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Georgia Assessments for the Certification of Educators®

GACE® Study Companion

Chemistry Assessment

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About the Assessment

Assessment Name	Chemistry
Grade Level	6–12
Test Code	Test I: 028 Test II: 029 Combined Test I and Test II: 528
Testing Time	Test I: 2 hours Test II: 2 hours Combined Test I and Test II: 4 hours
Test Duration	Test I: 2.5 hours Test II: 2.5 hours Combined Test I and Test II: 5 hours
Test Format	Computer delivered
Number of Selected-response Questions	Test I: 60 Test II: 60 Combined Test I and Test II: 120
Question Format	The test consists of a variety of short-answer questions such as selected-response questions, where you select one answer choice or multiple answer choices (depending on what the question asks for), questions where you enter your answer in a text box, and other types of questions. You can review the possible question types in the ***Guide to Taking a GACE Computer-delivered Test***.
Number of Constructed-response Questions	Test I: 0 Test II: 0 Combined Test I and Test II: 0

The GACE Chemistry assessment is designed to measure the professional knowledge of prospective teachers of secondary school Chemistry in the state of Georgia.

This assessment includes two tests. You may take either test individually or the full assessment in a single session. The testing time is the amount of time you will have to answer the questions on the test. Test duration includes time for tutorials and directional screens that may be included in the test.

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

The questions in this assessment assess both basic knowledge across content areas and the ability to apply principles.

The total number of questions that are scored is typically smaller than the total number of questions on the test. Most tests that contain selected-response questions also include embedded pretest questions, which are not used in calculating your score. By including pretest questions in the assessment, ETS is able to analyze actual test-taker performance on proposed new questions and determine whether they should be included in future versions of the test.

Content Specifications

Each test in this assessment is organized into content **subareas**. Each subarea is further defined by a set of **objectives** and their **knowledge statements**.

- The objectives broadly define what an entry-level educator in this field in Georgia public schools should know and be able to do.
- The knowledge statements describe in greater detail the knowledge and skills eligible for testing.
- Some tests also include content material at the evidence level. This content serves as descriptors of what each knowledge statement encompasses.

See a breakdown of the subareas and objectives for the tests in this assessment on the following pages.

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Test I Subareas

Subarea	Approx. Percentage of Test
I. Scientific Inquiry, Processes, Technology, and Society	32%
II. Nature of Matter and Energy	40%
III. Nomenclature, Chemical Composition, and Bonding and Structure	28%

Test I Objectives

Subarea I: Scientific Inquiry, Processes, Technology, and Society

Objective 1: Understands scientific inquiry and technology, and the relationship to society and the environment

The beginning Chemistry teacher:

A. Understands the processes involved in scientific inquiry
- Formulating problems
- Forming and testing hypotheses
- Development of theories, models, postulates, assumptions, and laws
- Process skills, including observing, concluding, comparing, inferring, categorizing, and generalizing

B. Understands experimental design
- Testing hypotheses
- Significance of controls
- Use and identification of variables
- Data collection planning

C. Understands the nature of scientific knowledge
- Subject to change
- Consistent with experimental evidence
- Reproducibility
- Unifying concepts and processes, including systems, models, constancy and change, equilibrium, and form and function
- Communicating experimental findings
- Undergoes peer review

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

D. Understands the major historical developments in chemistry and the contributions of major historical figures
    - How current chemical principles and models developed over time
    - Major developments in chemistry such as the atomic model and gas laws, including major historical figures

E. Understands the impact of chemistry and technology on the environment
    - Acid rain
    - Air and water pollution
    - Greenhouse gases
    - Ozone layer depletion
    - Waste disposal and recycling
    - Green chemistry

F. Understands applications of chemistry in daily life
    - Plastics, soaps, batteries, fuel cells, and other consumer products
    - Water purification
    - Chemical properties of household products
    - Pharmaceuticals
    - Medical imaging

