

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

**PHYSICAL SETTING
CHEMISTRY**

Tuesday, June 17, 2008 — 1:15 to 4:15 p.m., only

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 *Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in the examination booklet.

Your answer sheet for Part A and Part B–1 is the last page of this examination booklet. Turn to the last page and fold it along the perforations. Then, slowly and carefully, tear off your answer sheet and fill in the heading.

The answers to the questions in Part B–2 and Part C are to be written in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

Record the number of your choice for each Part A and Part B–1 multiple-choice question on your separate answer sheet. Write your answers to the Part B–2 and Part C questions in your answer booklet. All work 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 and in your answer booklet.

When you have completed the examination, you must sign the statement printed at the end of 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 *Reference Tables for Physical Setting/Chemistry* must be available for you to use while taking this examination.

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

DO NOT OPEN THIS EXAMINATION BOOKLET UNTIL THE SIGNAL IS GIVEN.

Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, write on the 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 *Reference Tables for Physical Setting/Chemistry*.

- 1 An atom in the ground state has seven valence electrons. This atom could be an atom of which element?
(1) calcium (3) oxygen
(2) fluorine (4) sodium
- 2 What is the total number of electrons in an atom of potassium?
(1) 18 (3) 20
(2) 19 (4) 39
- 3 A proton has a charge that is opposite the charge of
(1) an alpha particle (3) an electron
(2) a neutron (4) a positron
- 4 Which conclusion was a direct result of the gold foil experiment?
(1) An atom is mostly empty space with a dense, positively charged nucleus.
(2) An atom is composed of at least three types of subatomic particles.
(3) An electron has a positive charge and is located inside the nucleus.
(4) An electron has properties of both waves and particles.
- 5 Which statement identifies the element arsenic?
(1) Arsenic has an atomic number of 33.
(2) Arsenic has a melting point of 84 K.
(3) An atom of arsenic in the ground state has eight valence electrons.
(4) An atom of arsenic in the ground state has a radius of 146 pm.
- 6 Which element has an atom with the greatest attraction for electrons in a chemical bond?
(1) As (3) N
(2) Bi (4) P
- 7 Given the balanced equation representing a reaction:
$$\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell) + \text{energy}$$

In this reaction there is conservation of
(1) mass, only
(2) mass and charge, only
(3) charge and energy, only
(4) charge, energy, and mass
- 8 Which statement describes the composition of potassium chlorate, KClO_3 ?
(1) The proportion by mass of elements combined in potassium chlorate is fixed.
(2) The proportion by mass of elements combined in potassium chlorate varies.
(3) Potassium chlorate is composed of four elements.
(4) Potassium chlorate is composed of five elements.
- 9 As a bond between a hydrogen atom and a sulfur atom is formed, electrons are
(1) shared to form an ionic bond
(2) shared to form a covalent bond
(3) transferred to form an ionic bond
(4) transferred to form a covalent bond
- 10 Atoms of which element can bond to each other to form chains, rings, and networks?
(1) carbon (3) hydrogen
(2) fluorine (4) oxygen
- 11 Which formula represents a polar molecule?
(1) Br_2 (3) CH_4
(2) CO_2 (4) NH_3

