

CHEMISTRY

BOOKS - VIKRAM PUBLICATION (ANDHRA PUBLICATION)

CHEMICAL EQUILIBRIUM AND ACIDS BASES

Solved Problems

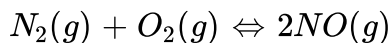
1. The following concentrations were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at $500K$. $[N_2] = 1.5 \times 10^{-2}M$. $[H_2] = 3.0 \times 10^{-2}M$ and $[NH_3] = 1.2 \times 10^{-2}M$. Calculate equilibrium constant.



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2. At equilibrium, the concentrations of $N_2 = 3.0 \times 10^{-3}M$, $O_2 = 4.2 \times 10^{-3}M$ and $NO = 2.8 \times 10^{-3}M$ in a sealed vessel at $800K$.

What will be K_c for the reaction



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3. PCl_5 , PCl_3 and Cl_2 are at equilibrium at $500K$ and having concentration $1.59M$ PCl_3 , $1.59M$ Cl_2 and $1.41M$ PCl_5 . Calculate K_c for the reaction $PCl_5 \rightleftharpoons PCl_3 + Cl_2$

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4. The value of $K_c = 4.24$ at $800K$ for the reaction,
 $CO(g) + H_2O(g) \rightleftharpoons CO_2(g) + H_2(g)$

Calculate equilibrium concentrations of CO_2 , H_2 , CO and H_2O at $800K$, if only CO and H_2O are present initially at concentrations of $0.1M$ each.

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5. For the equilibrium, $2NOCl(g) \rightleftharpoons 2NO(g) + Cl_2(g)$ the value of the equilibrium constant, K_c is 3.75×10^{-6} at $1069K$. Calculate the K_p for the reaction at this temperature ?

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6. The value of K_p for the reaction, $CO_2(g) + C(s) \rightleftharpoons 2CO(g)$ is 3.0 at $1000K$. If initially $P_{CO_2} = 0.48$ bar and $P_{CO} = 0$ bar and pure graphite is present, calculate the equilibrium partial pressures of CO and CO_2 .

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7. The value of K_c for the reaction $2A \rightleftharpoons B + C$ is 2×10^{-3} . At a given time, the composition of reaction mixture is $[A] = [B] = [C] = 3 \times 10^{-4}M$. In which direction the reaction will proceed ?

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8. 13.8g of N_2O_4 was placed in a 1L reaction vessel at 400K and allowed to attain equilibrium



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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9. 3.00 mol of PCl_5 kept in 1L closed reaction vessel was allowed to attain equilibrium at 380K. Calculate composition of the mixture at equilibrium $K_c = 1.80$

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10. The value of ΔG^\ominus for the phosphorylation of glucose in glycolysis is 13.8 kJ/mol. Find the value of K_c at 298 K.

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11. Hydrolysis of sucrose gives, $\text{Sucrose} + \text{H}_2\text{O} \rightleftharpoons \text{Glucose} + \text{Fructose}$
Equilibrium constant K_c for the reaction is 2×10^{13} at 300K . Calculate ΔG^\ominus at 300K .

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12. What will be the conjugate bases of the following Bronsted acids:
 HF , H_2SO_4 and HCO_3^- ?

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

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14. The species: H_2O , HCO_3^- , HSO_4^- and NH_3 can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and conjugate base.

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15. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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16. 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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17. Calculate pH of a 1.0×10^{-8} M solution of HCl.

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

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19. The pH of $0.1M$ monobasic acid is 4.50. Calculate the concentration of species H^+ .

A^- and HA at equilibrium. Also, determine the value of K_a and pK_a of the monobasic acid.

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20. Calculate the pH of $0.08M$ solution of hypochlorous acid, $HOCl$. The ionization constant of the acid is 2.5×10^{-5} . Determine the percent dissociation of $HOCl$.

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21. The pH of $0.004M$ hydrazine solution is 9.7. Calculate its ionization constant K_b and pK_b .

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22. 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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23. Determine the degree of ionization and pH of $0.05M$ of ammonia solution. The ionization constant of ammonia can be taken from Table 7.7. Also, calculate the ionization constant of the conjugate acid of ammonia.

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

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25. The pK_a of 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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26. Calculate the solubility of A_2X_3 in pure water, assuming that neither kind of ion reacts with water. The solubility product of A_2X_3 , $K_{sp} = 1.1 \times 10^{-23}$

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27. The values of K_{sp} of two sparingly soluble salts $Ni(OH)_2$ and $AgCN$ are 2.0×10^{-15} and 6×10^{-17} respectively. Which salt is more soluble? Explain .

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28. Calculate the molar solubility of $Ni(OH)_2$ in $0.10M NaOH$. The ionic product of $Ni(OH)_2$ is 2.0×10^{-15}

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1. Mole of PCl_5 is heated in a closed vessel of 1 litre capacity. At equilibrium 0.4 moles of chlorine is found. Calculate the equilibrium constant.

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2. Nitrogen dioxide forms dinitrogen tetroxide according to the equation $2NO_2(g) \rightleftharpoons N_2O_4(g)$ when 0.1 mole of NO_2 is added to a 1 litre flask at $25^\circ C$, the concentration changes so that at equilibrium $[NO_2] = 0.016M$ and $[N_2O_4] = 0.042M$.

- What is the value of the reaction Quotient before any reaction occurs.
- What is the value of the equilibrium constant for the reaction.

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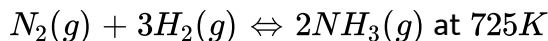
$25^{\circ}C$, the concentration changes so that at equilibrium

$$[NO_2] = 0.016M \text{ and } [N_2O_4] = 0.042M.$$

- What is the value of the reaction Quotient before any reaction occurs.
- What is the value of the equilibrium constant for the reaction.

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4. The equilibrium constant for the reaction:



is 6.0×10^{-2} . At equilibrium $[H_2] = 0.25\text{molL}^{-1}$ and

$$[NO_3] = 0.06\text{molL}^{-1}$$

Calculate the equilibrium concentration of N_2 .

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5. At certain temperature K_c for the reaction.

$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$ is 16. If initially one mole each of all the four gases are taken in one litre vessel, what are the equilibrium concentrations of NO and NO_2 ?



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6. Under certain conditions, the equilibrium constant for the decomposition of $PCl_5(g)$ into $PCl_3(g)$ and $Cl_2(g)$ is $0.0211 \text{ mol L}^{-1}$.

What are the equilibrium concentrations of PCl_5 , PCl_3 and Cl_2 if the initial concentration of PCl_5 was 1.00 M ?



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7. For the reactions $A + B \rightleftharpoons 3C$ at 25° C , a 3 litre vessel contains 1,2,4 mole of A, B and C respectively predict the direction of reaction if

- K_c for the reaction is 10
- K_c for the reaction is 15
- K_c for the reaction is 10.66



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8. For the reactions $A + B \rightleftharpoons 3C$ at $25^\circ C$, a 3 litre vessel contains 1,2,4 mole of A, B and C respectively predict the direction of reaction if

- K_c for the reaction is 10
- K_c for the reaction is 15
- K_c for the reaction is 10.66

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9. For the reactions $A + B \rightleftharpoons 3C$ at $25^\circ C$, a 3 litre vessel contains 1,2,4 mole of A, B and C respectively predict the direction of reaction if

- K_c for the reaction is 10
- K_c for the reaction is 15
- K_c for the reaction is 10.66

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10. A mixture of H_2 , N_2 and NH_3 with molar concentration $5.0 \times 10^{-3} \text{ molL}^{-1}$, $4.0 \times 10^{-3} \text{ molL}^{-1}$ and $2.0 \times 10^{-3} \text{ molL}^{-1}$

respectively was prepared and heated to $500K$. The value of K_c for the reaction:

$3H_2(g) + N_2(g) \rightleftharpoons 2NH_3(g)$ at this temperature is 60. Predict whether ammonia tends to form or decompose at this stage of concentration.

