



MULTIPLE-CHOICE QUESTIONS WITH SINGLE CORRECT ANSWER

(Answer by choosing only one of the options (A), (B), (C) or (D))

Periodic table with some essential data is given at the end of the test!

- Chlorine water is, basically, a solution of gaseous chlorine in water. Upon reaction with a solution of potassium iodide, the solution turns yellow-brown. Accordingly:
(A) chlorine is oxidized.
(B) chlorine is reduced.
(C) Potassium ions are oxidized.
(D) Potassium ions are reduced.
- Zinc is a metal that is located above hydrogen in the electromotive series of metals. This means that when reacting with hydrobromic acid:
(A) gaseous hydrogen evolves.
(B) gaseous HBr evolves.
(C) gaseous bromine evolves.
(D) cannot be determined without knowing the value of the corresponding electrode potential.
- When involved in chemical reactions, elemental iodine can:
(A) only be oxidized.
(B) only be reduced.
(C) be oxidized in some reactions and reduced in others.
(D) neither be oxidized nor reduced.
- Which of the listed half-reactions is **incorrectly** written?
(A) $O_2 + 2e^- = 2O^{2-}$
(B) $2O^{2-} - 2e^- = O_2$
(C) $O_2 + 2e^- = O^{2-}$
(D) all listed half-reactions are incorrectly written.
- At 50 °C, the ionic product of water is $5.48 \cdot 10^{-14} \text{ mol}^2 \text{ L}^{-2}$. Which of the following solutions with the corresponding pH value is basic?
(A) pH = 6.63
(B) pH = 7.00
(C) pH = 6.15
(D) pH = 5.55
- Which of the listed types of reactions proceed(s) to completion?
(A) Pyrolysis reactions.
(B) Reaction of alkali metals with water.
(C) Reaction of metals with oxidizing acids.
(D) All of the listed.
- Which of the listed solutions is neutral?
(A) NaCl, with $c(\text{NaCl}) = 0.01 \text{ mol/L}$
(B) NH_4Cl , $c(\text{NH}_4\text{Cl}) = 0.10 \text{ mol/L}$
(C) CH_3COOK , $c(\text{CH}_3\text{COOK}) = 1 \text{ mol/L}$
(D) $\text{CH}_3\text{CH}_2\text{COOH}$
- In the reaction written by the equation:
 $\text{NaOH} + \text{KIO}_3 + \text{P} \rightarrow \text{Na}_3\text{PO}_4 + \text{KI} + \text{H}_2\text{O}$
potassium iodate is a strong oxidizing agent. Therefore, potassium iodide:
(A) is a strong reducing agent.
(B) is a weak reducing agent.
(C) can be both a strong reducing and a strong oxidizing agent.
(D) can be both a weak reducing and a weak oxidizing agent.
- Which of the listed ions and neutral molecules can act as proton donors?
(A) H_3O^+ , NH_4^+ , H_2O .
(B) H^+ , NH_2^- , NH_3 .
(C) NO_2^- , HCl , K^+ .
(D) HCOOH , OH^- , CH_4 .
- Which of the listed reactions, written by the appropriate equations, is protolytic?
(A) $\text{H}_2\text{O} + \text{H}_2\text{O} \rightleftharpoons \text{H}_3\text{O}^+ + \text{OH}^-$
(B) $\text{NH}_3 + \text{NH}_3 \rightleftharpoons \text{NH}_4^+ + \text{NH}_2^-$
(C) $\text{HCl} + \text{H}_2\text{O} \rightleftharpoons \text{Cl}^- + \text{H}_3\text{O}^+$
(D) All of the listed are protolytic reactions.



11. The elementary step of a chemical reaction refers to:
- (A) whenever two particles collide.
 - (B) when a transformation of one, two, or three particles from the reactant(s) into a product(s) occurs.
 - (C) when an effective collision of a larger number of particles occurs, resulting in the formation of products.
 - (D) when the chemical reaction can be represented by a chemical equation.
12. For a chemical process from the chemical industry, which can be represented by the hypothetical equation $A \rightarrow 2P$, it is important to monitor how the reactant is consumed during the working day. Which of the listed parameters (defined by the appropriate formulae) will provide the best information for tracking the process?
- (A) $v(A) = -\frac{\Delta c(A)}{\Delta t}$
 - (B) $v = \frac{1}{v(A)} \frac{\Delta c(A)}{\Delta t}$
 - (C) $\Delta \zeta = \frac{\Delta n(A)}{v(A)}$
 - (D) Through any of the listed parameters, the process can be monitored to obtain the relevant information.
13. During the process of potassium chloride crystallization (at a given temperature), it was determined that the amount of heat released was -715 kJ/mol . What would be the corresponding physical quantity that describes this process?
- (A) $\Delta_r H$
 - (B) $\Delta_s H$
 - (C) $\Delta_m H$
 - (D) $\Delta_n H$
14. In photocatalytic reactions, the rate of the reaction is proportional to:
- (A) the amount of products formed during the process.
 - (B) the amount of reactants consumed during the reaction.
 - (C) the amount of absorbed light.
 - (D) the amount of catalyst.
15. When the rate of the forward reaction equals the rate of the reverse reaction, then:
- (A) $v(A) = 0$.
 - (B) $\Delta_r G = 0$.
 - (C) $K_{eq} = 0$.
 - (D) nothing of the listed above.

