

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

PHYSICAL SETTING CHEMISTRY

Wednesday, August 13, 2003 — 12:30 to 3:30 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 your use while taking this examination.

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

Part A

Answer all questions in this part.

Directions (1–35): 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*.

- Which electron transition represents a gain of energy?
 - from 2nd to 3rd shell
 - from 2nd to 1st shell
 - from 3rd to 2nd shell
 - from 3rd to 1st shell
- Which particles are found in the nucleus of an atom?
 - electrons, only
 - neutrons, only
 - protons and electrons
 - protons and neutrons
- What is the total number of valence electrons in an atom of sulfur in the ground state?
 - 6
 - 8
 - 3
 - 4
- An electron has a charge of
 - 1 and the same mass as a proton
 - +1 and the same mass as a proton
 - 1 and a smaller mass than a proton
 - +1 and a smaller mass than a proton
- The elements in the Periodic Table are arranged in order of increasing
 - atomic number
 - atomic radius
 - mass number
 - neutron number
- What is the correct IUPAC name for the compound NH_4Cl ?
 - nitrogen chloride
 - nitrogen chlorate
 - ammonium chloride
 - ammonium chlorate
- Which element is a solid at STP?
 - H_2
 - I_2
 - N_2
 - O_2
- In which compound is the percent by mass of oxygen greatest?
 - BeO
 - MgO
 - CaO
 - SrO
- Based on Reference Table *F*, which of these salts is the best electrolyte?
 - sodium nitrate
 - magnesium carbonate
 - silver chloride
 - barium sulfate
- What is conserved during a chemical reaction?
 - mass, only
 - charge, only
 - both mass and charge
 - neither mass nor charge
- Which type of bond is formed when electrons are transferred from one atom to another?
 - covalent
 - ionic
 - hydrogen
 - metallic
- Which Lewis electron-dot structure is drawn correctly for the atom it represents?
 - $\text{:}\ddot{\text{N}}$
 - $\text{:}\ddot{\text{F}}$
 - $\text{:}\ddot{\text{O}}$
 - $\text{:}\ddot{\text{Ne}}$

- 13 What occurs when an atom of chlorine forms a chloride ion?
- (1) The chlorine atom gains an electron, and its radius becomes smaller.
 - (2) The chlorine atom gains an electron, and its radius becomes larger.
 - (3) The chlorine atom loses an electron, and its radius becomes smaller.
 - (4) The chlorine atom loses an electron, and its radius becomes larger.

- 14 Which substance can *not* be decomposed by a chemical change?
- (1) Ne
 - (2) N₂O
 - (3) HF
 - (4) H₂O

- 15 Which of these substances has the strongest intermolecular forces?
- (1) H₂O
 - (2) H₂S
 - (3) H₂Se
 - (4) H₂Te

- 16 A real gas behaves more like an ideal gas when the gas molecules are
- (1) close and have strong attractive forces between them
 - (2) close and have weak attractive forces between them
 - (3) far apart and have strong attractive forces between them
 - (4) far apart and have weak attractive forces between them

- 17 Which phase change is an exothermic process?
- (1) CO₂(s) → CO₂(g)
 - (2) NH₃(g) → NH₃(ℓ)
 - (3) Cu(s) → Cu(ℓ)
 - (4) Hg(ℓ) → Hg(g)

- 18 Which of these contains only one substance?
- (1) distilled water
 - (2) sugar water
 - (3) saltwater
 - (4) rainwater

- 19 In which group of the Periodic Table do most of the elements exhibit both positive and negative oxidation states?
- (1) 17
 - (2) 2
 - (3) 12
 - (4) 7

- 20 At the same temperature and pressure, 1.0 liter of CO(g) and 1.0 liter of CO₂(g) have
- (1) equal masses and the same number of molecules
 - (2) different masses and a different number of molecules
 - (3) equal volumes and the same number of molecules
 - (4) different volumes and a different number of molecules

