The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Tuesday, January 22, 2002 — 9:15 a.m. to 12:15 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 Which sample of water has the *lowest* vapor pressure?

(1) 100 mL at 50°C
(2) 200 mL at 30°C
(3) 300 mL at 40°C
(4) 400 mL at 20°C

2 Which type of matter is composed of two or more different elements that are chemically combined in a definite ratio?

(1) a solution
(2) a compound
(3) a homogeneous mixture
(4) a heterogeneous mixture

3 A sealed flask containing 1.0 mole of $H_2(g)$ and a sealed flask containing 2.0 moles of He(g) are at the same temperature. The two gases must have equal

(1) masses
(2) volumes
(3) average kinetic energies
(4) numbers of molecules

4 Two basic properties of the gas phase are

(1) a definite shape and a definite volume
(2) a definite shape but no definite volume
(3) no definite shape but a definite volume
(4) no definite shape and no definite volume

5 The temperature at which the solid and liquid phases of matter exist in equilibrium is called its

(1) melting point
(2) boiling point
(3) heat of fusion
(4) heat of vaporization

6 Which element has an atom with the electron configuration 2–8–8–2?

(1) Mg
(2) Ni
(3) Ca
(4) Ge

7 Which type of radiation has *neither* mass nor charge?

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

8 Which list of particles is in order of increasing mass?

(1) proton → electron → alpha particle
(2) proton → alpha particle → electron
(3) electron → proton → alpha particle
(4) alpha particle → electron → proton

9 Compared to a sodium atom in the ground state, a sodium atom in the excited state must have

(1) a greater number of electrons
(2) a smaller number of electrons
(3) an electron with greater energy
(4) an electron with less energy

10 Which particles are isotopes of each other?

(1) ${}^{1}_{1}X$ and ${}^{3}_{1}X$
(2) ${}^{2}_{1}X$ and ${}^{3}_{2}X$
(3) ${}^{2}_{1}X$ and ${}^{4}_{2}X$
(4) ${}^{3}_{1}X$ and ${}^{3}_{2}X$

11 Which electron-dot symbol correctly represents an atom of its given element?

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

12 The half-life of a radioactive substance is 2.5 minutes. What fraction of the original radioactive substance remains after 10 minutes?

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

(2) $\frac{1}{4}$ (4) $\frac{1}{16}$

13 Given the unbalanced equation:

$$\_\_\_ Mg(ClO_3)_2(s) \rightarrow \_\_\_ MgCl_2(s) + \_\_\_ O_2(g)$$

What is the coefficient of O_2 when the equation is balanced correctly using the *smallest* whole-number coefficients?

(1) 1 (3) 3

(2) 2 (4) 4

14 The burning of magnesium involves a conversion of

(1) chemical energy to mechanical energy
(2) chemical energy to heat energy
(3) heat energy to chemical energy
(4) heat energy to mechanical energy

15 The chemical formula for nickel (II) bromide is

(1) Ni_2Br (3) N_2Br

(2) $NiBr_2$ (4) NBr_2

16 Which statement explains why H_2O has a higher boiling point than N_2?

(1) H_2O has greater molar mass than N_2.
(2) H_2O has less molar mass than N_2.
(3) H_2O has stronger intermolecular forces than N_2.
(4) H_2O has weaker intermolecular forces than N_2.

17 The ability of carbon to attract electrons is

(1) greater than that of nitrogen, but less than that of oxygen
(2) less than that of nitrogen, but greater than that of oxygen
(3) greater than that of nitrogen and oxygen
(4) less than that of nitrogen and oxygen

18 In aqueous solution, a chloride ion is attracted to which end of the water molecule?

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

19 Which statement best describes the substance that results when electrons are transferred from a metal to a nonmetal?

(1) It contains ionic bonds and has a low melting point.
(2) It contains ionic bonds and has a high melting point.
(3) It contains covalent bonds and has a low melting point.
(4) It contains covalent bonds and has a high melting point.

20 Which trends appear as the elements in Period 3 are considered from left to right?

(1) Metallic character decreases, and electronegativity decreases.
(2) Metallic character decreases, and electronegativity increases.
(3) Metallic character increases, and electronegativity decreases.
(4) Metallic character increases, and electronegativity increases.