Tasks/Problems:

(Write down the solution procedure and the answer in the designated place.)

A periodic table with some essential data is given at the end of the test!

1. In order to carry out an analytical procedure, it would be necessary to prepare a solution of hydroiodic acid with a quantitative concentration of the acid at 0.200 mol/L. In the laboratory, there were 3 solutions of HI available, with the following declarations:

(1)	(2)	(3)
Hydroiodic acid, HI	HI	HI
$w = 57 \%$	$c = 0,231 \text{ mol/L}$	$c = 0.152 \text{ mol/L}$
$\rho = 1.701 \text{ g/cm}^3 (25 \text{ }^\circ\text{C})$	$\rho = 1,05 \text{ g/cm}^3 (25 \text{ }^\circ\text{C})$	$\rho = 1.04 \text{ g/cm}^3 (25 \text{ }^\circ\text{C})$
$M_r = 127.911$	25.4.2023	12.9.2023
MERCK, 5.2021	Analyst: Vera Spasoska	Analyst: Vera Spasoska

All data and measurements refer to a temperature of 25 °C! Hydroiodic acid is a strong acid and is completely dissociated in aqueous solution.

(A) What is the concentration of hydrogen ions in the first solution, in mol/L? (3)

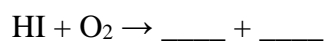
(B) At what ratio should the volumes of solutions 2 and 3 be taken to prepare a solution with the required quantitative concentration of HI (0.20 mol/L)? (3)



(C) What is the volume of the first solution that has to be taken to prepare 100 mL of HI solution with the required quantitative concentration (0.20 mol/L)? **(1)**

(D) What is the pH of the solution that needs to be prepared? **(1)**

Hydroiodic acid is unstable, and it decomposes in the presence of air and light according to the equation:



(E) Complete the reaction equation and balance it using an electronic scheme. **(4)**

(F) Fill in and encircle the correct answer: **(4)**

In the given reaction, HI is: a) oxidized to _____

b) reduced to _____

In the given reaction, O₂ is: a) oxidized to _____

b) reduced to _____

In the given reaction, HI is: a) oxidation agent

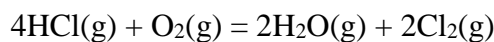
b) reducing agent

In the given reaction, O₂ is: a) oxidation agent

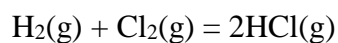
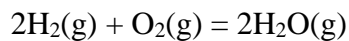
b) reducing agent



2. One of the methods for industrial production of chlorine involves introducing a gas mixture of HCl and O₂ over a catalyst of copper or manganese, at a temperature of 1000 °C. The following equilibrium is established:



The equilibrium constants for the reactions given by the equations:



are 10²¹ and 10¹¹, respectively.

(A) What are the units used to express the equilibrium constants for the three listed reactions? **(1)**

(B) What is the value of the equilibrium constant for the first reaction? **(4)**



3. In a chemical laboratory, two identical chemical reactions were set simultaneously. For this purpose, equal amounts of reactants were placed in each reaction vessel, and both reactions were stopped at the same time. The only difference was that one reaction was conducted at a higher temperature compared to the other. After a certain time, it was spectroscopically determined that in the reaction conducted at a lower temperature, half of the initial amount of reactant A remained unreacted. In the other reaction, however, it was found that the quantity decreased by a factor of 6 compared to the initial amount.

(A) Which reaction is slower and by what factor? (4)

(B) What is the value of the temperature coefficient for this reaction? (2)

(C) For conducting the reaction at a lower temperature, 1 mol of each reactant was taken. It was determined that after 2 hours from the start, 0.6 mol of reactant A and 0.2 mol of reactant B remained. In what stoichiometric ratio do A and B react? (3)



1 H 1.008																	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 22.99	12 Mg 24.31											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.39	31 Ga 69.72	32 Ge 72.61	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 181.0	74 W 183.8	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (263)	107 Bh (262)	108 Hs (265)	109 Mt (266)	110 Ds (281)	111 Uuu (272)	112 Uub (285)	113 Uut (284)	114 Uuq (289)	115 Uup (288)			

58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm (145)	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)