1. Starting with 2 moles of PCl_5 in 1 litre container,
0.5 moles of PCl_5 dissociates till equilibrium at 25ºC. Equilibrium constant K_C is :

(a)6 (b)4.5 (c) $\frac{1}{6}$ (d)None

2. The r.m.s. speed of molecules of a gas of density 4.0 kg m^{-3} and pressure 1.2×10^5 Nm^{-2} is -
(a)300 m s^{-1} (b)900 m s^{-1} (c)600 m s^{-1} (d)400 m s^{-1}

3. In a chemical reaction, the rate constant for the backward reaction is 7.5×10^{-4} and the equilibrium constant is 1.5. The rate constant for the forward reaction is -
(a)5×10^{-4} (b)2×10^{-3}
(c)1.125×10^{-3} (d)9.0×10^{-4}

4. For the equilibrium $NH_4HS(s) \rightleftharpoons NH_3(g) + H_2S(g)$
$K_c = 1.8 \times 10^{-4}$ at 298 K. The value of K_p at 298 K would be -
(a)0.108 (b)4.4×10^{-3} (c)1.8×10^{-4} (d)4.4×10^{-4}

5. If K for the reaction $2HI(g) \rightleftharpoons H_2(g) + I_2(g)$, is 0.025 at a certain temperature, the value of K for the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$ at the same temperature would be -
(a)10 (b)40 (c) $\sqrt{30}$ (d) $\sqrt{40}$

6. The dissociation constants of two acids HA_1 and HA_2 are 3.0×10^{-4} and 1.8×10^{-5} respectively. The relative strengths of the acids will be approximately
(a)1 : 4 (b)4 : 1 (c)1 : 16 (d)16 : 1

7. The equilibrium constant, K_p for the reaction

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$$

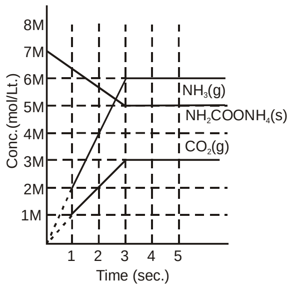
is 4.0 atm^{-1} at 1000 K. What would be the partial pressure of O_2 if at equilibrium the amount of SO_2 and SO_3 is the same ?
(a) 16.0 atm (b) 0.25 atm
(c) 1 atm (d) 0.75 atm

8. For the reaction $A_2(g) + 2B_2 \rightleftharpoons 2C_2(g)$
the partial pressure of A_2, B_2 at equilibrium are 0.80 atm and 0.40 atm respectively. The pressure of the system is 2.80 atm. The equilibrium constant K_p will be
(a) 20 (b) 5.0 (c) 0.02 (d) 0.2

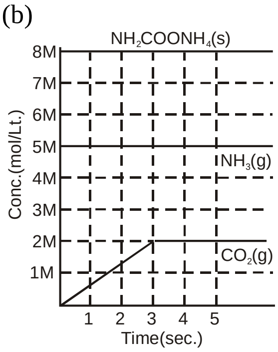
9. If the anions (a) form hexagonal closest packing and cations(c) occupy only 2/3 octahedral voids in it, then the general formula of the compound is
(a) CA (b) CA_2 (c) C_2A_3 (d) C_3A_2

10. For the reaction N_2O_4 (g) $\rightleftharpoons$ $2NO_2$ (g), if percentage dissociation of N_2O_4 are 20%, 45%, 65% & 80%, then the sequence of observed vapour densities will be :
(a)$d_{20} > d_{45} > d_{65} > d_{80}$ (b) $d_{80} > d_{65} > d_{45} > d_{20}$
(c)$d_{20} = d_{45} = d_{65} = d_{80}$ (d) $(d_{20} = d_{45}) > (d_{65} = d_{80})$

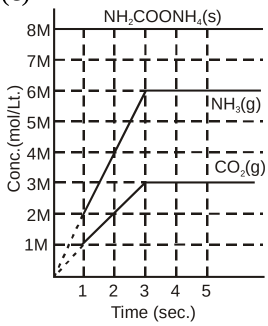
11. Solid ammonium carbamate dissociate to give ammonia and carbon dioxide as follows
$NH_2COONH_4(s) \rightleftharpoons 2NH_3(g) + CO_2(g)$
which of the following graph correctly represents the equilibrium.
(a)



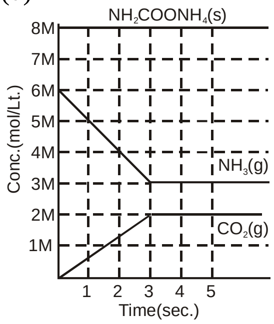
(b)



