

Large-Type Edition

The University of the State of New York
REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Wednesday, June 24, 2026 — 9:15 a.m. to 12:15 p.m., only

The possession or use of any communications device is strictly prohibited when taking this examination. If you have or use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

This is a test of your knowledge of chemistry. Use that knowledge to answer all questions in this examination. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in this examination booklet.

A separate answer sheet for Part A and Part B–1 has been provided to you. Follow the instructions from the proctor for completing the student information on your answer sheet. Record your answers to the Part A and Part B–1 multiple-choice questions on this separate answer sheet. Record your answers for the questions in Part B–2 and Part C in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

All answers in your answer booklet should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on your separate answer sheet or in your answer booklet as directed.

When you have completed the examination, you must sign the statement printed on your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice. . .

A four-function or scientific calculator and a copy of the *2011 Edition Reference Tables for Physical Setting/Chemistry* must be available for you to use while taking this examination.

DO NOT START THIS EXAMINATION UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

- | | |
|--|--|
| <p>1 Based on the wave-mechanical model of the atom, which statement describes the electrons in an indium atom in the ground state?</p> <p>(1) Electrons are located in the nucleus.
(2) Electrons are positively charged.
(3) Electrons are at a fixed distance from the nucleus.
(4) Electrons are in regions called orbitals.</p> <p>2 Which electron configuration represents a bromine atom in an excited state?</p> <p>(1) 2-8-18-7-1 (3) 2-8-18-8
(2) 2-8-18-6-1 (4) 2-8-18-7</p> | <p>3 What energy change occurs when light is produced by excited lithium atoms?</p> <p>(1) Energy is released as electrons move from lower to higher energy states.
(2) Energy is released as electrons move from higher to lower energy states.
(3) Energy is absorbed as electrons move from lower to higher energy states.
(4) Energy is absorbed as electrons move from higher to lower energy states.</p> <p>4 Which list contains the symbols of two metals and two metalloids?</p> <p>(1) Si, Fe, As, Zr (3) Na, Ca, Mn, Te
(2) V, Zn, Sb, Hg (4) S, Ge, Au, Pb</p> |
|--|--|

- 5 Graphite and diamond are solid forms of carbon and have
- (1) the same properties and the same crystal structure
 - (2) the same properties and different crystal structures
 - (3) different properties and the same crystal structure
 - (4) different properties and different crystal structures
- 6 Which formula represents a nonpolar molecule?
- (1) HCl
 - (2) NH₃
 - (3) H₂O
 - (4) CH₄
- 7 When two iodine atoms become an iodine molecule, energy is
- (1) released as a bond is formed
 - (2) absorbed as a bond is formed
 - (3) released as a bond is broken
 - (4) absorbed as a bond is broken
- 8 Based on Table *H*, what is the vapor pressure of ethanol at 50.°C?
- (1) 12 kPa
 - (2) 29 kPa
 - (3) 63 kPa
 - (4) 83 kPa

- 9 Which laboratory process can be used to separate a mixture of two liquids based on the difference in their boiling points?
- (1) chromatography
 - (2) crystallization
 - (3) distillation
 - (4) filtration
- 10 Which sample of argon gas has atoms with the highest average kinetic energy?
- (1) 40 g of argon gas at 20°C
 - (2) 30 g of argon gas at 40°C
 - (3) 20 g of argon gas at 60°C
 - (4) 10 g of argon gas at 80°C
- 11 Gas behavior becomes more ideal when a gas has a
- (1) higher temperature and a lower pressure
 - (2) higher temperature and a higher pressure
 - (3) lower temperature and a lower pressure
 - (4) lower temperature and a higher pressure

12 Which statement describes the distance between the particles and the attractions between the particles in an ideal gas?

- (1) The particles are larger than the distance between them and there are strong attractive forces between the particles.
- (2) The particles are smaller than the distance between them and there are strong attractive forces between the particles.
- (3) The particles are larger than the distance between them and there are no attractive forces between the particles.
- (4) The particles are smaller than the distance between them and there are no attractive forces between the particles.

