2. The expression for the reaction quotient , Q, is similar to that for equilibrim constant , Q, is similar to that for equilibrium constant K. The value of Q for the given composition of a reaction mixture helps us to know whether the reaction will move forward or backward or remain in equilibrium . It also helps to predict the effect of pressure on the direction of the gaseous reaction .In certain reactions, addition of inert gas also favours either the formation of reactants or products . The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation , d In $K_p/dT = \Delta H^\circ / RT^2$ where enthaply change, ΔH° , is taken as constant in the small temperature range.

The reaction $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3$ is in equilibrium . Now the reaction mixture is compressed to half the volume

A. More of ammonia will be formed

B. Ammonia will dissociate back into N_2 and H_2

C. There will be no effect on equilibrium

D. Equilibrium constant of the reaction will change

Answer: A

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3. The expression for the reaction quotient , Q, is similar to that for equilibrim constant , Q, is similar to that for equilibrium constant K. The value of Q for the given composition of a reaction mixture helps us to know whether the reaction will move forward or backward or remain in equilibrium . It also helps to predict the effect of pressure on the direction of the gaseous reaction .In certain reactions, addition of inert gas also favours either the formation of reactants or products . The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation , d In $K_p/dT = \Delta H^\circ / RT^2$ where enthaply change, ΔH° , is taken as constant in the small temperature range.

For the above reaction in equilibrium , helium gas was added but the mixture was allowed to expand to keep the pressure constant . Then

A. More of ammonia will be formed

B. Ammonia will dissociate back into N_2 and H_2

C. There will be no effect on equilibrium

D. Equilibrium constant of the reaction will change

Answer: B

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4. The expression for the reaction quotient , Q, is similar to that for equilibrim constant , Q, is similar to that for equilibrium constant K. The value of Q for the given composition of a reaction mixture helps us to know whether the reaction will move forward or backward or remain in equilibrium . It also helps to predict the effect of pressure on the direction of the gaseous reaction .In certain reactions, addition of inert gas also favours either the formation of reactants or products . The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation , d In $K_p / dT = \Delta H^\circ / RT^2$ where enthaply change, ΔH° , is taken as constant in the small temperature range.

Which of the following will be correct ?

A. Plot of In k_p versus $1/T^2$ will be linear with + ve slope

B. Plot of In $K_p$verus$1/T$ will be linear with + vve slope

C. Plot of In K_p versus$1/T^2$ will be linear with -ve slope

D. Plot of In K_p versus $1/T$ will be linear with -ve slope

Answer: D

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5. The expression for the reaction quotient , Q, is similar to that for equilibrim constant , Q, is similar to that for equilibrium constant K. The value of Q for the given composition of a reaction mixture helps us to know whether the reaction will move forward or backward or remain in equilibrium . It also helps to predict the effect of pressure on the direction of the gaseous reaction .In certain reactions, addition of inert gas also favours either the formation of reactants or products . The value of equilibrium constant of a reaction changes with change of temperature and the change is given by van't Hoff equation , d In $K_p / dT = \Delta H^\circ / RT^2$ where enthaply change, ΔH° , is taken as constant in the small temperature range.

In which of the following case , equilibrium constant decreases with increase of temperature ?

A. When the reaction is exothermic

B. When the reaction is endothermic

C. When the reaction is in the gaseous phase

D. When the reaction takes place in the solution.

Answer: A

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6. Thermal decomposition of gaseous X_2 to gaseous X at 298 K takes place according to the equation :

$X_2(g) \Leftrightarrow 2X(g)$ The standard reaction Gibbs energy , $\Delta_r G^\circ$ of this reaction is positive . At the start of the reaction, there is positive . At the start of the reaction , there is one mole of X_2 and no. As the reaction proceeds , the number of moles of X formed is given by β. Thus $\beta_{equilbrium}$ is the number of moles of X formed at equilibrium . The reaction is carried out at a constant total pressure of 2 bar . Consider the gases to behave ideally .

(Given : R = $0 \cdot 0833$ L bar $K^{-1} mol^{-1}$).

The equilibrium constant K_p for this reaction at 298 K, in terms of $\beta_{equilibrium}$, is

A. $\frac{8\beta^2_{\text{equilibrium}}}{2 - \beta_{\text{equilibrium}}}$

B. $\frac{8\beta^2_{\text{equilibrium}}}{4 - \beta^2_{\text{equilibrium}}}$

C. $\frac{4\beta^2_{\text{equilibrium}}}{2 - \beta_{\text{equilibrium}}}$

D. $\frac{4\beta^2_{\text{equilibrium}}}{4 - \beta^2_{\text{equilibrium}}}$

Answer: B

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7. Thermal decomposition of gaseous X_2 to gaseous X at $298K$ takes place according to the following equation:

$X(g) \Leftrightarrow 2X(g)$

The standard reaction Gibbs energy $\Delta_r G^\circ$, of this reaction is positive. At the start of the reaction, there is one mole of X_2 and no X. As the reaction proceeds, the number of moles of X formed is given by β. Thus $\beta_{\text{equilibrium}}$ is the number of moles of X formed at equilibrium. The reaction is carried out at a constant total pressure of 2 bar. Consider the gases to behave ideally.

[Given, $R = 0.083L$ bar $K^{-1} mol^{-1}$)

The incorrect statement among the following for this reaction, is

A. Decrease in the total pressure will result in formation of more moles of gaseous X

B. At the start of the reaction, dissociation of gaseous X_2 takes place spontaneously

C. $\beta._{\text{equilibrium}} = 0 \cdot 7$

D. $K_c < 1$

Answer: C

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Competition Focus (Jee(Main and advanced)/Medical Entrance) VI. INTEGER TYPE QUESTIONS

1. The answer to each of the folowing questions is a single digit integar, ranging from 0 to 9. If the correct answers to the question numbers A, B, C and D (say) are 4,0,9 and 2 respectively , then the correct darkening of bubbles should be as shown on the side :

If concentrations of SO_2 and O_2 in the equilibrium reaction , $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$ are quadrupled , the concentration of SO_3 now will be times .... times.

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2. The answer to each of the folowing questions is a single digit integar, ranging from 0 to 9. If the correct answers to the question numbers A, B, C and D (say) are 4,0,9 and 2 respectively , then the correct darkening of bubbles should be as shown on the side :

Equilibrium constant for the reaction $A_3(g) + 3B_2(g) \Leftrightarrow 3AB_2(g)$ is $64 \cdot 0$Then the equilibrium constant for the reaction will be

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3. The answer to each of the folowing questions is a single digit integar, ranging from 0 to 9. If the correct answers to the question numbers A, B, C and D (say) are 4,0,9 and 2 respectively , then the correct darkening of bubbles should be as shown on the side :

For the reaction involving oxidation of ammonia by oxygen to form nitric oxide and water vapour , the equilibrium constant has the units $(\text{bar})^n$. Then n is

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Competition Focus (Jee(Main and advanced)/Medical Entrance) VII. NUMERICAL VALUE TYPE QUESTIONS

1. The approach to the following equilibrium was observed kinetically from both directions :

$PtCl_4^{2-} + H_2O ? \left[Pt\left(H_2O\right)Cl_3^-\right] + Cl^-$ at $25\,^\circ C$, it was found that

$-\frac{\Delta}{\Delta t}\left[PtCl_4^{2-}\right] = \left[3.9 \times 10^{-5}\ \text{sec}^{-1}\right]\left[PtCl_4^{2-}\right] - \left[2.1 \times 10^{-3}\ \text{L. mol}^{-1}\ \text{sec}^{-1}\right] \times [$

What is the value of equilibrium constant for the complexation of the fourth Cl^- by Pt(II) ?

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Competition Focus (Jee(Main and advanced)/Medical Entrance) VIII. ASSERTION - REASON TYPE QUESTIONS (TYPE - I)

1. Each question given below contains STATEMENT -1 (Assertion) and STATEMENT -2 (Reason). It has four choice (a), (b), (c) and (d) out of which

ONLY ONE is correct . Choose the correct option as under :

Statement -1 Adding inert gas to dissociation equilibrium of N_2O_4 at constant pressure and temperature increases the dissociation .

Statement -2. Molar concentrations of the reactants and products decrease .

A. (a) Statement -1 is True , Statement -2 is true , Statement -2 is the correct explanation of Statement -1

B. (b) Statement -1 is True , Statement -2 is not a correct expanation of Statement -1 .

C. (c) Statement -1 is True, Statement -2 is False .

D. (d) Statement -1 is False , Statement -2 is True .

Answer: A

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2. Each question given below contains STATEMENT -1 (Assertion) and STATEMENT -2 (Reason). It has four choice (a), (b), (c) and (d) out of which ONLY ONE is correct . Choose the correct option as under :

Statement -1 K_p is always greater than K_c

Statement -2 . The reactions in the gaseous phase are usually faster than the reactions in the liquid phase.

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3. Each question given below contains STATEMENT -1 (Assertion) and STATEMENT -2 (Reason). It has four choice (a), (b), (c) and (d) out of which ONLY ONE is correct . Choose the correct option as under :

Statement -1. Reaction quotiet of a reaction at any time decides the direction in which the reaction will proceed.

Statement -2. The value of reaction quotient cannot be greater than the equilibrium constant .

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4. Each question given below contains STATEMENT -1 (Assertion) and STATEMENT -2 (Reason). It has four choice (a), (b), (c) and (d) out of which ONLY ONE is correct . Choose the correct option as under :

Statement -1. Equilibrium constant of an endothermic reaction increases with increase of temperature .

Statement -2. With increase in temperature , an endothermic reaction is favoured more in the forward direction.

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Competition Focus (Jee(Main and advanced)/Medical Entrance) VIII. ASSERTION - REASON TYPE QUESTIONS (TYPE - II)

1. In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

Assertion . The vapour pressure of a pure liquid has a fixed value at a particular temperature .

Reason . When equilibrium is reached , no more vapour are formed .

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: C

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2. In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

Assertion . A reversible reaction cannot be carried out in an open vessel.

Reason. When equilibrium is reached , no more vapour are formed .

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: D

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3. Assertion (A) : For the reaction

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

unit of $K_c = L^2 mol^{-2}$

Reason (R) : For the reaction

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

equilibrium constant $K_c = \dfrac{[NH_3]^2}{[N_2] \times [H_2]^3}$

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: A

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4. Assertion (A) : The equilibrium constant is fixed and characteristic for any given chemical reaction at a specified temperature.

Reason (R) : The composition of the final equilibrium mixture at a particular temperature depends upon the starting amount of reactants.

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: A

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5. In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

Assertion . The equilibrium constant of a reaction increases if temperature is increased .

Reason . The forward reaction becomes faster with increase of temperature .

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: D

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6. Assertion (A) : The active mass of pure solid and pure liquid is taken unity.

Reason (R) : The active mass of pure solids and liquids depends on the density and molecular mass. The density and molecular of a mass of pure liquids and solids are constant.

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: A

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7. In each of the following questions, a statement of Assertion is given followed by a corresponding statement of Reason just below it. Of the statements, mark the correct answer as

Assertion . If standard free energy change of a reaction is zero , this implies that equilibrium constant of the reaction is unity .

Reason . For a reaction in equilibrium , equilibrium constant is always unity .

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: C

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8. Assertion (A) : When a catalyst is added to a reaction mixture in equilibrium the amount of the products increases.

Reason (R) : The forward reaction becomes faster on adding the catalyst.

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: D

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9. Statement: The reaction: $2NO_{(g)} + O_{2(g)} \Leftrightarrow 2NO_2$ is favoured in the forward direction with increase of pressure.

Explanation: The reaction is exothermic.

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: B

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10. Assertion (A) : A catalyst does not influences the values of equilibrium constant

Reason (R) : Catalyst influences the rate of both forward and backward reactions equally.

A. If both assertion and reason are true, and reason is the true explanation of the assertion .

B. If both assertion and reason are true but reason is the true explanation of the assertion .

C. If assertion is true, but reason is false.

D. If both assertion and reason are false .

Answer: A

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Sample Problem

1. At $700K$, the equilibrium constant K_p for the reaction

$2SO_3(g) \Leftrightarrow 2SO_2(g) + O_2(g)$

is $1.80 \times 10^{-3} kPa$. What is the numerical value of K_c in moles per litre for this reaction at the same temperature?

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2. At 773 K, the equilibrium constant K_c for the reaction,

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ is $6.02 \times 10^{-2} L^2 mol^{-2}$.

Calculate the value of K_p at the same temperature.

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3. For the equilibrium

$2NOCl(g) \Leftrightarrow 2NO(g) + Cl_2(g)$

the value of the equilibrium constant, K_c is 3.75×10^{-6} at $1069K$.

Calcualate the K_p for the reaction at this temperature?

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4. K_p for the reaction ,$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3$ is 49 at a certain temperature. Calculate the value K_p at the same temperature for the reaction

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5. The following concentrations were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at $500K$. $\left[N_2\right] = 1.5 \times 10^{-2} M$, $\left[H_2\right] = 3.0 \times 10^{-2} M$, and $\left[NH_3\right] = 1.2 \times 10^{-2} M$. Calculate the equilibrium constant.

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6. For an equilibrium reaction, the rate constants for the forward and the backward reaction are 2.38×10^{-4} and 8.15×10^{-5}, respectively. Calculate the equilibrium constant for the reaction.

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7. In a reaction between H_2 and I_2 at a certain temperature, the amounts of H_2, I_2 and HI at equilibrium were found to be 0.45 mol, 0.39 mol, and 3.0 mol respectively. Calculate the equilibrium constant for the reaction at the given temperature.

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8. Two moles of PCl_5 were heated to $327^\circ C$ in a closed two-litre vessel, and when equilibrium was achieved, PCl_5 was found to be 40% dissociated into PCl_3 and Cl_2. Calculate the equilibrium constant K_p and K_c for this reaction.

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9. For the reaction,

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

the partial pressure of N_2 and H_2 are 0.80 and 0.40 atmosphere, respectively, at equilibrium. The total pressure of the system is 2.80 atm. What is K_p for the above reaction?

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10. $0.1 mol$ of PCl_5 is vaporised in a litre vessel at $260\,^{\circ}C$. Calculate the concentration of Cl_2 at equilibrium, if the equilibrium constant for the dissociation of PCl_5 is 0.0414.

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11. At 1,000 K in the reaction $CO_2(g) + C(s) \rightarrow 2CO(g)$

The value of $P_{CO_2} = 0.48$ bar and $P_{CO} = 0$bar. Pure graphite is present. The equilibrium partial pressures of CO and CO_2 are 0.66 bar and 0.15 bar respectively. Calculate K_P of the reaction.

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12. A vessel at $1000K$ contains carbon dioxide with a pressure of $0.5 atm$. Some of the carbon dioxide is converted to carbon monoxide on addition of graphite. Calculate the value of K_p if total pressure at equilibrium is $0.8 atm$.

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13. The value of

K_c for the reaction , $2A \Leftrightarrow B + C$ is $2 \cdot 0 \times 10^{-3}$ AT a given time, the compositio

In which direction , the reaction will proceed ?

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14. In the equilibrium,

$CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$, at 1073 K,the pressure of CO_2 is found to be $2 \cdot$

What is the equilibrium constant of this reaaction at 1073 K ?

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15. AB_2 dissociates as

$AB_2(g) \Leftrightarrow AB(g) + B(g)$. If the initial pressure is 500 mm of Hg and the total pressure at equilibrium is 700 mm of Hg. Calculate K_p for the reaction.

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16. The degree of dissociation of PCl_5 ata certain temperature and atmospheric pressure is $0 \cdot 2$. Calculate the pressure at which it will be half (50 %) dissociated at the same temperature .

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17. Determine the concentration of CO_2 which will be in equilibrium with 2.5×10^{-2} mol $L^{-1} of CO at 100^{\circ} C$ for the reaction

$FeO(s) + CO(g) \Leftrightarrow Fe(s) + CO_2, K_c = 5.0$

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18. The value of $K_c = 4.24$ at $800K$ for the reaction.

$CO(g) + H_2O(g) \Leftrightarrow CO_2(g) + H_2(g)$

Calculate equilibrium concentration of CO_2, H_2, CO and H_2O at $800K$. If only CO and H_2O are present initially at concentrations of $0.10M$ each.

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19. 3.00 mol of PCl_5 kept in 1 L closed reaction vessel was allowed to attain equilibrium at 380K. Calculate the composition of the mixture at equilibrium. $K_c = 1.80$.

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20. At $700K$, hydrogen and bromine react to form hydrogen bromine. The value of equilibrium constant for this reaction is 5×10^8. Calculate the amount of the H_2, Br_2 and HBr at equilibrium if a mixture of $0.6 mol$ of H_2 and $0.2 mol$ of Br_2 is heated to $700K$.

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21. 13.8 g of N_2O_4 was placed in 1 L reaction vessel at 400K and allowed to attain equilibrium :$N_2O_4(g) \Leftrightarrow 2NO_2(g)$.

the total pressure at equilibrium was found to be 9.15 bar. Calculate K_c, K_p and partial pressure at equilibrium .

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22. The value of $\Delta G^{\ominus}$ for the phosphorylation of glycose in glycolysis is $13.8 kJmol^{-1}$. Find the value of K_c at $298K$

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23. K_p for the reaction $N_2 + 3H_2 \Leftrightarrow 2NH_3$ at $400^{\circ} C$ is 1.64×10^{-4}. Find K_c. Also find $\Delta G^{\ominus}$ using K_p and K_c values and interpret the difference.

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24. The vapour density of PCl_5 at $43K$ is is found to be 70.2. Find the degree of dissociation of PCl_5 at this temperature.

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25. At $627^{\circ}C$ and 1 atm SO_3 is partially dissociated into SO_2 and O_2 by the reaction

$SO_3(g) \Leftrightarrow SO_2(g) + 1/2O_2(g)$

The density of the equilibrium mixture is $0.925 gL^{-1}$. What is the degree of dissociation?

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26. $20\% \, N_2O_4$ molecules are dissociated in a sample of gas at $27^{\circ}C$ and 760 torr. Calculate the density of the equilibrium mixture.

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27. Calculate the degree of dissociation and concentration of H_3O^+ ions in 0.01 M solution of formic acid $\left(K_c = 2.1 \times 10^{-4} \text{ at } 298K\right)$

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28. What will be the conjugate bases for the Bronsted acids ? HF, H_2SO_4 and HCO_3^-

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29. Write the conjugate acids for the Bronsted bases : NH_2^-, NH_3 and $HCOO^-$

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30. Write four species which act both as Bronsted acid as well as base. Write their corresponding conjugate acids and bases.

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31. Classify the following species into Lewis acid and Lewis base and show how these act as such.

a. $\overset{\ominus}{OH}$ b. $F^{\ominus}$ c. $H^{\oplus}$ d. BCI_3

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32. Classify the following species as Lewis acids and Lewis bases

$NH_3, BF_3, SnCl_4, C_5H_5N, CO, Ni^{2+}$

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33. Calculate t the H^+ ion concentration in 0.10 M acetic acid solution. Given that the dissociation constant of acetic acid in water is 1.8×10^{-5}

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34. Nicotinic acid $\left(K_a = 1.4 \times 10^{-5}\right)$ is repersented by the formula HNiC. Calculate its per cent dissociation in a solution, which contains 0.10 mole of nicotinic acid per 2.0 litre of solution.

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35. Calculate the H_3O^+ and OH^- ion concen- trations at 25° C in

(i) 0.02 N HCl solution (ii) 0.005 N NaOH solution

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36. Calculate the concentration of H_3O^+ ions in a mixture of 0.02 M acetic acid and 0.2 M sodium acetate. Given that the ionization constant (K_a) for acetic acid is 1.8×10^{-5}.