- 12 Two solid samples each contain sulfur, oxygen, and sodium, only. These samples have the same color, melting point, density, and reaction with an aqueous barium chloride solution. It can be concluded that the two samples are the same
- (1) compound
 - (2) element
 - (3) mixture
 - (4) solution
- 13 Which equation represents a physical change?
- (1) $\text{H}_2\text{O}(s) + 6.01 \text{ kJ} \rightarrow \text{H}_2\text{O}(\ell)$
 - (2) $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{g}) + 483.6 \text{ kJ}$
 - (3) $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) + 53.0 \text{ kJ} \rightarrow 2\text{HI}(\text{g})$
 - (4) $\text{N}_2(\text{g}) + 2\text{O}_2(\text{g}) + 66.4 \text{ kJ} \rightarrow 2\text{NO}_2(\text{g})$
- 14 Which liquid has the *lowest* vapor pressure at 65°C ?
- (1) ethanoic acid
 - (2) ethanol
 - (3) propanone
 - (4) water
- 15 Which substance can *not* be broken down by a chemical reaction?
- (1) ammonia
 - (2) argon
 - (3) methane
 - (4) water
- 16 In which sample is the average kinetic energy of the particles greatest?
- (1) 10. mL of $\text{HCl}(\text{aq})$ at 25°C
 - (2) 15 mL of $\text{HCl}(\text{aq})$ at $20.^\circ\text{C}$
 - (3) 10. mL of $\text{H}_2\text{O}(\ell)$ at 35°C
 - (4) 15 mL of $\text{H}_2\text{O}(\ell)$ at $30.^\circ\text{C}$
- 17 A thermometer is in a beaker of water. Which statement best explains why the thermometer reading initially increases when $\text{LiBr}(s)$ is dissolved in the water?
- (1) The entropy of the $\text{LiBr}(\text{aq})$ is greater than the entropy of the water.
 - (2) The entropy of the $\text{LiBr}(\text{aq})$ is less than the entropy of the water.
 - (3) The dissolving of the $\text{LiBr}(s)$ in water is an endothermic process.
 - (4) The dissolving of the $\text{LiBr}(s)$ in water is an exothermic process.
- 18 Which process increases the potential energy of the particles of a sample?
- (1) condensation
 - (2) deposition
 - (3) solidification
 - (4) vaporization
- 19 Which sample at STP has the same number of molecules as 5 liters of $\text{NO}_2(\text{g})$ at STP?
- (1) 5 grams of $\text{H}_2(\text{g})$
 - (2) 5 liters of $\text{CH}_4(\text{g})$
 - (3) 5 moles of $\text{O}_2(\text{g})$
 - (4) 5×10^{23} molecules of $\text{CO}_2(\text{g})$
- 20 Under which conditions of temperature and pressure does oxygen gas behave *least* like an ideal gas?
- (1) low temperature and low pressure
 - (2) low temperature and high pressure
 - (3) high temperature and low pressure
 - (4) high temperature and high pressure
- 21 How is a chemical reaction affected by the addition of a catalyst?
- (1) The activation energy decreases.
 - (2) The heat of reaction increases.
 - (3) The number of collisions between particles decreases.
 - (4) The potential energy of the reactants increases.
- 22 Systems in nature tend to undergo changes toward
- (1) lower energy and less disorder
 - (2) lower energy and more disorder
 - (3) higher energy and less disorder
 - (4) higher energy and more disorder
- 23 What can be concluded if an ion of an element is *smaller* than an atom of the same element?
- (1) The ion is negatively charged because it has fewer electrons than the atom.
 - (2) The ion is negatively charged because it has more electrons than the atom.
 - (3) The ion is positively charged because it has fewer electrons than the atom.
 - (4) The ion is positively charged because it has more electrons than the atom.

- 24 Which class of organic compounds has molecules that contain nitrogen atoms?
(1) alcohol (3) ether
(2) amine (4) ketone
- 25 Which two compounds have the same molecular formula but different chemical and physical properties?
(1) $\text{CH}_3\text{CH}_2\text{Cl}$ and $\text{CH}_3\text{CH}_2\text{Br}$
(2) CH_3CHCH_2 and $\text{CH}_3\text{CH}_2\text{CH}_3$
(3) CH_3CHO and CH_3COCH_3
(4) $\text{CH}_3\text{CH}_2\text{OH}$ and CH_3OCH_3
- 26 Which half-reaction equation represents the reduction of a potassium ion?
(1) $\text{K}^+ + \text{e}^- \rightarrow \text{K}$ (3) $\text{K}^+ \rightarrow \text{K} + \text{e}^-$
(2) $\text{K} + \text{e}^- \rightarrow \text{K}^+$ (4) $\text{K} \rightarrow \text{K}^+ + \text{e}^-$
- 27 According to the Arrhenius theory, an acid is a substance that
(1) changes litmus from red to blue
(2) changes phenolphthalein from colorless to pink
(3) produces hydronium ions as the only positive ions in an aqueous solution
(4) produces hydroxide ions as the only negative ions in an aqueous solution
- 28 Which type of reaction occurs when a high-energy particle collides with the nucleus of an atom, converting that atom to an atom of a different element?
(1) addition (3) substitution
(2) neutralization (4) transmutation
- 29 Which particle is emitted when an atom of ^{85}Kr spontaneously decays?
(1) an alpha particle (3) a neutron
(2) a beta particle (4) a proton
- 30 What is a problem commonly associated with nuclear power facilities?
(1) A small quantity of energy is produced.
(2) Reaction products contribute to acid rain.
(3) It is impossible to control nuclear fission.
(4) It is difficult to dispose of wastes.
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Part B-1

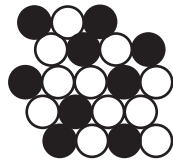
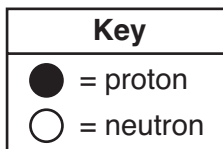
Answer all questions in this part.

