NES

PROFILE

Chemistry (306)

PEARSON

NES Profile: Chemistry (306)

Overview

This *NES Profile* provides information about the test, including the approximate percentage of the total test score derived from each content domain. The complete set of the content domains, the test framework, is provided here and contains all of the competencies and descriptive statements that define the content of the test.

This *NES Profile* includes the following materials:

» the test competencies associated with each content domain

» a set of descriptive statements that further explain each competency

» sample test questions aligned to the competencies

» any applicable reference materials, as noted below

Test Field	Chemistry (306)
Test Format	Multiple-choice questions
Number of Questions	Approximately 150
Test Duration	Up to 3 hours and 45 minutes
Reference Materials	Periodic Table Formula/Constants Page Scientific Calculator
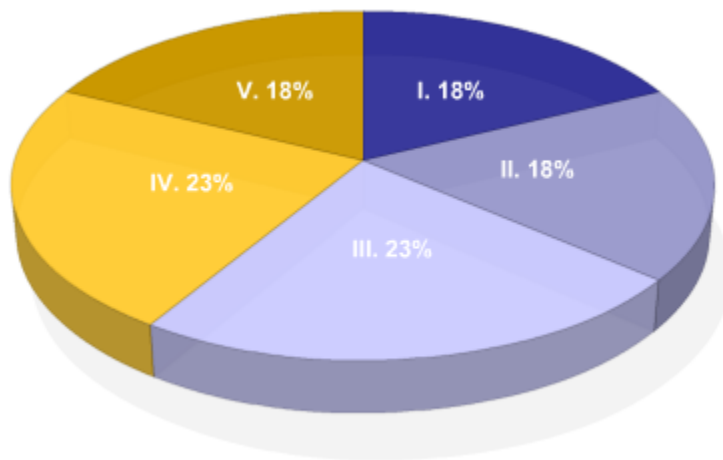
Key	Approximate Percentage of Test	Content Domain	Range of Competencies
	18%	I. Nature of Science	0001–0003
	18%	II. Matter and Atomic Structure	0004–0006
	23%	III. Energy and Chemical Bonding	0007–0010
	23%	IV. Chemical Reactions	0011–0014
	18%	V. Stoichiometry and Solutions	0015–0017

CONSTANTS

Description	Value
Ideal gas constant (R)	0.0821 L•atm/mol·K = 8.31 J/mol•K
Faraday constant (F)	9.65×10^4 C/mol e^- = 9.65×10^4 J/V•mol e^-
Rydberg constant (R)	1.097×10^7 m^{-1}
Planck's constant (h)	6.63×10^{-34} J•s
Boltzmann constant (k)	1.38×10^{-23} J/K
Rydberg constant × Planck's constant × speed of light in a vacuum (Rhc)	2.18×10^{-18} J
Molal freezing point depression constant for water (K_f)	1.86°C/m
Molal boiling point elevation constant for water (K_b)	0.51°C/m
Heat of fusion of water (ΔH_{fus})	334 J/g = 80 cal/g = 6.01 kJ/mol
Heat of vaporization of water (ΔH_{vap})	2260 J/g = 540 cal/g = 40.7 kJ/mol
Specific heat (s) of water (liquid)	4.184 J/g•K = 4.184 J/g•°C = 1.0 cal/g•°C
Dissociation constant of water (K_w)	1.0×10^{-14} at 25°C
Standard atmospheric pressure (STP)	1 atm = 760 mm Hg = 760 torr = 101.325 kPa
Speed of light in a vacuum (c)	3.00×10^8 m/s
1 calorie (cal)	4.184 J
1 watt (W)	1 J/s

