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WORKBOOK

Fundamentals of Terminology, Reading, Interpreting and Solving Problems in Chemistry in English

General Chemistry

Advanced Level

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A. Fetisova, A. Svistunov, T. Litvinova. Fundamentals of terminology, reading, interpreting and solving problems in chemistry in English. *General Chemistry. Advanced Level.* Workbook.-M: I.M. Sechenov First MSMU, 2016.

Рабочая тетрадь (Workbook) составляет единый учебно-методический комплекс с учебным пособием (Textbook) и тестовой книжкой (Test Book) образовательного курса довузовской подготовки для профильных классов медицинской направленности «Химия на английском» для учащихся средних образовательных школ. Рабочая тетрадь (Workbook) предназначена для углубленного изучения избранных разделов общей химии, эффективного усвоения навыков и отработки умений обучаемыми при чтении, интерпретации и решении заданий по химии на английском языке.

Для учащихся 10-11-х профильных классов средних образовательных школ, изучающих химию по программам углубленной подготовки; преподавателей химии и английского языка; самостоятельного изучения основных разделов общей химии на английском языке и подготовке к сдаче экзаменов по химии в соответствии с международными программами.

Учебное пособие создано по приоритетному направлению ***Развитие системы профильного обучения в условиях интеграции общего и дополнительного образования.***

CONTENTS

UNIT I

CHECK-UP A BASIC LEVEL

For the tests 1-16 choose one correct answer

1. The electron configuration $1s^2 2s^2 2p^6 3s^2 3p^6$ corresponds to ion
(a) Mg^{2+} (b) S^{2-} (c) Al^{3+} (d) N^{3-}

2. The electron configuration of the neon atom corresponds to
(a) F^0 (b) Cl^- (c) C^{+4} (d) Na^+

3. In which a number the chemical elements are arranged in order of increasing atomic radius?
(a) Lithium, beryllium, boron, carbon
(b) Phosphorus, sulfur, chlorine, argon
(c) Antimony, arsenic, phosphorus, nitrogen
(d) Fluorine, chlorine, bromine, iodine

4. Which element forms the strongest base?
(a) Lithium
(b) Copper
(c) Beryllium
(d) Zink

5. In the molecules of hydrogen chloride and bromine chemical bond, respectively
(a) Ionic and covalent polar
(b) Covalent polar and covalent nonpolar
(c) Covalent nonpolar and covalent polar
(d) Hydrogen bond and covalent polar

6. The ionic nature of bond most expressed in the compound
(a) Magnesium chloride
(b) Beryllium chloride
(c) Carbon tetrachloride
(d) Dichlorine monoxide

7. The same oxidation number chlorine has in each of the two compounds
(a) $CrCl_3$ and Cl_2O_7
(b) $KClO_4$ and Cl_2O_7
(c) KCl and HClO
(d) $KClO_2$ and $BaCl_2$

8. The same oxidation number iron has in each of the two compounds
(a) FeO and $FeCO_3$
(b) $Fe(OH)_3$ and $FeCl_2$
(c) Fe_2O_3 and $Fe(NO_3)_2$
(d) FeO and $FePO_4$

9. The ionic crystal lattice has
(a) Chlorine (gas)
(b) Cesium chloride
(c) Phosphorus (III) chloride
(d) Carbon monoxide

10. For the substances with metal crystal lattice **NOT** typical
(a) Conductivity
(b) Heat conduction
(c) Brittleness
(d) Ductility

11. Which oxide does not form salts?
(a) N_2O (b) NO_2 (c) N_2O_5 (d) P_2O_3

12. Formulae of acidic oxide, acid and salt, respectively, are recorded in the row
(a) CaO, HCl, $CaCl_2$
(b) SO_2, H_2S, $NaHSO_3$
(c) SO_2, $Al_2(SO_4)_3$, HNO_3
(d) ZnO, $Zn(OH)_2$, H_2S

13. In which a number the simple substances are arranged in order of increasing their metal properties?
(a) Sodium, magnesium, aluminium
(b) Potassium, sodium, beryllium
(c) Lithium, sodium, potassium
(d) Barium, strontium, calcium

14. True or not the following statements about magnesium and its compounds?
A. Magnesium can react both with acids and bases.
B. Magnesium oxide is basic oxide.
I true only A
II true only B
III both statements are true
IV neither statement is true

15. Aluminium chloride can react in the solution with
(a) Potassium sulfate
(b) Magnesium sulfate
(c) Nitric acid
(d) Calcium hydroxide

16. Aluminium can react with the solutions of
(a) Calcium chloride and nitric acid
(b) Sulfuric acid and calcium nitrate
(c) Copper (II) sulfate and sodium chloride
(d) Copper (II) chloride and potassium hydroxide

17. Write the chemical equations according to the scheme

Aluminium + $Cl_2 \rightarrow \mathbf{X_1}$ + potassium hydroxide $\rightarrow \mathbf{X_2}$ + nitric acid (excess) $\rightarrow \mathbf{X_3}$

(1)

(2)

(3)

Identify and give the full systematic names of the products

X_1_____

X_2_____

X_3_____

18. Write the chemical equations according to the scheme

Magnesium carbonate + **X** $\rightarrow$ Magnesium chloride + **Y** $\rightarrow$ Magnesium nitrate

(1)

(2)

Identify and give the full systematic names of the reactants

X_____

Y_____

Translate into Russian and solve the problems 19 and 20

19. Calculate the volume (STP) of hydrogen theoretically required for synthesis of 100 L of ammonia.

Translation:

Solution (in English):

20. Calculate the volume (STP) of oxygen required for the complete combustion 1 mol of gaseous ammonia with nitrogen formation.

