The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
CHEMISTRY

Wednesday, June 23, 2004 — 9:15 a.m. to 12:15 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 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 (1–33): 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 The modern model of the atom is based on the work of
(1) one scientist over a short period of time
(2) one scientist over a long period of time
(3) many scientists over a short period of time
(4) many scientists over a long period of time

2 Which statement is true about the charges assigned to an electron and a proton?
(1) Both an electron and a proton are positive.
(2) An electron is positive and a proton is negative.
(3) An electron is negative and a proton is positive.
(4) Both an electron and a proton are negative.

3 In the wave-mechanical model, an orbital is a region of space in an atom where there is
(1) a high probability of finding an electron
(2) a high probability of finding a neutron
(3) a circular path in which electrons are found
(4) a circular path in which neutrons are found

4 What is the charge of the nucleus in an atom of oxygen-17?
(1) 0
(2) –2
(3) +8
(4) +17

5 Which pair of symbols represents a metalloid and a noble gas?
(1) Si and Bi
(2) As and Ar
(3) Ge and Te
(4) Ne and Xe

6 Which statement describes a chemical property of iron?
(1) Iron can be flattened into sheets.
(2) Iron conducts electricity and heat.
(3) Iron combines with oxygen to form rust.
(4) Iron can be drawn into a wire.

7 Given the reaction:

$$N_2(g) + 3\ H_2(g) \rightleftharpoons 2\ NH_3(g)$$

What is the mole-to-mole ratio between nitrogen gas and hydrogen gas?
(1) 1:2
(2) 1:3
(3) 2:2
(4) 2:3

8 What is the percent by mass of oxygen in propanal, CH_3CH_2CHO?
(1) 10.0%
(2) 27.6%
(3) 38.1%
(4) 62.1%

9 Covalent bonds are formed when electrons are
(1) transferred from one atom to another
(2) captured by the nucleus
(3) mobile within a metal
(4) shared between two atoms

10 Which type of molecule is CF_4?
(1) polar, with a symmetrical distribution of charge
(2) polar, with an asymmetrical distribution of charge
(3) nonpolar, with a symmetrical distribution of charge
(4) nonpolar, with an asymmetrical distribution of charge

11 Which change occurs when a barium atom loses two electrons?
(1) It becomes a negative ion and its radius decreases.
(2) It becomes a negative ion and its radius increases.
(3) It becomes a positive ion and its radius decreases.
(4) It becomes a positive ion and its radius increases.

12 Conductivity in a metal results from the metal atoms having

(1) high electronegativity
(2) high ionization energy
(3) highly mobile protons in the nucleus
(4) highly mobile electrons in the valence shell

13 Which of these elements has the *least* attraction for electrons in a chemical bond?

(1) oxygen
(2) fluorine
(3) nitrogen
(4) chlorine

14 Recovering the salt from a mixture of salt and water could best be accomplished by

(1) evaporation
(2) filtration
(3) paper chromatography
(4) density determination

15 The average kinetic energy of water molecules is greatest in which of these samples?

(1) 10 g of water at 35°C
(2) 10 g of water at 55°C
(3) 100 g of water at 25°C
(4) 100 g of water at 45°C

16 Helium is most likely to behave as an ideal gas when it is under

(1) high pressure and high temperature
(2) high pressure and low temperature
(3) low pressure and high temperature
(4) low pressure and low temperature

17 At STP, the element oxygen can exist as either O_2 or O_3 gas molecules. These two forms of the element have

(1) the same chemical and physical properties
(2) the same chemical properties and different physical properties
(3) different chemical properties and the same physical properties
(4) different chemical and physical properties

18 Which sample contains particles in a rigid, fixed, geometric pattern?

(1) $CO_2(aq)$
(2) $HCl(g)$
(3) $H_2O(\ell)$
(4) $KCl(s)$

19 Given the reaction at 25°C:

$$Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

The rate of this reaction can be increased by using 5.0 grams of powdered zinc instead of a 5.0-gram strip of zinc because the powdered zinc has

(1) lower kinetic energy
(2) lower concentration
(3) more surface area
(4) more zinc atoms

20 Which statement about a system at equilibrium is true?

(1) The forward reaction rate is less than the reverse reaction rate.
(2) The forward reaction rate is greater than the reverse reaction rate.
(3) The forward reaction rate is equal to the reverse reaction rate.
(4) The forward reaction rate stops and the reverse reaction rate continues.