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37. 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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38. The concentration of hydrogen ion in a sample of soft drink is $3.8 \times 10^{-3} M$. What is its pH?

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39. A solution has been prepared by dissolving 0.63 g of nitric acid in 100 mL. What is its pH value ? Assume that the acid is completely dissociated.

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40. Calculate the pH of $\frac{N}{1000}$ sodium hydroxide (NaOH) solution assuming complete ionisation.

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41. 4.0 g of NaOH are dissolved per litre. Find (i) molarity of the solution (ii) OH^{-} ion concentration (iii) pH value of the solution (At. Masses : Na =

23, O=16, H=1).

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42. Calculate the pH of a 0.01 N solution of acetic acid. K_a for CH_3COOH is 1.8×10^{-5} at $25\,^\circ$C.

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43. Calculate the H^+ ion concentration in 0.1 M CH_3COOH if the degree of dissociation of the acid is 0.0132

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44. Calculate the pH of a 5.0 M H_3PO_4 solution and the equilibrium concentrations of the species $H_3PO_4, H_2PO_4^{2-}$ and PO_4^{3-}. $\Big(K_{a_1} = 7.5 \times 10^{-5} \times 10^{-3}, K_{a_2} = 6.2 \times 10^{-8}, K_{a_3} =$

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45. What would be the pH of a solution obtained by mixing 100 ml of 0.1 N HCl and 9.9 ml of 1.0 N NaOH solution ?

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46. Calculate the pH of a solution obtained by mixing equal volumes of the solutions with pH = 3 and pH = 5.

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47. Equal volumes of two solutions with pH=4 and pH = 10 are mixed. The pH of resulting solution will be

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48. Calculate the pH of the solution obtained by mixing 100 cm^3 of solution with pH = 3 with $400 cm^3$ of solution with pH = 4 .

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49. The value of k_w is 9.55×10^{-14} at a certain temperature . Calculate the pH of water at this temperature .

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50. Calculate the H_3O^+ ion concentration of a solution having pH 6.58.

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51. Calculate the mass of HCl present per litre of the solution whose pH value is 1.301.

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52. How many grams of NaOH must be dissolved in one litre of the solution to give it a pH value of 12 ?

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53. The pH of a solution obtained by dissolving 0.1 mole of an acid HA is 100 ml of the aqueous solution was found to be 3.0 . Calculate the dissociation constant of the acid.

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54. Calculate the pH of 10^{-8} M HCl solution .

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55. Calculate the pH of 10^{-10} M NaOH solution.

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56. An acid having pH = 6 is diluted 1000 times. What will be the pH of the final solution ?

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57. $1cm^3$ of 0.01 N HCl solution is added to one litre of sodium chloride solution . Calculate the pH of the resulting solution.

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58. The ionization constant of HF is 3.2×10^{-4}. Calculate the degree of dissociation of HF in its 0.02 M solution. Calculate the concentration of all the species present $\left(H_3O^+, F^- \text{ and } HF\right)$ in the solution and its pH .

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59. Calculate the pH of the solution in which $0.2MNH_4Cl$ and $0.1MNH_3$ are present. The pK_b of ammonia solution is 4.75.

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60. Calcuate the degree of ionisation and pH of 0.05 M solution of a weak base having the ionization constant $\left(K_b\right)$ is 1.77×10^{-5}. Also calculate the ionisation constnat of the conjugate acid of this base.

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61. The ionization constant of propanoic acid is 1.32×10^{-5}. Calculate the degree of ionization of the acid in its $0.05M$ solution and also its pH. What will be its degree of ionization if the solution is $0.01M$ on HCl also?

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62. Calculate the hydrolysis constant, degree of hydrolysis and pH of 0.10 M KCN solution at $15^{\circ}C$. For HCN, $K_a = 6.2 \times 10^{-10}$.

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63. What is the pH of a $0.50M$ aqueous NaCN solution ? $\left(pK_b of CN^- = 4.70\right)$

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64. Calculate the percentage of hydrolysis in 0.003 M aqueous solution of NaOCN. K_a for HOCN $= 3.33 \times 10^{-4} M$.

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65. Calculate the pH of 0.10 M solution of NH_4Cl. The dissociation constant $\left(K_b\right)$ of NH_3 is 1.6×10^{-5}.

Watch Video Solution

66. The pK_a fo acetic acid and pK_b of ammonium hydroxide are 4.76 and 4.75 respectively . Calculate the pH of ammonium acetate solution .

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67. The solubility of AgCl in water at 25° C is found to be 1.06×10^{-5} moles per litre. Calculate the solubility product of AgCl at this temperature.

Watch Video Solution

68. The solubility of Mg$(OH)_2$ is 8.352×10^{-3} g/litre at 290° C. Find out its K_{sp} at this temperature.

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69. Calculate the pH after 50.0 mL of 0.1 M ammonia solution is treated with 25.0 mL of 0.10 M HCl. The dissociation constant of ammonia, $K_b = 1.77 \times 10^{-5}$

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70. The solubility product for silver choride is 1.2×10^{-10} at 298 K. Calculate the solubility of silver chloride at 298 K.

Watch Video Solution

71. Lead chloride has a solubility product of 1.7×10^{-5} at 298 K. Calculate its solubility at this temperature.

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72. The solubility product of AgCl in water is 1.5×10^{-10} .Calculate its solubility in 0.01 M NaCl aqueous solution.

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73. Given that solubility product of $BaSO_4$ is 1×10^{-10}, will precipitate form when

a. Equal volumes of $2 \times 10^{-3} MBaC1_2$ solution and $2 \times 10^{-4} MNa_2SO_4$ solution, are mixed?

b. Equal volumes of $2 \times 10^{-8} MBaC1_2$ solution and $2 \times 10^{-3} MNa_2SO_4$ solution, are mixed?

c. $100 mL$ of $10^{-3} MBaC1_2$ and $400 mL$ of $10^{-6} MNa_2SO_4$ are mixed?

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74. Calculate pH at which $Mg(OH)_2$ begins to precipitate from a solution containing $0.10M$ Mg^{2+} ions. $\left(K_{sp} \text{ of } Mg(OH)_2 = 1 \times 10^{-11}\right)$

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75. Calculate the pH of a buffer which is 0.1 M in acetic acid and 0.15 M in sodium acetate. Given that the ionization constants of acetic acid is 1.75×10^{-5}. Also calculate the change in pH of the buffer if to 1 litre of the buffer

(i) 1 cc of 1 M NaOH are added (ii) 1 cc of 1 M HCl are added.

Assume that the change in volume is negligible.

What will be the buffer index of the above buffer ?

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76. Calculate the pH of a solution obtained by mixing 5 mL of 0.1 M NH_4 OH with 250 mL of 0.1 M NH_4 Cl solution . K_b for $NH_4OH = 1.8 \times 10^{-5}$.

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77. A buffer solution with pH 9 is to be prepared by mixing NH_4Cl and NH_4OH. Calculate the number of moles of NH_4Cl that should be added to one litre of 1.0 M $NH_4OH\left(K_b = 1.8 \times 10^{-5}\right)$

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78. $pH = 7.40, K_1 \text{of} H_2CO_3 = 4.5 \times 10^{-7}$. What will be the ratio of $\left[HCO_3^-\right]$ to $\left[H_2CO_3\right]$?

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79. Calculate the pH in a solution that is $0.1M$ in acetic acid and $0.1M$ in benozic acid. $K_a f \text{ or } CH_3COOH$ and $C_6H_5COOHare1.8 \times 10^{-5}$ and 6.5×10^{-5} respectively.

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80. Calculate the pH of a solution that contains 1.00 M HF $\left(K_a = 7.2 \times 10^{-4}\right)$ and 5.00 M HClO $\left(K_a = 3.5 \times 10^{-8}\right)$.

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Example

1. Calculate the simultaneous solubilities of $AgSCN$ and $AgBr$.

$K_{sp}(AgSCN) = 1.0 \times 10^{-12}$, $K_{sp}(AgBr) = 5.0 \times 10^{-13}$

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Curiosity Question

1. Why solution of sugar in water does not conduct electricity whereas that of common salt in water does ?

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2. Neutral solutions have pH = 7 at 298 K. A sample of pure water is found to have pH $<$ 7. Does it mean that it is acidic ? Explain.

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3. A student prepared solutions of NaCl, Na_2CO_3 and NH_4Cl. He put them separately in three test tubes. He forgot to label them. All solutions were colourless . How should he proceed to know the solutions present in the three test tubes ?

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4. Why pH of our blood remains almost constant of 7.4 though we quite often eat spicy food ?

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Problems For Practice

1. K_p for the reaction :

$N_2O_4(g) \Leftrightarrow 2NO_2(g)$ is 0.157 atm at $27^\circ C$ and 1 atm pressure . Calculate K_c for the reaction.

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2. For the reaction $A(g) + B(s) \Leftrightarrow C(g) + D(g), K_c = 49 moldm^{-3}$ at $127\,^\circ C$. Calculate K_p.

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3. At equilibrium, the concentrations of $N_2 = 3 \cdot 0 \times 10^{-3} M, O_2 = 4 \cdot 2 \times 10^{-3} M$ and $No = 2 \cdot 8 \times 10^{-3} M$ in a sealed vessel at 800 K. What will be K_c for the raction

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$?

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4. PCl_5, PCl_3 and Cl_2 are at equilibrium at $500K$ and having concentration $1.59 MPCl_3$, $1.59 MCl_2$ and $1.41 MPCl_5$. Calculate K_c for the reaction,

$PCl_5 \Leftrightarrow PCl_3 + Cl_2$

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5. Calculate the equilibrium constants K_p and K_c for the reaction ,

$CO(g) + 1/2O_2(g) \Leftrightarrow CO_2$

Given that the partial pressures at equilibrium in a vessel at 3000 K are

$p_{co} = 0.4 \text{ atm } . p_{co_2} = 0.6 \text{ atm }$ and $p_{o_2} = 0.2 \text{ atm}$

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6. $1.5 mol$ of PCl_5 are heated at constant temperature in a closed vessel of $4L$ capacity. At the equilibrium point, PCl_5 is 35% dissociated into PCl_3 and Cl_2. Calculate the equilibrium constant.

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7. The equilibrium composition for the reaction is

PCl_3	$+$	Cl_2	$\Leftrightarrow$	PCl_5
0.20		0.10		$0.40 molL^{-1}$

What will be the equilibrium concentration of PCl_5 on adding $0.10 mol$ of Cl_2 at the same temperature?

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8. If 1 mole of acetic acid and 1 mole of ethyl alchol are mixed and reaction proceeds to equilibrium , the concentrations of acetic acid and water are found to be $1/3 \text{ and } 2/3$ mole respectively . If 1 mole of ethyl acetate and 3 moles of water are mixed , how much ester is present when equilibrium is reached ?

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9. Calculate the degree of dissociation of HI at $450^\circ C$ if the equilibrium constant for the dissociation reaction is 0.263.

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10. One mole of pure ammonia was injected into a one litre flask at a certain temperature. The equilibrium mixture was then analysed and found to contain 0.30 mole of H_2 . Calculate (i) the concentration of of N_2 and (ii) the concentration of NH_3 at equilibrium.

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11. Amount of PCl_5 (in moles) need to be added to one litre vessel at $250\ ^\circ C$ in order to obtain a concentration of 0.1mole of Cl_2 for the given change is:

$PCl_5 \Leftrightarrow PCl_3 + Cl_2\ , K_c = 0.0414mollitre^{-1}$

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12. In an experiment , 2 moles of HI are taken into an evacuated 10.0 litre container at 720 K. The equilibrium constant equals to 0.0156for the gaseous reaction, $2HI(g) \Leftrightarrow H_2(g) + I_2(g)$. find equilibrium concentration of $HI(g), H_2(g), I_2(g)$.

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13. When PCl_5 is heated in a closed vessel at 575 K, the total pressure at equilibrium is found to be 1 atm and partial pressure of Cl_2 is found to the 0.324 atm . Calculate the equilibrium constant $\left(K_p\right)$ for the decomposition reaction.

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14. In the dissociation of HI, 20% of HI is dissociated at equilibrium. Calculate K_p for

$HI(g) \Leftrightarrow 1/2H_2(g) + 1/2I_2(g)$

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15. A reaction mixture containing N_2 at $0 \cdot 50$ atm, at $0 \cdot 05$ atmNH_3 and $3 \cdot 0$ atm of hydrogen is heated to 450°

In which direction the reaction

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$ will go if K_p is$4 \cdot 28 \times 10^{-5}$?

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16. The equilibrium constant for the reaction :

$CH_3COOH + C_2H_5OH \Leftrightarrow CH_3COOC_2H_5 + H_2O$

is 4.0 at $25\ ^\circ C$. Calculate the weight of ethyl acetate that will be obtained when 120 g of acetic acid are reacted with 92 g of ethyl alcohol.

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17. At $448\ ^\circ C$, the equilibrium constant $\left(K_c\right)$ for the reaction

$H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

is 50.5. Presict the direction in which the reaction will proceed to reach equilibrium at $448\ ^\circ C$, if we start with 2.0×10^{-2} mol of HI, 1.0×10^{-2} mol of H_2 and 3.0×10^{-2} mol of I_2 in a $2.0L$ constainer.

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18. For the reaction , $2NO(g) + Cl_2(g) \Leftrightarrow 2NOCl(g)$ and the following info is given:

p_{NOCl}= $0.32atm$

p_{NO}= $0.22atm$

p_{Cl_2}= $0.11atm$

then find K_p

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19. The K_p values for the reaction, $H_2 + I_2 \Leftrightarrow 2HI$, at $460^\circ C$ is 49. If the initial pressure of H_2 and I_2 is $0.5atm$ respectively, determine the partial pressure of each gas at equilibrium.

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20. Calculate the degree of ionisation and $\left[H_3O^+\right]$ of 0.01 M acetic acid solution . K_a for acetic at 298 K is 1.8×10^{-5}

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21. A 0.01 M solution of acetic acid is 1.34 % ionised (degree of dissociation = 0.0134) at 298 K. What is the ionization constant of acetic acid ?

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22. What will be the percentage of dissociation in 1.0 M CH_3COOH at equilibrium having dissociation constant of 1.8×10^{-5}?

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23. Nicotinic acid $\left(K_a = 1.4 \times 10^{-5}\right)$ is repersented by the formula HNiC. Calculate its per cent dissociation in a solution, which contains 0.10 mole of nicotinic acid per 2.0 litre of solution.

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24. Calculate the concentration of H^+ (aq) in 0.2 M solution of HCN. Given that the dissociation constant of HCN in water is 4.9×10^{-10}.

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25. If hydrogen ion concentration in a solution is 1×10^{-5} moles/litre, calculate the concentration of OH ion in this solution $\left(K_w = 10^{-14}\text{moles}^2 L^{-2}\right)$.

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26. Calculate the pH value of 0.001 N HNO_3 solution.

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27. Calculate the pH value of 10^{-3} M HCl solution.

Watch Video Solution

28. What is the pH of a solution whose H^{+} ion concentration is $2 \times 10^{-5}g$ ions/litre ?

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29. 0.049 g of H_2SO_4 is dissolved per litre of the given solution . Calculate the pH of the solution.

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30. Calculate the pH of a solution which is 1×10^{-3} M with respect to sulphuric acid.

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31. The concentration of hydronium ions in a cup of black coffee is 1.3×10^{-5} M. Find the pH of the coffee. Is this coffee acidic or alkaline ?

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32. Calculate the pH value of (a) 0.0001 M NaOH (b) 0.01 M NaOH and (c) 0.04 M NaOH solution at 25° C.

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33. Calculate the pH of a solution containing 2 g caustic soda/litre of water.

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34. How many grams of sodium hydroxide must be dissolved in one litre of water to prepare its N/10 solution ? What will be its pH value ?

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35. Acetic acid has a dissociation constant of 1.8×10^{-5}. Calculate the pH value of the decinormal solution of acetic acid.

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36. A 0.05 N solution of acetic acid is found to be 1.9% ionized at $25^{\circ}C$. Calculate (i) K_a for acetic acid and (ii) the pH of the solution.

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37. Calculate the pH value of a solution of 0.1 M $NH_3\left(K_b = 1.8 \times 10^{-5}\right)$

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38. A sample of sour milk was found to be 0.1 M solution of lactic acid $CH_3CH(OH)COOH$. What is the pH of the sample of milk ? K_a for lactic acid at $25\,^{\circ}C$ is 1.37×10^{-4}.

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39. Calculate the pH of 0.15 M solution of hypochlorous acid HClO $\left(K_a = 9.6 \times 10^{-6}\right)$.

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40. Calculate the pH and concentration of all

species present at equilibrium in 0.1 M H_3PO_4 solution.

$K_{a_1} = 7.5 \times 10^{-3}, K_{a_2} = 6.2 \times 10^{-8}, K_{a_3} = 4.2 \times 10^{-13}$

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41. Calculate the pH of a solution obtained by mixing 50ml of$0.2M$ HCl with 49.9 mL of 0.2m NaOH solution.

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42. The pH of a solution obtained by mixing equal volumes of $\frac{N}{10}NaOH$ and $\frac{N}{20}HCl$

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43. Calculate the pH value of a mixture containing 50 ml of 1 N HCl and 30 ml of 1 N NaOH solution, assuming both to be completely dissociated.

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44. A $50ml$ solution of $pH = 1$ is mixed with a $50ml$ solution of $pH = 2$. The pH of the mixture will be nearly

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45. What will be the resultant pH when 200 mL of an aqueous solution of HCl (pH =2.0) is mixed with 300 mL of an aqueous solution of NaOH (pH =12.0) ?

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46. The value of K_w at a certain temperature is 6.25×10^{-14}. Calculate the pH of water.

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47. Calculate the H_3O^+ ion concentration of a solution having a pH of 10.6

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48. The pH of blood serum is 7.4 . What is the hydrogen ion concentration of blood serum ?

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49. Urine has a pH of 6.0 . If a patient eliminates 1300 ml of urine per day, how many gram equivalents of the acid he eliminates per day ?

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50. Lemon juice has a pH = 2.1 . If all the acid in lemon is citric acid $\left(HCit. \Leftrightarrow H^+ + \mathrm{Cit}^{-1}\right)$ and K_a for citric acid is 8.4×10^{-4} mole/litre, what is the concentration of citric acid in lemon juice ?

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51. The pH of 0.1 M solution of an organic acid is 3.0. Calculate the dissociation constant of the acid.

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52. It has been found that the pH of a $0.01M$ solution of an organic acid is 4.15. Calculate the concentration of the anion, the ionization constant of the acid and its pK_a.

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53. The pH of $0.005M$ codenine $\left(C_{18}H_{21}NO_3\right)$ solution is 9.95. Calculate its ionisation constant and pK_b.

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54. 10^{-6} M NaOH solution is diluted 100 times. Calculate the pH of the diluted base.

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55. What will be the pH of the resulting solution if to a 100 ml of HCl solution of pH = 1.0, 900 ml of distilled water is added ?

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56. The pH of a solution is 5. Its hydrogen ion concentration is increased 100 times. What is the pH of the resulting solution ?

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57. Calculate the pH of a solution obtained by diluting 25 ml of N/100 HCl to 500 ml.

Watch Video Solution

58. 1 ml of 13.6 M HCl is diluted with water to give 1 litre of the solution. Calculate pH of the resulting solution.

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59. The pH of $0.1M$ monobasic acid is 4.50. Calculate the concentration of species, $H^{\oplus}, A^{\Theta}$, and HA at equilibrium. Also determine the value of K_a and pK_a of the monobasic acid.

