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Exercise 7.1

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

- what is the initial effect of the change on vapour pressure?
- How do rates of evaporation and condensation change initially?
- What happens when equilibrium is restored finally and what will be the final vapour pressure?

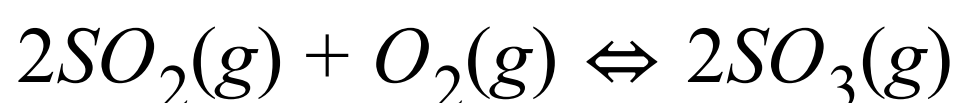
CORRECT ANSWER: N//A

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Exercise 7.2

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

$$[SO_2] = 0.60M, [O_2] = 0.82M \text{ and } [SO_3] = 1.90M?$$

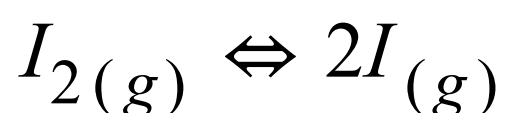


CORRECT ANSWER: 12.229

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Exercise 7.3

At a certain temperature and a total pressure of $10^5 Pa$, iodine vapour contains 40 % by volume of I atoms, Calculate K_p for the equilibrium.

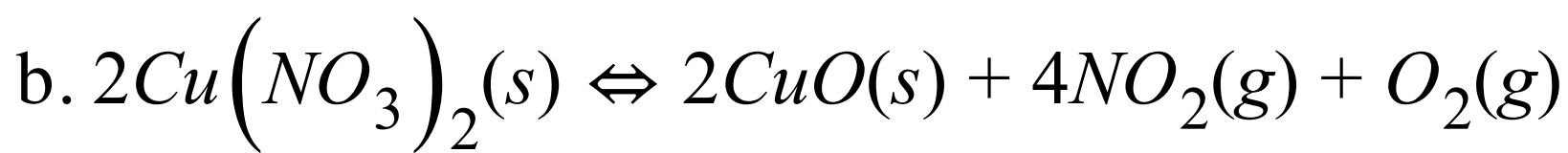
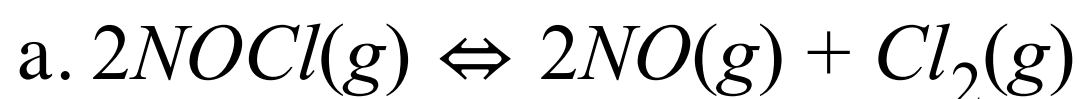


CORRECT ANSWER: 2.67×10^4

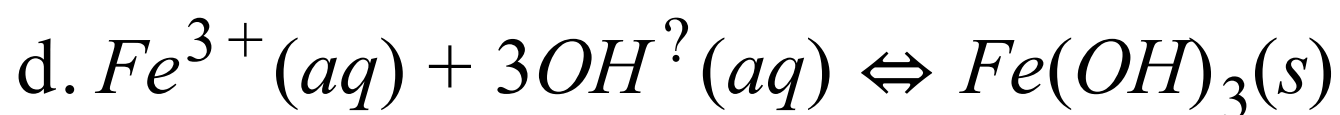
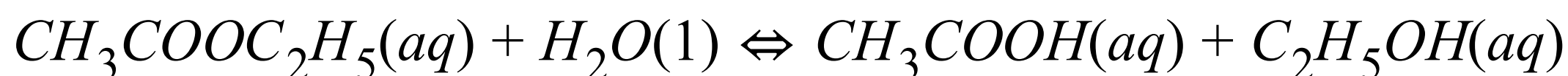
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Exercise 7.4

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



c.

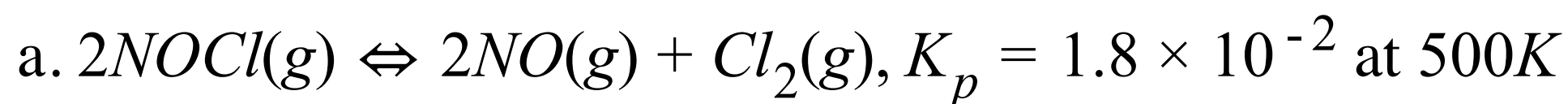


CORRECT ANSWER: N/A

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Exercise 7.5

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

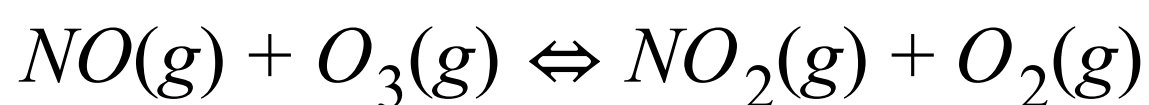


CORRECT ANSWER: (I) 4.33×10^{-4} (II) 1.90

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Exercise 7.6

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



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

CORRECT ANSWER: 1.59×10^{-15}

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Exercise 7.7

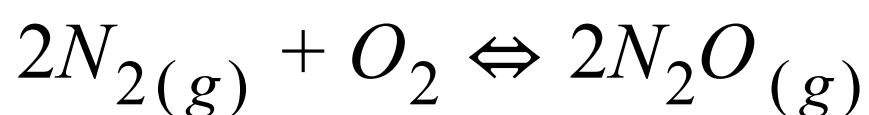
Explain why pure liquids and solids can be ignored while writing the equilibrium constant expression?