21 A catalyst increases the rate of a chemical reaction by

(1) lowering the activation energy of the reaction
(2) lowering the potential energy of the products
(3) raising the temperature of the reactants
(4) raising the concentration of the reactants

22 Which element must be present in an organic compound?

(1) hydrogen
(2) oxygen
(3) carbon
(4) nitrogen

23 Which compound is a saturated hydrocarbon?

(1) hexane
(2) hexene
(3) hexanol
(4) hexanal

24 Given the reaction:

This reaction is an example of

(1) fermentation
(2) saponification
(3) hydrogenation
(4) esterification

25 Which of these compounds has chemical properties most similar to the chemical properties of ethanoic acid?

(1) C_3H_7COOH
(2) C_2H_5OH
(3) $C_2H_5COOC_2H_5$
(4) $C_2H_5OC_2H_5$

26 Given the reaction that occurs in an electrochemical cell:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

During this reaction, the oxidation number of Zn changes from

(1) 0 to +2
(2) 0 to –2
(3) +2 to 0
(4) –2 to 0

27 A voltaic cell spontaneously converts

(1) electrical energy to chemical energy
(2) chemical energy to electrical energy
(3) electrical energy to nuclear energy
(4) nuclear energy to electrical energy

28 Which pair of formulas represents two compounds that are electrolytes?

(1) HCl and CH_3OH
(2) HCl and NaOH
(3) C_5H_{12} and CH_3OH
(4) C_5H_{12} and NaOH

29 Hydrogen chloride, HCl, is classified as an Arrhenius acid because it produces

(1) H^+ ions in aqueous solution
(2) Cl^- ions in aqueous solution
(3) OH^- ions in aqueous solution
(4) NH_4^+ ions in aqueous solution

30 Which compound could serve as a reactant in a neutralization reaction?

(1) NaCl
(2) KOH
(3) CH_3OH
(4) CH_3CHO

31 Which of these particles has the greatest mass?

(1) alpha
(2) beta
(3) neutron
(4) positron

32 In a nuclear fusion reaction, the mass of the products is

(1) less than the mass of the reactants because some of the mass has been converted to energy
(2) less than the mass of the reactants because some of the energy has been converted to mass
(3) more than the mass of the reactants because some of the mass has been converted to energy
(4) more than the mass of the reactants because some of the energy has been converted to mass

33 Which of these types of radiation has the greatest penetrating power?

(1) alpha
(2) beta
(3) gamma
(4) positron

Part B–1

Answer all questions in this part.

Directions (34–50): 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*.

34 How many electrons are contained in an Au^{3+} ion?

(1) 76
(2) 79
(3) 82
(4) 197

35 Which electron configuration represents the electrons of an atom in an excited state?

(1) 2–4
(2) 2–6
(3) 2–7–2
(4) 2–8–2

36 In comparison to an atom of $^{19}_{9}F$ in the ground state, an atom of $^{12}_{6}C$ in the ground state has

(1) three fewer neutrons
(2) three fewer valence electrons
(3) three more neutrons
(4) three more valence electrons

37 Element *X* is a solid that is brittle, lacks luster, and has six valence electrons. In which group on the Periodic Table would element *X* be found?

(1) 1
(2) 2
(3) 15
(4) 16

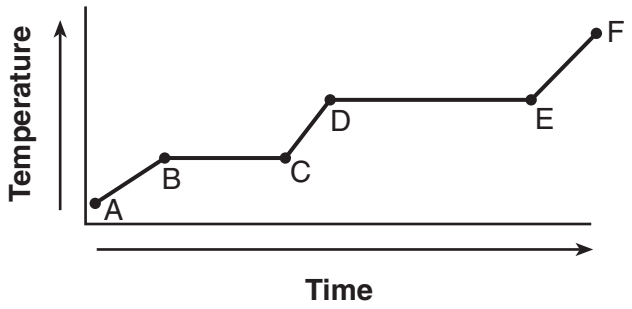
38 What is the empirical formula for the compound $C_6H_{12}O_6$?

