

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

CHEMISTRY

Thursday, August 13, 1998 — 12:30 to 3:30 p.m., only

The last page of the booklet is the answer sheet. Fold the last page along the perforations and, slowly and carefully, tear off the answer sheet. Then fill in the heading of your answer sheet.

All of your answers are to be recorded on the separate answer sheet. For each question, decide which of the choices given is the best answer. Then on the answer sheet, in the row of numbers for that question, circle with pencil the number of the choice that you have selected. The sample below is an example of the first step in recording your answers.

SAMPLE: ① 2 3 4

If you wish to change an answer, erase your first penciled circle and then circle with pencil the number of the answer you want. After you have completed the examination and you have decided that all of the circled answers represent your best judgment, signal a proctor and turn in all examination material except your answer sheet. Then and only then, place an X in ink in each penciled circle. Be sure to mark only one answer with an X in ink for each question. No credit will be given for any question with two or more X's marked. The sample below indicates how your final choice should be marked with an X in ink.

SAMPLE: ⊗ 2 3 4

The "Reference Tables for Chemistry," which you may need to answer some questions in this examination, are supplied separately. Be certain you have a copy of these reference tables before you begin the examination.

When you have completed the examination, you must sign the statement printed at the end of the 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 cannot be accepted if you fail to sign this declaration.

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

10 Which nuclear equation represents beta decay?

- (1) ${}_{13}^{27}\text{Al} + {}_2^4\text{He} \rightarrow {}_{15}^{30}\text{P} + {}_0^1\text{n}$
(2) ${}_{92}^{238}\text{U} \rightarrow {}_{90}^{234}\text{Th} + {}_2^4\text{He}$
(3) ${}_{6}^{14}\text{C} \rightarrow {}_{7}^{14}\text{N} + {}_{-1}^0\text{e}$
(4) ${}_{18}^{37}\text{Ar} + {}_{-1}^0\text{e} \rightarrow {}_{17}^{37}\text{Cl}$

11 What is the total number of sublevels in the fourth principal energy level?

- (1) 1 (3) 3
(2) 2 (4) 4

12 Which atom in the ground state has only one unpaired electron in its valence shell?

- (1) aluminum (3) phosphorus
(2) silicon (4) sulfur

13 Which electron dot symbol represents the atom in Period 4 with the highest first ionization energy?

- (1) $\ddot{\text{X}}$ (3) $\cdot\ddot{\text{X}}\cdot$
(2) $\ddot{\text{X}}\cdot$ (4) $:\ddot{\text{X}}:$

14 Which of these elements in Period 3 has the *least* tendency to attract electrons?

- (1) Mg (3) S
(2) Al (4) Cl

15 Which terms describe a substance that has a low melting point and poor electrical conductivity?

- (1) covalent and metallic
(2) covalent and molecular
(3) ionic and molecular
(4) ionic and metallic

16 Which chemical formula is both an empirical formula and a molecular formula?

- (1) CH_4
(2) C_2H_6
(3) CH_3COOH
(4) $\text{CH}_3\text{CH}_2\text{COOCH}_3$

17 How many grams of sodium are represented by the symbol Na?

- (1) 1.0 g of Na (3) 11 g of Na
(2) 10. g of Na (4) 23 g of Na

18 The shape and bonding in a diatomic bromine molecule are best described as

- (1) symmetrical and polar
(2) symmetrical and nonpolar
(3) asymmetrical and polar
(4) asymmetrical and nonpolar

19 What is the total number of moles of hydrogen atoms contained in 1 mole of $(\text{NH}_4)_2\text{C}_2\text{O}_4$?

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

20 Which element at STP is a poor conductor of electricity and has a relatively high electronegativity?

- (1) Cu (3) Mg
(2) S (4) Fe

21 The element arsenic (As) has the properties of

- (1) metals, only
(2) nonmetals, only
(3) both metals and nonmetals
(4) neither metals nor nonmetals

22 The elements calcium and strontium have similar chemical properties because they both have the same

- (1) atomic number
(2) mass number
(3) number of valence electrons
(4) number of completely filled sublevels