CORRECT ANSWER: N/A

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Exercise 7.8

Reaction between nitrogen and oxygen takes place as following:



If a mixture of 0.482 mole N_2 and 0.933 mole of O_2 is placed in a

reaction vessel of volume 10 litre and allowed to form N_2O at a

temperature for which $K_c = 2.0 \times 10^{-37} \text{ litremol}^{-1}$. Determine the

composition of equilibrium mixture.

CORRECT ANSWER: $[N_2] = 0.0482 \text{MOLL}^{-1}$,

$[O_2] = 0.0933 \text{MOLL}^{-1}$. $[N_2O] = 6.6 \times 10^{-21} \text{MOLL}^{-1}$

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Exercise 7.9

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



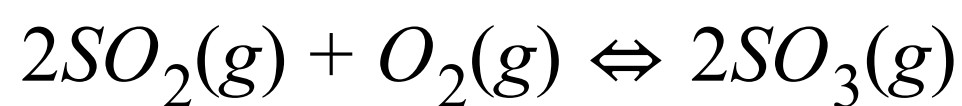
When 0.087mole of NO and 0.0437mole of Br_2 are mixed in a closed container at constant temperature, 0.0518mole of $NOBr$ is obtained at equilibrium. Calculate equilibrium amount of nitric oxide and bromine.

CORRECT ANSWER: 0.0352MOL OF NO AND
0.0178MOL OF BR_2

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Exercise 7.10

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



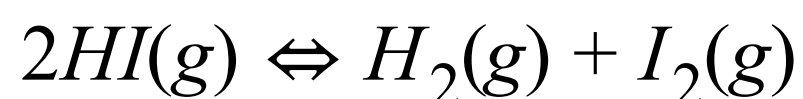
What is K_c at this temperature?

CORRECT ANSWER: $7.47 \times 10^{11} \text{M}^{-1}$

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Exercise 7.11

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



CORRECT ANSWER: 4.0

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Exercise 7.12

A mixture of 1.57mol of N_2 , 1.92mol of H_2 and 8.13mol of NH_3 is introduced into a 20L reaction vessel at 500K . At this temperature, the equilibrium constant K_c for the reaction

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ is 1.7×10^2 . Is the reaction mixture at equilibrium? If not, what is the direction of the net reaction?

CORRECT ANSWER: $Q_c = 2.379 \times 10^3$, NO.

REACTION IS NOT AT EQUILIBRIUM.

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Exercise 7.13

The equilibrium constant expression for a gas reaction is :

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

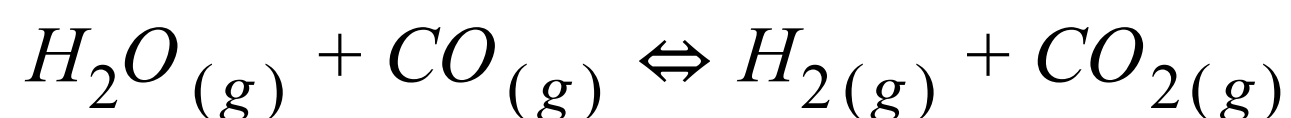
Write the balanced chemical equation corresponding to this expression.

CORRECT ANSWER: N/A

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Exercise 7.14

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

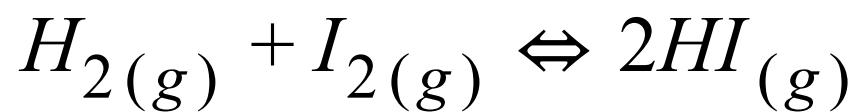


Calculate the equilibrium constant for the reaction.

CORRECT ANSWER: 0.44

Exercise 7.15

At 700K equilibrium constant for the reaction,



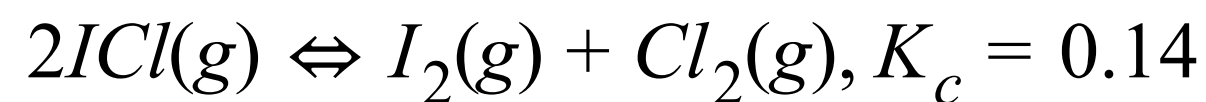
is 54.8. If 0.5mollitre^{-1} of $HI_{(g)}$ is present at equilibrium at 700K, what are the concentrations of $H_{2(g)}$ and $I_{2(g)}$, assuming that we initially started with $HI_{(g)}$ and allowed it to reach equilibrium at 700K.

CORRECT ANSWER: 0.068MOLL^{-1} EACH OF H_2 AND I_2

Exercise 7.16

What is the equilibrium concentration of each of the substance in

the equilibrium when the initial concentration of ICl was $0.78M$?



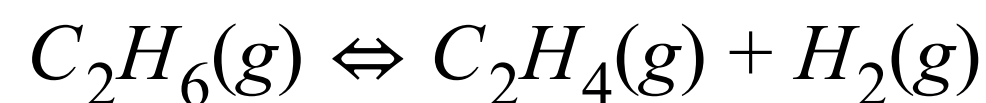
CORRECT ANSWER:

$$[I_2] = [Cl_2] = 0.167M. [ICl] = 0.0446M$$

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Exercise 7.17

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



CORRECT ANSWER: $[C_2H_6]_{EQ} = 3.62ATM$

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Exercise 7.18

The ester, ethyl acetate is formed by the reaction between ethanol and acetic acid and equilibrium is represented as:

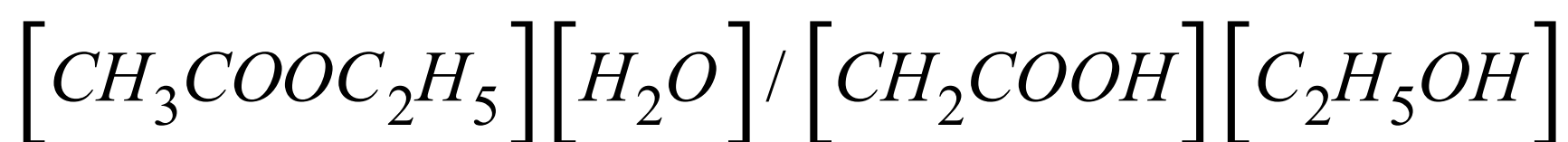


(a) Write the concentration ratio (reaction quotient), Q_e , for this reaction. Note that water is not in excess and is not a solvent in this reaction.

(b) At 293K, if one starts with 1.00mole of acetic acid and 0.180 of ethanol, there is 0.171mole of ethyl acetate in the final equilibrium mixture. Calculate the equilibrium constant.

(c) Starting with 0.500mole of ethanol and 1.000mole of acetic acid and maintaining it at 293K, 0.214mole of ethyl acetate is found after some time. Has equilibrium been reached?

CORRECT ANSWER: (I)



(II) 3.92 , (III) VALUE OF Q_C IS LESS THAN K_C

THEREFORE EQUILIBRIUM IS NOT ATTAINED.

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Exercise 7.19

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

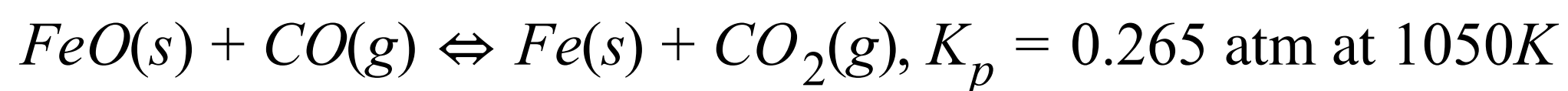
CORRECT ANSWER: 0.02MOLL^{-1} FOR BOTH.

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Exercise 7.20

One of the reaction that takes place in producing steel from iron ore is the reduction of iron(II) oxide by carbon monoxide to give iron

metal and CO_2 .



What are the equilibrium partial pressure of CO and CO_2 at $1050K$

if the partial pressure are: $p_{CO} = 1.4atm$ and $p_{CO_2} = 0.80atm$?

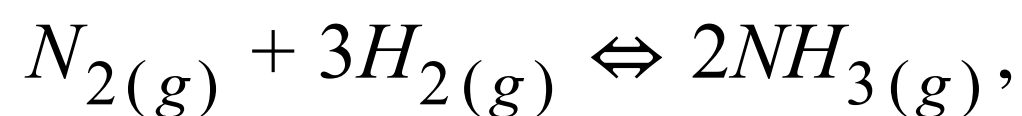
CORRECT ANSWER: $[P_{CO}] = 1.739ATM,$

$[P_{CO_2}] = 0.461 \text{ ATM.}$

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Exercise 7.21

Equilibrium constant, K_c for the reaction,



at $500K$ is $0.061 \text{ litre}^2 \text{ mole}^{-2}$. At a particular time, the analysis

shows that composition of the reaction mixture is $3.00 \text{ mol litre}^{-1} N_2,$

$2.00 \text{ mol litre}^{-1} H_2,$ and $0.500 \text{ mol litre}^{-1} NH_3$. Is the reaction at

equilibrium? If not, in which direction does the reaction tend to

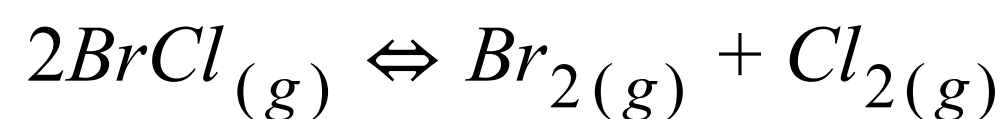
proceed to reach equilibrium?

CORRECT ANSWER: NO, THE REACTION
PROCEEDS TO FORM MORE PRODUCTS.

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Exercise 7.22

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



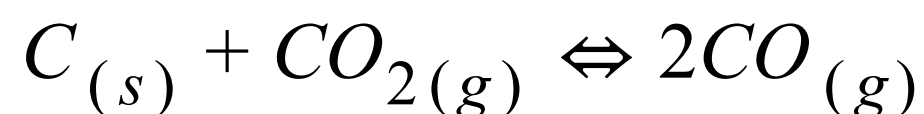
For which $K_c = 32$ at $500K$. If initially pure $BrCl$ is present at a concentration of $3.30 \times 10^{-3} \text{ mol litre}^{-1}$, what is its molar concentration in the mixture at equilibrium?

CORRECT ANSWER: $3 \times 10^{-4} \text{ MOLL}^{-1}$

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Exercise 7.23

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



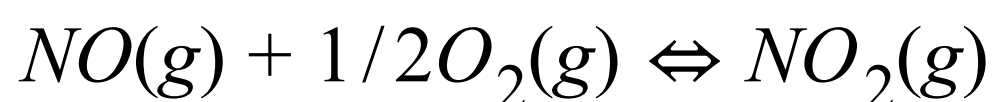
Calculate K_c for the reaction at the above temperature.

