The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Friday, June 18, 1999 — 1:15 to 4:15 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: (X) 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.

Part I

Answer all 56 questions in this part. [65]

Directions (1–56): For *each* statement or question, select the word or expression that, of those given, best completes the statement or answers the question. Record your answer on the separate answer sheet in accordance with the directions on the front page of this booklet.

1 Solid *A* at 80°C is immersed in liquid *B* at 60°C. Which statement correctly describes the energy changes between *A* and *B*?

(1) *A* releases heat and *B* absorbs heat.
(2) *A* absorbs heat and *B* releases heat.
(3) Both *A* and *B* absorb heat.
(4) Both *A* and *B* release heat.

2 Given the phase equilibrium at a pressure of 1 atmosphere:

$$H_2O(s) \rightleftharpoons H_2O(\ell)$$

What is the temperature of the equilibrium mixture?

(1) 273°C
(2) 273 K
(3) 373°C
(4) 373 K

3 Which statement is an identifying characteristic of a mixture?

(1) A mixture can consist of a single element.
(2) A mixture can be separated by physical means.
(3) A mixture must have a definite composition by weight.
(4) A mixture must be homogeneous.

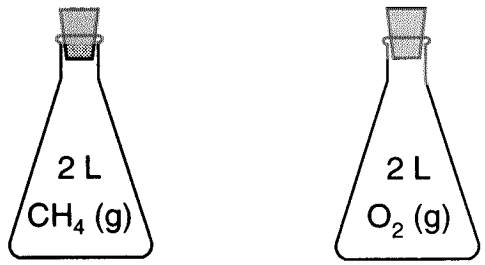
4 Which phase change is endothermic?

(1) gas → solid
(2) gas → liquid
(3) liquid → solid
(4) liquid → gas

5 What volume will a 300.-milliliter sample of a gas at STP occupy when the pressure is doubled at constant temperature?

(1) 150. mL
(2) 450. mL
(3) 300. mL
(4) 600. mL

6 Each stoppered flask below contains 2 liters of a gas at STP.



Each gas sample has the same

(1) density
(2) mass
(3) number of molecules
(4) number of atoms

7 Which electron configuration represents an atom in the excited state?

(1) $1s^2 2s^2 2p^6 3s^2$
(2) $1s^2 2s^2 2p^6 3s^1$
(3) $1s^2 2s^2 2p^6$
(4) $1s^2 2s^2 2p^5 3s^2$

8 Which electron-dot symbol represents an atom of chlorine in the ground state?

(1) Cl
(2) Cl
(3) Cl
(4) Cl

9 What is the total number of electrons in an atom of an element with an atomic number of 18 and a mass number of 40?

(1) 18
(2) 22
(3) 40
(4) 58

10 After bombarding a gold foil sheet with alpha particles, scientists concluded that atoms consist mainly of

(1) electrons
(2) empty space
(3) protons
(4) neutrons

11 Which element has atoms in the ground state with a sublevel that is only half filled?

(1) helium
(2) beryllium
(3) nitrogen
(4) neon

12 Which sublevel contains a total of 5 orbitals?

(1) *s*
(2) *p*
(3) *d*
(4) *f*

13 In how many days will a 12-gram sample of $^{131}_{53}I$ decay, leaving a total of 1.5 grams of the original isotope?

(1) 8.0
(2) 16
(3) 20.
(4) 24

14 Electronegativity is a measure of an atom's ability to

(1) attract the electrons in the bond between the atom and another atom
(2) repel the electrons in the bond between the atom and another atom
(3) attract the protons of another atom
(4) repel the protons of another atom

15 The molecular formula of a compound is represented by X_3Y_6. What is the empirical formula of this compound?

(1) X_3Y
(2) X_2Y
(3) XY_2
(4) XY_3

16 Given the unbalanced equation:

$$\_\_CaSO_4 + \_\_AlCl_3 \rightarrow \_\_Al_2(SO_4)_3 + \_\_CaCl_2$$

What is the coefficient of $Al_2(SO_4)_3$ when the equation is completely balanced using the smallest whole-number coefficients?

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

17 What is the total number of moles of sulfur atoms in 1 mole of $Fe_2(SO_4)_3$?

(1) 1
(2) 15
(3) 3
(4) 17

18 The elements Li and F combine to form an ionic compound. The electron configurations in this compound are the same as the electron configurations of atoms in Group

(1) 1
(2) 14
(3) 17
(4) 18

19 An element with an electronegativity of 0.9 bonds with an element with an electronegativity of 3.1. Which phrase best describes the bond between these elements?

(1) mostly ionic in character and formed between two nonmetals
(2) mostly ionic in character and formed between a metal and a nonmetal
(3) mostly covalent in character and formed between two nonmetals
(4) mostly covalent in character and formed between a metal and a nonmetal

20 The symmetrical structure of the CH_4 molecule is due to the fact that the four single bonds between carbon and hydrogen atoms are directed toward the corners of a

(1) triangle
(2) tetrahedron
(3) square
(4) rectangle

21 As the elements in Group 15 are considered in order of increasing atomic number, which sequence in properties occurs?

(1) nonmetal → metalloid → metal
(2) metalloid → metal → nonmetal
(3) metal → metalloid → nonmetal
(4) metal → nonmetal → metalloid