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60. Calculate the pH of 0.08 solution of $HOCI$ (hydrochlorous acid). The ionisation constant of the acid is 2.5×10^{-5}. Determine the percent dissociation of $HOCI$.

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61. The pH of 0.04 M hydrazine solution is 9.7 . Calculate its ionization constant K_b and pK_b.

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62. What would be the pH of 0.1 molar sodium acetate solution, given that the dissociation constant of acetic acid is 1.8×10^{-5}.

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63. The dissociation constant of aniline $\left(C_6H_5NH_2\right)$ as a base is 5.93×10^{-10}. The ionic product of water at $25^\circ C$ is 1.02×10^{-14}. Calculate the percentage hydrolysis of aniline hydrochloride in 1.0 N solution at $25^\circ C$.Also calculate the pH of the solution.

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64. At $25^\circ C$, the ionisation constant of anilinium hydroxide is 4.6×10^{-10}. Taking ionic product of water as 1×10^{-14}, calculate (a) hydrolysis constant of anilinium chloride (b) the degree of hydrolysis and pH value of 0.2 molar solution of the salt.

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65. Calculate the pH of $0.05M$ sodium acetate solution, if the pK_a of acetic acid is 4.74.

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66. The pK_a of CH_3COOH and pK_a of nH_4OH is 4.76 and 4.75, respectively. Calculate the hydrolysis constant of ammonium acetate $\left(CH_3COONH_4\right)$ at $298K$ and also the drgree of hydrolysis and pH of its (a) $0.01M$ and (b) $0.04M$ solutions.

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67. Calculate the pH of 0.01 M solution of NH_4CN. The dissociation constants K_a for $HCN = 6.2 \times 10^{-10}$ and K_b for $NH_3 = 1.6 \times 10^{-5}$.

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68. Calculate the pH of an aqueous solution of $1.0M$ ammonium formate assuming complete dissociation. $\left(pK_a\right.$ of formic acid $= 3.8$ and pK_b of ammonia $= 4.8)$

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69. Calculate the hydrolysis constant of the salt containing NO_2^-. Given the K_a for $HNO_2 = 4.5 \times 10^{-10}$

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70. Calculate the solubility product of silver bromide if the solubility of the salt in saturated solution is 5.7×10^{-7} moles/litre.

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71. A saturated solution of sparingly soluble lead chloride on analysis was found to contain 11.84 g/ litre of the salt at room temperature. Calculate the solubility product constant at room temperature. (At. wt . : Pb = 207, Cl = 35.5)

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72. The solubility of lead iodide in water is 0.63 g/litre. Calculate the solubility product of lead iodide. (At mass of Pb = 207 , I = 127)

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73. Calculate the solubility of silver chloride in water at room temperature if the solubility product of AgCl is 1.6×10^{-10}.

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74. If solubility product for CaF_2 is 1.7×10^{-10} at 298 K, calculate the solubility in mol L^{-1}.

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75. How many moles of $AgBr\left(K_{sp} = 5 \times 10^{-13}\right)$ will dissolve in a 0.01 M NaBr solution ? (NaBr is completely ionised in solution)

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76. Calcualte the solubility of M_2X_3 in pure water, assuming that neither kind of ion reacts with H_2O. The solubility product of M_2X_3, $K_{sp} = 1.1 \times 10^{-23}$.

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77. The values of K_{sp} of two sparingly solubles salts, $Ni(OH)_2$ and $AgCN$ are 2.0×10^{-15} and 6×10^{-7} respectively, which salt is more soluble? Explain

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78. Find out the solubility of $Ni(OH)_2$ in $0.1M$ NaOH Given that the ionic product of $Ni(OH)_2$ is 2×10^{-15}.

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79. Given that the solubility product of radium sulphate $\left(RaSO_4\right)$ is 4×10^{-11}. Calculate the solubility in (a) pure water (b) 0.10 M Na_2SO_4.

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80. Predict whether a precipitate will be formed or not on mixing 20 mL of 0.001 M NaCl with 80 mL of 0.01 M $AgNO_3$ solution $\left(K_{sp} \text{ for } AgCI = 1.5 \times 10^{-10}\right)$

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81. If 20 ml of $2 \times 10^{-5} BaCl_2$ solution is mixed with 20 ml of $1 \times 10^{-5} MNa_2SO_4$ solution, will a ppt. form ? $\left(K_{sp} \text{for} BaSO_4 \text{ is} 1.0 \times 10^{-10}\right)$

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82. 0.03 mole of Ca^{2+} ions is added to a litre of 0.01 M SO_4^{2-} solution. Will it cause precipitation of $CaSO_4$? $K_{sp}\text{for}CaSO_4 = 2.4 \times 10^{-5}$.

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83. $PbCl_2$ has a solubility product of 1.7×10^{-8}. Will a precipitate of $PbCi_2$ form when 0.010 mole of lead nitrate and 0.010 mole of potassium chloride are mixed and water added upto 1 litre ?

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84. How much volume of 0.1 M Hac should be added to 50 mL of 0.2 M NaAc solution if we want to prepare a buffer solution of pH 4.91. Given pK_a for acetic acid is 4.76.

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85. How much of $0.3M$ ammonium hydroxide should be mixed with 30 mL of $0.2M$ solution of ammonium chloride to give buffer solutions of $pH8.65$ and 10 ? (Give: $pK_b of NH_4OH = 4.75$)

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86. The ionization constant of fromic acid is 1.8×10^{-4}. Calculate the ratio of sodium formate and formic acid in a buffer of pH 4.25 .

Watch Video Solution

Advanced Problems (For Competitions)

1. Given: $Ag\left(NH_3\right)_2^+ \Leftrightarrow Ag^+ 2NH_3, K_C = 6.2 \times 10^{-8}$ and K_{SP} of $AgCI = 1.8 \times 10^{-10}$ at 298 K. Calculate the concentration of the complex in $1.0M$ aqueous ammonia.

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2. Calcium lactate is a salt of weak acid and represented as $Ca(LaC)_2$. A saturated solution of $Ca(LaC)_2$ contains 0.13 mole of salt in 0.50 litre solution. The pOH of this is 5.60. Assuming complete dissociation os salt, calculate K_a of lactic acid.

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3. An aqueous solution of a metal bromide $MBr_2(0.05M)$ is saturated with H_2S. What is the minimum pH at which MS will precipitate ? K_{SP} for $MS = 6.0 \times 10^{-21}$. Concentration of saturqated $H_2S = 0.1M, K_1 = 10^{-7}$ and $K_2 = 1.3 \times 10^{-13}$ for H_2S .

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4. 0.15 mole of pyridinium chloride has been added into $500cm^3$ of $0.2M$ pyridine solution. Calculate pH and hydroxyl ion contration in the resulting solution, assuming no change in volume. $\left(K_b \text{for pyridine} = 1.5 \times 10^{-9} M\right)$

Watch Video Solution

5. A sample of hard water contains $96 ppm.$ ofSO_4^{2-} and $183 ppm$ ofHCO_3^-, with Ca^{2+} as the only cation. How many moles of CaO will be required to remove HCO_3^- from $1000 kg$ of this water? If $1000 kg$ of this water is treated with the amount of CaO calculated above, what will be the concentration (in ppm)of residual Ca^{2+} ions (Assume $CaCO_3$ to be completely insoluble in water)? If the Ca^{2+} ions in one litre of the treated water are completely exchange with hydrogen ions, what will be its pH (One ppm means one part of the substance in one million part of water, weight/weight)?

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6. The ionisation constant of NH_4^+ in water is 5.6×10^{-10} at $25^\circ C$. The rate constant for the rection of NH_4^+ and OH^- to form NH_3 and H_2O at $25^\circ C 3.4 \times 10^{10}$ $\text{L mol}^{-1} s^{-1}$. Calculate the rate constant for proton from water to NH_3.

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7. An aqueous solution of aniline of concentration 0.24 M is prepared. What concentraton of sodium hydroxide is needed in this solution so that anilinium ion concentration remains at 1×10^{-8} M? $\left(K_a \text{for} C_6H_5NH_3^+ = 2.4 \times 10^{-6} M\right)$

View Text Solution

8. Determine the number of mole of AgI which may be dissolved in 1.0 litre of $1 MCN^-$ solution. K_{SP} for AgI and K_C for $Ag(CN)_2^-$ are $1.2 \times 10^{-17} M^2$ and $7.1 \times 10^{19} M^{-2}$ respectively.

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9. Determine the concentration of NH_3 solution whose one litre can dissolve 0.10 mole AgCl. K_{SP} of AgCl and K_f of $Ag\left(NH_3\right)_2^+$ are $1.0 \times 10^{-10}M^2$ and $1.6 \times 10^7 M^{-2}$ respectively.

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10. The average concentration of SO_2 in the atmosphere over a city on a cetrain day is 10 ppm, when the average temperature is 298 K. Given that the solubility of SO_2 in water at 298 K is 1.3653 mol $litre^{-1}$ and the pK_a of H_2SO_3 is 1.92, estimate the pH of rain on that day.

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11. What $\left(H_3O^+\right)$ must be maintained in a saturated H_2S solution to precipitate Pb^{2+} , but not Zn^{2+} from a solution in which each ion is present at a concetration of $0.01M$? $\left(K_{SP}\text{for } H_2S = 1.1 \times 10^{-22}, K_{SP}\text{for } ZnS = 1.0 \times 10^{-21}\right)$

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12. 500 mL of 0.2 M aqueous solution of acetic acid is mixed with 500 mL of 0.2 M HCl at $25^\circ C$.

(i) Calculate the degree of dissociation of acetic acid in the resulting solution and pH of the solution.

(ii) If 6 g of NaOH is added to the above solution, determine the final pH [Assume there is no change in volume on mixing : K_a of acetic acid is 1.75×10^{-5} mol L^{-1}]

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13. An aqueous solution contains 10% amonia by mass and has a density of $0.99 gcm^{-3}$. Calculate hydroxy1 and hydrogen ion concentration in this solution K_a for $NH_4^{\oplus} = 5.0 \times 10^{-10} M$.

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14. The pH of blood stream is maintained by a proper balance of H_2CO_3 and $NaHCO_3$ concentrations. What volume of 5 M $NaHCO_3$ solution, shnould be mixed with 10 mL sample of blood, which is 2 M in H_2CO_3 in order to maintain a pH of $7.4\left(K_af \text{ or } H_2CO_3$in blood $=7.8 \times 10^{-7}\right)$

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15. A sample of hard water contains 100 ppm of $CaSO_4$. What minimum fraction of water should be evaporated off so that solid $CaSO_4$ begins to separate out ? K_{sp} for $CaSO_4$ is 9.0×10^{-6}.

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16. Calculate the solubility of AgCN in a buffer solution of pH $3 \cdot 00$. K_{sp} for AgCN is 2.2×10^{-16} and K_a for HCN is 6.2×10^{-12}.

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17. $0.16g$ of N_2H_4 are dissolved in water and the total volume made upto 500 mL. Calculate the percentage of N_2H_4 that has reacted with water in this solution. $\left(K_bf \text{ or } N_2H_4 = 4.0 \times 10^{-6} < \right)$

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18. The K_{sp} of $Ca(OH)_2$ is 4.42×10^{-5} at $25\,^\circ C$. A 500 ml of saturated solution of $Ca(OH)_2$ is mixed with an equal volume of $0.4MNaOH$. How much $Ca(OH)_2$ in mg is precipitated ?

Watch Video Solution

19. Calculate the pH of

(i) 1 M H_2SO_4 $(ii)2MH_2SO_4$ $(iii)10^{-2}MH_2SO_4$ solutions.

Given that the second ionization constant $\left(K_{a_2}\right)$ of H_2SO_4 if 10^{-2}.

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Test Your Grip (I. Multiple choice Questions)

1. What is the conjugate base of OH^{-}?

A. O_2

B. H_2O

C. O^{-}

D. O^{2-}

Answer: D

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2. C_2H_5ONa acts as .... In C_2H_5OH.

A. strong acid

B. weak acid

C. strong base

D. weak base

Answer: A::B::C::D

Watch Video Solution

3. Which of the following molecules acts as a Lewis acid?

A. $(CH_3)_2O$

B. $(CH_3)_3P$

C. $(CH_3)_3N$

D. $(CH_3)_3B$

Answer: B::C::D

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4. Which of the following can act both as a Bronsted acid as well as a Bronsted base ?

A. H_3PO_4

B. $AlCl_3$

C. CH_3COO^-

D. H_2O

Answer: D

Watch Video Solution

5. The K_a value of formic acid and acetic acid are respectively 1.77×10^{-4} and 1.75×10^{-5}. The ratio of the acid strength of 0.1 N acids is

A. 10

B. 3.178

C. 0.3

D. 0.1

Answer: A::B

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6. The correct order of acidity for the following is

A. $HCN > ClCH_2COOH > HCOOH > CH_3COOH$

B. $HCN > HCOON > ClCH_2COON > CH_3COOH$

C. $ClCH_2COOH > HCOOH > CH_3CH_3COOH > HCN$

D. $ClCH_2COOH > HCN > HCOOH > CH_3COOH$

Answer: C

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7. When rain is accompanied by a thunderstorm, the collected rain water will have a pH value

A. slightly higer than that when the thunder storm is not there

B. uninfluenced by the thunder storm

C. which depends on the amount of dust in air

D. slightly lower than that of rain water without thunder storm

Answer: A::C::D

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8. An acid HA ionizes as $HA \Leftrightarrow H^{+} + A^{-}$ The pH of $1.0M$ solution is 5. Its dissociation constant would be

A. 1×10^{-10}

B. 5

C. 5×10^{-8}

D. 1×10^{-5}

Answer: A

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9. What is the percentage hydrolysis of NaCN is $N/80$ soluiton, when the dissociation constant for HCN is 1.3×10^{-9} and $K_w = 1.0 \times 10^{-14}$

A. 2.48

B. 5.26

C. 8.2

D. 9.6

Answer: A::C

Watch Video Solution

10. If pK_a of acetic acid and pK_b of ammonium hydroxide are 4.76 each. Find the pH of ammonium acetate.

A. 7

B. less than 7

C. more than 7

D. zero

Answer: A::B::C::D

Watch Video Solution

11. The ionization constant of ammonium hydroxide is 1.77×10^{-5} at $298K$. Hydrolysis constant of ammonium chloride is

A. 6.50×10^{-12}

B. 5.65×10^{-13}

C. 5.65×10^{-12}

D. 5.65×10^{-10}

Answer: B::D

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12. The aqueous solution of which of the salts has pH close to 7 ?

A. $FeCl_3$

B. CH_3COONa

C. CH_3COONH_4

D. KCN

Answer: C

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13. In the titration of a weak acid aginst a strong base, at the half-equivalence point (half. Neutralisation)

A. $pH = \frac{1}{2}pK_a$

B. $pH = pK_a$

C. $pH = 2pK_a$

D. None of these

Answer: B

View Text Solution

14. Volume of 0.1 M NaOH needed for the neutralisation of 20 mL of 0.05 M oxalic acid is

A. 10 mL

B. 15 mL

C. 20 mL

D. 30 mL

Answer: A::B::C

Watch Video Solution

15. What is the correct representation for the solubility product of SnS_2 ?

A. $\left[Sn^{2+}\right]\left[S^{2-}\right]^2$

B. $\left[Sn^{4+}\right]\left[S^{2-}\right]^2$

C. $\left[Sn^{2+}\right]\left[2S^{2-}\right]^2$

D. $\left[Sn^{2+}\right]\left[2S^{2-}\right]^2$

Answer: B

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16. The K_{sp} of $PbCrO_4$ is 1.0×10^{-16}. Then the molar solubility of $PbCrO_4$ is

A. 1.0×10^{-6}

B. 1.0×10^{-4}

C. 1.0×10^{-16}

D. 1.0×10^{-8}

Answer: B::C::D

Watch Video Solution

17. In a mixture of weak acid and its salt, the ratio of concentration of acid to salt is increased ten-fold. The pH of the solution

A. decreases by one

B. decreases by one tenth

C. increases by one

D. increases ten-fold.

Answer: A::C::D

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18. The principal buffer present in human blood is

A. $NaH_2PO_4 + Na_2HPO_4$

B. $H_3PO_4 + NaH_2PO_4$

C. $Na_2HPO_4 + Na_3PO_4$

D. $H_2CO_3 + HCO_3^-$

Answer: D

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19. Which of the following will occur if a 0.1 M solution of a weak acid is diluted to 0.01 M at constant temperature

A. $\left[H^+\right]$ will decrease to 0.01 M

B. pH will decrease

C. percentage ionization will increase

D. K_a will increase.

Answer: C

Watch Video Solution

Test Your Grip (II. Fill in the blanks)

1. A bulb containing N_2O_4 is colourless in ice. Its colour inboiling water is .... while in water at 298 K, it is ....

Watch Video Solution

2. Equimolar amounts of H_2 and I_2 were taken in a bulb maintained at $500^\circ C$. Dark violet colour faded to light violet which does not change further. This shows that the bulb contains .... amounts of ....

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3. According to law of mass action rate of a chemical reaction is proportional to

Watch Video Solution

4. In terms of rate constants for forward and backward reactions $\left(k_f \text{ and } k_b\right)$, equilibrium constant of a reaction is equal to ....

Watch Video Solution

5. Equilibrium constant of a reaction does not change with .... but changes with ....

Watch Video Solution

6. Ratio K_p/K_c of the reaction $2SO_2 + O_2 \Leftrightarrow 2SO_3$ is equal to ....

Watch Video Solution

7. Equilibrium constant for the reaction , $N_2 + 3H_2 \Leftrightarrow 2NH_3$ is K, then equilibrium constant for the reaction, $NH_3 \Leftrightarrow \frac{1}{2}N_2 + \frac{3}{2}H_2$ will be ....

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8. Adding a catalyst to a reaction at equilibrium

Watch Video Solution

9. The equilibrium constant of an endothermic reaction .... with increase of temperature.

Watch Video Solution

10. Write the expression for equilibrium constant K_p for the reaction,

$3Fe(s) + 4H_2O(g) \Leftrightarrow Fe_3O_4(s) + 4H_2(g)$.

Watch Video Solution

11. If the concentration quotient of a reaction in greater than its equilibrium constant, then the reaction will proceed in the _____ direction.

Watch Video Solution

12. N_2 gas id added to the reaction equilibrium $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$ at constant temperature . If pressure is kept constant, equilibrium constant will ...... and equilibrium will shift in the .... direction.

Watch Video Solution

13. Solution of $FeCl_3$ (yellow) and NH_4SCN (colourless) were mixed in a beaker. Red colour was obtained . On adding $HgCl_2$ to the solution, the intensity of colour will ....

Watch Video Solution

14. Exothermic reactions are favoured by ___ in temperature

Watch Video Solution

15. Low pressure is favourable for those reversible reactions in which there is .... in the number of molecules.

Watch Video Solution

16. When the pressure is applied over system ice $\Leftrightarrow$ wate what will happen

Watch Video Solution

17. The degree of dissociation of a weak electrolyte is ....one whereas that of a strong electrolyte is ....one.

Watch Video Solution

18. If c is the molar concentration of the solution of a weak electrolyte, then its degree of dissociation is proportional to ....

Watch Video Solution

19. H^{+} ions in aqueous solutions exist as ....ions.

Watch Video Solution

20. A substance which can act both as an acid and a base is called ....

Watch Video Solution

21. The conjugate acid of OH^{-} ions is ___ and conjugate base is ___

Watch Video Solution

22. In the reaction between BF_3 and NH_3, BF_3 acts as ....whereas NH_3 acts as ....

Watch Video Solution

Watch Video Solution

23. If K_{a_1} and K_{a_2} are the dissociation constants of two acids HA_1 and HA_2, then the ratio of strengths of their solutions with equimolar concentration is ....