13 A reaction is most likely to occur if reactant particles collide with proper

- (1) density and radii
- (2) charge and pressure
- (3) energy and orientation
- (4) volume and mass

14 What is the pressure of 77 kPa expressed in atmospheres?

- (1) 0.76 atm
- (2) 1.3 atm
- (3) 77 atm
- (4) 7800 atm

15 At STP, which sample contains the same number of molecules as 20.0 liters of $\text{N}_2(\text{g})$ at STP?

- (1) 10.0 L of $\text{H}_2(\text{g})$
- (2) 20.0 L of $\text{CO}_2(\text{g})$
- (3) 30.0 L of $\text{F}_2(\text{g})$
- (4) 40.0 L of $\text{SO}_2(\text{g})$

16 What happens to the energy of the molecules in a liquid sample of a substance as it solidifies at its freezing point?

- (1) Potential energy and average kinetic energy both decrease.
- (2) Potential energy and average kinetic energy both increase.
- (3) Potential energy decreases and average kinetic energy remains constant.
- (4) Potential energy remains constant and average kinetic energy increases.

17 Based on Table I, which compound is formed from its elements at 101.3 kPa and 298 K by an endothermic reaction?

- (1) CO_2
- (2) NO_2
- (3) C_2H_6
- (4) NH_3

- 18 LeChatelier's principle can be used to predict the
- (1) reactivity of a metal
 - (2) volume of a gas at STP
 - (3) concentration of an aqueous solution
 - (4) effect of a stress on a system at equilibrium

- 19 Which mathematical expression represents the heat of reaction for a chemical reaction in terms of potential energy, PE?

- (1) $(\text{PE of products}) + (\text{PE of reactants})$
- (2) $(\text{PE of products}) \times (\text{PE of reactants})$
- (3) $(\text{PE of products}) - (\text{PE of reactants})$
- (4) $(\text{PE of products}) \div (\text{PE of reactants})$

- 20 Which phrase describes the effect of adding a catalyst to a chemical reaction, causing the reaction rate to increase?

- (1) same reaction pathway, lower activation energy
- (2) same reaction pathway, higher activation energy
- (3) different reaction pathway, lower activation energy
- (4) different reaction pathway, higher activation energy

- 21 In terms of energy and disorder, chemical systems in nature tend to undergo changes toward

- (1) increasing energy and increasing disorder
- (2) increasing energy and decreasing disorder
- (3) decreasing energy and increasing disorder
- (4) decreasing energy and decreasing disorder

- 22 Which element is present in all organic compounds?

- | | |
|--------------|------------|
| (1) carbon | (3) oxygen |
| (2) nitrogen | (4) sulfur |

- 23 Which class of organic compounds has molecules that each contain a nitrogen atom?

- | | |
|------------|-----------|
| (1) amide | (3) ester |
| (2) halide | (4) ether |

- 24 Which statement describes the electrodes in an operating electrochemical cell?

- (1) Oxidation and reduction both occur at the cathode.
- (2) Oxidation and reduction both occur at the anode.
- (3) Reduction occurs at the cathode and oxidation occurs at the anode.
- (4) Reduction occurs at the anode and oxidation occurs at the cathode.

25 Which statement describes the energy conversion that occurs in an operating voltaic cell?

- (1) Chemical energy is converted to electrical energy.
- (2) Electrical energy is converted to chemical energy.
- (3) Chemical energy is converted to nuclear energy.
- (4) Nuclear energy is converted to chemical energy.

26 Which compound is an Arrhenius acid?

- (1) NH_3
- (2) H_2SO_3
- (3) $\text{Ba}(\text{OH})_2$
- (4) KOH

27 Which term identifies the change that occurs when the nucleus of an atom is converted from one element to another?

- (1) addition
- (2) combustion
- (3) sublimation
- (4) transmutation

28 The energy released during a nuclear reaction is produced when

- (1) an alpha particle becomes a beta particle
- (2) a beta particle becomes an alpha particle
- (3) mass is converted into energy
- (4) energy is converted into mass

29 Which reaction releases the most energy per mole of reactants?

- (1) fission
- (2) neutralization
- (3) esterification
- (4) substitution

30 What is a risk associated with the long-term storage of waste produced by a nuclear power plant?

- (1) radioactive dating
- (2) biological exposure
- (3) treatment of disease
- (4) tracing chemical processes

Part B–1
Answer all questions in this part.

Directions (31–50): For each statement or question, record on your separate answer sheet the number of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the 2011 Edition Reference Tables for Physical Setting/Chemistry.

31 Which statement describes the relative energy of the electrons in different electron shells of a krypton atom in the ground state?