G. Understands the advantages and disadvantages associated with various types of energy production
    - Renewable and nonrenewable energy resources
    - Conservation, recycling, and sustainability
    - Pros and cons of power generation based on various sources, such as fossil and nuclear fuel, hydropower, wind power, solar power, and geothermal power

Objective 2: Understands how to conduct laboratory processes, including the collection and analysis of data

The beginning Chemistry teacher:

A. Understands how to collect, evaluate, manipulate, interpret, and report data
    - Significant figures in collected data and calculations
    - Organization and presentation of data
    - Interpret and draw conclusions from data presented in tables, graphs, and charts
    - Note trends in data and relationships between variables
    - Make predictions and conclusions based on data

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

B. Understands units of measurement, notation systems, conversions, and mathematics used in chemistry
   - Standard units of measurement
   - Unit conversion and dimensional analysis
   - Scientific notation
   - Measurement equipment

C. Understands basic error analysis
   - Determining mean
   - Accuracy and precision
   - Identifying sources and effects of error
   - Percent error

D. Understands the appropriate preparation, use, storage, and disposal of materials in the laboratory
   - Appropriate use
   - Safe disposal
   - Appropriate storage
   - Preparation for classroom use
   - Safe procedures and safety precautions

E. Understands the appropriate use and need for maintenance and calibration of laboratory equipment
   - Appropriate use
   - Appropriate storage
   - Maintenance
   - Calibration
   - Preparation for classroom use
   - Safety procedures and precautions when using equipment

F. Understands safety procedures and precautions for the high school chemistry laboratory
   - Location and use of standard safety equipment, such as eyewash stations and showers
   - Laboratory safety rules for students
   - Appropriate apparel and conduct in the laboratory, such as wearing goggles
   - Emergency procedures

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Subarea II: Nature of Matter and Energy

Objective 1: Understands basic principles of matter and energy

The beginning Chemistry teacher:

A. Understands the organization of matter
   - Pure substances (elements and compounds)
   - Mixtures (homogeneous, heterogeneous, solutions, suspensions)
   - States of matter (solid, liquid, gas, plasma)
   - Atoms, ions, molecules

B. Understands the differences between chemical and physical properties/changes
   - Chemical versus physical properties
   - Chemical versus physical changes
   - Intensive versus extensive properties
   - Conservation of matter

C. Understands different forms of energy and conservation of energy
   - Kinetic and potential energy
   - Chemical, electrical, electromagnetic, nuclear, and thermal energy
   - Conversions between different forms of energy within chemical systems
   - Law of conservation of energy

D. Understands kinetic molecular theory, including ideal gases
   - Assumptions of the kinetic molecular theory
   - Ideal gases and the ideal gas laws
   - Ideal versus real gas behavior

Objective 2: Understands the atomic model of matter

The beginning Chemistry teacher:

A. Understands the current model of atomic structure
   - Description of atomic model, including subatomic particles, orbitals/quantum numbers (energy levels and sublevels; s, p, d, ...)
   - Experimental basis, including the gold foil experiment and spectral lines
   - Isotopes (mass number, average atomic mass)

B. Understands the electron configuration of the elements based on the periodic table
   - Aufbau principle, Hund's rule, Pauli exclusion principle
   - Correlation between electron configuration and the periodic table
   - Relationship between electron configuration and chemical and physical properties

C. Understands radioactivity
   - Characteristics of alpha particles, beta particles, and gamma radiation
   - Radioactive decay processes
   - Half-life
   - Fission and fusion
   - Balancing nuclear reactions and identifying products of nuclear reactions

D. Understands how the electronic absorption and emission spectra of elements are related to electron energy levels
   - Electronic energy transitions in atoms; e.g., ground state, excited states, emission/absorption of energy
   - Energy of electronic absorption/emission spectral lines in various regions of the electromagnetic spectrum
   - Relationship between energy, frequency, and wavelength