FORMULAS

Description	Formula
Gibbs free energy equation	$\Delta G = \Delta H - T\Delta S$
Nernst equation	$E = E° - \dfrac{RT}{n\text{F}} \ln Q$
	$E = E° - \left(\dfrac{0.0257 \text{ V}}{n}\right) \ln Q$ at 298 K
	$E = E° - \left(\dfrac{0.0592 \text{ V}}{n}\right) \log Q$ at 298 K
Relationship between emf and free energy change for reactants and products in their standard states	$\Delta G° = -nFE°$
Energy change as an electron transitions between energy states	$\Delta E = Rhc\left(\dfrac{1}{n_i^2} - \dfrac{1}{n_f^2}\right)$
Henderson-Hasselbalch equation	$\text{pH} = pKa + \log\left(\dfrac{[\text{conjugate base}]}{[\text{acid}]}\right)$
Coulombs (C)	$C = \text{amperes} \times \text{seconds}$
Photon energy	$E = h\nu$
Speed of light	$c = \lambda\nu$
Nuclear binding energy	$\Delta E = c^2 \Delta m$
Amount of heat (q)	$q = ms\Delta T$
Root-mean-square speed	$u_{\text{rms}} = \sqrt{\dfrac{3RT}{M}}$
Graham's law of diffusion	$\dfrac{r_1}{r_2} = \sqrt{\dfrac{M_2}{M_1}}$

NOTES FOR CHEMISTRY TEST

Not all constants and formulas necessary are listed, nor are all constants and formulas listed used on this test.

While attention has been paid to significant figures, no answer should be considered incorrect solely because of the number of significant figures.

PERIODIC TABLE OF THE ELEMENTS

1A 1	2A 2		3B 3	4B 4	5B 5	6B 6	7B 7	8B 8	8B 9	8B 10	1B 11	2B 12	3A 13	4A 14	5A 15	6A 16	7A 17	8A 18
1 H 1.01																		2 He 4.00
3 Li 6.94	4 Be 9.01												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 23.0	12 Mg 24.3												13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
19 K 39.1	20 Ca 40.1		21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
37 Rb 85.5	38 Sr 87.6		39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc (98.9)	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	57–71	72 Hf 178.5	73 Ta 180.9	74 W 183.9	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)	89–103	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (282)	112 Cn (285)	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (294)	118 Og (294)

Lanthanide Series	57 La 138.9	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
Actinide Series	89 Ac (227)	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)

Calculator Information

A scientific calculator will be provided with your test. You may not use your own scientific calculator or calculator manual.

Content Domain I: Nature of Science

Competencies:

0001 Understand principles and procedures of scientific inquiry.

Descriptive Statements:

» Demonstrate knowledge of the principles and procedures for designing and carrying out scientific investigations.

» Recognize methods and criteria for collecting, organizing, analyzing, and numerically and graphically presenting scientific data.

» Recognize the evidential basis of scientific claims.

» Demonstrate knowledge of the safety procedures and hazards associated with chemical investigations and the materials, equipment, and measurement standards used in chemistry.

» Apply basic mathematical procedures and concepts of uncertainty in reporting data and solving problems in chemistry.

Sample Item:

Which of the following is best accomplished using a mass spectrometer?

A.   determining the percent abundance of an element's natural isotopes

B.   determining the triple point of an unknown substance

C.   determining the reaction rate for a chemical reaction involving a gas

D.   determining the electronegativity value of an element

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the equipment used in chemistry. A mass spectrometer measures the masses and relative abundance of atomic or molecular ions in a sample. These numerical values can be used to calculate the percent abundance of an element's natural isotopes.

0002 Understand the history and nature of science.

Descriptive Statements:

» Demonstrate knowledge of the historical development of major scientific ideas.

» Demonstrate knowledge of major contemporary theories, laws, models, and concepts in physics, biology, and Earth and space science.

» Demonstrate knowledge of unifying themes, principles, and relationships that connect the different branches of the sciences and the uses and limitations of models.

» Demonstrate knowledge of the nature of science and its characteristics as a system of inquiry.

Sample Item:

DNA → RNA → protein

Which of the following biological processes does the pathway shown above summarize?

    A. mitosis

    B. cellular respiration

    C. meiosis

    D. gene expression

Correct Response and Explanation

D. This question requires the examinee to demonstrate knowledge of major contemporary concepts in biology. DNA is a molecule that stores genetic information in cells. The pathway shows the translation of genetic information from DNA to RNA to protein, a process that leads to the active expression of genetic information.