(1) CH_2O
(2) $C_2H_4O_2$
(3) $C_3H_6O_3$
(4) $C_6H_{12}O_6$

39 The bonds between hydrogen and oxygen in a water molecule are classified as

(1) polar covalent
(2) nonpolar covalent
(3) ionic
(4) metallic

40 The graph below represents the uniform heating of a substance, starting with the substance as a solid below its melting point.



Which line segment represents an increase in potential energy and no change in average kinetic energy?

(1) $\overline{AB}$
(2) $\overline{BC}$
(3) $\overline{CD}$
(4) $\overline{EF}$

41 Using your knowledge of chemistry and the information in Reference Table *H*, which statement concerning propanone and water at 50°C is true?

(1) Propanone has a higher vapor pressure and stronger intermolecular forces than water.
(2) Propanone has a higher vapor pressure and weaker intermolecular forces than water.
(3) Propanone has a lower vapor pressure and stronger intermolecular forces than water.
(4) Propanone has a lower vapor pressure and weaker intermolecular forces than water.

42 A solution that is at equilibrium must be

(1) concentrated
(2) dilute
(3) saturated
(4) unsaturated

43 Given the reaction:

$$N_2(g) + O_2(g) + 182.6\ kJ \rightleftharpoons 2\ NO(g)$$

Which change would cause an immediate increase in the rate of the forward reaction?

(1) increasing the concentration of NO(g)
(2) increasing the concentration of $N_2(g)$
(3) decreasing the reaction temperature
(4) decreasing the reaction pressure

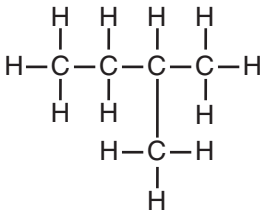
44 Which 10-milliliter sample of water has the greatest degree of disorder?

(1) $H_2O(g)$ at 120°C
(2) $H_2O(\ell)$ at 80°C
(3) $H_2O(\ell)$ at 20°C
(4) $H_2O(s)$ at 0°C

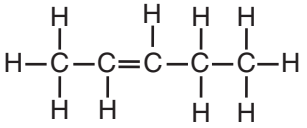
45 Which pH indicates a basic solution?

(1) 1
(2) 5
(3) 7
(4) 12

46 Which structural formula represents 2-pentyne?



(1)



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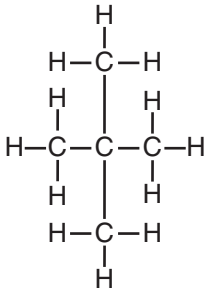

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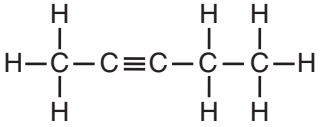
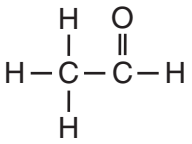
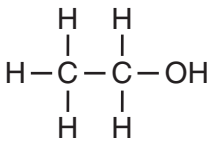


(4)

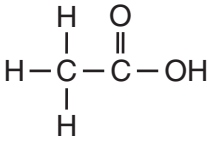
47 Which structural formula represents an ether?



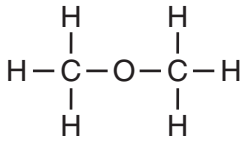
(1)



(3)



(2)



(4)

48 Given the reaction for the corrosion of aluminum:

$$4\ Al + 3\ O_2 \rightarrow 2\ Al_2O_3$$

Which half-reaction correctly represents the oxidation that occurs?

(1) $Al + 3e^- \rightarrow Al^{3+}$
(2) $Al \rightarrow Al^{3+} + 3e^-$
(3) $O_2 + 4e^- \rightarrow 2\ O^{2-}$
(4) $O_2 \rightarrow 2\ O^{2-} + 4e^-$

49 Based on Reference Table *N*, what fraction of a sample of gold-198 remains radioactive after 2.69 days?

(1) $\frac{1}{4}$
(2) $\frac{1}{2}$
(3) $\frac{3}{4}$
(4) $\frac{7}{8}$

Note that question 50 has only three choices.