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11. At $500K$, K_p value for the reaction

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 2.5×10^{10} .

Find the value of K_p for each of following reactions at the same temperature.

a. $SO_2(g) + 1/2O_2(g) \rightleftharpoons SO_3(g)$

b. $SO_3(g) \rightleftharpoons SO_2(g) + 1/2O_2(g)$

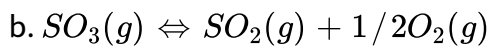
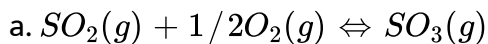
c. $3SO_2(g) + 3/2O_2(g) \rightleftharpoons 3SO_3(g)$

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12. At $500K$, K_p value for the reaction

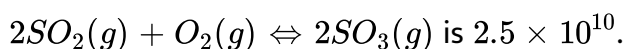
$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 2.5×10^{10} .

Find the value of K_p for each of followign reactions at the same temperature.

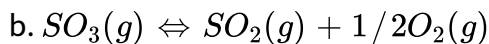
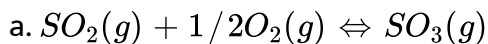


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13. At $500K$, K_p value for the reaction



Find the value of K_p for each of followign reactions at the same temperature.



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14. K_c for the reaction $N_2O(g) \rightleftharpoons 2NO_2(g)$ is 4.63×10^{-3} at $25^\circ C$.

a. What is the value of K_p at this temperature?

b. At $25^\circ C$, if the partial pressure of $N_2O_4(g)$ at equilibrium is 0.2 atm, calculate equilibrium pressure of $NO_2(g)$

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15. K_c for the reaction $N_2O(g) \rightleftharpoons 2NO_2(g)$ is 4.63×10^{-3} at $25^\circ C$.

a. What is the value of K_p at this temperature?

b. At $25^\circ C$, if the partial pressure of $N_2O_4(g)$ at equilibrium is 0.2 atm, calculate equilibrium pressure of $NO_2(g)$

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16. At $27^\circ C$, K_p value for the reversible reaction $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ is 0.65, calculate K_c .

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17. K_c for the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is 0.5 at 400K find K_p

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18. 1 mole of A and 1 mol³ of B are taken in a 5 litre flask, 0.5 mole of c is formed in the equilibrium of



What is molar concentration of each species if the reaction is carried with 2 mole A, 1 mole of B in a 5 litre flask at the same temperature.

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19. For the following reaction

$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$ 0.4 mole of Cl_2 are taken in a 1 litre flask.

If $K_c = 0.2$ predict the direction in which reaction proceeds.

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20. In an equilibrium $A + B \rightleftharpoons C + D$, A and B are mixed in a vessel at temperature T. The initial concentration of A was twice the initial concentration of B. After the attainment of equilibrium, concentration of C was thrice concentration of B, calculate K_c .

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21. A mixture of SO_2 , SO_3 and O_2 gases are maintained at equilibrium in 10 litre flask at a temperature at which K_c for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 100. At equilibrium.

a. If no. of moles of SO_3 and SO_2 in flask are same, how many moles of O_2 are present.

b. If no. of moles of SO_3 in flask is twice the no. of moles SO_2 how many moles of O_2 are present.

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22. A mixture of SO_2 , SO_3 and O_2 gases are maintained at equilibrium in 10 litre flask at a temperature at which K_c for the reaction $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ is 100. At equilibrium.

a. If no. of moles of SO_3 and SO_2 in flask are same, how many moles of O_2 are present.

b. If no. of moles of SO_3 in flask is twice the no. of moles SO_2 how many moles of O_2 are present.

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23. For $A + B \rightleftharpoons C$, the equilibrium concentrations of A and B at a temperature are 15molL^{-1} . When volume is doubled the reaction has equilibrium concentration of A is 10molL^{-1} . Calculate

a. K_c

b. concentration of C in original equilibrium.

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24. For $A + B \rightleftharpoons C$, the equilibrium concentrations of A and B at a temperature are 15molL^{-1} . When volume is doubled the reaction has equilibrium concentration of A is 10molL^{-1} . Calculate

a. K_c

b concentration of C in original equilibrium.



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25. A vessel at 100K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted into CO on addition of graphite. Calculate the value of K if total pressure at equilibrium is 0.8 atm.



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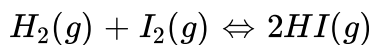
26. The K_p values for the reaction

$\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ at 460°C is 49. If the initial pressure of H_2 and I_2 are 0.5 atm respectively, determine the partial pressure of each gases at equilibrium.



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27. 0.5 mol of H_2 and 0.5 mole of I_2 react in 10 litre flask at $448^\circ C$. The equilibrium constant K_c is 50 for

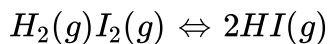


- What is the value of K_p
- Calculate mole of I_2 at equilibrium.



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28. 0.5 mol of H_2 and 0.5 mole of I_2 react in 10 litre flask at $448^\circ C$. The equilibrium constant K_c is 50 for

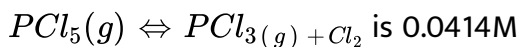


Calculate mole of I_2 at equilibrium.



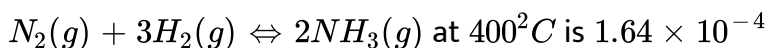
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29. How much PCl_5 must be added to a one litre vessel at $250^\circ C$ in order to obtain concentration of 0.1 mole of Cl_2 at equilibrium K_C for



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30. K_p for the reaction

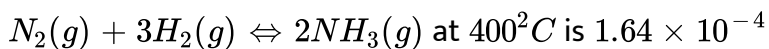


a. Calculate K_c

b. Calculate ΔG° value of K_c value.

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31. K_p for the reaction

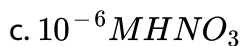
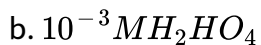
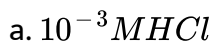


a. Calculate K_c

b. Calculate ΔG° value of K_c value.

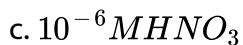
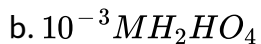
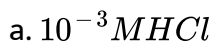
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32. Calculate pH of



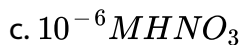
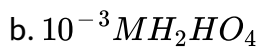
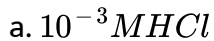
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33. Calculate pH of



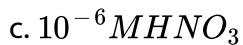
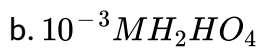
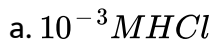
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34. Calculate pH of



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35. Calculate pH of



A. a. 1.7

B. b. 1.4

C. c. 2

D. d. 4

Answer:



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36. Calculate the pH for

a. $0.001MNaOH$

b. $0.01MCa(OH)_2$

c. $0.0008MBa(OH)_2$

d. $0.004MNaOH$



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37. Calculate the pH for

a. $0.001MNaOH$

b. $0.01MCa(OH)_2$

c. $0.0008MBa(OH)_2$

d. $0.004MNaOH$



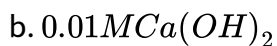
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38. Calculate the pH for



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39. Calculate the pH for



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40. The pH of a solution is 3.6. Calculate H_3O^+ ion concentration.