0003 Understand the relationships among science, technology, engineering, mathematics, and society.

Descriptive Statements:

» Analyze the interrelationships among chemistry, technology, engineering, mathematics, and society.

» Evaluate scientific research and the coverage of science in the media.

» Analyze social, economic, and ethical issues associated with technological and scientific developments.

Sample Item:

Flexible polyurethane foams are used in many commercial products, such as upholstered furniture, bedding, automobile seats, and sponges. An important component in the manufacturing of flexible polyurethane foams are polyols, which are typically derived from petroleum products. In 2007, Cargill, Incorporated, was awarded a Presidential Green Chemistry Challenge Award from the Environmental Protection Agency (EPA) for its research into polyols made from renewable biological resources. The quality and performance of the polyurethane foam made from these non-petroleum-based polyols proved comparable to the quality and performance of the polyurethane foam made from petroleum-based polyols.

The passage above illustrates which of the following about the relationships among science, technology, and society?

    A. Private industry is reluctant to comply with EPA standards without strict government oversight.

    B. Chemistry research can play a significant role in solving major environmental problems.

    C. Environmentally friendly technologies can only be competitive with government support.

    D. Applied chemistry research is increasing due to a decrease in public funding for basic research.

Correct Response and Explanation

B. This question requires the examinee to analyze the interrelationships among science, technology, and society. Knowledge of chemistry can be used to assess existing manufacturing protocols and to propose alternative procedures. These new procedures can play a significant role in mitigating the environmental problems facing society.

Content Domain II: Matter and Atomic Structure

Competencies:

0004 Understand the properties of matter.

Descriptive Statements:

» Analyze the characteristics of elements, compounds, and mixtures.

» Apply methods used to determine the chemical and physical properties of unknown substances.

» Analyze physical, chemical, and nuclear changes in matter.

» Demonstrate knowledge of the characteristics of radioactive materials.

Sample Item:

Which of the following only occurs during a nuclear change?

A. Valence electrons are raised to higher energy levels.

B. Two or more types of atoms are combined.

C. Energy is released to the surroundings.

D. An element's atomic number is reduced.

Correct Response and Explanation

D. This question requires the examinee to demonstrate knowledge of the characteristics of radioactive materials. Chemical and physical changes do not involve changes within the nucleus of an atom and therefore would not lead to a reduction in an element's atomic number. This type of change would only result from a nuclear change.

0005 Understand atomic theory and the periodic table.

Descriptive Statements:

» Analyze various historical and contemporary models of atomic structure and the supporting evidence for these models.

» Demonstrate knowledge of the properties of and interactions between electrons, protons, and neutrons; and the relationships among energy levels, photons, and atomic spectra.

» Demonstrate the ability to analyze electron configurations, orbital notations (or diagrams), and Lewis (or electron) dot symbols.

» Demonstrate knowledge of the organization of the periodic table and its usefulness in predicting the physical and chemical properties and relative reactivity of given elements.

Sample Item:

Which of the following elements is the most electronegative?

    A. hydrogen

    B. fluorine

    C. radon

    D. francium

Correct Response and Explanation

B. This question requires the examinee to demonstrate knowledge of the periodic table and its usefulness in predicting the relative reactivity of given elements. The electronegativity of elements in the periodic table tends to increase from bottom to top within a group and from left to right across a period. Of the given elements, fluorine is in the uppermost position on the right-hand side of the periodic table.

0006 Understand the kinetic molecular theory, the nature of phase changes, and the gas laws.

Descriptive Statements:

» Demonstrate knowledge of the basic principles of the kinetic molecular theory and the distinguishing characteristics of the four states of matter.

» Analyze heating and cooling curves and phase diagrams.

» Demonstrate knowledge of the relationships among volume, temperature, and pressure in gases.

» Solve problems involving the gas laws.

Sample Item:

A gas occupies a volume of 1.25 liters at a pressure of 825 mm Hg. What will be the final pressure of this gas if it is compressed into a volume of 725 mL at constant temperature?