Directions (31–50): For each statement or question, write on the 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 *Reference Tables for Physical Setting/Chemistry*.

- 31 The wave-mechanical model of the atom is required to explain the
- (1) mass number and atomic number of an atom
 - (2) organization of atoms in a crystal
 - (3) radioactive nature of some atoms
 - (4) spectra of elements with multielectron atoms

- 32 Magnesium and calcium have similar chemical properties because an atom of each element has the same total number of
- (1) electron shells
 - (2) valence electrons
 - (3) neutrons
 - (4) protons

- 33 The diagram below represents the nucleus of an atom.

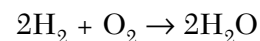


What are the atomic number and mass number of this atom?

- (1) The atomic number is 9 and the mass number is 19.
 - (2) The atomic number is 9 and the mass number is 20.
 - (3) The atomic number is 11 and the mass number is 19.
 - (4) The atomic number is 11 and the mass number is 20.
- 34 A barium atom attains a stable electron configuration when it bonds with
- (1) one chlorine atom
 - (2) two chlorine atoms
 - (3) one sodium atom
 - (4) two sodium atoms

- 35 A student measures the mass and volume of a piece of aluminum. The measurements are 25.6 grams and 9.1 cubic centimeters. The student calculates the density of the aluminum. What is the percent error of the student's calculated density of aluminum?
- (1) 1%
 - (2) 2%
 - (3) 3%
 - (4) 4%

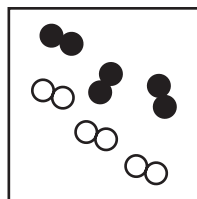
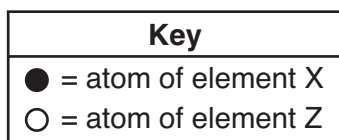
- 36 Given the balanced equation representing a reaction:



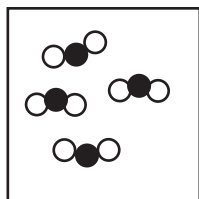
What is the total mass of water formed when 8 grams of hydrogen reacts completely with 64 grams of oxygen?

- (1) 18 g
 - (2) 36 g
 - (3) 56 g
 - (4) 72 g
- 37 Which compound contains both ionic and covalent bonds?
- (1) ammonia
 - (2) methane
 - (3) sodium nitrate
 - (4) potassium chloride
- 38 An iron bar at 325 K is placed in a sample of water. The iron bar gains energy from the water if the temperature of the water is
- (1) 65 K
 - (2) 45 K
 - (3) 65°C
 - (4) 45°C

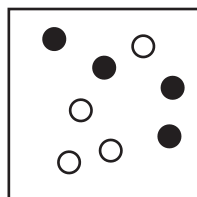
- 39 Which particle model diagram represents only one compound composed of elements X and Z?



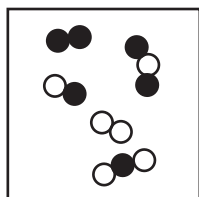
(1)



(3)



(2)



(4)

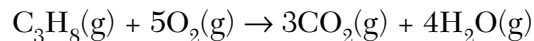
- 40 Given the balanced equation representing a reaction:



Which statement explains why the energy term is written to the right of the arrow?

- (1) The compound CuS is composed of two metals.
 - (2) The compound CuS is composed of two nonmetals.
 - (3) Energy is absorbed as the bonds in CuS form.
 - (4) Energy is released as the bonds in CuS form.
- 41 A 1.0-gram sample of which element will uniformly fill a closed 2.0-liter container at STP?
- (1) antimony
 - (2) sulfur
 - (3) tellurium
 - (4) xenon

- 42 Given the balanced equation representing a reaction:



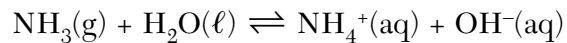
What is the total number of moles of $\text{O}_2(\text{g})$ required for the complete combustion of 1.5 moles of $\text{C}_3\text{H}_8(\text{g})$?

