

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

PHYSICAL SETTING CHEMISTRY

Thursday, January 26, 2006 — 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 Which two nuclides are isotopes of the same element?

- (1) $^{20}_{11}\text{Na}$ and $^{20}_{10}\text{Ne}$ (3) $^{39}_{19}\text{K}$ and $^{42}_{19}\text{K}$
(2) $^{39}_{19}\text{K}$ and $^{40}_{20}\text{Ca}$ (4) $^{14}_6\text{C}$ and $^{14}_7\text{N}$

2 An atom of oxygen is in an excited state. When an electron in this atom moves from the third shell to the second shell, energy is

- (1) emitted by the nucleus
(2) emitted by the electron
(3) absorbed by the nucleus
(4) absorbed by the electron

3 The charge of a beryllium-9 nucleus is

- (1) +13 (3) +5
(2) +9 (4) +4

4 Which sequence represents a correct order of historical developments leading to the modern model of the atom?

- (1) the atom is a hard sphere → most of the atom is empty space → electrons exist in orbitals outside the nucleus
(2) the atom is a hard sphere → electrons exist in orbitals outside the nucleus → most of the atom is empty space
(3) most of the atom is empty space → electrons exist in orbitals outside the nucleus → the atom is a hard sphere
(4) most of the atom is empty space → the atom is a hard sphere → electrons exist in orbitals outside the nucleus

5 Which statement describes a chemical property of oxygen?

- (1) Oxygen has a melting point of 55 K.
(2) Oxygen can combine with a metal to produce a compound.
(3) Oxygen gas is slightly soluble in water.
(4) Oxygen gas can be compressed.

6 The element in Group 14, Period 3 on the Periodic Table is classified as a

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

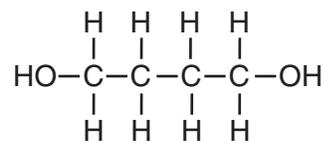
7 Which trends are observed when the elements in Period 3 on the Periodic Table are considered in order of increasing atomic number?

- (1) The atomic radius decreases, and the first ionization energy generally increases.
(2) The atomic radius decreases, and the first ionization energy generally decreases.
(3) The atomic radius increases, and the first ionization energy generally increases.
(4) The atomic radius increases, and the first ionization energy generally decreases.

8 What is the chemical formula for sodium sulfate?

- (1) Na_2SO_3 (3) NaSO_3
(2) Na_2SO_4 (4) NaSO_4

9 Given the structural formula:



What is the empirical formula of this compound?

- (1) CH_3O (3) $\text{C}_4\text{H}_{10}\text{O}_2$
(2) $\text{C}_2\text{H}_5\text{O}$ (4) $\text{C}_8\text{H}_{20}\text{O}_4$

10 Which chemical equation is correctly balanced?

- (1) $\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g})$
(2) $\text{N}_2(\text{g}) + \text{H}_2(\text{g}) \rightarrow \text{NH}_3(\text{g})$
(3) $2\text{NaCl}(\text{s}) \rightarrow \text{Na}(\text{s}) + \text{Cl}_2(\text{g})$
(4) $2\text{KCl}(\text{s}) \rightarrow 2\text{K}(\text{s}) + \text{Cl}_2(\text{g})$

- 11 Compared to a calcium atom, the calcium ion Ca^{2+} has
 (1) more protons (3) more electrons
 (2) fewer protons (4) fewer electrons
- 12 Which type of bond is found in sodium bromide?
 (1) covalent (3) ionic
 (2) hydrogen (4) metallic
- 13 Which substance can *not* be decomposed by ordinary chemical means?
 (1) methane (3) ethanol
 (2) mercury (4) ammonia
- 14 A mixture of crystals of salt and sugar is added to water and stirred until all solids have dissolved. Which statement best describes the resulting mixture?
 (1) The mixture is homogeneous and can be separated by filtration.
 (2) The mixture is homogeneous and cannot be separated by filtration.
 (3) The mixture is heterogeneous and can be separated by filtration.
 (4) The mixture is heterogeneous and cannot be separated by filtration.
- 15 Under which conditions of temperature and pressure would a sample of $\text{H}_2(\text{g})$ behave most like an ideal gas?
 (1) 0°C and 100 kPa
 (2) 0°C and 300 kPa
 (3) 150°C and 100 kPa
 (4) 150°C and 300 kPa
- 16 In a chemical reaction, the difference between the potential energy of the products and the potential energy of the reactants is defined as the
 (1) activation energy
 (2) ionization energy
 (3) heat of reaction
 (4) heat of vaporization
- 17 Which substance is an Arrhenius base?
 (1) KCl (3) KOH
 (2) CH_3Cl (4) CH_3OH
- 18 Given the balanced equation:

