CHEMISTRY

BOOKS - V PUBLICATION

EQUILIBRIUM

Question Bank

1. A liquid is in equilibrium with its vapour in a sealed container at a fixed temoperature. The volume of the container is suddenly increased. What is the initial effect of the change on vapour pressyre?

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2. What is 'K_c' for the following equilibrium when the equilibrium concentration of each sub'stance is:

$[SO_2] = 0.60M$, $[O_2] = 0.82M$ and $[SO_3] = 1.90M 2SO_2(g) + O_2(g) \Leftrightarrow 2$

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3. At a certain temperature and total pressure of 10^5 Pa ,iodine vapour contains $40\,\%$ by volume of iodine atoms. Calaulate K_p for the equilibrium, $1_2(g) \Leftrightarrow 2I(g)$.

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

i) '2 NOCl_(g)^ hArr 2 NO_(g)+Cl_2(g)'

ii) '2 Cu(NO_3)_(s) hArr 2 CuO_(s)^2+4 NO_2(g)+O_2(g)'

iii) 'CH_3 COOC_2 H_5(aq)+H_2 O_(l) hArr CH_3 COOH_(aq)+C_2 H_5 OH_(aq)'

iv) 'F e_((aq) ^(3+)+3 OH_ (aq)^- hArr F e(O H)_3(s)'

v) 'I_2(s)+5 F_2 hArr 2 IF_5'

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

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

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

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

What is K_c for the reverse reactions?

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

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8. Reaction between 'N_2' and 'O_2' takes place as following:

'2 N_2 (g)+O_2(g) hArr 2 N_2 O_(g)'

If a mixture of '0.482' mol of 'N_2' and '0.933' mol of 'O_2' is placed in a reaction vessel of volume '10 L' and allowed to form 'N_2 O' at a temperature for which 'K c=2.0 xx 10^-(37)' Determine the composition of equilibrium mixture.

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

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10. The equilibrium constant expression for a gas reaction is Kc =[N H3]^4 + [O2]^5 / [N O]^4+ [H2O]^6 Write the balanced chemical equation

corresponding to this expression.

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11. One mole of H_2O and one mole of CO are taken in a 10L vessel and heated to 725K. At equilibrium $40\,\%$ of water (by mass) reacts with CO according to the equation

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

Calculate the equilibrium constant for the reaction.

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

'CH_3 COOH_( )+C_2 H_5 OH_(l) hArr CH_3 COOC_2 H_5_(l)+H_2 O_(l)'

i) Write the concentration ratio (reaction quotient), 'Q_c', for this reaction (note: water is not in excess and is not a solvent in this reaction)

ii) At '293 K', if one starts with '1.00' mol of acetic acid and '0.18 mol' of ethanol, there is '0.171' mol of ethyl acetate in the final equilibrium

mixture. Calculate the equilibrium constant.

iii) Starting with '0.5' mol of ethanol and '1.0' mol of acetic acid and maintaining it at 293 ' K, '0.214' mol of ethyl acetate is found after sometime. Has equilibrium been reached?

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13. Equilibrium constant 'K_c' for the reaction

'N_2(g)+3 H_2(g) hArr 2 N H_3(g)' at '500 K' is '0.061'

At a particular time, the analysis shows that composition of the reaction mixture is '3.0 molL^(-1) N_2, 2.0' mol 'L^(-1) . H^2' and '0.5 mol L^(-1) NH_3 .' Is the reaction at equilibrium? If not in which direction does the reaction tend to proceed to reach equilibrium?

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14. Calculate (a) ΔG^0 and (b) the equilibrium constant for the formation of NO_2 from NO and O_2 at 298 K

$$NO_g + \frac{1}{2}O_2(g) \Leftrightarrow NO_2(g)$$

where $\Delta G_f^0(NO_2)$=52.0 k J / mol

$\Delta G_f^0(NO)$=87.0 k J / mol

$\Delta G_f^0(O_2)$=0 k J / mol

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15. Do the number of moles of reaction products increase, decrease or remain or remain same when each of the following equilibria is subjected to a decrease in pressure by increasing the volume?