CORRECT ANSWER: 0.149

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Exercise 7.24

Calculate (a) ΔG° and (b) the equilibrium constant for the formation of NO and O_2 at $298K$



where

$$\Delta_f G^\circ (NO_2) = 52.0 kJmol^{-1}$$

$$\Delta_f G^\circ(\text{NO}) = 87.0 \text{ kJ mol}^{-1}$$

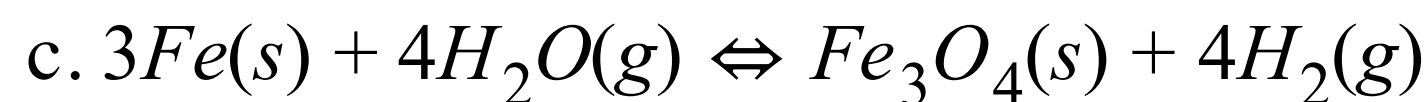
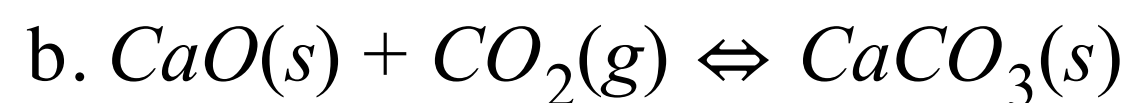
$$\Delta_f G^\circ(\text{O}_2) = 0 \text{ kJ mol}^{-1}$$

CORRECT ANSWER: A) -35.0 KJ, B) 1.365×10^6

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Exercise 7.25

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

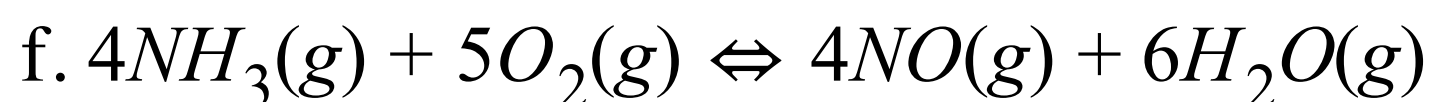
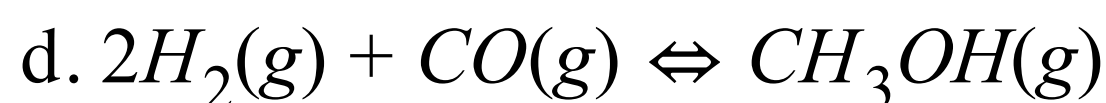
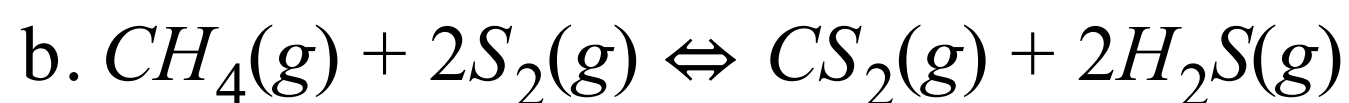
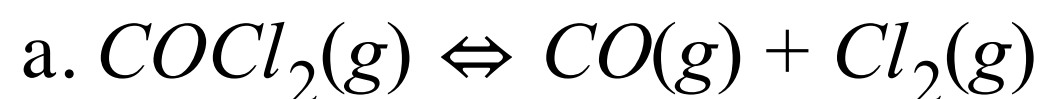


CORRECT ANSWER: N/A

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Exercise 7.26

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

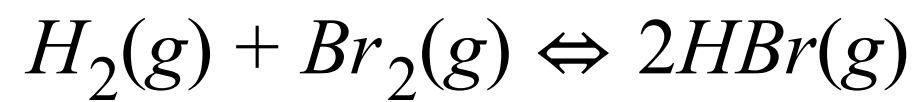


CORRECT ANSWER: N//A

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Exercise 7.27

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



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

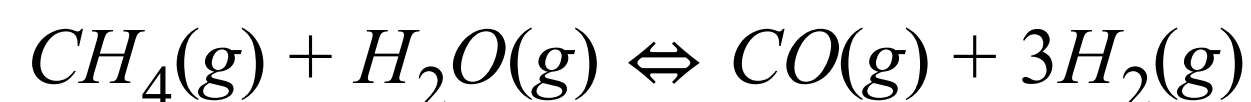
CORRECT ANSWER:

$$\left[P_{H_2} \right]_{EQ} = \left[P_{BR_2} \right]_{EQ} = 2.5 \times 10^{-2} \text{ BAR}, \left[P_{HBR} \right] = 10.0 \text{ BAR}$$

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Exercise 7.28

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



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

b. How will the value of K_p and composition of equilibrium mixture be affected by

- i. Increasing the pressure
- ii. Increasing the temperature
- iii. Using a catalyst?