Objective 3: Understands the basic principles of thermodynamics

The beginning Chemistry teacher:

A. Understands temperature, thermal energy, and heat capacity, including temperature scales, units of energy, and calculations involving these concepts
   - Temperature and temperature scales
   - Thermal energy and units of energy
   - Heat transfer
   - Heat capacity and specific heat
   - Calorimetry calculations

B. Understands concepts and calculations involving phase transitions between the various states of matter
   - Phase transitions
   - Phase diagrams (triple point)
   - Heats of vaporization, fusion, and sublimation
   - Heating curves

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

C. Understands the energetics of chemical reactions
   - Exothermic and endothermic reactions
   - Bond energy
   - Hess's law

D. Understands how the laws of thermodynamics relate to chemical reactions and phase changes
   - Laws of thermodynamics (first, second, third)
   - Spontaneous processes and reversible processes
   - Change in enthalpy and entropy in chemical/physical processes

Subarea III: Nomenclature, Chemical Composition, and Bonding and Structure

Objective 1: Understands the nomenclature of compounds and their chemical composition

The beginning Chemistry teacher:

A. Understands the systematic names and chemical formulas of simple inorganic compounds
   - Binary compounds
   - Acids, bases, and salts
   - Hydrates

B. Understands the names of common organic compounds based on their functional groups
   - Alkanes, alkenes, and alkynes
   - Alcohols, ethers, ketones, aldehydes, amines

C. Understands the mole concept and how it applies to chemical composition
   - Avogadro's number, molar mass, and mole conversions
   - Calculation of empirical and molecular formulas
   - Percent composition

Objective 2: Understands various types of bonding, the structure of molecules, and intermolecular forces

The beginning Chemistry teacher:

A. Understands types of bonds and their properties
   - Relative bond lengths
   - Relative bond strengths
   - Covalent bonding
   - Ionic bonding
   - Metallic bonding

B. Understands structural formulas and molecular geometry (shape)
   - Lewis structures, including formal charges
   - Resonance structures
   - Molecular geometry (shape and approximate bond angles)
   - Polar and nonpolar molecules

C. Understands intermolecular interactions
   - Hydrogen bonding
   - London forces (instantaneous induced dipole-dipole)
   - Dipole-dipole
   - Dipole-induced dipole

D. Understands how bonding and molecular geometry correlate with physical properties
   - Boiling points
   - Melting points
   - Solubility
   - Equilibrium vapor pressure

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Test II Subareas

Subarea	Approx. Percentage of Test
I. Periodicity and Chemical Reactions	52%
II. Solutions and Solubility; and Acid-Base Chemistry	48%

Test II Objectives

Subarea I: Periodicity and Chemical Reactions

Objective 1: Understands how to use the periodic table and the periodic trends in the properties of the elements

The beginning Chemistry teacher:

A. Understands the basis of the periodic table and general layout
   - Arranged in groups and periods
   - Atomic number and mass
   - Symbols of the elements
   - Metals, nonmetals, metalloids
   - Transition elements

B. Understands the periodic trends in physical and chemical properties of the elements
   - Atomic/ionic radius
   - Ionization energy
   - Electron affinity
   - Electronegativity
   - Physical properties, such as boiling/melting points and conductivity
   - Chemical reactivity

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Objective 2: Understands how equations represent chemical reactions and are used to do stoichiometric calculations

The beginning Chemistry teacher:

A. Understands how to identify, write, and predict products of simple reaction types
   - Combustion
   - Neutralization
   - Decomposition
   - Synthesis
   - Dehydration
   - Single and double replacement
   - Oxidation-reduction

B. Understands how to balance chemical equations
   - Simple chemical equations
   - Chemical equations involving oxidation-reduction

C. Understands how to perform stoichiometric calculations
   - Simple calculations based on balanced chemical equations involving moles, mass, and volume
   - Limiting reagent calculations and percent yield