Translation:

Solution (in English):

21. Set the correspondence between the scheme of a chemical reaction and change in oxidation number of the oxidizing agent.

Scheme of a Reaction	The change in the oxidation number of the oxidizer
(a) $FeCl_3+HI \rightarrow FeCl_2+I_2+HCl$	(1) $Cl^{+7} \rightarrow Cl^{-1}$
(b) $FeCl_2+Cl_2 \rightarrow FeCl_3$	(2) $2I^- \rightarrow I_2^0$
(c) $KClO_4 \rightarrow KCl+O_2$	(3) $Fe^{3+} \rightarrow Fe^{2+}$
(d) $Fe_3O_4+HI \rightarrow FeI_2+I_2+H_2O$	(4) $2O^{2-} \rightarrow O_2^0$
	(5) $Cl_2^0 \rightarrow 2Cl^{-1}$
	(6) $Fe^{2+} \rightarrow Fe^{3+}$

Answer

(a)	(b)	(c)	(d)

22. Set the correspondence between the change in oxidation number of sulfur and names of the reacted substances

Change in Oxidation Number	Reactants
(a) $S^0 \rightarrow S^{+4}$	(1) Copper and diluted sulfuric acid
(b) $S^{+4} \rightarrow S^{+6}$	(2) Hydrogen sulfide and oxygen
(c) $S^{-2} \rightarrow S^0$	(3) Sulfur and concentrated sulfuric acid
(d) $S^{+6} \rightarrow S^{+4}$	(4) Iron (II) sulfide and hydrochloric acid
	(5) Sulfur (IV) oxide and oxygen

Answer

(a)	(b)	(c)	(d)

23. Set the correspondence between the formula of the salt and the equation of the process occurring at the anode during the electrolysis of an aqueous solution.

Salt	Anode Process
(a) Potassium chloride	(1) $2H_2O - 4\bar{e} \rightarrow O_2 + 4H^+$
(b) Aluminium bromide	(2) $2H_2O + 2\bar{e} \rightarrow H_2 + 2OH^-$
(c) Copper (II) sulfate	(3) $2Cl^- - 2\bar{e} \rightarrow Cl_2^0$
(d) Silver nitrate	(4) $2Br^- - 2\bar{e} \rightarrow Br_2^0$
	(5) $2SO_4^{2-} - 2\bar{e} \rightarrow S_2O_8^{2-}$
	(6) $2NO_3^- + 2\bar{e} \rightarrow 2NO_2 + O_2$

Answer

(a)	(b)	(c)	(d)

24. Set the correspondence between the formula of the salt and the formed product at the inert anode during the electrolysis of its aqueous solution.

Salt	Anode Product
(a) Sodium fluoride	(1) Fluorine
(b) Aluminium bromide	(2) Chlorine
(c) Copper (II) chloride	(3) Bromine
(d) Strontium iodide	(4) Iodine
	(5) Oxygen
	(6) Hydrogen

Answer

(a)	(b)	(c)	(d)

25. Set the correspondence between the formula of the salt and the type of hydrolysis of this salt.

Salt	Type of Hydrolysis
(a) Ammonium carbonate	1) by cation
(b) Ammonium chloride	2) by anion
(c) Sodium carbonate	3) both by cation and by anion
(d) Sodium nitrite	

Answer

(a)	(b)	(c)	(d)

26. Set the correspondence between the name of the salt and the medium reaction of its aqueous solution.

Salt Name	Medium Reaction of an aqueous solution of salt
(a) Ammonium nitrate	(1) Neutral
(b) Potassium nitrite	(2) Acidic
(c) Lithium chloride	(3) Basic
(d) Sodium sulfide	

Answer

(a)	(b)	(c)	(d)

Translate into Russian and solve the problems 27 and 28

27. Calculate the volume (STP) of gas evolved by dissolving 44 g of iron (II) sulfide in excess of sulfuric acid.

Translation:

Solution (in English):

28. The solution of barium chloride mixed with excess of solution of sodium sulfate. The mass of formed precipitate is equal to 58.25 g. Calculate the mass of barium chloride in the initial solution.