- 21 Which type of reaction occurs when nonmetal atoms become negative nonmetal ions?
- (1) oxidation
 - (2) reduction
 - (3) substitution
 - (4) condensation

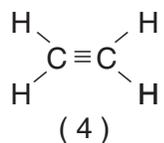
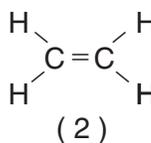
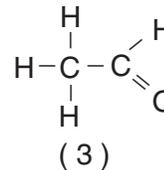
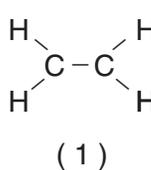
- 22 Given the reaction:



Once equilibrium is reached, which statement is accurate?

- (1) The concentration of Ag⁺(aq) is greater than the concentration of Cl⁻(aq).
- (2) The AgCl(s) will be completely consumed.
- (3) The rates of the forward and reverse reactions are equal.
- (4) The entropy of the forward reaction will continue to decrease.

- 23 Which structural formula *correctly* represents a hydrocarbon molecule?



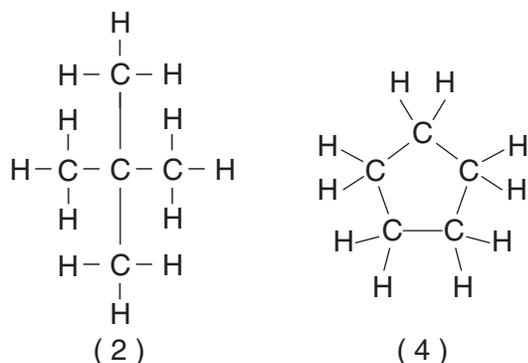
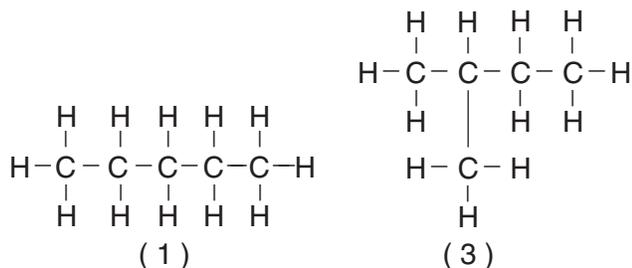
24 Given the structural formulas for two organic compounds:



The differences in their physical and chemical properties are primarily due to their different

- (1) number of carbon atoms
 (2) number of hydrogen atoms
 (3) molecular masses
 (4) functional groups

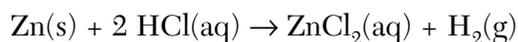
25 Which structural formula represents a molecule that is *not* an isomer of pentane?



26 The bonds in the compound MgSO_4 can be described as

- (1) ionic, only
 (2) covalent, only
 (3) both ionic and covalent
 (4) neither ionic nor covalent

27 Given the reaction:



Which statement correctly describes what occurs when this reaction takes place in a closed system?

- (1) Atoms of Zn(s) lose electrons and are oxidized.
 (2) Atoms of Zn(s) gain electrons and are reduced.
 (3) There is a net loss of mass.
 (4) There is a net gain of mass.

28 When the pH of a solution changes from a pH of 5 to a pH of 3, the hydronium ion concentration is

- (1) 0.01 of the original content
 (2) 0.1 of the original content
 (3) 10 times the original content
 (4) 100 times the original content

29 A sample of Ca(OH)_2 is considered to be an Arrhenius base because it dissolves in water to yield

- (1) Ca^{2+} ions as the only positive ions in solution
 (2) H_3O^+ ions as the only positive ions in solution
 (3) OH^- ions as the only negative ions in solution
 (4) H^- ions as the only negative ions in solution

30 Which reaction occurs when hydrogen ions react with hydroxide ions to form water?

- (1) substitution
 (2) saponification
 (3) ionization
 (4) neutralization

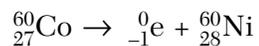
31 Which of these types of nuclear radiation has the greatest penetrating power?

