Equilibrium Concentrations: name: _____

1) The given chemical reaction illustrates the synthesis of a chlorofluorocarbon (CCl_4), which was formerly widely employed in refrigeration and aerosol industries before its detrimental impact on the ozone layer was recognized.

Reaction: $CS_2\,(g) + 3Cl_2\,(g) \rightleftharpoons S_2Cl_2\,(g) + CCl_4\,(g)$

In a 1.5-liter container, 1.35 moles of CS_2 and 2.085 moles of Cl_2 are initially introduced. Upon reaching equilibrium, 0.51 moles of CCl_4 are formed.

What is value of the equilibrium constant.

Données :

$n_{CS_{2i}} = 1{,}35$ mol
$n_{Cl_{2i}} = 2{,}085$ mol
$n_{CCl_{4\,éq}} = 0{,}510$ mol
$V = 1{,}50$ L
$K_c = ?$

Calcul :

1. Calcul des concentrations :

$$[CS_2]_i = \frac{1{,}35\text{ mol}}{1{,}50\text{ L}} = 0{,}900\text{ mol/L} \qquad [CCl_4]_{éq} = \frac{0{,}510\text{ mol}}{1{,}50\text{ L}} = 0{,}340\text{ mol/L}$$

$$[Cl_2]_i = \frac{2{,}085\text{ mol}}{1{,}50\text{ L}} = 1{,}39\text{ mol/L}$$

2. Report des données et utilisation du tableau IVÉ où $C_{éq} = C_i + \Delta C$:

Concentration (mol/L)	$CS_2\,(g)$	+ $3\,Cl_2\,(g)$	$\rightleftharpoons$ $S_2Cl_2\,(g)$	+ $CCl_4\,(g)$
Initiale (C_i)	0,900	1,39	0	0
Variation (ΔC)	−0,340	−1,02	+0,340	+0,340
Équilibre ($C_{éq}$)	0,560	0,37	0,340	0,340

3. Calcul de la constante d'équilibre :

$$K_c = \frac{[S_2Cl_2]\cdot[CCl_4]}{[CS_2]\cdot[Cl_2]^3} = \frac{0{,}340\cdot 0{,}340}{0{,}560\cdot(0{,}37)^3} = 4{,}1$$

Réponse : La valeur de la constante d'équilibre est de 4,1.

2) The following synthesis reaction for NOBr takes place in a 2.5L container.

Reaction: $Br_2\,(g) + 2NO\,(g) \rightleftharpoons 2NOBr\,(g)$

At equilibrium the system contains 1.25 moles of Br_2, 0.75moles of NO, and 0.15moles of NOBr.

What is the value of the equilibrium constant for the above synthesis of NOBr and for the decomposition of NOBr.

Calcul :

1. Calcul des concentrations à l'équilibre :

$$C = \frac{n}{V}$$

$$[Br_2] = \frac{1{,}250\text{ mol}}{2{,}50\text{ L}} = 0{,}500\text{ mol/L}$$

$$[NO] = \frac{0{,}750\text{ mol}}{2{,}50\text{ L}} = 0{,}300\text{ mol/L}$$

$$[NOBr] = \frac{0{,}150\text{ mol}}{2{,}50\text{ L}} = 0{,}060\,0\text{ mol/L}$$

2. Calcul de la constante d'équilibre :

$$K_{c_{syn}} = \frac{[NOBr]^2}{[Br_2]\cdot[NO]^2} = \frac{(0{,}060\,0)^2}{0{,}500\cdot(0{,}300)^2} = 0{,}080\,0$$

3. Calcul de la constante d'équilibre de la réaction inverse :

$$K_{c_{déc}} = \frac{1}{K_{c_{syn}}} = \frac{1}{0{,}080\,0} = 12{,}5$$

3) Observe the following reaction:

Reaction: $H_2\,(g) + I_2\,(g) \rightleftharpoons 2HI\,(g)$

If 2 moles of H_2 and 3 moles of I_2 are placed in a 1L vessel at 1100K, what is the concentration of each gas at equilibrium if the K value is equal to 25 ?

T	Concentrations (mol/L)		
	1	1	2
I	2.00	3.00	0
C	-x	-x	+2x
E	2.00-x	3.00-x	+2x

$$K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{(2x)^2}{(2-x)(3-x)}$$

$$\left(x = \frac{-b \pm \sqrt{b^2-4ac}}{2a}\right)$$

$$25 = \frac{4x^2}{6-2x-3x+x^2}$$

solve for x:

$x = 4.28$ or 1.67

$[H_2] = 2 - 1.67 = 0.33\ mol/L$

$[I_2] = 3 - 1.67 = 1.33\ mol/L$

$[HI] = 2(1.67) = 3.34\ mol/L$