

Large-Type Edition

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

PHYSICAL SETTING CHEMISTRY

Wednesday, August 19, 2026 — 8:30 to 11:30 a.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.

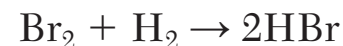
Directions (1–30): For *each* statement or question, record on your separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *2011 Edition Reference Tables for Physical Setting/Chemistry*.

- | | |
|---|--|
| <p>1 Which subatomic particles are located in the nucleus of a silicon atom?</p> <p>(1) electrons and positrons
(2) electrons and protons
(3) neutrons and positrons
(4) neutrons and protons</p> <p>2 The mass of a neutron is approximately equal to</p> <p>(1) 1 u (3) 1 kg
(2) 1 μg (4) 1 mol</p> <p>3 Based on the wave-mechanical model, which term identifies the region of the most probable location of an electron in an atom in the ground state?</p> <p>(1) nucleus (3) isotope
(2) spectra (4) orbital</p> | <p>4 What is the classification of the element on the Periodic Table in Group 16, Period 5?</p> <p>(1) noble gas (3) metalloid
(2) nonmetal (4) metal</p> <p>5 Which two elements have the most similar chemical properties?</p> <p>(1) magnesium and calcium
(2) nitrogen and oxygen
(3) gallium and germanium
(4) rubidium and barium</p> <p>6 Based on Table S, which element in Period 2 has the <i>smallest</i> atomic radius?</p> <p>(1) boron (3) fluorine
(2) carbon (4) lithium</p> |
|---|--|

- 7 Which substance can be broken down by chemical means?
- (1) Cd(s) (3) Xe(g)
(2) CO(g) (4) Cu(s)
- 8 Which term identifies a type of chemical reaction?
- (1) decomposition (3) solidification
(2) deposition (4) sublimation
- 9 At STP, a 10.-gram sample of liquid propanone and a 10.-gram sample of liquid water can be differentiated by their
- (1) mass (3) temperature
(2) phase (4) vapor pressure
- 10 Which terms represent two different major categories of compounds?
- (1) molecular and ionic
(2) molecular and covalent
(3) nuclear and ionic
(4) nuclear and covalent
- 11 Which formula represents a polar molecule?
- (1) H₂ (3) CO₂
(2) H₂O (4) CH₄

- 12 Which statement describes what happens when an atom of iodine gains an electron?
- (1) The atom becomes a positive ion with a smaller radius.
(2) The atom becomes a positive ion with a larger radius.
(3) The atom becomes a negative ion with a smaller radius.
(4) The atom becomes a negative ion with a larger radius.

- 13 Given the equation representing a reaction:



Which statement describes the energy changes that occur in this reaction?

- (1) Energy is released as bonds are broken, only.
(2) Energy is absorbed as bonds are formed, only.
(3) Energy is absorbed as bonds are broken, and energy is released as bonds are formed.
(4) Energy is absorbed as bonds are formed, and energy is released as bonds are broken.

14 Which property is used to determine the degree of polarity in a chemical bond that exists between two atoms?

- (1) acidity
- (2) molarity
- (3) conductivity
- (4) electronegativity

15 Which compound contains both ionic and covalent bonding?

- (1) SO_3
- (2) CaCl_2
- (3) NaOH
- (4) Al_2S_3

16 Which property allows the separation of a mixture of two different liquids by distillation?

- (1) boiling point
- (2) density
- (3) particle size
- (4) solubility

17 Which sample of iron has particles with the greatest average kinetic energy?

- (1) 20. g at $30.^{\circ}\text{C}$
- (2) 10. g at $40.^{\circ}\text{C}$
- (3) 20. g at $50.^{\circ}\text{C}$
- (4) 10. g at $60.^{\circ}\text{C}$

18 Which statement describes particles of an ideal gas, based on the kinetic molecular theory?

- (1) The particles are closely packed together.
- (2) The particles collide and the total energy of the system increases.
- (3) The particles have no attractive forces between them.
- (4) The particles are separated by small distances compared to their size.

