New York State Documents

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Thursday, June 22, 2000 — 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: ⊗ 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 The formula Al_2S_3 represents
(1) an element
(2) a binary compound
(3) a ternary compound
(4) a mixture

2 As the temperature of a gas is increased from 0°C to 10°C at constant pressure, the volume of the gas will
(1) increase by $\frac{1}{273}$
(2) increase by $\frac{10}{273}$
(3) decrease by $\frac{1}{273}$
(4) decrease by $\frac{10}{273}$

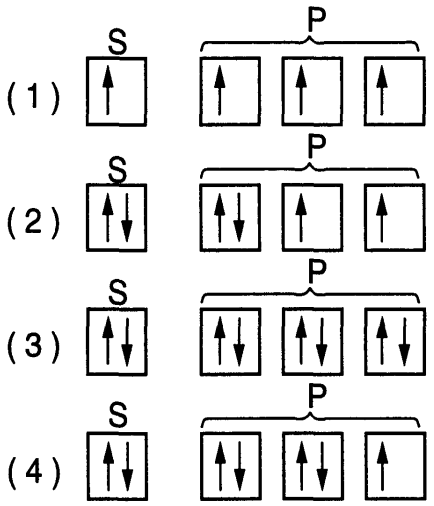
3 Water boils at 90°C when the pressure exerted on the liquid is equal to
(1) 50.0 torr
(2) 100.0 torr
(3) 525.8 torr
(4) 760.0 torr

4 Which species readily sublimes at room temperature?
(1) $CO_2(s)$
(2) $CO_2(\ell)$
(3) $CO_2(g)$
(4) $CO_2(aq)$

5 Which statement best describes all compounds?
(1) They can be decomposed by chemical change.
(2) They can be decomposed by physical means.
(3) They contain at least three elements.
(4) They contain ionic bonds.

6 What is the electron configuration of a Mn atom in the ground state?
(1) $1s^2 2s^2 2p^6 3s^2$
(2) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
(3) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^1 4p^1$
(4) $1s^2 2s^2 2p^6 3s^2 3p^6 3d^7$

7 Which orbital notation correctly represents a noble gas in the ground state?



8 Which type of radiation has zero mass and zero charge?
(1) alpha
(2) beta
(3) neutron
(4) gamma

9 What is the total number of protons and neutrons in an atom of $^{86}_{37}Rb$?
(1) 37
(2) 49
(3) 86
(4) 123

10 What is the total number of valence electrons in an atom of boron in the ground state?
(1) 1
(2) 7
(3) 3
(4) 5

11 What causes the emission of radiant energy that produces characteristic spectral lines?
(1) neutron absorption by the nucleus
(2) gamma ray emission from the nucleus
(3) movement of electrons to higher energy levels
(4) return of electrons to lower energy levels

12 Which atom in the ground state has three half-filled orbitals?

(1) P (3) Al
(2) Si (4) Li

13 Which particles may be gained, lost, or shared by an atom when it forms a chemical bond?

(1) protons (3) neutrons
(2) electrons (4) nucleons

14 Which molecular formula is correctly paired with its corresponding empirical formula?

(1) CO_2 and CO (3) C_6H_6 and C_2H_2
(2) C_2H_2 and CH_2 (4) P_4O_{10} and P_2O_5

15 Which of the following elements has the strongest attraction for electrons?

(1) boron (3) oxygen
(2) aluminum (4) sulfur

16 The table below shows four compounds and the boiling point of each.

Compound	Boiling Point
H_2O	100.°C
H_2S	–60.7°C
H_2Se	–41.5°C
H_2Te	–2.2°C

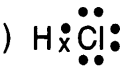
Which type of molecular attraction accounts for the high boiling point of H_2O?

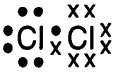
(1) molecule–ion
(2) ion–ion
(3) hydrogen bonding
(4) van der Waals forces

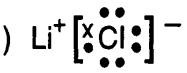
17 Which elements are both classified as metalloids?

(1) Ge and As (3) B and C
(2) Bi and Po (4) Si and P

18 Which electron dot diagram represents a molecule that has a polar covalent bond?

(1) 

(3) 

(2) 

(4) 

19 What is the total number of moles of atoms present in 1 gram formula mass of $Pb(C_2H_3O_2)_2$?

(1) 9 (3) 3
(2) 14 (4) 15

20 Elements in the Periodic Table are arranged according to their

(1) atomic number (3) relative activity
(2) atomic mass (4) relative size

21 Which Group 15 element exists as a diatomic molecule at STP?

(1) phosphorus (3) bismuth
(2) nitrogen (4) arsenic

22 Which element reacts vigorously with water?

(1) Zn (3) Fe
(2) Cu (4) Li

23 Atoms of metals tend to

(1) lose electrons and form negative ions
(2) lose electrons and form positive ions
(3) gain electrons and form negative ions
(4) gain electrons and form positive ions

24 Which halogen is a solid at STP?

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

25 What is the total number of molecules in a 0.5-mole sample of He gas?

(1) 6×10^{23} (3) 3×10^{23}
(2) 2×10^{23} (4) 4×10^{23}

26 What occurs as the atomic number of the elements in Period 2 increases?

(1) The nuclear charge of each successive atom decreases, and the covalent radius decreases.
(2) The nuclear charge of each successive atom decreases, and the covalent radius increases.
(3) The nuclear charge of each successive atom increases, and the covalent radius decreases.
(4) The nuclear charge of each successive atom increases, and the covalent radius increases.

27 Given the balanced equation:

$$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$$

What is the total number of liters of $CO_2(g)$ produced when 20.0 liters of $O_2(g)$ are completely consumed?

(1) 12.0 L
(2) 22.4 L
(3) 3.00 L
(4) 5.00 L

28 Given the balanced equation:

$$Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$$

What total mass of iron is necessary to produce 1.00 mole of copper?

(1) 26.0 g
(2) 55.8 g
(3) 112 g
(4) 192 g

29 The percent by mass of nitrogen in NH_4NO_3 is closest to

(1) 15%
(2) 20.%
(3) 35%
(4) 60.%

30 What is the molarity of a solution that contains 40. grams of NaOH in 0.50 liter of solution?

(1) 1.0 M
(2) 2.0 M
(3) 0.50 M
(4) 0.25 M

31 Given the system at equilibrium:

$$H_2(g) + F_2(g) \rightleftharpoons 2HF(g) + \text{heat}$$

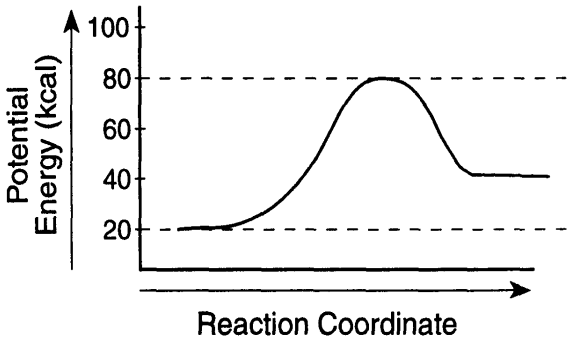
Which change will *not* shift the point of equilibrium?

(1) changing the pressure
(2) changing the temperature
(3) changing the concentration of $H_2(g)$
(4) changing the concentration of $HF(g)$

32 An increase in the surface area of reactants in a heterogeneous reaction will result in

(1) a decrease in the rate of the reaction
(2) an increase in the rate of the reaction
(3) a decrease in the heat of reaction
(4) an increase in the heat of reaction

33 A potential energy diagram of a chemical reaction is shown below.



What is the difference between the potential energy of the reactants and the potential energy of the products?