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24. If K_1 is ionization constant of $H_2S(aq) \Leftrightarrow 2H^+(aq) + S^{2-}(aq)$ and K_2 is that for $H_2S(aq) \Leftrightarrow H^+(aq) + HS^-(aq)$, then ionization constant of $HS^-(aq) \Leftrightarrow H^+(aq) + S^{2-}(aq)$ will be equal to ....

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25. Will ionic product of water increase or decrease if temperature is increased ?

Watch Video Solution

26. If K_a and K_b are the dissociation constants of weak acid and its conjugate base , $pK_a + pK_b$

Watch Video Solution

27. The pH of 10^{-8} M acid solution lies between ....and ....

Watch Video Solution

28. The pH of 10^{-10} M NaOH solution lies between........and ....

Watch Video Solution

29. The relation between pH, pK_a and concentration c of the solution of a weak acid is ....

Watch Video Solution

30. pH of a solution of $CuSO_4$ is.......... Than 7 and that of solution of Na_2CO_3 is ....than 7 .

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31. pH, ionization constant K_a and concentration c of the solution of the salt of a weak acid and strong base (like CH_3COOna) are related as ....

Watch Video Solution

32. The expression for the solubility product of $Ca_3(PO_4)_2$ will be K_{sp} = ...

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33. The solubility of AgCl in water is ....than that in NaCl solution.

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34. Mixing of solutions of $BaCl_2$ and Na_2SO_4 results in the formation of a precipitate of $BaSO_4$ only if.......greater than......... .

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35. An acidic buffer mixture consists of ....and........ .

Watch Video Solution

36. The number of moles of an acid or base added to one litre of the buffer solution so as to change its pH by one unit is called............of the buffer.

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Conceptual Questions (I. Storng and weak electrolytes, ionic equilibrium and Ostwalds dilution law)

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

Watch Video Solution

Conceptual Questions (II. Various concepts of Acids and Bases, their dissociation constants and strength)

1. What si the correct order of decreasing stability of the following carbocations.

$CH_3 - \overset{\oplus}{C}H - CH_3 I. \quad CH_3 - \overset{\oplus}{C}H - OCH_3 II.$

$CH_3 - \overset{\oplus}{C}H - CH_2 - OCH_3 III.$

Watch Video Solution

2. Write down the conjugate acid and conjugate base of

$(i)H_2O \quad (ii)HSO_4^- \quad (iii)NH_3 \quad (iv)HS^-$

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Watch Video Solution

3. Arrange the following in order of their

Increasing basicity: $H_2O, OH^-, CH_3OH, CH_3O^-$

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4. Ionization constants K_a for formic acid and acetic acid are 17.7×10^{-5} and 1.77×10^{-5}. Which acid is stronger and how many times the other if equimolar concentrations of the two are taken ?

Watch Video Solution

Conceptual Questions (III. Ionic product of water and pH)

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

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

Watch Video Solution

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

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4. What pH do you expect for 10^{-8} M solution of an acid ?

Watch Video Solution

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

Watch Video Solution

Conceptual Questions (IV. Salt hydrolysis)

1. For an aqueous solution of NH_4Cl, prove that $\left[H_3O^+\right] = \sqrt{K_hC}$.

Watch Video Solution

Conceptual Questions (V. Acid-base titrations)

1. The pH of an enzyme catalysed reaction has to be maintained between 7 and 8. What indicator should be used to monitor and a control the pH ?

Watch Video Solution

2. The pK_{ind} of an indicator is 10.5 For which pH transition range is the indicator most suitable.

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3. Benzoic acid is a monobasic acid. When 1.22 g of its pure sample are dissolved in water and titrated against base, 50 ml of 0.2 M NaOH are used up. Calculate the molar mass of benzoic acid.

Watch Video Solution

Conceptual Questions (VI. Solubility product, common ion effect and their applications)

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

Watch Video Solution

2. When is a precipitate formed when solutions of $BaCl_2$ and Na_2SO_4 are mixed ?

Watch Video Solution

3. Why solid NaCl starts separating out from a saturated solution of NaCl if HCl gas is passed through it ?

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4. Through a solution containing Cu^{2+} and Ni^{2+}, H_2S gas is passed after adding dil HCl, which will precipitate out and why ?

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

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Conceptual Questions (VII. Buffer solutions)

1. The ionization constant of formic acid is 1.8×10^{-4}. Around what pH will its mixture with sodium formate give buffer solution of highest capacity ?

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2. Blood is a buffer of H_2CO_3 and $\left[HCO_3^-\right]$ with pH = 7.40. Given K_1 of $H_2CO_3 = 4.5 \times 10^{-7}$. What will be the ratio of $\left[HCO_3^-\right]$ to $\left[H_2CO_3\right]$ in the blood ?

Watch Video Solution

NCERT (Questions and Exercises with Answers)

1. What is meant by the conjugate acid-base pair? Find the conjugate acid /base for the following species:

$HNO_2, CN^{\Theta}, HClO_4, F^{\Theta}, \overset{\Theta}{O}H, CO_3^{2-}$, and S^{2-}

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

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3. What will be the conjugate bases for the Bronsted acids ? HF, H_2SO_4 and HCO_3^-

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4. Write the conjugate acids for the Bronsted bases : NH_2^-, NH_3 and $HCOO^-$

Watch Video Solution

5. The species: $H_2O, HCO_3^{\ominus}, HSO_4^{\ominus}$ and NH_3 can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

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6. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base:

a. $\overset{\Theta}{O}H, b. F^{\Theta}, c. H^{\oplus}, d. BCl_3$

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7. The concentration of hydrogen ion in a sample of soft drink is $3.8 \times 10^{-3}M$. What is its pH?

Watch Video Solution

8. The pH of a sample of vinegar is 3.76, Calculate the concentration of hydrogen ion in it.

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9. The ionization constant of $HF, HCOOH$ and HCN at $298K$ are $6.8 \times 10^{-4}, 1.8 \times 10^{-4}$ and 4.8×10^{-9} respectively. Calculate the ionization constant of the corresponding conjugate base.

Watch Video Solution

10. The ionization constant of phenol is 1.0×10^{-10}. What is the concentration of phenolate ion in $0.05M$ solution of phenol? What will be its degree of ionization if the solution is also $0.01M$ in sodium phenolate?

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11. The first ionization constant of H_2S is 9.1×10^{-8}. Calculate the concentration of HS^{Θ} ion in its $0.1M$ solution. How will this concentration be affected if the solution is $0.1M$ in HCl also? If the second dissociation constant if H_2S is 1.2×10^{-13}, calculate the concentration of S^{2-} under both conditions.

Watch Video Solution

12. The ionization constant of acetic acid 1.74×10^{-5}. Calculate the degree of dissociation of acetic acid in its $0.05M$ solution. Calculate the concentration of acetate ion in the solution and its pH.

Watch Video Solution

13. It has been found that the pH of a $0.01M$ solution of an organic acid is 4.15. Calculate the concentration of the anion, the ionization constant of the acid and its pK_a.

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14. Assuming complete dissociation, calculate the pH of the following solutions,

a. $0.003MHCl$, b. $0.005MNaOH$,

c. $0.002MHBr$, d. $0.002MKOH$

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15. Calculate the pH of the following solutions:

a. $2g$ of $TlOH$ dissolved in water to give 2 litre of solution.

b. $0.3g$ of $Ca(OH)_2$ dissolved in water to give $500mL$ of solution.

c. $0.3g$ of $NaOH$ dissolved in water to give $200mL$ of solution.

d. $1mL$ of $13.6MHCl$ is duluted with water to give 1 litre of solution.

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16. The degree of ionization of a 0.1M bromoacetic acid solution is 0.132. Calculate the pH of the solution and the pK_a of bromoacetic acid.

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17. The pH of $0.005M$ codenine $\left(C_{18}H_{21}NO_3\right)$ solution is 9.95. Calculate its ionisation constant and pK_b.

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18. What is the pH of $0.001M$ aniline solution? The ionization constant of aniline 4.27×10^{-10}. Calculate the degree of ionization of aniline in the solution. Also calculate the ionization constant of the conjugate acid of aniline.

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19. Calculate the degree of ionisation of $0.05M$ acetic acid if its pK_a value is 4.74. How is the degree of dissociation affected when its solution also contains

a. $0.01M$, b. $0.1M$ in HCl?

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20. The ionisation constant of dimethylamine is 5.4×10^{-4}. Calculate its degree of ionization in its $0.02M$ solution. What percentage of dimethylamine is ionized if the solution is also $0.1M$ in $NaOH$?

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21. Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below :

(a) Human muscle – fluid, 6.83

(b) Human stomach fluid, 1.2

(c) Human blood, 7.38

(d) Human saliva, 6.4

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22. The pH of milk, black coffee, tomato juice, lemon juice and egg white are $6.8, 5.0, 4.2, 2.2$ and 7.8 respectively. Calculate corresponding hydrogen ion concentration in each.

Watch Video Solution

23. If $0.561g$ of (KOH) is dissolved in water to give. $200mL$ of solution at $298K$. Calculate the concentration of potassium, hydrogen and hydroxyl ions. What is its pH?

Watch Video Solution

24. The solubility of $Sr(OH)_2$ at $298K$ is $19.23gL^{-1}$ of solution. Calculate the concentrations cf strontium and hydroxyl ions and the pH of the solution.

Watch Video Solution

25. The ionization constant of propanoic acid is 1.32×10^{-5}. Calculate the degree of ionization of the acid in its $0.05M$ solution and also its pH. What will be its degree of ionization if the solution is $0.01M$ on HCl also?

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26. The pH of $0.1M$ solution of cyanic acid $(HCNO)$ is 2.34. Calculate the ionization constant of the acid and its degree of ionisation in the solution.

Watch Video Solution

27. The ionization constant of nitrous acid is 4.5×10^{-4}. Calculate the pH of $0.04M$ sodium nitrite solution and also its degree of hydrolysis.

Watch Video Solution

28. A $0.02M$ solution of pyridinium hydrochloride has $pH = 3.44$. Calculate the ionization constant of pyridine.

Watch Video Solution

29. Predict if the solutions of the following salts are neutral, acidic or basic: $NaCl$, KBr, $NaCN$, NH_4NO_3, $NaNO_2$ and KF

Watch Video Solution

30. The ionization constant of chloroacetic acid is 1.35×10^{-3}. What will be the pH of $0.1M$ acid and its $0.1M$ sodium salt solution?

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31. The ionic product of water at 310 K is 2.7×10^{-14}. What is the pH of neutral water at this temperature ?

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32. Calculate the pH of the resultant mixtures :

(a) 10 mL of 0.2 M $Ca(OH)_2$ + 25 mL of 0.1 M HCl (b)10 mL of 0.01 M H_2SO_4 + 10 mL of 0.01 M $Ca\left(OH_2\right)$

(c) 10 mL of 0.1 M H_2SO_4 + 10 mL of 0.1 M KOH

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33. Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298 K form their solubility product constants given below. Determine also the molarities of individual ions.

$K_{SP}\left(Ag_2CrO_4\right) = 1.1 \times 10^{-12}$,

$K_{SP}\left(BaCrO_4\right) = 1.2 \times 10^{-10}$,

$K_{SP}\left[Fe(OH)_3\right] = 1.0 \times 10^{-38}$,

$K_{SP}\left(PbCI_2\right) = 1.6 \times 10^{-5}$,

$K_{SP}\left(Hg_2I_2\right) = 4.5 \times 10^{-29}$.

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34. The solubility product constant of Ag_2CrO_4 and $AgBr$ are 1.1×10^{-12} and 5.0×10^{-13} respectively. Calculate the ratio of the molarities of their saturated solutions.

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35. Equal volumes of 0.002 M solution of sodium iodate and copper chlorate are mixed together . Will it lead to precipitation of copper iodate ? For copper iodate $K_{sp} = 7.4 \times 10^{-4}$

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36. The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzol is 2.5×10^{-13}. How many times is silver benzoate more soluble in a buffer of pH is 3.19 compared to its solubility in pure water?

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37. What is the maximum concentration of equimolar solutions of ferrous sulphate and sodium sulphide so that when mixed in equal volumes, there is no precipitation of iron sulphide? (For iron sulphide, $K_{sp} = 6.3 \times 10^{-18}$).

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38. What is the minimum volume of water required to dissolve $1.0g$ of calcium sulphate at $298K$?

(For calcium sulphate , $K_{sp} is 9.1 \times 10^{-6}$).

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39. The concentration of sulphide ion in 0.01 M HCl solution saturated with hydrogen sulphide is 1.0×10^{-19}M. If 10 mL of this solution is added to 5 mL of 0.04 M solution of the following : $FeSO_4, MnCl_2, ZnCl_2$ and $CdCl_2$, in which of these solutions precipitation will take place ?

Given K_{sp}, values :

$FeS = 6.3 \times 10^{-18}, MnS = 2.5 \times 10^{-13}, ZnS = 1.6 \times 10^{-24}, CdS = 8.0 \times 10^{-27}$

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Supplementary NCERT Exercise

1. A certain buffer is made by mixing sodium formate and formic acid in water. With the help of equations explain how this buffer neutratlizes addition of small amount of acid of base.

Watch Video Solution

2. A basic buffer is made by mixing ammonium hydroxide and ammonium nitrate in water . Explain how this buffer resists change in its pH on addition of a small amount of an acid or a base.

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3. What would be the pH of a solution obtained by mixing 10 g of acetic acid and 15 g of sodium acetate and making the volume equal to 1L. Dissociation constant of acetic acid at $25\,^{\circ}$C is 1.75×10^{-5}.

Watch Video Solution

4. A buffer solution contains 0.40 mol of ammonium hydroxide and 0.50 mol of ammonium chloride to make a buffer solution of 1 L. Calculate the pH of the resulting buffer solution. Dissociation constant of ammonium hydroxide at $25\,^{\circ}C$ is 1.81×10^{-5}.

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NCERT Exemplar Problems with answers, Hints and Solutions (Multiple choice Questions-I)

1. The relationship between K_p and K_c is $K_p = K_c(RT)^{\Delta n}$. What would be the value of Δn for the reaction :

$NH_4Cl(s) \Leftrightarrow NH_3(g) + HCl(g)$?

A. 1

B. 0.5

C. 1.5

D. 2

Answer: D

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2. For the reaction $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$, the standard free energy is $\Delta G^{\Theta} > 0$. the equilibrium constant (k) would be.

A. K= 0

B. $K > 1$

C. $K = 1$

D. $K < 1$

Answer: D

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3. Which of the following is not a general characteristic of equilibrium involving physical processes ?

A. Equilibrium is possible only in a closed system at a given temperature.

B. All measurable properties of the system remain constant.

C. All the physical processes stop at equilibrium.

D. The opposing processes occur at the same rate and there is dynamic but stable condition.

Answer: C

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4. PCl_5, PCl_3 and Cl_2 are at equilibrium at 500 K in a closed container and their concentrations are 0.8×10^{-3} mol L^{-1}, 1.2×10^{-3} mol L^{-1} and 1.2×10^{-3} mol L^{-1} respectively. The value of K_c for the reaction $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$ will be

A. 1.8×10^{-3} mol $L-^{1}$

B. 1.8×10^{-3}

C. $1.8 \times 10^{-3} L\text{mol}^{-1}$

D. 0.55×10^{4}

Answer: B

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5. Which of the following statements is incorrect ?

A. In equilibrium mixture of ice and water kept in perfectly insulated flask, mass of ice and water does not change with time.

B. The intensity of red colour increases when oxalic acid is added to a solution containing iron (III) nitrate and potassium thiocyanate.

C. On addition of catalyst, the equilibrium constant value is not affected.

D. Equilibrium constant for a reaction with negative ΔH value decreases as the temperature increases.

Answer: B

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6. When hydrochloric aicd is addded to cobalt and nitrate solution at room temperautre, the following reaction takes place and the reaction mixture becomes blue. On cooling the mixture it becomes pink. On the basis of this information mark the corect ansewer.

$\left[Co\left(H_2O\right)_6\right]\text{pink}^{3+}(aq) + 4CI^- \Leftrightarrow$

$CoCI_4\text{blue}^{2-}(aq) + 6H_2O(l)$

A. $\Delta H > 0$ for the reaction

B. $\Delta < 0$ for the reaction

C. $\Delta H = 0$ for the reaction

D. The sign of ΔH cannot be predicted on the basis of this information.

Answer: A

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7. The Ph OF NEUTRAL WATER AT $25^{\circ} C$ is $7.0.$ As the temperature increases, ionisation of water increases, however the concentration of H^{+} ions nad OH^{-} ions equal. What will be the ph of puire water at $60^{\circ} C$?

A. Equal to 7.0

B. Greater than 7.0

C. Less than 7.0

D. Equal to zero

Answer: C

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8. The ionisation cosntabnt of an acid, K_a is the meaure of strength of an acid. The K_a values of acetic acid, hypochlorous acid and formic acid are 1.74×10^{-5}, 3.0×10^{-8} and 1.8×10^{-4} respectively. Which of the following orders of ph of 0.1 mol dm^{-3} solutions of these acids is correct ?

A. acetic acid $>$ hypochlorous acid $>$ formic acid

B. hypochlorous acid $>$ acetic acid $>$ formic acid

C. formic acid $>$ hypochlorous acid $>$ acetic acid

D. fromic acid $>$ acetic acid $>$ hypochlorous acid

Answer: D

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9. K_{a1},$K_{a2}$and K_{a3} are the respective ionisation constants for the following reactions.

$H_2S \Leftrightarrow H^+ + HS^-$,$HS^- \Leftrightarrow H^+S^{-2}$

$H_2S \Leftrightarrow 2H^+ + S^{2-}$

The correct relationship between K_{a1},$K_{a2}$and K_{a3} is

A. $K_{a_3} = K_{a_1} \times K_{a_2}$

B. $K_{a_3} = K_{a_1} + K_{a_2}$

C. $K_{a_3} = K_{a_1} - K_{a_2}$

D. $K_{a_3} = K_{a_1} / K_{a_2}$

Answer: A

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10. Acidity of BF_3 can be explained on ths basis of which of the follwoing concepts?

A. Arrhenius concept

B. Bronsted Lowry concept

C. Lewis concept

D. Bronsted Lowry as well as Lewis concept.

Answer: C

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11. Which of the following will produce a buffer sollution when mixed in equal volumes ?

A. 0.1 mol $dm^{-3} NH_4OH$ and 0.1 mol dm^{-3} HCl

B. 0.05 mol $dm^{-3} NH_4OH$ and 0.1 mol dm^{-3} HCl

C. 0.1 mol $dm^{-3} NH_4OH$ and 0.05 mol dm^{-3} HCl

D. 0.1 mol $dm^{-3} CH_3COONa$ and 0.1 mol dm^{-3} NaOH

Answer: C

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12. In which of the following solvents silver chloride easily soluble ?

A. 0.1 mol $dm^{-3}AgNO_3$ solution

B. 0.1 mol dm^{-3} HCl solution

C. H_2O

D. Aqueous ammonia

Answer: D

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13. What will be the value of pH of 0.01 mol $\text{dm}^{-3}CH_3COOH\left(K_1 = 1.74 \times 10^{-5}\right)$?

A. 3.4

B. 3.6

C. 3.9

D. 3.0

Answer: A

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14. K_a for CH_3COOH is 1.8×10^{-5} and K_b for NH_4OH is 1.8×10^{-5} The pH of ammonium acetate will be :

A. 7.005

B. 4.75

C. 7.0

D. between 6 and 7.

Answer: C

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15. Which of the following options will be correct for the stage of half completion of the reaction : $A \Leftrightarrow B$?