    A. 479 mm Hg

    B. 748 mm Hg

    C. 1.30×10^3 mm Hg

    D. 1.42×10^3 mm Hg

Correct Response and Explanation

D. This question requires the examinee to solve a problem involving the gas laws. If the temperature and number of moles of a gas are held constant, the relationship between initial pressure and initial volume and a new pressure and a new volume is $P_1 V_1 = P_2 V_2$. This relationship can be used to calculate the new pressure when the initial pressure, initial volume, and new volume are known.

Content Domain III: Energy and Chemical Bonding

Competencies:

0007 Understand the principles of thermodynamics and calorimetry.

Descriptive Statements:

» Analyze the three laws of thermodynamics and their applications to chemical and biochemical systems.

» Predict the spontaneity of given chemical reactions.

» Differentiate among forms of energy and between heat and temperature.

» Analyze the results of calorimetry experiments.

Sample Item:

A 4.75 g sample of solid NaOH is dissolved in 50.5 g of H_2O in a constant-pressure calorimeter having a heat capacity of 18.5 J/°C. The temperature rises from 21.1°C to 33.6°C. Assuming that the solution has a specific heat capacity of 4.184 J/g•°C and negligible heat loss from the calorimeter, how much heat is produced in the solution process?

    A. 2.64 kJ

    B. 2.89 kJ

    C. 3.12 kJ

    D. 4.27 kJ

Correct Response and Explanation

C. This question requires the examinee to analyze the results of a calorimetry experiment. The total heat produced in the given solution process is equal to the heat absorbed by the solution plus the heat absorbed by the calorimeter. The heat absorbed by the solution is calculated using the equation $q = m \times s \times \Delta T$. The heat absorbed by the calorimeter is equal to $C_{calorimeter} \times \Delta T$.

0008 Understand energy relationships in chemical bonding, chemical reactions, and physical processes.

Descriptive Statements:

» Analyze energy changes due to the formation or breaking of chemical bonds.

» Analyze energy changes during chemical reactions, including the analysis of enthalpy diagrams.

» Analyze energy changes involved in phase transitions, dissolving solutes in solvents, and diluting solutions.

Sample Item:

Bond	Bond Enthalpy (kJ/mol)
H—H	436.4
H—Cl	431.9

$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
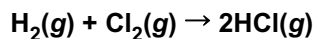
$\Delta H^\circ_{rxn} = -184.6$ kJ

Given the information shown above, what is the best estimate of the bond enthalpy for the Cl–Cl bond?

    A. 189.1 kJ/mol

    B. 242.8 kJ/mol

    C. 256.3 kJ/mol

    D. 585.1 kJ/mol

Correct Response and Explanation

B. This question requires the examinee to analyze energy changes due to the formation or breaking of chemical bonds. The enthalpy change for a chemical reaction is equal to the sum of the enthalpy changes involved in breaking existing bonds minus the sum of the enthalpy changes involved in forming new bonds. The bond enthalpy for the Cl–Cl bond can be calculated using this relationship and the given bond enthalpies for H–H and H–Cl.

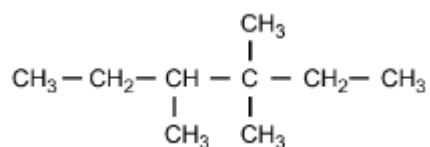**0009** Understand the nomenclature and structure of inorganic and organic compounds.

Descriptive Statements:

» Apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature.

» Analyze the characteristics of inorganic structures, including ionic solids, network solids, and metallic solids.

» Predict the geometry of molecules and polyatomic ions.

» Analyze the chemical composition and basic structure of organic compounds.

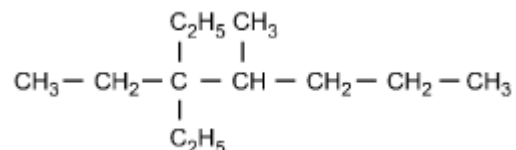» Recognize the characteristics of structural, geometric, and optical isomers.

