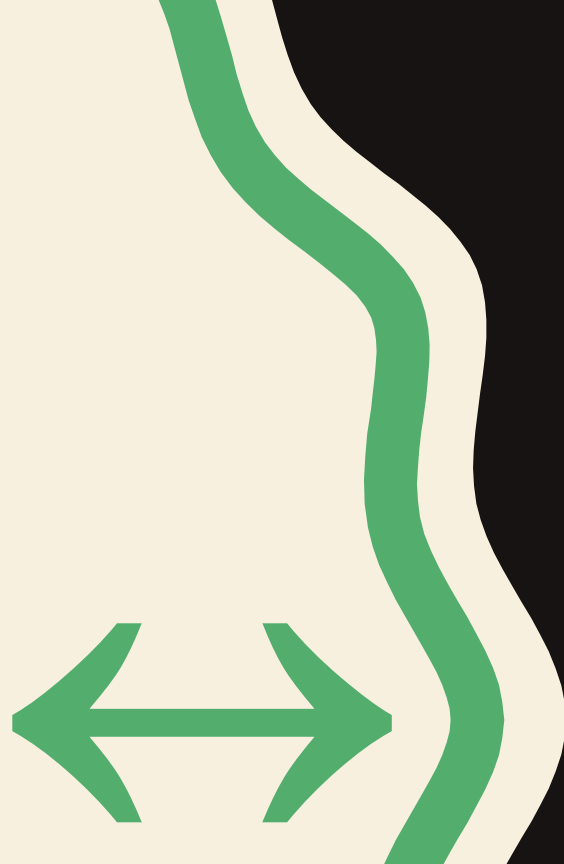


N45
ICE Tables



N45 ICE Tables

Target: I can use ICE tables to organize my concentration data to help me perform various equilibrium calculations.

Link to YouTube Presentation: <https://youtu.be/2mnYweqmKZE>

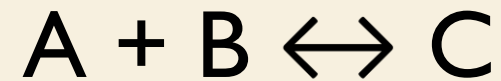
DETERMINING CONCENTRATIONS AT EQUILIBRIUM

What if you wanted to determine the concentrations of your reactants and products at equilibrium, but only know the initial concentrations?

**USE AN
ICE TABLE!**

WHAT IS AN ICE TABLE?

- A strategy for organizing information about a reaction in order to solve for []'s at equilibrium



- ICE stands for:

- Initial

- Change

- Equilibrium

Rxn	A	+	B	\leftrightarrow	C
I					
C					
E					
5%					
Answer					

STEPS FOR SETTING UP AN ICE TABLE

Glue in your steps

for setting up an ICE table.

**We will walk through them together
as we do some practice problems!**

**Highlight, annotate, process them as
we go through them!**

PRACTICE PROBLEM #1

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.



PRACTICE PROBLEM #1 STEPS 1, 2, 3

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.

Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I			
C			
E			
5%			
Answer			

PRACTICE PROBLEM #1 STEP 4

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.

Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C			
E			
5%			
Answer			

PRACTICE PROBLEM #1 STEP 5

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.

Be careful here!
Include coefficients!
Easy this time because all ones 😊



Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C	- x	+ x	+ x
E			
5%			
Answer			

PRACTICE PROBLEM #1 STEP 6

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.

Be careful
with the
+/- signs, pay
attention!



Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C	- x	+ x	+ x
E	1.3 - x	x	x
5%			
Answer			

PRACTICE PROBLEM #1

STEP 7

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous and $K_{\text{eq}} = 78.3$.

Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C	- x	+ x	+ x
E	1.3 - x	x	x
5%	NA	NA	NA
Answer			

$K > 1$, so
cant use
the 5%
rule 😞



PRACTICE PROBLEM #1

STEP 8

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous.

Forward Reaction is happening
zero products means $Q = 0$ so shifting right



Equilibrium Expression

$$K_{\text{eq}} = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]}$$

PRACTICE PROBLEM #1

STEP 8 cont...

Plug what you know about the []'s at equilibrium into your equilibrium expression

Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C	- x	+ x	+ x
E	1.3 - x	x	x
5%	NA	NA	NA
Answer			

$$K_{\text{eq}} = \frac{[\text{PCl}_3][\text{Cl}_2]}{[\text{PCl}_5]}$$

$$78.3 = \frac{[x][x]}{[1.3 - x]}$$

PRACTICE PROBLEM #1

STEP 8 cont...

$$78.3 = \frac{(x)(x)}{(1.3 - x)}$$

$$(1.3 - x) 78.3 = x^2$$

$$101.79 - 78.3x = x^2$$

$$0 = x^2 + 78.3x - 101.79$$

Solve using quadratic equation!

$$ax^2 + bx + c = 0$$

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


$$\frac{-78.3 \pm \sqrt{78.3^2 - 4(1)(-101.79)}}{2(1)}$$

$$x = 1.28 \text{ or } -79.58$$

-79.58 makes no sense!