$$\text{I}_2(\text{s}) + \text{energy} \rightarrow \text{I}_2(\text{g})$$
 As a sample of $\text{I}_2(\text{s})$ sublimates to $\text{I}_2(\text{g})$, the entropy of the sample
 (1) increases because the particles are less randomly arranged
 (2) increases because the particles are more randomly arranged
 (3) decreases because the particles are less randomly arranged
 (4) decreases because the particles are more randomly arranged
- 19 The multiple covalent bond in a molecule of 1-butene is a
 (1) double covalent bond that has 6 shared electrons
 (2) double covalent bond that has 4 shared electrons
 (3) triple covalent bond that has 6 shared electrons
 (4) triple covalent bond that has 4 shared electrons
- 20 In an oxidation-reduction reaction, reduction is defined as the
 (1) loss of protons (3) loss of electrons
 (2) gain of protons (4) gain of electrons
- 21 What is the oxidation number assigned to manganese in KMnO_4 ?
 (1) +7 (3) +3
 (2) +2 (4) +4
- 22 Which of the following aqueous solutions is the best conductor of electricity?
 (1) 0.10 M CH_3OH (3) 0.10 M NaOH
 (2) 1.0 M CH_3OH (4) 1.0 M NaOH
- 23 One acid-base theory states that an acid is
 (1) an H^- donor (3) an H^+ donor
 (2) an H^- acceptor (4) an H^+ acceptor

24 Positrons are spontaneously emitted from the nuclei of

- (1) potassium-37 (3) nitrogen-16
 (2) radium-226 (4) thorium-232

25 The amount of energy released from a fission reaction is much greater than the energy released from a chemical reaction because in a fission reaction

- (1) mass is converted into energy
 (2) energy is converted into mass
 (3) ionic bonds are broken
 (4) covalent bonds are broken

26 Which Lewis electron-dot diagram is correct for CO_2 ?



(1)

(3)



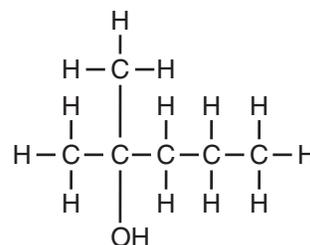
(2)

(4)

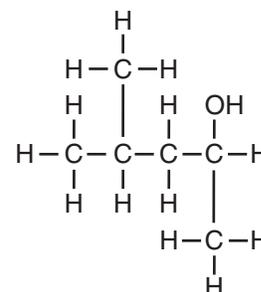
27 Types of nuclear reactions include fission, fusion, and

- (1) single replacement
 (2) neutralization
 (3) oxidation-reduction
 (4) transmutation

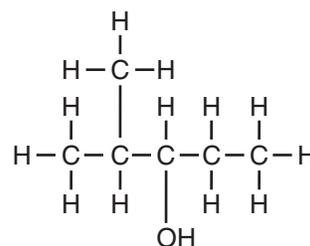
28 Which structural formula is correct for 2-methyl-3-pentanol?



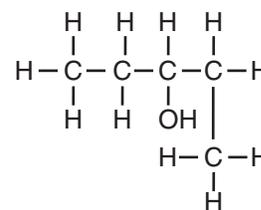
(1)



(3)



(2)



(4)

Note that questions 29 and 30 have only three choices.

29 When an atom becomes a positive ion, the radius of the atom

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

30 Compared to the freezing point of 1.0 M $\text{KCl}(\text{aq})$ at standard pressure, the freezing point of 1.0 M $\text{CaCl}_2(\text{aq})$ at standard pressure is

- (1) lower
 (2) higher
 (3) the same

Part B-1

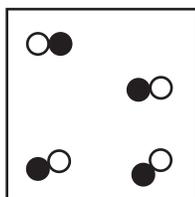
Answer all questions in this part.

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.

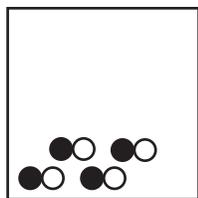
- 31 Which electron configuration represents the electrons in an atom of chlorine in an excited state?