(c)



(d)



12. The correct relationship between free energy change in a reaction and the corresponding equilibrium constant K is

(a) $-\Delta G^0 = RT \ln K$ (b) $\Delta G = RT \ln K$

(c) $-\Delta G = RT \ln K$ (d) $\Delta G^0 = RT \ln K$

13. Equilibrium constant for the following equilibrium is given at 0^0C.

$$Na_2HPO_4 \cdot 12H_2O\ (s) \rightleftharpoons Na_2HPO_4 \cdot 7H_2O\ (s) + 5H_2O(g) \quad K_P = 31.25 \times 10^{-13}$$

At equilibrium what will be partial pressure of water vapour :

(a) $\frac{1}{5} \times 10^{-3}$ atm (b) 0.5×10^{-3} atm

(c) 5×10^{-2} atm (d) 5×10^{-3} atm.

14. A liquid is in equilibrium with its vapour at its boiling point. On the average the molecules in the two phases have equal :

(a) Inter molecular forces (b) Potential energy

(c) Kinetic energy (d) None of these .

15. Given the following reaction at equilibrium
$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$. Some inert gas at constant pressure is added to the system. Predict which of the following facts will be affected
(a) More $NH_3(g)$ is produced
(b) Less $NH_3(g)$ is produced
(c) No affect on the equilibrium
(d) K_p of the reaction is decreased

16. Introduction of inert gas (at the same temperature) will affect the equilibrium if :
(a) Volume is constant and $\Delta n_g \neq 0$
(b) Pressure is constant and $\Delta n_g \neq 0$
(c)volume is constant and $\Delta n_g = 0$
(d) Pressure is constant and $\Delta n_g = 0$

17. In the preceeding problem, if $[A^+]$ and $[AB_2^{\square}]$ are y and x respectively, under equilibrium produced by adding the substance AB to the solvents, then K_1/K_2 is equal to
(a) $\frac{y}{x}(y-x)^2$ (b) $\frac{y^2(x+y)}{x}$
(c) $\frac{y^2(x+y)}{x}$ (d) $\frac{y}{x}(x-y)$

18. The equilibrium constant for the reaction,$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ at temperature T is 4×10^{-4} . The value of K_c for the reaction, $NO(g) \rightleftharpoons N_2(g) + \frac{1}{2} O_2(g)$ at the same temperature is
(a) 2.5×10^2 (b) 0.02 (c) 4×10^{-4} (d) 50

19. For the reaction, $2NO_2(g) \rightleftharpoons 2NO(g) + O_2(g)$,
($K_C = 1.8 \times 10^{-6}$ at 184°C)
(R = 0.0831 kJ/(mol.K))
When K_p and K_c are compared at 184°C it is found that
(a) Whether K_p is greater than, less than or equal to K_c depends upon the total gas pressure
(b) $K_p = K_c$
(c) K_p is less than K_c
(d) K_p is greater than K_c

20. For the following three reactions a, b and c, equilibrium constants are given:
(a)$CO(g) + H_2O(g) \ \ CO_2(g) + H_2(g)$; K_1
(b)$CH_4(g) + H_2O(g) \ \ CO(g) + 3H_2(g)$; K_2
(c)$CH_4(g) + 2H_2O(g) \ \ CO_2(g) + 4H_2(g)$; K_3
Which of the following relations is correct ?
(a) $K_2 K_3 = K_1$ (b) $K_3 = K_1K_2$
(c) $K_3 K_2^3 = K_1^2$ (d) $K_1\sqrt{K_2} = K_3$

21. A vessel at 1000 K contains CO_2 with a pressure of 0.5 atm. Some of the CO_2 is converted into CO on the addition of graphite. If the total pressure at equilibrium is 0.8 atm, the value of K is :
(a) 1.8 atm (b) 3 atm (c) 0.3 atm (d) 0.18

22. Ratio of active masses of 22 g CO_2, 3g H_2 and 7g N_2 in a gaseous mixture :
(a)22 : 3 : 7 (b) 0.5 : 3 : 7 (c) 1 : 3 : 1 (d) 1 : 3 : 0.5

23. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$ in the reversible reaction the moles of PCl_5, PCl_3 and Cl_2 are a, b and c respectively and total pressure is P then value of K_p is :