22 In which set do the elements exhibit the most similar chemical properties?

(1) N, O, and F
(2) Hg, Br, and Rn
(3) Li, Na, and K
(4) Al, Si, and P

23 Which reactant is most likely to have *d* electrons involved in a chemical reaction?

(1) a halogen
(2) a noble gas
(3) a transition element
(4) an alkali metal

24 Elements in a given period of the Periodic Table contain the same number of

(1) protons in the nucleus
(2) neutrons in the nucleus
(3) electrons in the outermost level
(4) occupied principal energy levels

25 The elements known as the alkaline earth metals are found in Group

(1) 1 (3) 16
(2) 2 (4) 17

26 The properties of silicon are characteristic of

(1) a metal, only
(2) a nonmetal, only
(3) both a metal and a nonmetal
(4) neither a metal nor a nonmetal

27 Which substance has the greatest molecular mass?

(1) H_2O_2 (3) CF_4
(2) NO (4) I_2

28 According to Reference Table *D*, which of the following substances is *least* soluble in 100 grams of water at 50°C?

(1) NaCl (3) NH_4Cl
(2) KCl (4) HCl

29 Which sample contains a total of 6.0×10^{23} atoms?

(1) 23 g Na (3) 42 g Kr
(2) 24 g C (4) 78 g K

30 A 20.-milliliter sample of 0.60 M HCl is diluted with water to a volume of 40. milliliters. What is the new concentration of the solution?

(1) 0.15 M (3) 0.30 M
(2) 0.60 M (4) 1.2 M

31 Given the reaction:

$$4Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$$

What is the minimum number of grams of oxygen gas required to produce 1.00 mole of aluminum oxide?

(1) 32.0 g (3) 96.0 g
(2) 48.0 g (4) 192 g

32 The minimum amount of energy required to start a chemical reaction is called

(1) entropy (3) free energy
(2) enthalpy (4) activation energy

33 Beaker *A* contains a 1-gram piece of zinc and beaker *B* contains 1 gram of powdered zinc. If 100 milliliters of 0.1 M HCl is added to each of the beakers, how does the rate of reaction in beaker *A* compare to the rate of reaction in beaker *B*?

(1) The rate in *A* is greater due to the smaller surface area of the zinc.
(2) The rate in *A* is greater due to the larger surface area of the zinc.
(3) The rate in *B* is greater due to the smaller surface area of the zinc.
(4) The rate in *B* is greater due to the larger surface area of the zinc.

34 Based on Reference Table *D*, which amount of a compound dissolved in 100 grams of water at the stated temperature represents a system at equilibrium?

(1) 20 g $KClO_3$ at 80°C
(2) 40 g KNO_3 at 25°C
(3) 40 g KCl at 60°C
(4) 60 g $NaNO_3$ at 40°C

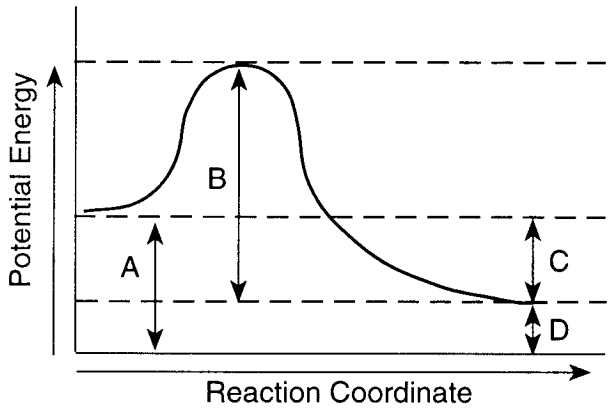
35 Given the reaction at equilibrium:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g) + 22 \text{ kcal}$$

Which stress would cause the equilibrium to shift to the left?

(1) increasing the temperature
(2) increasing the pressure
(3) adding $N_2(g)$ to the system
(4) adding $H_2(g)$ to the system

36 The potential energy diagram of a chemical reaction is shown below.



Which arrow represents the part of the reaction most likely to be affected by the addition of a catalyst?

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

37 Based on Reference Table *L*, which of the following acids is the strongest electrolyte?

(1) H_3PO_4
(2) HNO_2
(3) HCl
(4) HF

38 Based on Reference Table *L*, which substance is amphoteric (amphiprotic)?

(1) HS^-
(2) Br^-
(3) HBr
(4) H_2S

39 Which type of reaction occurs when 50-milliliter quantities of $Ba(OH)_2(aq)$ and $H_2SO_4(aq)$ are combined?

(1) hydrolysis
(2) ionization
(3) hydrogenation
(4) neutralization

40 In an acid solution, the $[H^+]$ ion is found to be 1×10^{-2} mole per liter. What is the $[OH^-]$ ion in moles per liter?

(1) 1×10^{-2}
(2) 1×10^{-7}
(3) 1×10^{-12}
(4) 1×10^{-14}

41 Which statement best describes the solution produced when an Arrhenius acid is dissolved in water?

(1) The only negative ion in solution is OH^-.
(2) The only negative ion in solution is HCO_3^-.
(3) The only positive ion in solution is H^+.
(4) The only positive ion in solution is NH_4^+.