Translation:

Solution (in English):

Complete the redox reactions 29 and 30 using half-equations.
Identify oxidizer and reducing agent

29. Iron (II) chloride + nitric acid (conc.) →

Balanced Chemical Equation

Half-equations

Oxidizer:**_____**

Reducing agent:**_____**

30. Potassium manganate + hydrochloric acid →

Balanced Chemical Equation

Half-equations

Oxidizer:**_____**

Reducing agent:**_____**

Multiple-Choice Questions (31-37)

31. Choose salts hydrolyzing only by anion:
- (a) potassium acetate
- (b) potassium chloride
- (c) potassium hydrogen phosphate
- (d) ammonium acetate
- (e) copper (II) acetate

32. Choose salts hydrolyzing only by cation:
- (a) zinc chloride
- (b) potassium chloride
- (c) ammonium sulfate
- (d) ammonium sulfite
- (e) aluminium sulfate

33. Mutual hydrolysis will occur after commixture of the solutions of
- (a) aluminium chloride and sodium sulfide
- (b) aluminium chloride and sodium sulfite
- (c) aluminium chloride and sodium sulfate
- (d) aluminium chloride and sodium carbonate
- (e) chromium (III) chloride and sodium sulfate

34. Mutual hydrolysis will occur after commixture of the solutions of
- (a) chromium (III) chloride and potassium sulfate
- (b) chromium (III) chloride and potassium sulfite
- (c) chromium (III) chloride and potassium sulfide
- (d) chromium (III) chloride and sodium carbonate
- (e) chromium (III) chloride and aluminium chloride

35. Choose salts whose aqueous solutions have pH < 7
- (a) aluminium chloride
- (b) potassium chloride
- (c) sodium sulfate
- (d) aluminium sulfate
- (e) ammonium sulfate

36. Choose salts whose aqueous solutions have neutral pH value:
- (a) sodium chloride
- (b) sodium bromide
- (c) sodium iodide
- (d) sodium nitrate
- (e) sodium sulfate

37. Choose salts whose aqueous solutions have pH > 7
- (a) sodium acetate
- (b) sodium carbonate
- (c) sodium sulfate
- (d) sodium sulfite
- (e) sodium sulfide

STOP

You can check your basic level knowledges using answers in the TEST BOOK

UNIT II

FUNDAMENTALS OF THERMOCHEMISTRY

I. Classify each processes as exothermic **(I)** or endothermic **(II)**:

(a) The burning of magnesium in air
(b) The crystallization of copper (II) sulfate from a saturated solution
(c) The thermal decomposition of magnesium nitrate
(d) The fermentation of glucose by yeast
(e) The evaporation of sea water

Answer

(a)	(b)	(c)	(d)	(e)

Give definitions of the terms:

Standard enthalpy change of reaction, ΔH_r^0

Standard enthalpy change of formation, ΔH_r^0

Standard enthalpy change of combustion, ΔH_c^0

II. Classify each of the following reactions as ΔH_r^o, ΔH_f^o, or ΔH_c^o:

(a) $MgCO_3(s) \rightarrow MgO(s) + CO_2(g)$
(b) $C\ (graphite) + O_2(g) \rightarrow CO_2(g)$
(c) $HCl(g) + NH_3(g) \rightarrow NH_4Cl(s)$
(d) $H_2(g) + 1/2O_2(g) \rightarrow H_2O\ (l)$

Answer

(a)	(b)	(c)	(d)

For the tests 1-6 choose <u>one</u> correct answer

1. Enthalpy is an expression for the
   (a) Heat content
   (b) Energy state
   (c) Reaction rate
   (d) Activation energy

2. The ordered form of energy transmission is:
   (a) Internal energy
   (b) Heat
   (c) Work
   (d) Enthalpy

3. The disordered form of energy transmission:
   (a) Work
   (b) Enthalpy
   (c) Internal energy
   (d) Heat

4. Standard conditions (STP) are
   (a) 0^oC and 2 atm
   (b) 32^oF and 76 torr
   (c) 273 K and 760 mm Hg
   (d) 1^oC and 7.6 cm Hg
   (e) 0 K and 760 mm Hg

5. The ΔH_f^o of a reaction is recorded for
   (a) 0^oC
   (b) 25^oC
   (c) 20^oC
   (d) 37^oC

6. If ΔH_r is -120 kcal, it indicates the reaction is
   (a) Endothermic
   (b) Exothermic
   (c) Reversible
   (d) Irreversible

Solve the Problems 1-3

1. If 0.8 mol of NO is converted to NO_2 in the following reaction, what amount of heat will be evolved?

$2NO(g) + O_2(g) \rightarrow 2NO_2(g) + 150$ kJ

Solution

(a) 30 kJ
(b) 60 kJ
(c) 80 kJ
(d) 130 kJ
(e) 150 kJ

2. How much heat energy is released when 8 g of hydrogen are burned? The thermal equation is $2H_2 + O_2 \rightarrow 2H_2O + 136.64$ kcal

Solution

(a) 68.32 kcal
(b) 102.48 kcal
(c) 136.64 kcal
(d) 273.28 kcal
(e) 546.56 kcal

3. How much heat is released by the following reaction
$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s) + 822$ kJ,
if 0.5 mol of sodium reacts completely with chlorine?

