Answers to extra questions from Study Unit 7

CHEMIESE EWEWIG. / *CHEMICAL EQUILIBRIUM.*

Q1

Bepaal K_2 vir die reaksie: / *Determine K_2 for the reaction:* $H_2O(g) \leftrightarrows H_2(g) + \frac{1}{2}O_2(g)$

as K_1 gelyk is aan $3{,}4 \times 10^{81}$ by 25^0C vir die volgende reaksie: / *if K_1 is equal to $3{,}4 \times 10^{81}$ at 25^0C for the following reaction:*

$$2H_2(g) + O_2(g) \leftrightarrows 2H_2O(g) \qquad K_1 = 3.4 \times 10^{81}$$

$K_2 = (1/K_1)^{½} = (1/3.4 \times 10^{81})^{½} = (2.94 \times 10^{-82})^{½} = 1.715 \times 10^{-41}$

Q2

By 900 ^{0}C is $K_c = 0.0108$ vir die volgende reaksie: / *At 900 ^0C, $K_c = 0.0108$ for the following reaction:*

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

Indien 'n mengsel van 15.0 g $CaCO_3$, 15.0 g CaO en 4.25 g CO_2 in 'n 10.0 L fles by 900 ^{0}C geplaas word, sal die hoeveelheid $CaCO_3$ toeneem, afneem of dieselfde bly wanneer die sisteem ewewig bereik? Omkring die opsie wat jy dink is reg. / *If a mixture of 15.0 g $CaCO_3$, 15.0 g CaO and 4.25 g CO_2 is placed in a 10.0 L vessel at 900 ^0C, will the amount of $CaCO_3$ increase, decrease or stay the same when the system reaches equilibrium? Circle the option that you think is correct.*

a) Toeneem. / *Increase.*

b) Afneem. / *Decrease.*

c) Dieselfde bly. / *Stay the same.*

Q3

'n Mengsel van CH_4 en H_2O word by 'n 1000 K oor 'n nikkelkatalisator gestuur. Die gasse wat dan vrygestel word, word in 'n 5.00 L fles opgevang. Analise van die gasse by ewewig lewer 0.308 mol CO, 1.287 mol H_2, 2.681 mol CH_4 en 2.686 mol H_2O. Bereken die ewewigskonstante, K_c, vir die reaksie by 1000 K. / *A mixture of CH_4 and H_2O is passed over a nickel catalyst at 1000 K. The emerging gasses is collected in a 5.00 L flask. Analysis of the gasses at equilibrium yielded 0.308 mol CO, 1.287 mol H_2, 2.681 mol CH_4 and 2.686 mol H_2O. Calculate the equilibrium constant, K_c, for the reaction at 1000 K.*

$CH_4(g) + H_2O(g) \leftrightarrows CO(g) + 3H_2(g)$ **Water is a gas at 1000 K**

$c_{CH4} = 2.681$ mol / 5 L = 0.536 M

$c_{H2O} = 2.686$ mol / 5 L = 0.537 M

c_{CO} = 0.308 mol / 5 L = 0.062 M

c_{H2} = 1.287 mol / 5 L = 0.257 M

$K_c = [CO][H_2]^3 / [CH_4][H_2O]$

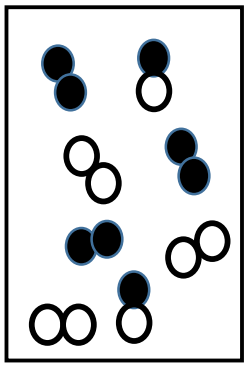
$K_c = (0.062)(0.257)^3 / (0.536)(0.537) = 0.00366$ (3.66×10^{-3})

Q4

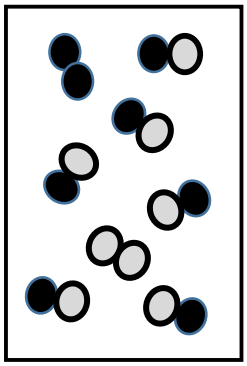
Die volgende prentjies stel die ewewigstoestand van drie verskillende reaksies voor, van die tipe: / *The following pictures represent the equilibrium state for three different reactions of the type:*

$A_2 + X_2 \leftrightarrows 2AX$ (X = B, C, of / *or* D).

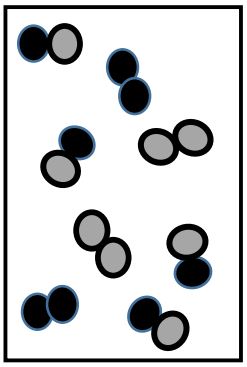
A = ● *B* = ○ *C* = ◍ *D* = ◍



$A_2 + B_2 \leftrightarrows 2AB$



$A_2 + C_2 \leftrightarrows 2AC$



$A_2 + D_2 \leftrightarrows 2AD$

Watter reaksie het die kleinste ewewigskonstante? / *Which reaction has the smallest equilibrium constant?*

$A_2 + B_2 \leftrightarrows 2AB$

Watter reaksie het die grootste ewewigskonstante? / *Which reaction has the largest equilibrium constant?*

$A_2 + C_2 \leftrightarrows 2AC$

Q5

Sal die konsentrasie van NO_2 (g) toeneem, afneem of dieselfde bly as die volgende ewewig versteur word deur:
Will the concentration of NO_2 (g) increase, decrease or remain the same when the following equilibrium is disturbed by:

$$ClNO_2(g) + NO(g) \leftrightarrows ClNO(g) + NO_2(g)$$

nog $ClNO_2$ by te voeg. / *adding more $ClNO_2$.*
equilibrium shifts towards more products (toeneem) (skuif regs)

nog ClNO by te voeg. / *adding more ClNO.*
equilibrium shifts towards more reactants (afneem) (skuif links)

nog NO by te voeg. / *adding more NO.*
equilibrium shifts towards more products (toeneem) (skuif regs)

