

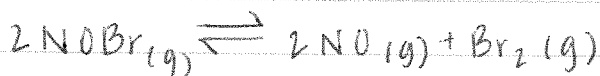
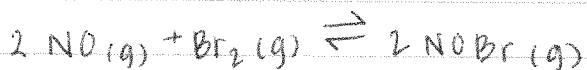
02/11/19

## Finding and using 'K'

\* Pure solids and liquids don't appear in K, only solutions and gases \*

$$* K_p = K_c (RT)^{\Delta n}$$

A) Reversing A RXN:



$$\therefore K_r = \frac{1}{K_f}$$

\* The  $K_r$  for a reverse rxn is the reciprocal of the fwd rxn.

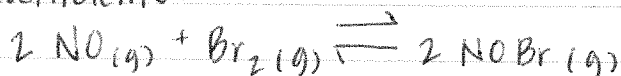
equilibrium expression

$$K_f = \frac{[\text{NOBr}]^2}{[\text{NO}]^2 [\text{Br}_2]}$$

$$K_r = \frac{[\text{NO}]^2 [\text{Br}_2]}{[\text{NOBr}]^2}$$

reverse rxn

B) Multiplying coefficients:



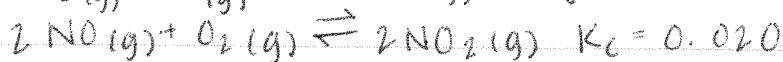
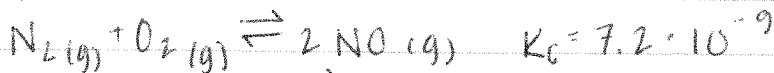
$$K_{f1} = \frac{[\text{NOBr}]^2}{[\text{NO}]^2 [\text{Br}_2]}$$

$$K_{f2} = \frac{[\text{NOBr}]^4}{[\text{NO}]^4 [\text{Br}_2]^2}$$

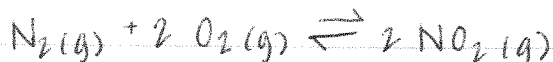
\* If we multiply a rxn coefficient by a factor, we raise K to that power

$$K_{f2} = (K_{f1})^2$$

C) Adding Two RXNs



What is  $K_c$  for:

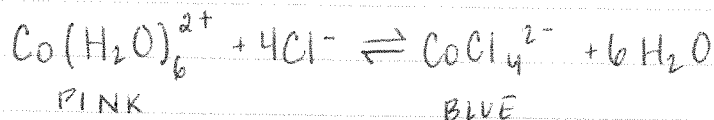


$$K_1 = \frac{[\text{NO}]^2}{[\text{N}_2][\text{O}_2]} \oplus K_2 = \frac{[\text{NO}_2]^2}{[\text{NO}]^2 [\text{O}_2]} \Rightarrow K_{1+2} = \frac{[\text{NO}_2]^2}{[\text{N}_2][\text{O}_2]^2} \odot K_1 \cdot K_2$$

\* When you add two rxns, the K for the overall rxn is the product of the Ks for the individual rxns.

# CLASS DEMO:

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temperature changes equilibrium

## Calculating K

①



Initially the vessel is charged at 500 K w/ BrCl(g) at a partial pressure of 0.500 atm. At equilibrium, the BrCl partial pressure is 0.040 atm. Calculate the value of  $K_p$  at 500 K.

$$\left\{ \begin{array}{l} K_c = \frac{[\text{Br}_2][\text{Cl}_2]}{[\text{BrCl}]^2} \\ K_p = \frac{P_{\text{Br}_2} P_{\text{Cl}_2}}{P_{\text{BrCl}}^2} \end{array} \right\} \text{ must know equilibrium values}$$

USE RICE (or) ICE TABLES

| R       | I      | C           | E |
|---------|--------|-------------|---|
| initial | change | equilibrium |   |

|   |            |                      |                 |   |                 |
|---|------------|----------------------|-----------------|---|-----------------|
| R | 2 BrCl     | $\rightleftharpoons$ | Br <sub>2</sub> | + | Cl <sub>2</sub> |
| I | 0.500 atm  |                      | 0 atm           |   | 0 atm           |
| C | -0.460 atm |                      | +0.23 atm       |   | +0.23 atm       |
| E | 0.040 atm  |                      | 0.23 atm        |   | 0.23 atm        |

$$PV = nRT$$

↑ ↑

'P' proportional to 'n' in constant temp

$$0.460 \text{ atm BrCl} \times \frac{1 \text{ atm Br}_2}{2 \text{ atm BrCl}} = 0.230 \text{ atm}$$

$$K_p = \frac{P_{\text{Br}_2} P_{\text{Cl}_2}}{P_{\text{BrCl}}^2} = \frac{(0.230)(0.230)}{(0.040)^2} = \boxed{33}$$

expected b/c more products than reactants.

## STEPS to Find 'K'

- 1) Tabulate knowns in RICE
- 2) Calculate the known concentrations & changes
- 3) use stoichiometry
- 4) use changes and initials to calculate equilibrium concentrations
- 5) use equilibrium concentrations to find 'K'

② What if no equilibrium concentrations are known?



The equilibrium constant  $K_p$  is 0.497 at 500 K. A gas cylinder at 500 K is charged w/  $\text{PCl}_5(g)$  at 1.66 atm. What are the equilibrium pressures of  $\text{PCl}_5$ ,  $\text{PCl}_3$ ,  $\text{Cl}_2$  at said temp?

$$K_p = \frac{P_{\text{PCl}_3} P_{\text{Cl}_2}}{P_{\text{PCl}_5}}$$

Substitute

$$= \frac{X \cdot X}{(1.66 - X)}$$

$$= 0.497$$

| R | $\text{PCl}_5$                      | $\rightleftharpoons$ | $\text{PCl}_3$ | $+$ | $\text{Cl}_2$ |
|---|-------------------------------------|----------------------|----------------|-----|---------------|
| I | 1.66 atm                            |                      | 0              |     | 0             |
| C | -x                                  |                      | +x             |     | +x            |
| E | 1.66 - x                            |                      | x              |     | x             |
|   | $\underbrace{1.66 - 0.693}_{0.967}$ |                      | 0.693          |     | 0.693         |

assigned variable (x)

$$\frac{X^2}{1.66 - X} = 0.497$$

$$X^2 = 0.497(1.66 - X)$$

$$X^2 + 0.497X - 0.825 = 0$$

Method #1:  
Quadratic  
Formula

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

$$X_1 = -1.19, \quad X_2 = 0.693$$

Reject