- (1) alpha
 (2) beta
 (3) neutron
 (4) gamma

32 Alpha particles and beta particles differ in

- (1) mass, only
 (2) charge, only
 (3) both mass and charge
 (4) neither mass nor charge

33 Given the nuclear reaction:



This reaction is an example of

- (1) fission
- (2) fusion
- (3) artificial transmutation
- (4) natural transmutation

34 As two chlorine atoms combine to form a molecule, energy is

- (1) absorbed
- (2) released
- (3) created
- (4) destroyed

Note that question 35 has only three choices.

35 In most aqueous reactions as temperature increases, the effectiveness of collisions between reacting particles

- (1) decreases
- (2) increases
- (3) remains the same

Part B-1

Answer all questions in this part.

Directions (36–50): 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*.

36 What is the total number of neutrons in an atom of an element that has a mass number of 19 and an atomic number of 9?

- (1) 9 (3) 19
(2) 10 (4) 28

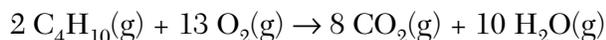
37 The element in Period 4 and Group 1 of the Periodic Table would be classified as a

- (1) metal (3) nonmetal
(2) metalloid (4) noble gas

38 As the elements in Period 2 of the Periodic Table are considered in succession from left to right, there is a decrease in atomic radius with increasing atomic number. This may best be explained by the fact that the

- (1) number of protons increases, and the number of shells of electrons remains the same
(2) number of protons increases, and the number of shells of electrons increases
(3) number of protons decreases, and the number of shells of electrons remains the same
(4) number of protons decreases, and the number of shells of electrons increases

39 Given the balanced equation:



What is the total number of moles of $\text{O}_2(\text{g})$ that must react completely with 5.00 moles of $\text{C}_4\text{H}_{10}(\text{g})$?

- (1) 10.0 (3) 26.5
(2) 20.0 (4) 32.5

40 Which particle has the same electron configuration as a potassium ion?

- (1) fluoride ion (3) neon atom
(2) sodium ion (4) argon atom

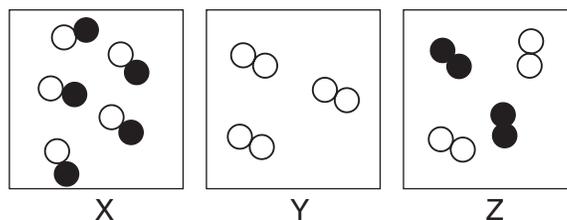
41 Which equation represents a double replacement reaction?

- (1) $2 \text{Na} + 2 \text{H}_2\text{O} \rightarrow 2 \text{NaOH} + \text{H}_2$
(2) $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$
(3) $\text{LiOH} + \text{HCl} \rightarrow \text{LiCl} + \text{H}_2\text{O}$
(4) $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$

42 What is the molecular formula of a compound that has a molecular mass of 54 and the empirical formula C_2H_3 ?

- (1) C_2H_3 (3) C_6H_9
(2) C_4H_6 (4) C_8H_{12}

43 Given the diagrams X, Y, and Z below:



Key
Atom of element A = ○
Atom of element B = ●

Which diagram or diagrams represent a mixture of elements A and B?

- (1) X, only (3) X and Y
(2) Z, only (4) X and Z

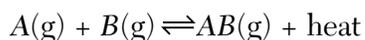
44 Which is an electron configuration for an atom of chlorine in the excited state?

- (1) 2–8–7 (3) 2–8–6–1
(2) 2–8–8 (4) 2–8–7–1

45 Based on the nature of the reactants in each of the equations below, which reaction at 25°C will occur at the fastest rate?