NO te verwyder. / *removing NO.*
equilibrium shifts towards more reactants (afneem) (skuif links)

Q6

Die volgende ewewigskonsentrasies by 127^0C word waargeneem vir die Haber-proses: / *The following equilibrium concentrations were observed for the Haber process at 127^0C:*

$[NH_3] = 3.1 \times 10^{-2}$ mol/L
$[N_2] = 8.5 \times 10^{-1}$ mol/L
$[H_2] = 3.1 \times 10^{-3}$ mol/L

1 Bereken die waarde van K_1 by 127^0C vir die reaksie van die Haberproses. / *Calculate the value of K_1 at 127^0C for the reaction of the Haber process.*
$N_2(g) + 3H_2(g) \leftrightarrows 2NH_3(g)$ the Haber process
$K_1 = [NH_3]^2 / ([N_2][H_2]^3) = (3.1 \times 10^{-2})^2 / (8.5 \times 10^{-1} \times (3.1 \times 10^{-3})^3) = 3.7950 \times 10^4$ L^2/mol^2

2 Bereken die waarde van die ewewigkonstante, K_2, by 127^0C vir die volgende reaksie.
Calculate the value of the equilibrium constant, K_2, at 127^0C for the following reaction:

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

$2NH_3(g) \leftrightarrows N_2(g) + 3H_2(g)$ the reverse reaction of (a) thus $K_2 = 1/K_1$
$K_2 = 1/(3.7950 \times 10^4) = 2.635 \times 10^{-5}$ mol^2/L^2

3 Bereken die waarde van die ewewigkonstante, K_3, by 127^0C vir die reaksie wat gegee word deur die vergelyking: / *Calculate the value of the equilibrium constant, K_3, at 127^0C for the reaction given by the equation:*

$$½N_2(g) + 3/2H_2(g) \leftrightarrows NH_3(g)$$

$½N_2(g) + 3/2H_2(g) \leftrightarrows NH_3(g)$ this reaction is (5.1.1) x ½] thus $K_3 = (K_1)^{½}$

$K_3 = (3.7950 \times 10^4)^{½} = 194.808$ L/mol

Q7

Gasagtige NOCl ontbind om die gasse NO en Cl_2 te vorm. By 35^0C is die ewewigskonstante 1.6×10^{-5} mol. Wat is die ewewigskonsentrasies wanneer 1.0 mol NOCl in 'n 2.0 liter fles geplaas word?

Gaseous NOCl decomposes to form the gases NO and Cl_2. At 35^0C the equilibrium constant is 1.6×10^{-5} mol/L. When 1.0 mol NOCl is placed in a 2.0 liter flask, what are the equilibrium concentrations?

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

$K = [NO]^2 [Cl_2] / [NOCl]^2 = 1.6 \times 10^{-5}$ mol/L and $[NOCl] = ½ = 0.50$ mol/L

	NOCl	NO	Cl_2
[Initial]	0.5	0	0
[change]	-2x	+2x	+x
[Equilibrium]	(0.5 – 2x)	2x	x
	0.48	2.0×10^{-2}	1.0×10^{-2}

$K = [NO]^2 [Cl_2] / [NOCl]^2 = (2x)^2(x) / (0.5 – 2x)^2$

[initial] / K >> 100 thus $0.5 / 1.6 \times 10^{-5} = 31250 > 100$ the x in (0.5 – 2x) can be ignored

$K = [NO]^2 [Cl_2] / [NOCl]^2 = (2x)^2(x) / (0.5)^2 = 4x^2 (x) / 0.25 = 1.6 \times 10^{-5}$

$X^3 = 1.0 \times 10^{-6}$

$x = 1.0 \times 10^{-2}$

Q8

Wat is die verskil tussen die ewewigskonstante en die reaksiekwosient? / *What is the difference between the equilibrium constant and the reaction quotient?*

$aA + bB \leftrightarrows cC + dD$ $K = ([A]^a [B]^b) / ([C]^c [D]^d)$ and $Q = ([A]^a [B]^b) / ([C]^c [D]^d)$

Both are determined with the same equation BUT K with equilibrium concentrations and Q with given concentrations to determine whether a reaction is at equilibrium, moving towards equilibrium or is past equilibrium.

Q9

Hoekom word gesê dat chemiese ewewigte in 'n dinamiese toestand is? / *Why are chemical equilibria said to be in a dynamic state?*

a. omrede die reagens konsentrasie stadig oor tyd afneem. / *because the reactant concentration decreases slowly over time.*

b. omrede die omgekeerde reaksie enige tyd dominant kan word. / *because the reverse reaction could become dominant at any moment.*

c. omrede die konsentrasies van al die chemiese spesies nie verander nie. / *because the concentrations of all chemical species do not change.*

d. omrede die voorwaartse en terugwaartse reaksies teen dieselfde tempo aanhou. / *because the forward and reverse reactions continue to occur at equal rates.*

Q10

0.55 M COI_2 word aanvanklik in 'n 2.00 L fles verhit en die reaksie word toegelaat om ewewig te bereik. By ewewig is die konsentrasie I_2 gelyk aan 0.022 M. Bereken die ewewigskonstante, K_c, vir die reaksie.

0.55 M of COI_2 is heated initially in a 2.00 L flask and the reaction is left to reach equilibrium. At equilibrium the concentration of I_2 is equal to 0.022 M. Calculate the equilibrium constant, K_c, for the reaction.

$$COI_2(g) \leftrightarrows CO(g) + I_2(g)$$