TEST QUESTIONS WITH MULTIPLE CHOICE ANSWERS (ONLY ONE CORRECT)

(Answer by encircling only one of the four offered answers under A, B, C or D)

1. According to this thermochemical equation:

$C_2H_5OH(l) + 3O_2(g) = 2CO_2(g) + 3H_2O(l)$

$\Delta_r H = -1370$ kJ/mol

which of the following expressions for ethanol combustion is correct?

A) The reaction enthalpy will be the same if gasous water is obtained.

B) This is endothermic reaction because the ethanol must be ignited off.

C) A smaller amount of heat will be released during the reaction if the water is obtained in gaseous state.

D) A greater amount of heat will be released in the reaction if the water is obtained in the gaseous state.

2. What will be the rate of concentration change of HCl, relative to that of MgO, for the reaction given by the following equation?

$MgO + 2HCl = MgCl_2 + H_2O$

A) The rate of concentration change of HCl will be two times greater than that of MgO.

B) The rate of concentration change of HCl will be two times smaller than that of MgO.

C) The rate of concentration change of HCl will be smaller for two than that of MgO.

D) The rate of concentration change of HCl will be greater for two than that of MgO.

3. The energy of the activated complex is:

A) smaller than the activation energy.

B) greater than the activation energy.

C) equal to the activation energy.

D) equal to the energy of the reactants.

4. Which expression is the correct one for the concentration equilibrium constant, for the reaction expressed by the following equation?

$C(s) + 2H_2(g) \rightleftharpoons CH_4(g)$

A) $K_c = \dfrac{c(CH_4)_e}{c(C)_e \cdot [c(H_2)_e]^2}$

B) $K_c = \dfrac{c(CH_4)_e}{[c(H_2)_e]^2}$

C) $K_c = \dfrac{c(CH_4)_e}{c(C)_e + [c(H_2)_e]^2}$

D) $K_c = \dfrac{c(C)_e \cdot [c(H_2)_e]^2}{c(CH_4)_e}$

5. The following equation, for the system in equilibrium, is given:

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

What is going to happen if the pressure of the reaction system is increased?

A) Nothing is going to happen since all the participants are gases.

B) The concentration of all of the participants will decrease.

C) The equilibrium will shift to the right i.e. towards obtaining SO_2 and O_2.

D) The equilibrium will shift to the left i.e. towards obtaining SO_3.

6. Which of the following particle species might be amphiprotolyte(s)?

I. HCO_3^- II. S^{2-} III. H_2O IV. $H_2PO_4^-$

A) Only I.

B) II, III and IV.

C) I, III and IV.

D) Only I and III.

7. At temperatures higher than 25 °C:

A) $K_w > 1\cdot10^{-14}$ mol^2/dm^6

B) $K_w < 1\cdot10^{-14}$ mol^2/dm^6

C) $K_w = 1\cdot10^{-14}$ mol^2/dm^6

D) It can not be known.

8. The pH value of NaOH solution is 12. What is the concentration of OH^- ions?

A) $c(OH^-) = 10^{-12}$ mol/dm^3

B) $c(OH^-) = 10^{-2}$ mol/dm^3

C) $c(OH^-) = 2$ mol/dm^3

D) $c(OH^-) = 12$ mol/dm^3

9. Which of the aqueous solutions of the following substances show pH > 7 at a temperature of 25 °C?

I. $NaHCO_3$ II. $(NH_4)_2SO_4$ III. CsOH IV. KCN

A) All of them.

B) Only III.

C) Only III and IV.

D) I, III и IV.

10. What is the oxidation number of phosphorus in $H_2P_2O_7^{2-}$?
A) +3
B) +5
C) +10
D) +6

11. In a certain oxidation-reduction reaction, nitric acid is converted to ammonia. This means that:
A. nitric acid is a reducing agent.
B. the oxidation number of nitrogen has increased.
C. nitric acid is an oxidizing agent.
D. nitric acid is oxidized.

12. Which of the following substances can be both oxidizing and reducing agent, depending on the substance with which it is reacting?
A. F_2
B. Na_2S
C. $KMnO_4$
D. $NaNO_2$

13. Which of the following equations does NOT represent a redox process?
A. $3KClO = KClO_3 + 2KCl$
B. $CuO + H_2SO_4 = CuSO_4 + H_2O$
C. $2Na + 2H_2O = 2NaOH + H_2$
D. $2Ba + O_2 = 2BaO$

14. The following reaction equation is given:
$P_4(s) + 10HClO + 6H_2O = 4H_3PO_4 + 10HCl$
Which substance is a reducing agent?
A. HClO
B. H_2O
C. P_4
D. None, since this is not a redox reaction.

15. What stoichiometric coefficients should be written in front of the formulae of the participants, in order to balance the equation?
$Fe^{2+}(aq) + Cr_2O_7^{2-}(aq) + H^+(aq) \longrightarrow Fe^{3+}(aq) + Cr^{3+}(aq) + H_2O(l)$
A) 1, 1, 14, 1, 2, 7
B) 6, 1, 14, 6, 2, 7
C) 6, 1, 2, 6, 2, 7
D) 1, 1, 2, 1, 2, 7

PROBLEMS

(Put the calculations and the answer to the problem at the designated place)

(M(C) = 12 g/mol; M(H) = 1 g/mol; M(O) = 16 g/mol; M(N) = 14 g/mol)

1. In a 3 L container, 12 mol of SO_3 were placed. At a particular temperature SO_3 is dissociated, according to the following equation:

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

At equilibrium, 3 mol of SO_2 were present in the reaction mixture. Calculate the concentration equilibrium constant for this reaction?