Solution

(a) 205.5 kJ
(b) 411 kJ
(c) 822 kJ
(d) 1644 kJ
(e) 3288 kJ

Formulate Hess`s Law of Heat Summation

Translate into Russian and Solve the Problems 4-8

4. Construct the enthalpy cycle and calculate the heat of ethanol formation using the following data:
$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(g)$; $\Delta H = -327.0$ kcal/mol
$H_2O(g) \rightarrow H_2(g) + 1/2O_2(g)$; $\Delta H = 68.3$ kcal/mol
$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta H = -94.1$ kcal/mol

Translation:

Solution (in English):

Enthalpy Cycle

5. Construct the enthalpy cycle and calculate the ΔH^o value for the reaction of magnesium oxide dissolution in water using the following data

$MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$; $\Delta H^o = -145.6$ kJ/mol

$H_2O(l) \rightarrow H^+(aq) + OH^-(aq)$; $\Delta H^o = 57.5$ kJ/mol

Translation:

Solution (in English):

Enthalpy Cycle

6. Calculate the value of standard enthalpy for the reactions of glucose transformation proceeding in organism:
(i) $C_6H_{12}O_6(s) + O_2(g) \rightarrow 6CO_2(g) + 6H_2O(l)$
(ii) $C_6H_{12}O_6(s) \rightarrow 2C_2H_5OH(l) + 2CO_2(g)$
$\Delta H_f^o [CO_2(g)] = -393.5$ kJ/mol
$\Delta H_f^o [H_2O (l)] = -286.0$ kJ/mol
$\Delta H_f^o [C_2H_5OH (l)] = -277.6$ kJ/mol
$\Delta H_f^o [C_6H_{12}O_6(s)] = -1264.0$ kJ/mol
Which of these reactions supplies more energy to the organism?

Translation:

Solution (in English):

7. Give the appropriate values for **(A)** and **(B)** in the sentences below.
1 mol of graphite is completely oxidized to carbon dioxide while evolving 394 kJ of heat, and 1 mol of carbon monoxide is completely oxidized to carbon dioxide while evolving 283 kJ of heat. At 0^{o}C, under 1 atm **(A)** L of oxygen is required to oxidize 1 mol of graphite to carbon monoxide with the heat evolution of **(B)** kJ.

Translation:

Solution (in English):

Answer

(A)_____L
(B)_____kJ

8. Upon the complete combustion of ethylene with the formation of liquid water, 6226 kJ were evolved. Calculate the volume of oxygen that entered into the reaction under standard conditions. The standard heat of ethylene combustion reaction is equal to -1411 kJ/mol.

Translation:

Solution (in English):

Thermochemical Equation

UNIT III

CHEMICAL EQUILIBRIUM

Characteristics of Equilibrium

An equilibrium reaction has four particular features under constant conditions:

- It is dynamic
- The forward and reverse reaction occur at the same rate
- The concentration of reactants and products remain constant at equilibrium
- It requires a closed system

Give a detailed explanation (in English)

1. **Dynamic equilibrium**

2. **The forward and reverse reaction occur at the same rate**

3. **The concentration of reactants and products remain constant at equilibrium**

4. **Equilibrium requires a closed system**

Formulate Le Chatelier`s Principle

For the tests 1-5 choose one correct answer

1. In which system the increasing of pressure will cause of the shifting equilibrium to the left?
   (a) $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g) + Q$
   (b) $N_2O_4(g) \Leftrightarrow 2NO_2(g) - Q$
   (c) $CO_2(g) + H_2(g) \Leftrightarrow CO(g) + H_2O(g) - Q$
   (d) $4HCl(g) + O_2(g) \Leftrightarrow 2H_2O(g) + 2Cl_2(g) + Q$

2. In which system the increasing of pressure and decreasing of temperature will cause of the shifting reaction equilibrium towards the products formation?
   (a) $N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g) + Q$
   (b) $N_2(g) + O_2(g) \Leftrightarrow 2NO(g) - Q$
   (c) $Cl_2(g) + H_2(g) \Leftrightarrow 2HCl(g) + Q$
   (d) $C_2H_2(g) \Leftrightarrow 2C(s) + H_2(g) – Q$

3. In which system the increasing of hydrogen concentration will cause of the shifting reaction equilibrium towards the reactants formation?
   (a) $C(s) + 2H_2(g) \Leftrightarrow CH_4(g)$
   (b) $2NH_3(g) \Leftrightarrow N_2(g) + 3H_2(g)$
   (c) $2H_2(g) + O_2(g) \Leftrightarrow 2H_2O(g)$
   (d) $FeO(s) + H_2(g) \Leftrightarrow Fe(s) + H_2O(g)$

4. Chemical equilibrium of the endothermic reaction $2PCl_3(g) \Leftrightarrow 3Cl_2(g) + 2P(s)$ will shift to the right if
   (a) concentration of chlorine will increase
   (b) concentration of PCl_3 will decrease
   (c) pressure will increase
   (d) temperature will increase
   (e) temperature will decrease

5. What would be the change of temperature and pressure for shift chemical equilibrium of exothermic reaction $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$ to formation of sulfur (VI) oxide?
   (a) elevation of temperature and depression of pressure;
   (b) depression both temperature and pressure;
   (c) elevation both temperature and pressure;
   (d) depression of temperature and elevation of pressure;
   (e) no change both temperature and pressure.