- (1) $C(s) + O_2(g) \rightarrow CO_2(g)$
- (2) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$
- (3) $CH_3OH(l) + CH_3COOH(l) \rightarrow CH_3COOCH_3(aq) + H_2O(l)$
- (4) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

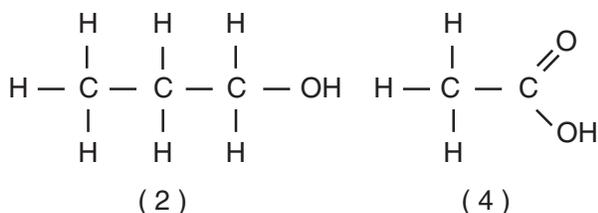
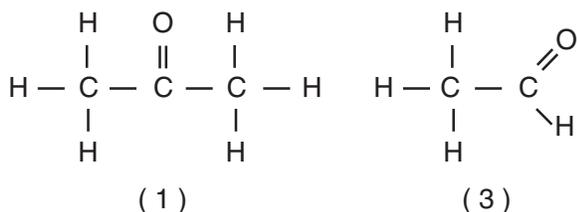
46 Given the reaction at equilibrium:



The concentration of $A(g)$ can be increased by

- (1) lowering the temperature
- (2) adding a catalyst
- (3) increasing the concentration of $AB(g)$
- (4) increasing the concentration of $B(g)$

47 Which structural formula represents an alcohol?



48 A voltaic cell differs from an electrolytic cell in that in a voltaic cell

- (1) energy is produced when the reaction occurs
- (2) energy is required for the reaction to occur
- (3) both oxidation and reduction occur
- (4) neither oxidation nor reduction occurs

49 What is the purpose of the salt bridge in a voltaic cell?

- (1) It blocks the flow of electrons.
- (2) It blocks the flow of positive and negative ions.
- (3) It is a path for the flow of electrons.
- (4) It is a path for the flow of positive and negative ions.

50 According to Reference Table N, which radioactive isotope will retain only one-eighth ($\frac{1}{8}$) its original radioactive atoms after approximately 43 days?

- | | |
|----------------|-------------------|
| (1) gold-198 | (3) phosphorus-32 |
| (2) iodine-131 | (4) radon-222 |

Part B–2

Answer all questions in this part.

Directions (51–62): 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*.

- 51 Explain how a catalyst may increase the rate of a chemical reaction. [1]
- 52 On the set of axes provided *in your answer booklet*, sketch the potential energy diagram for an endothermic chemical reaction that shows the activation energy and the potential energy of the reactants and the potential energy of the products. [2]
- 53 Given the reaction: $\text{Cl}_2 + 2 \text{HBr} \rightarrow \text{Br}_2 + 2 \text{HCl}$

Write a correctly balanced reduction half-reaction for this equation. [1]

Base your answers to questions 54 and 55 on the information below.

Given the unbalanced equation:



- 54 Balance the equation provided *in your answer booklet*, using the lowest whole-number coefficients. [1]
- 55 Identify the type of reaction represented. [1]

Base your answers to questions 56 through 58 on the *Reference Tables for Physical Setting/Chemistry*.

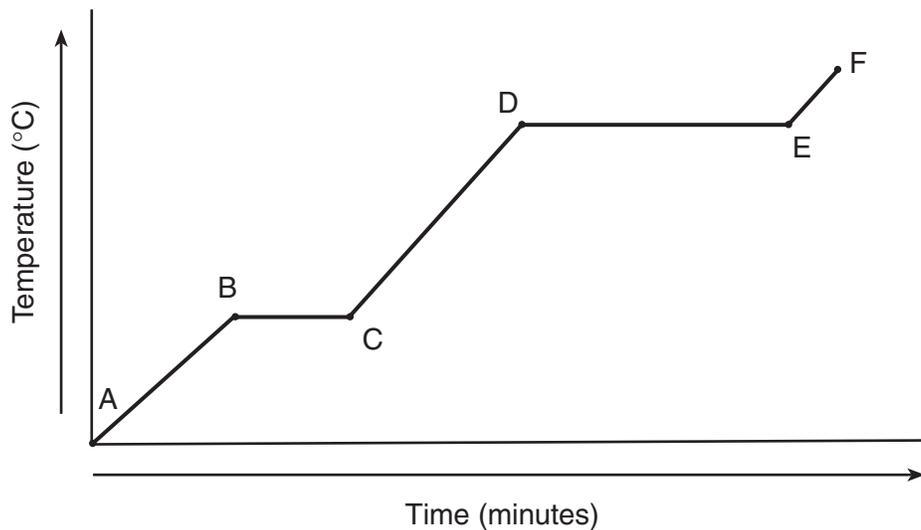
- 56 Complete the data table provided *in your answer booklet* for the following Group 18 elements: He, Ne, Ar, Kr, Xe [1]
- 57 Using information from your data table in question 56, construct a line graph on the grid provided *in your answer booklet*, following the directions below.
- Mark an appropriate scale on the axis labeled “First Ionization Energy (kJ/mol).” [1]
 - Plot the data from your data table. Circle each point and connect the points. [1]

