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Tables of chemical equilibrium

Consider this chemical equation: $2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$
In a 4 L container initially we have 2 mol of HCl and the pressure is 10 atm. At the equilibrium the dissociation percent of HCl is 20 %.
Determine the equilibrium constants Kc and Kp.

The table in terms of # of moles.

In our case:

	$2\ HCl\ (g)$	$\rightleftarrows Cl_2\ (g)$	$+ H_2\ (g)$
$n_{initial}$	2	0	0
Δn	-2x	x	x
n_{equil}	2-2x	x	x

Where:

$$2x = \frac{20}{100} * 2\ mol = 0.4\ mol$$

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{(0.05\ M)^2}{(0.4\ M)^2} = 0.0156$$

In general:

	$2\ HCl\ (g)$	$\rightleftarrows Cl_2\ (g)$	$+ H_2\ (g)$
$n_{initial}$	n_0	0	0
Δn	-2x	x	x
n_{equil}	n_0-2x	x	x

When initially only reactant

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{(x/V)^2}{[(n_0-2x)/V]^2} = \frac{x^2}{(n_0-2x)^2}$$

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In our case:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$n_{initial}$	2	0	0
Δn	-2α	α	α
n_{equil}	$2\ (1-\alpha)$	α	α

Where: $\alpha = \frac{20}{100} = 0.2$

$$Kc = \frac{[Cl_2]\ [H_2]}{[HCl]^2} = \frac{(0.05\ M)^2}{(0.4\ M)^2} = 0.0156$$

In general:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$n_{initial}$	n_0	0	0
Δn	$-n_0\alpha$	$n_0\alpha/2$	$n_0\alpha/2$
n_{equil}	$n_0\ (1-\alpha)$	$n_0\alpha/2$	$n_0\alpha/2$

When initially only reactant

$$Kc = \frac{[Cl_2]\ [H_2]}{[HCl]^2} = \frac{(n_0\alpha/2V)^2}{[n_0(1-\alpha)/V]^2} = \frac{\alpha^2}{4\ (1-\alpha)^2}$$

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Determine the equilibrium constants Kc and Kp.

The table in terms of concentrations.

In our case:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$c_{initial}$	0.5	0	0
Δc	-2x	x	x
c_{equil}	0.5-2x	x	x

Where:

$$2x = \frac{20}{100} * 0.5 \frac{mol}{L} = 0.1\ M$$

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{(0.05\ M)^2}{(0.4\ M)^2} = 0.0156$$

In general:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$c_{initial}$	c_0	0	0
Δc	-2x	x	x
c_{equil}	c_0-2x	x	x

When initially only reactant

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{(x)^2}{(c_0-2x)^2}$$

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Determine the equilibrium constants Kc and Kp.

The table in terms of concentrations.

In our case:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$c_{initial}$	0.5	0	0
Δc	$-0.5\ \alpha$	$0.25\ \alpha$	$0.25\ \alpha$
c_{equil}	$0.5\ (1-\alpha)$	$0.25\ \alpha$	$0.25\ \alpha$

Where: $\alpha = \frac{20}{100} = 0.2$

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{(0.05\ M)^2}{(0.4\ M)^2} = 0.0156$$

In general:

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$c_{initial}$	c_0	0	0
Δc	$-c_0\alpha$	$c_0\alpha/2$	$c_0\alpha/2$
c_{equil}	$c_0\ (1-\ \alpha)$	$c_0\alpha/2$	$c_0\alpha/2$

When initially only reactant

$$Kc = \frac{[Cl_2]\,[H_2]}{[HCl]^2} = \frac{\alpha^2}{4\ (1-\alpha)^2}$$

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In a 4 L container initially we have 2 mol of HCl and the pressure is 10 atm. At the equilibrium the dissociation percent of HCl is 20 %. Determine the equilibrium constants Kc and Kp.

The table in terms of pressure.

In our case:

	$2\ HCl\ (g)$	$\rightleftarrows Cl_2\ (g)$	$+\ H_2\ (g)$
$p_{initial}$	10	0	0
Δp	-2x	x	x
p_{equil}	10-2x	x	x

Where:

$$2x = \frac{20}{100} * 10\ atm = 2\ atm$$

$$Kp = \frac{P_{Cl_2}\ P_{H_2}}{P_{HCl}^{\ 2}} = \frac{(1\ atm)^2}{(8\ atm)^2} = 0.0156$$

In general:

	$2\ HCl\ (g)$	$\rightleftarrows Cl_2\ (g)$	$+\ H_2\ (g)$
$p_{initial}$	p_0	0	0
Δp	-2x	x	x
p_{equil}	p_0-2x	x	x

When initially only reactant

$$Kp = \frac{P_{Cl_2}\ P_{H_2}}{P_{HCl}^{\ 2}} = \frac{x^2}{(p_0 - 2x)^2}$$

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Determine the equilibrium constants Kc and Kp.

The table in terms of pressure.

In our case:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$p_{initial}$	10	0	0
Δp	$-10\ \alpha$	$5\ \alpha$	$5\ \alpha$
p_{equil}	$10\ (1-\alpha)$	$5\ \alpha$	$5\ \alpha$

Where:

$$\alpha = \frac{20}{100} = 0.2$$

$$Kp = \frac{P_{Cl_2}\ P_{H_2}}{P_{HCl}^{\ 2}} = \frac{(1\ atm)^2}{(8\ atm)^2} = 0.0156$$

In general:

$2\ HCl\ (g) \rightleftarrows Cl_2\ (g) + H_2\ (g)$

$p_{initial}$	p_0	0	0
Δp	$-\ p_0\ \alpha$	$p_0\ \alpha/2$	$p_0\ \alpha/2$
p_{equil}	$p_0\ (1-\ \alpha)$	$p_0\ \alpha/2$	$p_0\ \alpha/2$

When initially only reactant

$$Kp = \frac{P_{Cl_2}\ P_{H_2}}{P_{HCl}^{\ 2}} = \frac{\alpha^2}{4\ (1-\alpha)^2}$$