42 In which reaction is water acting only as a Brönsted-Lowry base?

(1) $H_2SO_4(aq) + H_2O(\ell) \rightleftharpoons HSO_4^-(aq) + H_3O^+(aq)$
(2) $NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$
(3) $CH_3COO^-(aq) + H_2O(\ell) \rightleftharpoons CH_3COOH(aq) + OH^-(aq)$
(4) $H_2O(\ell) + H_2O(\ell) \rightleftharpoons H_3O^+(aq) + OH^-(aq)$

43 Which of the following 0.1 M solutions has the *lowest* pH?

(1) 0.1 M NaOH
(2) 0.1 M CH_3OH
(3) 0.1 M NaCl
(4) 0.1 M HCl

44 The reaction $2H_2O(\ell) \rightarrow 2H_2(g) + O_2(g)$ is forced to occur by use of an externally applied electric current. This procedure is called

(1) neutralization
(2) esterification
(3) electrolysis
(4) hydrolysis

45 Given the reaction:

$$3Sn^{4+}(aq) + 2Cr(s) \rightarrow 3Sn^{2+}(aq) + 2Cr^{3+}(aq)$$

Which half-reaction correctly represents the reduction that occurs?

(1) $Sn^{4+}(aq) + 2e^- \rightarrow Sn^{2+}(aq)$
(2) $Sn^{2+}(aq) \rightarrow Sn^{4+}(aq) + 2e^-$
(3) $Cr(s) \rightarrow Cr^{3+}(aq) + 3e^-$
(4) $Cr^{3+}(aq) + 3e^- \rightarrow Cr(s)$

46 The oxidation number of nitrogen in N_2 is

(1) +1
(2) 0
(3) +3
(4) –3

47 Which reaction is an organic reaction?

(1) $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
(3) $3Cu^{2+}(aq) + 2Fe(s) \rightarrow 3Cu(s) + 2Fe^{3+}(aq)$
(4) $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

48 Given the reaction:

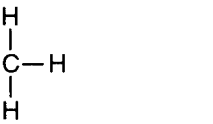
$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$

Which substance is oxidized?

(1) Zn(s)
(2) HCl(aq)
(3) $Cl^-(aq)$
(4) $H^+(aq)$

49 Which organic compound will dissolve in water to produce a solution that will turn blue litmus red?

(1)

(2)


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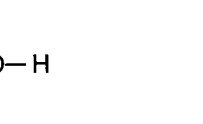

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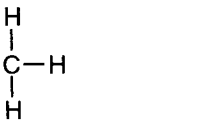


50 A redox reaction always demonstrates the conservation of

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

51 In which organic reaction is sugar converted to an alcohol and carbon dioxide?

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

52 Which three compounds belong to the same homologous series?

(1) CH_4, C_2H_6, C_3H_4
(2) C_3H_6, C_4H_8, C_5H_{10}
(3) C_4H_{10}, C_5H_{10}, C_6H_6
(4) C_2H_2, C_3H_4, C_4H_8

53 Which formula represents a saturated compound?

(1) C_2H_4
(2) C_2H_2
(3) C_3H_6
(4) C_3H_8

Note that questions 54 through 56 have only three choices.

54 Given the reaction: $2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$

As the reactants form products, the stability of the chemical system will

(1) decrease
(2) increase
(3) remain the same

55 As the elements of Group 1 are considered in order from top to bottom, the first ionization energy of each successive element will

(1) decrease
(2) increase
(3) remain the same

56 Given the reaction at equilibrium:

$$4HCl(g) + O_2(g) \rightleftharpoons 2Cl_2(g) + 2H_2O(g)$$

If the pressure on the system is increased, the concentration of $Cl_2(g)$ will

(1) decrease
(2) increase
(3) remain the same

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 Which substance can be decomposed by a chemical change?

(1) ammonia
(2) aluminum
(3) magnesium
(4) manganese

58 The heat required to change 1 gram of a solid at its normal melting point to a liquid at the same temperature is called the heat of

(1) vaporization
(2) fusion
(3) reaction
(4) formation

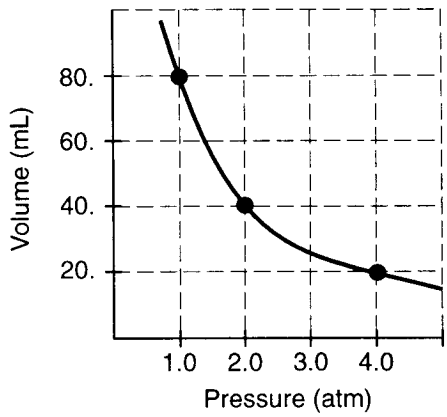
59 A real gas would behave most like an ideal gas under conditions of

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

60 The volume of a sample of a gas at 273°C is 200. liters. If the volume is decreased to 100. liters at constant pressure, what will be the new temperature of the gas?

(1) 0 K
(2) 100. K
(3) 273 K
(4) 546 K

61 The graph below represents the relationship between pressure and volume of a given mass of a gas at constant temperature.



The product of pressure and volume is constant. According to the graph, what is the product in atm•mL?

(1) 20.
(2) 40.
(3) 60.
(4) 80.

Group 2 — Atomic Structure

If you choose this group, be sure to answer questions 62–66.

62 The mass of a calcium atom is due primarily to the mass of its

(1) protons, only
(2) neutrons, only
(3) protons and neutrons
(4) protons and electrons

63 What is the maximum number of electrons that can occupy the fourth principal energy level of an atom?

(1) 6 (3) 18
(2) 8 (4) 32

64 Which element has no known stable isotope?

(1) Hg (3) Se
(2) Po (4) Zn

65 The characteristic spectral lines of elements are caused when electrons in an excited atom move from

(1) lower to higher energy levels, releasing energy
(2) lower to higher energy levels, absorbing energy
(3) higher to lower energy levels, releasing energy
(4) higher to lower energy levels, absorbing energy

66 What is the total number of protons contained in the nucleus of a carbon-14 atom?

(1) 6 (3) 12
(2) 8 (4) 14

Group 3 — Bonding

If you choose this group, be sure to answer questions 67–71.