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41. The pH of a solution is 8.6. Calculate the OH^- ion concentration

$$pH = 8.6$$

$$pOH = 5.4$$

$$-\log[OH^-] = 10^{-5.4}$$

$$[OH^-] = 10^{-6} \times 10^{0.6} = 10^{-6} \times \text{antilog } 0.6$$

$$[OH^-] = 3.98 \times 10^{-6}$$



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42. What is $[H^+]$ for a solution in which

a. $pH = 3$ b. $pH = 4.75$ c. $pH = 4.4$?



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43. What is $[H^+]$ for a solution in which

a. $pH = 3$ b. $pH = 4.75$ c. $pH = 4.4$?



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44. What is $[H^+]$ for a solution in which

a. $pH = 3$ b. $pH = 4.75$ c. $pH = 4.4$?



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45. A solution of $0.005 \text{ M } H_2SO_4$ is diluted 100 times. Calculate the pH of diluted solution.



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46. A solution of HCl has a $pH = 3$. If one ml of it is diluted to 1 litre, what will be the pH of the resulting solution?



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47. The P^H of 10^{-8} M HCl is

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48. Calculate the pH of the following basic solutions

a. $[OH^-] = 0.05M$ b. $[OH^-] = 2 \times 10^{-4}M$

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49. Calculate the pH of the following basic solutions

a. $[OH^-] = 0.05M$ b. $[OH^-] = 2 \times 10^{-4}M$

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50. 2g of $NaOH$ is dissolved in water to give 1 litre solution. What is the pH of the solution?

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51. Calculate the pH of the following solutions.

a. 0.37g fo $Ca(OH)_2$ dissolved in water to give 500 ml solution

b. 0.3 g of NaOH dissolved in water to give 200 ml solution

c. 0.1825% HCl aqueous solution

d. 1 ml of 13.6 M HCl is diluted with water to give 1 litre solution.



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52. Calculate the pH of the following solutions.

a. 0.37g fo $Ca(OH)_2$ dissolved in water to give 500 ml solution

b. 0.3 g of NaOH dissolved in water to give 200 ml solution

c. 0.1825% HCl aqueous solution

d. 1 ml of 13.6 M HCl is diluted with water to give 1 litre solution.



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53. Calculate the pH of the following solutions.

a. 0.37g of $Ca(OH)_2$ dissolved in water to give 500 ml solution

b. 0.3 g of NaOH dissolved in water to give 200 ml solution

c. 0.1825% HCl aqueous solution

d. 1 ml of 13.6 M HCl is diluted with water to give 1 litre solution.

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54. Calculate the pH of the following solution :

(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 13.6M HCl is diluted with water to give 1 litre of solution.

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55. How many grams of NaOH are present in 100 ml solution if pH of the solution is 10?



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



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57. Calculate the pH of 10^{-8} m NaOH



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58. 150 ml of 0.5 HCl and 100 ml of 0.2 M HCl are mixed. Find the pH of the resulting solution.



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59. Calculate the p of solution obtained by mixign 10 ml fo 0.1 M HCl and 40 ml off $0.2MH_2SO_4$.

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60. 100 ml of $pH = 4$ solution is mixed with 100 ml of $pH = 6$ solution. What is the pH of resulting solution?

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61. Equal volumes of M NaOH and 0.3 M KOH are mixed in an experiment. Find the POH and pH of the resulting solution.

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62. 60 ml of 1 M HCl is mixed with 40 ml of 1M NaOH. What is the pHH of resultant solution?



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63. Calculate the pH of a solution which contains 100 ml of 0.1 M HCl and 9.9 ml of 1.0 M NaOH.

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64. What will be the resultant pH when 200 ml of an aqueous solution of HCl having $pH = 2$ is mixed with 300 ml of an aqueous solution of NaOH having $pH = 12$?

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65. 50 ml of 0.2 M HCl is added to 30 ml of 0.1 M KOH solution. Find the pH of the solution.

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66. 40 ml of $0.2M\text{HNO}_3$ when reacted with 60 ml of $0.3M\text{NaOH}$ gave a mixed solution. What is the pH of the resulting solution?

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67. 50 ml of $0.1M\text{H}_2\text{SO}_4$ were added to 100 ml of $0.2M\text{HNO}_3$. Then the solution is diluted to 300 ml. What is the pH of the solution?

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68. What is the K_w value in the aqueous solution of $pK_w = 13.725$?

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69. The ionic product of water at 80°C is 2.44×10^{-13} . What are the concentrations of hydronium ion and the hydroxide in pure water at 80°C ?

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70. The ionization constant for water is 2.9×10^{-14} at 40°C . Calculate

$[\text{H}_3\text{O}^+]$, $[\text{OH}^-]$, pH and pOH for pure water at 40°C .

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71. Calculate the pH of

a. 0.002 M acetic acid having 2.3% dissociation.

b. 0.002 M NH_4OH having 2.3% dissociation.

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72. Calculate the pH of

a. 0.002 M acetic acid having 2.3% dissociation.

b. 0.002 M NH_4OH having 2.3% dissociation.

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73. Calculate K_a of acetic acid from equilibrium concentration given

below:

$$[H_3O^+] = [CH_3COO^-] = 1.34 \times 10^{-3} M, [CH_3COOH] = 9.866 \times 10^{-3} M$$

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74. Calculate pH of 0.1 M acetic acid having $K_a = 1.8 \times 10^{-5}$

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75. The pH of 0.1 M solution of weak mono protic acid is 4.0. Calculate its

$[H^+]$ and K_a .

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76. K_a of 0.02M CH_3COOH is 1.8×10^{-5} Calculate

a. $[H_3O^+]$ b. % ionization c. pH

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77. K_a of $0.02MCH^3COOH$ is 1.8×10^{-5} Calculate

a. $[H_3O^+]$ b. % ionization c. pH

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78. K_a of $0.02MCH^3COOH$ is 1.8×10^{-5} Calculate

a. $[H_3O^+]$ b. % ionization c. pH

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79. Calculate the pH of 0.01 M solution of CH_3COOH . K_a for CH_3COOH at 298K is 1.8×10^{-5}

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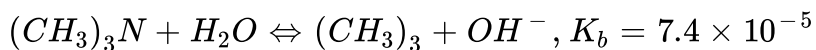
80. The pH of 0.1 M solution of an organic acid is 4.0. Calculate the dissociation constant of the acid.

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81. The ionization constants of HF , $HCOOH$ and HCN at 298 K are 6.8×10^{-4} , 1.8×10^{-4} and 4.7×10^{-9} respectively. Calculate the ionization constants of the corresponding conjugate base.

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82. Find the concentration of hydroxide ion in a 0.25 M solution of trimethylamine, a weak base.