23 Which element is malleable and ductile?

- (1) S (3) Ge
(2) Si (4) Au

24 Which gas is monatomic at STP?

- (1) nitrogen (3) fluorine
(2) neon (4) chlorine

38 Which compound is a salt?

- (1) Na_3PO_4 (3) CH_3COOH
(2) H_3PO_4 (4) $\text{Ca}(\text{OH})_2$

39 At 1 atm and 298 K, which of the K_a values listed below represents the strongest acid?

- (1) 1.1×10^{-7} (3) 5.6×10^{-11}
(2) 1.8×10^{-5} (4) 4.6×10^{-4}

40 Which compound will conduct an electric current when dissolved in water?

- (1) NaOH (3) $\text{C}_6\text{H}_{12}\text{O}_6$
(2) $\text{C}_2\text{H}_5\text{OH}$ (4) $\text{C}_{12}\text{H}_{22}\text{O}_{11}$

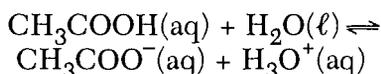
41 According to the Arrhenius theory of acids, citric acid in oranges and acetic acid in vinegar are classified as acids because their aqueous solutions contain

- (1) hydrogen ions (3) hydroxide ions
(2) hydrogen atoms (4) hydroxide atoms

42 If 20. milliliters of a 1.0 M solution of HCl is exactly neutralized by 40. milliliters of NaOH , the molarity of the NaOH solution is

- (1) 1.0 M (3) 0.50 M
(2) 2.0 M (4) 4.0 M

43 Given the reaction:



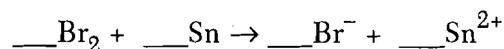
In this reaction, which substances are Brønsted-Lowry bases?

- (1) $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{H}_2\text{O}(\ell)$
(2) $\text{CH}_3\text{COOH}(\text{aq})$ and $\text{CH}_3\text{COO}^-(\text{aq})$
(3) $\text{H}_2\text{O}(\ell)$ and $\text{H}_3\text{O}^+(\text{aq})$
(4) $\text{H}_2\text{O}(\ell)$ and $\text{CH}_3\text{COO}^-(\text{aq})$

44 What is the oxidation number of sulfur in H_2SO_4 ?

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

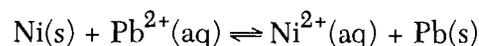
45 Given the unbalanced equation:



When the equation is correctly balanced using the smallest whole-number coefficients, the coefficient of Br^- is

- (1) 1 (3) 3
(2) 2 (4) 4

46 Given the redox reaction in an electrochemical cell:



A salt bridge is used to connect

- (1) $\text{Ni}(\text{s})$ and $\text{Pb}(\text{s})$
(2) $\text{Pb}^{2+}(\text{aq})$ and $\text{Ni}^{2+}(\text{aq})$
(3) $\text{Ni}(\text{s})$ and $\text{Ni}^{2+}(\text{aq})$
(4) $\text{Pb}^{2+}(\text{aq})$ and $\text{Pb}(\text{s})$

47 Which half-reaction correctly represents oxidation?

- (1) $\text{Sn}^{2+} + 2\text{e}^- \rightarrow \text{Sn}^0$
(2) $\text{Sn}^{4+} + 2\text{e}^- \rightarrow \text{Sn}^{2+}$
(3) $\text{Sn}^{2+} \rightarrow \text{Sn}^0 + 2\text{e}^-$
(4) $\text{Sn}^{2+} \rightarrow \text{Sn}^{4+} + 2\text{e}^-$

48 In a redox reaction, the reducing agent will

- (1) lose electrons and be reduced
(2) lose electrons and be oxidized
(3) gain electrons and be reduced
(4) gain electrons and be oxidized