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

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

i) 'COCl_2(g) hArr CO_(g)+Cl_2(g)'

ii) 'C H_4(g)+2 S_2(g) hArr CS_2(g)+2 H_2 S_(g)' iii) 'CO_2(g)+C_(s) hArr 2 CO_(g)'

iv) '2 H_2(g)+CO_ th) hArr CH_3 OH_(g)'

'v) CaCO_3(s) hArr CaO_(s)+CO_2(g)'

vi) '4 NH_3(g)+5 O_2(g) hArr 4 NO_(g)+6 H_2 O_(g'

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

'C H_4(g)+H_2 O_(g) hArr C O_(g)+3 H_2(g)'

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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18. Describe the effect of:

a) addition of H_2.

b) addition of CH_3OH

c) removal of CO

d) removal of CH_3OH $^\circ$

$2H_2(g) + CO_g \Leftrightarrow CH_3OH_g$

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19. At '473 K', equilibrium constant Kc for decomposition of phosphorus pentachloride 'PCl_5' is '8.3 xx 10^(-3) .' If decomposition is depicted as, 'PCl_5(g) hArr PCl_3(g)+Cl_2(g) , Delta, H^circ=124.0 kJmol^(-1)'

a. write an expression for 'K_c' for the reaction

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

c. what would be the effect on 'K' c if (i) more 'PCl_5' is added (ii) pressure is increased. (iii) the temperature is increased?

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20. Predict which of the following reaction will have appreciable concentration of reactants and products.

a) 'Cl_2(g) hArr 2 Cl_kg , K_c=5 xx 10^(-39)'

b) 'Cl_2(g)+2 NO_(g) hArr 2 NOCl_(g) , K_c=3.7 xx 10^8'

c) 'Cl_2(g)+2 NO_2(g) hArr 2 NO_2 Cl_(g) , K_c=1.8'

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21. The value of 'K_c' of the reaction '3O_2(g) gives 2O_3(g)' is '2.0 x 10^(-50' at '25^circ C'. If the equilibrium concentration of 'O_2' in air át '25^circ C' is '1.6 x 10^(-2)', what is the concentration of 'O_3' ?

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22. What is meant by the conjugate acid base pair? Find the conjugate acid '/' base for the following species:

$HNO_2, CN, HClO_4, F, OH, CO_3^{2-}$, and S^{2-}

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23. Which of the following are lewis acids?

'H_2 O, B F_3, H^+ , N H4+

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24. Write the conjugate bases of the following: H_2SO_4, NH_3, HCO_3^- and H_2O

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25. Write the conjugate acids of the following :NH_3, HCO_3^- and H_2O

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26. The species: 'H_2 O, HCO_3-, HSO_4-' and 'NH_3^-' can act both as Bronsted acids and bases. For each case give the corresponding conjugate acid and base.

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27. 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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28. The ionization constants of HF,HCOOH and HCN at 298K are 6.8×10^{-4},1.8×10^{-4} and 4.8×10^{-9} respectively. Calculate the ionizaion constants of the corresponding conjugate base.

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29. Assuming complete dissociation, calculate the pH of the following solutions:

(a) '0.003 M HCl'

(b) '0.005 M NaOH'

(c) '0.002 M HBr'

(d) '0.002 M KOH'

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30. The degree of ionisation of 0.1 M bromoacetic acid solution is 0.132. Calculate the pH of the solution and the pKa of bromoacetic acid.

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31. The 'p^H' of '0.005 M' codeine '(C_(18) H_(21) NO_3)' solution is '9.95' Calculate its ionization constant and 'pK_b'

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32. What is the pH of 0.001 M aniline solution. The ionization constant of aniline is 4.3× 10^-10.Cálculate the degree of ionization of aniline in the solution. Also calculate the ionization constant for the conjugate acid of aniline?

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33. the concentration of hydrogen ion in a sample of soft drink is 3.8×10^{-3}M. what is its ph?

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34. The 'p^H' of '0.1 M' solution of cyanic acid (HCNO) is 2.34. Calculate the ionization constant of the acid and its degree of ionization in the solution.

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35. The ionization constant of nitrous acid is 4.5×10^{-4}. Calculate thr pH of 0.04 M sodium nitrite solution and also its degree of hydrolysis.

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36. A 0.02 M solution of pyridinium hydrochloride has 'p^H=3.44'. Calculate the ionization constant of pyridine:

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37. Predict if the solution of the following salts are neutral, acidic or basic: 'NaCl, KBr, NaCN, NH_4 NO_3, NaNO_2' and 'KF'.