PRACTICE PROBLEM #1 STEP 9

If you have an initial concentration of $[\text{PCl}_5]$ at 1.3M, what are the concentrations of the products at equilibrium? Assume all reactants and products are aqueous.

Plug your x value into your E row to find your final answers! 

Rxn	$\text{PCl}_5 \leftrightarrow$	$\text{PCl}_3 +$	Cl_2
I	1.3	0	0
C	- x	+ x	+ x
E	1.3 - x	x	x
5%	NA	NA	NA
Answer	1.3 - 1.28 = 0.02 M	1.28 M	1.28 M

ISN'T THE QUADRATIC FORMULA FUN??????

What if we didn't have to use it ?!

WHAT IF THERE WAS A BETTER WAY????

USE THE 5% RULE!

5% RULE

What is it?

- A way for us to simplify the math involved when solving ICE table problems.

When can I use it?

- When X is small enough to be considered negligible
- The change ends up being so small that it isn't even considered valid when you take significant figures into account so you might as well ignore it!

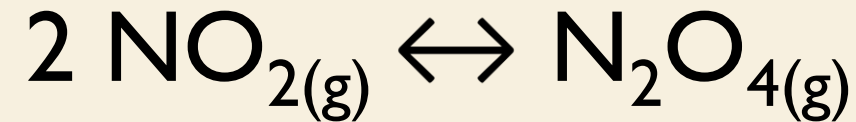
5% RULE

What counts as “negligible?”

- Required: $K < 1$
- When x ends up being 5% or less of the initial concentrations
 - *Can't know that until the end when you solve for x ! Ugh!*
 - *Good guestimate... if K is at least 1000x smaller than initial concentrations, you have a good chance of the 5% rule working*
- *You MUST check at the end to show that $\frac{x}{[initial]} \times 100 \leq 5\%$*

5% RULE EXAMPLE – PROBLEM #2

In the following reaction, $K_{\text{eq}} = 9.3 \times 10^{-7}$ at room temperature. Calculate the equilibrium concentration of N_2O_4 in a flask initially containing only 3.00 M of NO_2



5% RULE EXAMPLE

Set up your ICE table as normal through the equilibrium row. $2 \text{NO}_{2(g)} \rightarrow \text{N}_2\text{O}_{4(g)}$

Rxn	2NO_2	\leftrightarrow	N_2O_4
I	3		0
C	- 2x		+ x
E	$3 - 2x$		x
5%			
Answer			

Careful to use
the coefficients!
It's stoich right?!

5% RULE EXAMPLE

Now check to see that K is at least 1000x smaller than initial []'s ($K_{eq} = 9.3 \times 10^{-7}$ vs. 3)

Rxn	2NO_2	\leftrightarrow	N_2O_4
I	3		0
C	- 2x		+ x
E	$3 - 2x$		x
5%	3		x
Answer			

Yes it is!
Probably can use the 5% rule!
Ignore any subtraction or addition of x values.

← Leave any x values that are by themselves alone!

5% RULE EXAMPLE

Now plug your 5% equilibrium values into the Equilibrium Expression and solve for x! Math is easier! Wooahoo!

Rxn	2 NO ₂	↔	N ₂ O ₄
I	3		0
C	- 2x		+ x
E	3 - 2x		x
5%	3		x
Answer	3 M		8.37 x 10 ⁻⁶ M

$$K_{eq} = \frac{[N_2O_4]}{[NO_2]^2}$$

$$9.3 \times 10^{-7} = \frac{x}{3^2}$$

$$x = 8.37 \times 10^{-6}$$

← Plug your x value into your 5% row to find your final answers!

5% RULE EXAMPLE

DON'T FORGET! PROVE YOUR 5% RULE WAS VALID!

Rxn	2 NO ₂	↔	N ₂ O ₄
I	3		0
C	- 2x		+ x
E	3 - 2x		x
5%	3		x
Answer	3 M		8.37 x 10 ⁻⁶ M

$$\frac{x}{[initial]} x 100 \leq 5\%$$

$$\frac{8.37 \times 10^{-6}}{3} x 100 = 2.79 \times 10^{-4}$$

Yes, 5% rule was valid!

YOUTUBE LINK TO PRESENTATION

- <https://youtu.be/2mnYweqmKZE>