- (1) An electron in the first shell has more energy than an electron in the third shell.
- (2) An electron in the third shell has more energy than an electron in the second shell.
- (3) An electron in the second shell has less energy than an electron in the first shell.
- (4) An electron in the third shell has less energy than an electron in the second shell.

32 The table below lists properties of selected element samples at room temperature.

Properties of Selected Element Samples at Room Temperature

Element Sample	Mass (g)	Reacts with $\text{H}_2\text{O}(\ell)$
sodium	5.00	yes
nickel	5.00	no
gold	2.00	no

Based on this table, which statement describes a chemical property that can be used to differentiate two of these element samples from each other?

- (1) Sodium can be differentiated from gold based on mass.
- (2) Sodium can be differentiated from nickel based on the reaction with water.
- (3) Nickel can be differentiated from sodium based on mass.
- (4) Nickel can be differentiated from gold based on the reaction with water.

33 Which formula represents copper(II) phosphate?

- | | |
|------------------------------|----------------------------------|
| (1) Cu_2PO_4 | (3) $\text{Cu}_2(\text{PO}_4)_3$ |
| (2) Cu_3PO_4 | (4) $\text{Cu}_3(\text{PO}_4)_2$ |

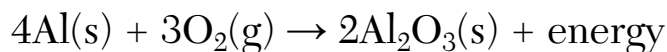
34 Given the balanced equation representing a reaction:



What is the mass of Li_2O produced when 4.8 grams of LiOH reacts completely to produce 1.8 grams of H_2O ?

- | | |
|-----------|-----------|
| (1) 4.2 g | (3) 3.0 g |
| (2) 6.6 g | (4) 7.8 g |

35 Given the balanced equation representing a reaction:



What is the number of moles of Al_2O_3 formed when 3.00 moles of Al reacts completely with oxygen?

- | | |
|--------------|--------------|
| (1) 1.50 mol | (3) 6.00 mol |
| (2) 2.25 mol | (4) 4.00 mol |

36 What is the gram-formula mass of $\text{Al}_2(\text{SO}_4)_3$?

- | | |
|----------------|----------------|
| (1) 150. g/mol | (3) 342 g/mol |
| (2) 262 g/mol | (4) 450. g/mol |

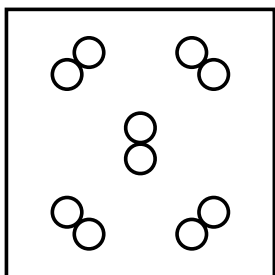
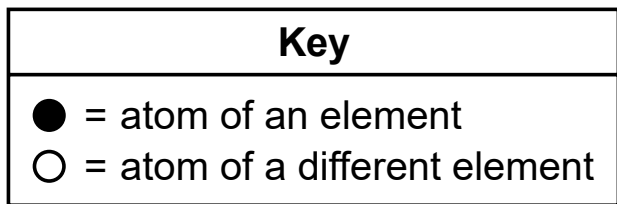
37 Based on boiling points on Table S, molecules of which element have the strongest intermolecular forces?

- | | |
|--------------|--------------|
| (1) bromine | (3) fluorine |
| (2) chlorine | (4) iodine |

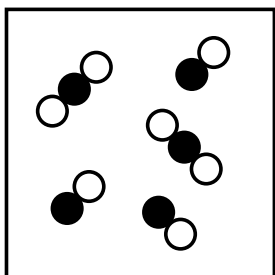
38 Based on Table S, what is the electronegativity difference between the sulfur atom and a hydrogen atom in a bond in a molecule of H_2S ?

- | | |
|---------|---------|
| (1) 0.4 | (3) 3.0 |
| (2) 1.8 | (4) 4.8 |

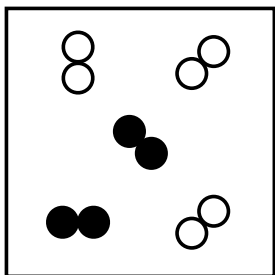
39 Which particle model diagram represents two different compounds?