- (1) 0.30 mol
 - (2) 1.5 mol
 - (3) 4.5 mol
 - (4) 7.5 mol
- 43 A sample of gas occupies a volume of 50.0 milliliters in a cylinder with a movable piston. The pressure of the sample is 0.90 atmosphere and the temperature is 298 K. What is the volume of the sample at STP?
- (1) 41 mL
 - (2) 49 mL
 - (3) 51 mL
 - (4) 55 mL
- 44 Which solution has the *lowest* freezing point?
- (1) 10. g of KI dissolved in 100. g of water
 - (2) 20. g of KI dissolved in 200. g of water
 - (3) 30. g of KI dissolved in 100. g of water
 - (4) 40. g of KI dissolved in 200. g of water
- 45 Which 1-mole sample has the *least* entropy?
- (1) $\text{Br}_2(\text{s})$ at 266 K
 - (2) $\text{Br}_2(\ell)$ at 266 K
 - (3) $\text{Br}_2(\ell)$ at 332 K
 - (4) $\text{Br}_2(\text{g})$ at 332 K
- 46 At 20.°C, a 1.2-gram sample of Mg ribbon reacts rapidly with 10.0 milliliters of 1.0 M HCl(aq). Which change in conditions would have caused the reaction to proceed more slowly?
- (1) increasing the initial temperature to 25°C
 - (2) decreasing the concentration of HCl(aq) to 0.1 M
 - (3) using 1.2 g of powdered Mg
 - (4) using 2.4 g of Mg ribbon
- 47 Which general formula represents the compound $\text{CH}_3\text{CH}_2\text{CCH}_3$?
- (1) C_nH_n
 - (2) C_nH_{2n}
 - (3) $\text{C}_n\text{H}_{2n-2}$
 - (4) $\text{C}_n\text{H}_{2n+2}$

48 Which compound dissolves in water to form an aqueous solution that can conduct an electric current?

- (1) CCl_4 (3) CH_3COOH
(2) $\text{C}_2\text{H}_5\text{OH}$ (4) CH_4

49 Given the equation representing a reaction at equilibrium:



The H^+ acceptor for the forward reaction is

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

50 An original sample of K-40 has a mass of 25.00 grams. After 3.9×10^9 years, 3.125 grams of the original sample remains unchanged. What is the half-life of K-40?

- (1) 1.3×10^9 y (3) 3.9×10^9 y
(2) 2.6×10^9 y (4) 1.2×10^{10} y

Part B–2

Answer all questions in this part.

Directions (51–64): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

Base your answers to questions 51 and 52 on the information below.

In a titration, 15.65 milliliters of a KOH(aq) solution exactly neutralized 10.00 milliliters of a 1.22 M HCl(aq) solution.

- 51 Complete the equation *in your answer booklet* for the titration reaction by writing the formula of *each* product. [1]
- 52 In the space *in your answer booklet*, show a correct numerical setup for calculating the molarity of the KOH(aq) solution. [1]
-

Base your answers to questions 53 through 55 on the information below.

A 150.-gram liquid sample of stearic acid, C₁₇H₃₅COOH, is cooled at a constant rate. The temperature of the sample is recorded at 2-minute intervals in the data table below.