19 A chemical reaction is most likely to occur when the reacting particles collide with the proper

- (1) solubility and mass
- (2) energy and orientation
- (3) alkalinity and density
- (4) conductivity and volume

20 Which term represents a strong intermolecular force?

- (1) covalent bonding
- (2) hydrogen bonding
- (3) ionic bonding
- (4) metallic bonding

21 Given the balanced equation:



Which statement explains the change in entropy of this system?

- (1) The entropy decreases because the particles are less randomly arranged.
- (2) The entropy decreases because the particles are more randomly arranged.
- (3) The entropy increases because the particles are less randomly arranged.
- (4) The entropy increases because the particles are more randomly arranged.

22 Systems in nature tend to undergo changes toward

- (1) less disorder and lower energy
- (2) less disorder and higher energy
- (3) greater disorder and lower energy
- (4) greater disorder and higher energy

23 Which element is present in all organic compounds?

- (1) carbon
- (2) chlorine
- (3) oxygen
- (4) nitrogen

24 Where do oxidation and reduction occur in an operating electrolytic cell?

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

25 Which energy conversion must occur in an operating voltaic cell?

- (1) electrical energy to chemical energy
- (2) chemical energy to electrical energy
- (3) chemical energy to mechanical energy
- (4) mechanical energy to chemical energy

26 Which substance is an electrolyte?

- (1) Ne
- (2) N₂
- (3) H₂O
- (4) H₂SO₃

27 According to one acid-base theory, a molecule acts as a base when the molecule

- (1) accepts an H⁺
- (2) donates an H⁺
- (3) accepts an H⁻
- (4) donates an H⁻

28 Which emission from an unstable nucleus has the *least* penetrating power but the greatest ionizing power?

- (1) alpha particles (3) gamma rays
- (2) beta particles (4) positrons

29 A similarity between fission and fusion is that both

- (1) are chemical reactions
 - (2) are nuclear reactions
 - (3) involve splitting a large nucleus into smaller nuclei
 - (4) involve combining two small nuclei to form a larger nucleus
-

30 Which statement describes the process by which energy is produced during a nuclear reaction?

- (1) Mass is lost due to the conversion of mass to energy.
- (2) Mass is lost due to the conversion of energy to mass.
- (3) Mass is gained due to the conversion of mass to energy.
- (4) Mass is gained due to the conversion of energy to mass.

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 proposal resulted directly from experiments using cathode ray tubes?
- The atom is a hard sphere.
 - The atom is mostly empty space.
 - The atom contains a positively charged center.
 - The atom contains negatively charged particles.
- 32 What are the number of protons and the number of neutrons in an atom of potassium-39?
- 19 protons and 19 neutrons
 - 19 protons and 20 neutrons
 - 20 protons and 19 neutrons
 - 39 protons and 39 neutrons
- 33 The mass and volume of a sample of palladium are measured at room temperature. The density of the palladium sample is calculated to be 13.8 grams per cubic centimeter. Based on Table S, what is the percent error of this calculated density?
- 13%
 - 14%
 - 15%
 - 18%
- 34 Based on Table S, which general trends in first ionization energy and electronegativity values are demonstrated by the first five elements in Group 15 as the elements are considered in order of increasing atomic number?
- The first ionization energy decreases and the electronegativity decreases.
 - The first ionization energy decreases and the electronegativity increases.
 - The first ionization energy increases and the electronegativity increases.
 - The first ionization energy increases and the electronegativity decreases.

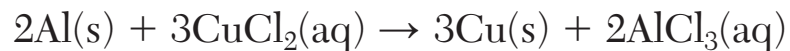
35 In the formula for the compound XCl_4 , the X could represent

- (1) lithium
- (2) potassium
- (3) neon
- (4) silicon

36 A compound has an empirical formula of NH_2 and a molar mass of 32 grams per mole. Which formula represents this compound?