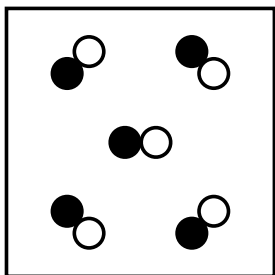
(1)



(3)



(2)



(4)

40 How many moles of solute are dissolved in 0.50 liter of a 0.40 M solution?

- | | |
|--------------|--------------|
| (1) 0.20 mol | (3) 0.50 mol |
| (2) 0.40 mol | (4) 0.90 mol |

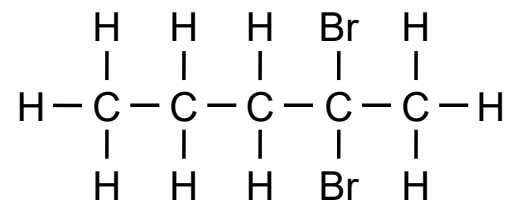
41 At standard pressure, what is the amount of heat that must be absorbed when a 44.1-gram sample of $\text{H}_2\text{O}(\ell)$ is completely vaporized at its boiling point?

- | | |
|------------|--------------|
| (1) 184 J | (3) 14 700 J |
| (2) 4410 J | (4) 99 700 J |

42 Which phrase describes the effect of an increase in temperature on the rate of a chemical reaction?

- (1) more collisions between reactant particles, faster reaction rate
- (2) more collisions between reactant particles, slower reaction rate
- (3) fewer collisions between reactant particles, faster reaction rate
- (4) fewer collisions between reactant particles, slower reaction rate

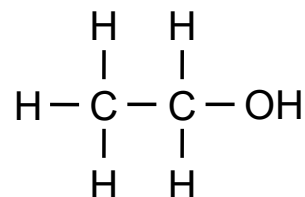
43 Given the formula for a compound:



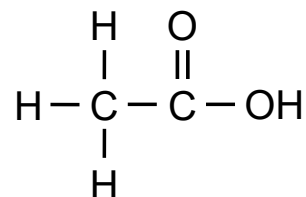
What is a chemical name for this compound?

- (1) 2,2-dibromopentane
- (2) 2,2-dibromopropane
- (3) 4,4-dibromopentane
- (4) 4,4-dibromopropane

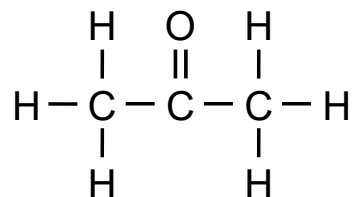
44 Which formula represents an organic acid?



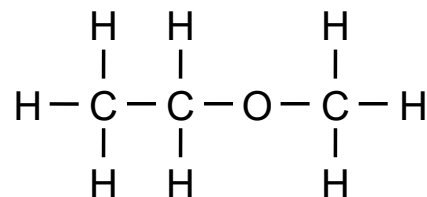
(1)



(3)



(2)



(4)