49 Which element is present in all organic compounds?

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

50 Which products are obtained when $\text{CH}_4(\text{g})$ burns completely in an excess of oxygen?

- (1) CO and H_2O (3) CO_2 and H_2O
(2) CO and C (4) CO_2 and CO

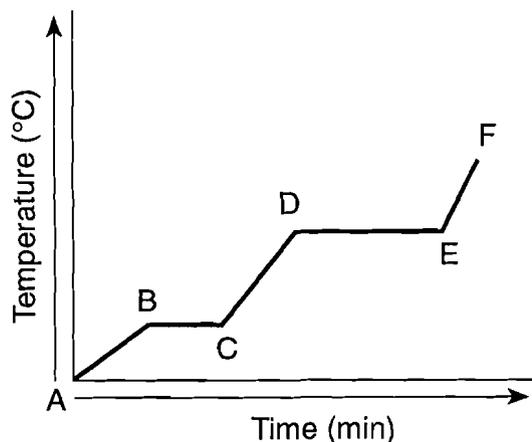
Part II

This part consists of twelve groups, each containing five questions. Each group tests a major area of the course. Choose seven of these twelve groups. Be sure that you answer all five questions in each group chosen. Record the answers to these questions on the separate answer sheet in accordance with the directions on the front page of this booklet. [35]

Group 1 — Matter and Energy

If you choose this group, be sure to answer questions 57–61.

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



Which segment of the graph represents a time when both the solid and liquid phases are present?

- (1) AB (2) BC (3) DE (4) EF
- 58 A gas at STP has a volume of 1.0 liter. If the pressure is doubled and the temperature remains constant, the new volume of the gas will be
- (1) 0.25 L (2) 2.0 L (3) 0.50 L (4) 4.0 L

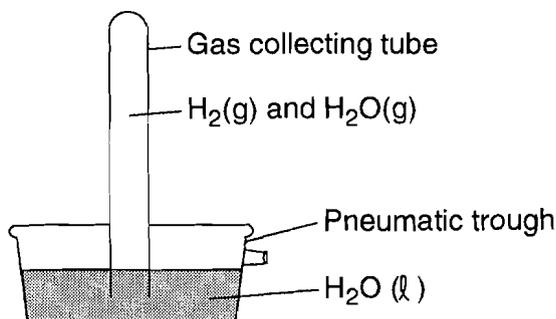
- 59 What is the normal boiling point of methane?

- (1) 20 K (2) 109 K (3) 121 K (4) 240 K

- 60 Which gas is *least* likely to obey the ideal gas laws at very high pressures and very low temperatures?

- (1) He (2) Ne (3) Kr (4) Xe

- 61 The diagram below shows the collection of H_2 gas over water at $25^\circ C$. The total pressure in the tube is 760.0 torr.



What is the pressure exerted by the hydrogen gas alone?

- (1) 23.8 torr (2) 736.2 torr (3) 760.0 torr (4) 793.8 torr

Group 4 — Periodic Table

If you choose this group, be sure to answer questions 72–76.

72 In which area of the Periodic Table are the elements with the strongest nonmetallic properties located?

- (1) lower left (3) lower right
(2) upper left (4) upper right

73 All of the atoms of the elements in Period 2 have the same number of

- (1) protons
(2) neutrons
(3) valence electrons
(4) occupied principal energy levels

74 Which of these metals loses electrons most readily?

- (1) calcium (3) potassium
(2) magnesium (4) sodium

75 If M represents an element in Group 2, the formula of its chloride would be

- (1) MCl (3) M_2Cl
(2) MCl_2 (4) M_2Cl_2

76 Which statement best compares the atomic radius of a potassium atom and the atomic radius of a calcium atom?

- (1) The radius of the potassium atom is smaller because of its smaller nuclear charge.
(2) The radius of the potassium atom is smaller because of its larger nuclear charge.
(3) The radius of the potassium atom is larger because of its smaller nuclear charge.
(4) The radius of the potassium atom is larger because of its larger nuclear charge.
-

Group 5 — Mathematics of Chemistry

If you choose this group, be sure to answer questions 77–81.

77 The table below lists four gases and their molecular mass.

Gas	Molecular Mass (g/mol)
A	2
B	4
C	17
D	20

Which gas diffuses at the *slowest* rate at STP?

- (1) A (3) C
(2) B (4) D

78 At 1 atmosphere of pressure, 25.0 grams of a compound at its normal boiling point is converted to a gas by the addition of 8,180 calories. What is the heat of vaporization for this compound, in calories per gram?

