

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

PHYSICAL SETTING CHEMISTRY

Wednesday, August 16, 2006 — 12:30 to 3:30 p.m., only

This is a test of your knowledge of chemistry. Use that knowledge to answer all questions in this examination. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*. You are to answer *all* questions in all parts of this examination according to the directions provided in the examination booklet.

Your answer sheet for Part A and Part B–1 is the last page of this examination booklet. Turn to the last page and fold it along the perforations. Then, slowly and carefully, tear off your answer sheet and fill in the heading.

The answers to the questions in Part B–2 and Part C are to be written in your separate answer booklet. Be sure to fill in the heading on the front of your answer booklet.

Record the number of your choice for each Part A and Part B–1 multiple-choice question on your separate answer sheet. Write your answers to the Part B–2 and Part C questions in your answer booklet. All work should be written in pen, except for graphs and drawings, which should be done in pencil. You may use scrap paper to work out the answers to the questions, but be sure to record all your answers on your separate answer sheet and in your answer booklet.

When you have completed the examination, you must sign the statement printed at the end of your separate answer sheet, indicating that you had no unlawful knowledge of the questions or answers prior to the examination and that you have neither given nor received assistance in answering any of the questions during the examination. Your answer sheet and answer booklet cannot be accepted if you fail to sign this declaration.

Notice . . .

A four-function or scientific calculator and a copy of the *Reference Tables for Physical Setting/Chemistry* must be available for you to use while taking this examination.

The use of any communications device is strictly prohibited when taking this examination. If you use any communications device, no matter how briefly, your examination will be invalidated and no score will be calculated for you.

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

Part A

Answer all questions in this part.

Directions (1–30): For *each* statement or question, write on the separate answer sheet the *number* of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

- Which statement correctly describes the charge of the nucleus and the charge of the electron cloud of an atom?
 - The nucleus is positive and the electron cloud is positive.
 - The nucleus is positive and the electron cloud is negative.
 - The nucleus is negative and the electron cloud is positive.
 - The nucleus is negative and the electron cloud is negative.
- Which Period 4 element has the most metallic properties?
 - As
 - Br
 - Ge
 - Sc
- Which property makes it possible to separate the oxygen and the nitrogen from a sample of liquefied air?
 - boiling point
 - conductivity
 - hardness
 - electronegativity
- Which statement explains why ozone gas, O_3 , and oxygen gas, O_2 , have different properties?
 - They are formed from different elements.
 - They have different molecular structures.
 - They have different oxidation numbers.
 - They have different electronegativities.
- Which statement is true about oxidation and reduction in an electrochemical cell?
 - Both occur at the anode.
 - Both occur at the cathode.
 - Oxidation occurs at the anode and reduction occurs at the cathode.
 - Oxidation occurs at the cathode and reduction occurs at the anode.
- A compound is made up of iron and oxygen, only. The ratio of iron ions to oxide ions is 2:3 in this compound. The IUPAC name for this compound is
 - triiron dioxide
 - iron(II) oxide
 - iron(III) oxide
 - iron trioxide
- Which process is a chemical change?
 - melting of ice
 - boiling of water
 - subliming of ice
 - decomposing of water
- Which substance contains bonds that involved the transfer of electrons from one atom to another?
 - CO_2
 - NH_3
 - KBr
 - Cl_2
- What is the total number of pairs of electrons shared in a molecule of N_2 ?
 - one pair
 - two pairs
 - three pairs
 - four pairs
- Which formula represents a nonpolar molecule containing polar covalent bonds?
 - H_2O
 - CCl_4
 - NH_3
 - H_2
- The degree of polarity of a chemical bond in a molecule of a compound can be predicted by determining the difference in the
 - melting points of the elements in the compound
 - densities of the elements in the compound
 - electronegativities of the bonded atoms in a molecule of the compound
 - atomic masses of the bonded atoms in a molecule of the compound