Example: 

- 58 Based on your graph in question 57, describe the trend in first ionization energy of Group 18 elements as the atomic number increases. [1]

Base your answers to questions 59 through 62 on the information below.

Given the heating curve where substance X starts as a solid below its melting point and is heated uniformly:



- 59 Identify the process that takes place during line segment \overline{DE} of the heating curve. [1]
- 60 Identify a line segment in which the average kinetic energy is increasing. [1]
- 61 Using (\bullet) to represent particles of substance X , draw at least *five* particles as they would appear in the substance at point F . Use the box provided *in your answer booklet*. [1]
- 62 Describe, in terms of *particle behavior* or *energy*, what is happening to substance X during line segment \overline{BC} . [1]
-

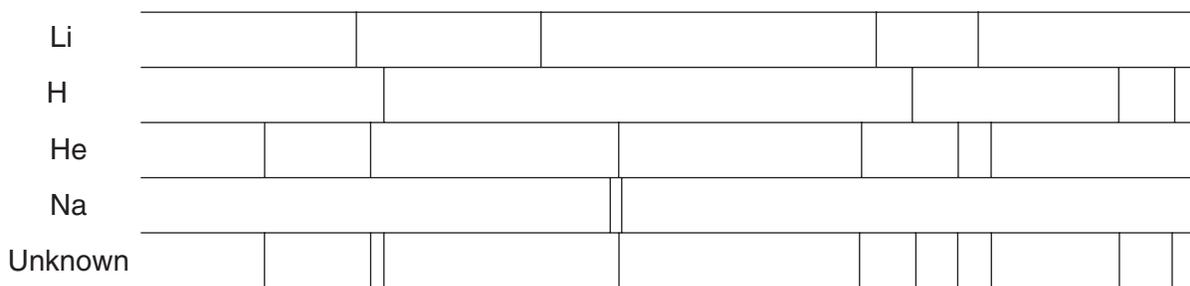
Part C

Answer all questions in this part.

Directions (63–78): 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 63 and 64 on the diagram below, which shows bright-line spectra of selected elements.

Bright-Line Spectra



63 Identify the *two* elements in the unknown spectrum. [2]

64 Explain how a bright-line spectrum is produced, in terms of *excited state*, *energy transitions*, and *ground state*. [2]

65 The table below gives information about two isotopes of element X.

Isotope	Mass	Relative Abundance
X-10	10.01	19.91%
X-11	11.01	80.09%

Calculate the average atomic mass of element X.

- Show a correct numerical setup in the space provided *in your answer booklet*. [1]
- Record your answer. [1]
- Express your answer to the correct number of significant figures. [1]

66 A student determines the density of zinc to be 7.56 grams per milliliter. If the accepted density is 7.14 grams per milliliter, what is the student's percent error?

- Show a correct numerical setup in the space provided *in your answer booklet*. [1]
- Record your answer. [1]

Base your answers to questions 67 through 69 on the information below.

