

K_p & K_c Relationship and Characteristics of K

- (a) $n_p = n_r$ then $K_p = K_c$
 where n_p = no. of moles of product
 n_r = no. of moles of reactant.
- (d) $K_1 = \frac{[NO_2]}{[NO][O_2]^{1/2}}$; $K_2 = \frac{[NO]^2[O_2]}{[NO_2]^2}$

$$\Rightarrow \frac{[NO_2]^2}{[NO]^2[O_2]} = \frac{1}{K_2} \Rightarrow \frac{[NO_2]}{[NO][O_2]^{1/2}} = \frac{1}{\sqrt{K_2}}$$

$$\Rightarrow K_1 = \frac{1}{\sqrt{K_2}}; K_2 = \frac{1}{K_1^2}$$
- (a) $K_p = K_c(RT)^{\Delta n} = 26(0.0821 \times 523)^{-1} = 0.61$.
 $\Delta n_g = 1 - 2 = -1$
- (b) $K_p = K_c(RT)^{\Delta n}$

Explanation:

The relation between **K_p** (based on partial pressures) and **K_c** (based on concentrations) is:

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

where

Δn = (number of moles of gaseous products) – (number of moles of gaseous reactants),

R = gas constant, and

T = absolute temperature (in kelvin).

- (d) In presence of little H_2SO_4 (as catalyst) about $2/3$ mole of each of CH_3COOH and C_2H_5OH react to form $2/3$ mole of the product at equilibrium.
- (d) K_1 for reaction $2HI \rightleftharpoons H_2 + I_2$ is 0.25 K_2 for reaction $H_2 + I_2 \rightleftharpoons 2HI$ will be $K_2 = \frac{1}{K_1} =$

$$\frac{1}{0.25} = 4$$

Because IInd reaction is reverse of Ist.



7 (c) $K_p = K_c (RT)^{-2}$

Explanation:

For the relation $K_p = K_c (RT)^{\Delta n}$,

$\Delta n = (\text{moles of gaseous products}) - (\text{moles of gaseous reactants})$

$$= 2 - (1 + 3) = 2 - 4 = -2$$

So, $K_p = K_c (RT)^{-2}$.

8 (d) The temperature

Explanation:

The equilibrium constant **Kc** or **Kp** depends **only on temperature** because it is derived from the thermodynamic properties ($\Delta G^\circ = -RT \ln K$).

It does **not** depend on volume, pressure, or initial concentrations — those only affect how quickly equilibrium is reached or the position of equilibrium, not the value of K.

9. (a) For the reaction,



$$K_p = P_{\text{CO}_2} \text{ and } K_c = [\text{CO}_2]$$

$$(\because [\text{CaCO}_3] = 1 \text{ and } [\text{CaO}] = 1 \text{ for solids})$$

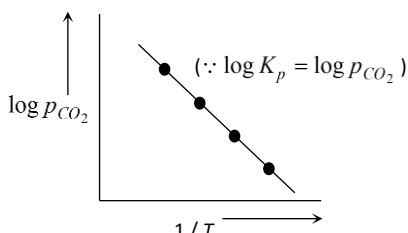
According to Arrhenius equation we have

$$K = Ae^{-\Delta H_r^\circ / RT}$$

Taking logarithm, we have

$$\log K_p = \log A - \frac{\Delta H_r^\circ}{RT(2.303)}$$

This is an equation of straight line. When $\log K_p$ is plotted against $1/T$, we get a straight line.



The intercept of this line = $\log A$, slope = $-\Delta H_r^\circ / 2.303 R$

Knowing the value of slope from the plot and universal gas constant R , ΔH_r° can be calculated.

(Equation of straight line : $Y = mx + C$. Here,

$$\log K_p = -\frac{\Delta H_r^\circ}{2.303R} \left(\frac{1}{T}\right) + \log A$$

$$Y \quad m \quad x \quad C$$

10. (b) $K_p = K_c(RT)^{\Delta n}$; When $\Delta n = 2 - (2 + 1) = -1$, i.e. negative,
 $K_p < K_c$.

11. (c) $K_1 = \frac{[SO_3]}{[SO_2][O_2]^{1/2}}$ and $K_2 = \frac{[SO_2]^2[O_2]}{[SO_3]^2}$, $K_2 = \frac{1}{K_1^2}$.

- 12 (c) Remains the same

Explanation:

The **equilibrium constant (K_c)** depends **only on temperature** — not on the initial concentrations of reactants or products.

When the concentration of reactants is increased, the system temporarily shifts its equilibrium position (according to Le Chatelier's principle), but the **value of K_c itself remains unchanged** as long as the temperature is constant.

13. (c) Reaction is reversed. Hence

$$K = \frac{1}{(2.4 \times 10^{-3})} = 4.2 \times 10^2$$

14. (c) $K_p = \frac{[P_{CO}]^2}{[P_{CO_2}]} = \frac{4 \times 4}{2} = 8$.

15. (d) K_{c_1} for $H_2 + I_2 \rightleftharpoons 2HI$ is 50

$$K_{c_2} \text{ for } 2HI \rightleftharpoons H_2 + I_2$$

$$K_{c_2} = \frac{1}{K_{c_1}} = \frac{1}{50} = 0.02$$

16. (c) $K_p = K_c(RT)^{\Delta n}$



$\Delta n = -1$ for reaction $2SO_2 + O_2 \rightleftharpoons 2SO_3$

So for this reaction K_p is less than K_c .

17. (c) $K_p = K_c(RT)^{\Delta n}$; $\Delta n = 2 - 2 = 0$

18. (c) For the reaction $H_2 + I_2 \rightleftharpoons 2HI$

$$\Delta n = 0$$

$$\text{So } K_p = K_c \therefore 50.0$$

19. (d) For reaction $2SO_3 \rightleftharpoons O_2 + 2SO_2$

Δn is +ve so K_p is more than K_c .

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

20. (c) $\Delta n = 2 - 1 = 1$

$$K_p = K_c(RT)$$