- 12 Which statement best describes the shape and volume of an aluminum cylinder at STP?
- (1) It has a definite shape and a definite volume.
 - (2) It has a definite shape and no definite volume.
 - (3) It has no definite shape and a definite volume.
 - (4) It has no definite shape and no definite volume.
- 13 Which two substances can *not* be broken down by chemical change?
- (1) C and CuO
 - (2) C and Cu
 - (3) CO₂ and CuO
 - (4) CO₂ and Cu
- 14 Which compound is insoluble in water?
- (1) BaSO₄
 - (2) CaCrO₄
 - (3) KClO₃
 - (4) Na₂S
- 15 A sample of a gas is contained in a closed rigid cylinder. According to kinetic molecular theory, what occurs when the gas inside the cylinder is heated?
- (1) The number of gas molecules increases.
 - (2) The number of collisions between gas molecules per unit time decreases.
 - (3) The average velocity of the gas molecules increases.
 - (4) The volume of the gas decreases.
- 16 Which statement best describes how a catalyst increases the rate of a reaction?
- (1) The catalyst provides an alternate reaction pathway with a higher activation energy.
 - (2) The catalyst provides an alternate reaction pathway with a lower activation energy.
 - (3) The catalyst provides the same reaction pathway with a higher activation energy.
 - (4) The catalyst provides the same reaction pathway with a lower activation energy.
- 17 The compounds 2-butanol and 2-butene both contain
- (1) double bonds, only
 - (2) single bonds, only
 - (3) carbon atoms
 - (4) oxygen atoms

- 18 The data table below gives the temperature and pressure of four different gas samples, each in a 2-liter container.

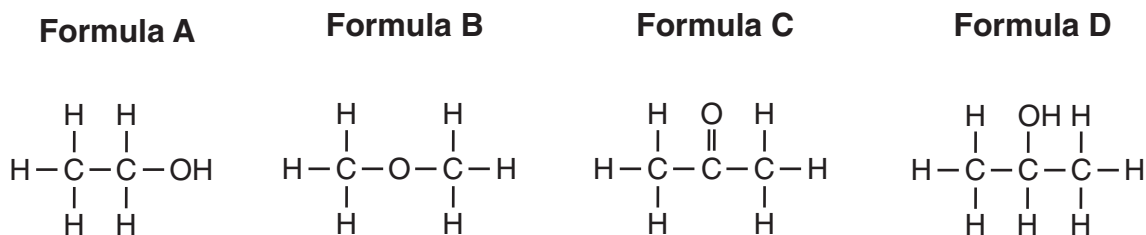
Temperature and Pressure of Gas Samples

Gas Sample	Temperature (K)	Pressure (atm)
He	300.	1.20
Ne	300.	1.00
CO ₂	200.	1.20
CH ₄	300.	1.00

Which two gas samples contain the same total number of particles?

- (1) CH₄ and CO₂
 - (2) CH₄ and Ne
 - (3) He and CO₂
 - (4) He and Ne
- 19 A chemical reaction is at equilibrium. Compared to the rate of the forward reaction, the rate of the reverse reaction is
- (1) faster and more reactant is produced
 - (2) faster and more product is produced
 - (3) the same and the reaction has stopped
 - (4) the same and the reaction continues in both directions
- 20 Which organic compound is a saturated hydrocarbon?
- (1) ethyne
 - (2) ethene
 - (3) ethanol
 - (4) ethane
- 21 A substance is classified as an electrolyte because
- (1) it has a high melting point
 - (2) it contains covalent bonds
 - (3) its aqueous solution conducts an electric current
 - (4) its aqueous solution has a pH value of 7
- 22 Half-reactions can be written to represent all
- (1) double-replacement reactions
 - (2) neutralization reactions
 - (3) fission and fusion reactions
 - (4) oxidation and reduction reactions

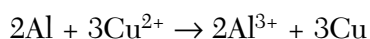
23 Given the structural formulas:



Which two formulas represent compounds that are isomers of each other?

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

24 Given the balanced equation representing a redox reaction:



Which statement is true about this reaction?

- (1) Each Al loses $2e^-$ and each Cu^{2+} gains $3e^-$.
- (2) Each Al loses $3e^-$ and each Cu^{2+} gains $2e^-$.
- (3) Each Al^{3+} gains $2e^-$ and each Cu loses $3e^-$.
- (4) Each Al^{3+} gains $3e^-$ and each Cu loses $2e^-$.