67 At 298 K, the vapor pressure of H_2O is less than the vapor pressure of CH_3OH because H_2O has

(1) larger molecules
(2) a larger molecular mass
(3) stronger ionic bonds
(4) stronger hydrogen bonds

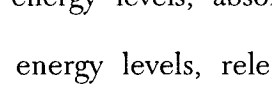
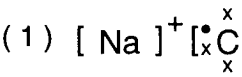
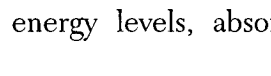
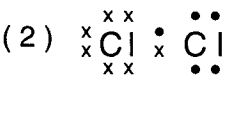
68 The chemical formula $CaCO_3$ is an example of an expression that is

(1) quantitative, only
(2) qualitative, only
(3) both quantitative and qualitative
(4) neither quantitative nor qualitative

69 When NaCl(s) is dissolved in $H_2O(\ell)$, the sodium ion is attracted to the water molecule's

(1) negative end, which is hydrogen
(2) negative end, which is oxygen
(3) positive end, which is hydrogen
(4) positive end, which is oxygen

70 Which electron-dot formula represents a substance that contains a nonpolar covalent bond?

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

71 What is the correct formula for iron (II) sulfide?

(1) FeS (3) Fe_2S_3
(2) $FeSO_3$ (4) $Fe_2(SO_4)_3$

Group 4 — Periodic Table

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

72 Which of the following groups in the Periodic Table contain elements so highly reactive they are never found in the free state?

(1) 1 and 2
(2) 1 and 11
(3) 2 and 15
(4) 11 and 15

73 The presence of which ion usually produces a colored solution?

(1) K^+
(2) F^-
(3) Fe^{2+}
(4) S^{2-}

74 How does the size of a barium ion compare to the size of a barium atom?

(1) The ion is smaller because it has fewer electrons.
(2) The ion is smaller because it has more electrons.
(3) The ion is larger because it has fewer electrons.
(4) The ion is larger because it has more electrons.

75 Which element is brittle in the solid phase and is a *poor* conductor of heat and electricity?

(1) calcium
(2) sulfur
(3) strontium
(4) copper

76 Which halogen can only be prepared by the electrolysis of its fused compounds?

(1) I_2
(2) Cl_2
(3) Br_2
(4) F_2

Group 5 — Mathematics of Chemistry

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

77 What is the mass of 1 mole of a gas that has a density of 2.00 grams per liter at STP?

(1) 11.2 g
(2) 22.4 g
(3) 33.6 g
(4) 44.8 g

78 Dissolving 1 mole of KCl in 1,000 grams of H_2O affects

(1) the boiling point of the H_2O, only
(2) the freezing point of the H_2O, only
(3) both the boiling point and the freezing point of the H_2O
(4) neither the boiling point nor the freezing point of the H_2O

79 The heat of vaporization of a liquid is 320. calories per gram. What is the minimum number of calories needed to change 40.0 grams of the liquid to vapor at the boiling point?

(1) 8.00
(2) 320.
(3) 3,280
(4) 12,800

80 A compound was analyzed and found to contain 75% carbon and 25% hydrogen by mass. What is the compound's empirical formula?

(1) CH
(2) CH_2
(3) CH_3
(4) CH_4

81 Which gas diffuses most rapidly at STP?

(1) Ne
(2) Ar
(3) Cl_2
(4) F_2

Group 6 — Kinetics and Equilibrium

If you choose this group, be sure to answer questions 82–86.

82 According to Reference Table *G*, which compound is spontaneously formed even though the reaction is endothermic?

(1) $ICl(g)$ (3) $H_2O(\ell)$
(2) $CO_2(g)$ (4) $Al_2O_3(s)$

83 Given the reaction at equilibrium:

$$BaCrO_4(s) \rightleftharpoons Ba^{2+}(aq) + CrO_4^{2-}(aq)$$

Which substance, when added to the mixture, will cause an increase in the amount of $BaCrO_4(s)$?

(1) K_2CO_3 (3) $BaCl_2$
(2) $CaCO_3$ (4) $CaCl_2$

84 At 1 atmosphere and 298 K, which saturated salt solution is most concentrated? [Refer to Reference Table *M*.]

(1) $PbCO_3$ (3) AgBr
(2) $PbCrO_4$ (4) AgCl

85 Given the reaction:

$$A_2B(s) \rightleftharpoons 2A^+(aq) + B^{2-}(aq)$$

What is the solubility product constant expression (K_{sp}) for this reaction?

(1) $2[A^+]\,[B^{2-}]$ (3) $[A^+]^2\,[B^{2-}]$
(2) $2[A^+] + [B^{2-}]$ (4) $[A^+]^2 + [B^{2-}]$

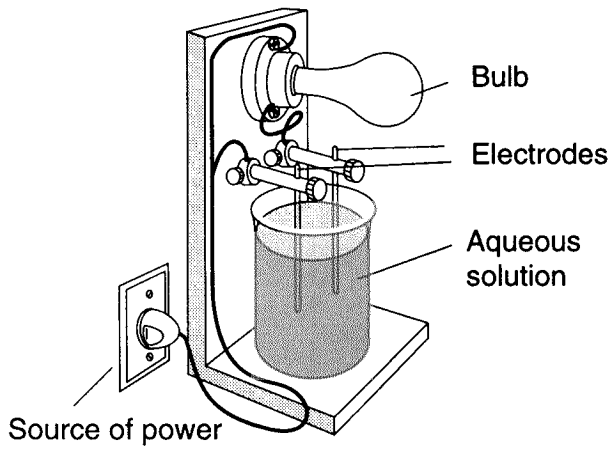
86 Which factors must be equal when a reversible chemical process reaches equilibrium?