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

34 Given the reaction:

$$Zn(s) + 2HCl(aq) \rightarrow$$
$$Zn^{2+}(aq) + 2Cl^{-}(aq) + H_2(g)$$

If the concentration of the HCl(aq) is increased, the frequency of reacting collisions will

(1) decrease, producing a decrease in the reaction rate
(2) decrease, producing an increase in the reaction rate
(3) increase, producing a decrease in the reaction rate
(4) increase, producing an increase in the reaction rate

35 Two reactant particles collide with proper orientation. The collision will be effective if the particles have

(1) high activation energy
(2) high ionization energy
(3) sufficient kinetic energy
(4) sufficient potential energy

36 Based on Reference Table *D*, what change will cause the solubility of $KNO_3(s)$ to increase?

(1) decreasing the pressure
(2) increasing the pressure
(3) decreasing the temperature
(4) increasing the temperature

37 Which of the following ionization constants (K_a) represents the strongest acid?

(1) $K_a = 1 \times 10^{-14}$
(2) $K_a = 1 \times 10^{-7}$
(3) $K_a = 1 \times 10^{-4}$
(4) $K_a = 1 \times 10^{-2}$

38 Based on Reference Table *L*, which of the following compounds is the *weakest* electrolyte?

(1) HI
(2) HNO_3
(3) H_3PO_4
(4) H_2SO_4

39 Based on Reference Table *L*, which substance can function only as a Brönsted-Lowry acid?

(1) HCl
(2) HSO_4^-
(3) HCO_3^-
(4) NH_3

40 If the pH of a solution is 9, the solution is

(1) acidic, which turns phenolphthalein pink
(2) acidic, which turns phenolphthalein colorless
(3) basic, which turns phenolphthalein pink
(4) basic, which turns phenolphthalein colorless

41 Given the reaction:

$$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$$

Which species is the strongest conjugate base?

(1) CO_3^{2-}
(2) H_2O
(3) HCO_3^-
(4) OH^-

42 What is the pH of a 0.001 M KOH solution?

(1) 14
(2) 11
(3) 3
(4) 7

43 Which simple oxidation-reduction reaction is *not* correctly balanced?

(1) $Sn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Sn^{2+}(aq)$
(2) $Ni(s) + Sn^{2+}(aq) \rightarrow Sn(s) + Ni^{2+}(aq)$
(3) $2I^-(aq) + Fe^{3+}(aq) \rightarrow Fe^{2+}(aq) + I_2(s)$
(4) $2I^-(aq) + Hg^{2+}(aq) \rightarrow Hg(\ell) + I_2(s)$

44 In the reaction $H_2S + NH_3 \rightleftharpoons NH_4^+ + HS^-$, the two Brönsted-Lowry bases are

(1) NH_3 and HS^-
(2) NH_3 and NH_4^+
(3) H_2S and NH_3
(4) H_2S and HS^-

45 A student wishes to set up an electrochemical cell. The following list of materials and equipment will be used:

- two 250-mL beakers
- wire
- one piece of Zn metal
- 125 mL of 0.10 M $Zn(NO_3)_2$
- voltmeter
- switch
- one piece of Pb metal
- 125 mL of 0.10 M $Pb(NO_3)_2$

For the cell to operate properly, the student will also need

(1) an anode
(2) a cathode
(3) an external path for electrons
(4) a salt bridge

46 Given the cell reaction:

$$Ca(s) + Mg^{2+}(aq) \rightarrow Ca^{2+}(aq) + Mg(s)$$

Which substance is oxidized?

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

47 Chlorine has an oxidation state of +3 in the compound

(1) HClO
(2) $HClO_2$
(3) $HClO_3$
(4) $HClO_4$

48 Given the cell reaction:

$$Sn(s) + Pb^{2+}(aq) \rightarrow Sn^{2+}(aq) + Pb(s)$$

The reduction half-reaction for this cell is

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

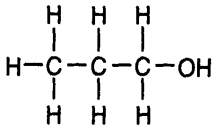
49 Proteins are produced through the process of

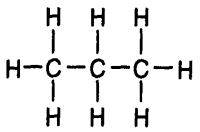
(1) addition
(2) substitution
(3) polymerization
(4) combustion

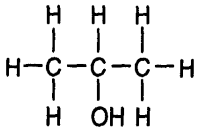
50 What are the products of a fermentation reaction?

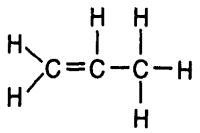
(1) an alcohol and carbon monoxide
(2) an alcohol and carbon dioxide
(3) a salt and water
(4) a salt and an acid

51 Which structural formula represents a saturated hydrocarbon?

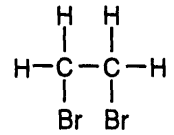
(1) 

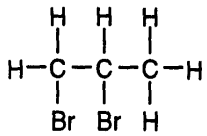
(3) 

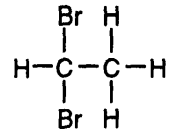
(2) 

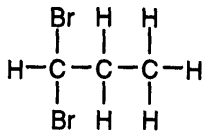
(4) 

52 Which structural formula represents 1,1-dibromopropane?

(1) 

(3) 

(2) 

(4) 

53 The principal products of saponification, a reaction between a fat and a base, are soap and

(1) water
(2) glycerol
(3) carbon dioxide
(4) ethyl alcohol

Note that questions 54 through 56 have only three choices.

54 As a solid substance absorbs heat at its melting point, the melting point will

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

55 Given the redox reaction:

$$2NaCl(\ell) \rightarrow 2Na(\ell) + Cl_2(g)$$

As the Cl^- is oxidized, the oxidation number of chlorine will

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

56 As energy is released during the formation of a bond, the stability of the chemical system generally 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 term represents a form of energy?

(1) heat
(2) degree
(3) kilocalorie
(4) temperature

58 Which change of phase is exothermic?

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

59 A gas sample consisting of 2 moles of hydrogen and 1 mole of oxygen is collected over water at 29°C and 750 torr. What is the partial pressure of the hydrogen in the sample?

(1) 240 torr
(2) 480 torr
(3) 720 torr
(4) 750 torr

60 What is the equilibrium temperature of an ice-water mixture at a pressure of 1 atmosphere?

(1) 0°C
(2) 32°C
(3) 100°C
(4) 273°C

61 The list below shows four samples: *A*, *B*, *C*, and *D*.

(*A*) HCl(aq)
(*B*) NaCl(aq)
(*C*) HCl(g)
(*D*) NaCl(s)

Which samples are substances?

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

Group 2 — Atomic Structure

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

62 Which subatomic particles have a mass of approximately 1 atomic mass unit each?

(1) proton and electron
(2) proton and neutron
(3) neutron and positron
(4) electron and positron

63 Which atoms are isotopes of the same element?

(1) ${}^{24}_{12}X$ and ${}^{25}_{12}X$
(2) ${}^{20}_{10}X$ and ${}^{20}_{11}X$
(3) ${}^{31}_{15}X$ and ${}^{32}_{16}X$
(4) ${}^{31}_{19}X$ and ${}^{31}_{19}X$

64 What is the total number of grams of a 32-gram sample of ${}^{32}P$ remaining after 71.5 days of decay?

(1) 1.0 g
(2) 2.0 g
(3) 8.0 g
(4) 4.0 g

65 Experiments with gold foil indicated that atoms

(1) usually have a uniform distribution of positive charges
(2) usually have a uniform distribution of negative charges
(3) contain a positively charged, dense center
(4) contain a negatively charged, dense center

66 What is the total number of completely filled sublevels found in an atom of krypton in the ground state?

(1) 10
(2) 2
(3) 8
(4) 4

Group 3 — Bonding

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

67 Which atom will form an ionic bond with a Br atom?

(1) N (3) O
(2) Li (4) C

68 Given the unbalanced equation:

$$\_\_\_\_N_2(g) + \_\_\_\_O_2(g) \rightarrow \_\_\_\_N_2O_5(g)$$

When the equation is balanced using *smallest* whole numbers, the coefficient of $N_2(g)$ will be

(1) 1 (3) 5
(2) 2 (4) 4

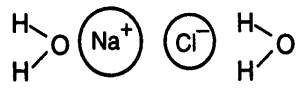
69 Which molecule is polar and contains polar bonds?