A. $\Delta G^{\Theta} = 0$

B. $\Delta G^{\Theta} > 0$

C. $\Delta G^{\Theta} = \ < 0$

D. $\Delta G^{\Theta} = \ - RT \ln 2$

Answer: A

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16. On increasing the pressure, in which dirction will the gas phase reaction proceed to re-establish equilibrium, is predicated by applying the Le Chatelier's principle. Consider the reaction.

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

Which of the following is correct, if the total pressure at which the equlibrium is established, is increased without changing the temperature ?

A. K will remain same

B. K will decrease

C. K will increase

D. K will increase initially and decrease when pressure is very high.

Answer: A

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17. What will be the correct order of vapour pressure of water, acetone and ether at $30. ^\circ C$. Given that among these compounds, water has maximum boiling point and ether has minimum boiling point ?

A. Water $<$ ether $<$ acetone

B. Water $<$ acetone $<$ ether

C. Ether $<$ acetone $<$ water

D. Acetone $<$ ether $<$ water

Answer: B

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18. At 500 K, equlibrium constant, K_c for the following reaction is 5.

$1/2H_2(g) + 1/2(g) \Leftrightarrow HI(g)$

What would be the equilibrium constant K_c for the reaction

$2hi(g) \Leftrightarrow H_2(g) + l_2(g)$

A. 0.04

B. 0.4

C. 25

D. 2.5

Answer: A

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19. In which of the following reactions, the equilibrium reamins unaffected on addition of small amount of argon at constant volume?

A. $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

B. $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$

C. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

D. The equilibrium will remain unaffected in all the three cases.

Answer: D

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NCERT Exemplar Problems with answers, Hints and Solutions (Multiple Choice Questions-II)

1. For the reaction $N_2O_4(g) \Leftrightarrow 2NO_2(g)$, the value of K is 50 at 400 K and 1700 at 500 K. Which of the following options is correct?

A. The reaction is endothermic

B. The reaction is exothermic

C. If $NO_2(g)$ and $N_2O_4(g)$ are mixed at 400 K at partial pressures 20 bar and 2 bar respectively, more $N_2O_4(g)$ will be formed,

D. The entropy of the system increases.

Answer: A::C::D

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2. At a particular temperature and atmospheric pressure, the solid and liquid phases of a pure substance can exist i equilibrium. Which of the following term defines this temperature ?

A. Normal melting point

B. Equilibrium temperature

C. Boiling point

D. Freezing point

Answer: A::D

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NCERT Exemplar Problems with answers, Hints and Solutions (Short Answer Questions)

1. The ionisation of hydrochloric in water is given below:

$$HCl(aq) + H_2O(l) \Leftrightarrow H_3O^+ Cl^-(aq)$$

Label two conjugate acid- base pairs in this ionisation.

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2. The aqueous solution of sugart does not conduct electricity. However when sodium chloride is added to water, it conducts electricity. How will you explain this statement on the basis of ionisation and how is it affected by concentration of sodium chloride ?

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3. BF_3 does not have proton but still acts as an acid and reacts with NH_3. Why is it so? What type of bond is formed between the two ?

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4. Ionisation constant of a weak base MOH, is given by the expression

$$K_b = \frac{\left[M^+\right]\left[OH^-\right]}{[MOH]}$$

Values of ionisation constant of some weak bases at a particular temperature are given below :

$Base K_b$ Dimethylamine 5.4×10^{-4} $H_2O(l)$ 1.3×10^{-14} Pyridine 1.77×10^{-9} Ammonia

Arrange the bases in decreasing order of the extent of their ionisation at equilibrium. Which of the above base is the strongest?

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5. Conjugate acid of a weak base is always stronger. What will be the decrinsing order of basic strength of the following conjugate bases?

$OH^-, RO^-, CH_3, COO^-, CI^-$

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6. Arrange the following in increasing order of ph:

$KNO_3(aq), CH_3COONa(aq), NH_4CI(aq), C_6H_5COONH_4(aq)$

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7. The value of K_c for the reaction $2HI(g) \Leftrightarrow H_2 + I_2(g)$ is 1×10^{-4}. At a given time, t he composition of reaction mixture is

$[HI] = 2 \times 10^{-5} mol, \left[H_2\right] = 1 \times 10^{-5}$ mol and $\left[I_2\right] = 1 \times 10^{-5}$ mol

In which direction will the reaction proceed ?

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8. On the basis of the equation $ph = -\log\left[H^+\right]$,the ph of 10^{-8} mol dm^{-3} solution of HCl should be 8. However, it is observed to be less than 7.0. Explain the reason.

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9. ph of a solution of a strong acid is 5.0.What will be the ph of the solution obtained after dilluting the given solution to 100 times ?

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10. A sparingly soluble salt gets precipitated only when the prudct of concentration of its ions in th e solution $\left(Q_{sp}\right)$ becomes greater than its solubility product. If solubility of $BaSO_4$ in water is 8×10^{-4} mol dm^{-3}. Calculater its solubility in 0.01 mol dm^{-3} of H_2SO_4.

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11. pH of 0.08 mol dm^{-3} HOCl solution is 2.85. Calculate its ionisation constant.

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12. Calculate the ph of a solution formed by mixing equal volumes of two solutions A and B of a strong acids having $ph = 6$ and $ph = 4$ respectively.

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13. The solubility product of $Al(OH)_3$ is 2.7×10^{-11}. Calculate its solubility is gL^{-1} and also find out pH of this solution .

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14. Calculate the volume of water required to dissolve$0.1g$ lead (II) chloride to get a saturaed solution $\left(K_{sp}\right.$ of $PbCI_2 = 3.2 \times 10^{-8}$, atomic mass of $Pb = 207u$). Multiply your answer with 10 to get answer.

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15. A reaction between ammonia and boron triflurdie is given below :

$:NH_3 + BF_3 \rightarrow H_3N:BF_3$

Identify the acid and base in this reaction. Which theory explanis it ? What is the hybridsation of B and N in the additon compound ?

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16. Following data is given for the reaction : $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

Given that $\Delta_f H^\circ [CaO(s)] = -635.1 \text{kJ mol}^{-1}$

$\Delta_f H^\circ \left[CO_2(g)\right] = -393.5 \text{kJ mol}^{-1}$

$\Delta_f H^\circ \left[CaCO_3(s)\right] = -1206.9 \text{kJ mol}^{-1}$

Predict the effect of temperature on the equilibrium constant of the above reaction.

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NCERT Exemplar Problems with answers, Hints and Solutions (Matching Type Questions)

1. Match the tererms given is Column I with the type of solutions given in Column II.

	Column I		Column II
A.	Soda water	1.	A solution of gas in solid.
B.	Sugar solution	2.	A slution of gas in gas.
C.	German silver	3.	A solution of solid in liquid.
D.	Air	4.	A solution of solid in solid.
E.	Hydrogen gas in palladium.	5.	A solution of gas in liquid.
		6.	A solution of liquid in solid.

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2. For the reaction : $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$

Equilibrium constant $K_c = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$

Some reactions are written below in Column I and their equilibrium constants in terms of K_c are written in Column II. Match the following reactions with the corresponding equilibrium constant

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3.

$(A)\Delta G^{\Theta} > 0$	$(i) K > 1$
$(B)\Delta G^{\Theta} < 0$	$(ii) K = 1$
$(C)\Delta G^{\Theta} = 0$	$(iii) K = 0$
	$(iv) K < 1$

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4. Match the following species with the corresponding conjugate acid

	Species		Conjugate acid
(i)	NH_3	(a)	CO_3^{2-}
(ii)	HCO_3^-	(b)	NH_4^+
(iii)	H_2O	(c)	H_3O^+
(iv)	HSO_4^-	(d)	H_2SO_4
		(e)	H_2CO_3

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5. Match the following graphical variation with their description

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6. Match Column I with Column II.

	Column I		Column II
(i)	Equilibrium	(a)	$\Delta G > 0, K < 1$
(ii)	Spontaneous reaction	(b)	$\Delta G = 0$
(iii)	Non-spontaneous reaction	(c)	$\Delta G^{\Theta} = 0$
		(d)	$\Delta G < 0, K > 1$

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NCERT Exemplar Problems with answers, Hints and Solutions (Assertion and Reason Type Questions)

1. Asseration (A) : Increasing order of acidity of hydrogen halides is

$HF < HCI < HBr < HI$

Reason (R): While comparing acids formed by the elements belonging to the same group of periodic table, H-A bond strength is a more important factor in determining acidity of an acid than the polar nature of the bond.

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. Both A and R are false.

Answer: A

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2. Asseration : A solution containing a mixture of acetic acid and sodium acetate maintains a constant value of ph on addition of small amounts of acid or alkali.

Reason : A solution containing a mixture of acetic acid and sodium acetate acts as a buffer solution around ph 4.75.

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. Both A and R are false.

Answer: A

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3. Asseration : The ionisation of hydrogen sulphide in water is low in the presence of hydrochloric acid.

Reason : Hydrogen sulphide is a weak acid.

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. Both A and R are false.

Answer: B

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4. Assertion (A) : For any chemical reaction at particular temperature, the equilibrium constant is fixed and is a characteristic property.

Reason (R) : Equilibrium constant is independent of temperature.

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. Both A and R are false.

Answer: C

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5. Statement-1: Aqueous solution of ammonium carbonate is basic.

Statement-2: Acidic/basic nature of a salt solution of a salt of weak acid and weak base depends on K_a and K_b value of the acid and the base forming it.

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. Both A and R are false.

Answer: A

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6. Asseration : An aqeous solution of ammonium acetate can act as buffer.

Reason: Acetic acid is a weak acid and NH_4OH is a weak base.

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. Both A and R are false.

Answer: B

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7. Asseration : In the dissociation of PCI_5 at constant pressure and temperature addition of helium at equilibrium increases the dissociation of PCI_5.

Reason : Helium removes CI_2 from the field of action.

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. Both A and R are false.

Answer: C

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NCERT Exemplar Problems with answers, Hints and Solutions (Long Answer Questions)

1. How can you predict the following stages of a reaction by comparing the value of K_c and Q_c?

(i) Net reaction proceeds in the forward direction.

(ii) Net reaction proceeds in the backward direction.

(iii) No net reaction occurs.

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2. On the basis of Le Chatelier principle explain how temperature and pressure can be adjusted to increase the yield of ammonia int he following reaction.

$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g), \Delta H = -92.38 KJMol^{-1}$

What will be the effect of addition of argon to the avove mixture at cosntant volume ?

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3. A sparingly soluble salt having general formula A_xB_y and molar solubility s is in equilibrium with its saturated solution. Derive a relationship between the solubility and solubility product for such salt.

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4. Write a relation between ΔG and Q and deifine the meaning of each term and answer the following :

Why a reaction proceeds forward when $Q < K$ and no net reaction occure when $Q = K$.

Explain the effect of increase in presure in terms of reaction quotient Q for the reaction : $CO(g) + 3H_2(g) \Leftrightarrow CH_4(g) + H_2O(g)$

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Additional Questions (Very short answer questions) (I. Strong and weak electrolytes, ionic equilibrium and Ostwalds dilution law)

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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Additional Questions (Very short answer questions)

1. What is the difference between a conjugate acid and its conjugate base ?

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Additional Questions (Very short answer questions) (II. Various concepts of Acids and Bases, their dissocaition constants and strength)

1. Which concept can justify that $CaO + SO_3 \rightarrow CaSO_4$ is an acid-base reaction ?

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2. Fill in the blanks : A strong acid has a weak.......and a weak base has a strong........

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3. What is the active mass of water ?

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Additional Questions (Very short answer questions) (III. Ionic product of water and pH)

1. What is pK_w ? What is its value of 25°C ?

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2. What is the relationship between pK_a and pK_b values where K_a and K_b represent constants of the acid and its conjugate base respectively ?

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3. What is the relationship between pH and pOH ?

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Additional Questions (Very short answer questions) (IV. Salt hydrolysis and Calculation of K_h, h and pH)

1. What will be the pH of 1M $NaNO_3$ solution at $25^\circ C$?

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Additional Questions (Very short answer questions) (V. Acid-base titrations)

1. Which indicator should preferably be used for titration of NH_4OH with HCl solution?

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2. What is the relationship between $pK_{\ln}$ and pH at the equivalence point ?

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

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4. What is the range of a pH indicator in terms of its dissociation constant $\left(K_{\ln}\right)$?

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Additional Questions (Very short answer questions) (VI. Solubility product, common ion effect and their applications)

1. Write the expression for solubility product of calcium phosphate in terms of its molar solubility, S.

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2. What is the function of adding NH_4OH in group V ?

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Additional Questions (Very short answer questions) (VII. Buffer solutions)

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

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Additional Questions (short answer questions) (I. Strong and weak electrolytes, ionic equilibrium and Ostwalds dilution law)

1. What are strong and weak electrolytes ? Derive an expression for the calculation of the degree of ionization of a weak electrolyte.

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2. Derive and define Ostwald's Dilution Law.

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Additional Questions (short answer questions) (II. Various concepts of Acids and Bases, their dissociation constants and strength)

1. Discuss Lowry-Bronsted and Lewis concept of acids and bases.

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2. What is meant by the conjugate acid-base pair ?

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3. Discuss Lewis definition of acids and bases . How is it more useful than the Bronsted defination ?

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4. Define the terms 'acid' and 'base' according to each of the following concepts:

(i) Arrhenius (ii) Bronsted-Lowry (iii) Lewis

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5. Derive expression for dissociation constants of weak acids

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6. How do you explain the strengths of acids and bases on the basis of Arrhenius theory?

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7. Justify the statement that a strong acid has a weak conjugate base and strong base has a weak conjugate acid.

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Additional Questions (short answer questions) (III. Ionic product of water and pH)

1. What do you understand by the term 'ionic product of water' ? How has this concept been useful in defining the acidity and basicity of a solution ?

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2. Explain the term 'ionic product of water'

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3. How does K_w vary with temperature and why ?

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4. Briefly explain the term 'pH'.

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Additional Questions (short answer questions) (V. Acid-base titrations)

1. Briefly explain why phenophthalein is not a suitable indicator when the base is weak acid why methyl orange is not suitable when the acid is weak.

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Additional Questions (short answer questions) (VI. Solubility product, common ion effect and their applications)

1. Explain the term (i) Solubility product (ii) Common ion effect.

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Additional Questions (short answer questions) (VII. Buffer solutions)

1. What is the Buffer solution ? Give an example of an acidic buffer and explain

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2. Derive Henderson-Hasselbalch equation.

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Additional Questions (long answer questions)

1. What are strong and weak electrolytes ? Define the term 'degree of ionization' and derive how the degree of ionization is related to the concentration of the solution of the electrolyte.

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2. What are acids and bases according to (i) arrhenius concept (ii) Bronsted-Lowry concept ? In what respects (ii) is superior to (i) ?

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3. What is Lewis concept of Acids and Bases ? Classify the following into Lewis acids or Lewis bases giving reasons : $H_2O, BF_3, NH_3, SiF_4, Ag^+, Cl^-, CO_2$

What are the advantages and limitations of this concept over the earlier concepts ?

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Analytical Questions And Problems With Answers/Solutions (Questions)

1. Out of CH_3COO^- and OH^- which is stronger base and why ?

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

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3. Between Na^+ and Ag^+ which is stronger Lewis acid and why?

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4. Explain why pH of 0.1 molar solution of acetic acid will be higher than that of 0.1 molar solution of HCl ?

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5. A solution turns methyl orange into yellow. The approximate pH of solution is : \

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6. 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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7. Will AgCl be more soluble in aqueous solution or NaCl solution and why?

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

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9. Why in Group V of qualitative analysis, sufficient NH_4OH solution should be added before adding $\left(NH_4\right)_2CO_3$ solution ?

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10. A buffer solution of acetic acid and sodium acetate is diluted 10 times. What is the effect on its pH ?

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11. Anhydrous $AlCl_3$ is covalent. From the data given below, predict whether it would remain covalent or become ionic in aqueous solution (Ionization energy for $Al = 5137kJ\text{mol}^{-1}$, $\Delta H_{\text{hydration}}\text{for}Al^{3+} = -4665kJ\text{mol}^{-1}$, $\Delta H_{\text{hydration}}$ for $Cl^{-1} = -381kJ\text{mol}^{-1}$).

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12. Give reasons for the following :

(i) Magnesium is not precipitated from a solution of its salt by NH_4OH in the presence of NH_4Cl.

(ii) Ammonium chloride is acidic in liquid ammonia solvent

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13. What type of salts are Na_2HPO_3 and NaHS ?

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14. Calssify the following as acid or base according to Bronsted-Lowry theory and name their corresponding conjugate base or acid

$(i)NH_3 \quad (ii)CH_3COO^-$

$(iii)H_3O^+ \quad (iv)H^- \quad (v)HOO^- \quad (vi)S_2O_8^{2-}$.

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15. Prove that the dergee of dissociation of weak acid is given by:

$$\alpha = \frac{1}{1 + 10^{pK_a - pH}}$$

where K_a is its dissociation constant of the weak acid.

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16. Arrange the following oxides in the increasing order of Bronsted basicity. $CI_2O_7, BaO, SO_3, CO_2, B_2O_3$

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17. What are the conjugate bases of the following ?

$CH_3OH, HN_3, \left[Al\left(H_2O\right)_6\right]^{3+}$.

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18. Glycine is an α-amino acid. It exists in the form of Zwitter ion as $.^{+}NH_3CH_2COO^{-}$. Write the formula of its (i) conjugate acid (ii) conjugate base.

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19. Write reaction for autoprotolysis of water. How is ionic product of water related to ionization constant of water ? Derive the relationship.

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20. Give reason for the following :

(i) Zinc is not precipitated as $Zn(OH)_2$ on adding NH_4OH to a zinc salt solution containing NH_4Cl.

(ii) $BaSO_4$ precipitate is washed with water containing a small amount of H_2SO_4 in gravimetric analysis.

(iii) CO_2 is more soluble in aqueous NaOH solution than in water.

(iv) A brown precipitate in a bottle containing aqueous $FeCl_3$ solution appears pm standing.

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21. Why PO_4^{3-} ion is not amphiprotic ?

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22. In the reaction between BF_3 and $C_2H_5OC_2H_5$ which one of them will act as an acid ? Justify your answer.

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Analytical Questions And Problems With Answers/Solutions (Problems)

1. The pH of pure water at $25^\circ C$ and $35^\circ C$ are 7 and 6, respectively. Calculate the heat of formation of water from $H^{\oplus}$ and $\overset{\ominus}{O}H$.

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2. Approximate pH of $0.01M$ aqueous H_2S solution, when K_1 and K_2 for H_2S at $25^\circ C$ are 1×10^{-7} and 1.3×10^{-13} respectively:

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3. What volume of $0.1M$ sodium formate solution should be added to 50 mL of 0.05 M formic acid to produce a buffer solution of $pH = 4.0$? $\left(pK_a\right.$ of fomic acid $\left. = 3.80\right)$

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4. Calculate the pH at equivalence point when a solution of $0.10M$ acetic acid is titrated with a solution of 0.10 M hydroxide

$\left(K_a \text{ for acetic acid is } 1.9 \times 10^{-5}\right)$

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5. A certain weak acid has a disspciatoin constant 1.0×10^{-4}, the equilibrium constant for its reaction with strong base is :-

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6. The pH of 0.05 M aqueous solution of diethylamine is 12.0. Calculate its K_b .