50 As the elements of Group 1 on the Periodic Table are considered in order of increasing atomic radius, the ionization energy of each successive element generally

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

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 through 53 on the balanced chemical equation below.

$$2\ H_2O \rightarrow 2\ H_2 + O_2$$

51 What type of reaction does this equation represent? [1]

52 How does the balanced chemical equation show the Law of Conservation of Mass? [1]

53 What is the total number of moles of O_2 produced when 8 moles of H_2O is completely consumed? [1]

Base your answers to questions 54 and 55 on the unbalanced redox reaction below.

$$Cu(s) + AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + Ag(s)$$

54 Write the reduction half-reaction. [1]

55 Balance the redox equation *in your answer booklet,* using the smallest whole-number coefficients. [1]

Base your answers to questions 56 through 58 on the information below.

A student titrates 60.0 mL of $HNO_3(aq)$ with 0.30 M NaOH(aq). Phenolphthalein is used as the indicator. After adding 42.2 mL of NaOH(aq), a color change remains for 25 seconds, and the student stops the titration.

56 What color change does phenolphthalein undergo during this titration? [1]

57 In the space provided *in your answer booklet,* show a correct numerical setup for calculating the molarity of the $HNO_3(aq)$. [1]

58 According to the data, how many significant figures should be present in the calculated molarity of the $HNO_3(aq)$? [1]

Base your answers to questions 59 through 61 on the data table below, which shows three isotopes of neon.

Isotope	**Atomic Mass** (atomic mass units)	**Percent Natural Abundance**
^{20}Ne	19.99	90.9%
^{21}Ne	20.99	0.3%
^{22}Ne	21.99	8.8%

59 In terms of *atomic particles,* state one difference between these three isotopes of neon. [1]

60 Based on the atomic masses and the natural abundances shown in the data table, in the space provided *in your answer booklet,* show a correct numerical setup for calculating the average atomic mass of neon. [1]

61 Based on natural abundances, the average atomic mass of neon is closest to which whole number? [1]

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62 Based on the Periodic Table, explain why Na and K have similar chemical properties. [1]

63 In the space to the right of the reactants and arrow provided *in your answer booklet,* draw the structural formula for the product of the reaction shown. [1]

64 Given the nuclear equation:

$$^{58}_{29}\text{Cu} \rightarrow {}^{58}_{28}\text{Ni} + X$$

What nuclear particle is represented by X? [1]

Part C

Answer all questions in this part.

Directions (65–85): 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 65 through 67 on the information and equation below.

Antacids can be used to neutralize excess stomach acid. Brand *A* antacid contains the acid-neutralizing agent magnesium hydroxide, $Mg(OH)_2$. It reacts with HCl(aq) in the stomach, according to the following balanced equation:

$$2\ HCl(aq) + Mg(OH)_2(s) \rightarrow MgCl_2(aq) + 2\ H_2O(\ell)$$

65 In the space provided *in your answer booklet,* show a correct numerical setup for calculating the number of moles of $Mg(OH)_2$ (gram-formula mass = 58.3 grams/mole) in an 8.40-gram sample. [1]

66 If a person produces 0.050 mole of excess HCl in the stomach, how many moles of $Mg(OH)_2$ are needed to neutralize this excess hydrochloric acid? [1]

67 Brand *B* antacid contains the acid-neutralizing agent sodium hydrogen carbonate. Write the chemical formula for sodium hydrogen carbonate. [1]

Base your answers to questions 68 through 70 on the information below.

Naphthalene, a nonpolar substance that sublimes at room temperature, can be used to protect wool clothing from being eaten by moths.