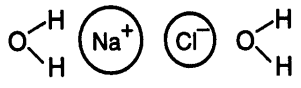
(1) CCl_4 (3) N_2
(2) CO_2 (4) NH_3

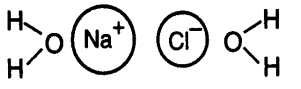
70 The *strongest* van der Waals forces of attraction exist between molecules of

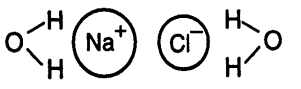
(1) I_2 (3) Cl_2
(2) Br_2 (4) F_2

71 Which diagram best illustrates the ion-molecule attractions that occur when the ions of NaCl(s) are added to water?

(1) 

(2) 

(3) 

(4) 

Group 4 — Periodic Table

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

72 An element has a first ionization energy of 314 kilocalories/mole and an electronegativity of 3.5. It is classified as a

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

73 At which location in the Periodic Table would the most active metallic element be found?

(1) in Group 1 at the top
(2) in Group 1 at the bottom
(3) in Group 17 at the top
(4) in Group 17 at the bottom

74 Which set of properties is most characteristic of transition elements?

(1) colorless ions in solution, multiple positive oxidation states
(2) colorless ions in solution, multiple negative oxidation states
(3) colored ions in solution, multiple positive oxidation states
(4) colored ions in solution, multiple negative oxidation states

75 An atom with the electron configuration $1s^2 2s^2 2p^6 3s^2$ would most likely

(1) decrease in size as it forms a positive ion
(2) increase in size as it forms a positive ion
(3) decrease in size as it forms a negative ion
(4) increase in size as it forms a negative ion

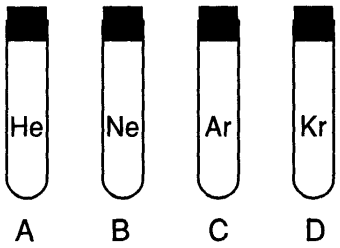
76 The properties of carbon are expected to be most similar to those of

(1) boron (3) silicon
(2) aluminum (4) phosphorus

Group 5 — Mathematics of Chemistry

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

77 The stoppered tubes below, labeled *A* through *D*, each contain a different gas.



When the tubes are unstoppered at the same time and under the same conditions of temperature and pressure, from which tube will gas diffuse at the fastest rate?

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

78 A compound whose empirical formula is NO_2 could have a molecular mass of

(1) 23 (3) 92
(2) 39 (4) 120

79 The density of a gas is 1.43 grams per liter at STP. The mass of 1 mole of this gas is equal to

(1) 1.43 g (3) 22.4 g
(2) 15.7 g (4) 32.0 g

80 What is the total number of kilocalories required to boil 100. grams of water at 100°C and 1 atmosphere? [Refer to Reference Table *A*.]

(1) 1.80 kcal (3) 53.9 kcal
(2) 18.0 kcal (4) 539 kcal

81 Which property of a distilled water solution will *not* be affected by adding 50 mL of $CH_3OH(\ell)$ to 100 mL of the water solution at 25°C?

(1) conductivity (3) freezing point
(2) vapor pressure (4) boiling point

Group 6 — Kinetics and Equilibrium

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

82 Based on Reference Table *M*, which compound has a K_{sp} closest to the K_{sp} of $PbCrO_4$?

(1) Ag_2CrO_4
(2) $AgBr$
(3) $ZnCO_3$
(4) $PbCl_2$

83 Adding a catalyst to a chemical reaction changes the rate of reaction by causing

(1) a decrease in the activation energy
(2) an increase in the activation energy
(3) a decrease in the heat of reaction
(4) an increase in the heat of reaction

84 Which change in a sample of water is accompanied by the greatest increase in entropy?

(1) $H_2O(\ell)$ at 100°C is changed to $H_2O(g)$ at 200°C.
(2) $H_2O(g)$ at 100°C is changed to $H_2O(g)$ at 200°C.
(3) $H_2O(s)$ at −100°C is changed to $H_2O(s)$ at 0°C.
(4) $H_2O(s)$ at −100°C is changed to $H_2O(\ell)$ at 0°C.

85 According to Reference Table *G*, which reaction spontaneously forms a compound from its elements?

(1) $H_2(g) + I_2(g) \rightarrow 2HI(g)$
(2) $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$
(3) $N_2(g) + O_2(g) \rightarrow 2NO(g)$
(4) $N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$

86 Given the solution at equilibrium:

$$CaSO_4(s) \rightleftharpoons Ca^{2+}(aq) + SO_4^{2-}(aq)$$

When Na_2SO_4 is added to the system, how will the equilibrium shift?

(1) The amount of $CaSO_4(s)$ will decrease, and the concentration of $Ca^{2+}(aq)$ will decrease.
(2) The amount of $CaSO_4(s)$ will decrease, and the concentration of $Ca^{2+}(aq)$ will increase.
(3) The amount of $CaSO_4(s)$ will increase, and the concentration of $Ca^{2+}(aq)$ will decrease.
(4) The amount of $CaSO_4(s)$ will increase, and the concentration of $Ca^{2+}(aq)$ will increase.

Group 7 — Acids and Bases

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

87 When HCl is dissolved in water, the only positive ion present in the solution is the

(1) hydrogen ion
(2) hydroxide ion
(3) hydride ion
(4) chloride ion

88 Given the reaction:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

How many milliliters of 1 M NaOH are needed to exactly neutralize 100 milliliters of 1 M H_2SO_4?

(1) 50 mL
(2) 200 mL
(3) 300 mL
(4) 400 mL

89 According to the Brönsted-Lowry theory, H_2O is considered to be a base when it

(1) donates an electron
(2) accepts an electron
(3) donates a proton
(4) accepts a proton

90 Given the neutralization reaction:

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2HOH$$

Which compound is a salt?

(1) KOH
(2) H_2SO_4
(3) K_2SO_4
(4) HOH

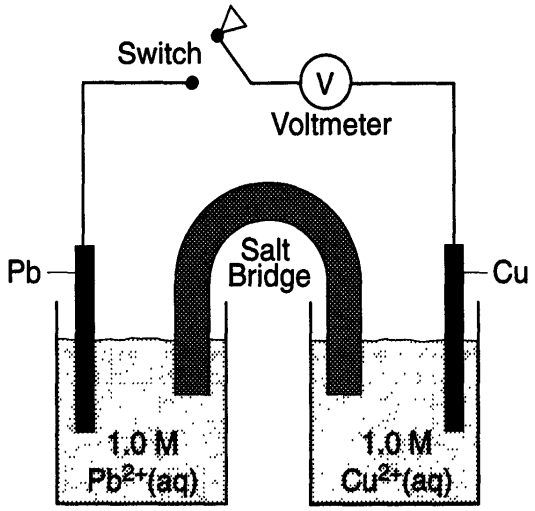
91 Which acid-base pair will always undergo a reaction that produces a neutral solution?

(1) a weak acid and a weak base
(2) a weak acid and a strong base
(3) a strong acid and a weak base
(4) a strong acid and a strong base

Group 8 — Redox and Electrochemistry

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

Base your answers to questions 92 and 93 on the diagram of a chemical cell and the equation shown below. The reaction occurs at 1 atmosphere and 298 K.



$$Pb(s) + Cu^{2+}(aq) \longrightarrow Pb^{2+}(aq) + Cu(s)$$

92 When the switch is closed, the cell voltage (E^0) is

(1) –0.21 V
(2) +0.21 V
(3) –0.47 V
(4) +0.47 V

93 Which change occurs when the switch is closed?

(1) Pb is oxidized, and electrons flow to the Cu electrode.
(2) Pb is reduced, and electrons flow to the Cu electrode.
(3) Cu is oxidized, and electrons flow to the Pb electrode.
(4) Cu is reduced, and electrons flow to the Pb electrode.

94 Based on Reference Table *N*, the standard electrode potential for the reduction of gold (III) ions is

(1) +1.50 V
(2) +0.80 V
(3) –0.80 V
(4) –1.50 V

95 In an electrolytic cell, a negative ion will migrate to and undergo oxidation at the

(1) anode, which is negatively charged
(2) anode, which is positively charged
(3) cathode, which is negatively charged
(4) cathode, which is positively charged

96 Given the unbalanced equation:

$$\_\_\ Ag_2S + 8HNO_3 \rightarrow$$
$$\_\_\ AgNO_3 + 2NO + \_\_\ S + \_\_\ H_2O$$

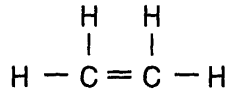
What is the coefficient of Ag_2S when the equation is completely balanced using the *smallest* whole numbers?

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

Group 9 — Organic Chemistry

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

97 Given the compound:



The symbol = represents

(1) one pair of shared electrons
(2) two pairs of shared electrons
(3) a single covalent bond
(4) a coordinate covalent bond

98 An organic compound containing one or more OH groups as the only functional group is classified as an

(1) aldehyde
(2) alcohol
(3) ester
(4) ether

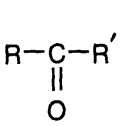
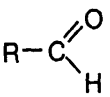
99 The reaction during which monomers are combined and water is released is called

(1) saponification
(2) neutralization
(3) addition polymerization
(4) condensation polymerization

100 One molecule of glycerol contains a total of

(1) two –OH groups
(2) two $-CH_3$ groups
(3) three –OH groups
(4) three $-CH_3$ groups

101 What is the general formula for an ether?

(1) R–OH
(2) 
(3) R–O–R′
(4) 

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 in a lead-acid battery?