45 Based on Table *J*, which element will spontaneously react with a solution of $\text{Zn}(\text{NO}_3)_2(\text{aq})$?

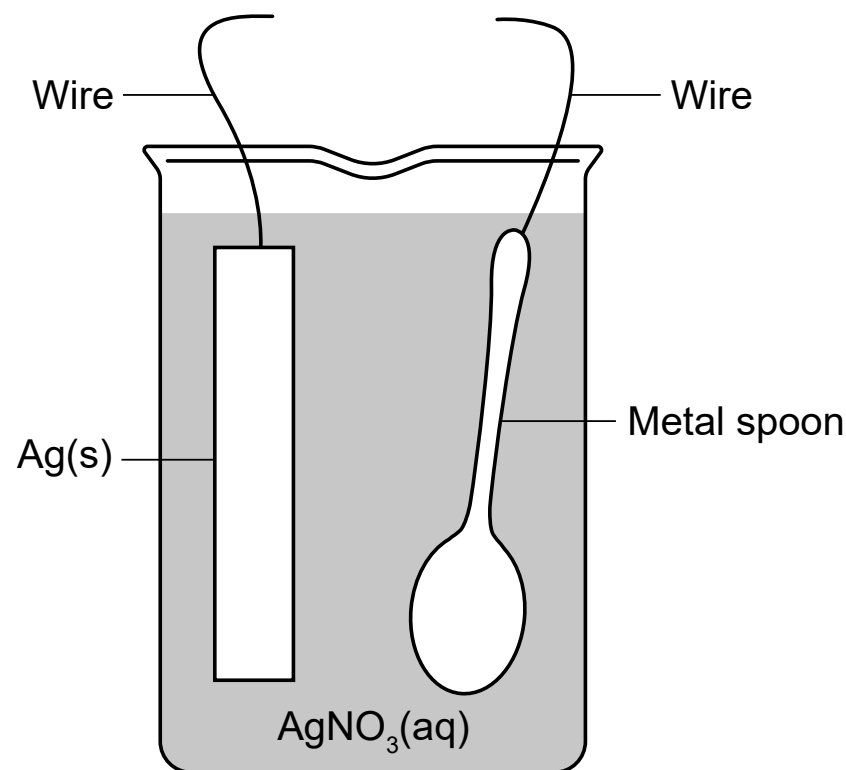
(1) Co

(3) Sn

(2) Cu

(4) Sr

46 The diagram below represents an incomplete electrolytic cell that can be used to plate a metal spoon with silver.



What is missing in the diagram that is required for the cell to operate?

(1) a battery

(3) a salt bridge

(2) a voltmeter

(4) a closed switch

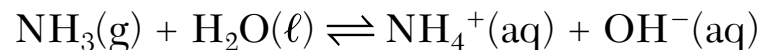
47 Which statement explains why potassium chloride is classified as an electrolyte?

- (1) KCl contains a metal.
- (2) KCl has a high melting point.
- (3) KCl is a solid at STP.
- (4) KCl releases ions in an aqueous solution.

48 In a titration, 15.0 mL of a 0.350 M KOH(aq) solution exactly neutralizes 10.0 mL of an HCl(aq) solution. What is the concentration of the HCl(aq) solution?

- (1) 0.233 M
- (2) 0.350 M
- (3) 0.525 M
- (4) 1.75 M

49 Given the equation representing a reversible reaction:



According to one acid-base theory, the two H^+ acceptors are

- (1) $\text{NH}_3(\text{g})$ and $\text{NH}_4^+(\text{aq})$
- (2) $\text{NH}_3(\text{g})$ and $\text{OH}^-(\text{aq})$
- (3) $\text{H}_2\text{O}(\ell)$ and $\text{NH}_4^+(\text{aq})$
- (4) $\text{H}_2\text{O}(\ell)$ and $\text{OH}^-(\text{aq})$

50 Which equation represents a nuclear fusion reaction?

- (1) $\text{H} + \text{H} \rightarrow \text{H}_2$
- (2) ${}^2_1\text{H} + {}^3_1\text{H} \rightarrow {}^4_2\text{He} + {}^1_0\text{n}$
- (3) ${}^{14}_7\text{N} + {}^1_0\text{n} \rightarrow {}^{14}_6\text{C} + {}^1_1\text{H}$
- (4) $\text{UF}_4 + \text{F}_2 \rightarrow \text{UF}_6$

Part B–2

Answer all questions in this part.

Directions (51-65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

Base your answers to questions 51 through 53 on the information below and on your knowledge of chemistry.

The elements in Group 2 on the Periodic Table of the Elements have similar chemical properties.

- 51 State, in terms of valence electrons, why the chemical properties of the elements in Group 2 are similar. [1]
- 52 Based on Table S, state the general trend in electronegativity for these elements as they are considered in order of increasing atomic number. [1]
- 53 Determine the number of neutrons in an atom of Ba-138. [1]
-

Base your answers to questions 54 through 57 on the information below and on your knowledge of chemistry.

Selected properties of copper are listed in the table below.

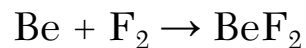
Selected Properties of Copper

Conducts heat and electricity.
Density is 8.96 g/cm^3 at room temperature.

- 54 Identify the type of bonding that allows solid copper to conduct electricity. [1]
- 55 Compare the amount of thermal energy in a 1.0-kg block of copper at 25°C to the amount of thermal energy in a 3.0-kg block of copper at 25°C . [1]
- 56 Show a numerical setup for calculating the volume of a 14.20-gram sample of copper at room temperature. [1]
- 57 The density of a sample of copper was calculated to be 9.59 g/cm^3 at room temperature. Determine the percent error for this calculated density of the copper. [1]
-

Base your answer to questions 58 and 59 on the information below and on your knowledge of chemistry.

The elements beryllium and fluorine can react to form the compound beryllium fluoride as represented by the equation below.



58 Compare the number of electrons lost to the number of electrons gained during this redox reaction. [1]

59 Write a balanced half-reaction equation for the oxidation of the beryllium. [1]

Base your answers to questions 60 through 62 on the information below and on your knowledge of chemistry.