21 Which statement is true about the properties of the elements in any one period of the Periodic Table?

(1) They are determined by the number of neutrons.
(2) They are determined by the number of electrons in the first shell.
(3) They change in a generally systematic manner.
(4) They change in a random, unpredictable manner.

22 Arsenic and silicon are similar in that they both

(1) have the same ionization energy
(2) have the same covalent radius
(3) are transition metals
(4) are metalloids

23 Which statement explains why the radius of a lithium atom is larger than the radius of a lithium ion?

(1) Metals lose electrons when forming an ion.
(2) Metals gain electrons when forming an ion.
(3) Nonmetals lose electrons when forming an ion.
(4) Nonmetals gain electrons when forming an ion.

24 The atoms of the elements in Group 2 have the same

(1) mass number
(2) atomic number
(3) number of protons
(4) number of valence electrons

25 Which element has the highest electrical conductivity?

(1) Mg (3) He
(2) H (4) Cl

26 Most metals have the properties of

(1) brittleness and high ionization energy
(2) brittleness and low ionization energy
(3) ductility and high ionization energy
(4) ductility and low ionization energy

27 Given the reaction:

$$C_6H_{12}O_6(s) + 6\,O_2(g) \rightarrow 6CO_2(g) + 6H_2(\ell)$$

How many moles of $C_6H_{12}O_6(s)$ are needed to produce 24 moles of carbon dioxide?

(1) 1.0 mole (3) 24 moles
(2) 12 moles (4) 4.0 moles

28 Which formula is an empirical formula?

(1) C_2H_6 (3) H_2O
(2) C_4H_{10} (4) H_2O_2

29 What is the percent by mass of oxygen in $Ca(OH)_2$? [formula mass = 74.1]

(1) 21.6% (3) 45.9%
(2) 43.2% (4) 54.1%

30 A closed container holds 3.0 moles of CO_2 gas at STP. What is the total number of moles of Ne(g) that can be placed in a container of the same size at STP?

(1) 1.0 mole (3) 3.0 moles
(2) 1.5 moles (4) 0.0 moles

31 According to Reference Table *G*, how many grams of KNO_3 would be needed to saturate 200 grams of water at 70°C?

(1) 43 g (3) 134 g
(2) 86 g (4) 268 g

32 According to Reference Table *G*, which of these substances is most soluble at 60°C?

(1) NaCl (3) $KClO_3$
(2) KCl (4) NH_4Cl

33 Which statement best describes a chemical reaction when it reaches equilibrium?

(1) The concentrations of reactants and products are the same.
(2) The concentrations of the reactants decrease to zero.
(3) The forward and reverse reaction rates are the same.
(4) The forward reaction rate decreases to zero.

34 Which reaction has the greatest increase in entropy?

(1) $2H_2O(\ell) \rightarrow 2H_2(g) + O_2(g)$
(2) $2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$
(3) $H_2O(g) \rightarrow H_2O(\ell)$
(4) $H_2O(\ell) \rightarrow H_2O(s)$

35 In a potential energy diagram, the difference between the potential energy of the products and the potential energy of the reactants is equal to the

(1) heat of reaction
(2) entropy of the reaction
(3) activation energy of the forward reaction
(4) activation energy of the reverse reaction

36 Equal volumes of 0.1 M NaOH and 0.1 M HCl are thoroughly mixed. The resulting solution has a pH closest to

(1) 5 (3) 3
(2) 7 (4) 9

37 Which substance can act as an Arrhenius base in an aqueous solution?

(1) LiCl (3) LiBr
(2) $LiNO_3$ (4) LiOH

38 Based on Reference Table *F*, which salt is the strongest electrolyte?

(1) $CaCO_3$ (3) AgCl
(2) Na_2SO_4 (4) $Zn_3(PO_4)_2$

39 How many liters of 2.5 M HCl are required to exactly neutralize 1.5 liters of 5.0 M NaOH?

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

40 Given the reaction:

$$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$

The water acts as the

(1) base (3) proton acceptor
(2) acid (4) electron donor

41 Which reaction represents the process of neutralization?

(1) $Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$
(2) $HCl(aq) + KOH(aq) \rightarrow KCl(aq) + H_2O(\ell)$
(3) $Pb(NO_3)_2(aq) + CaCl_2(aq) \rightarrow Ca(NO_3)_2(aq) + PbCl_2(s)$
(4) $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