D. Understands important biochemical compounds
   - Carbohydrates, including simple sugars
   - Lipids
   - Proteins and amino acids
   - DNA and RNA
   - Products of photosynthesis and respiration

E. Understands common organic compounds; i.e., is able to identify functional groups
   - Alcohols
   - Ketones and aldehydes
   - Alkanes, alkenes, and alkynes
   - Ethers
   - Carboxylic acids
   - Amines
   - Benzene

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Objective 3: Understands chemical equilibrium, reaction kinetics, and oxidation-reduction chemistry

The beginning Chemistry teacher:

A. Understands chemical reaction equilibrium
   - Equilibrium constants and equilibrium expressions for simple reactions
   - Le Chatelier's principle

B. Understands basic chemical kinetics
   - Simple rate laws, rate constants, and reaction order
   - Activation energy and reaction mechanisms, including catalysts
   - Factors affecting reaction rate, such as concentration, surface area, and temperature

C. Understands oxidation-reduction reactions and how to determine oxidation states
   - Oxidation states
   - Identify oxidation-reduction reactions and half-reactions
   - Standard reduction potentials
   - Electrochemical reactivity series
   - Electrochemical cells

Subarea II: Solutions and Solubility; and Acid-Base Chemistry

Objective 1: Understands properties of solutions, including concentration, solubility, dissolution, and equilibrium

The beginning Chemistry teacher:

A. Understands solution terminology and calculations
   - Dilute, concentrated, saturated, unsaturated, supersaturated
   - Solvent, solute
   - Concentration units
   - Preparation of solutions of varying concentrations

B. Understands factors affecting solubility and dissolution rate
   - Effect of temperature, pressure, surface area, and agitation on rate of dissolving
   - Effect of temperature and pressure on solubility
   - Solubility curves

C. Understands solution phenomena based on colligative properties
   - Freezing point depression
   - Boiling point elevation
   - Vapor pressure effects
   - Osmotic pressure

D. Understands common applications of equilibrium in ionic solutions
   - Solubility of ionic compounds, including solubility rules and slightly soluble compounds
   - K_{sp} calculations, including percent dissociation and precipitation
   - Common ion effect
   - Electrolytes, nonelectrolytes, and electrical conductivity

Objective 2: Understands acid-base chemistry, including pH calculations, titrations, and equilibrium

The beginning Chemistry teacher:

A. Understands how to define and identify acids and bases
   - Arrhenius acids and bases
   - Brønsted-Lowry acids and bases
   - Neutralization and equivalence point

B. Understands the pH scale and can perform calculations involving pH and pOH
   - pH scale
   - Calculation of pH and pOH
   - Calculation of $[H^+]$ and $[OH^-]$

C. Understands concepts and calculations involving acid-base titrations
   - Use and selection of indicators (e.g., phenolphthalein, litmus paper)
   - Endpoint determination
   - Calculations based on titrations

D. Understands the equilibrium relationships in acid-base chemistry
   - Strong/weak acids and bases, including common examples
   - Monoprotic and polyprotic acids
   - K_a, K_b, K_w, and percent dissociation
   - Buffer solutions

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Practice Questions

The practice questions in this study companion are designed to familiarize you with the types of questions you may see on the assessment. While they illustrate some of the formats and types of questions you will see on the test, your performance on these sample questions should not be viewed as a predictor of your performance on the actual test. Fundamentally, the most important component in ensuring your success is familiarity with the content that is covered on the assessment.

To respond to a practice question, choose one of the answer options listed. Be sure to read the directions carefully to ensure that you know what is required for each question. You may find it helpful to time yourself to simulate actual testing conditions. A correct answer and a rationale for each sample test question are in the section following the practice questions.

Keep in mind that the test you take at an actual administration will have different questions, although the proportion of questions in each subarea will be approximately the same. You should not expect the percentage of questions you answer correctly in these practice questions to be exactly the same as when you take the test at an actual administration, since numerous factors affect a person's performance in any given testing situation.