I. For the reaction

$CH_3COOH(l) + C_2H_5OH(l) \Leftrightarrow CH_3COOC_2H_5(l) + H_2O(l)$

explain what happens to the position of equilibrium when:

(a) more ethyl ethanoate is added

(b) some ethanol is removed

II. For the reaction

$Ce^{4+}(aq) + Fe^{2+}(aq) \Leftrightarrow Ce^{3+}(aq) + Fe^{3+}(aq)$

explain what happens to the position of equilibrium when:

(a) the concentration of $Fe^{2+}(aq)$ ions is increased

(b) water is added to the equilibrium mixture

III. In the reaction

$Ag_2CO_3(s) \Leftrightarrow Ag_2O(s) + CO_2(s)$

Increasing the temperature increases the amount of carbon dioxide formed at constant pressure. Is this reaction exothermic or endothermic? Explain your answer.

Explanation:

IV. Write equilibrium expression for the reactions

(a) $CO(g) + 2H_2(g) \Leftrightarrow CH_3OH(g)$

Kc =

(b) $4HCl(g) + O_2(g) \Leftrightarrow 2H_2O(g) + 2Cl_2(g)$

Kc =

Translate into Russian and Solve the Problems 1 and 2

1. Propanone reacts with hydrogen cyanide as follows:

$$CH_3COCH_3 + HCN \Leftrightarrow CH_3C(OH)(CN)CH_3$$

A mixture of 0.0500 mol L^{-1} propanone and 0.0500 mol L^{-1} hydrogen cyanide is left to reach equilibrium at room temperature. At equilibrium the concentration of the product is 0.0233 mol L^{-1}. Calculate K_c of this reaction.

Translation:

Solution (in English):

2. Calculate the value of Kc for the following reaction

$$H_2(g) + CO_2(g) \Leftrightarrow H_2O(g) + CO(g)$$

It is known, that initial concentration of hydrogen is equal to 10.00 mol L^{-1}, and the same for carbon dioxide. The equilibrium concentration value of carbon monoxide is equal to 9.47 mol L^{-1}.

Translation:

Solution (in English):

Give definitions

A Brønsted-Lowry acid is_____

A Brønsted-Lowry base is_____

V. Identify the acid and the base on the right-hand side of the equilibrium

$H_2S + H_2O \Leftrightarrow HS^- + H_3O^+$

***The acid is*_____**

***The base is*_____**

VI. Identify the acid on the right-hand side of this equation which is conjugate with the base on the left-hand side

$NH_2CH_2COOH + OH^- \Leftrightarrow NH_2CH_2COO^- + H_2O$

***The base is*_____**

***The conjugate acid is*_____**

VII. Identify the base on the right-hand side of this equation which is conjugate with the acid on the left-hand side

$NH_2CH_2COOH + OH^- \Leftrightarrow NH_2CH_2COO^- + H_2O$

***The acid is*_____**

***The conjugate base is*_____**

VIII. Identify the base on the right-hand side of this equation which is conjugate with the acid on the left-hand side

$NH_2CH_2COOH + H_3O^+ \Leftrightarrow H_3N^{\oplus}CH_2COOH + H_2O$

***The acid is*_____**

***The conjugate base is*_____**

IX. Identify the acid on the right-hand side of this equation which is conjugate with the base on the left-hand side

$NH_2CH_2COOH + H_3O^+ \Leftrightarrow H_3N^{\oplus}CH_2COOH + H_2O$

***The base is*_____**

***The conjugate acid is*_____**

For the test 6 choose <u>one</u> correct answer

6. Which of the solutions a) to d) exhibits a pH value of 2?

(a) 0.01 mol L^{-1} aqueous solution of acetic acid
(b) 0.05 mol L^{-1} sulfuric acid
(c) 0.01 mol L^{-1} hydrochloric acid
(d) 1×10^{-12} mol L^{-1} aqueous solution of sodium hydroxide

Give definitions

Partial pressure is _____

_____

Anesthetic pressure is _____

_____

Translate into Russian and Solve the Problems 3 and 4

3. The reaction below was carried out at a pressure 100.0 kPa and at constant temperature

$N_2(g) + O_2(g) \Leftrightarrow 2NO(g)$

The partial pressure of nitrogen and oxygen are both 48.5 kPa. Calculate the partial pressure of the nitrogen (II) oxide at equilibrium.

Translation:

Solution (in English):

4. Nitrogen reacts with hydrogen to form ammonia. The pressure exerted by the mixture of hydrogen, nitrogen and ammonia is 2.00×10^4 kPa. Under these conditions the partial pressure of nitrogen is 1.49×10^4 kPa and the partial pressure of hydrogen is 0.40×10^4 kPa. Calculate the value of Kp for the ammonia formation reaction.