42 Which expression correctly represents a balanced reduction half-reaction?

(1) $Na^+ + e^- \rightarrow Na$ (3) $Cl_2 + 2e^- \rightarrow Cl^-$
(2) $Na \rightarrow Na^+ + e^-$ (4) $2Cl^- \rightarrow Cl_2 + 2e^-$

43 Which component of an electrochemical cell is correctly paired with its function?

(1) external conductor — allows the solutions to mix
(2) external conductor — permits the migration of ions
(3) salt bridge — allows the solutions to mix
(4) salt bridge — permits the migration of ions

44 In which substance is the oxidation number of Cl equal to +1?

(1) Cl_2 (3) $AlCl_3$
(2) Cl_2O (4) $HClO_2$

45 Given the reaction:

$$2Na(s) + 2H_2O(\ell) \rightarrow 2NaOH(aq) + H_2(g)$$

Which substance undergoes oxidation?

(1) Na (3) H_2
(2) NaOH (4) H_2O

46 In which substance does hydrogen have an oxidation number of zero?

(1) LiH (3) H_2S
(2) H_2O (4) H_2

47 In a redox reaction, there is conservation of

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

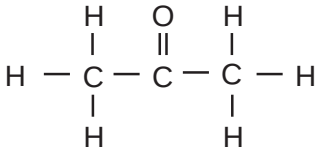
48 Which element is present in all organic compounds?

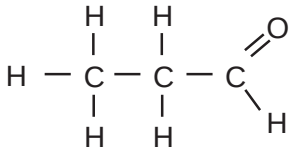
(1) H (3) C
(2) He (4) Ca

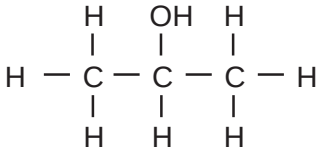
49 When butane burns in an excess of oxygen, the principal products are

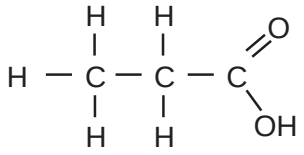
(1) CO_2 and H_2O (3) CO and H_2O
(2) CO_2 and H_2 (4) CO and H_2

50 Which structural formula represents an isomer of 1-propanol?

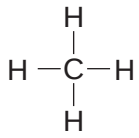
(1) 

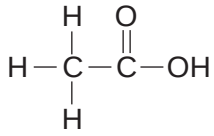
(2) 

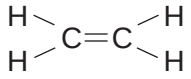
(3) 

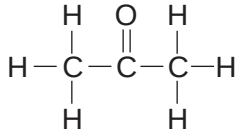
(4) 

51 Which structural formula represents an unsaturated hydrocarbon?

(1) 

(2) 

(3) 

(4) 

52 Organic compounds that are essentially nonpolar and exhibit weak intermolecular forces have

(1) low vapor pressure
(2) low melting points
(3) high boiling points
(4) high electrical conductivity in solution

Note that questions 53 through 56 have only three choices.

53 As the concentration of reacting particles increases, the rate of reaction generally

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

54 As an aqueous solution becomes more acidic, the hydroxide ion concentration

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

55 As the pressure on a gas confined above a liquid increases, the solubility of the gas in the liquid

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

56 As the temperature of a gas increases at constant pressure, the volume of the gas

(1) decreases
(2) increases
(3) remains 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 has vibrating particles in regular, fixed positions?

(1) Ca(s)
(2) Hg(ℓ)
(3) $Cl_2(g)$
(4) $CaCl_2(aq)$

58 Based on Reference Table *H*, which sample has the highest vapor pressure?

(1) water at 20°C
(2) water at 80°C
(3) ethanol at 50°C
(4) ethanol at 65°C

59 If 4.00 moles of oxygen gas, 3.00 moles of hydrogen gas, and 1.00 mole of nitrogen gas are combined in a closed container at standard pressure, what is the partial pressure exerted by the hydrogen gas?