Sample Item:

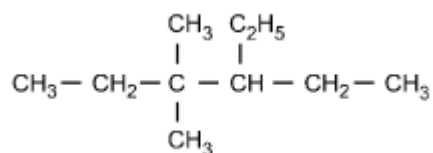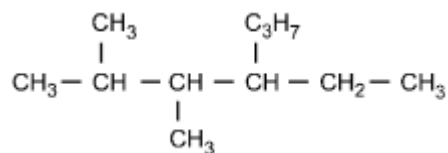**Which of the following structural formulas represents 4-ethyl-3, 3-dimethylhexane?**

A.

$$CH_3-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{CH}-\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-CH_2-CH_3$$

B.

$$CH_3-CH_2-\underset{\underset{\displaystyle C_2H_5}{|}}{\overset{\overset{\displaystyle C_2H_5}{|}}{C}}-\underset{\overset{\displaystyle CH_3}{|}}{CH}-CH_2-CH_2-CH_3$$

C.

$$CH_3-CH_2-\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle CH_3}{|}}{C}}-\underset{\overset{\displaystyle C_2H_5}{|}}{CH}-CH_2-CH_3$$

D.

$$CH_3-\underset{\overset{\displaystyle CH_3}{|}}{CH}-CH-\underset{\underset{\displaystyle CH_3}{|}}{\overset{\overset{\displaystyle C_3H_7}{|}}{CH}}-CH_2-CH_3$$

Correct Response and Explanation

C. This question requires the examinee to apply the International Union of Pure and Applied Chemistry (IUPAC) rules of nomenclature. 4-ethyl-3, 3-dimethylhexane is an alkane consisting of six continuous carbon atoms. An ethyl group (C_2H_5) is attached to the number 4 carbon and two methyl groups (CH_3) are attached to the number 3 carbon.

0010 Understand chemical bonding and intermolecular forces and their effect on the properties of substances.

Descriptive Statements:

» Compare the characteristics of types of chemical bonds.
» Analyze chemical bonding in terms of electron behavior and the factors that affect bond strength.
» Analyze the characteristics of various types of intermolecular forces and the forces between molecules of a given structure.
» Relate the properties of substances to their atomic bonds and intermolecular forces.

Sample Item:

The high melting point of diamond is due to:

    A.   strong covalent bonds between carbon atoms.

    B.   an irregular, three-dimensional crystal structure.

    C.   delocalized, highly mobile bonding electrons.

    D.   extensive van der Waals forces between carbon atoms.

Correct Response and Explanation

A. This question requires the examinee to relate the properties of substances to their atomic bonds. Diamond is a covalent-network crystalline solid. The carbon atoms in this network are linked by covalent bonds. This strong bonding between carbon atoms is responsible for the high melting point of diamond.

Content Domain IV: Chemical Reactions

Competencies:
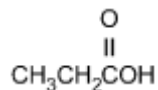
0011 Understand the nature of chemical reactions.

Descriptive Statements:

» Analyze different types of chemical reactions.

» Predict the outcomes of chemical reactions.

» Demonstrate knowledge of collision theory and factors that influence reaction rates.
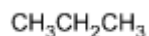
» Analyze rate problems and experimental rate data.

Sample Item:

Which of the following products is formed by an esterification reaction between acetic acid (CH_3CO_2H) and ethanol (CH_3CH_2OH)?

A.

$$\overset{\displaystyle O}{\overset{\displaystyle \|}{CH_3CH_2COH}}$$

B.

$$CH_3CH_2CH_3$$

C.

$$\overset{\displaystyle O}{\overset{\displaystyle \|}{CH_3COCH_2CH_3}}$$

D.

$$\overset{O\ \ H}{\underset{\underset{H}{|}}{\overset{\|\ \ |}{CH_3COOCH_2CH_3}}}$$

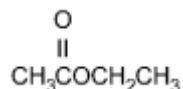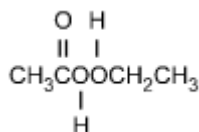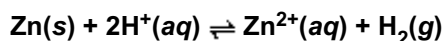**Correct Response and Explanation**

C. This question requires the examinee to analyze different types of chemical reactions. In the esterification reaction between acetic acid and ethanol, the OH group from acetic acid and the H attached to the O in ethanol combine to form water. The remaining portions of the acetic acid and ethanol molecules combine to form the ester, ethyl acetate.