(1) mass of the reactants and mass of the products
(2) rate of the forward reaction and rate of the reverse reaction
(3) concentration of the reactants and concentration of the products
(4) activation energy of the forward reaction and activation energy of the reverse reaction

Group 7 — Acids and Bases

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

87 The diagram below shows an apparatus used to test the conductivity of various materials.



Which aqueous solution will cause the bulb to light?

(1) $C_6H_{12}O_6(aq)$
(2) $C_{12}H_{22}O_{11}(aq)$
(3) $CH_3OH(aq)$
(4) $LiOH(aq)$

88 If 50.0 milliliters of 3.0 M HNO_3 completely neutralized 150.0 milliliters of KOH, what was the molarity of the KOH solution?

(1) 1.0 M
(2) 4.5 M
(3) 3.0 M
(4) 6.0 M

89 According to the Arrhenius theory, which list of compounds includes only bases?

(1) KOH, $Ca(OH)_2$, and CH_3OH
(2) KOH, NaOH, and LiOH
(3) LiOH, $Ca(OH)_2$, and $C_2H_4(OH)_2$
(4) NaOH, $Ca(OH)_2$, and CH_3COOH

90 Given the reaction:

$$NH_3(g) + H_2O(\ell) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$$

Which is a conjugate acid-base pair?

(1) $H_2O(\ell)$ and $NH_4^+(aq)$
(2) $H_2O(\ell)$ and $NH_3(g)$
(3) $NH_3(g)$ and $OH^-(aq)$
(4) $NH_3(g)$ and $NH_4^+(aq)$

91 Given the reaction:

$$HC_2H_3O_2(aq) + KOH(aq) \rightarrow KC_2H_3O_2(aq) + H_2O(\ell)$$

The products of this reaction form a salt solution that is

(1) acidic and turns litmus blue
(2) acidic and turns litmus red
(3) basic and turns litmus blue
(4) basic and turns litmus red

Group 8 — Redox and Electrochemistry

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

92 What is the E^0 for the half-reaction $Cu^+ + e^- \rightarrow Cu(s)$?

(1) –0.52 V
(2) –0.34 V
(3) +0.34 V
(4) +0.52 V

93 Given the balanced reaction:

$$2Al(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2(g)$$

What is the total number of moles of electrons gained by $H^+(aq)$ when 2 moles of Al(s) is completely reacted?

(1) 6
(2) 2
(3) 3
(4) 12

94 Given the redox reaction:

$$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$$

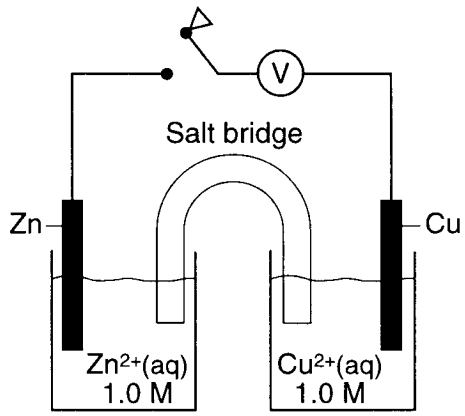
Which species acts as the oxidizing agent?

(1) Cu(s)
(2) $Cu^{2+}(aq)$
(3) Mg(s)
(4) $Mg^{2+}(aq)$

95 In an electrolytic cell, the negative electrode is called the

(1) anode, at which oxidation occurs
(2) anode, at which reduction occurs
(3) cathode, at which oxidation occurs
(4) cathode, at which reduction occurs

96 The diagram below represents an electrochemical cell.



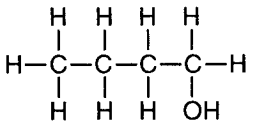
What occurs when the switch is closed?

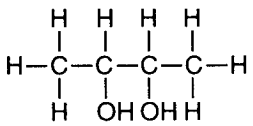
(1) Zn is reduced.
(2) Cu is oxidized.
(3) Electrons flow from Cu to Zn.
(4) Electrons flow from Zn to Cu.

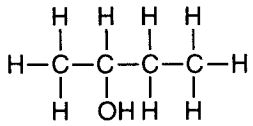
Group 9 — Organic Chemistry

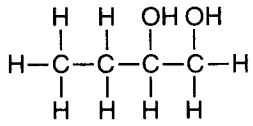
If you choose this group, be sure to answer questions 97–101.