- (1) 25.0 cal/g (3) 540. cal/g
(2) 327 cal/g (4) 8,180 cal/g

79 If 11 grams of a gas occupies 5.6 liters at STP, what is its gram molecular mass?

- (1) 11 g/mol (3) 44 g/mol
(2) 22 g/mol (4) 88 g/mol

80 An 80.-gram sample of water at 10.°C absorbs 400. calories of heat energy. What is the final temperature of the water?

- (1) 50.°C (3) 5.0°C
(2) 15°C (4) 4.0°C

81 Given the reaction: $4Al + 3O_2 \rightarrow 2Al_2O_3$

What is the total number of moles of aluminum oxide that can be formed when 54 grams of aluminum reacts completely with oxygen?

- (1) 1.0 mole (3) 3.0 moles
(2) 2.0 moles (4) 4.0 moles
-

Group 7 — Acids and Bases

If you choose this group, be sure to answer questions 87–91.

87 Which relationship is present in a solution that has a pH of 7?

- (1) $[\text{H}^+] = [\text{OH}^-]$
- (2) $[\text{H}^+] > [\text{OH}^-]$
- (3) $[\text{H}^+] < [\text{OH}^-]$
- (4) $[\text{H}^+] + [\text{OH}^-] = K_w$

88 According to Reference Table N, which metal will react spontaneously with hydrochloric acid?

- (1) Ag
- (2) Hg
- (3) Cu
- (4) Ni

89 According to Reference Table L, which substance is amphoteric (amphiprotic)?

- (1) HI
- (2) OH^-
- (3) HF
- (4) NH_4^+

90 The pH of a 0.1 M solution is 11. What is the concentration of H_3O^+ ions, in moles per liter?

- (1) 1×10^{-1}
- (2) 1×10^{-3}
- (3) 1×10^{-11}
- (4) 1×10^{-13}

91 Red litmus will turn blue when placed in an aqueous solution of

- (1) KCl
 - (2) KOH
 - (3) CH_3OH
 - (4) CH_3COOH
-

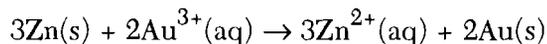
Group 8 — Redox and Electricity

If you choose this group, be sure to answer questions 92–96.

92 Equilibrium is attained in a chemical cell when the cell voltage is equal to

- (1) +1.00 V
- (2) +2.00 V
- (3) 0.00 V
- (4) -1.00 V

93 Given the reaction:



What is the maximum cell voltage (E^0) for the overall reaction?

- (1) +1.50 V
- (2) +2.26 V
- (3) +5.28 V
- (4) +0.74 V

94 Based on Reference Table N, which ion will oxidize Pb to Pb^{2+} ?

- (1) Cu^{2+}
- (2) Ni^{2+}
- (3) Fe^{2+}
- (4) Zn^{2+}

95 Which net reaction occurs by the process of electrolysis?

- (1) $2\text{H}_2\text{O}(\ell) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g})$
- (2) $2\text{HgO}(s) \rightarrow 2\text{Hg}(\ell) + \text{O}_2(\text{g})$
- (3) $2\text{KClO}_3(\ell) \rightarrow 2\text{KCl}(s) + 3\text{O}_2(\text{g})$
- (4) $\text{MgCO}_3(s) \rightarrow \text{MgO}(s) + \text{CO}_2(s)$

96 Which reaction is a nonspontaneous redox reaction under standard conditions?

- (1) $\text{Sn}(s) + 2\text{HCl}(\text{aq}) \rightarrow \text{SnCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 - (2) $\text{Cu}(s) + 2\text{HCl}(\text{aq}) \rightarrow \text{CuCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 - (3) $\text{Ba}(s) + 2\text{HCl}(\text{aq}) \rightarrow \text{BaCl}_2(\text{aq}) + \text{H}_2(\text{g})$
 - (4) $\text{Mg}(s) + 2\text{HCl}(\text{aq}) \rightarrow \text{MgCl}_2(\text{aq}) + \text{H}_2(\text{g})$
-

Group 10 — Applications of Chemical Principles

If you choose this group, be sure to answer questions 102–106.