CORRECT ANSWER: N/A

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Exercise 7.29

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:

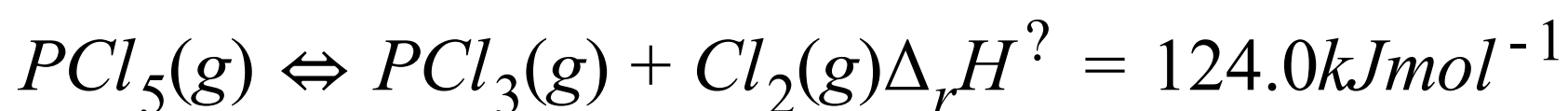


CORRECT ANSWER: N//A

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Exercise 7.30

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

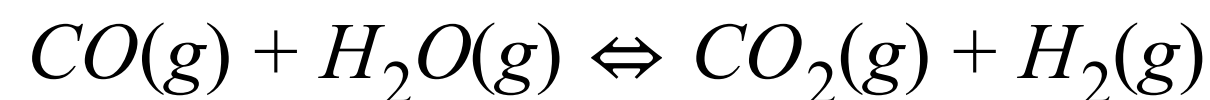


- Write an expression for K_c for the reaction.
- What is the value of K_c for the reverse reaction at the same temperature?
- What would be the effect on K_c if
 - More PCl_5 is added
 - Pressure is increased
 - The temperature is increased?

CORRECT ANSWER: B) 120.48

Exercise 7.31

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

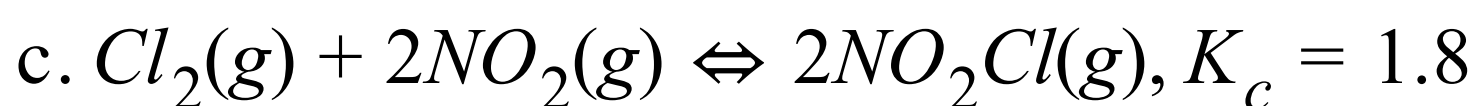
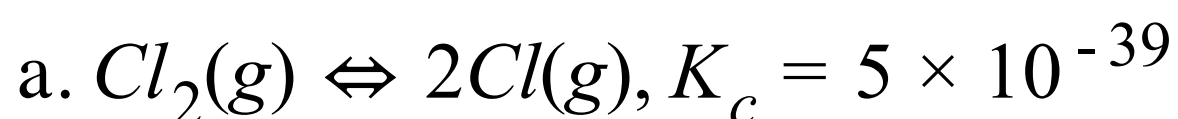


If a reaction vessel at 400 C is charged with an equimolar mixture of CO and steam such that $p_{CO} = p_{H_2O} = 4.0\text{ bar}$, what will be the partial pressure of H_2 at equilibrium? $K_p = 0.1$ at 400 C .

CORRECT ANSWER: $[H_2]_{EQ} = 0.96\text{ BAR}$

Exercise 7.32

Predict which of the following reactions will have appreciable concentration of reactants and products:



CORRECT ANSWER: N/A

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Exercise 7.33

The value of K_c for the reaction $3O_2(g) \rightleftharpoons 2O_3(g)$ is 2.0×10^{-50} at $25^\circ C$. If the equilibrium concentration of O_2 in air at $25^\circ C$ is 1.6×10^{-2} , what is the concentration of O_3 ?

CORRECT ANSWER: $2.86 \times 10^{-28} M$

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Exercise 7.34

The reaction, $CO(g) + 3H_2(g) \rightleftharpoons CH_4(g) + H_2O(g)$ is at equilibrium at $1300K$ in a $1L$ flask. It also contains $0.30mol$ of CO , $0.10mol$ of H_2 and $0.02 mol$ of H_2O and an unknown amount of CH_4 in the flask. Determine the concentration of CH_4 in the mixture. The equilibrium constant K_c for the reaction at the given temperature is 3.90 .

CORRECT ANSWER: 5.85×10^{-3}

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Exercise 7.35

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-}

CORRECT ANSWER:

NO_2^- , HCN , ClO_4 , HF , H_2O , HCO_3^- , HS^-

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Exercise 7.36

Which of the followings are Lewis acids: H_2O , BF_3 , H^\oplus and NH_4^+ ?

CORRECT ANSWER: BF_3 , H^+ , NH_4^+

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Exercise 7.37

Write the conjugate bases for the following Brddotonsted acids

(a) HF (b) H_2SO_4 (c) $HCO_3^?$

CORRECT ANSWER: F^- , HSO_4^- , CO_3^{2-}

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Exercise 7.38

Write the conjugate acids for the following Bronsted bases:

?

a. NH_2 b. NH_3 c. $HCOO^-$?

CORRECT ANSWER: NH_3 , NH_4^+ , $HCOOH$

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Exercise 7.39

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 base.

CORRECT ANSWER: N/A

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Exercise 7.40

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^{\oplus} , d. BCl_3

CORRECT ANSWER: N//A

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Exercise 7.41

The concentration of hydrogen ion in a sample of soft drink is

$3.8 \times 10^{-3} M$. What is its pH ?

CORRECT ANSWER: 2.42

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Exercise 7.42

The pH of a sample of vinegar is 3.76, Calculate the concentration of hydrogen ion in it.

CORRECT ANSWER: $1.7 \times 10^{-4} M$

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Exercise 7.43

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

CORRECT ANSWER:

$F^- = 1.5 \times 10^{-11}$, $HCOO^- = 5.6 \times 10^{-11}$, $CN^- = 2.08 \times 10^{-6}$

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Exercise 7.44

The ionization constant of phenol is 1.0×10^{-10} . What is the concentration of phenolate ion in $0.05M$ solution of phenol? What will be its degree of ionization if the solution is also $0.01M$ in sodium phenolate?