0012 Understand the principles of chemical equilibrium.

Descriptive Statements:

» Demonstrate knowledge of the concept of chemical equilibrium and the factors that influence chemical equilibrium.

» Apply Le Châtelier's principle to chemical systems.

» Solve problems involving equilibrium constants.

Sample Item:

$$Zn(s) + 2H^+(aq) \rightleftharpoons Zn^{2+}(aq) + H_2(g)$$

Which of the following is the equilibrium constant expression for the equation shown above?

A.

$$\frac{[Zn^{2+}]\,[H_2]}{[Zn]\,[H^+]}$$

B.

$$\frac{[Zn^{2+}] + (P_{H_2})}{[Zn] + 2[H^+]}$$

C.

$$\frac{[Zn^{2+}]}{2[H^+]}$$

D.

$$\frac{[Zn^{2+}]\,(P_{H_2})}{[H^+]^2}$$

Correct Response and Explanation

D. This question requires the examinee to solve problems involving equilibrium constants. When writing equilibrium constant expressions, pure solid and pure liquid compounds are omitted and the pressure of gaseous compounds can be used in place of concentration. The equilibrium constant expression for this reaction is equal to the concentration of $Zn^{2+}(aq)$ × the pressure of $H_2(g)$ each raised to a power equal to its stoichiometric coefficient, divided by the concentration of $H^+(aq)$ raised to a power equal to its stoichiometric coefficient.

0013 Understand acid-base chemistry.

Descriptive Statements:

» Analyze acids and bases according to how they behave and how they are defined.
» Determine the hydronium ion concentration, hydroxide ion concentration, pH, and pOH for acid, base, and salt solutions.
» Demonstrate knowledge of the relationship between molecular structure and acid strength and the relative strengths of acids and bases.
» Analyze buffer solutions qualitatively and quantitatively.
» Demonstrate knowledge of the principles and applications of acid-base titrations.

Sample Item:

Which of the following explains why nitric acid (HNO$_3$) is a stronger acid than nitrous acid (HNO$_2$)?

    A.   The additional oxygen present in nitric acid increases the polarity of the O–H bond.

    B.   The extent of ionization is directly related to molecular weight when comparing related compounds.

    C.   The anion formed by removing H$^+$ from nitrous acid is more stable than the anion formed by removing H$^+$ from nitric acid.

    D.   The O–H bond in nitrous acid is weaker than the O–H bond in nitric acid.

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the relationship between molecular structure and acid strength. The strength of an acid is a function of its tendency to ionize. For oxoacids with the same central atom, acid strength increases as the oxidation number of the central atom increases because of the resulting increase in polarity of the O–H bond. The oxidation number of nitrogen in HNO$_3$ is +5 and in HNO$_2$ it is +3, thus the O–H bond in HNO$_3$ is more polar and ionizes more readily.

0014 Understand oxidation-reduction reactions and electrochemistry.

Descriptive Statements:

» Demonstrate knowledge of oxidation, reduction, oxidation numbers, and the balancing of oxidation-reduction equations.

» Analyze the components and operating principles of electrochemical cells and electrolytic cells.

» Solve problems involving electrochemical cells.

» Demonstrate knowledge of the applications of electrochemistry.

Sample Item:

Automobile mechanics measure the density of the electrolyte solution of lead storage batteries to determine the amount of charge remaining. Which of the following statements describes the cause of the change in electrolyte density as the battery's charge decreases?

    A.   The sulfuric acid electrolyte is consumed and water is formed.

    B.   Water evaporates and the electrolyte concentration increases.

    C.   The lead and lead(IV) oxide migrate from the solution to the electrodes.

    D.   Lead in the electrolyte solution precipitates out of the solution.

Correct Response and Explanation

A. This question requires the examinee to demonstrate knowledge of the applications of electrochemistry. During the normal operation of a lead storage battery, sulfuric acid is consumed and water is produced. The density of the electrolyte solution is related to how much of each of these substances is present in the solution.