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38. calculate the $[H^+]$ in the following biological fluid whose pH are given in brackets. Human muscle fluid(6.83)

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39. The pH of milk, black coffee, tomato juice, lemon juice and egg white are '6.8,5.0', 4.2,2.2 and '7.8' respectively. Calculate corresponding hydrogen ion concentration in each.

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40. What is the maximum concentration of equimolar solutions of ferrous sulphate and sodium sulphide so that when mixed in equal volumes, there is no precipitation of iron sulphide? (For iron sulphide 'K_sp=6.3 xx 10^(-18)').

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41. Two moles of PCl_5 were introduced in a 2L flask and heated at $600K$ to attain the equilibrium. PCl_5 was found to be $40\,\%$ dissociated into PCl_3 and Cl_2. Calculate the value of Kc.

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

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

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43. The 'pH'.of a tomato juice is '4.4'. Calculate '[H_3 O^+]'

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44. 4.9 g of sulphuric acid is present in $500mL$ of the solution. Calculate the pH of a solution.

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45. The ionization constant of acetic acid is 1.74 x 10^(-5) .Calculate the degree of dissociations of acetic acid in its '0.05 M' solution. Calculate the concentration of acetate ion in the solution.

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46. For the reaction $H_2(g) + I_2(g) \Leftrightarrow 2HI(g)$

$Kc = 54.8$ at $700K$. Calculate the value of K_p

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47. Calculate the pH of a solution when (i) $49.9ml$ of $0.1MNaOH$ and (ii) $50.0ml$ of $0.1MNaOH$ added to $50ml$ of $0.1MHCl$

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48. The ionic product of water at 310 K is 2.7×10^{-14}. What is the pH of neutral water at this temperature.

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49. The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-13}. How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility in pure'water?

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50. A 0.02M solution of pyridinium hydrochloride has ph = 3.44. Calculate the ionization constant of pyridine.

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51. Calculate '[OH^-]' in case of soft drink having 'pH=4.4'

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52. Calulate the pH of the buffer solution formed by mixing 0.2M NH_4Cl and 0.1M NH_3K_b of ammonia is 1.77×10^{-5}

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53. The solubility of 'CaF_2' in water at '298 K' is '1.7 xx 10^(-5)' grams per '100 cm^3 .' Calculąte the solubility product of 'CaF_2' at '298 K'.

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54. Benzoic acid is a monobasic acid. When '1.22' of its pure sample are dissolved is water and titrated against base '50 mL' of '0.2 M' NaOH are used up. Calculate the molar mass of benzoic acid.

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55. The solubility of AgCl in water at '25^circ C' is found to be '1.06 xx 10^(-5)' moles per litre. Calculate the solubility product of AgCl at this temperature.

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56. Lead chloride has a solubility product of '1.7 xx 10^(-5)' at '298 K .' Calculate its solubility at this temperature.

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57. The effect of increasing pressure on the gaseous equilibrium

'2 A+3 B=3 A+2 B' indicates that

A. forward reaction is favoured

B. backward reaction is favoured.

C. no effect of pressure

D. None of the these

Answer: C

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58. For the equilibrium reaction 2 NO2(g) ↔ N2 O4(g)+60.0 kJ The increase in temperature (1)Favour the formation of N O (2)Favours the decomposition of N2 O4 (3)does not effect the equilibrium (4)stops the reaction

A. favours the formation of 'N' O

B. favours the decomposition of 'N_2 O_*'

C. does not effect the equilibrium

D. stops the reaction

Answer: B

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59. Which of the following will favours the reverse reaction in a chemical equilibrium? (1)Increasing the concentration of one of the reactants. (2)Removal of atleast one of the products at regular intervals. (3)Increasing the concentration of one or more of the products. (4)None of the these

A. Increasing the concentration of one of the reactants

B. Removal of atleast one of the products at regular intervals.

C. Increasing the concentration of one or more of the products

D. None of the these

Answer: C

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60. Pick the correct statement from the following: the addition of a catalyst changes equilibrium constant., a catalyst speeds up the forward reaction but slows down the reverse reaction., the composition of

equilibriụm is changed by catalyst., addition of catalyst does not change the equilibtium concentrations