(1) 1.00 atm
(2) 0.125 atm
(3) 3.00 atm
(4) 0.375 atm

60 A real gas differs from an ideal gas because the molecules of real gas have

(1) some volume and no attraction for each other
(2) some volume and some attraction for each other
(3) no volume and no attraction for each other
(4) no volume and some attraction for each other

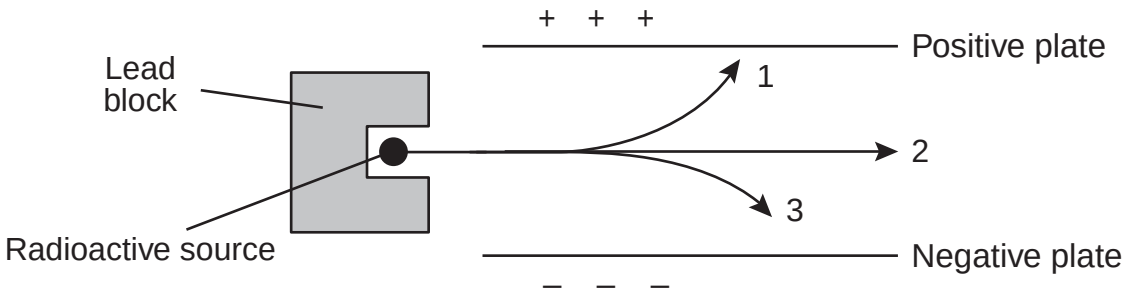
61 Which temperature change would cause the volume of a sample of an ideal gas to double when the pressure of the sample remains the same?

(1) from 200°C to 400°C
(2) from 400°C to 200°C
(3) from 200 K to 400 K
(4) from 400 K to 200 K

Group 2 — Atomic Structure

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

62 The diagram below represents radioactive emanations passing through an electric field.



Which type of emanation is represented by the arrow labeled 1?

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

63 What is the total number of neutrons in an atom of $^{7}_{3}Li$?

(1) 7
(2) 10
(3) 3
(4) 4

64 In Rutherford's gold foil experiments, some alpha particles were deflected from their original paths but most passed through the foil with no deflection. Which statement about gold atoms is supported by these experimental observations?

(1) Gold atoms consist mostly of empty space.
(2) Gold atoms are similar to alpha particles.
(3) Alpha particles and gold nuclei have opposite charges.
(4) Alpha particles are more dense than gold atoms.

65 The characteristic bright-line spectrum of an element occurs when electrons

(1) move from lower to higher energy levels
(2) move from higher to lower energy levels
(3) are lost by a neutral atom
(4) are gained by a neutral atom

66 What is the total number of valence electrons in a fluorine atom in the ground state?

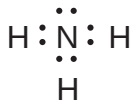
(1) 5
(2) 2
(3) 7
(4) 9

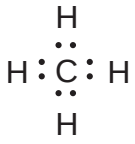
Group 3 — Bonding

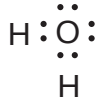
If you choose this group, be sure to answer questions 67–71.

67 Which electron-dot structure represents a nonpolar molecule?

(1) 

(3) 

(2) 

(4) 

68 Which bond is most polar?

(1) H—F
(2) H—Cl
(3) H—Br
(4) H—I

69 Which formula represents a compound that is formed primarily by sharing electrons?

(1) KCl
(2) $CaCl_2$
(3) $CrCl_3$
(4) CCl_4

70 When a chemical bond is broken, energy is

(1) absorbed, only
(2) released, only
(3) both absorbed and released
(4) neither absorbed nor released

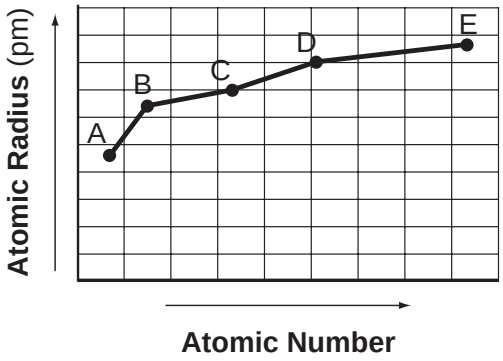
71 Which compound has molecules that form the strongest hydrogen bonds?