Given the equation for the dissolving of sodium chloride in water:



- 67 Describe what happens to entropy during this dissolving process. [1]
- 68 Explain, in terms of *particles*, why NaCl(s) does *not* conduct electricity. [1]
- 69 When NaCl(s) is added to water in a 250-milliliter beaker, the temperature of the mixture is lower than the original temperature of the water. Describe this observation in terms of *heat flow*. [1]
-

Base your answers to questions 70 through 74 on the article below, the *Reference Tables for Physical Setting/Chemistry*, and your knowledge of chemistry.

In the 1920s, paint used to inscribe the numbers on watch dials was composed of a luminescent (glow-in-the-dark) mixture. The powdered-paint base was a mixture of radium salts and zinc sulfide. As the paint was mixed, the powdered base became airborne and drifted throughout the workroom causing the contents of the workroom, including the painters' clothes and bodies, to glow in the dark.

The paint is luminescent because radiation from the radium salts strikes a scintillator. A scintillator is a material that emits visible light in response to ionizing radiation. In watch-dial paint, zinc sulfide acts as the scintillator.

Radium present in the radium salts decomposes spontaneously, emitting alpha particles. These particles can cause damage to the body when they enter human tissue. Alpha particles are especially harmful to the blood, liver, lungs, and spleen because they can alter genetic information in the cells. Radium can be deposited in the bones because it substitutes for calcium.

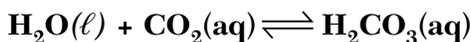
- 70 Write the notation for the alpha particles emitted by radium in the radium salts. [1]
- 71 How can particles emitted from radioactive nuclei damage human tissue? [1]
- 72 Why does radium substitute for calcium in bones? [1]
- 73 Explain why zinc sulfide is used in luminescent paint. [1]
- 74 Based on Reference Table *F*, describe the solubility of zinc sulfide in water. [1]
-

Base your answers to questions 75 through 78 on the article below and on your knowledge of chemistry.

Fizzies — A Splash from the Past

They're baaack . . . a splash from the past! Fizzies instant sparkling drink tablets, popular in the 1950s and 1960s, are now back on the market. What sets them apart from other powdered drinks is that they bubble and fizz when placed in water, forming an instant carbonated beverage.

The fizz in Fizzies is caused by bubbles of carbon dioxide (CO_2) gas that are released when the tablet is dropped into water. Careful observation reveals that these bubbles rise to the surface because CO_2 gas is much less dense than water. However, not all of the CO_2 gas rises to the surface; some of it dissolves in the water. The dissolved CO_2 can react with water to form carbonic acid, H_2CO_3 .



The pH of the Fizzies drink registers between 5 and 6, showing that the resulting solution is clearly acidic. Carbonic acid is found in other carbonated beverages as well. One of the ingredients on any soft drink label is carbonated water, which is another name for carbonic acid. However, in the production of soft drinks, the CO_2 is pumped into the solution under high pressure at the bottling plant.

— Brian Rohrig
Excerpted from "Fizzies—A Splash from the Past,"
Chem Matters, February 1998

- 75 What is the only positive ion in an aqueous solution of carbonic acid? [1]
- 76 CO_2 is pumped into the soft drink solution under high pressure. Why is high pressure necessary? [1]
- 77 Describe the solubility of CO_2 gas in water. [1]
- 78 Explain your response to question 77 in terms of the *molecular polarities* of $\text{CO}_2(\text{g})$ and $\text{H}_2\text{O}(\ell)$. [1]
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Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Wednesday, August 13, 2003 — 12:30 to 3:30 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 13 25
2 14 26
3 15 27
4 16 28
5 17 29
6 18 30
7 19 31
8 20 32
9 21 33
10 22 34
11 23 35
12 24

Part A Score

[Box for Part A Score]

Part B-1

- 36 44
37 45
38 46
39 47
40 48
41 49
42 50
43

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

Tear Here

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Tear Here