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83. The 0.005 M monobasic acid has a pH of 5. What is the extent of ionization?

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84. 50 ml of $0.1M NH_4OH$, 25 ml of $2M NH_4Cl$ were used to make a buffer. What is the pH if pK_a is 4.8?

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85. The pH of a buffer prepared by mixing 50 ml of $0.2M CH_3COOH$ and 25 ml of CH_3COONa is 4.8. If the pK_a is 4.8, what is the strength of CH_3COONa ?

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86. 50 ml of 0.1 M sodium acetate, 25 ml of 0.2 M acetic acid were added together to form the buffer solution. pK_a of CH_3COOH is 4.8. Find the pH of the solution.

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87. When 20 ml of 0.1 MNH_4OH are added to 20 ml of MNH_4Cl solution, the pH of the buffer formed is 8.2. What is the pK_b of NH_4OH ?

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88. One litre of buffer solution contains 0.1 mole of acetic acid and 1 mole of sodium acetate. Find its pH if pK_a of CH_3COOH is 4.8.

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89. 50 ml of 1M CH_3COOH solution, when added to 50 ml of 0.5 M NaOH gives a solution with a pH value 'X'. Find the value of 'X', pK_a of acetic acid is 4.8.

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90. The solubility product of AgCl is $1.6 \times 10^{-10} \text{ mol}^2 / \text{L}^2$. What is its solubility?

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91. The solubility product of $\text{Zr}(\text{OH})_2$ is $4.5 \times 10^{-17} \text{ mol}^3 \text{L}^{-3}$. What is solubility?

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92. The solubility of Ag_2CrO_4 is $1.3 \times 10^{-4} \text{ mol L}^{-1}$. What is the solubility product?

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93. The solubility of $A_2B = 2 \times 10^{-3} \text{ mol L}^{-1}$. What is solubility product?

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94. The solubility product of a salt $AB = 10^{-10} \text{ mol}^2 \text{ L}^{-2}$. What is the solubility?

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95. PQ and RS_2 are two sparingly soluble salts. Their solubility products are equal and each equal to 4.0×10^{-18} . Which salt is more soluble?



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96. In a 0.1 solution, acetic acid is 1.34% ionized. Calculate $[H^+]$, $[CH_3COO^-]$ and $[CH_3COOH]$ in the solution and calculate K_a of acetic acid.



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Important Questions

1. State law of chemical equilibrium.



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2. Why the concentrations of pure liquids and pure solids are ignored from equilibrium constant expressions?



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3. What is heterogeneous equilibrium?

Write two heterogeneous reactions.

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4. Define equilibrium constant.

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5. Write the relation between K_p and K_c

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6. Give two chemical equilibrium reactions for which $K_p = K_c$

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7. Give two chemical equilibrium reactions for which $K_p > K_c$.

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8. Give two chemical equilibrium reactions for which $K_p < K_c$.

 [Watch Video Solution](#)

9. What are the factors which influence the chemical equilibrium?

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10. What is the effect of pressure on gaseous chemical equilibrium?

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11. The equilibrium constants of a reaction at 27°C and at 127°C are 1.6×10^{-3} and 7.6×10^{-2} respectively. Is the reaction exothermic or endothermic?

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

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13. What is a Bronsted base? Give one example.

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14. What is Lewis acid? Give one example.

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15. What is meant by ionic product of water?

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16. All Bronsted bases are Lewis bases? Explain.

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17. All Lewis acids are not Bronsted acids. Why?

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18. Give two examples of salts whose aqueous solutions are basic.

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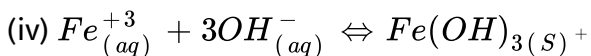
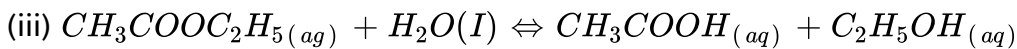
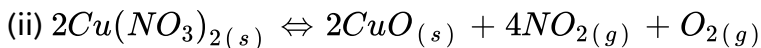
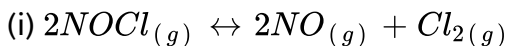
19. Give two examples of salts whose aqueous salts are acidic.

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20. What equation is used calculating the pH of an acid buffer?

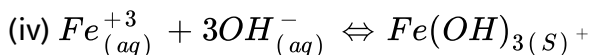
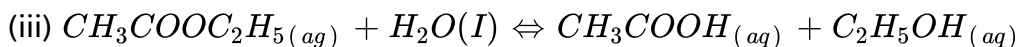
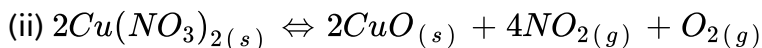
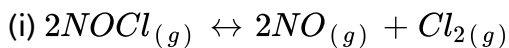
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21. Write expression for the equilibrium constant, K_c , for each of the following reactions:



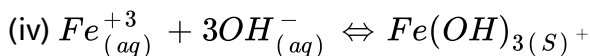
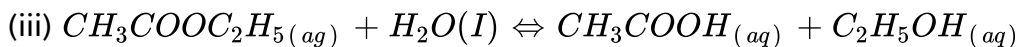
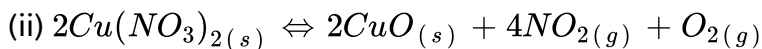
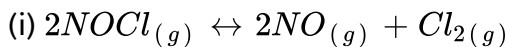
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22. Write expression for the equilibrium constant, K_c , for each of the following reactions:



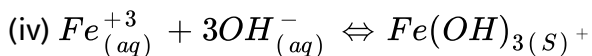
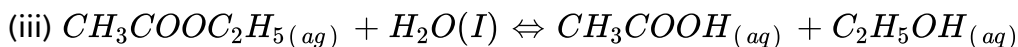
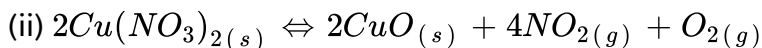
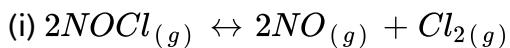
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23. Write expression for the equilibrium constant, K_c , for each of the following reactions:



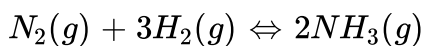
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24. Write expression for the equilibrium constant, K_c , for each of the following reactions:



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25. Derive the relation between K_p and K_c for the equilibrium reaction.



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26. Why sealed soda water bottle on opening shows the evolution of gas with effervescence?

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27. Explain the significance of : a very large value of K

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28. Explain the significance of : a very small value of K

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29. Explain the significance of : a value of K of about 1.0

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30. Why is it useful to compare Q with K ?

What is the situation when

a. $Q = K$ b. $Q < K$ c. $Q > K$?

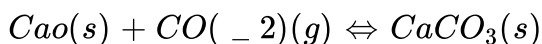
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31. Does the number of moles of reaction products increase, decrease, or remains same when each of the following equilibrium is subjected to a decrease in pressure by increasing the volume?



