Welcome students myself.

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today will be presenting for

the program Bachelor of Science and

the subject chemistry for the semester 2

for the paper code, CHC 102 entitled ,

physical chemistry and the.

Organic chemistry,

so today I will be discussing the module

no 13 of the Unit 2 chemical equilibrium.

That is, a relation between KP kc and Kx

for the reaction involving ideal cases.

In this module I will be

discussing the relation between the

equilibrium constant KP and kx.

Then we will see a relation

between KP and KC.

After that we will see the relation between

all these three equilibrium constant Kp,

kc and kx.

So at the end of this module you

should able to derive a relation

between the equilibrium constant KP,

Kc and kx and should be able to solve

the problem based on this relationship.

So let us start without today's

discussion on the topic.

A relation between Kp, kc
and kx.

So for this,

let us consider a following general

reaction wherein the a moles of A

react with b moles of B to give you

the C moles of C + D moles of D.

Now for the equation for an

ideal gaseous system,

the equilibrium constant expression

can be written either in terms of

partial pressure or concentration,

or mole fraction, and so on.

When it is expressed in terms of

partial pressure, it is represented as Kp, and it is given as a ratio of partial

pressure of products to that of

the partial pressure of reactant,

while when it is expressed in terms of

concentration, it is represented as.

Kc and is given as a ratio of

concentration of product to that

of the concentration of the reactant ,

while when it is expressed in

terms of mole fraction,

it is represented as Kx is given

as mole fraction of product to that

of the mole fraction of reactant.

Now knowing this how kc, kx and kp

are expressed.

Let us see how they are related.

So first we will see how Kp and KC

are related now we know.

In an ideal gas,

each component obeys

Daltons law of partial pressure.

Now what is this Daltons law of partial pressure?

It says that at a constant temperature,

total pressure is sum of the

partial pressure of the each of

the component and it is expressesed

Pi is equal to Xi into P.

So where in the P is total pressure.

And Pi is a partial pressure of I th component

with a mole fraction Xi the mixture.

So this is how the pressure is

related to mole fraction.

So knowing this relation will

see how Kp and Kx are related.

For this will consider again a

reaction wherein in a moles of A

react with be moles or B to give

you the c moles of C and d moles of D

now for this reaction.

The equilibrium constant Kp can

be expressed as a ratio partial

pressure of product to that of

the partial pressure of the reactant.

That is if you can see over here,

it is expressed as partial pressure

of C raised to coefficient c.

Into partial pressure of D

raised to coefficient d upon

partial pressure of A raised to

coefficient a into partial pressure,
of B raised to coefficient b.

Now how we can relate it

to the mole fraction?

We know from Dalton's

law of partial pressure,

we can write a partial pressure as a

product of total pressure into mole fraction.

So we have P_A is equal to X_A into P

P_B is equal to X_B into P, P_C

is equal to Xc into P and P_D.

is equal to X_D into P.

Now substituting this terms in

the above expression will get the

expression which is this form.

Now if you can see this expression,

the pressure is a total pressure.

P stands for the total pressure

and this is something that is

constant so we can take it out

along with its coefficient.

So we'll get the expression which is in

this form that is will

get your mole fraction.

Something with more friction.

And here we here partial pressure of p

raised to c into p raised to d upon p raised to a into

p raised to b
and we know

according from mathematics,

From we know when the base is same,

we can add the powers when two

terms are multiplied we can add the

powers so we can write P raised to

C + D an upon p raised two A+B.

And we know when the base is same

and we the two terms are divided

we can subtract the power.

So based on this will have the

expression P raised to (c + d) minus (a+b)

Look at the small fraction term

that is nothing but that is your.

Kx so we can write.

K_P is equal to K_X into P raised to delta n

where in delta n stands for the

change in the number of moles.

That is number of moles of product

minus number of moles of reactant

that will be C + d -- A + B.

So this is how Kp and Kx s are related now.

Let us look at next that is a

relation between K_P and K_C.

That is how KP is related to Kc.

Now we know for an ideal gas mixture.