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Directions: Each of the questions or incomplete statements below is followed by four suggested answers or completions. Select the one that is best in each case.

1. In a laboratory experiment, crystals are heated in a dry glass test tube using a Bunsen burner. During heating, a clear liquid is observed inside the mouth of the test tube. Which of the following statements is the most reasonable conclusion drawn from the observation?

   A. The gas fuel used to heat the crystals forms water as it burns.
   B. The crystals give off water when heated.
   C. The crystals give off both hydrogen and oxygen gases that combine to form water.
   D. Condensation from the air collects on the test tube as the crystals are heated.

Answer and Rationale

2. Suppose that a mixture of 8 g of sugar, 5.20 g of salt, and 100.01 g of flour is prepared. What is the total mass of the mixture expressed with the correct number of significant figures?

   A. 100 g
   B. 110 g
   C. 113 g
   D. 113.2 g

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

3. Which of the following gases is poisonous even in small quantities and therefore requires special consideration when used in a classroom?

   A. Steam
   B. Hydrogen
   C. Hydrogen sulfide
   D. Carbon dioxide

Answer and Rationale

4. Which of the following properties of a solid substance depends on the amount of the sample?

   A. Temperature
   B. Half-life
   C. Density
   D. Volume

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

5. A certain gas has a density of 3.40 g/L at standard temperature and pressure. The molar mass of the gas is

   A. (22.4×3.40) g
   B. 22.4 g
   C. $\frac{22.4}{3.40}$ g
   D. $\frac{3.40}{22.4}$ g

Answer and Rationale

6.

Isotope	Isotopic Mass (amu)	Percent Abundance
41	40.9	10.0%
44	43.9	30.0%
46	45.9	60.0%

A fictional element with the three naturally occurring isotopes described above would be listed in the periodic table with an atomic mass of

   A. 42.1
   B. 43.6
   C. 44.8
   D. 45.9

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

7. In an attempt to compare the half-lives of two radioactive elements, X and Y, a scientist set aside 400 g of each. After six months, the scientist found that 25 g of X and 200 g of Y remained. Which of the following statements is true?

   A. The half-life of Y is twice the half-life of X.
   B. The half-life of Y is four times the half-life of X.
   C. The half-life of Y is eight times the half-life of X.
   D. Unless the exact time interval is established, a comparison cannot be made.

Answer and Rationale

8. Which of the following processes involves the release of energy (is exothermic)?

   A. Ice melting at 15°C
   B. Water evaporating at 25°C
   C. NaCl dissolving in water at 25°C
   D. Water vapor condensing at 15°C

Answer and Rationale

9. A reaction is spontaneous at all temperatures if ΔH and ΔS have which of the following values?

   A. $\Delta H > 0$ and $\Delta S < 0$
   B. $\Delta H > 0$ and $\Delta S > 0$
   C. $\Delta H < 0$ and $\Delta S < 0$
   D. $\Delta H < 0$ and $\Delta S > 0$

Answer and Rationale

10. The correct formula for copper(I) sulfate is

   A. $CuSO_4$
   B. Cu_2SO_4
   C. Cu_4SO
   D. Cu_4SO_4

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

11. What mass of oxygen, O_2, contains very nearly the same number of molecules as 36.0 g of H_2O?

    A. 64.0 g
    B. 32.0 g
    C. 16.0 g
    D. 8.0 g

Answer and Rationale

12. Which of the following compounds exhibits hydrogen bonding?

    A. H_2
    B. NaH
    C. CH_4
    D. CH_3OH

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

13. Liquids with molecules held together by van der Waals forces have which of the following properties compared to liquids with molecules of similar mass with dipole-dipole interactions?

    A. Higher solubilities in water
    B. Higher melting points
    C. Lower boiling points
    D. Higher electrical conductivities in the solid phase

Answer and Rationale

14. Of the following elements, which is most likely to react with water at room temperature and pressure?

    A. Au
    B. C
    C. Na
    D. Ag

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

15. When 0.50 mol of octane, C_8H_{18}, is burned completely and the reaction products are brought to 20°C and 1 atm, the products include which of the following?