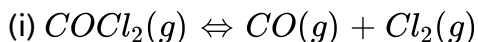
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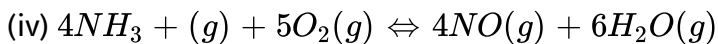
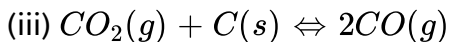
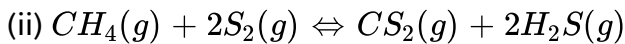
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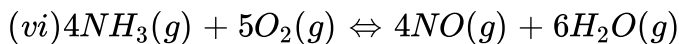
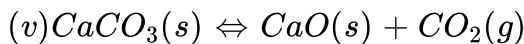
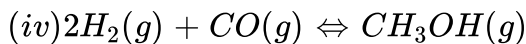
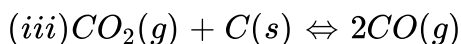
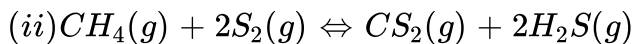
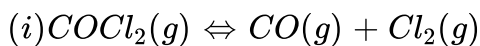
33. Which of the following reactions will get affected by increasing the pressure? Also mention whether change will cause the reaction to go into forward or backward direction.





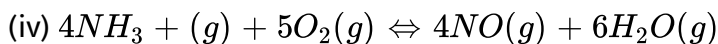
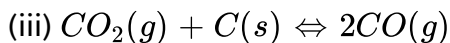
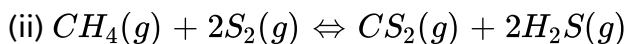
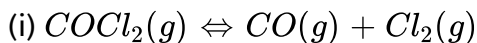
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34. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction to go into forward or backward direction.



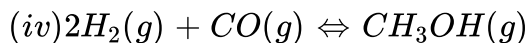
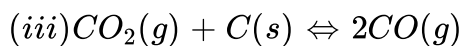
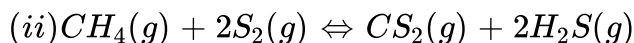
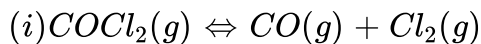
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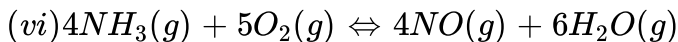
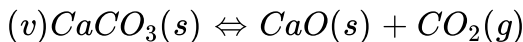
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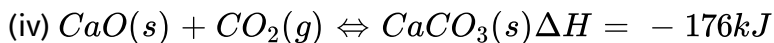
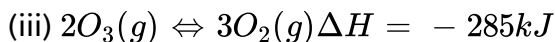
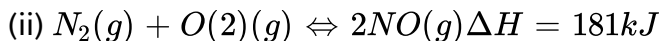
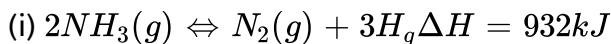
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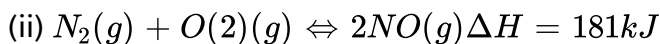
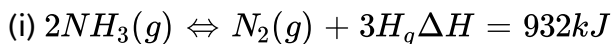
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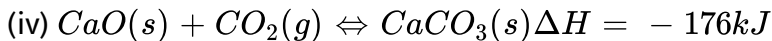
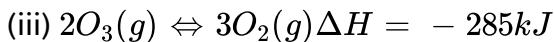
37. How will an increase in pressure and affect each of the following equilibria? An increase in temperature



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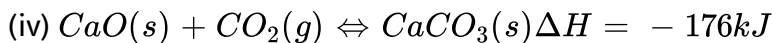
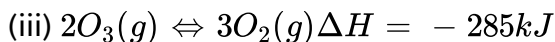
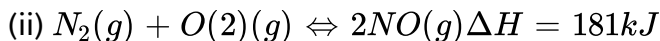
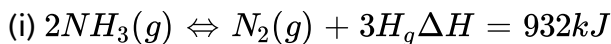
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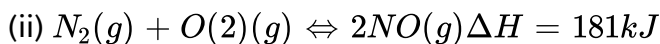
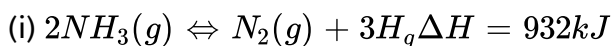
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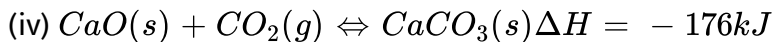
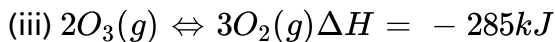
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40. How will an increase in pressure and affect each of the following equilibria? An increase in temperature





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41. The dissociation of HI is independent of pressure, while the dissociation of PCl_3 depends upon the pressure applied explain.

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42. Explain the Arrhenius concept of acids and bases.

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43. What is a conjugate acid base pair? Illustration with examples.

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44. Show by suitable equations that each of the following species can act as a Bronsted base: H_2O

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45. The species H_2O , HCO_3^- , HSO_4^- and NH_3 can act both as Bronsted acids and base. Give the corresponding conjugate acid and base for each of them.

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46. Classify the species $AlCl_3$, NY_3 , Mg^{+2} and H_2O into Lewis acids and Lewis bases and justify your answer?

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47. Define ionic product of water. What is the value at room temperature?



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48. Define pH. pH cannot be calculated directly from the molar concentration of a weak acid or weak base. Why? Derive an equation for the pH of a weak acid.



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49. What is common ion effect? Illustrate.



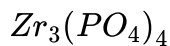
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50. Define solubility product. Write solubility product expressions for the following:



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51. Define solubility product. Write solubility product expressions for the following:



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52. Aqueous solution of NH_4Cl is acidic. Explain.

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53. Aqueous solution of CH_3COONa is basic. Explain

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54. What are equilibrium processes? Explain equilibrium in Physical and Chemical processes with examples.

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55. What are the important features of equilibrium constant? Discuss any two applications of equilibrium constant.

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56. What is Le Chatelier's principle? Discuss briefly the factors which can influence the equilibrium.

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57. Discuss the application of LE Chatellier's principle for the industrial synthesis of Ammonia and sulphur trioxide.

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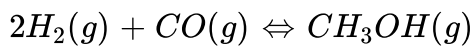
58. Describe the effect of:

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.



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59. Explain the concept of Bronsted acids and Bronsted bases. Illustrate the answer with suitable examples.

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60. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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61. Define pH. What is buffer solution? Derive Henderson-Hasselbalch equation for calculating the pH of an acid buffer solution.

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62. Explain the term Hydrolysis of salts with examples. Discuss the pH of the following types of salt solutions.

(i) Salts of weak acid and strong base.

(ii) Salts of strong acid and weak base.

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63. Explain the term Hydrolysis of salts with examples. Discuss the pH of the following types of salt solutions.

(i) Salts of weak acid and strong base.

(ii) Salts of strong acid and weak base.

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64. What is solubility product? Explain the common ion effect on solubility of ionic salts.

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Very Short Answer Questions

1. State law of chemical equilibrium.

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2. Can equilibrium be achieved between water and its vapours in an open vessel? Explain.

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3. Why the concentrations of pure liquids and pure solids are ignored from equilibrium constant expressions?

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4. What is homogeneous equilibrium? Write two homogeneous reactions.

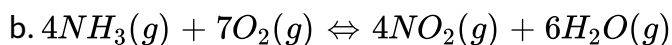
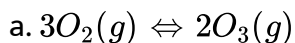
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5. What is heterogenous equilibrium?

Write two heterogeneous reactions.

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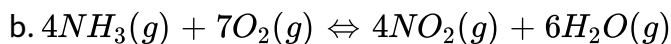
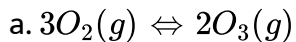
6. Write reaction quotient, Q , for each of the following reactions.