(1) HI
(2) HBr
(3) HF
(4) HCl

Group 4 — Periodic Table

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

72 The graph below represents the relationship between atomic radii, in picometers, and increasing atomic number for elements in Group 15.



Which element is most metallic?

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

73 As the atoms in Period 3 of the Periodic Table are considered from left to right, the atoms generally show

(1) an increase in radius and an increase in ionization energy
(2) an increase in radius and a decrease in ionization energy
(3) a decrease in radius and an increase in ionization energy
(4) a decrease in radius and a decrease in ionization energy

74 Which element of Group 17 exists as a solid at 25°C and standard pressure?

(1) fluorine
(2) chlorine
(3) bromine
(4) iodine

75 Which group in the Periodic Table contains elements that are all monatomic gases at STP?

(1) 15
(2) 16
(3) 17
(4) 18

76 Which molecule contains a triple covalent bond between its atoms?

(1) N_2
(2) O_2
(3) F_2
(4) H_2

Group 5 — Mathematics of Chemistry

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

77 Which sample of matter is classified as a solution?

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

78 A 3.00-liter sample of gas is at 288 K and 1.00 atm. If the pressure of the gas is increased to 2.00 atm and its volume is decreased to 1.50 liters, the Kelvin temperature of the sample will be

(1) 144 K
(2) 288 K
(3) 432 K
(4) 576 K

79 The gram-formula mass of $(NH_4)_2CO_3$ is

(1) 46.0 g
(2) 64.0 g
(3) 78.0 g
(4) 96.0 g

80 What is the total number of moles of atoms contained in 1 mole of NH_3?

(1) 1 mole
(2) 2 moles
(3) 3 moles
(4) 4 moles

81 Which preparation produces a 2.0 M solution of $C_6H_{12}O_6$? [molecular mass = 180.0]

(1) 90.0 g of $C_6H_{12}O_6$ dissolved in 500.0 mL of solution
(2) 90.0 g of $C_6H_{12}O_6$ dissolved in 1000. mL of solution
(3) 180.0 g of $C_6H_{12}O_6$ dissolved in 500.0 mL of solution
(4) 180.0 g of $C_6H_{12}O_6$ dissolved in 1000. mL of solution

Group 6 — Kinetics and Equilibrium

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

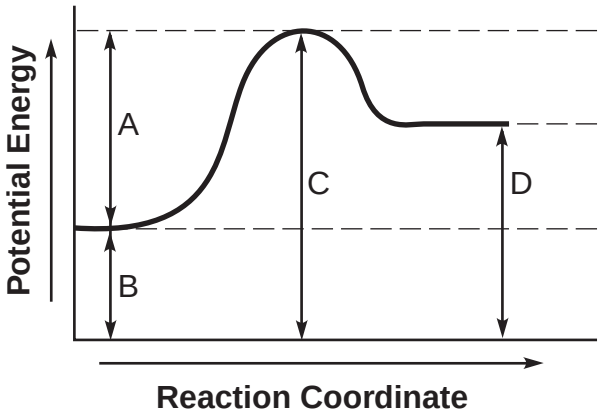
82 Which sample has the greatest entropy?

(1) $NH_3(g)$
(2) $NH_3(\ell)$
(3) $NH_3(s)$
(4) $NH_3(aq)$

83 The activation energy required for a chemical reaction can be *decreased* by

(1) increasing the surface area of the reactant
(2) increasing the temperature of the reactant
(3) adding a catalyst to the reaction
(4) adding more reactant

84 Given the potential energy diagram of a chemical reaction:



Which arrow represents the potential energy of the reactants?

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

85 Given the reaction at equilibrium:

$$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g) + \text{heat}$$

Which change will shift the equilibrium to the right?

(1) increasing the temperature
(2) increasing the pressure
(3) decreasing the amount of $SO_2(g)$
(4) decreasing the amount of $O_2(g)$

86 What occurs when the temperature is increased in a system at equilibrium at constant pressure?

(1) The rate of the forward reaction increases, and the rate of the reverse reaction decreases.
(2) The rate of the forward reaction decreases, and the rate of the reverse reaction increases.
(3) The rate of the endothermic reaction increases.
(4) The rate of the exothermic reaction decreases.

