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Class: 11
Subject: Chemistry
Topic: Equilibrium
No. of Questions: 20
Duration: 60 Min
Maximum Marks: 60

1. When sodium chloride was warmed with concentrated sulphuric acid, hydrogen chloride was evolved. Because sulphuric acid is

   A. a stronger acid than hydrochloric acid
   B. heavier than hydrogen chloride
   C. less volatile than hydrogen chloride
   D. more reactive than isopropyl chloride
   Sol: c

2. For the reaction PCl_3 (g) + Cl_2 (g) f PCl_5 (g), the value of Kc at 250^0 C is 26 mol dm-3 The value of K_P at this temperature in atmospheres is

   A. 0.61
   B. 0.57
   C. 0.46
   D. 0.83

   Sol: A
   $K_P = K_C (RT)^{\Delta n}$
   $K_C = 26 \qquad T = (250 + 273)K = 523\,K \qquad R = 0.0821$ lit - atm. $\Delta n = -1$
   $\therefore K_P = \frac{26}{0.0821 \times 525} = 0.61$ atm.
   Note : In this problem unit of K_C is mol dm^{-3}. Hence unit of K_P is atm and value of R is 0.0821 lit atm

3. Equilibrium constant of a reversible reaction is 3.2. If the velocity constant of the forward reaction is 1.12×10^{-3}, the velocity constant of the backward reaction is

   A. 4.32×10^{-3}
   B. 2.86×10^{-4}
   C. 3.5×10^{-4}
   D. 3.5×10^{-3}

   Sol: b
   Kp = Kc $(RT)^{\Delta n}$ Δn = + 1 Kp = Kc RT. Substitution and simplification gives option 2 as the answer

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4. For a reaction where KP < KC, the reaction is favored by

   A. high pressure
   B. low pressure
   C. high temperature
   D. low temperature
   Sol: a
   For a reaction where KP < KC, n is negative. Hence forward raction takes place with the reduction in the number of moles. So according to Le-Chetelier principle, the forward reaction is favoured by high pressure

5. For the equilibrium reaction 2HI(g) f H2 (g) + l2(g) the equilibrium constant is 1.0 x 10^{-5}, what is the concentration of HI if the equilibrium concentrations of H2 and l2 are 1.2 x 10^{-5} 1.2 x 10^{-4} M respectively

   A. 12 x 10^{-4}
   B. 12 x 10^{-3} M
   C. 12 x 10^{-2}
   D. 1.2 x 10^{-2}

   Sol: D

$$\begin{array}{lccccc} & 2HI & \leftrightarrow & H_2 & + & I_2 \\ \text{at equilibriu m} & x & & 1.2\times10^{-5} & & 1.2\times10^{-4} \end{array}$$

$$K=\frac{1.2\times10^{-5}\times1.2\times10^{-4}}{x^2}=10^{-5} \text{ or } x=1.2\times10^{-2}$$

6. A reaction at equilibrium means

   A. both forward and backward reaction are stopped
   B. the masses of the reactants and products are equal
   C. concentration of the reactants and the products are equal
   D. The velocity of both forward and backward reactions are equal

   Sol: D
   Option 4 means that the rate of forward reaction is equal to the rate of backward reaction. Under these conditions the reaction is at equilibrium

7. Le chatelier's principle is applicable only to a

   A. homogeneous reaction
   B. heterogeneous reaction
   C. system in equilibrium
   D. irreversible reaction

   Sol: C

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8. In which of the following KP is less than KC?

   A. $N_2(g) + O_2(g) \; f \; 2NO(g)$
   B. $2SO_2(g) + O_2(g) \; f \; 2SO_3(g)$
   C. $2HI(g) \; f \; H_2(g) + 12(g)$
   D. $N_2O_4(g) \; f \; 2NO_2(g)$

   Sol: b
   $KP = KC (RT)^{\Delta n}$, KP < KC if Δ n is negative. It is the case for the example given in option 2

9. The thermal effects of a reaction depend on?

   A. initial. concentration of reactants
   B. conditions of the reacting substances and the products formed
   C. final conditions of reacting substances
   D. none

   Sol: b

10. Two moles of nitrogen and two moles of hydrogen are taken in a closed vessel of a five litre capacity and suitable conditions are provided for the reaction. When equilibrium is reached it is found that half a mole of nitrogen is used up. The equilibrium concentration of ammonia is

    A. 0.2
    B. 0.4
    C. 0.3
    D. 0.1

    Sol: b
    $N_2 + 3H_2 \; f \; NH_3$ Amount of N_2 used up and ammonia formed are in the ratio 1: 2. (0.5 mole of N_2 is used up). Hence amount of ammonia formed in 5 litre vessel = 1 mole. Hence active mass of ammonia at equilibrium = 1/5 = 0.2 mol dm^{-3}

11. **Assertion (A)** The pH of an aqueous solution of acetic acid remains unchanged on the addition of sodium acetate. **Reason (R)** The ionisation of acetic acid is suppressed by the addition of sodium acetate.

