SECTION 4

TEST II SAMPLE QUESTIONS

This section of the Georgia Assessments for the Certification of Educators® (GACE™) Preparation Guide provides sample selected-response questions with an annotated answer key for you to review as part of your preparation for the test. The sample selected-response questions are designed to illustrate the nature of the test questions. Work through the questions carefully before referring to the annotated answer key, which follows the sample selected-response questions. The answer key provides the correct response to each question, describes why each correct response is the best answer, and lists the objective within the test framework to which each question is linked.

Please note that a periodic table and a set of constants and formulas are provided for this test. Please refer to these materials as needed in responding to the sample test questions and assignments. These materials are located in the Assessment Reference Materials section at the end of this preparation guide.

A scientific calculator may be used for this test as needed in responding to the sample test questions and assignments. Please refer to the current GACE registration bulletin for information about the use of calculators at the test administration.

QUESTIONS

1. Which of the following factors has the most significant influence on the electromotive force (emf) of a voltaic cell?

   A. the surface area of the metal electrodes immersed in the solutions

   B. the difference between the concentrations of the metallic sulfate solutions

   C. the electrical resistance of the metallic wire in the external circuit

   D. the difference between the reduction potentials of the metal electrodes

2. **Use the table below to answer the question that follows.**

Trial	Initial [A] (*M*)	Initial [B] (*M*)	Initial Rate (*M*/s)
1	0.50	0.50	0.10
2	0.50	1.00	0.20
3	1.00	1.00	0.40

The table above reports the results of an experiment for the reaction $A + B \longrightarrow C$ with different concentrations of reactants in three separate trials. Based on the data above, what would be the initial rate of reaction if the initial concentrations of A and B were each 0.25 *M*?

A. 0.025 *M*/s

B. 0.050 *M*/s

C. 0.250 *M*/s

D. 0.500 *M*/s

3. One mole of nitrogen gas (N_2) reacts with one mole of oxygen gas (O_2) at high temperatures to form two moles of nitrogen monoxide (NO). The equilibrium constant for the reaction is 1.20×10^{-4} at a temperature of 2000°C. When equal amounts of O_2 and N_2 are reacted, the equilibrium concentration of NO is 1.6×10^{-3}. What is the equilibrium concentration of O_2?

   A. 1.33×10^{-7} *M*

   B. 1.15×10^{-4} *M*

   C. 2.13×10^{-2} *M*

   D. 1.46×10^{-1} *M*

4. Which of the following statements is a tenet of the Lewis acid-base theory but not the Arrhenius and Brønsted-Lowry theories?

   A. Hydroxide ions are attracted to hydrogen ions in solution.

   B. Oxidation and reduction occurs during a titration.

   C. Structures that accept electron pairs react with electron pair donors.

   D. Protons combine with water molecules to form hydronium ions.

5. Which of the following gases would occupy a volume of 5.00 L and contain 4.03×10^{23} atoms at STP?

   A. O_2

   B. CO_2

   C. NH_3

   D. CH_4

6. **Use the information below to answer the question that follows.**

   $NaHCO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

   How many grams of sodium hydrogen carbonate will remain unreacted when 10.0 mL of a 0.50 *M* solution of hydrochloric acid is slowly poured onto a 1.0 g sample of sodium hydrogen carbonate?

   A. 0.42 g

   B. 0.50 g

   C. 0.58 g

   D. 0.84 g

7. Many historians of science recognize that alchemy in medieval Europe contributed to the eventual development of chemistry. Which of the following aspects of the tradition of alchemy is most closely connected with the practice of modern science?

   A. Alchemists identified and manipulated many of the same elements studied by modern researchers.

   B. Alchemists made decisions about what subjects they chose to investigate based on economic considerations.

   C. Alchemists relied on theories established by previous generations to interpret the results of their investigations.

   D. Alchemists made careful observations and carried out systematic experiments to test various hypotheses.

8. A lab technician cuts a glass tube to the length required for a particular experiment. Prior to using the cut glass tube, the lab technician should *first*:

   A. sand the cut end of the glass tube with fine-grade sandpaper.

   B. round the cut end of the glass tube by heating it over a flame.

   C. coat the cut end of the glass tube with glycerin.

   D. remove fragments from the cut end of the glass tube with tweezers.

9. Which of the following mathematical expressions can be used to determine the number of moles of Li_2CO_3 in a 100 g sample of that compound?