Group 7 — Acids and Bases

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

87 A solution with a pH of 11 is first tested with phenolphthalein and then with litmus. What is the color of each indicator in this solution?

(1) Phenolphthalein is colorless and litmus is blue.
(2) Phenolphthalein is colorless and litmus is red.
(3) Phenolphthalein is pink and litmus is blue.
(4) Phenolphthalein is pink and litmus is red.

88 An example of a nonelectrolyte is

(1) $C_6H_{12}O_6(aq)$ (3) $NaCl(aq)$
(2) $K_2SO_4(aq)$ (4) $HCl(aq)$

89 What produces hydrogen ions as the only positive ions in aqueous solution?

(1) KOH (3) NH_3
(2) HBr (4) NaCl

90 Which type of reaction will produce water and a salt?

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

91 Which statement describes the characteristics of an Arrhenius base?

(1) It changes blue litmus to red and has a pH less than 7.
(2) It changes blue litmus to red and has a pH greater than 7.
(3) It changes red litmus to blue and has a pH less than 7.
(4) It changes red litmus to blue and has a pH greater than 7.

Group 8 — Redox and Electrochemistry

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

92 Which procedure requires the use of an external electric current to force a redox reaction to occur?

(1) polymerization (3) electrolysis
(2) distillation (4) saponification

93 Given the balanced equation:

$$3Fe^{3+}(aq) + Al(s) \rightarrow 3Fe^{2+}(aq) + Al^{3+}(aq)$$

What is the total number of moles of electrons lost by 2 moles of Al(s)?

(1) 1 mole (3) 3 moles
(2) 6 moles (4) 9 moles

94 Given the reaction:

$$Cu(s) + 4HNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2NO_2(g) + 2H_2O(\ell)$$

As the reaction occurs, what happens to copper?

(1) It undergoes reduction and its oxidation number decreases.
(2) It undergoes reduction and its oxidation number increases.
(3) It undergoes oxidation and its oxidation number decreases.
(4) It undergoes oxidation and its oxidation number increases.

95 In any redox reaction, a reactant can undergo a decrease in oxidation number by

(1) losing electrons, only
(2) gaining electrons, only
(3) losing protons, only
(4) gaining protons, only

96 Which is a redox reaction?

(1) $H^+ + Cl^- \rightarrow HCl$
(2) $NaOH + HCl \rightarrow NaCl + H_2O$
(3) $Fe + 2HCl \rightarrow FeCl_2 + H_2$
(4) $MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$

Group 9 — Organic Chemistry

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

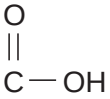
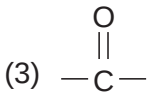
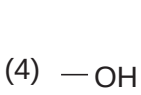
97 Which organic reaction produces rubber and plastics?

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

98 Which compounds are isomers?

(1) CH_3OH and CH_3CH_2OH
(2) CH_4 and CCl_4
(3) CH_3CH_2CHO and CH_3COCH_3
(4) CH_3CH_2OH and CH_3CH_2COOH

99 Which functional group, when attached to a chain of carbon atoms, will produce an organic molecule with the characteristic properties of an aldehyde?

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

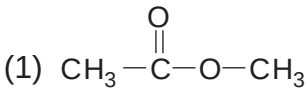
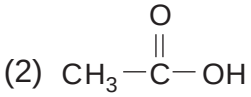
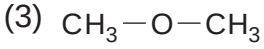
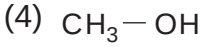
100 Given the equation:

$$CH_4 + Br_2 \rightarrow CH_3Br + HBr$$

Which type of reaction does this equation represent?