- 102 Which type of chemical reaction occurs when an iron nail rusts?
(1) neutralization
(2) condensation
(3) oxidation-reduction
(4) ionization-dissociation
- 103 Which of these gases obtained from petroleum is also known as bottled gas?
(1) ethane (3) propane
(2) ethene (4) propene
- 104 Which element is obtained only by the electrolysis of its fused salt?
(1) K (3) Cr
(2) Zn (4) Fe
- 105 Which metals occur naturally as sulfide ores and then are changed to oxides and reduced to free metals?
(1) Au and Ag (3) Cu and Zn
(2) K and Li (4) Cu and K
- 106 Which compound is produced in the first step of the contact process?
(1) SO_2 (3) H_2S
(2) SO_3 (4) H_2SO_3
-

Group 11 — Nuclear Chemistry

If you choose this group, be sure to answer questions 107–111.

- 107 Which substance can be used as a fuel in a fission reactor?
(1) ^2H (3) ^{226}Ra
(2) ^4H (4) ^{235}U
- 108 Which characteristics should a radioactive isotope have if it is to be used for medical diagnosis?
(1) short half-life and slow elimination from the body
(2) short half-life and fast elimination from the body
(3) long half-life and slow elimination from the body
(4) long half-life and fast elimination from the body
- 109 Which particles can be accelerated in an electric or magnetic field?
(1) alpha and gamma (3) alpha and beta
(2) beta and neutron (4) beta and gamma
- 110 Which is a gaseous radioactive waste product that is released into the atmosphere after it has decayed to a safe radiation level?
(1) radon-222 (3) cesium-137
(2) radium-226 (4) cobalt-60
- 111 During a fission reaction, which type of particle is captured by a nucleus?
(1) deuteron (3) neutron
(2) electron (4) proton
-

Part II (35 credits)

Answer the questions in only seven of the twelve groups in this part. Be sure to mark the answers to the groups of questions you choose in accordance with the instructions on the front cover of the test booklet. Leave blank the five groups of questions you do not choose to answer.

Group 1 Matter and Energy					
57	1	2	3	4	
58	1	2	3	4	
59	1	2	3	4	
60	1	2	3	4	
61	1	2	3	4	

Group 2 Atomic Structure					
62	1	2	3	4	
63	1	2	3	4	
64	1	2	3	4	
65	1	2	3	4	
66	1	2	3	4	

Group 3 Bonding					
67	1	2	3	4	
68	1	2	3	4	
69	1	2	3	4	
70	1	2	3	4	
71	1	2	3	4	

Group 4 Periodic Table					
72	1	2	3	4	
73	1	2	3	4	
74	1	2	3	4	
75	1	2	3	4	
76	1	2	3	4	

Group 5 Mathematics of Chemistry					
77	1	2	3	4	
78	1	2	3	4	
79	1	2	3	4	
80	1	2	3	4	
81	1	2	3	4	

Group 6 Kinetics and Equilibrium					
82	1	2	3	4	
83	1	2	3	4	
84	1	2	3	4	
85	1	2	3	4	
86	1	2	3	4	

Group 7 Acids and Bases					
87	1	2	3	4	
88	1	2	3	4	
89	1	2	3	4	
90	1	2	3	4	
91	1	2	3	4	

Group 8 Redox and Electrochemistry					
92	1	2	3	4	
93	1	2	3	4	
94	1	2	3	4	
95	1	2	3	4	
96	1	2	3	4	

Group 9 Organic Chemistry					
97	1	2	3	4	
98	1	2	3	4	
99	1	2	3	4	
100	1	2	3	4	
101	1	2	3	4	

Group 10 Applications of Chemical Principles					
102	1	2	3	4	
103	1	2	3	4	
104	1	2	3	4	
105	1	2	3	4	
106	1	2	3	4	

Group 11 Nuclear Chemistry					
107	1	2	3	4	
108	1	2	3	4	
109	1	2	3	4	
110	1	2	3	4	
111	1	2	3	4	

Group 12 Laboratory Activities					
112	1	2	3	4	
113	1	2	3	4	
114	1	2	3	4	
115	1	2	3	4	
116	1	2	3	4	

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