(1) addition
(2) substitution
(3) esterification
(4) oxidation-reduction

103 Which metals are obtained by electrolysis of their fused salts?

(1) K and Ca
(2) K and Cr
(3) Cu and Zn
(4) Cu and Hg

104 Given the redox reaction:

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

Which species is oxidized during discharge?

(1) Cd
(2) Cd^{2+}
(3) $Ni(OH)_3$
(4) $Ni(OH)_2$

105 Petroleum is primarily a mixture of

(1) alcohol molecules
(2) ester molecules
(3) hydrocarbon molecules
(4) organic acid molecules

106 By which process is petroleum separated into its components according to their different boiling points?

(1) contact process
(2) Haber process
(3) fractional distillation
(4) cracking

Group 11 — Nuclear Chemistry

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

107 Organic molecules react to form a product. These reactions may be studied by using

(1) Sr-90
(2) Co-60
(3) N-16
(4) C-14

108 In a fission reactor, the speed of the neutrons may be decreased by

(1) a moderator
(2) an accelerator
(3) a fuel rod
(4) shielding

109 Which statement explains why fusion reactions are difficult to initiate?

(1) Positive nuclei attract each other.
(2) Positive nuclei repel each other.
(3) Neutrons prevent nuclei from getting close enough to fuse.
(4) Electrons prevent nuclei from getting close enough to fuse.

110 A particle accelerator is used to provide charged particles with sufficient

(1) kinetic energy to penetrate a nucleus
(2) kinetic energy to penetrate an electron cloud
(3) potential energy to penetrate a nucleus
(4) potential energy to penetrate an electron cloud

111 In which reaction is mass converted to energy by the process of fission?

(1) ${}^{14}_{7}\mathrm{N} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{14}_{6}\mathrm{C} + {}^{1}_{1}\mathrm{H}$

(2) ${}^{235}_{92}\mathrm{U} + {}^{1}_{0}\mathrm{n} \rightarrow {}^{87}_{35}\mathrm{Br} + {}^{146}_{57}\mathrm{La} + 3{}^{1}_{0}\mathrm{n}$

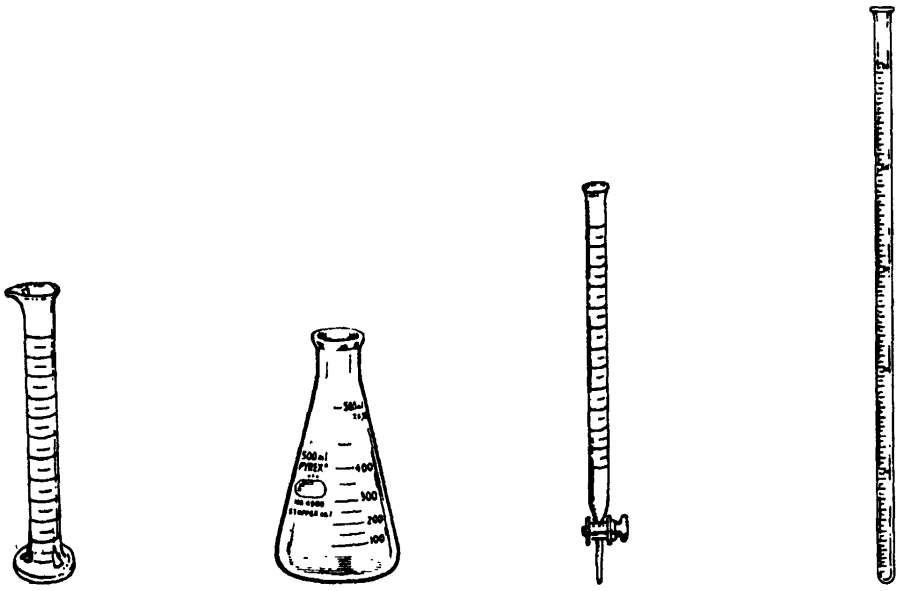
(3) ${}^{226}_{88}\mathrm{Ra} \rightarrow {}^{222}_{86}\mathrm{Rn} + {}^{4}_{2}\mathrm{He}$

(4) ${}^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{4}_{2}\mathrm{He}$

Group 12 — Laboratory Activities

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

112 Which piece of glassware is used for accurately measuring volumes of an acid and a base during a titration?



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

113 The results of testing a colorless solution with three indicators are shown in the table below.

Indicator	Result
red litmus	blue
blue litmus	blue
phenolphthalein	pink

Which formula could represent the solution tested?

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

114 What is the product of (2.324 cm × 1.11 cm) expressed to the correct number of significant figures?

(1) 2.58 cm^2
(2) 2.5780 cm^2
(3) 2.5796 cm^2
(4) 2.57964 cm^2

115 A student determined the percentage of water of hydration in $BaCl_2 \cdot 2H_2O$ by using the data in the table below.

Quantity Measured	Value Obtained
mass of $BaCl_2 \cdot 2H_2O$	3.80 grams
mass of $BaCl_2$	3.20 grams
% of water calculated	15.79%

The accepted percentage value for the water of hydration is 14.75%. What is the student's percent error?

(1) 1.04%
(2) 6.00%
(3) 6.59%
(4) 7.05%

116 By which process is a precipitate most easily separated from the liquid in which it is suspended?

(1) neutralization
(2) distillation
(3) condensation
(4) filtration

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

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

CHEMISTRY

Thursday, June 22, 2000 — 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	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					

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

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 .....

Tear Here

Tear Here

The University of the State of New York
THE STATE EDUCATION DEPARTMENT
Albany, New York 12234

Reference Tables for Chemistry

A

PHYSICAL CONSTANTS AND CONVERSION FACTORS

Name	*Symbol*	*Value(s)*	*Units*
Angstrom unit	Å	1×10^{-10} m	meter
Avogadro number	N_A	6.02×10^{23} per mol	
Charge of electron	e	1.60×10^{-19} C	coulomb
Electron volt	eV	1.60×10^{-19} J	joule
Speed of light	c	3.00×10^{8} m/s	meters/second
Planck's constant	h	6.63×10^{-34} J•s	joule-second
		1.58×10^{-37} kcal•s	kilocalorie-second
Universal gas constant	R	0.0821 L•atm/mol•K	liter-atmosphere/mole-kelvin
		1.98 cal/mol•K	calories/mole-kelvin
		8.31 J/mol•K	joules/mole-kelvin
Atomic mass unit	μ(amu)	1.66×10^{-24} g	gram
Volume standard, liter	L	1×10^{3} cm^3 = 1 dm^3	cubic centimeters, cubic decimeter
Standard pressure, atmosphere	atm	101.3 kPa	kilopascals
		760 mmHg	millimeters of mercury
		760 torr	torr
Heat equivalent, kilocalorie	kcal	4.18×10^{3} J	joules

Physical Constants for H_2O

Molal freezing point depression	1.86°C
Molal boiling point elevation	0.52°C
Heat of fusion	79.72 cal/g
Heat of vaporization	539.4 cal/g

B

STANDARD UNITS

Symbol	*Name*	*Quantity*
m	meter	length
kg	kilogram	mass
Pa	pascal	pressure
K	kelvin	thermodynamic temperature
mol	mole	amount of substance
J	joule	energy, work, quantity of heat
s	second	time
C	coulomb	quantity of electricity
V	volt	electric potential, potential difference
L	liter	volume