Content Domain V: Stoichiometry and Solutions

Competencies:

0015 Understand the mole concept.

Descriptive Statements:

» Demonstrate knowledge of the mole concept and its use in chemical calculations.

» Solve problems involving molar mass, percent-composition, and empirical and molecular formulas.

Sample Item:

Which of the following is equivalent to 1.42×10^{23} atoms?

A. 25.0 g Br

B. 15.0 g Cu

C. 19.0 g Sn

D. 23.0 g Mn

Correct Response and Explanation

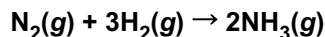**B.** This question requires the examinee to demonstrate knowledge of the mole concept. The number of moles of an element is equal to the product of the mass of the element ÷ the molar mass of the element × Avogadro's number.

0016 Understand stoichiometry.

Descriptive Statements:

» Demonstrate the ability to interpret chemical notation, balance chemical equations, and recognize net ionic equations.

» Solve stoichiometric problems involving moles, mass, volume, and energy, including limiting reactant and percent yield.

Sample Item:

$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Given the equation shown above, how much NH_3 is formed when 823 g of N_2 are combined with 145 g of H_2?

A. 58.8 g

B. 96.7 g

C. 815 g

D. 1650 g

Correct Response and Explanation

C. This question requires the examinee to solve stoichiometric problems involving mass. By calculating the number of moles of each reactant and analyzing the stoichiometric relationship between them, H_2 can be identified as the limiting reactant. From the stoichiometric relationship between H_2 and NH_3, the number of moles of product formed can be calculated. This mole quantity can then be converted into mass using the molar mass of NH_3.

0017 Understand the properties of solutions and colloidal suspensions.

Descriptive Statements:

» Demonstrate knowledge of different types of solutions, colloids, and suspensions.
» Solve problems involving concentrations of solutions.
» Analyze factors that affect solubility and solubility curves.
» Analyze the colligative properties of solutions.

Sample Item:

**Solubility Curves for
Two Ionic Compounds in Water**

Key
— ▲ — compound A
— ■ — compound B
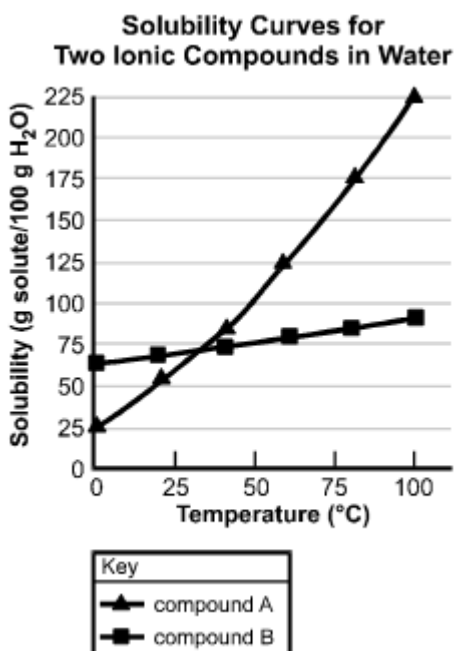
Based on the solubility curves shown above, which of the following procedures will be most effective in isolating the greatest amount of pure compound A from a mixture consisting of 200 g of compound A and 15 g of compound B?

    A.   dissolving the mixture in 100 g of water and then heating to the solution's boiling point

    B.   dissolving the mixture in 100 g of water at 100°C and then decreasing the temperature to 0°C

    C.   dissolving the mixture in 100 g of water at 75°C, filtering the solution, and then retaining the filtrate

    D.   dissolving the mixture in 100 g of water and then slowly increasing the temperature to 100°C

Correct Response and Explanation

B. This question requires the examinee to analyze solubility curves. Based on the solubility curves provided, both compound A and compound B will be completely in solution when dissolved in 100 g of water at 100°C. As the temperature of the solution is decreased to 0°C, 175 g of compound A will come out of the solution, while all of compound B will remain in the solution. This is the procedure that yields the greatest amount of pure compound A.