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7. 0.1 M HA is tritrated against 0.1 M NaOH . Find the pH the end point . Dissociation constant for the end acid HA is 5×10^{-6} and degree of hydrolysis , $h < 1$

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8. A sample of AgCI was treated with $5.00mL$ of $1.5M\ Na_2CO_3$ solubility to give Ag_2CO_3 . The remaining solution contained $0.0026gofCI^-$ per litre. Calculate the solubility product of AgCI. $\left(K_{SP}f \text{ or } Ag_2CO_3 = 8.2 \times 10^{-12}\right)$

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9. An acid type indicator, H In differs in colour from its conjugate base $\left(In^-\right)$. The human eye is sensitive to colour differences only when the ratio $\left[In^-\right]/[HIn]$ is greater than 10 or smaller than 0.1. What should to observe a complete colour change ? $\left(K_a = 1.0 \times 10^{-5}\right)$

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10. 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 $0.6molL^{-1}$. $\left(pK_bf \text{ or } NH_3 = 4.7, \log 2 = 0.30\right)$

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11. K_a for ascorbic acid $(Hasc) is 5 \times 10^{-5}$. Calculate the hydrogen in an aqueous solution in which the concentration of Asc^{-} ions in $0.02M$.

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12. 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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13. Two buffer, (X) and (Y) of pH 4.0 and 6.0 respectively are prepared from acid HA and the salt NaA. Both the buffers are 0.50 M in HA. What would be the pH of the solution obtained by mixing equal volumes of the two buffers ? $\left(K_{HA} = 1.0 \times 10^{-5}\right)$

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14. A sample of mixed alkalis containing NaOH and Na_2CO_3 is titrated in the following two schemes :

(i) 10 ml of above mixture requires 8 ml of 0.1 N HCl by using phenolphthalein.

(ii) 10 ml of above mixture requires 10 ml of 0.1 N HCl by using methyl orange.

Calculate the ratio of the weight of NaOH and Na_2CO_3 in the sample mixture.

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15. How many times of the acetic acid concentration, acetate salt should be added to a given acetic acid solution to obtain a solution of pH = 7.0 (K_a for $CH_3COOH = 1.8 \times 10^{-5}$) .

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16. Calculate the percentage dissociation of 0.5 M NH_3 at $25^\circ C$ in a solution of pH = 12.

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17. The ratio of pH of solution (1) containing 1 mole ofCH_3COONa and 1 mole of HCl and solution (II) containing 1 mole of CH_3COONa and 1 mole of acetic acid in one litre is :

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18. 0.1 M CH_3COOH solution is titrated against 0.05 M NaOh . Calculate pH at $1/4^{th}$ and $3/4^{th}$ stage of neutralization of acid , the pH for 0.1 M CH_3COOH is 3 .

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19. Calculate the weight of $(NH_4)_2SO_4$ which must be added to $500 mL$ of $0.2 M NH_3$ to yield a solution of $pH = 9.35$. K_a for $NH_3 = 1.78 \times 10^{-5}$.

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (I. Storng and weak electrolytes, ionic equilibrium and Ostwalds dilution law)

1. Which one of the following is the correct quadratic form of the Ostwald's dilution law equation

A. $\alpha^2 C + \alpha K - K = 0$

B. $\alpha^2 C - \alpha K - K = 0$

C. $\alpha^2 C - \alpha K + K = 0$

D. $\alpha^2 C + \alpha K + K = 0$

Answer: A

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2. The percentage of pyridine $\left(C_5H_5N\right)$ that forms pyridinium ion $\left(C_5H_5N^+H\right)$ in a 0.10 M aqueous pyridine solution (K_b for $C_5H_5N = 1.7 \times 10^{-9}$) is

A. 0.0077

B. 0.016

C. 6.0E-5

D. 0.00013

Answer: D

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3. Ionisation constant of CH_3COOH is 1.7×10^{-5} and concentration of $H^+ ions$ is 3.4×10^{-4}. Then, find out initial concentration of CH_3COOH molecules.

A. 3.4×10^{-4}

B. 3.4×10^{-3}

C. 6.8×10^{-3}

D. 1.7×10^{-3}

Answer: C

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4. At $25^{\circ} C$, the dissociation constant of a base. BOH is 1.0×10^{-12}. The concentration of hydroxyl ions in 0.01M aqueous solution of the base would be

A. $1.0 \times 10^{-6} \text{mol } L^{-1}$

B. $1.0 \times 10^{-7} \text{mol } L^{-1}$

C. $2.0 \times 10^{-6} \text{mol } L^{-1}$

D. $1.0 \times 10^{-5} \text{mol } L^{-1}$

Answer: B

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5. For a concentrated solution of a weak electrolyte, A_xB_y of concentration 'C', the degree of dissociation α is given by

A. $\alpha = \sqrt{K_{eq}/C(x+y)}$

B. $\alpha = \sqrt{K_{eq}C/(xy)}$

C. $\alpha = \left(K_{eq}/C^{x+y-1}x^x y^y\right)^{1/(x+y)}$

D.

Answer: C

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6. A weak monobasic acid is 1% ionized in 0.1 M solution at 25°C. The percentage of ionization in its 0.025 M solution is :

A. 1

B. 2

C. 3

D. 4

Answer: B

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7. Aqueous solution of which of the following compounds is the best conductor of electric current?

A. Ammonia, NH_3

B. Fructose, $C_6H_{12}O_6$

C. Acetic acid, $C_2H_4O_2$

D. Hydrochloric acid HCl

Answer: D

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (II. Various concepts of Acids and Bases, their dissociation constants and strength)

1. In the equation $I_2 + I^- \rightarrow , I_3^-$ which is Lewis base

A. I_2

B. I^-

C. I_3^-

D. None of these

Answer: B

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2. Which of the following are Lewis acids?

A. PH_3 and BCl_3

B. $AlCl_3$ and $SiCl_4$

C. PH_3 and $SiCl_4$

D. BCl_3 and $AlCl_3$

Answer: D

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3. Conjugate base of H_2 is

A. H_3^+

B. H_3^-

C. H^+

D. H^-

Answer: D

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4. The conjugate base of OH^- is :

A. O^{2-}

B. O^-

C. H_2O

D. O_2

Answer: A

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5. Which one of the following is the correct statement ?

A. HC_3^- is the conjugate base of CO_3^{2-}

B. NH_2^- is the conjugate acid of NH_3

C. NH_3 is the conjugate base of NH_2^-

D. H_2CO_3 is the conjugate base of HCO_3^-

Answer: C

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6. Which one of the following species cannot act as both Bronsted acid and base ?

A. H_2O

B. HCO_3^-

C. HSO_4^-

D. NH_2^-

Answer: D

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7. Which one of the following behaves as Lewis base as well as Bronsted-Lowry base ?

A. Carbonium ion

B. Carbanion

C. Carbenium ion

D. All of these

Answer: B

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8. Mg^{2+} is .... Than Al^{3+}

A. stronger Lewis acid

B. stronger Lewis base

C. weaker Lewis acid

D. weaker Lewis base

Answer: C

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9. Sulphanilic acid is a/an:

A. Arrhenius acid

B. Lewis base

C. Both (a) and (b)

D. Neither (a) nor (b)

Answer: C

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10. Choose the correct order arranged in decreasing order of basicity

A. $CH \equiv C^- > CH_3O^- > OH^-$

B. $OH^- > CH_3O^- CH - = C^-$

C. $CH_3O^- > OH^- > CH \equiv C^-$

D. $CH_3O^- > CH \equiv C^- > OH^-$

Answer: A

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11. Which one of the following ionic species has the greatest proton affinity to form stable compound ?

A. I^-

B. HS^-

C. NH_2^-

D. F^-

Answer: C

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12. The correct order of increasing basicity of the given conjugate bases $(R = CH_3)$ is

A. $CRCOO^- < NH_2^- < HC \equiv C^- < R^-$

B. $RCOO^- < HC \equiv C^- < NH_2^- < R^-$

C. $RCOO^- < HC \equiv C^- < R^- < NH_2^-$

D. $R^- < HC \equiv C^- < RCOO^- < NH_2^-$

Answer: B

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13. 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. (iii) only

B. (i) only

C. (ii) ony

D. (i) and (ii)

Answer: C

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14. Which one of the following molecules hydrides acts as a Lewis acid ?

A. CH_4

B. NH_3

C. H_2O

D. B_2H_6

Answer: D

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15. Which of the of the following fluoro -compouds is most likely to beahve as a Lewis base?

A. BF_3

B. PF_3

C. CF_4

D. SiF_4

Answer: B

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16. Which of the following statements about HCO_3^- are correct ?

1. It is a Bronsted acid

2. It can ionize in water to form CO_3^{2-} (aq)

3. It does not exist in aqueous solution

4. It is a Bronsted base.

Select the correct answer using the codes given below

A. 1, 2 and 3

B. 2, 3 and 4

C. 1, 3 and 4

D. 1, 2 and 4

Answer: D

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17. Which of the following is least likely to behave as Lewis acid?

A. OH^-

B. H_2O

C. NH_3

D. BF_3

Answer: D

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18. The correct order of increasing $\left[H_3O^+\right]$ in the following aqueous solution is :

A. $0.01MH_2S < 0.01MH_2SO_4 < 0.01MNaCl < 0.01MNaNO_2$

B. $0.01MNaCl < 0.01MNaNO_2 < 0.01MH_2S < 0.01MH_2SO_4$

C. $0.01MNaNO_2 < 0.01MNaCl < 0.01MH_2S < 0.01MH_2SO_4$

D. $0.01MH_2S < 0.01MNaNO_2 < 0.01MNaCl < 0.01MH_2SO_4$.

Answer: C

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19. Strongest conjugate base is

A. Cl^{-}

B. Br^{-}

C. F^{-}

D. I^{-}

Answer: C

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20. The strongest base of the following species is

A. NH^{2-}

B. OH^{-}

C. O^{2-}

D. S^{2-}

Answer: A

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21. In $HS^-, I^-, R-NH_2, NH_3$ order of proton accepting tendency will be

A. $I^- > NH_3 > R-NH_2 > HS^-$

B. $NH_3 > R-NH_2 > HS^- > I^-$

C. $R-NH_2 > NH_3 > HS^- > I^-$

D. $HS^- > R-NH_2 > NH_3 > I^-$

Answer: C

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22. In which cases, the order of acidic strength is not correct ?

A. $HI > HBr > HCl$

B. $HIO_4 > HBrO_4 > HClO_4$

C. $HClO_4 > HClO_3 > HClO_2$

D. $HF > H_2O > NH_3$

Answer: B

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23. 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 concentrations of H^+ and HCO_3^- are approximately equal.

B. The concentration of H^+ is double that of CO_3^-.

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

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

Answer: A

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24. The correct order of decreasing acidic nature of $H_2O, ROH, CH \equiv CH$ and NH_3 is

A. $CH \equiv Ch > H_2O > ROH > NH_3$

B. $H_2O > ROH > CH \equiv CH > NH_3$

C. $ROH > NH_3 > CH \equiv CH > H_2O$

D. $H_2O > rOH > NH_3 > CH \equiv CH$

Answer: B

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25. Which one of the following is a hard base ?

A. Ag^+

B. Cr^{3+}

C. I^-

D. F^-

Answer: D

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26. Which of the following solvents are aprotic?

A. 1,2,3

B. 1,3,4

C. 2,3

D. 1,3

Answer: C

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27. According to hard and soft acid base principle, a hard acid

A. has low charge density

B. shows preference for soft bases

C. shows preference for donor atoms of low electronegativitiy

D. is not polarizable

Answer: D

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28. Calculate $\left[OH^{-}\right]$ and % dissociation of 0.01 M solution of ammonium hydroxide solution. The ionization constant for

$NH_4OH\left(K_b\right) = 1.8 \times 10^{-5}$

A. 1.8×10^{-7}

B. 1.8×10^{-6}

C. 1.8×10^{-4}

D. 1.8×10^{-3}

Answer: B

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29. Boric acid is an acid because its molecule

A. contains replaceable H^{+} ion

B. gives up a proton

C. accepts OH^{-} from water releasing proton

D. combines with proton from water molecule

Answer: A

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30. In the following reactions, ZnO is respectively acting as a/an

$ZnO + Na_2O \Rightarrow NaZnO_2$

$ZnO + CO_2 \rightarrow ZnCO_3$

A. Acid and acid

B. Acid and base

C. Base and acid

D. Base and base

Answer: B

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (III. Ionic product of water and pH)

1. The pH of $10^{-8}M$ solution of HCl in water is

A. 8

B. -8

C. between 7 and 8

D. between 6 and 7.

Answer: D

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2. Which of the following will decrease the pH of a 50 ml solution of $0.01 MHCI$?

A. Addition of 50 mL of 0.01 M HCl

B. Addition of 50 mL of 0.002 M HCl

C. Addition of 150 mL of 0.002 M HCl

D. Addition of 5 mL of 1 M HCl

Answer: D

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3. If a neutral solution has $pK_w = 13.36$ at $50\,^{\circ} C$, then pH of the solution is

A. 6.68

B. 7

C. 7.63

D. None of these

Answer: A

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4. If pK_b for fluoride ion at $25^\circ C$ is 10.83 the ionisation constant of hydrofluoric acid at this temperature is

A. 1.74×10^{-5}

B. 3.52×10^{-3}

C. 6.75×10^{-4}

D. 5.38×10^{-2}.

Answer: C

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5. The pH of a solution obtained by mixing 100 mL of a solution pH=3 with 400 mL of a solution of pH=4 is

A. 3- log 2.8

B. 7- log 2.8

C. 4- log 2.8

D. 5- log 2.8

Answer: C

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6. The pH of a 0.1 M aqueous solution of a weak acid (HA) is 3. What is its degree of dissociation ?

A. 0.01

B. 0.1

C. 0.5

D. 0.25

Answer: A

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7. The pK_a of acetic acid is 4.74 . The concentration of CH_3COOH is 0.01 M. The pH of CH_3COOH is

A. 3.37

B. 4.37

C. 4.74

D. 0.474

Answer: A

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8. 0.365g of HCl gas was passed through 100 cm^3 of 0.2 M NaOH solution. The pH of the resulting solution would be

A. 1

B. 5

C. 8

D. 13

Answer: D

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9. How many times a 0.1 M strong monobasic solution should be diluted so that the pH of the resulting solution is tripled ?

A. 20 times

B. 200 times

C. 5.55×10^2 times

D. 5.55×10^4 times

Answer: D

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10. Aspirin (acetyl salicyclic acid, molar mass $180 g \text{mol}^{-1}$) used as analgesic has pK_a value of 2. Two tablets of aspirin each weighing 90 mg are dissolved in 100 mL of water. The pH of the solution is

A. 0.5

B. 1.0

C. 2.0

D. 4.0

Answer: C

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11. The pH of a solution obtained by mixing 50 mL of 0.2 M HCl with 50 mL of 0.20 M CH_3COOH is

A. 0.30

B. 0.70

C. 1.00

D. 2.00

Answer: C

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12. Calculate the pH of 10^{-8} M HCl solution .

A. $9.525 \times 10^{-8} M$

B. $1.0 \times 10^{-8} M$

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

D. $1.0525 \times 10^{-7} M$

Answer: D

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13. 40 ml of 0.1 M ammonia is mixed with 20 ml of $0.1 MHCI$. What is the pH of the mixture ? (pK_b of ammonia solution is 4.74.)

A. 4.74

B. 2.26

C. 9.26

D. 5.00

Answer: C

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14. $10^{-6} MNaOH$ is diluted by 100 times. The pH of diluted base is

A. between 5 and 6

B. between 6 and 7

C. between 10 and 11

D. between 7 and 8

Answer: D

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15. 0.023 g of sodium metal is reacted with 100cm^3 of water. The pH of the resulting solution is

A. 10

B. 11

C. 9

D. 12

Answer: D

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16. 0.1 M HCl and $0.1MH_2SO_4$, each of volume 2 ml are mixed and the volume is made up to 6 ml by adding 2ml of 0.01 N NaCl solution. The pH of the resulting mixture is

A. 1.17

B. 1.0

C. 0.3

D. log 2 - log 3

Answer: B

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17. The pH of the solution produced by mixing equal volume of $2.0 \times 10^{-3} MHClO_4$ and $1.0 \times 10^{-2} MKClO_4$ is

A. 2.7

B. 2.3

C. 3.0

D. 1.0

Answer: C

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18. pH value of which of the following is not equal to one

A. $0.1MCH_3COOH$

B. $0.1MHNO_3$

C. $0.05MH_2SO_4$

D. $50cm^3 0.4MHCl + 50cm^3 0.2MNaOH$

Answer: A

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19. The pH of the solution formed on mixing 20 mL of $0.05 M H_2SO_4$ with 5.0 mL of 0.45 M NaOH of 298 K is

A. 6

B. 2

C. 12

D. 7

Answer: C

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20. 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. 9.0 L

B. 0.1 L

C. 0.9 L

D. 2.0 L

Answer: A

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21. The correct descending order of the heat liberated (in kJ) during the neutralization of the acids $CH_3COOH(W), HF(X), HCOOH(Y)$ and HCN(Z) under indentical conditions $\left(K_a \text{ of} CH_3COOH = 1.8 \times 10^{-5}, HCOOH = 1.8 \times 10^{-4}, HCN = 4.9 \times 10^{-10}\right.$ and is

A. $Y > X > Z > W$

B. $X > Y > W > Z$

C. $Z > X > Y > Z$

D. $Z > W > X > Y$

Answer: B

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22. Following solutions were prepared by mixing different volumes of NaOH and HCl of different concentrations:

a. 60 mL $\frac{M}{10} HCl + 40 mL \frac{M}{10}$ NaOH

b. 55 mL $\frac{M}{10} HCl + 45 mL \frac{M}{10}$ NaOH

c.75 mL $\frac{M}{5} HCl + 25 mL \frac{M}{5}$ NaOH

d. 100 mL $\frac{M}{10} HCl + 100 mL \frac{M}{10}$ NaOH

pH of which one of them will be equal to 1 ?

A. (2)

B. (1)

C. (4)

D. (3)

Answer: D

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (IV. Salt hydrolysis)

1. The pH of 0.1 M solution of the following salts increases in the order

A. $NaCl < NH_4Cl < NaCN < HCl$

B. $HCl < NH_4Cl < NaCl < NaCl$

C. $NaCN < NH_4Cl < NaCl < HCl$

D. $HCl < NaCl < NaCN < NH_4Cl.$

Answer: B

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

A. $0.0001\,\%$

B. $0.01\,\%$

C. $0.1\,\%$

D. $0.15\,\%$

Answer: B

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3. The pK_a of an acid HA is 4.77 and pK_b of a base of BOH is 4.75 . The pH of 0.1 M aqueous solution of the salt AB is

A. 7.02

B. 7.01

C. 6.99

D. 7.00

Answer: B

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4. Equimolar solutions of the following were prepared in water separately. Which one of the solutions will record the highest pH ?

A. $SrCl_2$

B. $BaCl_2$

C. $MgCl_2$

D. $CaCl_2$

Answer: B

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5. Which of the following salts will give highest pH in water ?

A. KCl

B. NaCl

C. Na_2CO_3

D. $CuSO_4$

Answer: C

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6. The aqueous solution of which of the following salt will have the lowest pH ?

A. NaClO

B. $NaClO_4$

C. $NaClO_3$

D. $NaClO_2$

Answer: B

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7. pK_a of a weak acid (HA) and pB_b of a weak base (BOH) are 3.2 and 3.4 respectively. The pH of their salt (AB) solution is

A. 7.0

B. 1.0

C. 7.2

D. 6.9

Answer: D

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8. Which of the following salts is the most basic in aqueous solution ?