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

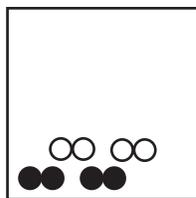
- 32 Given the particle diagram representing four molecules of a substance:



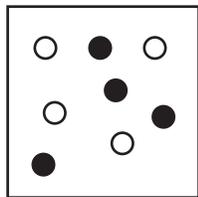
Which particle diagram best represents this same substance after a physical change has taken place?



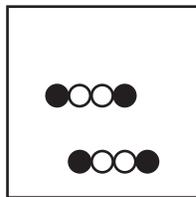
(1)



(3)



(2)



(4)

- 33 What is the percent composition by mass of nitrogen in NH_4NO_3 (gram-formula mass = 80.0 grams/mole)?

(1) 17.5% (3) 52.5%
(2) 35.0% (4) 60.0%

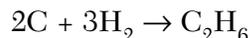
- 34 The atomic mass of element A is 63.6 atomic mass units. The only naturally occurring isotopes of element A are A-63 and A-65. The percent abundances in a naturally occurring sample of element A are closest to

(1) 31% A-63 and 69% A-65
(2) 50% A-63 and 50% A-65
(3) 69% A-63 and 31% A-65
(4) 100% A-63 and 0% A-65

- 35 Elements Q, X, and Z are in the same group on the Periodic Table and are listed in order of increasing atomic number. The melting point of element Q is -219°C and the melting point of element Z is -7°C . Which temperature is closest to the melting point of element X?

(1) -7°C (3) -219°C
(2) -101°C (4) -226°C

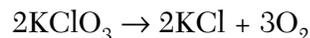
- 36 Given the balanced equation:



What is the total number of moles of C that must completely react to produce 2.0 moles of C_2H_6 ?

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

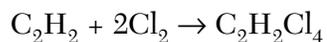
- 37 Given the balanced equation:



Which type of reaction is represented by this equation?

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

46 Given the balanced equation for an organic reaction:



This reaction is best classified as

- (1) addition (3) fermentation
(2) esterification (4) substitution

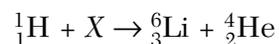
47 Which indicator is yellow in a solution with a pH of 9.8?

- (1) methyl orange (3) bromcresol green
(2) bromthymol blue (4) thymol blue

48 How many milliliters of 0.100 M NaOH(aq) would be needed to completely neutralize 50.0 milliliters of 0.300 M HCl(aq)?

- (1) 16.7 mL (3) 150. mL
(2) 50.0 mL (4) 300. mL

49 Given the nuclear equation:



The particle represented by X is

- (1) ${}^9_4\text{Li}$ (3) ${}^{10}_5\text{Be}$
(2) ${}^9_4\text{Be}$ (4) ${}^{10}_6\text{C}$

50 The decay of which radioisotope can be used to estimate the age of the fossilized remains of an insect?

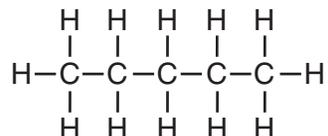
- (1) Rn-222 (3) Co-60
(2) I-131 (4) C-14

Part B-2

Answer all questions in this part.

Directions (51–67): 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 What is the total number of neutrons in an atom of aluminum-27? [1]
- 52 Explain, in terms of atomic structure, why the atomic radius of iodine is greater than the atomic radius of fluorine. [1]
- 53 In the space *in your answer booklet*, draw a Lewis electron-dot diagram of a selenium atom in the ground state. [1]
- 54 Explain, in terms of atomic structure, why liquid mercury is a good electrical conductor. [1]
- 55 Given the structural formula of pentane:

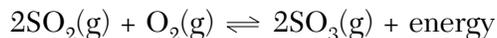


In the space *in your answer booklet*, draw a structural formula for an isomer of pentane. [1]

- 56 Based on Reference Table N, what is the fraction of a sample of potassium-42 that will remain unchanged after 62.0 hours? [1]
- 57 What is the total number of moles in 80.0 grams of $\text{C}_2\text{H}_5\text{Cl}$ (gram-formula mass = 64.5 grams/mole)? [1]
- 58 What is the total amount of heat energy, in joules, absorbed by 25.0 grams of water when the temperature of the water increases from 24.0°C to 36.0°C ? [1]

Base your answers to questions 59 and 60 on the information and balanced equation below.