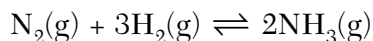
Cooling Data for Stearic Acid

Time (min)	Temperature (°C)
0	75.0
2	72.0
4	69.3
6	69.3
8	69.3
10.	69.3
12	65.0

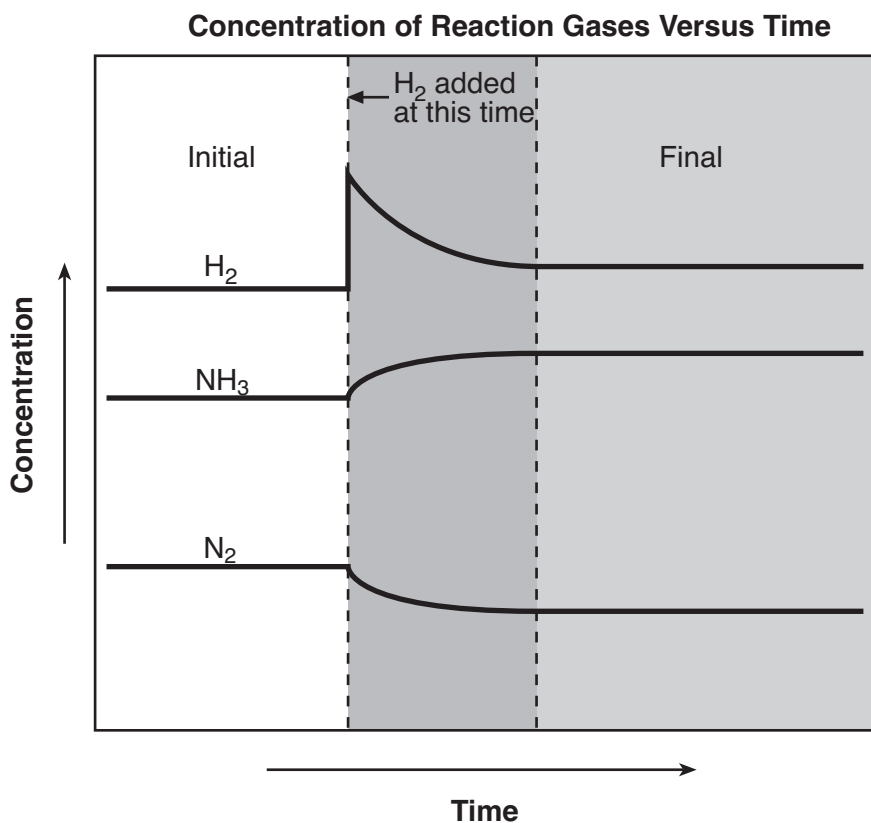
- 53 Identify the physical change occurring during the time interval 4 minutes to 10. minutes. [1]
- 54 On the grid *in your answer booklet*:
- Mark an appropriate scale on the axis labeled “Temperature (°C).” [1]
 - Plot the data from the data table. Circle and connect the points. [1]
- 55 Determine the gram-formula mass of stearic acid. [1]
-

Base your answers to questions 62 through 64 on the information below.

Nitrogen gas, hydrogen gas, and ammonia gas are in equilibrium in a closed container at constant temperature and pressure. The equation below represents this equilibrium.



The graph below shows the initial concentration of each gas, the changes that occur as a result of adding $\text{H}_2(\text{g})$ to the system, and the final concentrations when equilibrium is reestablished.



- 62 What information on the graph indicates that the system was initially at equilibrium? [1]
- 63 Explain, in terms of LeChatelier's principle, why the final concentration of $\text{NH}_3(\text{g})$ is greater than the initial concentration of $\text{NH}_3(\text{g})$. [1]
- 64 Explain, in terms of collision theory, why the concentration of $\text{H}_2(\text{g})$ begins to *decrease* immediately after more $\text{H}_2(\text{g})$ is added to the system. [1]
-

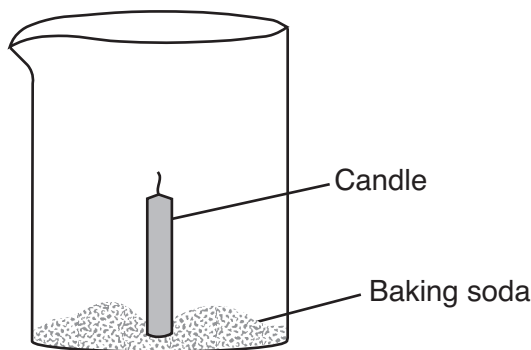
Part C

Answer all questions in this part.

Directions (65–79): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

Base your answers to questions 65 through 67 on the information below.

An unlit candle is secured to the bottom of a 200-milliliter glass beaker. Baking soda (sodium hydrogen carbonate) is added around the base of the candle as shown below.



The candle is lit and dilute ethanoic acid is poured down the inside of the beaker. As the acid reacts with the baking soda, bubbles of CO_2 gas form. After a few seconds, the air in the beaker is replaced by 0.20 liter of CO_2 gas, causing the candle flame to go out. The density of CO_2 gas is 1.8 grams per liter at room temperature.

- 65 Write the chemical formula for baking soda. [1]
- 66 In the space *in your answer booklet*, draw a structural formula for the acid that was poured into the beaker. [1]
- 67 Calculate the mass of the CO_2 gas that replaced the air in the beaker. Your response must include *both* a correct numerical setup and the calculated result. [2]
-

Base your answers to questions 68 through 71 on the information below.