(a) $\frac{bc}{a}.RT$ (b) $\frac{b}{(a+b+c)}.P$

(c) $\frac{bc.P}{a(a+b+c)}$ (d) $\frac{c}{(a+b+c)}.P$

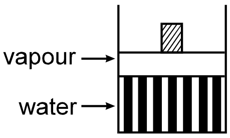
24. The degree of dissociation of PCl_5(a) obeying the equilibrium, $PCl_5 \rightleftharpoons PCl_3 + Cl_2$, is approximately related to the presure at equilibrium by (given a<< 1) :

(a) $\alpha \propto P$ (b) $\alpha \propto \frac{1}{\sqrt{P}}$ (c) $\alpha \propto \frac{1}{P^2}$ (d) $\alpha \propto \frac{1}{P^4}$

25. In the system, $LaCl_3(s) + H_2O(g) + \text{heat} \rightleftharpoons LaClO(s) + 2HCl(g)$, equilibrium is established. More water vapour is added to restablish the equlibrium. The pressure of water vapour is doubled. The factor by which pressure of HCl is changed is:

(a) 2 (b) $\sqrt{2}$ (c) $\sqrt{3}$ (d) $\sqrt{5}$

26. Some quantity of water is contained in a container as shown in figure. As neon is added to this system at constant pressure, the amount of liquid water in the vessel



(a) Increases (b) Decreases

(c) Remains same (d) Changes unpredictably

27. When a bottle of cold drink is opened, the gas comes out with a fizz due to :

(a) Decrease in temperature

(b) Increase in pressure

(c) Decrease in pressure suddenly which results in decrease of solubility of CO_2 gas in water

(d) None

28. In the Haber process for the industrial manufacturing of ammonia involving the reaction,

$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 200 atm pressure in the presence of a catalyst, a temperature of about 500^0C is used. This is considered as optimum temperature for the process because

(a) Yield is maximum at this temperature

(b) Catalyst is active only at this temperature

(c) Energy needed for the reaction is easily obtained at this temperature

(d) Rate of the catalytic reaction is fast enough while the yield is also appreciable for this exothermic reaction at this temperature.

29. For the reaction, $CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$ then

K_p / K_c is equal to :

(a) 1/RT (b) 1.0 (c) $\sqrt{RT}$ (d) RT

30. Consider the following reversible gaseous reactions (at 298 K) :

(a) $N_2O_4 \rightleftharpoons 2NO_2$(a) $N_2O_4 \rightleftharpoons 2NO_2$

(b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$

(c) $2HI \rightleftharpoons H_2 + I_2$

(d) $X + Y \rightleftharpoons 4Z$

1. (c)

$PCl_5 \rightleftharpoons PCl_3 + Cl_2$

2 0 0

1.5 0.5 0.5

$$K_C = \frac{(0.5)(0.5)}{1.5}$$

2. (a)

$$u = \sqrt{\frac{3P}{d}}$$

3. (c)

$$K = \frac{K_f}{K_b}$$

4. (a)

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

5. (b)

$$\frac{1}{K} = \frac{1}{0.025} = 40$$

6. (b)

$$\frac{\text{st.of } HA_1}{\text{st.of } HA_2} = \sqrt{\frac{K_{a_1}}{K_{a_2}}}$$

7. (b)

$2SO_2\,(g) + O_2 \rightleftharpoons 2SO_3(g)$

$Kp = 4.0\ atm^{-2}$

$$K_p = \frac{(SO_3)^3}{(SO_2)^2\left(O^2\right)}$$

Given that at equilibrium the amount of SO_2 and SO_3 is the same so

$$\frac{(SO_3)^2}{(SO_2)^2\left(O^2\right)} = 4$$

$\Rightarrow$ □ $[O_2] = \frac{1}{4}$ = 0.25 atm.

8. (a)

$A_2(g) + 2B_2(g) \rightleftharpoons 2C_2(g)$

P_{A2} = 0.80 atm., $P_{B\,2}$ = 0.4 atm.

Total pressure of the system = 2.8 atm.

$\therefore P_{C\,2}$ = 2.8 – 0.8 – 0.4 = 1.6

$$K_p = \frac{P_{C_2}^2}{P_{A_2} \times P_{B_2}^3} = \frac{(1.6)^2}{0.8 \times (0.4)^2} = 20$$

9. (c)

No. of A atoms = 6.

No. of C atoms = $6\times\frac{2}{3}$ = 4.

$\therefore$ Formula = C_4A_6 or C_2A_3.

10. (a)

$(VD)_{mix}$ $\frac{M_{mix}}{2} = \frac{M}{2(1+\alpha)}$

so, as α increases $(VD)_{mix}$ decreases.

11. (c)

Gas product concentration increases while that of solid reactant is constant.