    A. Both (A) and (R) are true and (R) is the correct explanation of (A).
    B. Both (A) and (R) are true but (R) is not the correct explanation of (A).
    C. (A) is true but (R) is false.
    D. (A) is false but (R) is true.

    Sol: D

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12. For the equilibrium: N2(g)+ 3H2(g) f 2NH3(g), the equilibrium constant, KP =

A. Kc(RT)
B. KC =(RT)2
C. KC
D. $\frac{kc}{(RT)^2}$

Sol: D

13. Which one of the following gaseous equilibrium system has the unit, mol dm^{-3} for the equilibrium constant?

A. H2 + I2 f 2HI
B. PCl5 f PCl3 + Cl2
C. PCl3 + Cl2 f PCl5
D. N2 + 3H2 f 2NH3

Sol: B
If the unit of KC is mol dm^{-3} then the total power of the numerator in the expression for KC should be one more than the denominator. In other words, Δn= +1. This is found to be so in option 2

14. A mixture of 0.3 mole of H_2 and 0.3 mole of I_2 is allowed to react in a 10 liter evacuated flask at 500°C. The reaction is $H_2 + I_2$ f 2HI. The K is found to be 64. The amount of unreacted I_2 at equilibrium is

A. 0.03 mole
B. 0.06 mole
C. 0.15 mole
D. 0.2 mole

Sol: B

	H_2	$+I_2$	$\rightleftharpoons$ 2HI
Amount taken	0.3	0.3	0
Amount reacted	x	x	0
Amount at equilbrium	(0.3 - x)	(0.3 - x)	2x

$K = \frac{(2x)^2}{(0.3-x)^2} = 64$ or $x = 0.24$. Hence amount of unreacted iodine $= 0.3 - 0.24 = 0.06$

15. **Assertion (A)** H2O is a Lewis base but not a Lewis acid.
Reason (R) H2O is amphiprotic.

A. Both (A) and (R) are true and (R) is the correct explanation of (A).
B. Both (A) and (R) are true but (R) is not the correct explanation of (A).
C. (A) is true but (R) is false.
D. (A) is false but (R) is true.

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Sol: B

16. The equilibrium N2 + O2 f 2NO is established in a reaction vessel of 2.5 litres capacity. The amounts of nitrogen and oxygen taken at the start were 2 moles and 4 moles respectively. Half a mole of nitrogen has been used up a equilibrium. The molar concentration of nitric oxide is

A. 0.2
B. 0.4
C. 0.6
D. 0.1

Sol: B
Amount of N2 used = 0.5 moles. Amount of NO formed (O2 : NO = 1 : 2) = 1 moles. Molar concentration of NO = 1/2.5 = 0.4 mol Dm^{-3}

17. Neutralization reaction goes to completion because

A. the products are soluble
B. one of the product is undissociated
C. equivalent amounts of acid and base are used up
D. the reaction is exothermic

Sol: B
NaOH + HCl f NaCl+ H2O. Product water is undissociates, Hence the reaction cannot be reversed. So the reaction goes to completion

18. At a certain temperature, for the reaction $N_2+O_2 \Leftrightarrow 2NO$, if K = 0.09 the equilibrium constant for $NO \Leftrightarrow \frac{1}{2} N_2 + \frac{1}{2} O_2$ is

A. 0.03
B. 3.3
C. 81
D. 27

Sol: B
The equilibriu m constant for the reverse reaction is $\frac{1}{K}$. Since the equation given is further divided by 2, the value of the equlibrium constant w ill be. $\frac{1}{K}$ Hence the answer is $\frac{1}{\sqrt{0.009}} = 3.3$

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19. For an exothermic reaction the equilibrium constant

A. increases when the temperature is increased
B. decreases when the temperature is increased
C. is independent of temperature
D. decreases when the pressure is increased

Sol: B
The reaction is exothermic means the forward reaction is exothermic. When the temperature is increased, backward endothermic reaction is favoured. So K_2 increases faster than K_1. So value of K decreases

20. To which one of the following reactions, Le-chatelier principle not applicable?

A. $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
B. $N_2, + O_2 \rightleftharpoons 2NO$
C. $CaCO_3 \rightleftharpoons CaO + CO_2$
D. $AgNO_3 + NaCl \rightleftharpoons AgCl + NaNO_3$

Sol: D
Option 4 is not a system at equilibrium since ionic reaction go to completion. Formation and precipitation of AgCl further favours the completion of the reaction