A. $Al(CN)_3$

B. CH_3COOK

C. $FeCl_3$

D. $Pb\left(CH_3COO\right)_2$

Answer: B

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (V. Acid-base titrations)

1. 2.5 mL of $\frac{2}{5}$ M weak monoacidic base $\left(K_b = 1 \times 10^{-12} \text{at} 25^\circ C\right)$ is titrated with $\frac{2}{15}$ M HCl in water at 25° C. The concentration of H^+ at equivalence point is $\left(K_w = 1 \times 10^{-14} \text{at} 25^\circ C\right)$

A. $3.7 \times 10^{-13} M$

B. $3.2 \times 10^{-7} M$

C. $3.2 \times 10^{-2}M$

D. $2.7 \times 10^{-2}M$

Answer: C

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2. 20mL of 0.5 M HCl and 35 mL of 0.1 N NaOH are mixed. The resulting solution will

A. be neutral

B. be basic

C. turn phenolphthalein solution pink

D. turn methyl orange red

Answer: D

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3. Determine the pH of the solution that results from the addition of 20.00 mL of 0.01 M Ca $(OH)_2$ to 30.00 mL of 0.01 M HCl

A. 11.30

B. 10.53

C. 2.70

D. 8.35

Answer: A

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4. What is the pH of the resulting solution when equal volumes of $0.1 MNaOH$ and $0.01 MHCl$ are mixed?

A. 7.0

B. 1.04

C. 12.65

D. 2.0

Answer: C

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5. 30 cc of $\frac{M}{3}$ HCl, 20cc of $\frac{M}{2}$ HNO_3 and 40 cc of $\frac{M}{4}NaOH$ solutions are mixed and the volume was made upto $1dm^3$. The pH of the resulting solution is :

A. 2

B. 1

C. 3

D. 8

Answer: A

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6. A solution containing Na_2CO_3 and NaOH requires 300 mL of 0.1 N HCl using phenolphthalein as an indicator. Methyl orange is then added to above titrated solution when a further 25 mL of 0.2 M HCl is required. The amount of NaOH present in the original solution is

A. 0.5 g

B. 1g

C. 2g

D. 4g

Answer: B

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7. $50cm^2$ of 0.2 N HCl is titrated against 0.1 N NaOH solution. The titration is discontinued after is completed by adding 0.5 N KOH. The volume of KOH required for completing the titration is

A. $12cm^3$

B. $10cm^3$

C. $25cm^3$

D. $10.5cm^3$

Answer: B

View Text Solution

8. 20.0 L of 0.2 M weak acid $\left(pK_a = 5.0\right)$ is titrated against 0.2 M strong base. What is the pH at the equivalence point ?

A. 5.0

B. 7.0

C. 9.0

D. 11.0

Answer: C

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9. The rapid change of pH near the stoichiometric point of an acid-base titration is the basic of indicator detection. pH of the solution is related to the ratio of the concentration of conjugate acid $(H \in)$ and base $\left(In^{-}\right)$ forms of the indicator by the expression

A. $\log. \dfrac{\left[In^{-}\right]}{\left[In^{-}\right]} = pK_{In} - pH$

B. $\log. \dfrac{\left[HIn^{-}\right]}{\left[In^{-}\right]} = pK_{In} - pH$

C. $\log. \dfrac{\left[HIn^{-}\right]}{\left[In^{-}\right]} = pH_{In} - pK_{In}$

D. $\log. \dfrac{\left[In^{-}\right]}{\left[HIn^{-}\right]} = pH_{In} - pK_{In}$

Answer: D

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10. An alkali is titrated against an acid with methyl orange as indicator, which of the following is a correct combination?

A.
	Base	Acid	End point
(a)	Weak	Strong	Colourless to pink

B.
	Base	Acid	End point
(b)	Strong	Strong	Pinkish red to yellow

C.
	Base	Acid	End point
(b)	Weak	Strong	Yellow to pinkish red

D.
	Base	Acid	End point
(b)	Strong	Strong	Pink to colourless

Answer: C

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (VI. Solubility product, common ion effect and their applications)

1. Amongst the following hydroxides, the one which has the lowest value of K sp at ordinary temperature is:

A. $Mg(OH)_2$

B. $Ca(OH)_2$

C. $Ba(OH)_2$

D. $Be(OH)_2$

Answer: D

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2. The solubility of AgCl(s) having solubility product 1.6×10^{-10}, in $0.2M$ NaCl solution will be

A. $1.26 \times 10^{-5}M$

B. $1.6 \times 10^{-9}M$

C. $1.6 \times 10^{-11}M$

D. zero

Answer: B

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3. The solubility product of AgCl is 4.0×10^{-10} at 298 K . The solubility of AgCl in 0.04 M Ca Cl_2 will be

A. $2.0 \times 10^{-5} m$

B. $1.0 \times 10^{-4} m$

C. $5.0 \times 10^{-9} m$

D. 2.2×10^{-4}m

Answer: C

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4. the solubility of A_2B_3 is y mol dm^{-3}. Its solubility product is

A. $6y^4$

B. $64y^4$

C. $36y^5$

D. $108y^5$

Answer: D

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5. The molar solubility (in mol L^{-1}) of a sparingly soluble salt MX_4 is $'s'$. The corresponding solubility product K_{sp}, $'s'$ is given in terms of K_{sp} by the relation

A. $S = \left(\frac{K_{sp}}{129}\right)^{1/4}$

B. $S = \left(\frac{K_{sp}}{256}\right)^{1/5}$

C. $S = \left(256K_{sp}\right)^{1/5}$

D. $s = \left(128K_{sp}\right)^{1/4}$

Answer: B

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6. On adding 0.1 M solution each of Ag^{+}, Ba^{2+}, Ca^{2+} ions in a Na_2SO_4 solution, species first precipitated is $\left(K_{sp}BaSO_4 = 10^{-11}, K_{sp}CaSO_4 = 10^{-6}, K_{sp}Ag_2SO_4 = 10^{-5}\right)$

A. Ag_2SO_4

B. $BaSO_4$

C. $CaSO_4$

D. all of these

Answer: B

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7. Equal volumes of the following Ca^{2+} and F^{-} solutions are mixed. In which of the solutions will precipitation occur ? $\left(K_{sp}\text{of}CaF_2 = 1.7 \times 10^{-10}\right)$

(1) $10^{-2}MCa^{2+} + 10^{-5}MF^{-}$

(2) $10^{-3} M Ca^{2+} + 10^{-3} M F^{-}$

(3) $10^{-4} M Ca^{2+} + 10^{-2} M F^{-}$

(4)$10^{-2} M Ca^{2+} + 10^{-3} M F^{-}$

Select the correct answer using the codes given below:

A. $10^{-2} M Ca^{2+} + 10^{-5} M F^{-}$

B. $10^{-3} M Ca^{2+} + 10^{-3} M F^{-}$

C. $10^{-4} M Ca^{2+} + 10^{-2} M F^{-}$

D. $10^{-2} M Ca^{2+} + 10^{-3} M F^{-}$

Answer: D

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8. The K_{sp} of $PbCO_3$ and $MgCO_3$ are 1.5×10^{-15} and 1×10^{-15} respectively at 298 K. The concentration of Pb^{2+} ions in a saturated solution containing $MgCO_3$ and $PbCO_3$ is

A. $1.5 \times 10^{-8} M$

B. $3 \times 10^{-8} M$

C. $2 \times 10^{-8} M$

D. $2.5 \times 10^{-8} M$

Answer: B

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9. K_{sp} for $Ca(OH)_2$ is 5.5×10^{-6}. What is the maximum pH that can be attained in a sewage tank treated with slaked lime ?

A. 9.35

B. 10.35

C. 11.35

D. 12.35

Answer: d

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10. For which of the following sparingly soluble salt the solubility (s) and solubility product $\left(K_{sp}\right)$ are related by the expression $s = \left(K_{sp}/4\right)^{1/3}$

A. $BaSO_4$

B. $Ca_3\left(PO_4\right)_2$

C. Hg_2Cl_2

D. Ag_3PO_4

Answer: C

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11. When 30 mL of 5.93 millimolar solution of $AgNO_3$ was added to 2.0 mL of 8.89 millimolar solution of KCl, the mixture turns turbid. The solubility product of AgCl is

A. $1.96 \times 10^{-6}\text{mol}^2L^{-2}$

B. $3.92 \times 10^{-6} \text{mol}^2 L^{-2}$

C. $1.96 \times 10^{-6} \text{mol}^{-1} L^{-1}$

D. $3.92 \times 10^{-6} \text{mol}^{-1} L^{-1}$

Answer: A

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12. In a saturated solution of the spatingly soluble strong electrolyte $AgIO_3$ (molecular mass $= 283$) the equilibrium which sets in is

$AgIO_3(s) \Leftrightarrow Ag^+(aq) + IO_3^-(aq)$

If the solubility product constant K_{SP} of $AgIO_3$ at a given temperature is 1.0×10^{-8}, what is the mass of $AgIO_3$ cotained in $100mL$ of its saturated solution?

A. $1.0 \times 10^{-4} g$

B. $28.3 \times 10^{-2} g$

C. $2.83 \times 10^{-3} g$

D. $1.0 \times 10^{-7} g$

Answer: C

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13. Solubility product constant $\left(K_{sp}\right)$ of salts of types MX, MX_2 and M_3X at temperature 'T' are 4.0×10^{-8}, 3.2×10^{-14} and 2.7×10^{-15}, respectively. Solubilities $\left(\text{mol. Dm}^{-3}\right.$ of the salts at temperature 'T' are in the order

A. $MX > MX_2 > M_3X$

B. $M_3X > MX_2 > MX$

C. $MX_2 > M_3X > MX$

D. $MX > M_3X > MX_2$

Answer: D

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14. The solubility product of a sparingly soluble metal hydroxide $\left[M(OH)_2\right]$ is $5 \times 10^{-16} mol^3 dm^{-9}$ at 298 K. Find the pH of its saturated aqueous solution.

A. 5

B. 9

C. 11.5

D. 2.5

Answer: B

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15. Solubility product of silver bromide is 5.0×10^{-13}. The quantity of potassium bromide (molar mass taken as $120 g mol^{-1}$) to be added to $1L$ of $0.05M$ solution of silver nitrate to start the precipitation of $AgBr$ is

A. $6.2 \times 10^{-5} g$

B. $5.0 \times 10^{-8} g$

C. $1.2 \times 10^{-10} g$

D. $1.2 \times 10^{-9} g$

Answer: D

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16. At $25^{\circ} C$, the solubility product of $Mg(OH)_2$ is 1.0×10^{-11}. At which pH, will Mg^{2+} ions start precipitating in the form of $Mg(OH)_2$ from a solution of $0.001 M Mg^{2+}$ ions ?

A. 11

B. 8

C. 9

D. 10

Answer: D

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17. If pH of a saturated solution of $Ba(OH)_2$ is 12, the value of its $K_{(SP)}$ is

A. $5.00 \times 10^{-7} M^3$

B. $4.00 \times 10^{-6} M^3$

C. $4.00 \times 10^{-7} M^3$

D. $5.00 \times 10^{-6} M^3$

Answer: A

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18. When solid lead iodide is added to water, the equilibrium concentration of I^- becomes $2.6 \times 10^{-3} M$. What is the K_{sp} for PbI_2 ?

A. 2.2×10^{-9}

B. 8.8×10^{-9}

C. 1.8×10^{-8}

D. 3.5×10^{-8}

Answer: B

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19. The solubility product (K_{sp}) of the following compounds are given at $25^{\circ}C$

Compound	K_{sp}
AgCl	1.1×10^{-10}
Agl	1.0×10^{-16}
$PbCrO_4$	4.0×10^{-14}
Ag_2CO_3	8.0×10^{-12}

The most soluble and least soluble compound are respectively

A. $AgCl$ and $PbCrO_4$

B. AgI and Ag_2CO_3

C. $AgCl$ and Ag_2CO_3

D. Ag_2CO_3 and AgI

Answer: D

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20. The K_{sp} of $Ag_2CrO_4, AgCl, AgBr$ and AgI are respectively, $1.1 \times 10^{-12}, 1.8 \times 10^{-10}, 5.0 \times 10^{-13}, 8.3 \times 10^{-17}$. Which one of the following salts will precipitate last if $AgNO_3$ solution is added to the solution containing equal moles of NaCl,NaBr,NaI and Na_2CrO_4 ?

A. AgBr

B. Ag_2CrO_4

C. AgI

D. AgCl

Answer: B

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21. At 25° C, the solubility product of Hg_2CI_2 in water is $3.2 \times 10^{-17} mol^3 dm^{-9}$ what is the solubility of Hg_2CI_2 in water at 25° C ?

A. $1.2 \times 10^{-12} M$

B. $3.0 \times 10^{-6} M$

C. $2 \times 10^{-6} M$

D. $1.2 \times 10^{-16} M$

Answer: C

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22. What is the minimum volume of water required to dissolve 1 g of calcium sulphate at 298 K. K_{sp} for $CaSO_4$ is 9.0×10^{-6}.

A. 2.45 L

B. 4.08 L

C. 4.90 L

D. 3.00 L

Answer: A

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23. If the salt M_2X, QY_2 and PZ_3 have the same solubilites, their K_{sp} values are related as (s <1)

A. $K_{sp}(M_2X) = K_{sp}(QY_2) < K_{sp}(PZ_3)$

B. $K_{sp}(M_2X) > K_{sp}(QY_2) = K_{sp}(PZ_3)$

C. $K_{sp}(M_2X) < K_{sp}(QY_2) = K_{sp}(PZ_3)$

D. $K_{sp}(M_2X) > K_{sp}(QY_2) > K_{sp}(PZ_3)$

Answer: A

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24. H_2S is passed into one dm^3 of a solution containing 0.1 mole of Zn^{2+} and 0.1 mole of the Cu^{2+} till the sulphide ion concentration reaches 8.1×10^{-10} moles. Which one of the following statements is true? $\left[K_{sp}\right.$ of ZnS and CuS are 3×10^{-22} and 8×10^{-36} respectively]

A. Only ZnS precipitates

B. Both CuS and ZnS precipitate

C. Only CuS precipitates

D. No precipitation occurs

Answer: B

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25. Passing H_2S gas into a mixture of $Mn^{2+}, Ni^{2+}, Cu^{2+}$ and Hg^{2+} ions in an acidified aqueous solution precipitates

A. CuS and HgS

B. MnS and CuS

C. MnS and NiS

D. NiS and HgS

Answer: A

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26. In presence of HCl, H_2S results the precipitation of group-2 radicals but not group-4 radicals during qualitative analysis. It is due to

A. higher concentration of H^+

B. lower concentration of H^+

C. higher concentration of S^{2-}

D. lower concentration of S^{2-}

Answer: D

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27. In qualitative analysis, the metals of group I can be separated from other ions by precipitating them as chloride salts. A solution initially contains Ag^{+} and Pb^{+} at a concentration of 0.10M. Aqueous HCl is added to this solution until be Cl^{-} concentration is 0.10M. What will be concentration of Ag^{+} and Pb^{2+} be at equilibrium ?

(K_{sp} for AgCl $= 1.8 \times 10^{-10}$

K_{sp} for $PbCl_2 = 1.7 \times 10^{-5}$)

A. $\left[Ag^{+}\right] = 1.8 \times 10^{-7}M, \left[Pb^{2+}\right] = 1.7 \times 10^{-6}M$

B. $\left[Ag^{+}\right] = 1.8 \times 10^{-11}M, \left[Pb^{2+}\right] = 8.5 \times 10^{-5}M$

C. $\left[Ag^{+}\right] = 1.8 \times 10^{-9}M, \left[Pb^{2+}\right] = 1.7 \times 10^{-3}M$

D. $\left[Ag^{+}\right] = 1.8 \times 10^{-11}M, \left[Pb^{2+}\right] = 8.5 \times 10^{-4}M$

Answer: C

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28. The K_{sp} of Ag_2CrO_4 is 1.1×10^{-12} at $298K$. The solubility (in mol/L) of Ag_2CrO_4 in a $0.1MAgNO_3$ solution is

A. 1.1×10^{-11}

B. 1.1×10^{-10}

C. 1.1×10^{-12}

D. 1.1×10^{-9}

Answer: B

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29. Concentration of the Ag^{+} ions in a saturated solution of $Ag_2CO_2O_4$ is $2.2 \times 10^{-4} molL^{-1}$ Solubility product of $Ag_2C_2O_4$ is:

A. 2.42×10^{-8}

B. 2.66×10^{-12}

C. 4.5×10^{-11}

D. 5.3×10^{-12}

Answer: D

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30. Using the Gibbs energy change, $\Delta G^{\circ} = +63.3kJ$, for the following reaction,

$Ag_2CO_3 \Leftrightarrow 2Ag^+(aq) + CO_3^{2-}$

the K_{sp} of $Ag_2CO_3(s)$ in water at $25^{\circ}C$ is

$\left(R = 8.314JK^{-1}mol^{-1}\right)$

A. 3.2×20^{-26}

B. 8.0×10^{-12}

C. 2.9×10^{-3}

D. 7.9×10^{-12}

Answer: B

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31. MY and NY_3 two nearly insoluble salts, have the same K_{sp} values of 6.2×10^{-13} at room temperature. Which statement would be true in rearged to MY and NY_3 ?

A. The addition of the salt of KY to the solution of MY and NY_3 will have no effect on their solubilities

B. The molar solubilities of MY and NY_3 in water are identical

C. The molar solubility of MY in water is less than that of NY_3

D. The salts MY and NY_3 are more soluble in 0.5 M KY than in pure water .

Answer: C

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32. The solubility of $BaSO_4$ in water is $2.42 \times 10^{-3} gL^{-1}$ at $298K$. The value of its solubility product $\left(K_{sp}\right)$ will be (Given molar mass of $BaSO_4 = 233 gmol^{-1}$)

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

B. $1.08 \times 10^{-12} \text{mol}^2 L^{-2}$

C. $1.08 \times 10^{-14} \text{mol}^2 L^{-2}$

D. $1.08 \times 10^{-8} \text{mol}^2 L^{-2}$

Answer: A

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33. An aqueous solution contains an unknown concentration of Ba^{2+}. When 50 mL of a 1 M solution of Na_2SO_4 is added, $BaSO_4$ just begins to precipitate. The final volume is 500 mL. The solubility product of $BaSO_4$ is 1×10^{-10}. What is the original concentration of Ba^{2+}?