12. (a)

From thermodynamics.

13. (d)

$Na_2HPO_4 .12H_2O(s) \rightleftharpoons Na_2HPO_4.7H_2O\ (s) + 5H_2O\ (g)$ $K_P = 31.25\times10^{-13}$

$$K_P = (P_{H_2O})^5$$

$$(P_{H_2O})^5 = 31.25\times10^{-3}$$

$$(P_{H_2O}) = (3125)^{1/5}\times(10^{-15})^{1/5}$$

$$(P_{H_2O}) = 5\times10^{-3}$$

14. (d)

At equilibrium between liquid and vapour, molecules have same kinetic energy.

15. (b)

On adding inert gas at constant pressure effect on equilibrium will be similar to as if volume of container has been increased.

16. (b)

For constant volume, reaction quotient (Q) will remain constant.

17. (a)

$$AB \rightleftharpoons A^+ + B^- \qquad AB + B^- \rightleftharpoons AB_2^-$$

a–x–y y (y–x) (a–x–y) y–x x

$$K_1 = \frac{y(y-x)}{(a-x-y)} \qquad K_2 = \frac{x}{(a-x-y)(y-x)}$$

$$\frac{K_1}{K_2} = \frac{\left[\frac{y(y-x)}{(a-x-y)}\right]}{\frac{x}{(a-x-y)(y-x)}}$$

$$\Rightarrow \quad \frac{K_1}{K_2} = \frac{y}{x}(y-x)^2$$

18. (d)

$$N_2(g)+O_2(g) \rightleftharpoons 2NO(g);$$

$$K_c = \frac{[NO]^2}{[N_2][O_2]} = 4\times10^{-4}$$

$$NO(g) \rightleftharpoons N_2(g)+\frac{1}{2}O_2(g);$$

19. (d)

$$K_p = K_c(RT)^{\Delta n} \qquad \Delta n = 3-2=1.$$

$K_p = K_c\ (0.0821 \times 457)^1$. $K_p > K_c$.

20. (b)

c = a + b

21. (a)

$$CO_2(g) + C(s) \rightleftharpoons 2CO\ (g)$$

0.5 atm 0.5–p 2p

Total pressure = 0.5 – P + 2P = 0.8

P = 0.3

$$K_p \frac{P_{CO}^2}{P_{CO_2}} = \frac{(2P)^2}{(0.5-P)} = \frac{(0.6)^2}{(0.5-0.3)}$$

$K_p = 1.8$

22. (d)

Moles of $CO_2 = \frac{22}{44} = \frac{1}{2}$

Moles of $H_2 = \frac{3}{2}$

Moles of $N_2 = \frac{7}{28} = \frac{1}{4}$

Ratio of active masses = 1/2 : 3/2 : 1/4 or 1 : 3 : 0.5

23. (c)

$$Kp = \frac{P'PCl \times P'Cl_2}{P'PCl_5} = \frac{\frac{b}{(a+b+c)}P \times \frac{c}{(a+b+c)} \times P}{\frac{a}{(a+b+c)}P}$$

$$K_p = \frac{bc.P}{a(a+b+c)}$$

24. (b)

$$K_P = \frac{\alpha^2}{1-\alpha^2}P \approx \alpha^2 P.$$

so, $\alpha \approx \sqrt{\frac{K_P}{P}}$

25. (b)

$$LaCl_3(s) + H_2O(g) + heat \longrightarrow LaClO(s) + 2HCl(g)$$

$$K_p = \frac{p_{HCl}^2}{p_{H_2O}} = \frac{p_{HCl}^2}{2p_{H_2O}} \qquad p_{HCl} = \sqrt{2}P_{HCl}$$

26. (b)

$$H_2O(\ell) \rightleftharpoons H_2O(g)$$

$$K_p = \left(P_{H_2O}\right)$$

When neon is added at constant pressure, we have to increase volume of the container. So more water will evaporate to mantain equilibrium

27. (c)

Solubility of gas is directly proportional to the pressure of gas above liquid.

28. (d)

On increasing temperature though reaction equilibrium shifts in the backward direction but for rate of reaction to be higher, higher temperature is required and particle 500^0C is found to be optimum temperautre.

29. (a)

$$CO(g) + CI_2(g) \rightleftharpoons COCI_2(g)$$

$$\Delta n = 1 - 2 = -1; \ K_p = K_c(RT)^{\Delta n} \quad \therefore \quad \frac{K_p}{K_c} = (RT)^{-1} = \frac{1}{RT}$$

30. (a)

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