97 Which structural formula represents a primary alcohol?

(1)


(2)


(3)


(4)


98 Which materials are naturally occurring polymers?

(1) nylon and cellulose
(2) nylon and polyethylene
(3) starch and cellulose
(4) starch and polyethylene

99 Which formula represents an isomer of the compound propanoic acid, CH_3CH_2COOH?

(1) $CH_3CH_2CH_2OH$
(2) $CH_3CH_2CH_2COOH$
(3) $CH_3CH(OH)CH_2OH$
(4) CH_3COOCH_3

100 The compound 1,2-ethanediol is a

(1) monohydroxy alcohol
(2) dihydroxy alcohol
(3) primary alcohol
(4) secondary alcohol

101 Which reaction best represents the complete combustion of ethene?

(1) $C_2H_4 + HCl \rightarrow C_2H_5Cl$
(2) $C_2H_4 + Cl_2 \rightarrow C_2H_4Cl_2$
(3) $C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O$
(4) $C_2H_4 + H_2O \rightarrow C_2H_5OH$

Group 10 — Applications of Chemical Principles

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

102 During the contact process, the ores of which kind of compounds are burned to produce SO_2?

(1) bromides
(2) carbides
(3) phosphides
(4) sulfides

103 Given the equation for the overall reaction in a lead-acid storage battery:

$$Pb(s) + PbO_2(s) + 2H_2SO_4(aq) \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} 2PbSO_4(s) + 2H_2O(\ell)$$

Which occurs during the charging of the battery?

(1) The concentration of H_2SO_4 decreases and the number of moles of Pb(s) increases.
(2) The concentration of H_2SO_4 decreases and the number of moles of $H_2O(\ell)$ increases.
(3) The concentration of H_2SO_4 increases and the number of moles of Pb(s) decreases.
(4) The concentration of H_2SO_4 increases and the number of moles of $H_2O(\ell)$ decreases.

104 The corrosion of iron is an example of

(1) an oxidation-reduction reaction
(2) an addition reaction
(3) a substitution reaction
(4) a neutralization reaction

105 The separation of petroleum into components based on their boiling points is accomplished by

(1) cracking
(2) melting
(3) fractional distillation
(4) addition polymerization

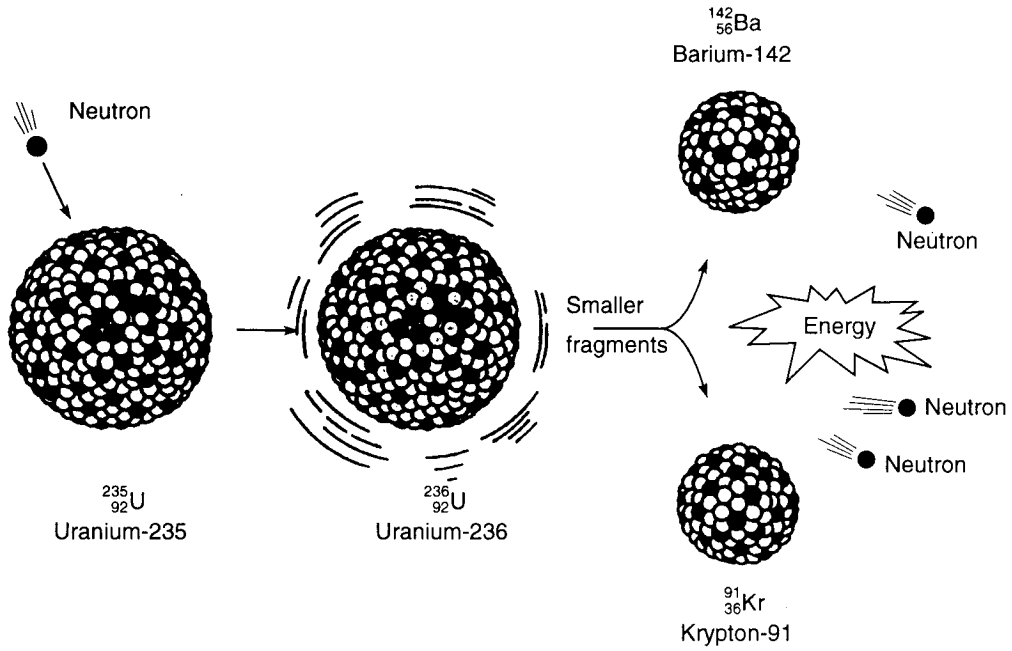
106 Petroleum is a complex mixture of many

(1) hydrocarbons
(2) aldehydes
(3) organic halides
(4) ketones

Group 11 — Nuclear Chemistry

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

107 The diagram below represents a nuclear reaction in which a neutron bombards a heavy nucleus.



Which type of reaction does the diagram illustrate?

(1) fission
(2) fusion
(3) alpha decay
(4) beta decay

---

108 Within a nuclear reactor, the purpose of the moderator is to

(1) absorb neutrons in the reactor core
(2) absorb neutrons in the outer containment structure
(3) slow down neutrons in the reactor core
(4) slow down neutrons in the outer containment structure

109 The radioisotope I-131 is used to

(1) control nuclear reactors
(2) determine the age of fossils
(3) diagnose thyroid disorders
(4) trigger fusion reactors

110 In which list can all particles be accelerated by an electric field?

(1) alpha particles, beta particles, and neutrons
(2) alpha particles, beta particles, and protons
(3) alpha particles, protons, and neutrons
(4) beta particles, protons, and neutrons

111 Given the nuclear reaction:

$$^{9}_{4}\text{Be} + X \rightarrow {}^{12}_{6}\text{C} + {}^{1}_{0}\text{n}$$

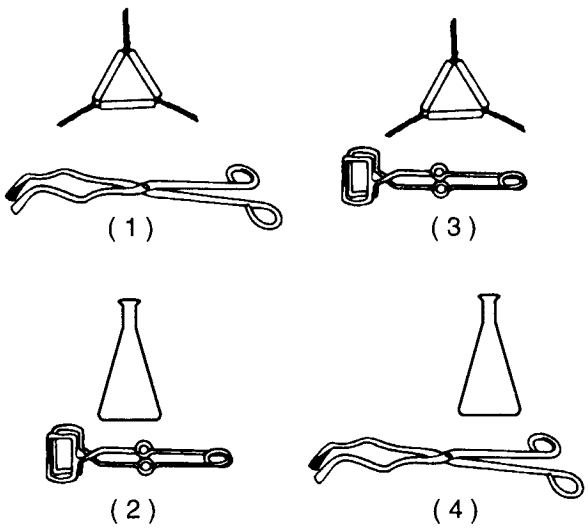
What is the identity of particle X?