During a laboratory activity, appropriate safety equipment was used and safety procedures were followed. A student measured the pH values of four samples of household mixtures and distilled water. The pH values measured by the student are listed in the table below.

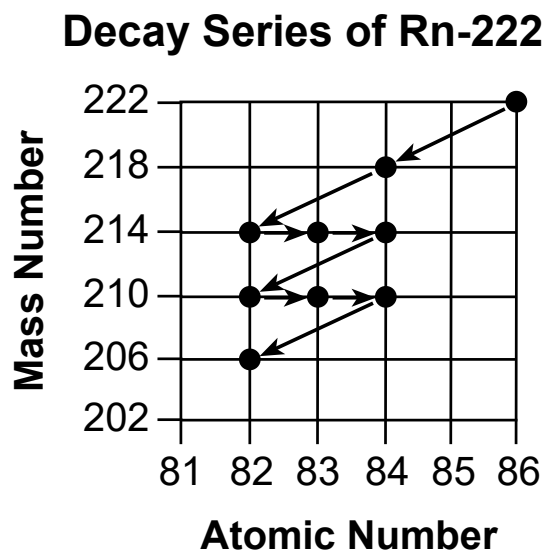
pH Values of Five Samples

Sample	pH Value
lemon juice	2.0
black coffee	5.0
distilled water	7.0
milk of magnesia	10.0
household ammonia	11.0

- 60 Identify the sample that is the most basic. [1]
- 61 State the color of bromcresol green if it is added to a sample of the distilled water. [1]
- 62 Compare the hydronium ion concentration in the lemon juice sample to the hydronium ion concentration in the black coffee sample. [1]
-

Base your answers to questions 63 through 65 on the information below and on your knowledge of chemistry.

An atom of Rn-222 decays to an atom of Pb-206 through a series of steps, as shown on the graph below. In the graph, each point represents a nuclide and each arrow represents a nuclear decay mode during the decay series.



- 63 Based on Table N, determine the time required for an original 20.0-milligram sample of Rn-222 to decay until only 5.0 milligrams of the sample remains unchanged. [1]
- 64 Based on the decay series graph and Table O, identify the nuclear decay mode represented by an arrow that goes from atomic number 84 to atomic number 82. [1]
- 65 Complete the equation *in your answer booklet* for the decay of Bi-210 by writing a notation for the missing product. [1]

Part C

Answer all questions in this part.

Directions (66-85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

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Base your answers to questions 66 through 69 on the information below and on your knowledge of chemistry.

Europium is an element used in lasers and energy-saving light bulbs. The two naturally occurring isotopes of europium are Eu-151 and Eu-153. The table below shows the atomic mass and the percent natural abundance for each of these isotopes.

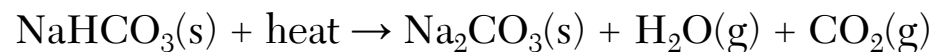
Naturally Occurring Isotopes of Europium

Isotope	Atomic Mass (u)	Natural Abundance (%)
Eu-151	150.92	47.81
Eu-153	152.92	52.19

- 66 State, in terms of *both* protons and electrons, why an atom of europium is electrically neutral. [1]
- 67 Compare the mass of a proton in an atom of europium to the mass of an electron in an atom of europium. [1]
- 68 State, in terms of *both* protons and neutrons, why an atom of Eu-151 and an atom of Eu-153 are isotopes of each other. [1]
- 69 Show a numerical setup for calculating the atomic mass of the element europium. [1]

Base your answers to questions 70 through 72 on the information below and on your knowledge of chemistry.

When making baked goods in an oven, baking soda, $\text{NaHCO}_3(\text{s})$, is often used in recipes as a source of carbon dioxide gas. The carbon dioxide gas produced gives baked goods a less dense composition because the gas takes up space in the structure as items bake in an oven. The unbalanced equation below represents a reaction of baking soda to produce carbon dioxide gas.



- 70 Determine the percent composition by mass of oxygen in baking soda, NaHCO_3 (gram-formula mass = 84 g/mol). [1]
- 71 Balance the equation for the reaction *in your answer booklet*, using the *smallest* whole-number coefficients. [1]
- 72 State, in terms of substances, why this equation represents a decomposition reaction. [1]
-

Base your answers to questions 73 through 75 on the information below and on your knowledge of chemistry.