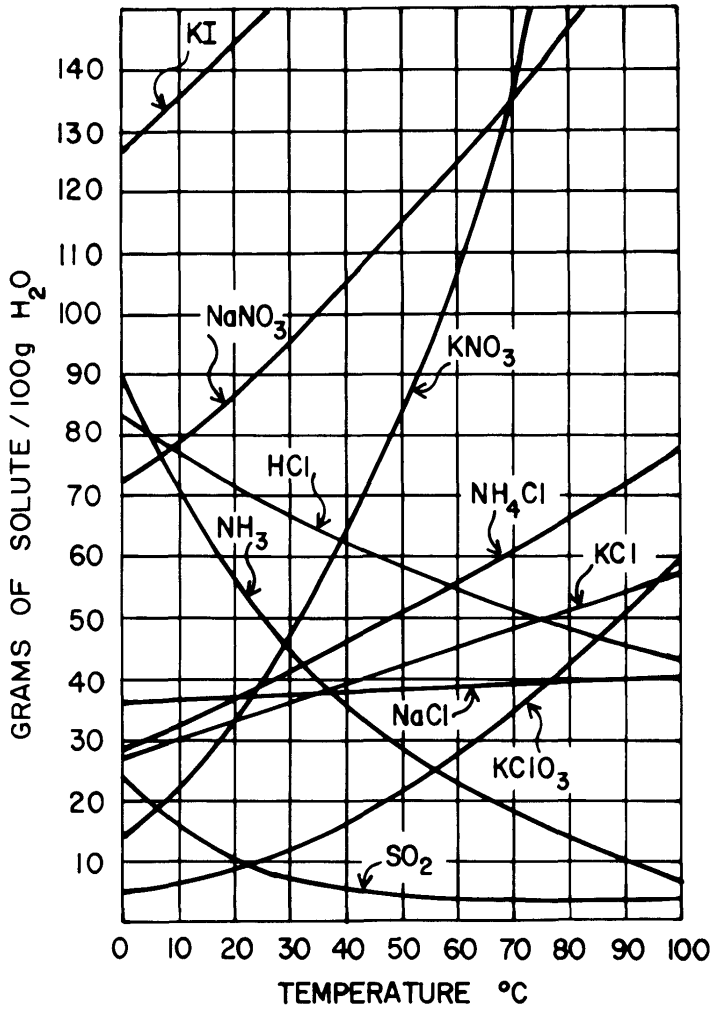
Selected Prefixes

Factor	*Prefix*	*Symbol*
10^{6}	mega	M
10^{3}	kilo	k
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ
10^{-9}	nano	n

C

DENSITY AND BOILING POINTS OF SOME COMMON GASES			
Name		*Density* grams/liter at STP*	*Boiling Point* (at 1 atm) K
Air	—	1.29	—
Ammonia	NH_3	0.771	240
Carbon dioxide	CO_2	1.98	195
Carbon monoxide	CO	1.25	82
Chlorine	Cl_2	3.21	238
Hydrogen	H_2	0.0899	20
Hydrogen chloride	HCl	1.64	188
Hydrogen sulfide	H_2S	1.54	212
Methane	CH_4	0.716	109
Nitrogen	N_2	1.25	77
Nitrogen (II) oxide	NO	1.34	121
Oxygen	O_2	1.43	90
Sulfur dioxide	SO_2	2.92	263
*STP is defined as 273K and 1 atm			

D



E

TABLE OF SOLUBILITIES IN WATER i — nearly insoluble ss — slightly soluble s — soluble d — decomposes n —not isolated	acetate	bromide	carbonate	chloride	chromate	hydroxide	iodide	nitrate	phosphate	sulfate	sulfide
Aluminum	ss	s	n	s	n	i	s	s	i	s	d
Ammonium	s	s	s	s	s	s	s	s	s	s	s
Barium	s	s	i	s	i	s	s	s	i	i	d
Calcium	s	s	i	s	s	ss	s	s	i	ss	d
Copper II	s	s	i	s	i	i	n	s	i	s	i
Iron II	s	s	i	s	n	i	s	s	i	s	i
Iron III	s	s	n	s	i	i	n	s	i	ss	d
Lead	s	ss	i	ss	i	i	ss	s	i	i	i
Magnesium	s	s	i	s	s	i	s	s	i	s	d
Mercury I	ss	i	i	i	ss	n	i	s	i	ss	i
Mercury II	s	ss	i	s	ss	i	i	s	i	d	i
Potassium	s	s	s	s	s	s	s	s	s	s	s
Silver	ss	i	i	i	ss	n	i	s	i	ss	i
Sodium	s	s	s	s	s	s	s	s	s	s	s
Zinc	s	s	i	s	s	i	s	s	i	s	i

F

SELECTED POLYATOMIC IONS			
Hg_2^{2+}	dimercury (I)	CrO_4^{2-}	chromate
NH_4^+	ammonium	$Cr_2O_7^{2-}$	dichromate
$C_2H_3O_2^-$, CH_3COO^-	acetate	MnO_4^-	permanganate
		MnO_4^{2-}	manganate
CN^-	cyanide	NO_2^-	nitrite
CO_3^{2-}	carbonate	NO_3^-	nitrate
HCO_3^-	hydrogen carbonate	OH^-	hydroxide
		PO_4^{3-}	phosphate
$C_2O_4^{2-}$	oxalate	SCN^-	thiocyanate
ClO^-	hypochlorite	SO_3^{2-}	sulfite
ClO_2^-	chlorite	SO_4^{2-}	sulfate
ClO_3^-	chlorate	HSO_4^-	hydrogen sulfate
ClO_4^-	perchlorate	$S_2O_3^{2-}$	thiosulfate

G

STANDARD ENERGIES OF FORMATION OF COMPOUNDS AT 1 atm AND 298 K

Compound	*Heat (Enthalpy) of Formation** kcal/mol ($\triangle H_f^\circ$)	*Free Energy of Formation* kcal/mol ($\triangle G_f^\circ$)
Aluminum oxide $Al_2O_3(s)$	-400.5	-378.2
Ammonia $NH_3(g)$	-11.0	-3.9
Barium sulfate $BaSO_4(s)$	-352.1	-325.6
Calcium hydroxide $Ca(OH)_2(s)$	-235.7	-214.8
Carbon dioxide $CO_2(g)$	-94.1	-94.3
Carbon monoxide $CO(g)$	-26.4	-32.8
Copper (II) sulfate $CuSO_4(s)$	-184.4	-158.2
Ethane $C_2H_6(g)$	-20.2	-7.9
Ethene (ethylene) $C_2H_4(g)$	12.5	16.3
Ethyne (acetylene) $C_2H_2(g)$	54.2	50.0
Hydrogen fluoride $HF(g)$	-64.8	-65.3
Hydrogen iodide $HI(g)$	6.3	0.4
Iodine chloride $ICl(g)$	4.3	-1.3
Lead (II) oxide $PbO(s)$	-51.5	-45.0
Magnesium oxide $MgO(s)$	-143.8	-136.1
Nitrogen (II) oxide $NO(g)$	21.6	20.7
Nitrogen (IV) oxide $NO_2(g)$	7.9	12.3
Potassium chloride $KCl(s)$	-104.4	-97.8
Sodium chloride $NaCl(s)$	-98.3	-91.8
Sulfur dioxide $SO_2(g)$	-70.9	-71.7
Water $H_2O(g)$	-57.8	-54.6
Water $H_2O(\ell)$	-68.3	-56.7

* Minus sign indicates an exothermic reaction.

Sample equations:

$$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s) + 400.5 \text{ kcal}$$

$$2Al(s) + \frac{3}{2}O_2(g) \rightarrow Al_2O_3(s) \quad \triangle H = -400.5 \text{ kcal/mol}$$

H

SELECTED RADIOISOTOPES

Nuclide	*Half-Life*	*Decay Mode*
^{198}Au	2.69 d	β^-
^{14}C	5730 y	β^-
^{60}Co	5.26 y	β^-
^{137}Cs	30.23 y	β^-
^{220}Fr	27.5 s	α
^{3}H	12.26 y	β^-
^{131}I	8.07 d	β^-
^{37}K	1.23 s	β^+
^{42}K	12.4 h	β^-
^{85}Kr	10.76 y	β^-
^{85m}Kr*	4.39 h	γ
^{16}N	7.2 s	β^-
^{32}P	14.3 d	β^-
^{239}Pu	2.44×10^4 y	α
^{226}Ra	1600 y	α
^{222}Rn	3.82 d	α
^{90}Sr	28.1 y	β^-
^{99}Tc	2.13×10^5 y	β^-
^{99m}Tc*	6.01 h	γ
^{232}Th	1.4×10^{10} y	α
^{233}U	1.62×10^5 y	α
^{235}U	7.1×10^8 y	α
^{238}U	4.51×10^9 y	α

y = years; d = days; h = hours; s = seconds

*m = meta stable or excited state of the same nucleus. Gamma decay from such a state is called an isomeric transition (IT).

Nuclear isomers are different energy states of the same nucleus, each having a different measurable lifetime.