- (1) NH
- (2) NH_2
- (3) N_2H_2
- (4) N_2H_4

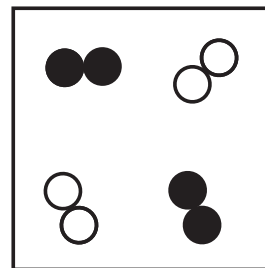
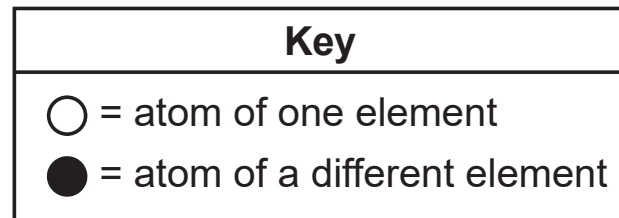
37 Given the equation representing a chemical reaction:



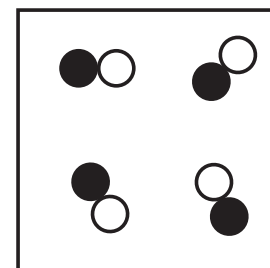
Which type of chemical reaction is represented by this equation?

- (1) synthesis
- (2) decomposition
- (3) single replacement
- (4) double replacement

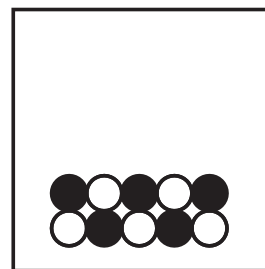
38 Which particle model diagram represents *one* substance in the gas phase?



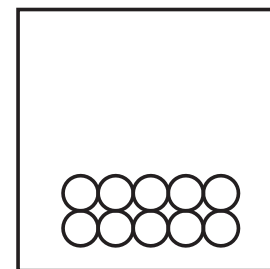
(1)



(3)



(2)



(4)

39 At 10.°C, 5.0 grams of KCl is dissolved in 100. grams of H₂O(ℓ). Based on Table G, how many additional grams of KCl(s) must be dissolved to saturate the solution at 10.°C?

- (1) 11 g (3) 25 g
(2) 18 g (4) 30. g

40 A solution was made by dissolving 2.0 moles of a solute in enough water to make 0.50 liter of solution. What is the molarity of this solution?

- (1) 0.25 M (3) 0.50 M
(2) 2.0 M (4) 4.0 M

41 What is the amount of heat required to completely melt a 92.6-gram sample of solid lead at its melting point? The heat of fusion of lead is 23.0 J/g.

- (1) 2130 J (3) 30 900 J
(2) 8950 J (4) 55 600 J

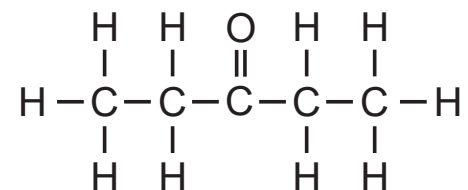
42 Based on Table S, which statement gives the physical state of the element listed at STP?

- (1) Francium is a liquid.
(2) Gallium is a solid.
(3) Mercury is a solid.
(4) Silver is a liquid.

43 Which equation represents a physical equilibrium?

- (1) $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$
(2) $2\text{NO}_2(\text{g}) \rightleftharpoons \text{N}_2\text{O}_4(\text{g})$
(3) $\text{CO}_2(\text{s}) \rightleftharpoons \text{CO}_2(\text{g})$
(4) $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$

44 Given the formula representing a compound:



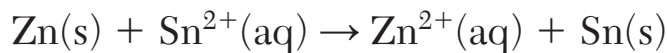
What is a chemical name of this compound?

- (1) pentanoic acid (3) 3-pentanal
(2) ethyl propanoate (4) 3-pentanone

45 Which half-reaction equation represents oxidation?

- (1) $\text{Mn} \rightarrow \text{Mn}^{2+} + 2\text{e}^{-}$
- (2) $\text{Mn}^{2+} \rightarrow 2\text{e}^{-} + \text{Mn}$
- (3) $\text{Ag} + \text{e}^{-} \rightarrow \text{Ag}^{+}$
- (4) $\text{Ag}^{+} + \text{e}^{-} \rightarrow \text{Ag}$

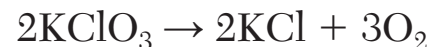
46 Given the ionic equation for a reaction:



How many moles of electrons are gained by the $\text{Sn}^{2+}(\text{aq})$ when the Zn(s) loses 2.0 moles of electrons?