    A. 18 mol $H_2O(l)$
    B. Close to 100 L $CO_2(g)$
    C. Close to 180 L $CO_2(g)$
    D. Close to 200 L $H_2O(g)$

Answer and Rationale

16. Which of the following is an important function of carbohydrates in living organisms?

    A. They are the primary component of enzymes.
    B. They constitute a source of energy for the organism.
    C. They contain the genetic information of the cell.
    D. They are the primary components of the shells of mollusks.

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

17. Which of the following is true about any chemical reaction that is at equilibrium?

A. The molecules stop reacting.
B. Only side reactions continue; the main reaction stops.
C. Forward and reverse reactions occur at equal rates.
D. There are as many molecules of reactant as there are molecules of product.

Answer and Rationale

18. For the reaction represented below, the equilibrium constant, K_c, is equal to which of the following options?

$$Zn_3(PO_4)_2(s) + 6\ H^+(aq) \rightleftharpoons 3\ Zn^{2+}(aq) + 2\ H_3PO_4(aq)$$

A. $\dfrac{[Zn^{2+}][H_3PO_4]}{[Zn_3(PO_4)_2][H^+]}$

B. $\dfrac{[Zn^{2+}]^3[H_3PO_4]^2}{[Zn_3(PO_4)_2][H^+]}$

C. $\dfrac{[Zn^{2+}][H_3PO_4]}{[H^+]}$

D. $\dfrac{[Zn^{2+}]^3[H_3PO_4]^2}{[H^+]^6}$

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

19. Which of the following elements generally has an oxidation state of +3 in compounds?

A. Ga
B. N
C. Li
D. Cl

Answer and Rationale

20. Based on the standard reduction potentials given for chromium and silver, what is the cell potential for the reaction represented below?

$$Ag^{+} + e^{-} \rightarrow Ag(s) \qquad E° = +0.80V$$
$$Cr^{3+} + 3\,e^{-} \rightarrow Cr(s) \qquad E° = -0.74V$$

$$3\,Ag^{+} + Cr(s) \rightarrow 3\,Ag(s) + Cr^{3+}$$

A. 0.06 V
B. 1.54 V
C. 1.66 V
D. 3.14 V

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

21. In the reaction of aqueous solutions of silver nitrate and sodium phosphate, a silver precipitate is formed. Which of the following is the balanced net ionic equation for the reaction?

A. $Ag^+(aq) + PO_4^{3-}(aq) \rightleftharpoons Na^+(aq) + AgPO_4(s)$
B. $Ag^+(aq) + PO_4^{3-}(aq) \rightleftharpoons AgPO_4(s)$
C. $3\ Ag^+(aq) + PO_4^{3-}(aq) \rightleftharpoons Ag_3PO_4(s)$
D. $4\ Ag^+(aq) + PO_4^{3-}(aq) \rightleftharpoons Ag_4PO_4(s)$

Answer and Rationale

22. The solubility product, K_{sp}, for $Mg(OH)_2$ is 1.0×10^{-11}. What is the concentration of Mg^{2+} in a saturated solution of the base?

A. $\sqrt{5.0 \times 10^{-12}}\ M$
B. $\sqrt{1.0 \times 10^{-11}}\ M$
C. $\sqrt[3]{2.5 \times 10^{-12}}\ M$
D. $\sqrt[3]{1.0 \times 10^{-11}}\ M$