(1) alpha particle
(2) beta particle
(3) proton
(4) neutron

Group 12 — Laboratory Activities

If you choose this group, be sure to answer questions 112–116.

112 Which set of laboratory equipment would most likely be used with a crucible?



113 A student calculated the percent by mass of water in a sample of $BaCl_2 \cdot 2H_2O$ to be 16.4%, but the accepted value is 14.8%. What was the student's percent error?

(1) $\frac{14.8}{16.4} \times 100\%$

(2) $\frac{16.4}{14.8} \times 100\%$

(3) $\frac{1.6}{14.8} \times 100\%$

(4) $\frac{14.8}{1.6} \times 100\%$

114 A student observed the following reaction:

$$AlCl_3(aq) + 3NaOH(aq) \rightarrow Al(OH)_3(s) + 3NaCl(aq)$$

After the products were filtered, which substance remained on the filter paper?

(1) NaCl
(2) NaOH
(3) $AlCl_3$
(4) $Al(OH)_3$

115 The table below shows the data collected by a student as heat was applied at a constant rate to a solid below its freezing point.

Time (min)	Temperature (°C)	Time (min)	Temperature (°C)
0	20	18	44
2	24	20	47
4	28	22	51
6	32	24	54
8	32	26	54
10	32	28	54
12	35	30	54
14	38	32	58
16	41	34	62

What is the boiling point of this substance?

(1) 32°C
(2) 54°C
(3) 62°C
(4) 100°C

116 Which quantity expresses the sum of the given masses to the correct number of significant figures?

$$\begin{array}{r} 22.1 \text{ g} \\ 375.66 \text{ g} \\ +\ 5400.132 \text{ g} \\ \hline \end{array}$$

(1) 5800 g
(2) 5798 g
(3) 5797.9 g
(4) 5797.892 g

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Friday, June 18, 1999 — 1:15 to 4:15 p.m., only

ANSWER SHEET

Student ..... Sex: ☐ Male ☐ Female

Teacher .....

School .....

Record all of your answers on this answer sheet in accordance with the instructions on the front cover of the test booklet.

Part I (65 credits)

1	1	2	3	4	**21**	1	2	3	4	**41**	1	2	3	4
2	1	2	3	4	**22**	1	2	3	4	**42**	1	2	3	4
3	1	2	3	4	**23**	1	2	3	4	**43**	1	2	3	4
4	1	2	3	4	**24**	1	2	3	4	**44**	1	2	3	4
5	1	2	3	4	**25**	1	2	3	4	**45**	1	2	3	4
6	1	2	3	4	**26**	1	2	3	4	**46**	1	2	3	4
7	1	2	3	4	**27**	1	2	3	4	**47**	1	2	3	4
8	1	2	3	4	**28**	1	2	3	4	**48**	1	2	3	4
9	1	2	3	4	**29**	1	2	3	4	**49**	1	2	3	4
10	1	2	3	4	**30**	1	2	3	4	**50**	1	2	3	4
11	1	2	3	4	**31**	1	2	3	4	**51**	1	2	3	4
12	1	2	3	4	**32**	1	2	3	4	**52**	1	2	3	4
13	1	2	3	4	**33**	1	2	3	4	**53**	1	2	3	4
14	1	2	3	4	**34**	1	2	3	4	**54**	1	2	3	
15	1	2	3	4	**35**	1	2	3	4	**55**	1	2	3	
16	1	2	3	4	**36**	1	2	3	4	**56**	1	2	3	
17	1	2	3	4	**37**	1	2	3	4					
18	1	2	3	4	**38**	1	2	3	4					
19	1	2	3	4	**39**	1	2	3	4					
20	1	2	3	4	**40**	1	2	3	4					

FOR TEACHER USE ONLY

	Credits
Part I (Use table below)	.....
Part II	.....
Total	.....

Rater's Initials: .....

Part I Credits

Directions to Teacher:

In the table below, draw a circle around the number of right answers and the adjacent number of credits. Then write the number of credits (not the number right) in the space provided above.

No. Right	Credits	No. Right	Credits
56	**65**	28	**40**
55	**64**	27	**39**
54	**63**	26	**38**
53	**62**	25	**38**
52	**61**	24	**37**
51	**61**	23	**36**
50	**60**	22	**35**
49	**59**	21	**34**
48	**58**	20	**33**
47	**57**	19	**32**
46	**56**	18	**31**
45	**55**	17	**30**
44	**54**	16	**30**
43	**53**	15	**29**
42	**53**	14	**28**
41	**52**	13	**26**
40	**51**	12	**24**
39	**50**	11	**22**
38	**49**	10	**20**
37	**48**	9	**18**
36	**47**	8	**16**
35	**46**	7	**14**
34	**46**	6	**12**
33	**45**	5	**10**
32	**44**	4	**8**
31	**43**	3	**6**
30	**42**	2	**4**
29	**41**	1	**2**
		0	**0**

No. right .....