Translation:

Solution (in English):

UNIT IV

FUNDAMENTALS OF CHEMICAL KINETICS

Give definitions of the terms:

Homogeneous Chemical Reaction

Heterogeneous Chemical Reaction

Rate of a Chemical Reaction

Activation Energy

Formulate and write the mathematic expression of the

- **Rate Law**

- **Van`t Hoff`s Rule**

For the tests 1-4 choose <u>one</u> correct answer

1. At the beginning of a reaction, the reaction rate for the reactants
(a) largest, then decreasing
(b) largest and remains constant
(c) smallest and remains constant
(d) smallest, then increasing

2. The reaction rate law applied to the reaction aA + bB→AB gives the expression
(a) rate = k $[A]^b[B]^a$
(b) rate = k $[A]^a[B]^b$
(c) rate = k $[AB]^a[A]^b$
(d) rate = k $[B]^a[AB]^b$

3. Which one is NOT an important condition for a chemical reaction?
(a) The reacting molecules are in the correct orientation to one another
(b) The molecules have enough energy to react once they have collided
(c) The molecules must make contact
(d) None of the above

4. In the equilibrium reaction A + B ↔ AB + heat (in a closed container), how could the forward reaction rate be increased?
I. By increasing the concentration of AB
II. By increasing the concentration of A
III. By removing some of product AB
(a) I only
(b) III only
(c) I, II, and III
(d) II and III only

Translate into Russian and Solve the Problems 1-4

1. How many times will the rate reaction $2A + B \rightarrow A_2B$ change if the concentration of substance A is doubled, and that of substance B is halved?

<u>Translation:</u>

<u>Solution (in English):</u>

2. How many times must the concentration of substances B_2 in the system

$2A_2(g) + B_2(g) \rightarrow 2A_2B(g)$ be increased for the rate of the forward reaction to remain unchanged when the concentration of substance A is lowered to one-fourth of its initial value?

Translation:

Solution (in English):

3. Industrially, phosgene is produced by passing purified carbon monoxide and chlorine gas through a bed of porous activated carbon, which serves as a catalyst. It is known that the concentration of carbon monoxide in the system was increased from 0.03 to 0.12 mol L^{-1}, and that of the chlorine from 0.02 to 0.06 mol L^{-1}. How many times did the rate of the forward reaction increase?

Translation:

Solution (in English):

4. Calculate the temperature coefficient value if the rate of the reaction grows 6.8 times when the temperature is increased by 30^oC.

Translation:

Solution (in English):

Examine the following Diagram 1 and answer the questions

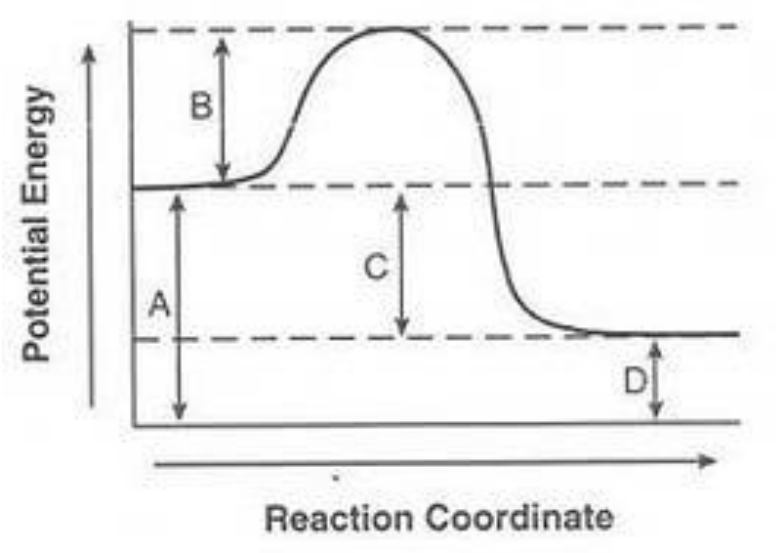

Diagram 1

- In this graphic representation of a chemical reaction

  (1) arrow **A** depicts_____
  (2) arrow **B** depicts_____
  (3) arrow **C** depicts_____
  (4) arrow **D** depicts_____
  (5) arrow **X** depicts_____

(a) The potential energy of the reactants
(b) The potential energy of the products
(c) The heat of the reaction for the forward reaction
(d) The activation energy of the forward reaction
(e) The activation energy of the reverse reaction

- ***Draw the missing arrow <u>X</u> at the diagram.***

- Is this reaction ***<u>exothermic</u>*** or ***<u>endothermic</u>***?