A. the addition of a catalyst changes equilibrium constant.

B. a catalyst speeds up the forward reaction but slows down the reverse reaction.

C. the composition of equilibriụm is changed by catalyst.

D. addition of catalyst does not change the equilibtium concentrations

Answer: D

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61. In law of mass action, the rate of reaction is directly proportional to

A. yolume of the container

B. equilibrium constant

C. nature of reactants

D. molar concentration of reactants

Answer: D

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62. In the manufacture of 'H_2 SO_4', the oxidation of 'SO_2' to 'SO_3' by 'O_2' is an exothermic reaction. The yield of 'SO_3' will be maximum if. :

A. temperature is increased and the pressure is decreased.

B. both the temperature and pressure are decreased.

C. the temperature is reduced and pressure is increased.

D. both the temperature and pressure are increased.

Answer: C

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63. Nitrogen combines with oxygen to form nitric oxide:

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g), \Delta H = +80kJmol^{-1}$

The decomposition of $NO(g)$ is favoured by : decrease in the pressure, increase in pressure, decrease in temperature, increasing the concentration of N_2

A. decrease in the pressure

B. increase in pressure

C. decrease in temperature

D. increasing the concentration of 'N_2'

Answer: C

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64. In the equilibrium

$H_3PO_4 + H_2O \Leftrightarrow H_2PO_4^- + H_3O^+$

the equilibrium constant is most likely to be changed by: adding $H_2PO_4^-$ ion, adding H_3PO_4, adding a catalyst, heating the mixture

A. adding 'H_2 PO_4^-', ion

B. adding 'H_3 PO_4'

C. adding a catalyst

D. heating the mixture

Answer: D

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65. $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g)$, $\Delta H = -93.5kJ$. What will happen when helium gas is added to the vessel at constant volume: more NH_3 is formed, less NH_3 is formed, No effect., None of these

A. more 'NH' is formed

B. less 'NH_3' is formed

C. No'effect.

D. None of these

Answer: C

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66. aqueous solution of ammonium acetate is

A. faintly acidic

B. faintly alkaline

C. fairly neutral

D. fairly acidic

Answer: C

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67. $CaCO_3(s) \Leftrightarrow CaO(s) + CO_2(g)$, ΔH=110k, the pressure of CO_2: increases on adding catalyst, decreases of T is raised, increases of T is raised, increases, if an inert gas is passed keeping T constant

A. increases on adding catalyst

B. decreases of 'T' is raised

C. increases of 'T' is raised

D. increases, if an inert gas is passed keeping T constant

Answer: C

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68. 1 mol of A and 0.5 mol of B were enclosed in a three litre vessel. The following equilibrium was established under suitable conditions:

$A + 2B \Leftrightarrow C$

At equilibrium, the amount of B was found to be 0.3 mol. The equilibrium constant K_c at the experimental temperature will be: 11.1 , 1.11, 0.01, 2.5

A. 11.1

B. 1.11

C. 0.01

D. 2.5

Answer: A

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69. K' 'for the reaction:

'CO_2(g)+H_2(g) hArr CO(g)+H_2 O(g)' is found to be 16 at a given' temperature. Originally equal number of moles of 'H_2', and 'CO_2', were placed in the flask. At equilibrium, the pressure of 'H_2 .' is '1.20 atm'. What is the partial pressure of 'CO' and 'H_2 O'.

A. 1.20' atm. Each

B. '2.40 ~atm'. Each

C. 4.80' átm. Each

D. 9.60 ~atm'. Each

Answer: C

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70. An equilibrium mixture for the reaction:

'2 H_2 S(g) gives 2 H_2(g)+S_2(g)' had 1 mol of hydrogen sulphide, '0.2' mole of 'H_2' and '0.8' mole of 'S', in 2 litre vessel. The value of 'K_c' is:

A. 0.004'

B. 0.080'

C. 0.016'

D. '0.160'

Answer: C

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71. A vessel of '1000 K' contains 'CO_2', with a pressure of '0.5 atm .' Some of the 'CO_2' converted into 'CO' on the addition of graphite. The value of 'K' if the total pressure at equilibrium is '0.8 atm'. is:

A. 0.18atm

B. 1.8atm

C. 0.3atm

D. 3atm

Answer: B

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72. In a system : . $A(s) \Leftrightarrow 2B(g) + 3C(g)$ if the concentration of C at equilibrium is increased by a factor of 2, it will cause the equilibrium concentration of B to change to : 2 times, $2\sqrt{2}$ times the original value, $\frac{1}{2}$ of the original value $\frac{1}{2\sqrt{2}}$ times the original value

A. 2 times

B. 2 sqrt2' times the original value

C. 1 / 2' of the original value

D. 1/(2sqrt3)' times the original value

Answer: D

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73. For a gaseous reaction:

$2X(g) \Leftrightarrow 2Y(g) + Z(g)$, $K_p = 1.8$ at $700^\circ C$. The value of K_c for the reaction :

$2Y(g) + Z(g) \Leftrightarrow 2X(g) at$

44.4

33.1

1.3×10^{-3}

0.031

A. 44.4

B. 33.1

C. 1.3×10^{-3}

D. 0.031

Answer: A

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74. The reaction:

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

was studied by starting with equal amounts of A and B in a constant volume vessel. Which of the following is true at equilibrium. : $[A] = [B]^{-}, [C] = [B], [B] < [A], [A] < [B]$

A. [A]=[B]^-'

B. [C]=[B]'

C. [B]lt[A]'

D. [A]lt[B]'

Answer: C

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75. The 'p' H of a solution is 5.9. If the hydrogen ion concentration is decerased hundred xx, the solution will be

A. mora acidic

B. neutral

C. basic

D. of the same acidity

Answer: C

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76. On adding '20 ml' of 'N / 10 NaOH' solution to '10 ml' of 'N / 1 0 HCl', the resulting solution will

A. turn blue litmus red

B. turn phenolphthalein solution pink

C. turn methyl orange red

D. will have no effect on red or blue litmus solution

Answer: B

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77. The 'pH' of a '10^(-8) M' solution of 'HCl' is:

A. 8

B. 6

C. between 6 and 7

D. between 7 and 8

Answer: C

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78. In a solution pH and pOH at $298K$ is equal. to: zero, 14, infinity, a negative number

A. zero

B. 14

C. infinity

D. a negative number

Answer: B

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79. Which of the following is a Lewis base? $AlCl3, AgCl, Al(OH_3), NH_3$

A. AlCl3'

B. AgCl'

C. Al(OH_3)'

D. NH_3'

Answer: D

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80. Precipitation takes place when the product of concentration of ions: equals the solubility product, exceeds the solubility product, is less than the solubility product, is negligible

A. equals the solubility product

B. exceeds the solubility product

C. is less than the solubility product

D. is negligible

Answer: B

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81. The solubility product of 'CaSO_4' is '6.4 xx 10^(-5) .' The solubility of salt in moles/litre is:

A. 8 xx 10^(-16)'.

B. 8 xx 10^(-2)'

C. '8 xx 10^(-3)'

D. 1.6 xx 10^(-2)'

Answer: C

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82. Among the following, the one which does not represent a conjugate acid base pair is:

A. 'HCl' and 'Cl'

B. HOH' and 'OH^-'

C. SO_2' and 'H_2 SO_4'

D. 'NH_3' and 'NH_4^+'

Answer: C

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83. 4 gm' of 'NaOH' are added in 1 litre. The 'pH' value, of the solution will be:

A. 1

B. zero

C. 7

D. 13

Answer: D

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84. An aqueous solution of 'A l_2((SO_4)_3)' would show:

A. both acidic and basic reaction

B. a neutral reaction

C. a basic reaction

D. an acidic reaction

Answer: D

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85. The [OH^-] of an aqueous solution is '1 xx 10^(-5) .' The 'pH' of the solution is

A. 5

B. 9

C. 4.5

D. 11

Answer: B

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86. Which of the following is amphoteric in nature: $H_3O^+, Cl^-, HSO_4^-, CO_3^{2-}$

A. H_3 O^+'

B. Cl^-'

C. HSO_4^-'

D. CO_ 3^2-'

Answer: C

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87. Which of the following will have highest pH in water solution? $NaCl, Na_2CO_3, KCl, CuSO_4$

A. NaCl'

B. Na_2 CO_3'

C. KCl'

D. 'CuSO_4'

Answer: B

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