- (1) 1.0 mol
- (2) 2.0 mol
- (3) 3.0 mol
- (4) 4.0 mol

47 Given the equation representing a reaction:



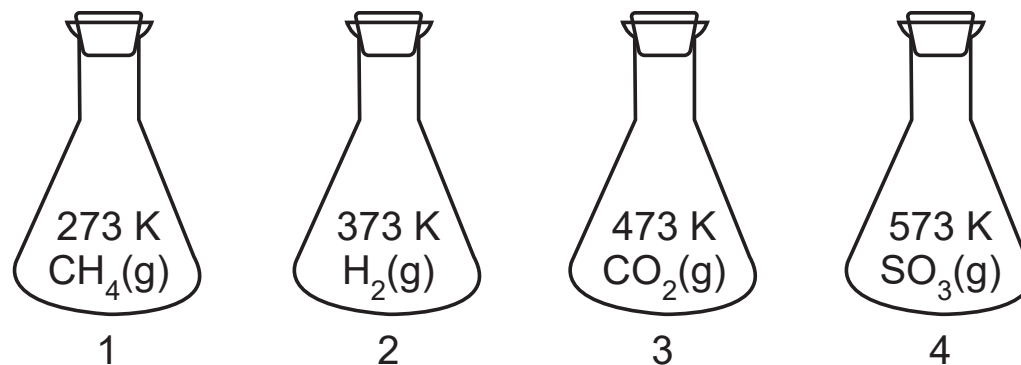
During this reaction, the oxidation number of oxygen changes from

- (1) -2 to 0
- (2) -3 to 0
- (3) $+3$ to -2
- (4) -2 to $+6$

48 Which equation represents the reaction that releases the greatest amount of energy per mole of reactant?

- (1) $\text{H}_2\text{O(g)} \rightarrow \text{H}_2\text{O(s)} + \text{energy}$
- (2) $\text{C}_2\text{H}_4(\text{g}) \rightarrow 2\text{C(s)} + 2\text{H}_2(\text{g}) + \text{energy}$
- (3) $2\text{NO(g)} \rightarrow \text{N}_2(\text{g}) + \text{O}_2(\text{g}) + \text{energy}$
- (4) ${}^{235}_{92}\text{U} + {}^1_0\text{n} \rightarrow {}^{141}_{56}\text{Ba} + {}^{92}_{36}\text{Kr} + 3{}^1_0\text{n} + \text{energy}$

49 Given a diagram representing four 500.-mL flasks, each filled with a different gas at 1 atm:



Which flask contains the same number of molecules as a 500.-mL flask of ammonia gas, NH₃(g), at 373 K and 1 atm?

(1) 1

(2) 2

(3) 3

(4) 4

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50 The table below lists two properties of selected unidentified elements.

Properties of Selected Elements

Unidentified Element	First Ionization Energy (kJ/mol)	Electronegativity
A	1312	2.2
E	1251	3.2
G	1008	2.7
J	403	0.8

Based on this table, an atom of which unidentified element has the strongest attraction for electrons in a chemical bond?

(1) *A*

(2) *E*

(3) *G*

(4) *J*

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*.

- 51 Determine the amount of heat absorbed when a 50.0-gram sample of H_2O is heated from 20.0°C to 60.0°C . [1]

Base your answers to questions 52 through 54 on the information below and on your knowledge of chemistry.

When a rubidium salt solution is heated during a flame test, colored light is produced. Rubidium has two naturally occurring isotopes, Rb-85 and Rb-87. The atomic mass and natural abundance of these rubidium isotopes are shown in the table below.

Data for the Two Isotopes of Rubidium

Isotope	Atomic Mass (u)	Natural Abundance (%)
Rb-85	84.91	72.17
Rb-87	86.91	27.83

- 52 Draw a Lewis electron-dot diagram for an atom of rubidium in the ground state. [1]
- 53 Show a numerical setup for calculating the atomic mass of rubidium. [1]
- 54 State, in terms of excited electrons, how the rubidium emits colored light during the flame test. [1]

Base your answers to questions 55 through 57 on the information below and on your knowledge of chemistry.

A 2.50-liter sample of helium gas in a sealed, rigid cylinder with a movable piston is at 298 K and 125 kPa.