CORRECT ANSWER: [PHENOLATE ION]

$= 2.2 \times 10^{-6}$, $\alpha = 4.47 \times 10^{-5}$, α IN SODIUM

PHENOLATE = 10^{-8}

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Exercise 7.45

The first ionization constant of H_2S is 9.1×10^{-8} . Calculate the concentration of HS^- ion in its $0.1M$ solution. How will this concentration be affected if the solution is $0.1M$ in HCl also? If the

second dissociation constant if H_2S is 1.2×10^{-13} , calculate the concentration of S^{2-} under both conditions.

CORRECT ANSWER: $[HS^-] = 9.54 \times 10^{-5}$, IN

$0.1M HCl [HS^-] = 9.1 \times 10^{-8} M, [S^{2-}] = 1.2 \times 10^{-13} M$, IN

$0.1M HCl [S^{2-}] = 1.09 \times 10^{-19} M$

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Exercise 7.46

The ionization constant of acetic acid 1.74×10^{-5} . Calculate the degree of dissociation of acetic acid in its $0.05M$ solution. Calculate the concentration of acetate ion in the solution and its pH .

CORRECT ANSWER: $[AC^-] = 0.00093, PH = 3.03$

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Exercise 7.47

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

CORRECT ANSWER:

$$[A^-] = 7.08 \times 10^{-5} M, K_A = 5.08 \times 10^{-7}, pK_A = 6.29$$

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Exercise 7.48

Assuming complete dissociation, calculate the pH of the following solutions,

a. $0.003M HCl$, b. $0.005M NaOH$,

c. $0.002M HBr$, d. $0.002M KOH$

CORRECT ANSWER: A) 2.52 , B) 11.70 , C) 2.70 , D)

11.30

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Exercise 7.49

Calculate the pH of the following solutions:

- 2g of $TlOH$ dissolved in water to give 2 litre of solution.
- 0.3g of $Ca(OH)_2$ dissolved in water to give 500mL of solution.
- 0.3g of $NaOH$ dissolved in water to give 200mL of solution.
- 1mL of 13.6M HCl is diluted with water to give 1 litre of solution.

CORRECT ANSWER: A) 11.65 , B) 12.21, C) 12.57 , D)

1.87

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Exercise 7.50

The degree of ionization of a 0.1M bromoacetic acid solution is 0.132. Calculate the pH of the solution and the pK_a of bromoacetic acid.

CORRECT ANSWER: PH = 1.88, PK_(A) = 2.70

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Exercise 7.51

The pH of 0.005 M codenine ($C_{(18)}H_{(21)}NO_{(3)}$) solution is 9.95. Calculate its ionisation constant and pK_b .

CORRECT ANSWER: $K_b = 1.6 \times 10^{-6}$, $PK_b = 5.8$

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Exercise 7.52

What is the pH of 0.001 M aniline solution? The ionization constant of aniline 4.27×10^{-10} . Calculate the degree of ionization of aniline in the solution. Also calculate the ionization constant of the conjugate acid of aniline.

CORRECT ANSWER: $\alpha = 6.53 \times 10^{-4}$, $K_{(A)} = 2.35 \times 10^{-5}$

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Exercise 7.53

Calculate the degree of ionisation of 0.05 M acetic acid if its $pK_{(a)}$ value is 4.74. How is the degree of dissociation affected when its solution also contains

a. 0.01 M, b. 0.1 M in HCl?

CORRECT ANSWER: A) 0.0018 , B) 0.00018

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Exercise 7.54

The ionisation constant of dimethylamine is 5.4×10^{-4} . Calculate its degree of ionization in its 0.02M solution. What percentage of dimethylamine is ionized if the solution is also 0.1 M in NaOH?

CORRECT ANSWER: ALPHA = 0.0054

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Exercise 7.55

Calculate the hydrogen ion concentration in the following biological fluids whose pH are given below:

- Human muscle-fluid, 6.83
- Human stomach fluid, 1.2
- Human blood, 7.38

d. Human saliva, 6.4.

CORRECT ANSWER: A) 1.48×10^{-7} M , B) 0.063 ,
C) 4.17×10^{-8} M , D) 3.98×10^{-7}

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Exercise 7.56

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.

CORRECT ANSWER: A) 1.5×10^{-7} M , B) 10^{-5} M , C) 6.31×10^{-5} M , D) 6.31×10^{-3} M

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Exercise 7.57

If 0.561 g of (KOH) is dissolved in water to give. 200 mL of solution at 298 K. Calculate the concentration of potassium, hydrogen and hydroxyl ions. What is its pH?

CORRECT ANSWER: $[K^{(+)}] = [OH^{(-)}] = 0.05M,$

$[H^{(+)}] = 2.0 \times 10^{(-13)} M$

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Exercise 7.58

The solubility of $Sr(OH)_2$ at 298 K is $19.23 \text{ g L}^{(-1)}$ of solution. Calculate the concentrations of strontium and hydroxyl ions and the pH of the solution.

CORRECT ANSWER: $[Sr^{(2+)}] = 0.1581M,$ $[OH^{(-)}] = 0.3162M,$ $pH = 13.50$

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Exercise 7.59

The ionization constant of propionic acid is 1.32×10^{-5} .

Calculate the degree of ionization of the acid in its 0.05M solution and also its pH. What will be its degree of ionization in the solution of 0.01N HCl ?

CORRECT ANSWER: ALPHA = 1.63×10^{-2} , PH = 3.09, IN PRESENCE OF 0.01 M HCL, ALPHA = 1.32×10^{-3}

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Exercise 7.60

The pH of 0.1 M solution of cyanic acid (HCNO) is 2.34. Calculate the ionization constant of the acid and its degree of ionisation in the solution.