(1) addition
(2) hydrogenation
(3) polymerization
(4) substitution

101 Which formula represents an ether?

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

Group 10 — Applications of Chemical Principles

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

102 Given the lead-acid battery reaction:

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

As the lead-acid battery discharges, sulfuric acid is a

(1) reactant, with decreasing concentration
(2) reactant, with increasing concentration
(3) product, with decreasing concentration
(4) product, with increasing concentration

103 Given the nickel-cadmium battery reaction:

$$2NiOOH + Cd + 2H_2O \underset{\text{charge}}{\overset{\text{discharge}}{\rightleftharpoons}} 2Ni(OH)_2 + Cd(OH)_2$$

During the discharge of the battery, Ni^{3+} ions are

(1) reduced, and cadmium metal is reduced
(2) reduced, and cadmium metal is oxidized
(3) oxidized, and cadmium metal is reduced
(4) oxidized, and cadmium metal is oxidized

104 Which metal can replace Cr in Cr_2O_3?

(1) nickel
(2) lead
(3) copper
(4) aluminum

105 Fractional distillation is a technique used to separate complex mixtures of hydrocarbons based on differences in their

(1) heats of fusion
(2) heats of vaporization
(3) melting points
(4) boiling points

106 Ammonia is produced commercially by the Haber reaction:

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

The formation of ammonia is favored by

(1) an increase in pressure
(2) a decrease in pressure
(3) removal of $N_2(g)$
(4) removal of $H_2(g)$

Group 11 — Nuclear Chemistry

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

107 Given the equation:

$$^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow X + {}^{17}_{8}\mathrm{O}$$

When the equation is balanced correctly, which particle is represented by X?

(1) $^{0}_{-1}\mathrm{e}$
(2) $^{1}_{1}\mathrm{H}$
(3) $^{2}_{1}\mathrm{H}$
(4) $^{1}_{0}\mathrm{n}$

108 When cobalt-60 undergoes nuclear decay, it emits

(1) a positron
(2) a neutron
(3) a beta particle
(4) an alpha particle

109 Which equation represents a fusion reaction?

(1) $^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He}$
(2) $^{14}_{6}\mathrm{C} \rightarrow {}^{0}_{-1}\mathrm{e} + {}^{14}_{7}\mathrm{N}$
(3) $^{238}_{92}\mathrm{U} + {}^{4}_{2}\mathrm{He} \rightarrow {}^{241}_{94}\mathrm{Pu} + {}^{1}_{0}\mathrm{n}$
(4) $^{1}_{0}\mathrm{n} + {}^{27}_{13}\mathrm{Al} \rightarrow {}^{24}_{11}\mathrm{Na} + {}^{4}_{2}\mathrm{He}$

110 Which process converts an atom from one element to another, when the nucleus of an atom is bombarded with high-energy particles?

(1) artificial transmutation
(2) natural transmutation
(3) addition polymerization
(4) condensation polymerization

111 A fission reaction is similar to a fusion reaction in that both reactions involve

(1) collisions between nuclei of high atomic number
(2) collisions between nuclei of low atomic number
(3) the conversion of mass to energy
(4) the conversion of energy to mass

Group 12 — Laboratory Activities

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

112 A sample of water is being heated from 20°C to 30°C, and the temperature is recorded every 2 minutes. Which table would be most appropriate for recording the data?

Time (min)	Temp (°C)
0	
2	
4	
6	
8	
10	

(1)

Time (min)	Temp (°C)
20	
22	
24	
26	
28	
30	

(2)

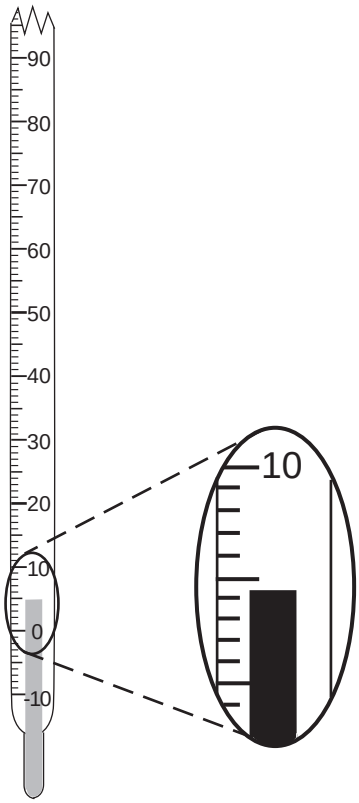
Temp (°C)	Time (min)
0	
2	
4	
6	
8	
10	

(3)

Temp (°C)	Time (min)
20	
22	
24	
26	
28	
30	

(4)

113 The diagram below represents a Celsius thermometer recording a certain temperature.



What is the correct reading of the thermometer?