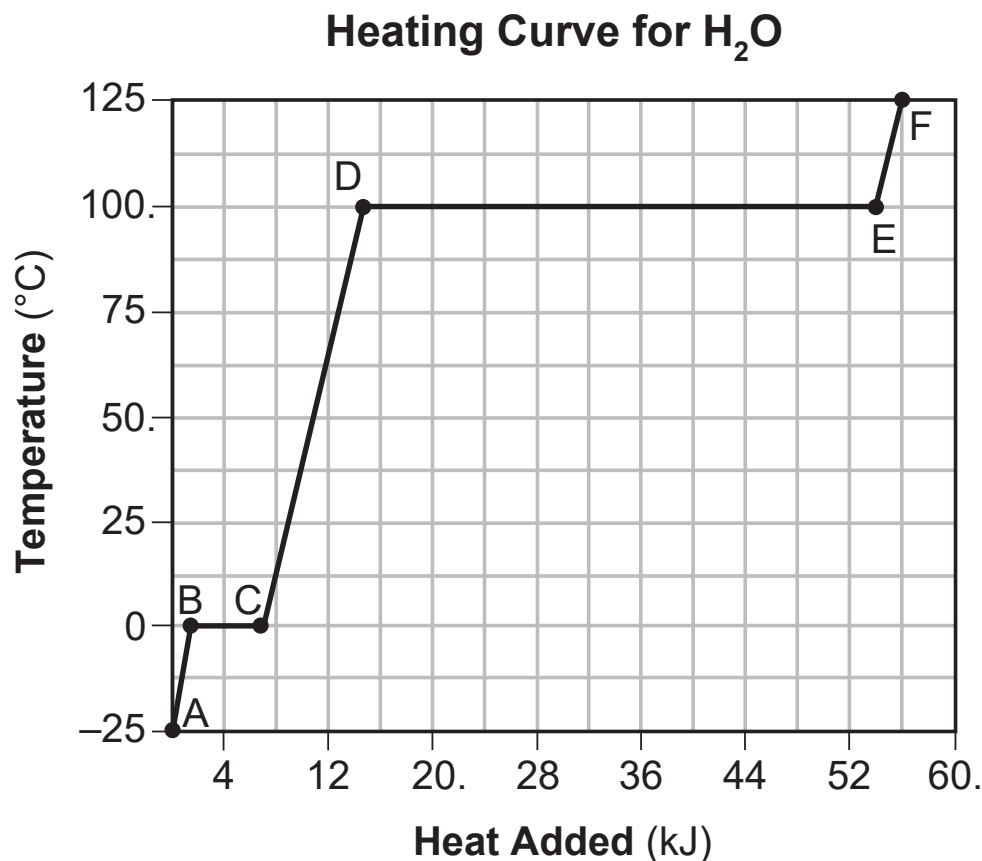
55 Compare the mass of the original 2.50-liter sample of helium to the mass of the helium gas when the piston is pushed farther into the cylinder. [1]

56 State a change in temperature and a change in pressure of the sample of helium that would cause this gas to behave more like an ideal gas. [1]

57 Determine the volume of the sample of helium at STP. [1]

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

The graph below represents the relationship between temperature and heat added as a sample of $\text{H}_2\text{O(s)}$ at -25°C is heated at standard pressure until the sample reaches 125°C .

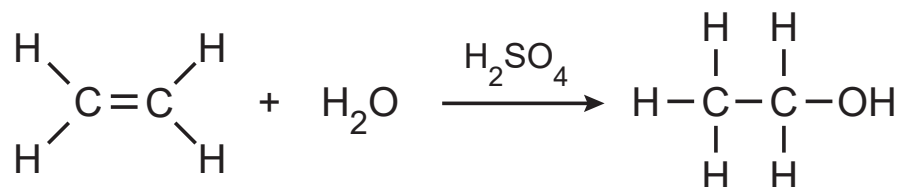


58 Identify the physical change that occurs during interval BC . [1]

59 State what happens to the potential energy of the molecules in the sample during interval DE . [1]

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

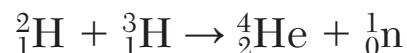
Ethanol is a very important industrial solvent. The equation below represents ethene reacting with water, using H_2SO_4 as a catalyst, to produce ethanol.