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7. Write reaction quotient, Q , for each of the following reactions.



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8. Define equilibrium constant.



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9. The equilibrium constant expression for a gas reaction is

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

Write the balanced chemical equation corresponding to this expression.



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10. Write the relation between K_p and K_c

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11. Under what conditions for a reaction K_p and K_c are numerically equal?

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12. Give two chemical equilibrium reactions for which $K_p = K_c$

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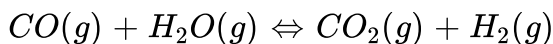
13. Give two chemical equilibrium reactions for which $K_p > K_c$.

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14. Give two chemical equilibrium reactions for which $K_p < K_c$.

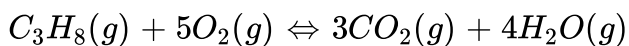
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15. Write the equations for the conversion of K_c to K_p for each of the following reaction.



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16. Write the equations for the conversion of K_c to K_p for each of the following reaction.



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17. What are the factors which influence the chemical equilibrium?

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18. What is the effect of pressure on gaseous chemical equilibrium?

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19. What is the effect of increase in concentration of reactants of a chemical reaction at equilibrium?

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20. Can catalyst disturb the state of equilibrium?

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21. On which factor, the equilibrium constant value changer?

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22. The equilibrium constants of a reaction at 27°C and at 127°C are 1.6×10^{-3} and 7.6×10^{-2} respectively. Is the reaction exothermic or endothermic?

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23. What is the effect of temperature on a system at equilibrium?

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

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25. What kind of equilibrium constant can be calculated from ΔG° value for a reaction involving only gases?



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26. What is a Bronsted base? Give one example.



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27. What is Lewis acid? Give one example.



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28. What is meant by ionic product of water?



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29. What is the value of K_w ? What are its units?



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30. What is the effect of temperature on ionic product of water?

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The ionic product of water is 1×10^{-14} at $25^\circ C$ and 3.0×10^{-14} at $40^\circ C$

is the above process endothermic or exothermic?

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32. All Bronsted bases are Lewis bases? Explain.

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33. All Lewis acids are not Bronsted acids. Why?

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34. What is degree of ionisation?

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35. What is the measure of strength of an acid and base?

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36. Give two examples of salts whose aqueous solutions are basic.

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37. Give two examples of salts whose aqueous salts are acidic.

 [Watch Video Solution](#)

38. What equation is used calculating the pH of an acid buffer?

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39. Phosphoric acid (H_3PO_4) have three ionization constants K_{a1} , K_{a2} and K_{a3} . Among these ionization constants which has a lower value ? Give reason for it.

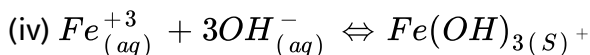
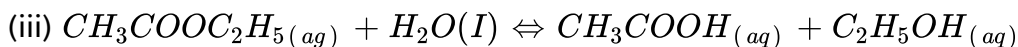
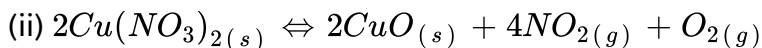
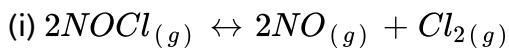
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40. Ice melts slowly at high altitudes. Explain Why?

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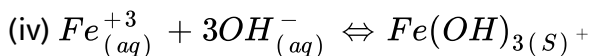
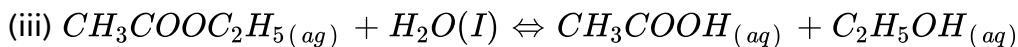
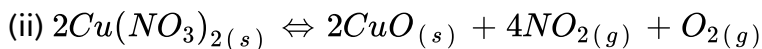
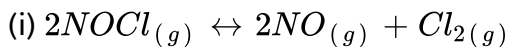
Short Answer Questions

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



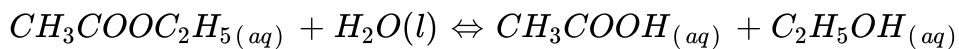
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2. Write expression for the equilibrium constant, K_c , for each of the following reactions:



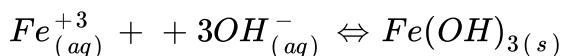
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3. Write expression for the equilibrium constant, K_c for each of the following reactions.



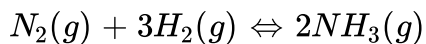
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4. Write expression for the equilibrium constant, K_c for each of the following reactions.



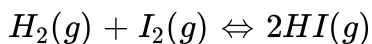
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5. Derive the relation between K_p and K_c for the equilibrium reaction.



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6. Define equilibrium constant. Write the equilibrium constant expression for the reaction of



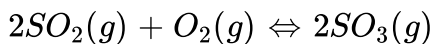
and its reverse reaction. How are the two equilibrium constants related?

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7. How does the values of equilibrium constant predict the extent of reaction?

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8. State law of chemical equilibrium? What is K_c for the following equilibrium when the equilibrium concentration of each substance is $[SO_2] = 0.60M$, $[O_2] = 0.82M$ and $[SO_3] = 1.90M$



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9. Why sealed soda water bottle on opening shows the evolution of gas with effervescence?

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10. Explain the significance of : a very large value of K

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11. Explain the significance of : a very small value of K

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12. Explain the significance of : a value of K of about 1.0

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13. Why is it useful to compare Q with K ?

What is the situation when

a. $Q = K$ b. $Q < K$ c. $Q > K$?



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14. Why is it useful to compare Q with K ?

What is the situation when

a. $Q = K$ b. $Q < K$ c. $Q > K$?



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15. Why is it useful to compare Q with K ?

What is the situation when

a. $Q = K$ b. $Q < K$ c. $Q > K$?



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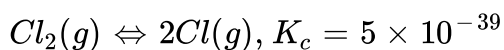
16. For the reaction

$Cl_2(g) + F_2(g) \rightleftharpoons ClF(g)$, $K_c = 19.9$ What will happen in a mixture originally containing $[Cl_2] = 0.04\text{molL}^{-1}$,

$[F_2] = 0.2\text{molL}^{-1}$ and $[ClF] = 7.3\text{molL}^{-1}$?

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17. Predict which of the following reactionn will have appreciable concentration of reactants and products:



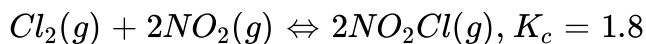
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18. Predict which of the following reactionn will have appreciable concentration of reactants and products:



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19. Predict which of the following reactionn will have appreciable concentration of reactants and products:



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20. How to recognise the conditions under which changes in pressure would effect system in equilibrium.

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21. What property of a reaction can be used to predict the effect of a change in temperature on the magnitude of an equilibrium constant?

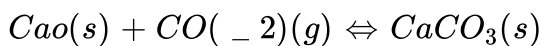
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22. Does the number of moles of reaction products increase, decrease, or remains same when each of the following equilibrium is subjected to a decrease in pressure by increasing the volume?



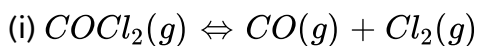
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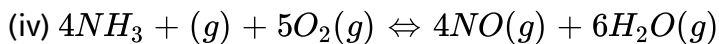
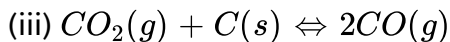
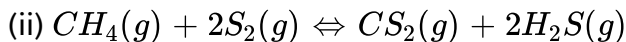
23. Does the number of moles of reaction products increase, decrease, or remains same when each of the following equilibrium is subjected to a decrease in pressure by increasing the volume?