A. $5 \times 10^{-9}M$

B. $2 \times 10^{-9}M$

C. $1.1 \times 10^{-9}M$

D. 1.0×10^{M}

Answer: C

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (VII. Buffer solutions)

1. Which one of the following pairs of solution is not an acidic buffer?

A. $H_2CO_3 + Na_2CO_3$

B. $H_3PO_4 + Na_3PO_4$

C. $HClO_4 + NaClO_4$

D. $CH_3COOH + CH_3COONa$

Answer: C

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2. How much sodium acetate should be added to a 0.1 M solution of CH_3COOH to give a solution of pH = 5.5 (pK_a of $CH_3COOH = 4.5$)

A. 0.1 M

B. 0.2 M

C. 1.0 M

D. 10.0 M

Answer: C

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3. 0.1 mole of $CH_3NH_2\left(K_b = 5 \times 10^{-4}\right)$ is mixed with 0.08 mole of HCl and diluted to one litre. The $\left[H^+\right]$ in solution is

A. 1.6×10^{-11}

B. 8×10^{-11}

C. 5×10^{-5}

D. 8×10^{-2}

Answer: B

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4. In which volume ratio NH_4Cl and NH_4OH solutions (each 1 M) should be mixed to get a buffer solution of pH 9.80 ? $\left(pK_b \text{of} NH_4OH = 4.74\right)$

A. $1:2.5$

B. $2.5:1$

C. $1:3.5$

D. $3.5:1$

Answer: C

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5. The ratio of volumes of CH_3COOH, 0.1 N to CH_3COONa, 0.1 N required to prepare a buffer solution of pH 5.74 is (given : pK_a of CH_3COOH is 4+74)

A. $10:1$

B. $5:1$

C. $1:5$

D. $1:10$

Answer: D

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6. Buffer index of a buffer of 0.1 M NH_4OH and 0.1 M NH_4Cl is $\left(pK_b \text{ for } NH_4OH = 4.74\right)$

A. 0.116

B. 0.232

C. 0.058

D. 0.348

Answer: A

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7. In a basic buffer, 0.0025 mole of NH_4Cl and 0.15 mole of NH_4OH are present. The pH of the solution will be $(pK_a = 4.74)$

A. 11.04

B. 10.24

C. 6.62

D. 5.48

Answer: A

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8. The pK_a of a weak acid (HA) is 4.5. The pOH of an aqueous buffered solution of HA in which 50% of the acid is ionized is:

A. 7.0

B. 4.5

C. 2.5

D. 9.5

Answer: D

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9. What is $\left[H^+\right]$ in mol/L of a solution that is $0.20M$ in CH_3COONa and $0.1M$ in CH_3COOH? K_a for CH_3COOH is 1.8×10^{-5}?

A. 9.0×10^{-6}

B. 3.5×10^{-4}

C. 1.1×10^{-5}

D. 1.8×10^{-5}

Answer: A

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10. A buffer solution contains 0.1 mole of sodium acetate in 1000 cm^3 of 0.1 M acetic acid. To the above buffer solution, 0.1 M acetic acid. To the above buffer solution, 0.1 mole of sodium acetate is further added and dissolved. The pH of the resulting buffer is equal to ....

A. pK_a - log2

B. pK_a

C. $pK_a + 2$

D. $pK_a + \log 2$

Answer: D

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11. A weak acid of dissociation constant 10^{-5} is being titrated with aqueous NaOH solution . The pH at the point of one third of neutralization of the acid will be

A. 5 log 2 - log 3

B. 5 - log 2

C. 5 - log 3

D. 5 - log 6

Answer: B

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12. A buffer solution is prepared in which the concentration of NH_3 is $0.30M$ and the concentration of NH_4^+ is $0.20M$. If the equilibrium constant, K_b for NH_3 equals 1.8×10^{-5}, what is the pH of this solution? ($\log 2.7 = 0.43$)

A. 8.73

B. 9.08

C. 9.43

D. 11.72

Answer: C

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Competition Focus (I. Multiple Choice Questions(with one correct Answer)) (VIII. Miscellaneous)

1. What is the pH of $0.01M$ glycine solution? For glycine, $K_{a_1} = 4.5 \times 10^{-3}$ and $K_{a_2} = 1.7 \times 10^{-10}$ at $298K$

A. 3.0

B. 10.0

C. 6.1

D. 7.2

Answer: C

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2. Autoprotolysis constant of NH_3 is

A. $\left[NH_4^+\right]\left[NH_3\right]$

B. $\left[NH_2^-\right]\left[NH_3\right]$

C. $\left[NH_4^+\right]\left[NH_2^-\right]$

D. $\left[NH_2^-\right]/\left[NH_2^-\right]$

Answer: C

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3. A patient is said to suffer from acidosis when the pH of his blood

A. falls below 7.35

B. rises above 7.35

C. shows sudden fall and rise

D. has strong basic character

Answer: A

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4. $NaHCO_3$ and NaOH cannot exist in a solution because of

A. common ion effect due to common Na^+ ions

B. redox reaction occurring between the two

C. neutralization reaction occurring between the two

D. different solubilities of the two in water.

Answer: C

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5. The charge balance equation of species in 0.100 M acetic solution is given by

A. $[H^+] = [OH^-]$

B. $[H^+] = [CH_3COO^-]$

C. $[H^+] = [OH^-] + [CH_3COO^-]$

D. $2[H^+] = [OH^-] + [CH_3COO^-]$

Answer: C

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6. If CO_2 is allowed to escape from the following reaction at equilibrium

$$CO_2 + H_2O + H_2CO_3 \Leftrightarrow 2H^+ + 2HCO_3^-$$

A. pH will decrease

B. pH will remain constant

C. pH will increase

D. forward reaction will be favoured

Answer: C

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Competition Focus (II. Multiple Choice Questions(with one or more than one correct Answers))

1. Which of the following statements are correct ?

A. According to Bronsted Lowry concept, H_2SO_4 can also act as a base

B. SiF_4 is an acid according to Lewis concept

C. Stronger the acid, higher is its pK_a value

D. HCl, HNO_3 and H_2SO_4 act as equally strong acids in any solvent.

Answer: A::B

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2. Which of the following statements are wrong?

A. pH of neutral water is always 7.0

B. When a base is titrated against an acid, the pH at the end point is 7.0

C. Lesser is the pH than 7, more acidic is the solution and higher the pH than 7, less basic is the solution

D. AgCl is more soluble in NH_3 than in water.

Answer: A::B::C

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3. Which of the following will have nearly equal pH ?

A. 100 ml 0.1 M HCl mixed with 50 ml water

B. 50 ml $0.1 M H_2SO_4$ mixed with 50 ml water

C. 50 ml of 0.1 M H_2SO_4 mixed with 100 ml water

D. 50 ml of 0.1 M HCl mixed with 50 ml of water

Answer: A::C

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

A. sodium acetate and acetic acid in water

B. sodium acetate and hydrochloric acid in water

C. ammonia and ammonium chloride in water

D. ammonia and sodium hydroxide in water

Answer: A::C

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5. The pair(s) of ions where BOTH the ions are precipitated upon passing H_2S gas in presence of dilute HCl is (are)

A. Ba^{2+}, Zn^{2+}

B. Bi^{3+}, Fe^{3+}

C. Cu^{2+}, Pb^{2+}

D. Hg^{2+}, Bi^{3+}

Answer: C::D

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Competition Focus (III. Multiple Choice Questions(Based on the given Passage/Comprehension))

1. A proper control of pH is very essential for many industrial as well as biological processes. Solutions with a definite pH can be prepared from single salts or mixtures of acids/bases and their salts. We also require solutions which resist change in pH and hence have a reserve value. Such solutions are called Buffer solutions. Henderson gave a theoretical equation for preparing acidic buffers of definite pH. The equation is

$$pH = pK_a + \log. \frac{[\text{Salt}]}{[\text{Acid}]}$$

a similar equation is used for basic buffers. The pH of aqueous solution of single salts is calculated by using an expression whose exact form depends upon the nature of the salt. For example, for salts of strong acid and weak base, the expression is

$$pH = 7 - \frac{1}{2}pK_b - \frac{1}{2}\log c$$

For weak acids and bases used by a chemist, data are given below:

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

Also logarithmic values of some numbers are given below :

log 1.8 = 0.2553, log 2 = 0.3010,

log 3 = 0.4771, log 5 = 0.6990

Report the correct pH value in each of the following cases.

100 mL of 0.10 M NaOH mixed with 100 ml of 0.05 M CH_3COOH solution

A. 10.4

B. 11.4

C. 12.4

D. 13.4

Answer: C

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Report the correct pH value in each of the following cases.

100 mL of 0.05 M NaOH mixed with 100 ml of 0.10 M CH_3COOH solution

A. 3.75

B. 4.75

C. 5.75

D. 6.75

Answer: B

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Report the correct pH value in each of the following cases.

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A. 5.72

B. 6.72

C. 7.72

D. 8.72

Answer: D

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Also logarithmic values of some numbers are given below :

log 1.8 = 0.2553, log 2 = 0.3010,

log 3 = 0.4771, log 5 = 0.6990

Report the correct pH value in each of the following cases.

100 mL of 0.10 M NH_4OH mixed with 100 of 0.05 M HCl solution

A. 6.25

B. 7.25

C. 8.25

D. 9.25

Answer: D

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5. A proper control of pH is very essential for many industrial as well as biological processes. Solutions with a definite pH can be prepared from single salts or mixtures of acids/bases and their salts. We also require solutions which resist change in pH and hence have a reserve value. Such solutions are called Buffer solutions. Henderson gave a theoretical equation for preparing acidic buffers of definite pH. The equation is

$$pH = pK_a + \log. \frac{[\text{Salt}]}{[\text{Acid}]}$$

a similar equation is used for basic buffers. The pH of aqueous solution of single salts is calculated by using an expression whose exact form depends upon the nature of the salt. For example, for salts of strong acid and weak base, the expression is

$$pH = 7 - \frac{1}{2}pK_b - \frac{1}{2}\log c$$

For weak acids and bases used by a chemist, data are given below:

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Report the correct pH value in each of the following cases.

100 mL of 0.05 M NH_4OH mixed with 100 mL of 0.10 M HCl solution

A. 1.6

B. 2.6

C. 3.6

D. 4.6

Answer: A

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6. When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temerature increase of $0.7\,^{\circ}$C was measured for the beaker and its contents (Expt. 1) . Because the enthalpy of neutralization of a strong acid with a strong base is a constant (-57.0 kJ mol^{-1}), the experiment could be used to measure the calorimeter constant.

In a second experiment (Expt. 2), 100 mL of 2.0 M acetic acid $\left(K_a = 2.0 \times 10^{-5}\right)$ was mixed with 100 mL of 1.0 M NaOH . (under identical conditions of Expt.1) where hte temperature rise of $5.6\,^{\circ}C$ was measured.

(Consider heat capacity of all solutions as $4.2 J g^{-1} K^{-1}$ and density of all solutions as 1.0 m mL^{-1})

Enthalpy of dissociation (in kJ mol^{-1}) of acetic acid obtained from Expt. 2 is

A. 1.0

B. 10.0

C. 24.5

D. 51.4

Answer: A

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7. When 100 mL of 1.0 M HCl was mixed with 100 mL of 1.0 M NaOH in an insulated beaker at constant pressure, a temerature increase of $0.7\,^{\circ}$C was measured for the beaker and its contents (Expt. 1) . Because the enthalpy of neutralization of a strong acid with a strong base is a constant (-57.0 kJ mol^{-1}), the experiment could be used to measure the calorimeter constant.

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The pH of the solution after Expt. 2 is

A. 2.8

B. 4.7

C. 5.0

D. 7.0

Answer: B

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Competition Focus (IV. Matching Type Questions)

1. Match the entries of column I with appropriate entries of column II and choose the correct option out of the four options (a), (b), (c), (d) given at the end of each question.

A. A-q, B-p, C-r, D-s

B. A-r, B-s, C-q, D-p

C. A-q, B-p, C-s, D-r

D. A-p, B-q, C-s, D-r

Answer: C

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2.

	Column I		Column II
(A)	Solubility of Hg_2Cl_2in0.1 M NaCl solution.	(p)	$10K_{sp}$
(B)	Solubility of PbI_2 in 0.01 M KI solution	(q)	$100K_{sp}$
(C)	Solubility of Ag_2CrO_4in 0.25 MK_2CrO_4solution.	(r)	$10000K_{sp}$
(D)	Solubility of calcium oxalate in 0.1 M oxalic acid aolution.	(s)	$\sqrt{K_{sp}}$

A. A-q, B-r, C-s, D-p

B. A-r, B-q, C-p, D-s

C. A-q, B-p, C-s, D-r

D. A-p, B-r, C-s, D-q

Answer: A

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3.

	Column I		Column II (pH)
(A)	MilK	(p)	2.2
(B)	Human saliva	(q)	6.4
(C)	Human blood	(r)	6.8
(D)	Lemon juice	(s)	7.4

A. A-p, B-q, C-s, D-r

B. A-r, B-q, C-s, D-p

C. A-r, B-s, C-q, D-p

D. A-q, B-r, C-s, D-p

Answer: B

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4. Dilution process of different aqueous solutions with water are given in List-I. The effects of dilution of the solutions on $\left[H^{+}\right]$ are given in List-II. (Note : Degree of dissociation (α) of weak acid and weak base is $< < 1$, degree of hydrolysis of salt $< < 1$, $\left[H^{+}\right]$ represents the concentration of H^+ ions)

A. $P \rightarrow 4, Q \rightarrow 2, R \rightarrow 3, S \rightarrow 1$

B. $P \rightarrow 4, Q \rightarrow 3, R \rightarrow 2, S \rightarrow 3$

C. $P \rightarrow 1, Q \rightarrow 4, R \rightarrow 5, S \rightarrow 3$

D. $P \rightarrow 1, Q \rightarrow 5, R \rightarrow 4, S \rightarrow 1$

Answer: D

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Competition Focus (V. Matrix-Match Type Questions)

1.

	Column I (Solvent)		Column II (Nature)
(A)	Methyl alcohol (CH_3OH)	(p)	Protophilic
(B)	Benzene (C_6H_6)	(q)	Protogenic
(C)	Ammonia (NH_3)	(r)	Amphiprotic
(D)	Acetic acid (CH_3COOH)	(s)	Aprotic

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	Column I(Types of titration)		Column II (Indicator used)
(A)	Strong acid vs strong base	(p)	Methyl orange
(B)	Strong acid vs weak base	(q)	Methyl red
(C)	Weak acid vs strong base	(r)	Phenolphthalein
(D)	Weak acid vs weak base	(s)	Bromothymol blue

2.

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Competition Focus (VI. Integer Type Questions)

1. The number of weak electrolytes among the following is

$CH_3COONa, H_2CO_3, HCOOH, C_2H_5HN_2, Na_2CO_3, Ca(OH)_2, CH_3COONH_4, HN$

.

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2. If the dissociation constants of two weak acids HA_1 and HA_2 are K_1 and K_2, then the relative strengths of HA_1 and HA_2 are given by

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3. The pH of 10^{-2} M NaOH solution is .... Times the pH of 10^{-2} M HCl solution

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4. If pK_a of a weak acid is 5, then pK_b of the conjugate base will

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5. If $0.049g$ of H_2SO_4 are present in 10 litre of the solution, the pH of the solution will be

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6. Calculate the pH of the solution in which $0.2 MNH_4Cl$ and $0.1 MNH_3$ are present. The pK_b of ammonia solution is 4.75.

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7. Most of the indicators have a useful colour change over a pH range of .... units.

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8. Universal indicator shows green colour when pH of the solution is nearly....... .

A. 4

B. 11

C. 12

D. 7

Answer: D

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

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10. The total number of diprotic acids among the following is

$H_3PO_4, H_2SO_4, H_3PO_3$

$H_2CO_3, H_2S_2O_7, H_3BO_3$

$H_3PO_2, H_2CrO_4, H_2SO_3$

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11. Amongst 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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12. In 1 L saturated solution of $AgCl\left[K_{sp}(AgCl) = 1.6 \times 10^{-19}\right]$, 0.1 mol of $CuCl\left[K_{sp}(CuCl) = 1.0 \times 10^{-6}\right]$ is added. The resultant concentration of Ag^+ in the solution is 1.6×10^{-x}. The value of "x" is

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Competition Focus (VII. Numerical Value Type Questions) (In Decimal Notation)

1. The solubility of a salt of weak acid (AB) at pH 3 is $Y \times 10^{-3}$ mol L^{-1}. The value of Y is ____. (Given that the value of solubility product of AB $\left(K_{sp}\right) = 2 \times 10^{-10}$ and the value of ionization constant of HB $\left(K_a\right) = 1 \times 10^{-8}$)

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Competition Focus (VIII. Assertion-Reason Type Questions)

1. Statement-1. The pK_a of a weak acid becomes equal to pH of the solution at the mid-point of its titration.

Statement-2. The molar concentrations of proton acceptor and proton donor become equal at mid point of a weak acid.

A. Statement-1 is True, Statement-2 is True , Statement-2 is the correct explanation of Statement - 1 .

B. Statement-1 is True, Statement - 2 is True , Statement-2 is NOT a correct explanation for Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: A

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2. Assertion (A): pH of HCI solution is less than that of acetic acid of the some concentartion.

Reason (R) : In equimolar solution, the number of titrable protons present in HCI is less than that present in acetic acid.

A. Statement-1 is True, Statement-2 is True , Statement-2 is the correct explanation of Statement - 1 .

B. Statement-1 is True, Statement - 2 is True , Statement-2 is NOT a correct explanation for Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: C

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3. Statement -1 HCO_3^- ion can act as a strong base.

Statement -2 CO_3^{2-} ion can act as a weak base.

A. Statement-1 is True, Statement-2 is True , Statement-2 is the correct explanation of Statement - 1 .

B. Statement-1 is True, Statement - 2 is True , Statement-2 is NOT a correct explanation for Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: B

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4. STATEMENT-1: pH of water decreases with increase in temperature.

STATEMENT-2 : K_w of water decreases with increase in temperature.

A. Statement-1 is True, Statement-2 is True , Statement-2 is the correct explanation of Statement - 1 .

B. Statement-1 is True, Statement - 2 is True , Statement-2 is NOT a correct explanation for Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: D

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5. Statement I In water, orthoboric acid behaves as a weak monobasic acid.

Statement II In water, orthoboric acid acts as a proton donor.

A. Statement-1 is True, Statement-2 is True , Statement-2 is the correct explanation of Statement - 1 .

B. Statement-1 is True, Statement - 2 is True , Statement-2 is NOT a correct explanation for Statement-1.

C. Statement-1 is True, Statement-2 is False.

D. Statement-1 is False, Statement-2 is True.

Answer: C

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6. Assertion. Degree of ionization of weak electrolyte increases with dilution.

Reason. Degree of ionization is inversely proportional to molar concentration.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: C

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7. Assertion. In case of polyprotic acids, first ionization constant in lowest.

Reason. The removal of first proton is most difficult. Further ionization becomes easier.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: D

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8. Assertion (A): pH of neutral solution is always 7.

Reason (R) : pH of solution does not depend upon temperature.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: D

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9. Asseration : A queous solution of ammonium carbonate is basic.

Reason : Acidic/basic nature of a salt of weak acid base depends on K_a and K_b value of the acid and the base forming it.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: A

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10. Assertion. The pH at the end point of any acid-base titration is always 7.

Reason. The aqueous solution of a salt is always neutral.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: D

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11. Assertion : Sb (III) is not precipitated as sulphide when in its alkaline solution H_2S is passed.

Reason : The concentration of S^{2-} ion in alkaline medium is inadequate for precipitation.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: C

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12. Assertion: Addition of silver ions to a mixture of aqueous sodium chloride and sodium bromide solution will first precipitate $AgBr$ rather than $AgCl$.

Reason : K_{sp} of $AgCl < K_{sp}$ of $AgBr$.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: C

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13. Assertion : On mixing 500 ml of $10^{-6} M Ca^{2+}$ ion and 500 ml of $30 \times 10^{-6} M F^{-}$ ion, the precipitate of CaF_2 will be obtained. $K_{sp}\left(CaF_2 = 10^{-18}\right)$

Reason : If K_{sp} is greater than ionic product, a precipitate will develop.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: D

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14. Assertion : NaCl is precipitated when HCl gas is passed in a saturated solution of NaCl.

Reason : HCl is strong acid.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: B

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15. Assertion. Precipitation of soap is made by the addition of salt (NaCl).

Reason. Presence of common ion suppresses the dissociation of weak acid.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: C

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16. Assertion. An aqueous solution of ammonium acetate can act as buffer.

Reason. An aqueous solution of any pure salt acts as a buffer.

A. If both assertion and reason are true, and reason is the true explanation of the assertion.

B. If both assertion and reason are true, but reason is not the true explanation of the assertion.

C. If aasertion is true, but reason is false.

D. If both assertion and reason are false.

Answer: C

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