CORRECT ANSWER: $K_a = 2.09 \times 10^{-4}$ AND

DEGREE OF IONIZATION = 0.0457

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Exercise 7.61

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

CORRECT ANSWER: PH = 7.97. DEGREE OF

HYDROLYSIS = 2.36×10^{-5}

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Exercise 7.62

A 0.02 M solution of pyridinium hydrochloride has pH=3.44.

Calculate the ionization constant of pyridine.

CORRECT ANSWER: $K_{\text{b}} = 1.5 \times 10^{-9}$

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Exercise 7.63

Predict if the solutions of the following salts are neutral, acidic or basic: NaCl, KBr, NaCN, NH_4NO_3 , NaNO_2 and KF

CORRECT ANSWER: NaCl, KBr SOLUTIONS ARE NEUTRAL, NaCN, NaNO_2 AND KF SOLUTION ARE BASIC AND NH_4NO_3 SOLUTION IS ACIDIC.

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Exercise 7.64

The ionization constant of chloroacetic acid is 1.35×10^{-3} . What will be the pH of 0.1 M acid and its 0.1M sodium salt solution?

CORRECT ANSWER: (A) PH OF ACID SOLUTION = 1.9 , (B) PH OF ITS SALT SOLUTION = 7.9

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Exercise 7.65

Ionic product of water at 310 K is 2.7×10^{-14} . What is the pH of natural water at this temperature?

CORRECT ANSWER: PH = 6.78

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Exercise 7.66

Calculate the pH of the resultant mixture:

- 10 mL of 0.2M Ca(OH)_2 + 25 mL of 0.1 M HCl
- 10 mL of 0.01 M H_2SO_4 + 10 mL of 0.01 M Ca(OH)_2 .
- 10 mL of 0.1 M H_2SO_4 + 10 mL of 0.1 M KOH.

CORRECT ANSWER: A) 12.6 , B) 7.00 , C) 1.3

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Exercise 7.67

Determine the solubilities of silver chromate, barium chromate, ferric hydroxide, lead chloride and mercurous iodide at 298K from their solubility product constants given in Table 7.9. Determine also the molarities of individual ions.

CORRECT ANSWER: SILVER CHROMATE $S = 0.65$

$\times 10^{-4}$ M; MOLARITY OF $Ag^{+} = 1.30 \times 10^{-4}$

M

MOLARITY OF $CrO_4^{2-} = 0.65 \times 10^{-4}$ M;

BARIUM CHROMATE $S = 1.1 \times 10^{-5}$ M; MOLARITY

OF

Ba^{2+} AND CrO_4^{2-} EACH IS 1.1×10^{-5} M;

FERRIC HYDROXIDE $S = 1.39 \times 10^{-10}$ M;

MOLARITY OF $Fe^{3+} = 1.39 \times 10^{-10}$ M;

MOLARITY OF $[OH^{-}] = 4.17 \times 10^{-10}$ M

LEAD CHLORIDE $S = 1.59 \times 10^{-2}$ M; MOLARITY
OF $Pb^{2+} = 1.59 \times 10^{-2}$ M

MOLARITY OF $Cl^{-} = 3.18 \times 10^{-2}$ M;

MERCUROUS IODIDE $S = 2.24 \times 10^{-10}$ M;

MOLARITY OF $Hg_{2}^{2+} = 2.24 \times 10^{-10}$ M AND

MOLARITY OF $I^{-} = 4.48 \times 10^{-10}$ M

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Exercise 7.68

The solubility product constant of Ag_2CrO_4 and $AgBr$ are 1.1×10^{-12} and 5.0×10^{-13} respectively. Calculate the ratio of the molarities of their saturated solutions.

CORRECT ANSWER: SILVER CHROMATE IS MORE SOLUBLE AND THE RATIO OF THEIR MOLARITIES = 91.9

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Exercise 7.69

Equal volumes of 0.002 M solution of sodium iodate and cupric chlorate are mixed together. Will it lead to precipitation of copper iodate?

("for cupric iodate" $K = 7.4 \times 10^{-8}$).

CORRECT ANSWER: NO PRECIPITATE

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Exercise 7.70

The ionisation constant of benzoic acid (PhCOOH) is $6.46 \times$

10^{-5}) and K_{sp} for silver benzoate is 2.5×10^{-3}). How many times is silver benzoate more soluble in a buffer of pH 3.19 compared to its solubility in pure water?

CORRECT ANSWER: SILVER BENZOATE IS 3.317 TIMES MORE SOLUBLE AT LOWER PH

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Exercise 7.71

What is the maximum concentration of equimolar solutions of ferrous sulphate and sodium sulphide so that when mixed in equal volumes, there is no precipitation of iron sulphide? (For iron sulphide, $K_{sp} = 6.3 \times 10^{-18}$).

CORRECT ANSWER: THE HIGHEST MOLARITY FOR THE SOLUTION IS 2.5×10^{-9} M

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Exercise 7.72

What is the minimum volume of water required to dissolve 1.0 g of calcium sulphate at 298 K?

(For calcium sulphate, K_{sp} is 9.1×10^{-6}).

CORRECT ANSWER: 2.43 LITRE OF WATER

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Exercise 7.73

The concentration of sulphide ion in 0.1 M HCl solution saturated with hydrogen sulphide is 1.0×10^{-19} M. If 10 mL of this is added to 5 mL of 0.04 M solution of the following: FeSO_4 , MnCl_2 , ZnCl_2 and CdCl_2 . In which of these solutions precipitation will take place?