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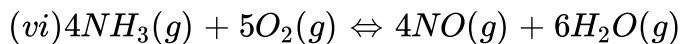
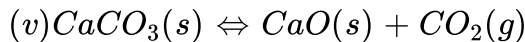
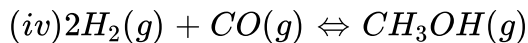
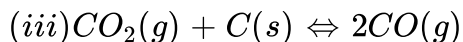
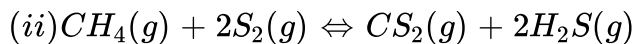
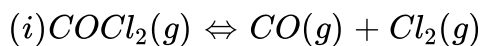
24. Which of the following reactions will get affected by increasing the pressure? Also mention whether change will cause the reaction to go into forward or backward direction.





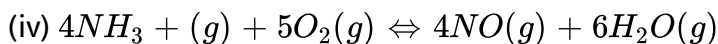
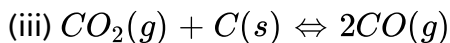
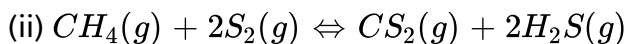
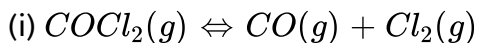
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25. Which of the following reactions will get affected by increasing the pressure? Also, mention whether change will cause the reaction to go into forward or backward direction.



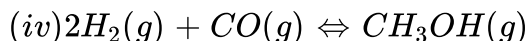
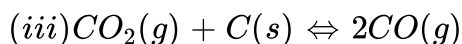
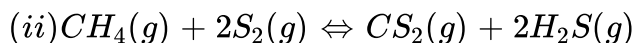
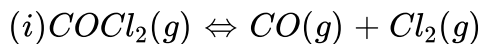
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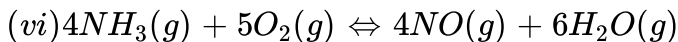
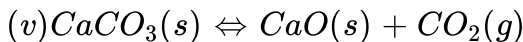
26. Which of the following reactions will get affected by increasing the pressure? Also mention whether change will cause the reaction to go into forward or backward direction.



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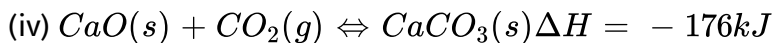
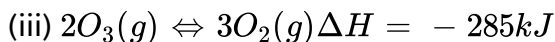
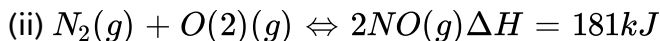
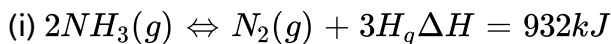
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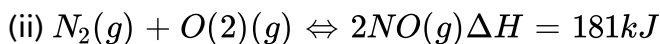
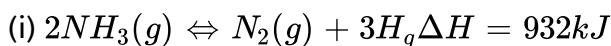
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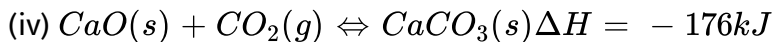
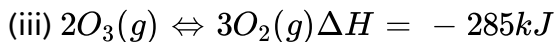
28. How will an increase in pressure and affect each of the following equilibria? An increase in temperature



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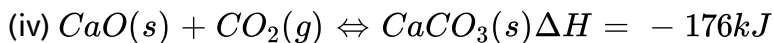
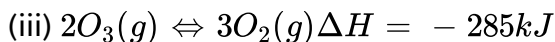
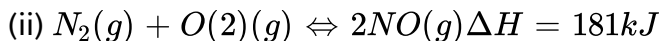
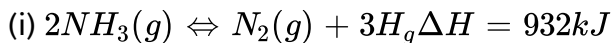
29. How will an increase in pressure and affect each of the following equilibria? An increase in temperature





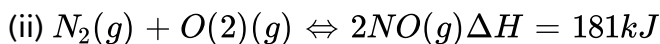
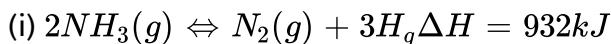
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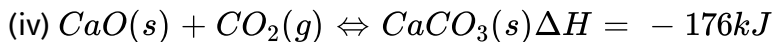
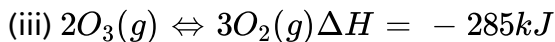
30. How will an increase in pressure and affect each of the following equilibria? An increase in temperature



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31. How will an increase in pressure and affect each of the following equilibria? An increase in temperature





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32. The dissociation of HI is independent of pressure, while the dissociation of PCl_3 depends upon the pressure applied explain.

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33. Explain the term: Electrolyte

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34. Explain the term: Non-electrolyte

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35. Explain the term: Strong and weak electrolytes

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36. Explain the term: Ionic equilibrium

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37. Explain the terms: extent of ionization and on what factors it depends

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38. Explain the Arrhenius concept of acids and bases.

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39. What is a conjugate acid base pair? Illustration with examples.



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40. Acetic acid is a weak acid. List in order of descending concentration all of the ionic and molecular species present in 1M aqueous solution of acetic acid.



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41. Show by suitable equations that each of the following species can act as a Bronsted base: H_2O



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42. Show by suitable equations that each of the following species can act as a Bronsted base: OH^-



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43. Show by suitable equations that each of the following species can act as a Bronsted base: C_2H_5OH

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44. Show by suitable equations that each of the following species can act as a Bronsted base: HPO_4^{-2}

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45. The species H_2O , HCO_3^- , HSO_4^- and NH_3 can act both as Bronsted acids and base. Give the corresponding conjugate acid and base for each of them.

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46. Write equation that shows $H_2PO_4^-$ acting both as an acid and as a base.

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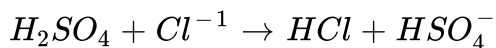
47. Write the conjugate acid and conjugate base of each of the following:



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48. Identify and label the Bronsted acid and its conjugate base, the

Bronsted base and its conjugate acid in each of the following equations.



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49. Classify the species $AlCl_3$, NY_3 , Mg^{+2} and H_2O into Lewis acids and

Lewis bases and justify your answer?

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50. What are the strengths of conjugate bases of a strong acid and a weak acid?

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51. What are the strengths of conjugate acids of a strong base and weak base?

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52. Define ionic product of water. What is the value at room temperature?

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53. Define pH. pH cannot be calculated directly from the molar concentration of a weak acid or weak base. Why? Derive an equation for the pH of a weak acid.

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54. Write equations to show the step wise ionization of the polyprotic acids H_2SO_4 and H_3PO_4 .

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55. Explain how acid strength changes among

i. the hydrides of the group elements and

(ii) the hydrides in the same row of the periodic.

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56. Explain how acid strength changes among

i. the hydrides of the group elements and

(ii) the hydrides in the same row of the periodic.

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57. Justify the statement that water behaves like an acid and also like a base on the basis of the protonic concept.

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58. What is the common ion effect? Illustrate.

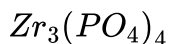
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59. Define the solubility product. Write the solubility product expressions for the following:



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60. Define the solubility product. Write the solubility product expressions for the following:





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61. Give the classification of salts. What types of salts undergo hydrolysis?



