

### $K_p$ & $K_c$ Relationship and Characteristics of $K$

21. (c) For this reaction there is no change in equilibrium constant by change of volume.

22. (c) If  $\Delta n = 0$  then  $K_p = K_c$

23. (a)  $k_p = k_c(RT)^{\Delta n}$   
 $\Delta n = 3 - 2 = 1$ ;  $k_p > k_c$ .

24. (d) Equilibrium constant depends upon temperature.

25. (d)  $2NOCl(g) = 2NO(g) + Cl_2(g)$

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

$$K_p = 3 \times 10^{-6} (0.0821 \times 700) = 172.41 \times 10^{-6}$$

$$= 1.72 \times 10^{-4}$$

26 (b)  $N_2 + O_2 \rightleftharpoons 2NO$

**Explanation:**

The relation between the two constants is  $K_p = K_c (RT)^{\Delta n}$ ,  
 where  $\Delta n = (\text{moles of gaseous products}) - (\text{moles of gaseous reactants})$ .

If  $\Delta n = 0$ , then  $(RT)^0 = 1$ , so  $K_p = K_c$ .

Now check each:

- (a)  $\Delta n = 2 - (1 + 3) = -2$
- (b)  $\Delta n = 2 - (1 + 1) = 0$
- (c)  $\Delta n = (1 + 1) - 1 = +1$
- (d)  $\Delta n = (2 + 1) - 2 = +1$

Hence, for  $N_2 + O_2 \rightleftharpoons 2NO$ ,  $K_p = K_c$ .

27. (b)  $K' = K^n$ ; Hence  $n = \frac{1}{2}$

$$\therefore K' = K^{1/2} = \sqrt{K}$$

28 (c) 16

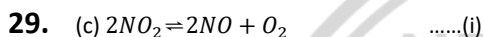


**Explanation:**

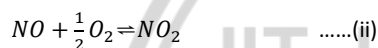
The equilibrium constant  $K_p$  depends **only on temperature** — not on pressure, volume, or concentration changes.

When the volume is reduced, the system temporarily shifts its equilibrium position (Le Chatelier's principle) to counter the change, but the **numerical value of  $K_p$  remains unchanged** as long as the temperature is constant.

Therefore,  $K_p = 16$  even after the volume is halved.



$$K = 1.6 \times 10^{-12}$$



Reaction (ii) is half of reaction (i)

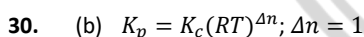
$$K = \frac{[NO]^2[O_2]}{[NO_2]^2}$$
 .....(i)

$$K' = \frac{[NO_2]}{[NO][O_2]^{1/2}}$$
 .....(ii)

On multiplying (i) and (ii)

$$K \times K' = \frac{[NO]^2[O_2]}{[NO_2]^2} \times \frac{[NO_2]}{[NO][O_2]^{1/2}} = \frac{[NO][O_2]^{1/2}}{[NO_2]} = \frac{1}{K'}$$

$$K \times K' = \frac{1}{K'}; K = \frac{1}{K'^2}; K' = \frac{1}{\sqrt{K}}$$



So  $K_c$  will be less than  $K_p$ .



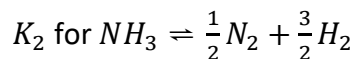
**Explanation:**

The **equilibrium constant (K)** depends **only on temperature**.

- A **catalyst** affects only the rate of attaining equilibrium, not the value of K.
- **Change in temperature** alters the equilibrium constant — it increases or decreases depending on whether the reaction is **endothermic or exothermic**.



32. (d)  $K_1$  for  $N_2 + 3H_2 \rightleftharpoons 2NH_3$



$$K_1 \times K_2 = \frac{[NH_3]^2}{[N_2][H_2]^3} \times \frac{[N_2]^{1/2}[H_2]^{3/2}}{[NH_3]}$$

$$K_1 \times K_2 = \frac{1}{K_2}; K_2 = \frac{1}{\sqrt{K_1}}$$

- 33 (d) The forward reaction is favoured by the addition of a catalyst

**Explanation:**

A catalyst only speeds up both the forward and reverse reactions equally, helping the system reach equilibrium faster.

It does not shift the position of equilibrium or favour either direction.

34. (a)  $K_p = K_c(RT)^{\Delta n}$ ;  $\Delta n = 2 - 4 = -2$

$$K_p = 6 \times 10^{-2} \times (0.0812 \times 773)^{-2}$$

$$K_p = \frac{6 \times 10^{-2}}{(0.0812 \times 773)^2} = 1.5 \times 10^{-5}.$$

35. (b)  $2.303 \log \frac{K_2}{K_1} = \frac{\Delta H}{R} \frac{[T_2 - T_1]}{T_1 \times T_2}$

$\Delta H = +ve$  for the reaction

36. (d)  $N_2 + 3H_2 \rightleftharpoons 2NH_3$

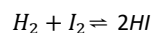
$$\Delta n = 2 - 4 = -2$$

$$K_p = K_c[RT]^{\Delta n}; K_p = K_c[RT]^{-2}$$

$$K_c = \frac{K_p}{[RT]^{-2}} = \frac{1.44 \times 10^{-5}}{[0.082 \times 773]^{-2}}$$

37. (d) Catalyst does not affect equilibrium constant.

38. (d)  $K$  for dissociation of  $HI$  = ?



$$K_a = 50, K_b = \frac{1}{50} = 0.02$$

39. (b)  $2SO_2 + O_2 \rightleftharpoons 2SO_3$  for this reaction

$$\Delta n = -1 ; \therefore K_c > K_p$$

40. (b)  $CaCO_{3(s)} \rightleftharpoons CaO_{(s)} + CO_{2(g)}$

$$K_p = P_{CO_2}$$

Solid molecule does not have partial pressure so in calculation of  $K_p$  only  $P_{CO_2}$  is applicable.