Given the equation for a reaction at equilibrium:



- 59 Explain, in terms of LeChatelier's principle, why the concentration of $\text{SO}_2(\text{g})$ increases when the temperature is increased. [1]
- 60 Explain, in terms of collisions between molecules, why increasing the concentration of $\text{O}_2(\text{g})$ produces a *decrease* in the concentration of $\text{SO}_2(\text{g})$. [1]

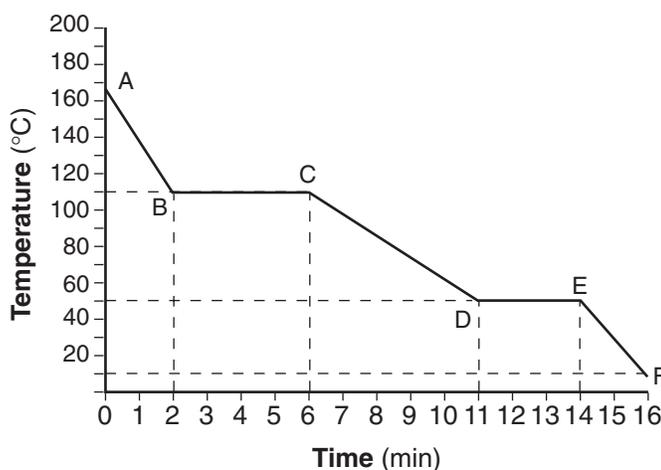
Base your answers to questions 61 through 65 on the table below.

Physical Properties of Four Gases

Name of Gas	hydrogen	hydrogen chloride	hydrogen bromide	hydrogen iodide
Molecular Structure	H-H	H-Cl	H-Br	H-I
Boiling Point (K) at 1 Atm	20.	188	207	237
Density (g/L) at STP	0.0899	1.64	?	5.66

- 61 The volume of 1.00 mole of hydrogen bromide at STP is 22.4 liters. The gram-formula mass of hydrogen bromide is 80.9 grams per mole. What is the density of hydrogen bromide at STP? [1]
- 62 The density of hydrogen at STP is 0.0899 gram per liter. Express this density to *two significant figures*. [1]
- 63 Explain, in terms of electronegativity difference, why the bond in H-Cl is more polar than the bond in H-I. [1]
- 64 Explain, in terms of intermolecular forces, why hydrogen has a *lower* boiling point than hydrogen bromide. [1]
- 65 Explain, in terms of molecular polarity, why hydrogen chloride is more soluble than hydrogen in water under the same conditions of temperature and pressure. [1]

Base your answers to questions 66 and 67 on the graph below, which represents the cooling of a substance starting at a temperature above its boiling point.



- 66 What is the melting point of this substance? [1]
- 67 Which segment of the graph represents the gas phase, only? [1]

Part C

Answer all questions in this part.

Directions (68–85): 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 68 through 70 on the information and table below.

A student conducts an experiment to determine how the temperature of water affects the rate at which an antacid tablet dissolves in the water. The student has three antacid tablets of the same size and composition. The student drops one tablet into each of three beakers containing 200. milliliters of water at different temperatures and measures the time it takes for each tablet to completely dissolve. The results are shown in the table below.

Dissolving Data for Three Antacid Tablets

Beaker	Original Temperature of Water (°C)	Time for Tablet to Dissolve (s)
1	20.	40.
2	30.	25
3	40.	10.

- 68 Describe the effect of water temperature on the rate of dissolving. [1]
- 69 Explain, in terms of collision theory, how water temperature influences the rate of dissolving. [1]
- 70 What change, other than temperature, would affect the rate of dissolving? [1]
-

Base your answers to questions 71 through 74 on the passage below.

Acid rain lowers the pH in ponds and lakes and over time can cause the death of some aquatic life. Acid rain is caused in large part by the burning of fossil fuels in power plants and by gasoline-powered vehicles. The acids commonly associated with acid rain are sulfurous acid, sulfuric acid, and nitric acid.

In general, fish can tolerate a pH range between 5 and 9. However, even small changes in pH can significantly affect the solubility and toxicity of common pollutants. Increased concentrations of these pollutants can adversely affect the behavior and normal life processes of fish and cause deformity, lower egg production, and less egg hatching.