(1) 5°C
(2) 4.3°C
(3) 0.3°C
(4) 4°C

114 Expressed to the correct number of significant figures, the sum of two masses is 445.2 grams. Which two masses produce this answer?

(1) 210.10 g + 235.100 g
(2) 210.100 g + 235.10 g
(3) 210.1 g + 235.1 g
(4) 210.10 g + 235.10 g

115 A student observed that the temperature of water increased when a salt was dissolved in it. The student should conclude that dissolving the salt caused

(1) formation of an acidic solution
(2) formation of a basic solution
(3) an exothermic reaction
(4) an endothermic reaction

116 A dry mixture of KNO_3 and sand could be separated by

(1) adding water to the mixture and filtering
(2) adding water to the mixture and evaporating
(3) heating the mixture to a high temperature
(4) cooling the mixture to a low temperature

Tear Here

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

Tear Here

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

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Tuesday, January 22, 2002 — 9:15 a.m. to 12:15 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	
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	**41**
55	**64**	27	**40**
54	**63**	26	**39**
53	**62**	25	**39**
52	**62**	24	**38**
51	**61**	23	**37**
50	**60**	22	**36**
49	**59**	21	**35**
48	**58**	20	**34**
47	**57**	19	**33**
46	**56**	18	**33**
45	**56**	17	**32**
44	**55**	16	**31**
43	**54**	15	**30**
42	**53**	14	**29**
41	**52**	13	**27**
40	**51**	12	**25**
39	**51**	11	**23**
38	**50**	10	**21**
37	**49**	9	**19**
36	**48**	8	**17**
35	**47**	7	**14**
34	**46**	6	**12**
33	**45**	5	**10**
32	**45**	4	**8**
31	**44**	3	**6**
30	**43**	2	**4**
29	**42**	1	**2**
		0	**0**

No. right .....

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

Tear Here

Tear Here

FOR TEACHERS ONLY

C

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

CHEMISTRY

Tuesday, January 22, 2002—9:15 a.m. to 12:15 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	1	2	3	**X**	**21**	1	2	**X**	4	**41**	1	**X**	3	4
2	1	**X**	3	4	**22**	1	2	3	**X**	**42**	**X**	2	3	4
3	1	2	**X**	4	**23**	**X**	2	3	4	**43**	1	2	3	**X**
4	1	2	3	**X**	**24**	1	2	3	**X**	**44**	1	**X**	3	4
5	**X**	2	3	4	**25**	**X**	2	3	4	**45**	**X**	2	3	4
6	1	2	**X**	4	**26**	1	2	3	**X**	**46**	1	2	3	**X**
7	**X**	2	3	4	**27**	1	2	3	**X**	**47**	1	2	**X**	4
8	1	2	**X**	4	**28**	1	2	**X**	4	**48**	1	2	**X**	4
9	1	2	**X**	4	**29**	1	**X**	3	4	**49**	**X**	2	3	4
10	**X**	2	3	4	**30**	1	2	**X**	4	**50**	1	2	**X**	4
11	1	**X**	3	4	**31**	1	2	3	**X**	**51**	1	2	**X**	4
12	1	2	3	**X**	**32**	1	2	3	**X**	**52**	1	**X**	3	4
13	1	2	**X**	4	**33**	1	2	**X**	4	**53**	1	**X**	3	
14	1	**X**	3	4	**34**	**X**	2	3	4	**54**	**X**	2	3	
15	1	**X**	3	4	**35**	**X**	2	3	4	**55**	1	**X**	3	
16	1	2	**X**	4	**36**	1	**X**	3	4	**56**	1	**X**	3	
17	1	2	3	**X**	**37**	1	2	3	**X**					
18	**X**	2	3	4	**38**	1	**X**	3	4					
19	1	**X**	3	4	**39**	1	2	**X**	4					
20	1	**X**	3	4	**40**	1	**X**	3	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	2	3	X
59	1	2	3	X
60	1	X	3	4
61	1	2	X	4

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

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

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

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

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

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

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

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

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

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

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