25 Which conversion of energy always occurs in a voltaic cell?

- (1) light energy to chemical energy
- (2) electrical energy to chemical energy
- (3) chemical energy to light energy
- (4) chemical energy to electrical energy

26 The compound $\text{NaOH}(s)$ dissolves in water to yield

- (1) hydroxide ions as the only negative ions
- (2) hydroxide ions as the only positive ions
- (3) hydronium ions as the only negative ions
- (4) hydronium ions as the only positive ions

27 Which equation represents a neutralization reaction?

- (1) $4\text{Fe}(s) + 3\text{O}_2(g) \rightarrow 2\text{Fe}_2\text{O}_3(s)$
- (2) $2\text{H}_2(g) + \text{O}_2(g) \rightarrow 2\text{H}_2\text{O}(\ell)$
- (3) $\text{HNO}_3(aq) + \text{KOH}(aq) \rightarrow \text{KNO}_3(aq) + \text{H}_2\text{O}(\ell)$
- (4) $\text{AgNO}_3(aq) + \text{KCl}(aq) \rightarrow \text{KNO}_3(aq) + \text{AgCl}(s)$

28 Which notation of a radioisotope is correctly paired with the notation of its emission particle?

- | | |
|--------------------------------------------|----------------------------------------|
| (1) ^{37}Ca and ^4_2He | (3) ^{16}N and ^1_1p |
| (2) ^{235}U and $^0_{+1}\text{e}$ | (4) ^3H and $^0_{-1}\text{e}$ |

29 Atoms of one element are converted to atoms of another element through

- | | |
|------------------|--------------------|
| (1) fermentation | (3) polymerization |
| (2) oxidation | (4) transmutation |

30 An atom of potassium-37 and an atom of potassium-42 differ in their total number of

- | | |
|---------------|---------------|
| (1) electrons | (3) protons |
| (2) neutrons | (4) positrons |
-

Part B-1

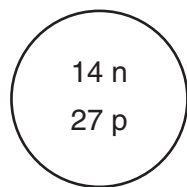
Answer all questions in this part.

Directions (31–50): For each statement or question, write on the separate answer sheet the number of the word or expression that, of those given, best completes the statement or answers the question. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

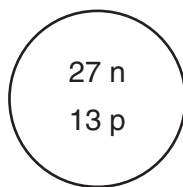
31 What is the mass number of an atom that has six protons, six electrons, and eight neutrons?

- (1) 6 (3) 14
(2) 12 (4) 20

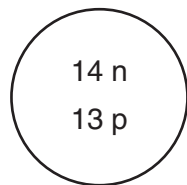
32 Which diagram represents the nucleus of an atom of ${}^{27}_{13}\text{Al}$?



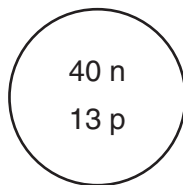
(1)



(3)



(2)



(4)

33 A student constructs a model for comparing the masses of subatomic particles. The student selects a small, metal sphere with a mass of 1 gram to represent an electron. A sphere with which mass would be most appropriate to represent a proton?

- (1) 1 g (3) $\frac{1}{2000}$ g
(2) $\frac{1}{2}$ g (4) 2000 g

34 Based on electronegativity values, which type of elements tends to have the greatest attraction for electrons in a bond?

- (1) metals (3) nonmetals
(2) metalloids (4) noble gases

35 Which list of elements from Group 2 on the Periodic Table is arranged in order of increasing atomic radius?

- (1) Be, Mg, Ca (3) Ba, Ra, Sr
(2) Ca, Mg, Be (4) Sr, Ra, Ba

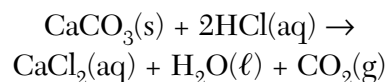
36 Which half-reaction shows conservation of charge?

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

37 The percent composition by mass of magnesium in MgBr_2 (gram-formula mass = 184 grams/mole) is equal to

- (1) $\frac{24}{184} \times 100$ (3) $\frac{184}{24} \times 100$
(2) $\frac{160}{184} \times 100$ (4) $\frac{184}{160} \times 100$

38 Given the balanced equation:



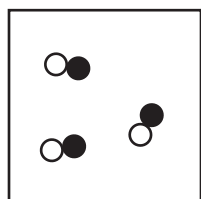
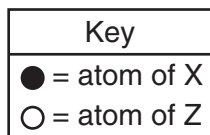
What is the total number of moles of CO_2 formed when 20. moles of HCl is completely consumed?