We have ideal gas law which is

given as P_IV is equal to N_I into RT.

Now will rearrange the situation

so will get Pi is equal to an ni upon v into RT

what is an ni upon v.

it is nothing but it is concentration.

So we can write it as what Pi is equal

to Ci into RT where Ci stands

which is equal to ni upon is

molar concentration of it component

in the mixture of the total volume.

So this is how we can relate

a partial pressure

with concentration.

So now we'll see how K_P and K_C

are related for this again will

consider reaction wherein A reacts with B to give you C and D the equilibrium constant.

K_P for this can be expressed as

what a ratio of partial pressure

of products to that of the reactant.

Now from ideal gas law we know

partial pressures can be expressed

in terms of concentration as P_A is

equal to C_A into RT P_B is equal to.

C_B into RT, P_C is equal to C_C into

RT & P_D is equal to C_D into RT.

Now substituting this terms in

the above expression will get

the expression which is in this form if you can see in this expression,

RT are something that is constant so

we can take them out with their power.

So we get the expression,

which is something like this that

is concentration on one side and

RT terms on the other side.

Now here we can apply same

rule when the base is same.

Two terms are multiplied.

The powers can be added.

And when the base is same,

two terms are divided.

The powers can be subtracted,

so using that we can write K_P is

equal to something with concentration

into RT raised to C + d -- A + B.

Now if you see that concentration

terms over here,

it is a ratio concentration of

product to that of the reactant

That is nothing but your Kc.

So we can relate.

KP is equal to Kc in two RT

Raised to delta n where in Delta

is again change the number of moles

So this is how K_P is related to Kc.

So from this we saw how KP is related to

Kc and how KP is related to Kx. Now

We'll see how all these three

terms are related.

That is how KP, KX and KC are related now

from first derivation we came to

know that K_P is equal to K_X into

P raised to delta n, from second derivation

we came to know K_P is equal to

Kc into RT raised to delta n.

So from both this we can write K_P.

Is equal to K_X into P raised to delta n which

is equal to K_C into RT raised to delta n .

This is how KP Kc and

Kx are related now.

this delta in over here can be negative.

It can be positive and or it can

be zero when it is 0 the number of

moles of product will be equal to

number of moles of reactant so delta n

is equal to 0 under their condition.

Number of moles of product is equal

to number of moles of reactant and in

that case the K_P will become equal to K_X.

Is equal to kc,

so in this module we discuss

the relation between kp, kc and kx OK.

Now let us solve some problem

based on this relation.

OK so the problem is calculate KC

for the reaction wherein N 204 is

getting converted to two molecules of No2.

The KP is given to us that

is 0.157 atmosphere

at 25 degrees Celsius and one

atmospheric pressure the R which

is gas constant is provided to us.

Now how to? Solve this problem.

So we write the reaction whereinN204

is getting converted to an N02.

Now we need to calculate KC.

The KP is given to us so we need to

understand the relation between KP

and KC and the relation is KP is equal

to KC into RT raised to delta n?

So now we will rearrange it in

such a way that we get kc.

OK so will you arrange at kc

is equal to Kp upon RT raised to delta n?

Now in this formula or your KP

is provided to us that is 0.157.atmosphere

R is a gas constant

that is also some constant value which

is provided to us T is temperature

which is given as 25 degrees Celsius

will convert it to Kelvin by adding 273

and now what is this delta n? delta n is

change in number of moles so

that we will come to know from the

reaction, if you see number of moles

of product are two and reactant is

one so delta n will be 2 minus one

that is equal to 1 so substituting.

All these values in the K_C equation will get,

that is KP 0.157 R as gas constant constant,

whatever value that is being given

temperature that is 303

Kelvin will get.

Kc is equal to 6.38 into ten raised to minus 3
moles per liter.

So this is how we can solve

the problem based on this KP,

KC or KP Kx relation.

So in this module we have discussed the

relation between kp, kc and kx and we have

solved problem based on this relation.

So these are the some of the

references that you can refer.

Thank you.