- 60 Based on Table *R*, write the name of the class of compounds to which ethanol belongs. [1]
- 61 State, in terms of carbon-carbon bonds, why the ethene is an unsaturated organic compound. [1]
- 62 State, in terms of the arrangement of atoms and molecular formulas, why dimethyl ether, CH_3OCH_3 , is an isomer of the ethanol in the equation. [1]
-

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

Three isotopes of hydrogen are H-1, H-2, and H-3. At extremely high temperatures, the H-2 and H-3 can fuse with each other as represented in the equation below.



- 63 Based on Table N, determine the original mass of a sample of H-3, if 2.0 milligrams of the original sample remain unchanged after 36.93 years. [1]
- 64 Based on Table N, identify the decay mode particle spontaneously emitted from an H-3 nuclide. [1]
- 65 Complete the equation *in your answer booklet* for the nuclear reaction between H-1 and H-2 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*.

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

On a space shuttle, there was a system to remove CO_2 from the air the astronauts breathed. The system used contaminant control cartridges, which each held a quantity of LiOH that was able to absorb 660 grams of CO_2 . The balanced equation below represents the reaction that occurs in a control cartridge.



- 66 Write a chemical name for the solid product in the equation. [1]
- 67 Determine the number of moles of LiOH that react completely to produce 6.0 moles of Li_2CO_3 in the contaminant control cartridge. [1]
- 68 Show a numerical setup for calculating the gram-formula mass of LiOH . [1]
- 69 Determine the number of moles of CO_2 in a 660-gram sample of CO_2 (gram-formula mass = 44 g/mol). [1]

Base your answers to questions 70 through 73 on the information below and on your knowledge of chemistry.

Seawater covers more than 70% of the surface of Earth. There are many dissolved ions in seawater. A list of the mass in grams for selected ions found in a 1000.-gram sample of seawater is shown in the table below.

Selected Ions in Seawater

Ion	Grams of Ion per 1000. Grams of Seawater
Mg^{2+}	1.139
HCO_3^-	0.085
Br^-	0.067
Ca^{2+}	0.056

- 70 Based on Table *F*, identify the seawater ion in the table above that will react with Ag^+ ions to form an insoluble compound. [1]
- 71 Determine the concentration of dissolved calcium ions in the seawater sample in parts per million. [1]
- 72 At standard pressure, compare the freezing point of the sample of seawater to the freezing point of a sample of $\text{H}_2\text{O}(\ell)$. [1]
- 73 Using the key in *your answer booklet*, draw *two* water molecules in the box, showing the orientation of *each* water molecule toward the magnesium ion. [1]

Base your answers to questions 74 through 77 on the information below and on your knowledge of chemistry.

Calcium hypochlorite, $\text{Ca}(\text{ClO})_2$, is added to swimming pools, in tablet or powdered form, to control bacteria. This disinfectant reacts with water to produce hypochlorous acid, $\text{HClO}(\text{aq})$, as shown in balanced equation 1 below.



In a closed system, hypochlorous acid and water reach an equilibrium as shown in equation 2 below.