- 71 Acid rain caused the pH of a body of water to decrease. Explain this pH decrease in terms of the change in concentration of hydronium ions. [1]
- 72 Write the chemical formula of a *negative* polyatomic ion present in an aqueous nitric acid solution. [1]
- 73 Using information in the passage, describe *one* effect of acid rain on future generations of fish species in ponds and lakes. [1]
- 74 Sulfur dioxide, SO_2 , is one of the gases that reacts with water to produce acid rain. According to Reference Table G, describe how the solubility of sulfur dioxide in water is affected by an increase in water temperature. [1]
-

Base your answers to questions 75 through 77 on the information below.

A student is instructed to make 0.250 liter of a 0.200 M aqueous solution of $\text{Ca}(\text{NO}_3)_2$.

- 75 What is the gram-formula mass of $\text{Ca}(\text{NO}_3)_2$? [1]
- 76 In the space *in your answer booklet*, show a correct numerical setup for calculating the total number of moles of $\text{Ca}(\text{NO}_3)_2$ needed to make 0.250 liter of the 0.200 M calcium nitrate solution. [1]
- 77 In order to prepare the described solution in the laboratory, two quantities must be measured accurately. One of these quantities is the volume of the solution. What other quantity must be measured to prepare this solution? [1]
-

Base your answers to questions 78 through 80 on the data in Reference Table S.

78 On the data table *in your answer booklet*, record the boiling points for He, Ne, Ar, Kr, and Xe. [1]

79 On the grid *in your answer booklet*, plot the boiling point versus the atomic number for He, Ne, Ar, Kr, and Xe. Circle and connect the points. [1]



80 Based on your graph, describe the trend in the boiling points of these elements as the atomic number increases. [1]

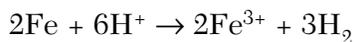
Base your answers to questions 81 and 82 on the information below.

A lightbulb contains argon gas at a temperature of 295 K and at a pressure of 75 kilopascals. The lightbulb is switched on, and after 30 minutes its temperature is 418 K.

81 In the space *in your answer booklet*, show a correct numerical setup for calculating the pressure of the gas inside the lightbulb at 418 K. Assume the volume of the lightbulb remains constant. [1]

82 What Celsius temperature is equal to 418 K? [1]

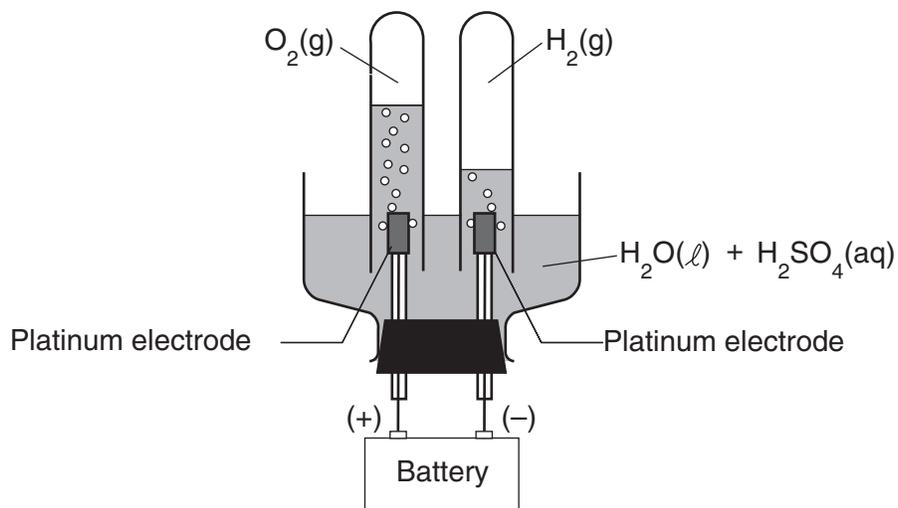
83 Because tap water is slightly acidic, water pipes made of iron corrode over time, as shown by the balanced ionic equation below:



Explain, in terms of chemical reactivity, why copper pipes are *less* likely to corrode than iron pipes. [1]

Base your answers to questions 84 and 85 on the information and diagram below.

The apparatus shown in the diagram consists of two inert platinum electrodes immersed in water. A small amount of an electrolyte, H_2SO_4 , must be added to the water for the reaction to take place. The electrodes are connected to a source that supplies electricity.



84 What type of electrochemical cell is shown? [1]

85 What particles are provided by the electrolyte that allow an electric current to flow? [1]

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Thursday, January 26, 2006 — 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

Tear Here

Tear Here

Tear Here