- (1) 5.0 mol (3) 20. mol
(2) 10. mol (4) 40. mol

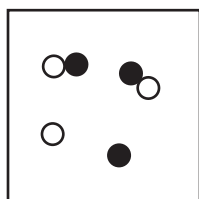
39 What amount of heat is required to completely melt a 29.95-gram sample of $\text{H}_2\text{O}(\text{s})$ at 0°C ?

- (1) 334 J (3) 1.00×10^3 J
(2) 2260 J (4) 1.00×10^4 J

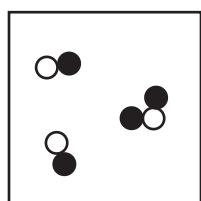
- 40 Which particle diagram represents a mixture of element X and element Z, only?



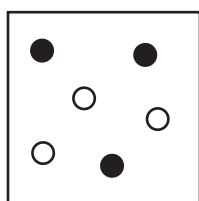
(1)



(3)



(2)



(4)

- 41 An unsaturated aqueous solution of NH_3 is at $90.^\circ\text{C}$ in 100. grams of water. According to Reference Table G, how many grams of NH_3 could this unsaturated solution contain?

- (1) 5 g (3) 15 g
 (2) 10. g (4) 20. g

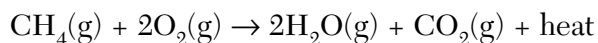
- 42 How many total moles of KNO_3 must be dissolved in water to make 1.5 liters of a 2.0 M solution?

- (1) 0.50 mol (3) 3.0 mol
 (2) 2.0 mol (4) 1.3 mol

- 43 Which statement explains why low temperature and high pressure are required to liquefy chlorine gas?

- (1) Chlorine molecules have weak covalent bonds.
 (2) Chlorine molecules have strong covalent bonds.
 (3) Chlorine molecules have weak intermolecular forces of attraction.
 (4) Chlorine molecules have strong intermolecular forces of attraction.

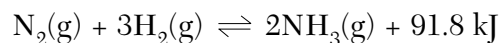
- 44 Given the balanced equation representing a reaction:



Which statement is true about energy in this reaction?

- (1) The reaction is exothermic because it releases heat.
 (2) The reaction is exothermic because it absorbs heat.
 (3) The reaction is endothermic because it releases heat.
 (4) The reaction is endothermic because it absorbs heat.

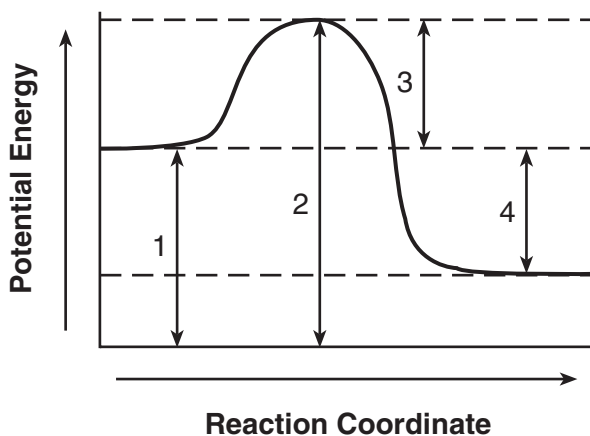
- 45 Given the reaction at equilibrium:



What occurs when the concentration of $\text{H}_2(\text{g})$ is increased?

- (1) The rate of the forward reaction increases and the concentration of $\text{N}_2(\text{g})$ decreases.
 (2) The rate of the forward reaction decreases and the concentration of $\text{N}_2(\text{g})$ increases.
 (3) The rate of the forward reaction and the concentration of $\text{N}_2(\text{g})$ both increase.
 (4) The rate of the forward reaction and the concentration of $\text{N}_2(\text{g})$ both decrease.

- 46 Given the potential energy diagram for a reaction:



Which interval on this diagram represents the difference between the potential energy of the products and the potential energy of the reactants?