The health of fish depends on the amount of oxygen dissolved in the water. A dissolved oxygen (DO) concentration between 6 parts per million and 8 parts per million is best for fish health. A DO concentration greater than 1 part per million is necessary for fish survival.

Fish health is also affected by water temperature and concentrations of dissolved ammonia, hydrogen sulfide, chloride compounds, and nitrate compounds. Most freshwater fish thrive in water with a pH between 6.5 and 8.5.

A student's fish tank contains fish, green plants, and 3800 grams of fish-tank water with 2.7×10^{-2} gram of dissolved oxygen. Phenolphthalein tests colorless and bromthymol blue tests blue in samples of the fish-tank water.

- 68 Based on the test results for the indicators phenolphthalein and bromthymol blue, what is the pH range of the fish-tank water? [1]
- 69 When the fish-tank water has a pH of 8.0, the hydronium ion concentration is 1.0×10^{-8} mole per liter. What is the hydronium ion concentration when the water has a pH of 7.0? [1]
- 70 State how an increase in the temperature of the fish-tank water affects the solubility of oxygen in the water. [1]
- 71 Determine if the DO concentration in the fish tank is healthy for fish. Your response must include:
- a correct numerical setup to calculate the DO concentration in the water in parts per million [1]
 - the calculated result [1]
 - a statement using your calculated result that tells why the DO concentration in the water is or is not healthy for fish [1]
-

Base your answers to questions 72 and 73 on the information below.

The Balmer series refers to the visible bright lines in the spectrum produced by hydrogen atoms. The color and wavelength of each line in this series are given in the table below.

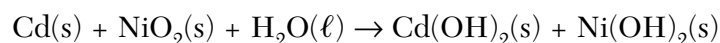
Balmer Series for Hydrogen

Color	Wavelength (nm)
red	656.3
blue green	486.1
blue	434.1
violet	410.2

- 72 On the diagram *in your answer booklet*, draw *four* vertical lines to represent the Balmer series. [1]
- 73 Explain, in terms of *both* subatomic particles and energy states, how the Balmer series is produced. [1]
-

Base your answers to questions 74 through 76 on the information below.

A flashlight can be powered by a rechargeable nickel-cadmium battery. In the battery, the anode is Cd(s) and the cathode is NiO₂(s). The unbalanced equation below represents the reaction that occurs as the battery produces electricity. When a nickel-cadmium battery is recharged, the reverse reaction occurs.



- 74 Balance the equation *in your answer booklet* for the reaction that produces electricity, using the smallest whole-number coefficients. [1]
- 75 Determine the change in oxidation number for the element that makes up the anode in the reaction that produces electricity. [1]
- 76 Explain why Cd would be above Ni if placed on Table J. [1]
-

Base your answers to questions 77 through 79 on the information below.

A battery-operated smoke detector produces an alarming sound when its electrical sensor detects smoke particles. Some ionizing smoke detectors contain the radioisotope americium-241, which undergoes alpha decay and has a half-life of 433 years. The emitted alpha particles ionize gas molecules in the air. As a result, an electric current flows through the detector. When smoke particles enter the detector, the flow of ions is interrupted, causing the alarm to sound.

- 77 Complete the nuclear equation *in your answer booklet* for the decay of Am-241. Your response must include the symbol, mass number, and atomic number for *each* product. [2]
- 78 State *one* scientific reason why Am-241 is a more appropriate radioactive source than Fr-220 in an ionizing smoke detector. [1]
- 79 Explain, in terms of particle behavior, why smoke particles cause the detector alarm to sound. [1]
-

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Tuesday, June 17, 2008 — 1:15 to 4:15 p.m., only

ANSWER SHEET

Student Sex: Male Female Grade

Teacher School

Record your answers to Part A and Part B-1 on this answer sheet.

Part A

- 1 11 21
2 12 22
3 13 23
4 14 24
5 15 25
6 16 26
7 17 27
8 18 28
9 19 29
10 20 30

Part A Score

[Box for Part A Score]

Part B-1

- 31 41
32 42
33 43
34 44
35 45
36 46
37 47
38 48
39 49
40 50

Part B-1 Score

[Box for Part B-1 Score]

Write your answers to Part B-2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

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