(I)

HEATS OF REACTION AT 1 atm and 298 K	
Reaction	$\triangle H$ (kcal)
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$	-212.8
$C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(\ell)$	-530.6
$CH_3OH(\ell) + \frac{3}{2}O_2(g) \rightarrow CO_2(g) + 2H_2O(\ell)$	-173.6
$C_6H_{12}O_6(s) + 6O_2(g) \rightarrow 6CO_2(g) + 6H_2O(\ell)$	-669.9
$CO(g) + \frac{1}{2}O_2(g) \rightarrow CO_2(g)$	-67.7
$C_8H_{18}(\ell) + \frac{25}{2}O_2(g) \rightarrow 8CO_2(g) + 9H_2O(\ell)$	-1302.7
$KNO_3(s) \xrightarrow{H_2O} K^+(aq) + NO_3^-(aq)$	+8.3
$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$	-10.6
$NH_4Cl(s) \xrightarrow{H_2O} NH_4^+(aq) + Cl^-(aq)$	+3.5
$NH_4NO_3(s) \xrightarrow{H_2O} NH_4^+(aq) + NO_3^-(aq)$	+6.1
$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$	+0.9
$KClO_3(s) \xrightarrow{H_2O} K^+(aq) + ClO_3^-(aq)$	+9.9
$LiBr(s) \xrightarrow{H_2O} Li^+(aq) + Br^-(aq)$	-11.7
$H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$	-13.8

(J)

SYMBOLS USED IN NUCLEAR CHEMISTRY		
alpha particle	${}^4_2He$	α
beta particle (electron)	${}^0_{-1}e$	β^-
gamma radiation		γ
neutron	${}^1_0n$	n
proton	${}^1_1H$	p
deuteron	${}^2_1H$	
triton	${}^3_1H$	
positron	${}^0_{+1}e$	β^+

IONIZATION ENERGIES AND ELECTRONEGATIVITIES

1																		18
313 H 2.2	← First Ionization Energy (kcal/mol of atoms) ← Electronegativity*																	567 He
	2											13	14	15	16	17		
125 Li 1.0	215 Be 1.5											191 B 2.0	260 C 2.6	336 N 3.1	314 O 3.5	402 F 4.0	497 Ne	
119 Na 0.9	176 Mg 1.2											138 Al 1.5	188 Si 1.9	242 P 2.2	239 S 2.6	300 Cl 3.2	363 Ar	
100 K 0.8	141 Ca 1.0											138 Ga 1.6	182 Ge 1.9	226 As 2.0	225 Se 2.5	273 Br 2.9	323 Kr	
96 Rb 0.8	131 Sr 1.0											133 In 1.7	169 Sn 1.8	199 Sb 2.1	208 Te 2.3	241 I 2.7	280 Xe	
90 Cs 0.7	120 Ba 0.9											141 Tl 1.8	171 Pb 1.8	168 Bi 1.9	194 Po 2.0	At 2.2	248 Rn	
Fr 0.7	122 Ra 0.9	* Arbitrary scale based on fluorine = 4.0																

(L) RELATIVE STRENGTHS OF ACIDS IN AQUEOUS SOLUTION AT 1 atm AND 298 K

Conjugate Pairs *ACID* = *BASE*	K_a
$HI = H^+ + I^-$	very large
$HBr = H^+ + Br^-$	very large
$HCl = H^+ + Cl^-$	very large
$HNO_3 = H^+ + NO_3^-$	very large
$H_2SO_4 = H^+ + HSO_4^-$	large
$H_2O + SO_2 = H^+ + HSO_3^-$	1.5×10^{-2}
$HSO_4^- = H^+ + SO_4^{2-}$	1.2×10^{-2}
$H_3PO_4 = H^+ + H_2PO_4^-$	7.5×10^{-3}
$Fe(H_2O)_6^{3+} = H^+ + Fe(H_2O)_5(OH)^{2+}$	8.9×10^{-4}
$HNO_2 = H^+ + NO_2^-$	4.6×10^{-4}
$HF = H^+ + F^-$	3.5×10^{-4}
$Cr(H_2O)_6^{3+} = H^+ + Cr(H_2O)_5(OH)^{2+}$	1.0×10^{-4}
$CH_3COOH = H^+ + CH_3COO^-$	1.8×10^{-5}
$Al(H_2O)_6^{3+} = H^+ + Al(H_2O)_5(OH)^{2+}$	1.1×10^{-5}
$H_2O + CO_2 = H^+ + HCO_3^-$	4.3×10^{-7}
$HSO_3^- = H^+ + SO_3^{2-}$	1.1×10^{-7}
$H_2S = H^+ + HS^-$	9.5×10^{-8}
$H_2PO_4^- = H^+ + HPO_4^{2-}$	6.2×10^{-8}
$NH_4^+ = H^+ + NH_3$	5.7×10^{-10}
$HCO_3^- = H^+ + CO_3^{2-}$	5.6×10^{-11}
$HPO_4^{2-} = H^+ + PO_4^{3-}$	2.2×10^{-13}
$HS^- = H^+ + S^{2-}$	1.3×10^{-14}
$H_2O = H^+ + OH^-$	1.0×10^{-14}
$OH^- = H^+ + O^{2-}$	$< 10^{-36}$
$NH_3 = H^+ + NH_2^-$	very small

Note: $H^+(aq) = H_3O^+$

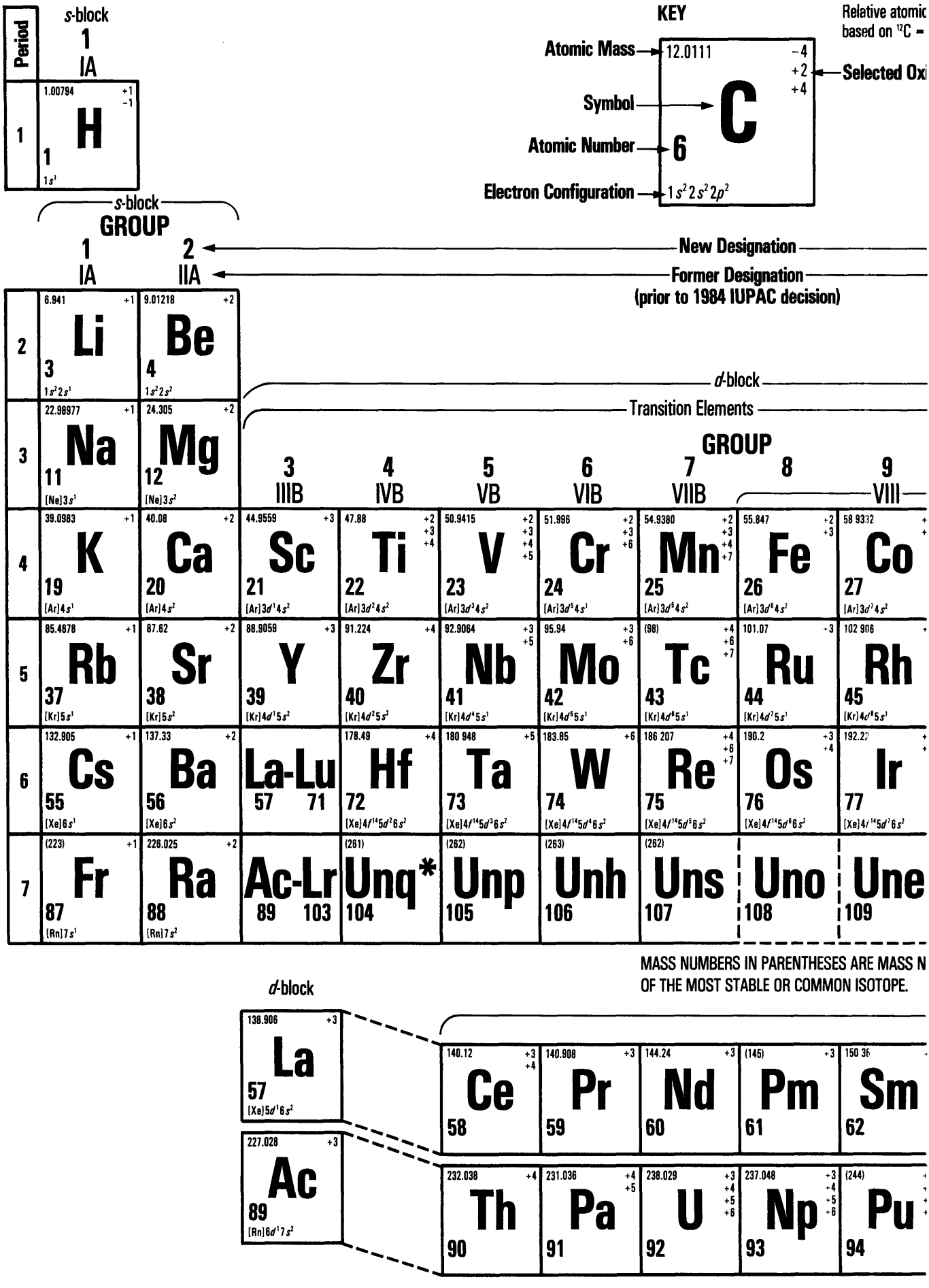
Sample equation: $HI + H_2O = H_3O^+ + I^-$