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

- 47 Based on bond type, which compound has the highest melting point?
- (1) CH_3OH (3) CaCl_2
(2) C_6H_{14} (4) CCl_4
- 48 A 100.00-gram sample of naturally occurring boron contains 19.78 grams of boron-10 (atomic mass = 10.01 atomic mass units) and 80.22 grams of boron-11 (atomic mass = 11.01 atomic mass units). Which numerical setup can be used to determine the atomic mass of naturally occurring boron?
- (1) $(0.1978)(10.01) + (0.8022)(11.01)$
(2) $(0.8022)(10.01) + (0.1978)(11.01)$
(3) $\frac{(0.1978)(10.01)}{(0.8022)(11.01)}$
(4) $\frac{(0.8022)(10.01)}{(0.1978)(11.01)}$
- 49 Which list of the phases of H_2O is arranged in order of increasing entropy?
- (1) ice, steam, and liquid water
(2) ice, liquid water, and steam
(3) steam, liquid water, and ice
(4) steam, ice, and liquid water
- 50 Solution A has a pH of 3 and solution Z has a pH of 6. How many times greater is the hydronium ion concentration in solution A than the hydronium ion concentration in solution Z?
- (1) 100 (3) 3
(2) 2 (4) 1000
-

Part B-2

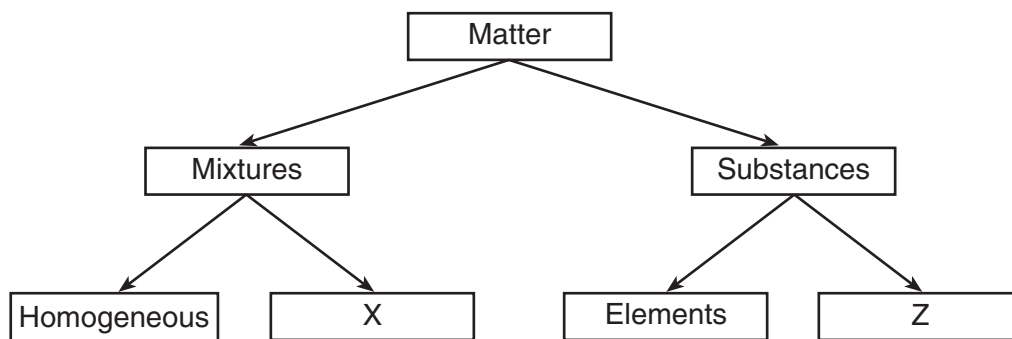
Answer all questions in this part.

Directions (51–65): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

- 51 In the space *in your answer booklet*, draw a Lewis electron-dot diagram for a sulfur atom in the ground state. [1]
- 52 Explain, in terms of electron configuration, why selenium and sulfur have similar chemical properties. [1]

Base your answers to questions 53 through 56 on the diagram below concerning the classification of matter.

Classification of Matter



- 53 What type of mixture is represented by *X*? [1]
- 54 What type of substance is represented by *Z*? [1]
- 55 Explain, in terms of particle arrangement, why NaCl(aq) is a homogeneous mixture. [1]
- 56 Given a mixture of sand and water, state *one* process that can be used to separate water from the sand. [1]
-

Base your answers to questions 57 through 60 on the information below.

An investigation was conducted to study the effect of the concentration of a reactant on the total time needed to complete a chemical reaction. Four trials of the same reaction were performed. In each trial the initial concentration of the reactant was different. The time needed for the chemical reaction to be completed was measured. The data for each of the four trials are shown in the table below.

Reactant Concentration and Reaction Time

Trial	Initial Concentration (M)	Reaction Time (s)
1	0.020	11
2	0.015	14
3	0.010	23
4	0.005	58

57 On the grid in your answer booklet, mark an appropriate scale on the axis labeled "Reaction Time (s)." An appropriate scale is one that allows a trend to be seen. [1]

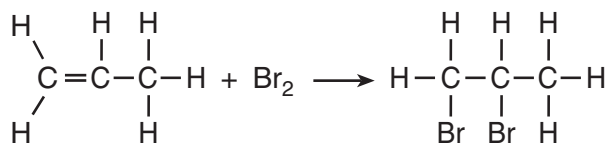
58 On the same grid, plot the data from the data table. Circle and connect the points. [1]

Example: 

59 State the effect of the concentration of the reactant on the rate of the chemical reaction. [1]

60 In a different experiment involving the same reaction, it was found that an increase in temperature increased the rate of the reaction. Explain this result in terms of collision theory. [1]

Base your answers to questions 61 through 63 on the equation below, which represents an organic compound reacting with bromine.



61 What is the IUPAC name for the organic compound that reacts with Br₂? [1]

62 What type of organic reaction is represented by this equation? [1]

63 What is the gram-formula mass of the product in this reaction? [1]

Part C

Answer all questions in this part.