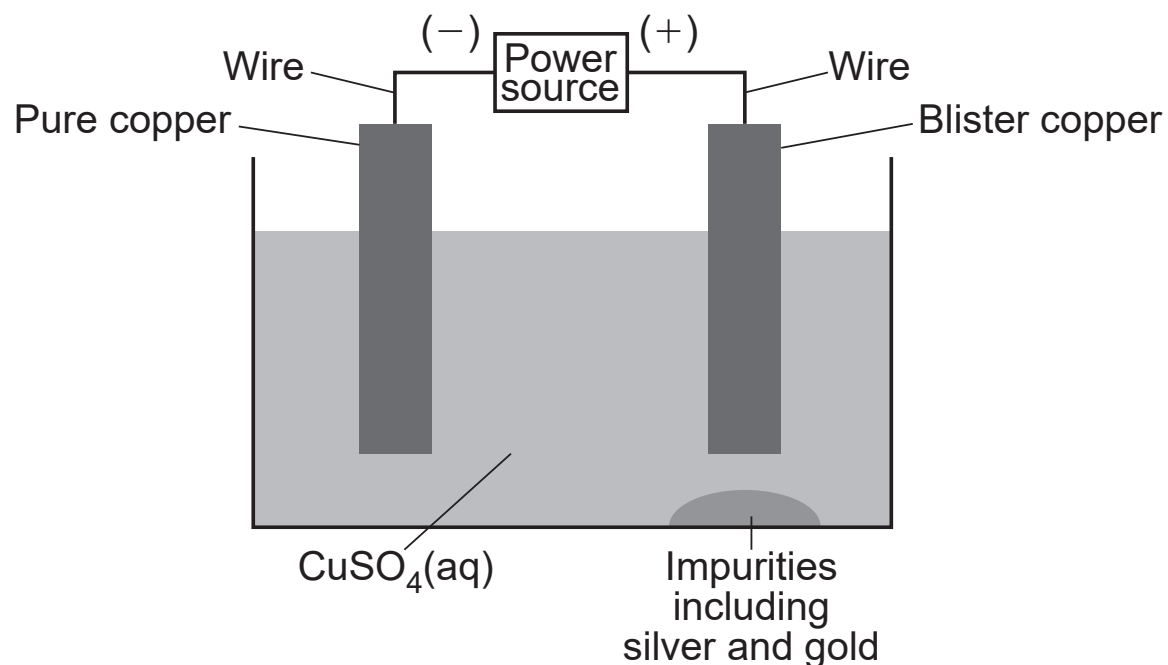
- 74 Compare the rate of the reaction using a $\text{Ca}(\text{ClO})_2$ tablet to the rate of the reaction using the same mass of powdered $\text{Ca}(\text{ClO})_2$ for the reaction in equation 1. [1]
- 75 On the labeled axes *in your answer booklet*, draw a potential energy diagram for the reaction represented by equation 1. [1]
- 76 Compare the rate of the forward reaction to the rate of the reverse reaction when the system represented by equation 2 reached equilibrium. [1]
- 77 State what happens to the concentration of $\text{HClO}(\text{aq})$ in equation 2 when the concentration of the $\text{ClO}^{-}(\text{aq})$ is increased. [1]

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Base your answers to questions 78 through 80 on the information below and on your knowledge of chemistry.

To produce copper, ores such as chalcopyrite, CuFeS_2 , are processed into impure copper electrodes called “blister copper.” During the final reaction in the process, an electrolytic cell contains a blister copper electrode, a pure copper electrode, and an aqueous solution of copper(II) sulfate. The $\text{Cu}^{2+}(\text{aq})$ ions in the solution form Cu atoms on the pure copper electrode. Impurities in the blister copper, such as silver and gold, settle to the bottom of the operating cell as represented in the diagram below.



- 78 Show a numerical setup for calculating the percent composition by mass of copper in chalcopyrite, CuFeS_2 (gram-formula mass = 183.5 g/mol). [1]
- 79 Write a balanced half-reaction equation that shows $\text{Cu}^{2+}(\text{aq})$ ions forming $\text{Cu}(\text{s})$ atoms. [1]
- 80 Based on Table *J*, explain why silver and gold atoms in the impurities are unreacted atoms in the electrolytic cell. [1]
-

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Base your answers to questions 81 through 85 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 0.10 M KOH(aq) solution with a pH value of 13.00 was used to determine the unknown molarity of an HCl(aq) solution. During one trial, a 15.0-milliliter sample of the HCl(aq) solution was exactly neutralized by 19.5 milliliters of the KOH(aq) solution.

- 81 State the color of the indicator litmus if it is added to a sample of the KOH(aq) solution. [1]
- 82 Determine the pH value of a solution that has a $\text{H}^+(\text{aq})$ ion concentration 100. times greater than the original KOH(aq) solution. [1]
- 83 Complete the equation *in your answer booklet* for the reaction by writing the formula of the missing product. [1]
- 84 Using the laboratory data, determine the concentration of the HCl(aq) solution. [1]
- 85 State why it is better to use data from multiple trials to determine the concentration of the hydrochloric acid, rather than data from only one trial. [1]
-