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62. What must be true of value of ΔG° for a reaction if

$$K > 1$$



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63. What must be true of value of ΔG° for a reaction if

$$K = 1$$



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64. What must be true of value of ΔG° for a reaction if

$$K = 1$$

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65. Aqueous solution of NH_4Cl is acidic. Explain.

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66. Aqueous solution of CH_3COONa is basic. Explain

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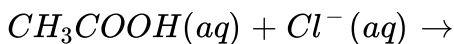
67. Give reason that acetic acid is less acidic in sodium acetate solution than in sodium chloride solution.

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68. $AgCl$ is less soluble in $AgNO_3$ solution than in pure water. Explain.

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69. Predict whether the following reaction will proceed from left to the right to any measurable extent:



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70. Aqueous solution of H_2S contains H_2S , HS^- , S^{2-} , H_3O^+ , OH^- and H_2O in varying concentrations. Which of these species can act only as a base? Which can act only as an acid? Which can act both as an acid and as a base?

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1. What are equilibrium processes? Explain equilibrium in Physical and Chemical processes with examples.

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2. What is meant by dynamic equilibrium?

Explain with suitable examples.

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3. Give the general characteristics of equilibrium involving physical processes.

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4. What are the important features of equilibrium constant? Discuss any two applications of equilibrium constant.





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5. What is Le Chatelier's principle? Discuss briefly the factors which can influence the equilibrium.



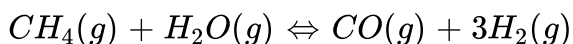
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6. Discuss the application of Le Chatelier's principle for the industrial synthesis of Ammonia and sulphur trioxide.



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

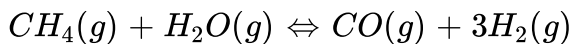


- Write an expression for K_p for the above reaction.
- How will the values of K_p and composition of equilibrium mixture be affected by

(i) increasing the pressure (ii) increasing the temperature (iii) using a catalyst?

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



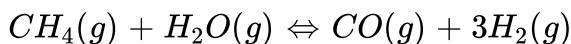
a. Write an expression for K_p for the above reaction.

b. How will the values 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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9. Dihydrogen gas is obtained from natural gas by partial oxidation with steam as per the following endothermic reaction.



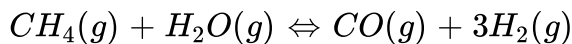
a. Write an expression for K_p for the above reaction.

b. How will the values 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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10. Dihydrogen gas is obtained from natural gas by partial oxidation with steam as per the following endothermic reaction.



a. Write an expression for K_p for the above reaction.

b. How will the values 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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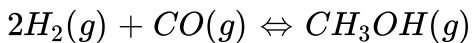
11. Describe the effect of:

a. addition of H_2

b. addition of CH_3OH

c. removal of CO

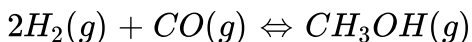
d. removal of CH_3OH on the equilibrium of the reaction.



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12. Describe the effect of:

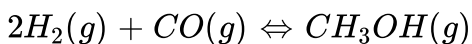
addition of CH_3OH on the equilibrium of the reaction



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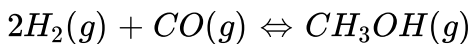
13. Describe the effect of:

removal of CO on the equilibrium of the reaction



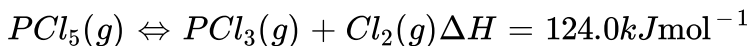
14. Describe the effect of:

- addition of H_2
- addition of CH_3OH
- removal of CO
- removal of CH_3OH on the equilibrium of the reaction.



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15. At 473K, equilibrium constant K_C for the decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3} . If the decomposition is depicted as:

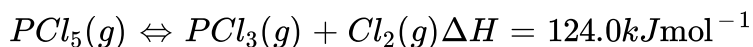


- Write an expression of K_c for the reaction.
- What is the value of K_c for the reverse reaction at the same temperature?
- What would be effect on K_c if

(i) more PCl_5 is added (ii) pressure is increased (iii) the temperature is increased.

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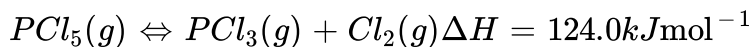
16. At 473K, equilibrium constant K_C for the decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3} . If the decomposition is depicted as:



- Write an expression of K_c for the reaction.
- What is the value of K_c for the reverse reaction at the same temperature?
- What would be effect on K_c if
 - more PCl_5 is added
 - pressure is increased
 - the temperature is increased.

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17. At 473K, equilibrium constant K_C for the decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3} . If the decomposition is depicted as:

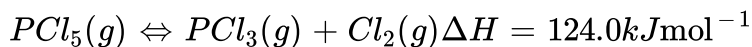


- Write an expression of K_c for the reaction.
- What is the value of K_c for the reverse reaction at the same temperature?
- What would be effect on K_c if
 - more PCl_5 is added
 - pressure is increased
 - the temperature is increased.



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18. At 473K, equilibrium constant K_C for the decomposition of phosphorus pentachloride, PCl_5 is 8.3×10^{-3} . If the decomposition is depicted as:



- Write an expression of K_c for the reaction.

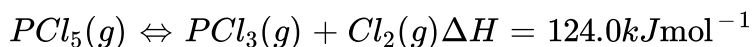
b. What is the value of K_c for the reverse reaction at the same temperature?

c. What would be effect on K_c if

(i) more PCl_5 is added (ii) pressure is increased (iii) the temperature in increased.

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19. At 473K, equilibrium constant K_C for the decompositioni of phosphorus pentachloride, PCl_5 is 8.3×10^{-3} . If the decomposition is depicted as:



a. Write an expression of 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 effect on K_c if

(i) more PCl_5 is added (ii) pressure is increased (iii) the temperature in increased.

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20. Explain the concept of Bronsted acids and Bronsted bases. Illustrate the answer with suitable examples.

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21. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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22. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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23. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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24. Explain Lewis acid base theory with suitable example. Classify the following species into Lewis acids and Lewis bases and show how these act as Lewis acid/base.

a. OH^- b. F^- c. H^+ d. BCl_3

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25. What is degree of ionization in respect of weak acids and weak bases? Derive the relationship between degree of ionization (α) and ionization

constant (K_a) for the weak acid HX.

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26. Define pH. What is buffer solution? Derive Henderson-Hasselbalch equation for calculating the pH of an acid buffer solution.

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27. Explain the term Hydrolysis of salts with examples. Discuss the pH of the following types of salt solutions.

(i) Salts of weak acid and strong base.

(ii) Salts of strong acid and weak base.

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28. Explain the term Hydrolysis of salts with examples. Discuss the pH of the following types of salt solutions.

(i) Salts of weak acid and strong base.

(ii) Salts of strong acid and weak base.

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29. What is solubility product? Explain the common ion effect on solubility of ionic salts.

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30. Write notes on

(i) Common ion effect

(ii) The relation between K_{sp} and solubility (S) of a sparingly soluble salt

$BaSO_4$.

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31. Write notes on

(i) Common ion effect

(ii) The relation between K_{sp} and solubility (S) of a sparingly soluble salt

$BaSO_4$.



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