CORRECT ANSWER: PRECIPITATION WILL TAKE PLACE IN CADMIUM CHLORIDE SOLUTION.

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Solved Example 1

The following concentrations were obtained for the formation of NH_3 from N_2 and H_2 at equilibrium at 500 K.

$[\text{N}_2]=1.5 \times 10^{-2} \text{ M}$, $[\text{H}_2]=3.0 \times 10^{-2} \text{ M}$, and

$[\text{NH}_3]=1.2 \times 10^{-2} \text{ M}$. Calculate the equilibrium constant.

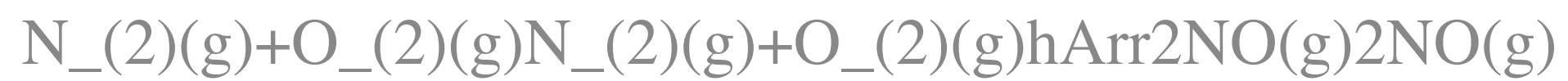
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Solved Example 2

At equilibrium, the concentrations of $\text{N}_2=3.0 \times 10^{-3} \text{ M}$,

$\text{O}_2=4.2 \times 10^{-3} \text{ M}$, and $\text{NO}=2.8 \times 10^{-3} \text{ M}$ in a sealed vessel

at 800K. What will be K_c for the reaction



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Solved Example 3

PCl_5 , PCl_3 and Cl_2 are at equilibrium at 500 K and having concentration 1.59 M PCl_3 , 1.59 M Cl_2 and 1.41 M PCl_5 .

Calculate K_c for the reaction,



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Solved Example 4

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



Calculate equilibrium concentration of CO_2 , H_2 , CO and H_2O at 800K. If only CO and H_2O are present initially at

concentrations of 0.10 M each.

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Solved Example 5

For the equilibrium



the value of the equilibrium constant, K_c is 3.75×10^{-6} at 1069 K. Calculate the K_p for the reaction at this temperature?

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Solved Example 6

The value of K_p for the reaction



is 3.0 bar at 1000 K. If initially $P_{\text{CO}_2} = 0.48$ bar, $P_{\text{CO}} = 0$ bar and pure graphite is present then determine equilibrium partial

pressure of CO and CO₂ .

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Solved Example 7

The value of K_c for the reaction $2A \rightleftharpoons B + C$ is 2.0×10^{-3} .

At a given time, the composition of reaction mixture is $[A] = [B] = [C] = 3 \times 10^{-4} \text{ M}$. In which direction the reaction will proceed?

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Solved Example 8

13.8 g of N₂O₄ was placed in a 1L reaction vessel at 400 K 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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Solved Example 9

3.00 mol of PCl_5 kept in 1L closed reaction vessel was allowed to attain equilibrium at 3.80 K. Calculate composition of the mixture at equilibrium $K_c = 1.80$

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Solved Example 10

The value of ΔG° for the phosphorylation of glucose in glycolysis is 13.8 kJ mol^{-1} . Find the value of K_c at 298 K

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Solved Example 11

Hydrolysis of sucrose gives



Equilibrium constant K_c for the reaction is 2×10^{13} at 300 K.

Calculate ΔG° at 300 K.

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Solved Example 12

Write the conjugate bases for the following Brønsted acids

(a) HF (b) H_2SO_4 (c) HCO_3^-

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Solved Example 13

Write the conjugate acids for the following Brønsted bases:

a. NH_2^- b. NH_3 c. HCOO^-

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Solved Example 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 base.

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Solved Example 15

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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Solved Example 16

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

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Solved Example 17

The pH of 10^{-8}M solution of HCl in water is

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Solved Example 18

The ionization constant of HF is 3.2×10^{-4} . Calculate the degree of ionization of HF in its 0.02M solution. Calculate the concentration of all species present in the solution and its pH.

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Solved Example 19

The pH of 0.1M monobasic acid is 4.50. Calculate the concentration of species, $H^+(aq)$, A^- , and HA at equilibrium. Also determine the value of K_a and pK_a of the monobasic acid.

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Solved Example 20

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

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Solved Example 21

The pH of 0.004M hydrazine ($NH_2.NH_2$) solution is 9.7.

Calculate its ionisation constant $K_{(b)}$ and $pK_{(b)}$.

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Solved Example 22

Calculate the pH of the solution in which 0.2 M NH_4Cl and 0.1 M NH_3 are present. The $pK_{(b)}$ of ammonia solution is 4.75.

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Solved Example 23

Determine the degree of ionization and pH of 0.05 M 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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Solved Example 24

50.0 mL of 0.10 M ammonia solution is treated with 25.0 mL of 0.10M HCl. If $K_b(\text{NH}_3) = 1.77 \times 10^{-5}$, the pH of the resulting solution will be

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Solved Example 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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Solved Example 26

Calculate the solubility of M_2X_3 in pure water, assuming that

neither kind of ion reacts with H_2O . The solubility product of M_2X_3 , $K_{\text{sp}} = 1.1 \times 10^{-23}$.

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Solved Example 27

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

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Solved Example 28

The solubility product of $\text{Ni}(\text{OH})_2$ is 2.0×10^{-15} . The molar solubility of $\text{Ni}(\text{OH})_2$ in 0.1 M NaOH solution is

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