(M) CONSTANTS FOR VARIOUS EQUILIBRIA AT 1 atm AND 298 K

$H_2O(\ell) = H^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$H_2O(\ell) + H_2O(\ell) = H_3O^+(aq) + OH^-(aq)$	$K_w = 1.0 \times 10^{-14}$
$CH_3COO^-(aq) + H_2O(\ell) = CH_3COOH(aq) + OH^-(aq)$	$K_b = 5.6 \times 10^{-10}$
$NaF(aq) + H_2O(\ell) = Na^+(aq) + OH^-(aq) + HF(aq)$	$K_b = 1.5 \times 10^{-11}$
$NH_3(aq) + H_2O(\ell) = NH_4^+(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-5}$
$CO_3^{2-}(aq) + H_2O(\ell) = HCO_3^-(aq) + OH^-(aq)$	$K_b = 1.8 \times 10^{-4}$
$Ag(NH_3)_2^+(aq) = Ag^+(aq) + 2NH_3(aq)$	$K_{eq} = 8.9 \times 10^{-8}$
$N_2(g) + 3H_2(g) = 2NH_3(g)$	$K_{eq} = 6.7 \times 10^5$
$H_2(g) + I_2(g) = 2HI(g)$	$K_{eq} = 3.5 \times 10^{-1}$

Compound	K_{sp}	*Compound*	K_{sp}
AgBr	5.0×10^{-13}	Li_2CO_3	2.5×10^{-2}
AgCl	1.8×10^{-10}	$PbCl_2$	1.6×10^{-5}
Ag_2CrO_4	1.1×10^{-12}	$PbCO_3$	7.4×10^{-14}
AgI	8.3×10^{-17}	$PbCrO_4$	2.8×10^{-13}
$BaSO_4$	1.1×10^{-10}	PbI_2	7.1×10^{-9}
$CaSO_4$	9.1×10^{-6}	$ZnCO_3$	1.4×10^{-11}

Periodic Table of the E



ements

masses are
12.00000

lation States

s-block

p-block

GROUP

10	11 IB	12 IIB	13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	18 0
								4.00260 0 **He** 2 $1s^2$
			10.81 +3 **B** 5 $1s^2 2s^2 2p^1$	12.0111 −4 +2 +4 **C** 6 $1s^2 2s^2 2p^2$	14.0067 −3 −2 −1 +1 +2 +3 +4 +5 **N** 7 $1s^2 2s^2 2p^3$	15.9994 −2 **O** 8 $1s^2 2s^2 2p^4$	18.998403 −1 **F** 9 $1s^2 2s^2 2p^5$	20.179 0 **Ne** 10 $1s^2 2s^2 2p^6$
			26.98154 +3 **Al** 13 [Ne] $3s^2 3p^1$	28.0855 −4 +2 +4 **Si** 14 [Ne] $3s^2 3p^2$	30.97376 −3 +3 +5 **P** 15 [Ne] $3s^2 3p^3$	32.06 −2 +4 +6 **S** 16 [Ne] $3s^2 3p^4$	35.453 −1 +1 +3 +5 +7 **Cl** 17 [Ne] $3s^2 3p^5$	39.948 0 **Ar** 18 [Ne] $3s^2 3p^6$
58.69 +2 +3 **Ni** 28 [Ar] $3d^8 4s^2$	63 546 +1 +2 **Cu** 29 [Ar] $3d^{10} 4s^1$	65.39 +2 **Zn** 30 [Ar] $3d^{10} 4s^2$	69 72 +3 **Ga** 31 [Ar] $3d^{10} 4s^2 4p^1$	72.59 −4 +2 +4 **Ge** 32 [Ar] $3d^{10} 4s^2 4p^2$	74.9216 −3 +3 +5 **As** 33 [Ar] $3d^{10} 4s^2 4p^3$	78.96 −2 +4 +6 **Se** 34 [Ar] $3d^{10} 4s^2 4p^4$	79.904 −1 +1 +5 **Br** 35 [Ar] $3d^{10} 4s^2 4p^5$	83.80 0 +2 **Kr** 36 [Ar] $3d^{10} 4s^2 4p^6$
106.42 +2 +4 **Pd** 46 [Kr] $4d^{10} 5s^0$	107.868 +1 **Ag** 47 [Kr] $4d^{10} 5s^1$	112 41 +2 **Cd** 48 [Kr] $4d^{10} 5s^2$	114 82 +3 **In** 49 [Kr] $4d^{10} 5s^2 5p^1$	118.71 +2 +4 **Sn** 50 [Kr] $4d^{10} 5s^2 5p^2$	121.75 −3 +3 +5 **Sb** 51 [Kr] $4d^{10} 5s^2 5p^3$	127.60 −2 +4 +6 **Te** 52 [Kr] $4d^{10} 5s^2 5p^4$	126.905 −1 +1 +5 +7 **I** 53 [Kr] $4d^{10} 5s^2 5p^5$	131.29 0 +2 +4 +6 **Xe** 54 [Kr] $4d^{10} 5s^2 5p^6$
195.08 +2 +4 **Pt** 78 [Xe] $4f^{14} 5d^9 6s^1$	196.967 +1 +3 **Au** 79 [Xe] $4f^{14} 5d^{10} 6s^1$	200.59 +1 +2 **Hg** 80 [Xe] $4f^{14} 5d^{10} 6s^2$	204 383 +1 +3 **Tl** 81 [Xe] $4f^{14} 5d^{10} 6s^2 6p^1$	207.2 +2 +4 **Pb** 82 [Xe] $4f^{14} 5d^{10} 6s^2 6p^2$	208.980 +3 +5 **Bi** 83 [Xe] $4f^{14} 5d^{10} 6s^2 6p^3$	(209) +2 +4 **Po** 84 [Xe] $4f^{14} 5d^{10} 6s^2 6p^4$	(210) **At** 85 [Xe] $4f^{14} 5d^{10} 6s^2 6p^5$	(222) 0 **Rn** 86 [Xe] $4f^{14} 5d^{10} 6s^2 6p^5$

* The systematic names and symbols for elements of atomic numbers greater than 103 will be used until the approval of trivial names by IUPAC.

UMBERS

f-block

151.96 +2 +3 **Eu** 63	157.25 +3 **Gd** 64	158.925 +3 **Tb** 65	162.50 +3 **Dy** 66	164 930 +3 **Ho** 67	167.26 +3 **Er** 68	168.934 +3 **Tm** 69	173.04 +2 +3 **Yb** 70	174.967 +3 **Lu** 71	Lanthanoid Series
(243) +3 +4 +5 +6 **Am** 95	(247) +3 **Cm** 96	(247) +3 +4 **Bk** 97	(251) +3 **Cf** 98	(252) **Es** 99	(257) **Fm** 100	(258) **Md** 101	(259) **No** 102	(260) **Lr** 103	Actinoid Series