   A. $100\text{ g } Li_2CO_3 \bullet \frac{34.95\text{ g}}{\text{mol}}$

   B. $\frac{73.89\ \frac{\text{g}}{\text{mol}}}{100\text{ g } Li_2CO_3}$

   C. $100\text{ g } Li_2CO_3 \bullet \frac{34.95\text{ mol}}{\text{g}}$

   D. $\frac{100\text{ g } Li_2CO_3}{73.89\ \frac{\text{g}}{\text{mol}}}$

10. The second law of thermodynamics is best illustrated by which of the following examples?

    A. Gasoline is produced from crude oil through the use of distillation.

    B. A bicycle left outdoors for several months begins to rust.

    C. Salt is removed from brackish water by the process of reverse osmosis.

    D. A soil sample is separated into sand, gravel, and silt by the use of sieves.

ANNOTATED ANSWER KEY

For question	The correct response is	Reason	Test Objective
1	D	The reduction potential of a substance indicates the tendency for that substance to be a reducing agent. If the reduction potentials of two substances in a voltaic cell are different, the substance with a greater negative value for a reduction potential will act as a reducing agent and be oxidized. The substance with a lower negative value for a reduction potential will act as an oxidizing agent and be reduced. The amount of difference in reduction potentials between the two substances will determine the amount of chemical potential energy that will be transformed into electrical energy in the external circuit connected to the voltaic cell.	0011
2	A	The rate constant for the reaction can be determined for each trial using the expression $k = \frac{\text{Rate}}{[A][B]}$, where $k =$ the rate constant. Substituting values from Trial 1 gives $k = \frac{0.10\ M/s}{[0.50\ M][0.50\ M]}$. Therefore, $k = 0.40$. Using the rate constant of 0.40 and substituting the 0.25 M concentrations given for reactants A and B into the above equation, the initial rate of reaction can be determined as follows: $k[A][B] = 0.40\ [0.25\ M][0.25\ M] = 0.025\ M/s$.	0012

For question	The correct response is	Reason	Test Objective
3	D	The balanced chemical equation for the reaction is $N_2 + O_2 \longrightarrow 2NO$. Therefore, the equilibrium concentration of O_2 can be determined by solving for the concentration of O_2 in the equilibrium expression $K_{eq} = \frac{[NO]^2}{[N_2][O_2]}$. Because each mole of O_2 reacts with one mole of N_2, entering the available data into the equilibrium expression results in the expression $1.20 \times 10^{-4} = \frac{[1.6 \times 10^{-3}]^2}{x^2}$. As a result, $x^2 = \frac{[1.6 \times 10^{-3}]^2}{1.2 \times 10^{-4}}$. Therefore, $x^2 = 2.133 \times 10^{-2}$ and $x = 1.46 \times 10^{-1}$.	0013
4	C	The Lewis definition of acids and bases focuses on the behavior of electrons during a chemical reaction rather than on the behavior of hydrogen ions and/or hydroxide ions. The Lewis acid-base system includes some reactions that do not involve proton transfers. The result is that the Lewis system provides a broader definition of acids and bases that can be used to describe changes in acid-base reactions that do not involve hydrogen ions or hydroxide ions.	0014
5	B	Since it is known that 6.02×10^{23} molecules of any gas occupies 22.4 L at STP, the following proportion can be used to solve the problem: $\frac{5.00\ L}{22.4\ L} = \frac{x\ \text{molecules}}{6.02 \times 10^{23}\ \text{molecules}}$. Solving for x gives $x = 1.34 \times 10^{23}$ molecules of the unknown gas. Dividing the number of atoms given in the problem, 4.03×10^{23} by the number of molecules of the unknown gas, 1.34×10^{23}, gives $\frac{4.03 \times 10^{23}}{1.34 \times 10^{23}} = 3.00$, which is the number of atoms in one molecule of the gas. Of the molecules listed, only CO_2 has 3 atoms.	0015

For question	The correct response is	Reason	Test Objective
6	C	The number of moles of HCl that reacts with $NaHCO_3$ can be determined using the expression $x = 0.010\ L \bullet \frac{0.50\ mol}{L}$. Therefore, $x = 0.005$ mol HCl. The number of grams of HCl involved in the reaction can be determined using the expression $x = 0.005\ mol\ HCl \bullet \frac{36.5\ g}{mol}$. Therefore, $x = 0.1825$ g HCl. The number of grams of HCl that would react with $NaHCO_3$ can be determined using the expression $\frac{84.0\ g\ NaHCO_3}{36.5\ g\ HCl} = \frac{x}{0.1825\ g\ HCl}$. As a result, $x = 0.42$ g of $NaHCO_3$. The amount of $NaHCO_3$ remaining unreacted would be equal to 0.58 g.	0016
7	D	The work of alchemists was for the most part unscientific and based on unfounded theories and superstition. However, the use of experimentation and observation to test hypotheses concerning the properties of metals was a part of the alchemist tradition that is integral to the practice of modern science.	0017
8	B	Rounding the sharp edges of the cut end of the glass tube will greatly reduce the risk of skin lacerations when experimenters use the glass tube. Heating the cut end of the glass tube is standard procedure for smoothing and rounding the sharp edge created by cutting the glass.	0018
9	D	Dividing the 100 g mass of the Li_2CO_3 by the gram molecular weight of Li_2CO_3 (73.89 g/mol) will give the number of moles of Li_2CO_3 contained in 100 g of Li_2CO_3 .	0019
10	B	The second law of thermodynamics states that the entropy, or disorder, of a system increases in a spontaneous process, such as rusting, and remains unchanged in an equilibrium process. Any process that is not spontaneous, such as an increase in the order within a system, requires an input of energy.	0020