68 Explain, in terms of *intermolecular forces,* why naphthalene sublimes. [1]

69 Explain why naphthalene is *not* expected to dissolve in water. [1]

70 The empirical formula for naphthalene is C_5H_4 and the molecular mass of naphthalene is 128 grams/mole. What is the molecular formula for naphthalene? [1]

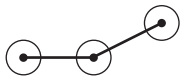
Base your answers to questions 71 through 74 on the data table below, which shows the solubility of a solid solute.

The Solubility of the Solute at Various Temperatures

Temperature (°C)	**Solute per 100 g of H_2O(g)**
0	18
20	20
40	24
60	29
80	36
100	49

71 On the grid provided *in your answer booklet,* mark an appropriate scale on the axis labeled "Solute per 100 g of H_2O(g)." An appropriate scale is one that allows a trend to be seen. [1]

72 On the same grid, plot the data from the data table. Circle and connect the points. [1]

Example: 

73 Based on the data table, if 15 grams of solute is dissolved in 100 grams of water at 40°C, how many *more* grams of solute can be dissolved in this solution to make it saturated at 40°C? [1]

74 According to Reference Table *G*, how many grams of $KClO_3$ must be dissolved in 100 grams of H_2O at 10°C to produce a saturated solution? [1]

Base your answers to questions 75 through 78 on the information below.

A weather balloon has a volume of 52.5 liters at a temperature of 295 K. The balloon is released and rises to an altitude where the temperature is 252 K.

75 How does this temperature change affect the gas particle motion? [1]

76 The original pressure at 295 K was 100.8 kPa and the pressure at the higher altitude at 252 K is 45.6 kPa. Assume the balloon does not burst. In the space provided *in your answer booklet,* show a correct numerical setup for calculating the volume of the balloon at the higher altitude. [1]

77 What Celsius temperature is equal to 252 K? [1]

78 What pressure, in atmospheres (atm), is equal to 45.6 kPa? [1]

Base your answers to questions 79 and 80 on the information and equation below.

Human blood contains dissolved carbonic acid, H_2CO_3, in equilibrium with carbon dioxide and water. The equilibrium system is shown below.

$$H_2CO_3(aq) \rightleftharpoons CO_2(aq) + H_2O(\ell)$$

79 Explain, using LeChatelier's principle, why decreasing the concentration of CO_2 decreases the concentration of H_2CO_3. [1]

80 What is the oxidation number of carbon in $H_2CO_3(aq)$? [1]

Base your answers to questions 81 through 84 on the information below.

A safe level of fluoride ions is added to many public drinking water supplies. Fluoride ions have been found to help prevent tooth decay. Another common source of fluoride ions is toothpaste. One of the fluoride compounds used in toothpaste is tin(II) fluoride.

A town located downstream from a chemical plant was concerned about fluoride ions from the plant leaking into its drinking water. According to the Environmental Protection Agency, the fluoride ion concentration in drinking water cannot exceed 4 ppm. The town hired a chemist to analyze its water. The chemist determined that a 175-gram sample of the town's water contains 0.000 250 gram of fluoride ions.

81 In the box provided *in your answer booklet,* draw a Lewis electron-dot diagram for a fluoride ion. [1]

82 What is the chemical formula for tin(II) fluoride? [1]

83 How many parts per million of fluoride ions are present in the analyzed sample? [1]

84 Is the town's drinking water safe to drink? Support your decision using information in the passage and your calculated fluoride level in question 83. [1]

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85 A plan is being developed for an experiment to test the effect of concentrated strong acids on a metal surface protected by various coatings. Some safety precautions would be the wearing of chemical safety goggles, an apron, and gloves. State one additional safety precaution that should be included in the plan. [1]

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING
CHEMISTRY

Wednesday, June 23, 2004 — 9:15 a.m. to 12:15 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	12	23 .....
2	13	24 .....
3	14	25 .....
4	15	26 .....
5	16	27 .....
6	17	28 .....
7	18	29 .....
8	19	30 .....
9	20	31 .....
10	21	32 .....
11	22	33 .....

Part A Score

Part B–1

34	43 .....
35	44 .....
36	45 .....
37	46 .....
38	47 .....
39	48 .....
40	49 .....
41	50 .....
42	

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

PS/CHEMISTRY