Questions 5-7 refer to the Diagram 2

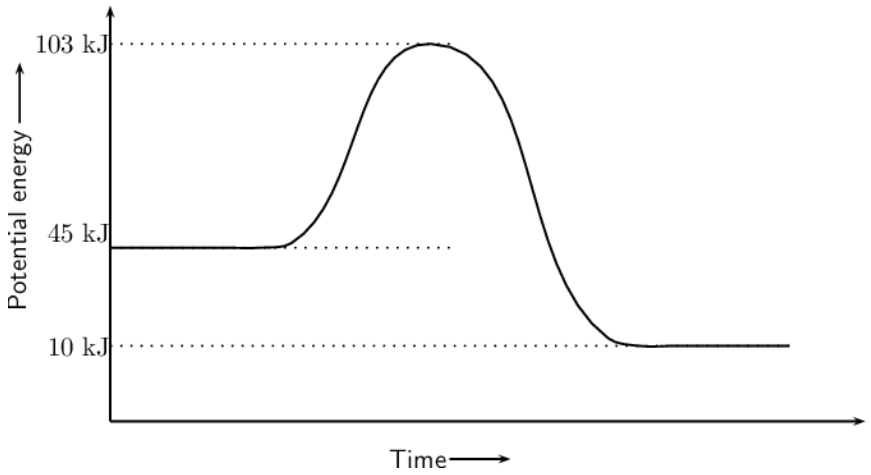

Diagram 2

5. In this graphic representation of a chemical reaction the activation energy of the forward reaction is
(a) 10 kJ
(b) 45 kJ
(c) 58 kJ
(d) 93 kJ
(e) 103 kJ

6. In this graphic representation of a chemical reaction the activation energy of the reverse reaction is
(a) 10 kJ
(b) 45 kJ
(c) 58 kJ
(d) 93 kJ
(e) 103 kJ

7. In this graphic representation of a chemical reaction indicate the difference between the activation energies for the forward and reverse reactions and equals the energy change in the reaction
(a) +10 kJ
(b) -35 kJ
(c) +35 kJ
(d) -45 kJ
(e) +45 kJ

Translate into Russian and Solve the Problem 5

5. The activation energy for the uncatalysed decomposition of ammonia to its elements is +335 kJ/mol. The enthalpy of reaction for this decomposition is +92 kJ/mol.

(a) Calculate the activation energy for uncatalysed formation of ammonia from nitrogen and hydrogen.

(b) Determine the standard enthalpy value of ammonia formation reaction, using the given data.

Translation:

Solution (in English):

UNIT V

REDOX REACTIONS AND ELECTROLYSIS

Give definitions of the terms

Oxidation number

Oxidizer

Reducing agent

Oxidation processes

Reduction processes

Electrolysis

Cathode

Anode

For the Equations 1-6:

i. Balance a redox reaction using half-equations.

ii. Identify oxidizer and reducing agent.

iii. Give the full systematic names of the reactants and products.

1. $P_2O_3 + HNO_3 + \ldots \rightarrow NO + \ldots$

i. Half-equations:

ii. Oxidizer_____

Reducing agent_____

iii. Systematic names of the

Reactants_____

_____

_____

Products_____

_____

_____

2. $PH_3 + AgNO_3 + \ldots \rightarrow Ag + HNO_3 + \ldots$

i. Half-equations:

ii. Oxidizer_____

Reducing agent_____

iii. Systematic names of the

Reactants_____

_____

_____

Products_____

_____

_____

3. KNO_2 + … + $H_2SO_4 \rightarrow I_2$ + NO + … + …

i. Half-equations:

ii. Oxidizer_____

Reducing agent_____

iii. Systematic names of the

Reactants_____

_____

_____

Products_____

_____

_____

4. **$HCOH + KMnO_4 + \ldots \rightarrow CO_2 + K_2SO_4 + \ldots + \ldots$**

i. Half-equations:

ii. Oxidizer_____

Reducing agent_____

iii. Systematic names of the

Reactants_____

_____

_____

Products_____

_____

_____

5. **$K_2MnO_4 + HCl \rightarrow MnCl_2 + Cl_2 + \ldots + \ldots$**

i. Half-equations:

ii. Oxidizer_____

Reducing agent_____

iii. Systematic names of the

Reactants_____

_____

_____

***Products*_____**

_____

_____

6. $Zn + KMnO_4 + \ldots \rightarrow MnSO_4 + K_2SO_4 + \ldots + \ldots$

i. Half-equations:

***ii. Oxidizer*_____**

***Reducing agent*_____**

iii. Systematic names of the

***Reactants*_____**

_____

_____

***Products*_____**

_____

_____

Tasks 1-9:

i. Write the reactions that occur during electrolysis (at the cathode and inert anode).
ii. Indicate oxidation and reduction processes.
iii. Write overall electrolysis reaction.

1. Potassium chloride

(a) Solution

At the Cathode

At the Anode

Overall Electrolysis Equation

(b) Melt

At the Cathode

At the Anode

Overall Electrolysis Equation

2. Copper (II) oxide

At the Cathode

At the Anode

Overall Electrolysis Equation

3. **Copper (II) fluoride**

(a) Solution

At the Cathode

At the Anode

Overall Electrolysis Equation

(b) Melt

At the Cathode

At the Anode

Overall Electrolysis Equation

4. **Solution of copper (II) sulfate**

At the Cathode

At the Anode

Overall Electrolysis Equation

5. **Solution of aluminium nitrate**

At the Cathode

At the Anode

Overall Electrolysis Equation

6. **Solution of silver nitrate**

At the Cathode

At the Anode

Overall Electrolysis Equation

7. **Solution of sodium hydroxide**

At the Cathode

At the Anode

Overall Electrolysis Equation

8. **Solution of sodium perchlorate**

At the Cathode

At the Anode

Overall Electrolysis Equation

9. **Solution of sulfuric acid**

At the Cathode

At the Anode

Overall Electrolysis Equation

Tasks 10

Give the appropriate name of the compound or ions for **(A)** to **(D)** below using chemical formulas. The e^- denotes an electron.
The overall reaction in a fuel cell that uses KOH as electrolyte is written as follows,