Concrete is an important material used in the construction of buildings and other structures. Concrete is made by mixing powdered cement with sand and gravel. These dry materials are mixed with water to start a series of chemical reactions. A main reaction that allows concrete to become hard and strong includes the hydration of tricalcium silicate, Ca_3SiO_5 , as shown in the balanced equation below.



73 State *two* types of chemical bonding in the calcium hydroxide product. [1]

74 Compare the radius of a calcium atom to the radius of a Ca^{2+} ion in Ca_3SiO_5 . [1]

75 In the space *in your answer booklet*, draw a Lewis electron-dot diagram for a molecule of H_2O . [1]

Base your answers to questions 76 through 79 on the information below and on your knowledge of chemistry.

The use of solid road salt and enhanced brine are two methods of deicing roads in winter months. The road salt is usually crushed solid sodium chloride. Enhanced brine is an aqueous solution containing sodium chloride, magnesium chloride, and calcium chloride. The percentages of these salts can vary.

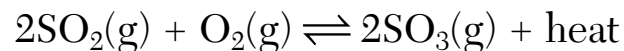
Rainfall can wash these salts into bodies of fresh water. This can have a harmful effect on living organisms when the concentration of chloride ions becomes greater than 0.23 gram per liter of fresh water.

A student does a laboratory investigation to determine the concentration of dissolved salts in a sample of water that came from a road treated with road salt. After collecting the sample of water, the student filtered the sample using filter paper. During this laboratory activity appropriate safety equipment was used and safety procedures were followed.

- 76 State evidence from the passage that enhanced brine is a mixture. [1]
- 77 State, in terms of particle size, why the dissolved salt ions in the student's sample passed through the filter paper. [1]
- 78 State, in terms of ions, why a 50.-mL sample of a solution that contains 0.92 gram of MgCl_2 has a lower freezing point than a 50.-mL sample of a solution that contains 0.11 gram of MgCl_2 . [1]
- 79 Show a numerical setup for calculating the concentration in parts per million of the Cl^- ions in a 1000.-gram aqueous solution that has 0.23 gram of dissolved Cl^- ions. [1]
-

Base your answers to questions 80 through 82 on the information below and on your knowledge of chemistry.

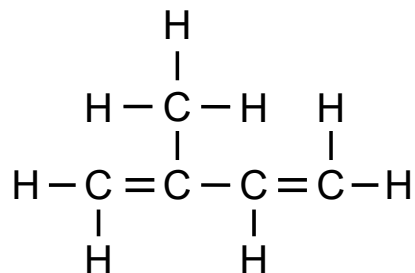
An important step in the industrial production of sulfuric acid is the reaction of sulfur dioxide gas and oxygen gas to produce sulfur trioxide gas. This reaction can reach equilibrium in a closed system, as represented by the equation below.



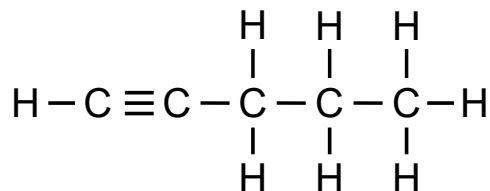
- 80 Compare the rate of the forward reaction to the rate of the reverse reaction when this system is at equilibrium. [1]
- 81 On the labeled axes *in your answer booklet*, draw a potential energy diagram for the forward reaction represented in the equation. [1]
- 82 Compare the entropy of a 1.0-mole sample of liquid oxygen, $\text{O}_2(\ell)$, to the entropy of a 1.0-mole sample of oxygen gas, $\text{O}_2(\text{g})$. [1]
-

Base your answers to questions 83 through 85 on the information below and on your knowledge of chemistry.

Natural rubber is made from the sap of the rubber tree, which is grown in tropical regions of the world. Natural rubber is mainly 1,4-polyisoprene. This compound consists of molecules that are long chains of many linked isoprene molecules. In the diagram below, compound 1 represents isoprene. Compound 2 represents an isomer of compound 1.



Compound 1



Compound 2

- 83 State, in terms of carbon-to-carbon bonds, why compound 1 is an unsaturated hydrocarbon. [1]
- 84 Based on Table Q, write the general formula for the homologous series that includes compound 2. [1]
- 85 Explain, in terms of *both* molecular formulas and structural formulas, why compound 2 is an isomer of compound 1. [1]
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