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

23. The pH of a 4.0×10^{-4} *M* HCl solution is between

A. 2 and 3.
B. 3 and 4.
C. 4 and 5.
D. 5 and 6.

Answer and Rationale

24. Which of the following is a strong acid in water?

A. HCl
B. CH_3COOH
C. RbOH
D. HF

Answer and Rationale

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Answer Key and Rationales

Question Number	Correct Answer	Rationale
1	B	**Option B is correct.** The crystals, when heated, may give off water in the form of steam. The warm, moist air rises to the mouth of the tube. The mouth is cooler than the rising warm air, so the water condenses inside the mouth. Back to Question
2	C	**Option C is correct.** When adding or subtracting measurements, the sum is only as precise as the least precise measurement. Since the mass of sugar (8 g) is the least precise quantity in the data set, and does not include digits to the right of the decimal, the sum must be rounded and should not include any digits to the right of the decimal. The sum of 8 + 5.20 + 100.01 is 113.21, but must be rounded to the ones place. Thus, the sum is correctly expressed as 113 (not 113.21). Back to Question
3	C	**Option C is correct.** Of the gases listed, only hydrogen sulfide is poisonous in small quantities. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
4	D	**Option D is correct.** The volume of a solid is a property of a substance, proportional to its mass, and therefore depends on the amount of the sample. Back to Question
5	A	**Option A is correct.** If 1 L of the given gas has a mass of 3.40 g, then 22.4 L (the volume of 1 mol of any gas at STP) would have a mass 22.4 times larger. Therefore, the molar mass of the gas is 22.4 × 3.40 g. Back to Question
6	C	**Option C is correct.** The atomic mass of the element can be calculated using the following equation: (0.10 × 40.9 amu) + (0.30 × 43.9 amu) + (0.60 × 45.9 amu) = 44.8 amu. However, in this example, the three incorrect options can easily be eliminated on the basis of the 60 percent abundance of isotope 46. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
7	B	**Option B is correct.** The decrease in the mass of element X from 400 g to 25 g indicates that four half-lives elapsed during the six months. During the same time period, one half-life elapsed for element Y. Therefore, the half-life of Y is four times that of X. Back to Question
8	D	**Option D is correct.** The processes in options A, B, and C are each endothermic and require the input of energy. The process in option D, gas changing to a liquid, releases energy and is exothermic. It is the reverse of the process of liquid changing to gas, as in option B. Back to Question
9	D	**Option D is correct.** Reactions are spontaneous if $\Delta G < 0$, where G is Gibbs energy. Since $\Delta G = \Delta H - T\Delta S$, then $\Delta G < 0$ if $\Delta H < 0$ and $\Delta S > 0$. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
10	B	**Option B is correct.** Copper(I) is Cu^{+} and sulfate is SO_4^{2-}; therefore, for charge neutrality the formula is Cu_2SO_4. Back to Question
11	A	**Option A is correct.** 36 g of H_2O contains 2.00 mol of H_2O molecules (molar mass 18.0 g). 2.00 mol of O_2 molecules have a total mass of 64.0 g (molar mass of O_2 is 32.0 g). Back to Question
12	D	**Option D is correct.** CH_3OH exhibits some degree of hydrogen bonding. H_2, NaH, and CH_4 do not exhibit hydrogen bonding. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
13	C	**Option C is correct.** Van der Waals forces is the collective name for weak attractive forces between molecules. In general, liquids held together by these forces only have lower boiling points than liquids with molecules of similar mass with dipole-dipole interactions. Back to Question
14	C	**Option C is correct.** Na is most reactive with water. Au, C, and Ag are unreactive with water. Back to Question
15	B	**Option B is correct.** Based on the balanced equation for the reaction, $2\ C_8H_{18} + 25\ O_2 \rightarrow 16\ CO_2 + 18\ H_2O$, 4.0 mol CO_2 gas is produced when 0.50 mol of C_8H_{18} is burned. The volume of 4.0 mol CO_2 gas is 96 L, which is close to 100 L. The volume is found from $V = nRT/P$, assuming ideal gas behavior. The calculation is: $V = (4\ \text{mol})(0.0821\ \text{L atm K}^{-1}\ \text{mol}^{-1})(293\ \text{K})/(1\ \text{atm}) = 96\ \text{L}$, where 20°C = 293 K. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
16	B	**Option B is correct.** Carbohydrates are broken down to glucose during digestion, and glucose is oxidized in the cell to produce energy in the form of ATP. Back to Question
17	C	**Option C is correct.** In an equilibrium, the forward and reverse reactions occur at equal rates. Back to Question
18	D	**Option D is correct.** The equilibrium constant Kc for a heterogeneous equilibrium reaction does NOT include any solid reactants. The concentrations of the nonsolid reaction species are raised to a power equal to the stoichiometric coefficients in the balanced reaction equation, with the products in the numerator and the reactants in the denominator. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
19	A	**Option A is correct.** The oxidation state of Ga is +3 in most of its compounds. Back to Question
20	B	**Option B is correct**. $E = E°(\text{Ag}) - E°(\text{Cr})$. $E = 0.80\ \text{V} - (-0.74)\ \text{V} = 1.54\ \text{V}$ Back to Question
21	C	**Option C is correct.** Option C is a balanced equation and has the correct formula for the precipitate, Ag_3PO_4. The other options, although balanced, have incorrect formulas for the precipitate. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Question Number	Correct Answer	Rationale
22	C	**Option C is correct.** For $Mg(OH)_2$, $K_{sp} = [Mg^{2+}][OH^-]^2$. This represents the concentration that can exist in a saturated solution. Since $[OH^-] = 2[Mg^{2+}]$, $K_{sp} = [Mg^{2+}](2[Mg^{2+}])^2 = 4[Mg^{2+}]^3 = 1.0 \times 10^{-11}$. Back to Question
23	B	**Option B is correct.** HCl dissociates completely. Since $[H^+] = 4.0 \times 10^{-4}$ *M*, pH = $-\log(4.0 \times 10^{-4}) = 3.4$. Hence, the pH is between 3 and 4. Back to Question
24	A	**Option A is correct.** The strength of an acid is related to the degree of dissociation in water. HCl is a strong acid, since in water it dissociates almost 100 percent. CH_3COOH and HF are weak acids that partially dissociate in water. RbOH is a base. Back to Question