N

STANDARD ELECTRODE POTENTIALS	
Ionic Concentrations 1 M Water At 298 K, 1 atm	
Half-Reaction	E^0 (volts)
$F_2(g) + 2e^- \rightarrow 2F^-$	+2.87
$8H^+ + MnO_4^- + 5e^- \rightarrow Mn^{2+} + 4H_2O$	+1.51
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.50
$Cl_2(g) + 2e^- \rightarrow 2Cl^-$	+1.36
$14H^+ + Cr_2O_7^{2-} + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$	+1.23
$4H^+ + O_2(g) + 4e^- \rightarrow 2H_2O$	+1.23
$4H^+ + MnO_2(s) + 2e^- \rightarrow Mn^{2+} + 2H_2O$	+1.22
$Br_2(\ell) + 2e^- \rightarrow 2Br^-$	+1.09
$Hg^{2+} + 2e^- \rightarrow Hg(\ell)$	+0.85
$Ag^+ + e^- \rightarrow Ag(s)$	+0.80
$Hg_2^{2+} + 2e^- \rightarrow 2Hg(\ell)$	+0.80
$Fe^{3+} + e^- \rightarrow Fe^{2+}$	+0.77
$I_2(s) + 2e^- \rightarrow 2I^-$	+0.54
$Cu^+ + e^- \rightarrow Cu(s)$	+0.52
$Cu^{2+} + 2e^- \rightarrow Cu(s)$	+0.34
$4H^+ + SO_4^{2-} + 2e^- \rightarrow SO_2(aq) + 2H_2O$	+0.17
$Sn^{4+} + 2e^- \rightarrow Sn^{2+}$	+0.15
$2H^+ + 2e^- \rightarrow H_2(g)$	0.00
$Pb^{2+} + 2e^- \rightarrow Pb(s)$	-0.13
$Sn^{2+} + 2e^- \rightarrow Sn(s)$	-0.14
$Ni^{2+} + 2e^- \rightarrow Ni(s)$	-0.26
$Co^{2+} + 2e^- \rightarrow Co(s)$	-0.28
$Fe^{2+} + 2e^- \rightarrow Fe(s)$	-0.45
$Cr^{3+} + 3e^- \rightarrow Cr(s)$	-0.74
$Zn^{2+} + 2e^- \rightarrow Zn(s)$	-0.76
$2H_2O + 2e^- \rightarrow 2OH^- + H_2(g)$	-0.83
$Mn^{2+} + 2e^- \rightarrow Mn(s)$	-1.19
$Al^{3+} + 3e^- \rightarrow Al(s)$	-1.66
$Mg^{2+} + 2e^- \rightarrow Mg(s)$	-2.37
$Na^+ + e^- \rightarrow Na(s)$	-2.71
$Ca^{2+} + 2e^- \rightarrow Ca(s)$	-2.87
$Sr^{2+} + 2e^- \rightarrow Sr(s)$	-2.89
$Ba^{2+} + 2e^- \rightarrow Ba(s)$	-2.91
$Cs^+ + e^- \rightarrow Cs(s)$	-2.92
$K^+ + e^- \rightarrow K(s)$	-2.93
$Rb^+ + e^- \rightarrow Rb(s)$	-2.98
$Li^+ + e^- \rightarrow Li(s)$	-3.04

O

VAPOR PRESSURE OF WATER			
°C	torr (mmHg)	°C	torr (mmHg)
0	4.6	26	25.2
5	6.5	27	26.7
10	9.2	28	28.3
15	12.8	29	30.0
16	13.6	30	31.8
17	14.5	40	55.3
18	15.5	50	92.5
19	16.5	60	149.4
20	17.5	70	233.7
21	18.7	80	355.1
22	19.8	90	525.8
23	21.1	100	760.0
24	22.4	105	906.1
25	23.8	110	1074.6

RADII OF ATOMS

KEY

Symbol →	F
Covalent Radius, Å →	0.64
Atomic Radius in Metals, Å →	(–)
Van der Waals Radius, Å →	1.35

A dash (–) indicates data are not available.

H 0.37 (–) 1.2																	He (–) (–) 1.22
Li 1.23 1.52 (–)	Be 0.89 1.13 (–)											B 0.88 (–) 2.08	C 0.77 (–) 1.85	N 0.70 (–) 1.54	O 0.66 (–) 1.40	F 0.64 (–) 1.35	Ne (–) (–) 1.60
Na 1.57 1.54 2.31	Mg 1.36 1.60 (–)											Al 1.25 1.43 (–)	Si 1.17 (–) 2.0	P 1.10 (–) 1.90	S 1.04 (–) 1.85	Cl 0.99 (–) 1.81	Ar (–) (–) 1.91
K 2.03 2.27 2.31	Ca 1.74 1.97 (–)	Sc 1.44 1.61 (–)	Ti 1.32 1.45 (–)	V 1.22 1.32 (–)	Cr 1.17 1.25 (–)	Mn 1.17 1.24 (–)	Fe 1.17 1.24 (–)	Co 1.16 1.25 (–)	Ni 1.15 1.25 (–)	Cu 1.17 1.28 (–)	Zn 1.25 1.33 (–)	Ga 1.25 1.22 (–)	Ge 1.22 1.23 (–)	As 1.21 (–) 2.0	Se 1.17 (–) 2.0	Br 1.14 (–) 1.95	Kr 1.89 (–) 1.98
Rb 2.16 2.48 2.44	Sr 1.92 2.15 (–)	Y 1.62 1.81 (–)	Zr 1.45 1.60 (–)	Nb 1.34 1.43 (–)	Mo 1.29 1.36 (–)	Tc (–) 1.36 (–)	Ru 1.24 1.33 (–)	Rh 1.25 1.35 (–)	Pd 1.28 1.38 (–)	Ag 1.34 1.44 (–)	Cd 1.41 1.49 (–)	In 1.50 1.63 (–)	Sn 1.40 1.41 (–)	Sb 1.41 (–) 2.2	Te 1.37 (–) 2.20	I 1.33 (–) 2.15	Xe 2.09 (–) (–)
Cs 2.35 2.65 2.62	Ba 1.98 2.17 (–)	La-Lu	Hf 1.44 1.56 (–)	Ta 1.34 1.43 (–)	W 1.30 1.37 (–)	Re 1.28 1.37 (–)	Os 1.26 1.34 (–)	Ir 1.26 1.36 (–)	Pt 1.29 1.38 (–)	Au 1.34 1.44 (–)	Hg 1.44 1.60 (–)	Tl 1.55 1.70 (–)	Pb 1.54 1.75 (–)	Bi 1.52 1.55 (–)	Po 1.53 1.67 (–)	At (–) (–) (–)	Rn 2.14 (–) (–)
Fr (–) 2.7 (–)	Ra (–) 2.20 (–)	Ac-Lr															

La 1.69 1.88 (–)	Ce 1.65 1.83 (–)	Pr 1.65 1.83 (–)	Nd 1.64 1.82 (–)	Pm (–) 1.81 (–)	Sm 1.66 1.80 (–)	Eu 1.85 2.04 (–)	Gd 1.61 1.80 (–)	Tb 1.59 1.78 (–)	Dy 1.59 1.77 (–)	Ho 1.58 1.77 (–)	Er 1.57 1.76 (–)	Tm 1.56 1.75 (–)	Yb 1.70 1.94 (–)	Lu 1.56 1.73 (–)
Ac (–) 1.88 (–)	Th (–) 1.80 (–)	Pa (–) 1.61 (–)	U (–) 1.39 (–)	Np (–) 1.31 (–)	Pu (–) 1.51 (–)	Am (–) 1.84 (–)	Cm (–) (–) (–)	Bk (–) (–) (–)	Cf (–) (–) (–)	Es (–) (–) (–)	Fm (–) (–) (–)	Md (–) (–) (–)	No (–) (–) (–)	Lr (–) (–) (–)

DET 509 (7-98–260,000)
8–066106

FOR TEACHERS ONLY

C

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

CHEMISTRY

Thursday, June 22, 2000—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	**X**	3	4	21	1	**X**	3	4	41	1	2	3	**X**
2	1	**X**	3	4	22	1	2	3	**X**	42	1	**X**	3	4
3	1	2	**X**	4	23	1	**X**	3	4	43	1	2	**X**	4
4	**X**	2	3	4	24	1	2	3	**X**	44	**X**	2	3	4
5	**X**	2	3	4	25	1	2	**X**	4	45	1	2	3	**X**
6	1	**X**	3	4	26	1	2	**X**	4	46	**X**	2	3	4
7	1	2	**X**	4	27	**X**	2	3	4	47	1	**X**	3	4
8	1	2	3	**X**	28	1	**X**	3	4	48	**X**	2	3	4
9	1	2	**X**	4	29	1	2	**X**	4	49	1	2	**X**	4
10	1	2	**X**	4	30	1	**X**	3	4	50	1	**X**	3	4
11	1	2	3	**X**	31	**X**	2	3	4	51	1	2	**X**	4
12	**X**	2	3	4	32	1	**X**	3	4	52	1	2	3	**X**
13	1	**X**	3	4	33	**X**	2	3	4	53	1	**X**	3	4
14	1	2	3	**X**	34	1	2	3	**X**	54	1	2	**X**	
15	1	2	**X**	4	35	1	2	**X**	4	55	1	**X**	3	
16	1	2	**X**	4	36	1	2	3	**X**	56	1	**X**	3	
17	**X**	2	3	4	37	1	2	3	**X**					
18	**X**	2	3	4	38	1	2	**X**	4					
19	1	2	3	**X**	39	**X**	2	3	4					
20	**X**	2	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	X	2	3	4
61	1	2	3	X

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

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

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

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

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

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

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

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

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

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

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