Directions (66–85): Record your answers in the spaces provided in your answer booklet. Some questions may require the use of the *Reference Tables for Physical Setting/Chemistry*.

Base your answers to questions 66 and 67 on the information below.

Some radioisotopes used as tracers make it possible for doctors to see the images of internal body parts and observe their functions. The table below lists information about three radioisotopes and the body part each radioisotope is used to study.

Medical Uses of Some Radioisotopes

Radioisotope	Half-life	Decay Mode	Body Part
^{24}Na	15 hours	beta	circulatory system
^{59}Fe	44.5 days	beta	red blood cells
^{131}I	8.1 days	beta	thyroid

- 66 Complete the equation *in your answer booklet* for the nuclear decay of the radioisotope used to study red blood cells. Include *both* the atomic number and the mass number for *each* missing particle. [1]
- 67 It could take up to 60. hours for a radioisotope to be delivered to the hospital from the laboratory where it is produced. What fraction of an original sample of ^{24}Na remains unchanged after 60. hours? [1]
-

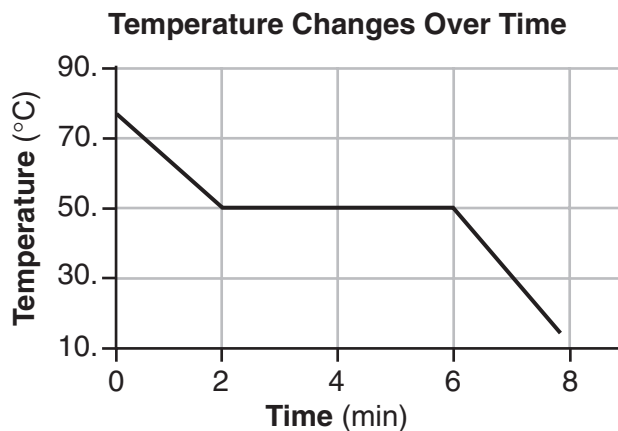
Base your answers to questions 68 through 71 on the information below.

A metal, M , was obtained from a compound in a rock sample. Experiments have determined that the element is a member of Group 2 on the Periodic Table of the Elements.

- 68 What is the phase of element M at STP? [1]
- 69 Explain, in terms of electrons, why element M is a good conductor of electricity. [1]
- 70 Explain why the radius of a positive ion of element M is *smaller* than the radius of an atom of element M . [1]
- 71 Using the symbol M for the element, write the chemical formula for the compound that forms when element M reacts with iodine. [1]
-

Base your answers to questions 72 through 75 on the information below.

The graph below shows a compound being cooled at a constant rate starting in the liquid phase at 75°C and ending at 15°C.



- 72 What is the freezing point of the compound, in degrees Celsius? [1]
- 73 State what is happening to the average kinetic energy of the particles of the sample between minute 2 and minute 6. [1]
- 74 A different experiment was conducted with another sample of the same compound starting in the solid phase. The sample was heated at a constant rate from 15°C to 75°C. On the graph *in your answer booklet*, draw the resulting heating curve. [1]
- 75 What kelvin temperature is equal to 15°C? [1]
-

Base your answers to questions 76 and 77 on the information below.

Using burets, a student titrated a sodium hydroxide solution of unknown concentration with a standard solution of 0.10 M hydrochloric acid. The data are recorded in the table below.

Titration Data

Solution	HCl(aq)	NaOH(aq)
Initial Buret Reading (mL)	15.50	5.00
Final Buret Reading (mL)	25.00	8.80

- 76 Determine *both* the total volume of HCl(aq) and the total volume of NaOH(aq) used in the titration. [1]
- 77 In the space *in your answer booklet*, show a correct numerical setup for calculating the molarity of the sodium hydroxide solution. [1]
-

Base your answers to questions 78 and 79 on the information below.

Many esters have distinctive odors, which lead to their widespread use as artificial flavorings and fragrances. For example, methyl butanoate has an odor like pineapple and ethyl methanoate has an odor like raspberry.

78 In the space *in your answer booklet*, draw a structural formula for the ester that has an odor like pineapple. [1]

79 What is a chemical name for the alcohol that reacts with methanoic acid to produce the ester that has an odor like raspberry? [1]

Base your answers to questions 80 and 81 on the information below.