Note: After clicking on a link, right click and select "Previous View" to go back to original text.

Preparation Resources

The resources listed below may help you prepare for the GACE assessment in this field. These preparation resources have been identified by content experts in the field to provide up-to-date information that relates to the field in general. You may wish to use current issues or editions of these materials to obtain information on specific topics for study and review.

Guide to Taking a GACE Computer-delivered Assessment

This guide explains how to navigate through a GACE assessment and how to answer different types of test questions. This free download is available in the Test Preparation Resources section of the GACE website at ***www.gace.ets.org/prepare***.

Reducing Test Anxiety

This guide provides practical help for people who suffer from test anxiety. Designed specifically for GACE test takers, but useful to anyone who has to take tests, this guide reviews the major causes of test anxiety and offers practical advice for how to counter each one. Download this guide for free from the Test Preparation Resources section of the GACE website at ***www.gace.ets.org/prepare***.

Study Tips: Preparing for a GACE Assessment

This document contains useful information on preparing for selected-response and constructed-response tests. The instruction, tips, and suggestions can help you become a better-prepared test taker. See the Test Preparation Resources section of the GACE website at ***www.gace.ets.org/prepare*** for this free download.

Journals

ChemMatters, American Chemical Society

The Science Teacher, National Science Teachers Association

Other Resources

Brown, T. E., Lemay, H. E., Bursten, B. E., Murphy, C. J., and Woodward, P. M. (2009). *Chemistry: The Central Science*, Eleventh Edition. Prentice Hall.

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Zumdahl, S. S., and Zumdahl, S. A. (2007). *Chemistry*, Seventh Edition. Houghton Mifflin.

Online Resources

American Chemical Society — ***www.acs.org***

National Science Teachers Association — ***www.nsta.org***

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