Your answers for Part II should be placed in the proper spaces on the back of this sheet.

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

FOR TEACHERS ONLY

C

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

CHEMISTRY

Friday, June 18, 1999—1:15 to 4:15 p.m., only

SCORING KEY

Part I

Refer to the table on the answer sheet for the number of credits to be given on Part I.

Part I (65 credits)

1	**X**	2	3	4	21	**X**	2	3	4	41	1	2	**X**	4
2	1	**X**	3	4	22	1	2	**X**	4	42	**X**	2	3	4
3	1	**X**	3	4	23	1	2	**X**	4	43	1	2	3	**X**
4	1	2	3	**X**	24	1	2	3	**X**	44	1	2	**X**	4
5	**X**	2	3	4	25	1	**X**	3	4	45	**X**	2	3	4
6	1	2	**X**	4	26	1	2	**X**	4	46	1	**X**	3	4
7	1	2	3	**X**	27	1	2	3	**X**	47	**X**	2	3	4
8	1	2	3	**X**	28	**X**	2	3	4	48	**X**	2	3	4
9	**X**	2	3	4	29	**X**	2	3	4	49	1	2	**X**	4
10	1	**X**	3	4	30	1	2	**X**	4	50	1	2	**X**	4
11	1	2	**X**	4	31	1	**X**	3	4	51	1	2	3	**X**
12	1	2	**X**	4	32	1	2	3	**X**	52	1	**X**	3	4
13	1	2	3	**X**	33	1	2	3	**X**	53	1	2	3	**X**
14	**X**	2	3	4	34	1	**X**	3	4	54	1	**X**	3	
15	1	2	**X**	4	35	**X**	2	3	4	55	**X**	2	3	
16	**X**	2	3	4	36	1	**X**	3	4	56	1	**X**	3	
17	1	2	**X**	4	37	1	2	**X**	4					
18	1	2	3	**X**	38	**X**	2	3	4					
19	1	**X**	3	4	39	1	2	3	**X**					
20	1	**X**	3	4	40	1	2	**X**	4					

Directions to the teacher:

Use only *red* ink or *red* pencil in rating Regents examination papers. Do *not* correct the student's work by making insertions or changes of any kind.

Scan each answer sheet to make certain that the student has marked only one answer for each question. If a student has marked two or more answers with an X in ink, draw a red line through the row of numbers for that question to indicate that no credit is to be allowed for that question when the answer sheet is scored.

To facilitate scoring, the scoring key has been printed in the same format as the answer sheet. The scoring key may be made into a scoring stencil by punching out the correct answers. Be sure that the stencil is aligned with the answer sheet so that the holes correspond to the correct answers. To aid in proper alignment, punch out the first and last item numbers in each part and place the stencil on the answer sheet so that these item numbers appear through the appropriate holes.

Part II

Allow a total of 35 credits, one credit for each question, for only seven of the twelve groups in this part. If more than seven groups are answered, only the first seven answered should be considered.

Group 1
Matter and Energy

57	**X**	2	3	4
58	1	**X**	3	4
59	1	**X**	3	4
60	1	2	**X**	4
61	1	2	3	**X**

Group 2
Atomic Structure

62	1	2	**X**	4
63	1	2	3	**X**
64	1	**X**	3	4
65	1	2	**X**	4
66	**X**	2	3	4

Group 3
Bonding

67	1	2	3	**X**
68	1	2	**X**	4
69	1	**X**	3	4
70	1	**X**	3	4
71	**X**	2	3	4

Group 4
Periodic Table

72	**X**	2	3	4
73	1	2	**X**	4
74	**X**	2	3	4
75	1	**X**	3	4
76	1	2	3	**X**

Group 5
Mathematics of Chemistry

77	1	2	3	**X**
78	1	2	**X**	4
79	1	2	3	**X**
80	1	2	3	**X**
81	**X**	2	3	4

Group 6
Kinetics and Equilibrium

82	**X**	2	3	4
83	1	2	**X**	4
84	1	2	3	**X**
85	1	2	**X**	4
86	1	**X**	3	4

Group 7
Acids and Bases

87	1	2	3	**X**
88	**X**	2	3	4
89	1	**X**	3	4
90	1	2	3	**X**
91	1	2	**X**	4

Group 8
Redox and Electrochemistry

92	1	2	3	**X**
93	**X**	2	3	4
94	1	**X**	3	4
95	1	2	3	**X**
96	1	2	3	**X**

Group 9
Organic Chemistry

97	**X**	2	3	4
98	1	2	**X**	4
99	1	2	3	**X**
100	1	**X**	3	4
101	1	2	**X**	4

Group 10
Applications of Chemical Principles

102	1	2	3	**X**
103	1	2	3	**X**
104	**X**	2	3	4
105	1	2	**X**	4
106	**X**	2	3	4

Group 11
Nuclear Chemistry

107	**X**	2	3	4
108	1	2	**X**	4
109	1	2	**X**	4
110	1	**X**	3	4
111	**X**	2	3	4

Group 12
Laboratory Activities

112	**X**	2	3	4
113	1	2	**X**	4
114	1	2	3	**X**
115	1	**X**	3	4
116	1	2	**X**	4