$2H_2 + O_2 \rightarrow 2H_2O$

At the anode, **(A)** is oxidized by the reaction

$$\mathbf{(A)} + 2\mathbf{(B)} \rightarrow 2\mathbf{(C)} + 2e^-$$

At the cathode, **(D)** is reduced by the reaction

$$\mathbf{(D)} + 2\mathbf{(C)} + 4e^- \rightarrow 4\mathbf{(B)}$$

Answer

(A)	(B)	(C)	(D)

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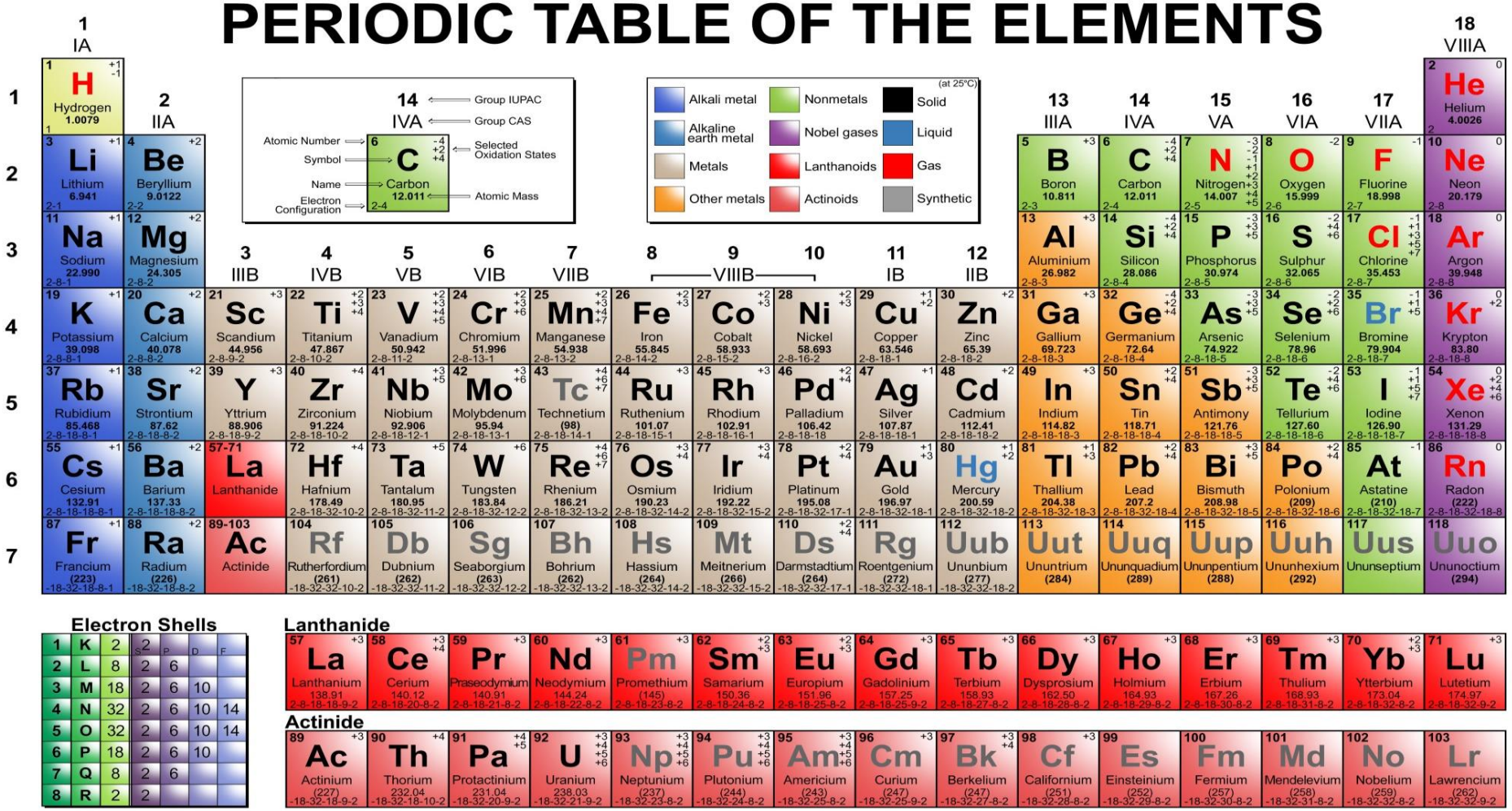

http://www.sciencegeek.net/tables/tables.shtml