SOLUTION:

$V = 3$ L

$n(SO_3)_0 = 12$ mol

$n(SO_2)_e = 3$ mol

$K_c = ?$

$n(SO_2)_e = n(SO_2)_0 + n(SO_2)_{izr.} = 3$ mol

$n(SO_3)_{izr.} = n(SO_2)_{izr.} = 3$ mol

$n(SO_3)_e = n(SO_3)_0 - n(SO_3)_{izr.} = 12$ mol – 3 mol = 9 mol

$n(O_2)_e = ½\, n(SO_2)_e = 1{,}5$ mol

$c(SO_3)_e = n(SO_3)_e / V = 9$ mol /3 L = 3 mol/L

$c(SO_2)_e = n(SO_2)_e / V = 3$ mol /3 L = 1 mol/L

$c(SO_2)_e = n(O_2)_e / V = 1{,}5$ mol /3 L = 0,5 mol/L

$$K_c = \frac{[c(SO_2)_e]^2 \cdot c(O_2)_e}{[c(SO_3)_e]^2} = \frac{(1\,\text{mol dm}^{-3})^2 \cdot 0{,}5\,\text{mol dm}^{-3}}{(3\,\text{mol dm}^{-3})^2 \cdot} = 0{,}056\,\text{mol dm}^{-3}$$

Problem 1. ANSWER: $K_c = 0{,}056$ mol/L

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2. What volume of HCl solution with c(HCl) = 12 mol/L and what volume of water must be taken to prepare 1600 mL of a pH = 1.5 solution?

SOLUTION:

$c(HCl)_1 = 12$ mol/L

$V(\text{p-p})_2 = 1600$ mL

$pH(\text{p-p})_2 = 1{,}5$

$V(\text{p-p})_1 = ?$

$V(H_2O) = ?$

$pH = -\log c(H^+)$

$c(H^+) = 10^{-pH} = 10^{-1{,}5} = 0{,}032$ mol/L

$c(HCl)_2 = 0{,}032$ mol/L

$c(HCl)_1 \cdot V(\text{p-p})_1 = c(HCl)_2 \cdot V(\text{p-p})_2$

12 mol/L · $V(\text{p-p})_1$ = 0,032 mol/L· 1600 mL

$$V(\text{p}-\text{p})_1 = \frac{0{,}032\ \text{mol/L} \cdot 1600\ \text{mL}}{12\ \text{mol/L}} = 4{,}3\ \text{mL}$$

$V(H_2O)$ = 1600 mL – 4,3 mL = 1595,7 mL

Problem 2. ANSWER: V(HCl) = 4,2 mL; $V(H_2O)$ = 1595,8 mL

3. Nitrogen is obtained by passing gaseous ammonia over copper(II) oxide at high temperature, and the other products are solid copper and water vapour.

A) Write down the reaction equation and balance it using electron scheme.
B) Which reactant is an oxidation agent and which is a reducing agent?
C) What mass of nitrogen will be obtained if 18.1g of NH_3 react with 90.4 g of copper(II) oxide?
D) What is the volume of this mass at standard conditions?

$A_r(N) = 14,01$; $A_r(H) = 1,08$; $A_r(Cu) = 63,55$; $A_r(O) = 16$

SOLUTION:

A)

$$2\overset{-3}{N}H_3(g) + 3\overset{+2}{Cu}O(s) \rightarrow \overset{0}{N_2}(g) + 3\overset{0}{Cu}(s) + 3H_2O(g)$$

$$\begin{array}{l|c|c} 2\overset{-3}{N} - 6e^- \rightarrow \overset{0}{N_2} & & 1 \\ & 6 & \\ \overset{+2}{Cu} + 2e^- \rightarrow \overset{0}{Cu} & & 3 \end{array}$$

Б) CuO is an oxidizing agent, and NH_3 is a reducing agent

В) $m(NH_3)_0 = 18,1$ g
$m(NH_3)_0 = 90,4$ g
$m(N_2) = ?$

$$n(NH_3)_0 = \frac{18,1\ g}{17,25\ g \cdot mol^{-1}} = 1,05\ mol \qquad n(CuO)_0 = \frac{90,4\ g}{79,55\ g \cdot mol^{-1}} = 1,14\ mol$$

$$\frac{n(NH_3)}{n(CuO)} = \frac{2}{3} \Rightarrow n(NH_3)_{izr.} = \frac{2}{3} \cdot n(CuO) = \frac{2}{3} \cdot 1,14\ mol = 0,76\ mol$$

0,76 mol NH_3 are needed for the whole quantity of CuO to react and there are 1,05 mol NH_3 available in the mixture, which means more than the needed quantity. Therefore, CuO is the limiting reagent.

$$\frac{n(N_2)}{n(CuO)} = \frac{1}{3} \Rightarrow n(N_2) = \frac{1}{3} \cdot n(CuO)$$

$$\frac{m(N_2)}{M(CuO)} = \frac{1}{3} \cdot 1,14\ mol \Rightarrow m(N_2) = \frac{1}{3} \cdot 1,14\ mol \cdot 28,02\ g \cdot mol^{-1} = 10,65 g$$

Г) $V(N_2)_{s.u.} = n(N_2) \cdot V_m = 0,38\ mol \cdot 22,4\ dm^3/mol = 8,51\ dm^3$

Problem 3. ANSWER: $m(N_2) = 10,6$ g; $V(N_2) = 8,5\ dm^3$