Three bottles of liquids labeled 1, 2, and 3 were found in a storeroom. One of the liquids is known to be drain cleaner. Drain cleaners commonly contain KOH or NaOH. The pH of each liquid at 25°C was determined with a pH meter. The table below shows the test results.

pH Test Results

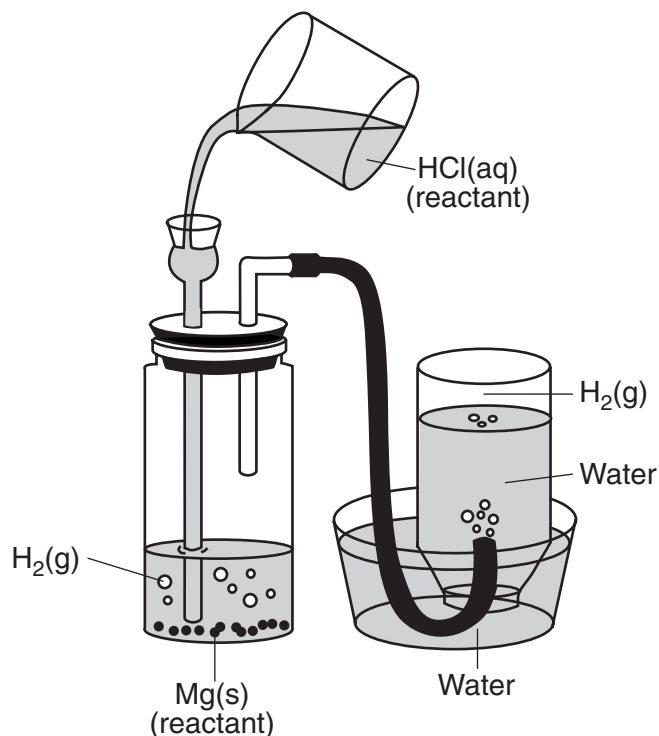
Bottle	pH of Liquid
1	3.8
2	7.0
3	12.8

80 Explain how the pH results in this table enable a student to correctly conclude that bottle 3 contains the drain cleaner. [1]

81 Explain, in terms of the pH values, why thymol blue is *not* a suitable indicator to distinguish between the contents of bottle 1 and bottle 2. [1]

Base your answers to questions 82 through 85 on the information below.

A student places a 2.50-gram sample of magnesium metal in a bottle and fits the bottle with a 2-hole stopper as shown in the diagram. Hydrochloric acid is added to the bottle, causing a reaction. As the reaction proceeds, hydrogen gas travels through the tubing to an inverted bottle filled with water, displacing some of the water in the bottle.



- 82 Balance the equation *in your answer booklet* for the reaction of magnesium and hydrochloric acid, using the smallest whole-number coefficients. [1]
- 83 Identify the type of chemical reaction that occurs when magnesium reacts with hydrochloric acid. [1]
- 84 In the space *in your answer booklet*, show a correct numerical setup for calculating the number of moles of magnesium used in the experiment. [1]
- 85 Based on Reference Table *J*, explain why Ag(s) will *not* react with HCl(aq) to generate H₂(g). [1]
-

Tear Here

The University of the State of New York

REGENTS HIGH SCHOOL EXAMINATION

PHYSICAL SETTING CHEMISTRY

Wednesday, August 16, 2006 — 12:30 to 3:30 p.m., only

ANSWER SHEET

Student Sex: Male Female Grade

Teacher School

Record your answers to Part A and Part B-1 on this answer sheet.

Part A

- 1 11 21
2 12 22
3 13 23
4 14 24
5 15 25
6 16 26
7 17 27
8 18 28
9 19 29
10 20 30

Part A Score

[Box for Part A Score]

Part B-1

- 31 41
32 42
33 43
34 44
35 45
36 46
37 47
38 48
39 49
40 50

Part B-1 Score

[Box for Part B-1 Score]

Write your answers to Part B-2 and Part C in your answer booklet.

The declaration below should be signed when you have completed the examination.

I do hereby affirm, at the close of this examination, that I had no unlawful knowledge of the questions or answers prior to the examination and that I have neither given nor received assistance in answering any of the questions during the examination.

Signature

Tear Here

Tear Here

Tear Here